Technol
A.

MECHANICAL ENGINEERING

The Journal of The American Society
of Mechanical Engineers

INDEX TO VOLUME 41

January to December
1919

160721
8/4/21

PUBLISHED BY

The American Society of Mechanical Engineers
29 West Thirty-ninth Street, New York

INDEX

MECHANICAL ENGINEERING

The Journal of The American Society of Mechanical Engineers

Volume 41, January to December 1919

TECHNICAL, SOCIETY AFFAIRS AND MISCELLANEOUS SECTIONS

(For Engineering Survey see Separate Index, page X)

D denotes discussion; C, correspondence; Roman numerals, pages in Section Two

A

B

C

D

E

F

G

H

N

O

P

R

S

T

ENGINEERING SURVEY

Volume 41 Number 1

MECHANICAL ENGINEERING

THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

JANUARY, 1919

PUBLISHED MONTHLY BY

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

29 West Thirty-ninth Street, New York

PRICE 35 CENTS A COPY, $3.00 A YEAR; TO MEMBERS AND AFFILIATES, 25 CENTS A COPY, $2.00 A YEAR. POSTAGE TO CANADA, 50 CENTS ADDITIONAL; TO FOREIGN COUNTRIES, $1.00 ADDITIONAL

Entered as second-class matter, January 4, 1912, at the Post Office, New York, N. Y., under the act of March 3, 1879.
Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized on July 8, 1918.

THE ENGINEERING INDEX

Now Conducted by The American Society of Mechanical Engineers and Published Monthly in The Journal of the Society

THE Engineering Index, published for 25 years in *The Engineering Magazine* and its successor, *Industrial Management*, and universally regarded as the standard index to engineering periodical literature, has been acquired by THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, and hereafter will be compiled and published by this Society. The first issue of the Index under its new management appears in this number of THE JOURNAL.

As heretofore, The Engineering Index will be regularly issued in three different forms:

1. As a part of THE JOURNAL of the Society, price $3.00 a year.
2. As a separate monthly publication for libraries or individuals desiring to clip the items for indexing purposes, price $3.00 a year.
3. As an annual volume in which all the items for the year are collected, price $3.00 a volume.

These prices are all subject to change.

The Engineering Index originated with Prof. J. B. Johnson of Washington University, St. Louis, Mo., in 1883 and for 12 years was prepared under his direction and published by the Association of Engineering Societies. It was then taken over by The Engineering Magazine Company of New York and has since had the personal attention of Mr. John R. Dunlap, the president of that company, who has found it to be a widely appreciated undertaking by engineers throughout the world. The development of his magazine in the specialized field of industrial management, however, made it seem desirable to place The Index in the hands of an engineering organization covering a broader field and serving engineers engaged in more varied activities.

For some time past THE JOURNAL of the A.S.M.E. has contained an extensive list of "Selected Titles of Engineering Articles." The acquiring of the Engineering Index means that this work must be extended to cover a broader field, and in this the Society will have the fullest coöperation of the Engineering Societies Library with its wonderful collection of engineering periodicals, comprising 1100 titles from all parts of the world, in some 10 different languages.

An idea of the possibilities of this undertaking and its usefulness to the profession can be judged by reference to the following list of publications which are among those regularly received in the Library in normal times and regularly reviewed by the engineering staff of the Society in the preparation of its index material:

Partial List of Periodicals to be Reviewed in the Engineering Index.

Aero Club d'Italia, Navigazione aerea, Rome
Acetylene Lighting and Welding Journal, London
Acetylene Journal, Chicago
Aeronautical Journal, London
Aeronautics, London
Aérophile, Paris
Allgemeine Automobil-Zeitung, Berlin
American Academy of Arts and Sciences, Proceedings, Boston.
American Architect, Boston
American Association for the Advancement of Science, Proceedings, Philadelphia
American Blacksmith, Buffalo
American Ceramic Society, Transactions, Columbus
American Chemical Journal, Baltimore
American Chemical Society, Proceedings, Easton, Pa.
Industrial and Engineering Chemistry, Journal (publ. by American Chemical Society), Easton, Pa.
Chemical Abstracts (publ. by American Chemical Society), Easton, Pa.
American Chemical Society, Journal, Easton, Pa.
American City, New York
American Concrete Institute, Journal, Philadelphia
American Contractor, Chicago
Aera (publ. by American Electric Railway Association), New York
American Electric Railway Association, Proceedings, New York
American Electrochemical Society, Transactions, Philadelphia
American Fertilizer, Philadelphia
American Forestry (publ. by American Forestry Association), Washington, D. C.
American Foundrymen's Association Transactions, New York
Gas Institute News (publ. by American Gas Institute), New York
American Gas Institute, Proceedings, New York
American Gas Light Journal, New York
American Industries, New York
American Institute of Architects, Harrisburg, Pa.
American Institute of Chemical Engineers, Transactions, New York
American Institute of Electrical Engineers, Proceedings, New York
American Institute of Metals, Bulletin, Buffalo
American Institute of Metals, Transactions, Buffalo
American Institute of Mining Engineers, Bulletin, New York
American Iron and Steel Association, Bulletin, Philadelphia
American Iron and Steel Institute, Monthly Bulletin, New York
American Journal of Mathematics, Baltimore
American Journal of Science, New Haven
American Machinist, New York
American Marine Engineer, Chicago
American Mathematical Society Bulletin, New York
American Mathematical Society, Transactions, New York
American Miller, Chicago
American Mining Congress, Monthly Bulletin, Denver
American Peat Society, Journal, Toledo
American Philosophical Society, Proceedings, Philadelphia
American Railway Association, Proceedings, New York
American Railway Engineering Association, Bulletin, Chicago
American Society for Swedish Engineers, Bulletin, Brooklyn
American Society for Testing Materials, Proceedings, Philadelphia
American Society of Agricultural Engineers, Transactions, Ames, Iowa
American Society of Civil Engineers, Proceedings, New York
Engineering Contractor (publ. by American Society of Engineering Contractors), New York
American Society of Heating and Ventilating Engineers, Transactions, New York
American Society of Marine Draftsmen, Journal, Washington, D. C.
American Society of Mechanical Engineers, Journal, New York
American Society of Naval Engineers, Journal, Washington, D. C.
American Society of Refrigerating Engineers, Journal, New York
American Stone Trade, Chicago
American Water Works Association, Proceedings, Baltimore.
Wood-Preserving (publ. by American Wood Preservers' Association), Baltimore
Annalen der Physik, Leipsic
Annalen der Physik, Beiblaetter, Leipsic
Annalen für Gewerbe und Bauwesen, Berlin
Annales de Chimie et de Physique, Paris
Annales des Mines, Paris
Annales des Ponts et Chaussées, Mémoires et Documents, Paris
Architectural Record, New York
Archiv für Eisenbahnwesen, Berlin
Archiv für Elektrotechnik, Berlin
Archives des Sciences Physiques et Naturellés, Paris
Arkiv för Kemi, Mineralogi och Geologi, Stockholm
Armierter Beton, Berlin
Armour Engineer, Chicago
Asociación Argentina de Electro Técnicos, Boletin, Buenos Aires
Asociación de Ingenieros Industriales de Barcelona, Revista Technológico Industrial, Barcelona
Atlantic Deeper Waterways Association Bulletin, Philadelphia
Australian Mining Standard, Melbourne
Autogene Metallbearbeitung, Halle
Automobile Engineer, London
Automobile Topics, New York
Automobile Trade Journal, Philadelphia
Automotor Journal, London
Beton und Eisen, Berlin
Boiler Maker, New York
Brick and Clay Record, Chicago
Foundry Trade Journal and Pattern-maker (publ. by British Foundrymen's Association), London
British Foundrymen's Association, Proceedings, London
Bulletin Technique de la Suisse Romande, Lausanne
Canadian Engineer, Toronto
Canadian Institute, Proceedings, Toronto
Canadian Machinery and Manufacturing News, Toronto
Canadian Manufacturer, Toronto
Canadian Mining Institute, Quarterly Bulletin, Montreal
Canadian Mining Journal, Toronto
Canadian Peat Society, Journal, Ottawa
Canadian Railway and Marine World, Toronto
Canadian Railway Club, Official Proceedings, Montreal
Canadian Society of Civil Engineers, Transactions, Montreal
Car Foremen's Association of Chicago, Proceedings, Chicago
Cassier's Magazine, New York
Cement and Engineering News, Chicago
Central Railway Club, Official Proceedings, New York
Chemical, Metallurgical and Mining Society of So. Africa, Journal, Johannesburg
Chemical Engineer, Philadelphia
Chemical News and Journal of Physical Science, London
Chemical Society of London, Journal, London
Chemiker Zeitung, Cöthen

Clay-Worker, Indianapolis
Cleveland Engineering Society, Journal, Cleveland
Coal Age, New York
Colliery Guardian and Journal of the Coal and Iron Trades, London
Compressed Air Magazine, New York
Concrete Age, Atlanta
Concrete and Constructional Engineering, London
Concrete Institute, Transactions and Notes, London
Concrete-Cement Age, Detroit
Cornell Civil Engineer (publ. by Cornell University, Association of Civil Engineers), Ithaca
Dansk Ingeniorforening, Ingenioren, Copenhagen
Deutsche Luftfahrer Zeitschrift, Berlin
Deutscher Verein von Gas und Wasserfachmännern, Verhandlungen, Munich
Dingler's Polytechnisches Journal, Stuttgart
Domestic Engineering, Chicago
Echo des Mines et de la Métallurgie, Paris
Electric Journal, Pittsburgh
Electrical Record, New York
Electrical Review and Western Electrician, New York
Electrical World, New York
Electrician, London
Electricien, Revue Internationale de l' Électricité, Paris
Elektrische Kraft-betriebe und Bahnen, Munich
Elektrochemische Zeitschrift, Berlin
Elektrotechnik und Maschinenbau, Vienna
Elektroteknisk Tidsskrift, Christiania
Engineer, London
Engineering, London
Engineering and Contracting, Chicago
Engineering and Mining Journal, New York
Engineering News-Record, New York
Engineering Review, London
Engineers' Club of Philadelphia, Proceedings, Philadelphia
Engineers' Society of Western Pennsylvania, Proceedings, Pittsburgh
Faraday Society, Transactions, London
Feuerungstechnik, Leipsic
Fire and Water Engineering, New York
Flight, London
Fördertechnik, Berlin
Franklin Institute, Journal, Philadelphia
Gas Age, New York
Gas and Oil Power, London
General Electric Review, Schenectady, N. Y.
Génie Civil, Paris
Geological Magazine, London
Geological Society of South Africa, Transactions (including Proceedings), Johannesburg
Geologisches Zentralblatt, Generalregister, Leipsic
Gesundheits-Ingenieur, Munich
Giesserei Zeitung, Berlin
Giornale del Genio Civile, Rome
Glückauf, Essen
Industria, Milan
Industrie des Tramways et Chemins der fer, Paris
Ingegneria Ferroviaria, Rome
Ingenieur (publ. by Koninklijk Instituut van Ingenieurs), The Hague
Institute of Marine Engineers, Transactions, Stratford
Institute of Metals, Journal, London
Institute of Radio Engineers, Proceedings, New York
Institution of Automobile Engineers, Proceedings, London
Institution of Civil Engineers, Minutes of Proceedings, London
Institution of Electrical Engineers, Journal, London
Institution of Engineers and Shipbuilders in Scotland, Transactions, Glasgow
Institution of Gas Engineers, Transactions, Westminster
Institution of Mechanical Engineers, Journal, London
Institution of Mining and Metallurgy, Bulletin, London
Institution of Mining and Metallurgy, Transactions, London
Institution of Mining Engineers, Transactions, Newcastle-upon-Tyne
Institution of Municipal and County Engineers, Proceedings, London
Institution of Naval Architects, Transactions, London
Institution of Petroleum Technologists, Journal, London
Instituto de Ingenieros de Chile, Anales, Santiago de Chile
Instituto Geologico de Mexico, Bulletin, Mexico
International Marine Engineering, New York
International Sugar Journal, Manchester
Iron Age, New York
Iron and Coal Trades Review, London
Iron and Steel Trades Journal, London
Journal du Pétrole, Paris
Journal für Gasbeleuchtung, Munich
Journal of Electricity, San Francisco
Journal of Geology, Chicago
Journal of Physical Chemistry, New York
Journal of the United States Artillery, Fort Monroe, Va.
Journal Télégraphique, Berne
Junior Institution of Engineers, Journal and Record of Transactions, London
Königliches Materialprüfungsamt zu Gross-Lichterfelde West, Mitteilungen, Berlin
Kyoto Imperial University, College of Science and Engineering, Memoirs, Kyoto
London, Edinburgh and Dublin Philosophical Magazine and Journal of Science, London
Louisiana Planter and Sugar Manufacturer, New Orleans
Machinery, New York
Machinery, London
Manufacturers' Record, Baltimore
Marine Engineer and Naval Architect, London
Marine Journal, New York
Marine Review, Cleveland
Mechanical World and Metal Trades Journal, London
Metal Industry, London
Metal Industry, New York
Metallurgical and Chemical Engineering, New York
Métallurgie, Paris
Mining and Engineering Review, Melbourne
Mining Journal, London
Mining Magazine, London
Mining Press, San Francisco
Model Engineer and Electrician, London
Motor Age, Chicago
Motor Boat, New York
National Fire Protection Association, Quarterly, Hartford
National Physical Laboratory, Report, Teddington, England
Natural Gas Journal, Buffalo
Nature, London
New England Water Works Association, Journal, Boston
New Zealand Institute, Transactions and Proceedings, Wellington
North of England Institute of Mining and Mechanical Engineers, Transactions, Newcastle-upon-Tyne
North-East Coast Institution of Engineers and Shipbuilders, Transactions, Newcastle-upon-Tyne
Nuovo Cimento, Pisa
Oelmotor, Vienna
Oesterreichische Zeitschrift für Bergund Hüttenwesen, Beilage, Bergrechtliche Blaetter, Vienna
Oesterreichischer Ingenieur und Architekten Verein, Zeitschrift, Vienna
Ohio Society of Mechanical, Electrical and Steam Engineers, Journal, Columbus
Oil, Paint and Drug Reporter, New York
Paper, New York
Paris, Académie des Sciences, Comptes Rendus Hebdomadaires des Séances de l'Académie, Paris
Paris, Académie des Sciences, Memoires de l'Académie Royale des Sciences de l' Institut de France, Paris
Peru, Cuerpo de Ingenieros de Minas, Boletin, Lima
Petroleum, Berlin
Petroleum Review, London
Petroleum World, London
Physical Review, New York
Physical Society of London, Proceedings, London
Physikalisch-technische Reichanstalt, Wissenschaftliche Abhandlungen, Berlin
Physikalische Zeitschrift, Leipsic
Post Office Electrical Engineers' Journal Institution of Post Office Electrical Engineers, London
Power, New York
Power Wagon, Chicago
Practical Engineer, London
Practical Engineer, Chicago
Praktische Maschinen-Konstructeur, Leipsic
Prometheus, Berlin
Promyshlenost i Torgovla, Petrograd
Przeglad Techniczny, Warsaw
Quarry, London
Queensland Government Mining Journal, Brisbane
Railway Age (mechanical edition), New York
Railway and Locomotive Engineering, New York
Railway Club of Pittsburgh, Official Proceedings, Pittsburgh
Railway Electrical Engineer (publ. by Association of Railway Electrical Engineers), Chicago
Railway Engineer, London
Railway Gazette, London
Railway Journal, Chicago
Railway Master-Mechanic, Chicago
Railway News, London
Railway Review, Chicago
Rassegna Mineraria Metallurgica e Chimica, Turin
Rauch und Staub, Düsseldorf
Refrigerating World, New York
Revista de Ingenieria y Arquitectura (publ. by Instituto de Ingenieros y Arquitectos de Valparaiso), Valparaiso
Revue de Métallurgie, Paris
Revue Générale des Chemins de Fer et des Tramways, Paris
Revue Générale des Sciences Pure et Appliquées, Paris
Revue Scientifique, Industrielle et Commerciale des Métaux & Alliages, Paris
Revue Universelle des Mines, de la Métallurgie, Paris
Richmond Railroad Club, Official Proceedings, Richmond, Va.
Rivista Marittima, Rome
Rivista Tecnica delle Ferrovie Italiane, Rome
Rock Products and Building Materials, Chicago
Royal Dublin Society, Scientific Proceedings, Dublin
Royal Institute of British Architects, Journal, London
Royal Philosophical Society of Glasgow, Proceedings, Glasgow
Royal Society of Arts, Journal, London
Royal Society of Edinburgh, Proceedings, Edinburgh
Royal Society of Edinburgh, Transactions, Edinburgh
Royal Society of London, Philosophical Transactions, London
Royal Society of New South Wales, Transactions, Journal and Proceedings, Sydney
Royal Society of Tasmania, Papers and Proceedings, Hobart Town.
Royal Society of Victoria, Proceedings, Melbourne
Safety Engineering, New York
St. Louis Railway Club, Official Proceedings, St. Louis
Salt Lake Mining Review, Salt Lake City
Schweizerische Bauzeitung, Zurich
Schweizerische Elektrotechnische Zeitschrift, Zurich
Schweizerischer Elektrotechnischer Verein, Bulletin, Zurich
Science, New York
Science Abstracts, London
Scientific American, New York
Shipbuilder, Newcastle-upon-Tyne
Shipbuilding and Shipping Record, London
Shipping Illustrated, New York
Sibley Journal of Engineering, Ithaca, N. Y.
Signal Engineer, Chicago
Sociedad Cientifica "Antonio Alzate," Memorias, Mexico
Sociedad Cientifica Argentina, Anales, Buenos Aires
Sociedad Colombiana de Ingenieros, Anales de Ingenieria, Bogota
Sociedad de Fomento Fabril, Boletin, Santiago de Chile
Sociedad de Ingenieros, Boletin, Informaciones y Memorias, Lima
Sociedad Geologica Mexicana, Boletin, Mexico
Sociedad Nacional de Mineria, Boletin, Santiago de Chile
Societa Chimica di Roma, Rendiconti, Rome
Societe Chimique de France, Bulletin, Paris
Societe de l'Industrie Minerale, Comptes-Rendus Mensuels, Saint-Etienne
Societe d'Encouragement pour l'Industrie Nationale, Bulletin, Paris
Société des Ingénieurs Civils de France, Memoires et Travaux, Paris
Société Française de Mineralogie, Bulletin, Paris
Société Internationale des Electriciens, Bulletin, Paris
Society for the Promotion of Engineering Education, Proceedings Lancaster, Pa.
Staffordshire Iron and Steel Institute, Proceedings, Stourbridge
Stahl und Eisen, Düsseldorf
Steam, New York
Steamship, Leith
Steel and Iron, Pittsburgh
Steel and Metal Digest, New York
Stone, New York
Sugar, Chicago
Survey, New York
Surveyor (publ. by Institution of Surveyors, New South Wales), Sydney
Surveyor and Municipal and County Engineer, London
Surveyor's Institution, Transactions, London
Technique Moderne, Paris
Teknisk Tidskrift, Stockholm
Teknisk Ukeblad, Christiania
Telegraph and Telephone Age, New York
Telephone Engineer, Chicago
Textile World Record, Boston
Times Engineering Supplement, London
Tokyo Imperial University, College of Science, Journal, Tokyo
Toronto University, Studies, Geological Series, Toronto
Tramway and Railway World, London
Transmitter, Sydney.
United States Army and Navy Journal, New York
United States Naval Institute, Proceedings, Annapolis, Md.
Verein der Deutsche Zucker-Industrie, Zeitschrift, Berlin
Verein der Gas-und Wasserfachmänner in Osterreich-Ungarn, Zeitschrift, Vienna
Verein Deutscher Ingenieure, Beiblatt, Technik und Wirtschaft, Berlin
Verein Deutscher Ingenieure, Beitraege zur Geschichte der Technik und Industrie, Berlin
Verein Deutscher Ingenieure, Mitteilungen über Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, Berlin
Verein Deutsche Ingenieure, Zeitschrift, Berlin
Verein zur Beförderung des Gewerbfleisses, Verhandlungen, Berlin
Victorian Institute of Engineers, Proceedings, Melbourne
Victorian Institute of Surveyors, Transactions, Melbourne
Water and Gas Review, New York
Werkstattstechnik, Berlin
West of Scotland Iron and Steel Institute, Journal, Glasgow
Western Australian Institution of Engineers, Proceedings, Perth
Western Canada Railway Club, Proceedings, Winnipeg
Western Engineering, San Francisco
Western Railway Club, Official Proceedings, Chicago
Western Society of Engineers, Journal, Chicago
Wireless Age, New York
Wireless World, London
Wisconsin Engineer, Madison, Wis.
Wood-Worker, Indianapolis
Worcester Polytechnic Institute, Journal, Worcester, Mass.
Zeitschrift für Angewandte Chemie, Leipsic
Zeitschrift für Anorganische Chemie, Leipsic
Zeitschrift für Beleuchtungswesen, Heiz und Lüftungs-technik, Berlin
Zeitschrift für Dampfkessel und Maschinenbetrieb, Berlin
Zeitschrift für das Gesamte Schiess- und Sprengstoffwesen, Munich
Zeitschrift für das Gesamte Turbinenwesen, Munich
Zeitschrift für die Gesamte Kälte-Industrie, Munich
Zeitschrift für Elektrochemie und Angewandte Physikalische Chemie, Halle, a. S.
Zeitschrift für Flugtechnik und Motorluftschiffahrt, Munich
Zeitschrift für Instrumentenkunde, Berlin
Zeitschrift für Komprimierte und Flüssige Gase sowie für die Pressluft-Industrie, Weimar
Zeitschrift für Physikalische Chemie, Leipsic
Zeitschrift für Praktische Geologie, Berlin
Zeitschrift für Sauerstoff- und Stickstoff-Industrie, Berlin
Zeitschrift für Schwachstromtechnik, Munich
Zeitschrift für Vermessungswesen, Stuttgart
Zeitschrift für Zuckerindustie in Böhmen, Prague
Zentralblatt der Bauverwaltung, Berlin
Zentralblatt für Chemie und Analyse der Hydraulischen Zemente, Halle a. S.

Spring Meeting

The Spring Meeting for 1919 will be held at Detroit and the date has been tentatively announced as June 17 to 20.

Coming Sections Meetings

Buffalo: A meeting has been arranged for January 29, at the Hotel Statler, at 8.30 p. m. Nathan L. Lieberman will deliver an address on Horsepower Requirements of Aeroplanes and Power Consumption through Parasite Resistance.

Minnesota: On January 6 the Section will hold a regular meeting at the Midway Branch of the St. Paul Association of Commerce. Prof. Peter Christianson of the School of Mines, University of Minnesota, will deliver the address of the evening.

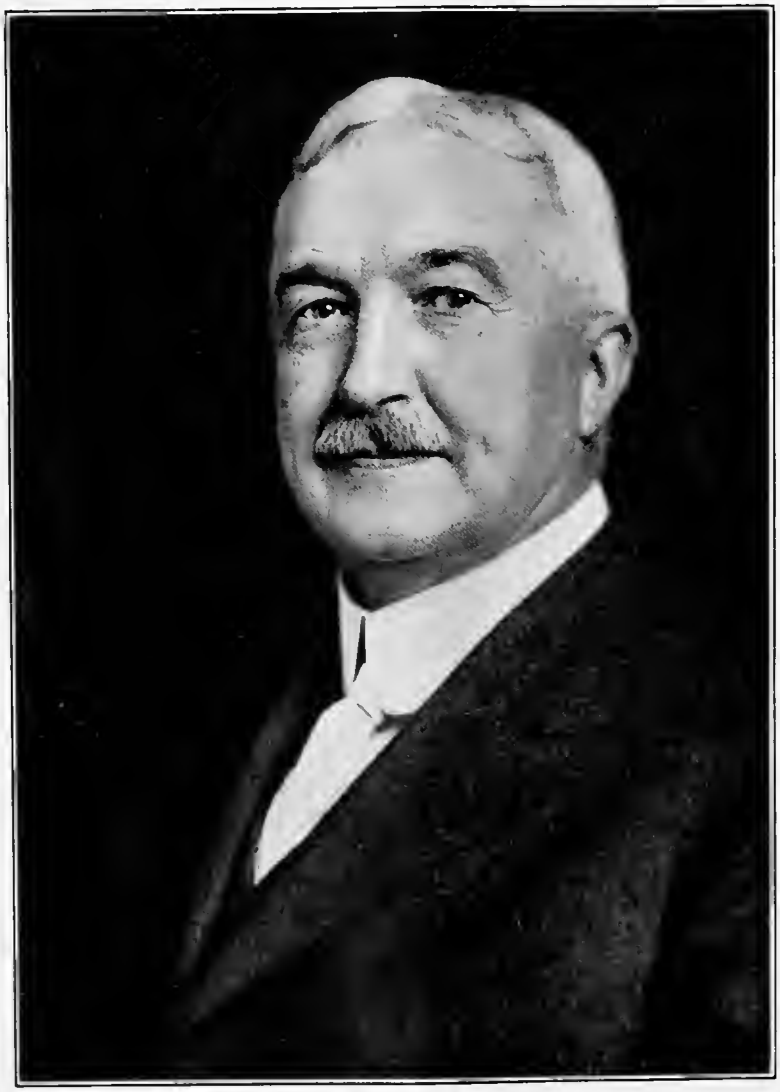
New Haven: Douglas K. Warner will speak before the members of the New Haven Branch on January 8, at 8 p. m., in the Mason Laboratory. The subject of his address will be Friction of Ball Bearings.

New York: A meeting is planned early in January at the Engineering Societies Building, at which W. W. Macon, Chairman of the Executive Committee of the New York Section, will relate his experiences abroad as a member of the delegation of technical editors.

Philadelphia: The Section will hold its monthly meeting in the Engineers' Club on January 28. William B. Dickson, Vice-President and Treasurer of the Midvale Steel and Ordnance Company, New York, will deliver an address on the subject of Relations between Employer and Employee.

San Francisco: The Section is planning an informal smoker to be held at the Engineers' Club early in January.

[illegible]



MORTIMER ELWYN COOLEY
PRESIDENT 1919
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

MECHANICAL ENGINEERING

THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Volume 41 January, 1919 Number 1

THE ANNUAL MEETING

THE thirty-ninth Annual Meeting of the Society held December 3 to 6, was a meeting strong and well-rounded out in its various elements, professionally and socially, simply conducted in accord with the spirit of the times, yet an occasion of very genuine pleasure to the large number in attendance. The total registration was 1717, of whom 1040 were members.

In this number of THE JOURNAL will be found an account of many of the features, including the conferring of Honorary Membership at the opening session and the President's address; the keynote session: the evening lectures, the important business meeting and the deliberations of the newly-formed Committee on Aims and Organization, the largest committee of the Society, representative of the Sections as well as of the Society at large. Accounts of the strictly technical sessions, those devoted to machine-shop subjects, refrigeration, power plants, textiles and miscellaneous subjects are reserved for a future number.

All of the events were held in the Engineering Societies Building. On Monday and Tuesday the Committee on Aims and Organization held several conferences, the conclusions of which were summarized in a progress report presented at the Business Session on Wednesday morning by the Chairman, L. C. Marburg, and published complete in this number.

President Main's address on Tuesday evening on Broader Opportunities for the Engineer voiced the desire for greater usefulness and the need for greater responsibilities which is felt alike by those in all professions and walks of life at the present time. The evening of the President's address was made still more notable by the double distinction of Honorary Membership conferred upon Charles M. Schwab and Orville Wright, with happy and appropriate remarks interspersed by Dr. John A. Brashear.

On each of the other evenings, Wednesday and Thursday, were lectures of wide appeal covering some of the important engineering work of the Army and Navy. On Wednesday evening Lieut.-Commander William L. Cathcart spoke on the Engineering Achievements of the Bureau of Steam Engineering During the War, illustrated by many lantern slides. He was followed by Lieut-Commander D. C. Buell, who gave the first showing before a public audience of slides and moving pictures of the high-powered 14-in. navy guns with railway mount which were used effectively at the close of the war in breaking the line of communication with Metz. On Thursday evening Colonel James B. Dillard of the Ordnance Department reviewed the engineering features of heavy railway artillery of this and other countries. It is a pleasure to be able to publish liberal abstracts of all of these lectures in this number of THE JOURNAL.

Following the lecture on Thursday evening was the customary reunion and dance with refreshments, and an innovation was the decorating of the foyer floor of the Engineering Societies Building so that a social time could be in process in the large hall on this floor at the same time that dancing was in process on the fifth floor of the building, a feature that all seemed to appreciate.

PROFESSIONAL SESSIONS

Several months ago the Committee on Meetings and Program, sensing the spirit of the times in relation to labor problems, planned for a session to last throughout one day of the Annual Meeting on the human elements that enter into these problems. This session was introduced by Dr. L. S. Rowe, Assistant Secretary of the Treasury. He was followed by others who dealt with various phases of the employment question here at home. This session was attended by a large number, both morning and afternoon, and drew out a great deal of discussion. A brief account of the discussion is given in this number.

A strong session was arranged by the Sub-Committee on Machine-Shop Practice which accorded with the efforts put forth by the Society for the standardization of master gages by the Bureau of Standards as a central point during war production; and the appointment by the Department of Commerce of the Screw Thread Commission as a result of Congressional action. Papers were presented reviewing the work of standardization accomplished by the British Engineering Standards Association and of practice in this country of thread-gage making and testing. Exhibits of gage-testing apparatus were arranged in the building by the Bureau of Standards and by the Joint Gage Laboratories of the British War Mission and the U. S. Bureau of Aircraft Production.

A pleasing event was the joint session with the American Society of Refrigerating Engineers, to which both societies contributed papers in which a great deal of interest was evidenced.

As at the several recent annual meetings, the Sub-Committee on Textiles prepared a strong session covering problems that mill engineers have to deal with; and one paper in particular attracted considerable attention, outlining as it did the work of the Bureau of Standards in developing a cotton fabric for use as a covering for airplane wings in the place of linen.

A session which drew out a large amount of discussion was that at which the paper on the Weights and Measures of Latin America by Frederick A. Halsey was presented, followed by a paper on Efficiency and Democracy by H. L. Gantt.

On Friday morning, owing to the absence of several authors, the two sessions planned upon power-plant and general subjects were combined into one general session.

ADDRESS BY DR. GEORGE W. KIRCHWEY

The plan of a luncheon, followed by an address, inaugurated so successfully last year was carried out again, on Wednesday of the meeting, with an address by Dr. George W. Kirchwey, formerly Dean of the Columbia Law School, on A Message from the Legal Profession; or, as Dr. Kirchwey very modestly said, from "the profession which is concerned mostly with the past to the profession that looks mostly into the future." Dr. Kirchwey said in part:

"As I understand it now, you are passing through an enlarging experience. You are members of a profession by the same token that medicine and law are professions, by virtue of the fact that to your specialized technical training there is added a recognition of your social obligation to make that training available for the good of the larger community. That you are doing in a conspicuous degree, in a rather exceptional way as compared with other professions, because your work is primarily public work. You cannot if you would hide your light under a bushel as the parochial lawyer or the parochially minded doctor may easily do, because you are constructing works of public utility. Nevertheless, for the most part the work appears to the onlooker to be a series of jobs—a job performed for the owner who hires you whether he be Uncle Sam or a private employer. . . .

"It was due more to historic accident than anything else that the legal profession became a public institution; that there was committed to it the actual administration in the courts, and almost of necessity the actual work of amending and reframing the law in the legislatures and Congress. Thus the legal profession has been thrust forward into a position of vast public service, and therefore of public observation; and may I say generally of public appreciation? . . . .

"The doctor, too easily concealing his light under a bushel, has of late years also emerged from obscurity. It is because of recent discoveries in the field of science, the germ theory of disease, to lump it together into a phrase, and some of the larger applications, that the medical profession has suddenly been transformed from one rendering service to individuals to one rendering a wholesale service to the entire community. . . .

"I take it that the greatest achievements of the engineer are performed largely in the spirit that the lawyer argues his case in behalf of a public or private client, or the doctor treats his patients, doing it in the most genuine professional spirit, but falling short in utility to the community at large, that larger community service which the doctor is now performing and which the lawyer in his administration of justice is performing.

"Now," said the speaker, "I am going to invite you all to join the new society of engineers which I have decided since getting on my feet to create, the society of social engineers. You and a few lawyers are eligible (laughter). What I am getting at is this: that under conditions as they exist today no one can any longer wash his hands after the manner of Pilate and say, 'What is this to me? Go and deal with this case as you think best if you are interested. I am not.' That is no longer a tolerable attitude for any man who belongs to a profession and claims the dignity and the rewards that go with devotion to a profession. You have been dealing with material things and in the process have created new social problems. The enormous aggregation of men in our great cities, their congestion, has been due to the lines of transportation that you have set up and to the facilities for manufacturing that you have concentrated. You are responsible for this mess which we call modern civilization (laughter and applause) and it is up to you to get us out of that mess."

Referring to conditions of employment and labor he said there must somehow be devised by some engineering genius a method of stabilizing industry so that it shall no longer be subject to those extraordinary fluctuations which bring so much misery in their train and there must be devised some method of adjusting the relations between employer and employee so that they shall work together harmoniously to a common end.

Concluding Exercises

The Annual Meeting concluded on Friday morning with a brief service of a religious character, addressed by Rev. Edmund M. Wylie of Montclair, N. J., lately in charge of Y. M. C. A. work in Great Britain and who has visited the whole of the Western Front. At this time Dr. Hollis who was in the chair recalled that the concluding session of the previous Annual Meeting had ended in silent prayer that another year might find our boys on the way home after a glorious victory. This hope had been realized and it was only fitting that we should close this year's sessions by a few words from one of the returning soldiers, a soldier of the cross, who went to St. Mihiel with one of our divisions and was present at that great victory.

Rev. Mr. Wylie said that nothing had impressed him so much in the spirit of service which the world is learning anew as the work of the engineers. He instanced many cases of the boys at the front becoming enthusiastic about the preparatory work accomplished by the engineers, both at home and abroad. The most striking illustration was of the battle of St. Mihiel. The French had held the salient against the Germans for a few days at a cost of 14,000 lives. It was captured by the Germans; and in two days the French recaptured it and held it 40 minutes at a cost of 20,000 lives. Before the first American division made its charge the engineers had said, "You can take it with little loss of life if a certain plan is followed." The preparations were made and because of their thoroughness the Americans captured St. Mihiel with a loss of only 60 men in dead and wounded.

"So," he said, "I come back with Paul's idea, that he should make himself servant unto all men. I believe the engineer's idea is the democratizing of all service; to make oneself a servant unto all mankind. We have not only blown to pieces old dynasties but outworn creeds which have separated us (applause); and I have never known the world so united on essentials as now.

"I believe what I found characterizing the soldiers of the different nationalities properly characterizes the engineers. I have heard the British catch up their slogan, 'Carry on! Carry on!' I have stood in the valley of the Marne where Joffre stood when he said, 'Defenders of France we retreat no further, we die here.' I have stood on the heights of Verdun and have heard again the voice of Petain saying, 'Il ne passeront'—they shall not pass; and as I went down 150 miles of the lines occupied in part by the Americans I discovered not only 'Carry on!' but '*Carry through! Carry through!*' I am rejoiced to stand here, your prayer answered this day, to say that our boys are on their way home after the glorious victory."

ENGINEERING AND THE WAR

"I shall never forget the impression made on me by the late Lord Kitchener, the man who started the first movements in this great war, when he said—'Mr. Schwab, this is not a war of men; it is a war of machines, and the nation and the army that will supply the machinery of war will be the ones that will win this war, and the quicker and the more expeditiously the machinery of warfare is supplied, the quicker will this war be won.' How almost prophetic was that statement, as subsequent events developed its truth, because, after all, this war has been won for us by the splendid engineering and industrial talent of the United States."—Charles M. Schwab.

ENGINEERING IN THE PERIOD OF READJUSTMENT

"The future will have problems and trials. The contests will not be of battle, but of industry. The conquests will not be of territory or thrones, but of markets.

"Upon our ability to resume our normal lines will depend to a large degree our prosperity at home and trade expansion abroad. We were unprepared for war and it has been a stupendous task to readjust our industries to a war basis. It will be no easy task to readjust ourselves for peace. In this readjustment our vision must extend beyond the state and nation out into the broad world."—President Main.

OPENING SESSION, TUESDAY EVENING

Presidential Address on Broader Opportunities for the Engineer—Introduction of the President-Elect—Conferring of Honorary Membership on Charles M. Schwab and Orville Wright

THE opening session of the thirty-ninth Annual Meeting was held in the auditorium of the Engineering Societies Building on Tuesday evening, December 3, when Mr. Charles T. Main delivered his presidential address on Broader Opportunities for the Engineer to a large and appreciative audience. President Main's address dealt with the work of the Society during the year of his incumbency and in particular with the many war activities of the Society as a body and of the membership as individuals. A wealth of interesting facts was also brought out regarding the technical work conducted by the Society, and various national developments in which the engineering profession could be of assistance and guidance were pointed out, as well as important problems in economics to whose right solution the efforts of engineers should be directed during the coming days of reconstruction. The text of the address appears elsewhere in this issue.

At the close of President Main's address the Tellers of Election reported through the Secretary that the following officers of the Society had been elected for the coming year:

President:
MORTIMER E. COOLEY

Vice-Presidents:
F. R. LOW
HENRY B. SARGENT
JOHN A. STEVENS

Managers:
CHARLES L. NEWCOMB
F. O. WELLS
C. RUSS RICHARDS

Treasurer:
WILLIAM H. WILEY

President Main then introduced President-elect Mortimer E. Cooley in a few sentences recounting briefly his professional attainments, and as a teacher, administrator, successful engineer and one of the best types of public servants he prophesied for him unusual success in his relations with the membership.

PRESIDENT-ELECT COOLEY RESPONDS

President-elect Cooley, in responding, thanked the speaker for the sentiments he had expressed, and remarked on the tension under which he had been as the time approached for his assumption of the responsibilities of the high office to which he had been elected. He recalled the first meeting of the Society which he had attended—at Pittsburgh, in May 1881, where only 93 persons were present, contrasting it with the audience before him, and spoke of the impressions made on him by the men then active in the affairs of the Society, mentioning Professor Sweet, Dr. Brashear and Charles T. Porter by name. It would be his prayer that he might do what lay in his power to carry out the program outlined in President Main's address, which could not fail to constitute a high and memorable work in the reconstruction of this country if successfully done, as he was sure it could be.

BON VOYAGE TO PRESIDENT MAIN

At the conclusion of Dean Cooley's remarks, Past-President Ira N. Hollis arose and made a statement to the effect that a few weeks before M. Millerand, President of the French Engineering Congress, had invited the American Society of Civil Engineers to send to France a delegation of engineers to engage in reconstruction work in the devastated lands. With great generosity and kindness and that brotherly relation which it was hoped might always prevail between engineering societies, the Board of Direction of the American Society of Civil Engineers had decided that they ought to share this honor with other engineering societies, and thereupon had invited The American Society of Mechanical Engineers, the American Institute of Mining Engineers and the American Institute of Electrical Engineers to join them in this great work abroad.

The announcement he desired to make was that, through the good wishes and consent of the Council of the Society, President Main would represent the Society abroad.

"Happy is the man who has this opportunity," said Dr. Hollis, "and happy should the members of this Society be because they have so good a representative to send abroad to lend a hand to our little sister of nations on the other side who stood at Liège and turned back the German hordes that the land of freedom might be saved. Happy, too, is he who is able to extend assistance to France, the country that gave us our impulse toward democracy, by the Revolutionary War, and gave us help to end it, and end that kind of autocracy which never since has existed in Anglo-Saxon countries.

"I have risen here at the request of the Council to wish Mr. Main a splendid voyage to the other side, and that he may perform that kind of successful work that we are delighted to give to those who have saved for us and for all humanity the freedom of the individual." [Applause.]

CHARLES M. SCHWAB MADE AN HONORARY MEMBER

President Main voiced his deep appreciation of the good wishes expressed by the previous speaker, and then continued:

"It has been said many times that to win the war we must have the plants to manufacture the implements for the control of the sea and air. As soon as this country declared war there was started a gigantic program in shipbuilding—but under conditions which soon became impossible, and it was necessary for the President of the United States to select the greatest man in industrial affairs, who had the necessary knowledge, force and action, and put this man in charge, without restrictions, of this gigantic undertaking. This man he found in the person of Charles M. Schwab, and in some way persuaded him to undertake the work.

"Mr. Schwab has been honored by membership in many societies and industrial organizations in this country and in Europe, and it is our great privilege tonight to show him our appreciation of his engineering ability, keen judgment, boundless energy and great patriotism in assuming and carrying through the biggest shipbuilding plan ever undertaken, at a time when his services were also urgently needed by the Government.

"To give a little personal touch to this matter I have asked a dear old friend of Mr. Schwab, 'Uncle John' Brashear, to say a few words."

Dr. Brashear, in responding, began by stating that of all the degrees and titles he possessed, none was more highly prized by him than the one under which he had been introduced and which had been conferred upon him by his friend of many years, Mr. Schwab. He recalled many incidents of his long acquaintance with Mr. Schwab and cited numerous instances where he had shown his readiness to lend financial assistance for the furtherance of scientific projects.

"Among the men I have known who have been interested in science and engineering," continued Dr. Brashear, "are the many who had human hearts in them. Unless you have that human touch in your souls, unless that is back of your scientific work, all that you have accomplished will be less effective than if you had such impulses. [Applause.]

"Why has Mr. Schwab succeeded in his great work? Not because he was an engineer away above all the rest of his fellows, not because he had a reputation for his wonderful engineering work, great as it was, but because he had that something in his heart that won him favor among the people whom he met, and we delight to honor him because he has set us an example of the human side of engineering—an example worthy of being followed by every engineer.

It's the human touch in this world that counts
The touch of your hand and mine,
That counts far more to the sinking heart
Than shelter or bread or wine;

For shelter is gone, when the day is o'er
And bread lasts only a day,
But the touch of the hand and the sound of the voice
Live on in the soul alway.

"God Bless Uncle Charley." [Loud applause.]

President Main then formally conferred the Honorary Membership upon Mr. Schwab, who responded in part as follows:

Mr. Schwab's Acceptance of Honorary Membership

"First of all let me pay the tribute to my old friend 'Uncle John' Brashear that he deserves. I have known him since boyhood. I, like himself, have met many distinguished men in my life, and it has been a great pleasure to me to say publicly, and have it quoted all over the world, that of all the great men I have ever known I regard 'Uncle John' Brashear as the greatest of them all. [Applause.]

Charles M. Schwab

"I thank you sincerely, Mr. President, more sincerely than any words of mine may express for the honor that you have given me tonight. Very often it is the popular acclaim, many think, which makes a thing worth while having. A great scientific society like this is not usually swayed by any popular acclaim or theatrical performance or popular deed. There is nothing in life that one cherishes so much as the good opinion of the people who know him. It is not the great public reputation that brings satisfaction to the human heart of the men worth while, but it is the acclaim and approval of the people who have known him and have known what he has done, and there is no honor that I have ever received, and there is no acclaim to which my ears have ever listened, that will bring me a deeper sense of real satisfaction and pleasure than the approval of this great engineering society of the United States. [Loud applause.]

"There are some sounds that are very sweet to the ears of the real man: one of them, as I have stated, is the approval of those who know, the other is the approval of those with whom you work, and during this great undertaking, during our national crisis, an equally pleasing sound to my ears has been the sound of the workingmen throughout the shipyards and factories and engineering works of the United States when their voices above the din of the hammers could be heard saying—'We are with you, Charley; we are with you, Charley,' and I can assure you that every man, however high his station in life, will only give his best efforts under the approval of his fellow man and those with whom he is associated. [Loud applause.]

"Now I lay no claim to distinction as an engineer. I have spent my life in engineering projects—only the earlier part in actual engineering work and that long since forgotten—but I wonder if it has occurred to you that this great war for the freedom of the nations of the world and of our great and glorious nation, has been won by the work and influence of the engineers?

"I remember with much vivid distinctness my friendship for, and association with, the late Lord Kitchener, that great English general, the man who started the first movements in this great war. When I sat with him in his office and saw the look of responsibility that rested upon his face, this simple great soldier in plain suit of khaki, without any decorations, an impression was left that shall never be forgotten when he said—'Mr. Schwab, this is not a war of men, it is a war of machines, and the nation and the army that will supply the machinery of war will be the ones that will win this war, and the quicker and the more expeditiously the machinery of warfare is supplied, the quicker will this war be won.' How almost prophetic was that statement, as subsequent events developed its truth, because, after all, this war has been won for us by the splendid engineering and industrial talent of the United States.

"When I was asked to undertake the shipbuilding program, it seemed so prodigious in its requirements as to stagger the imagination, and I can assure you that after a week or ten days in touch with the project had given me a realization of what it meant, I would have given anything in the world to have been free of the responsibility that was placed upon me, when I saw the magnitude of what had to be accomplished. I feared at first that I should not have the responsibility and the right to do it in my own way, and it was not long until I feared the responsibility itself, and longed for the opportunity to share it with others.

"But I immediately found, as is always the case in a great emergency, that it was not a problem of the creation of machines and methods of doing things—that if it was to be done at all, it was to be done through what I called 'human engineering,' and that was the interest to the highest degree of the men in the shipyards who had to do the work. As a result of undertaking this work I went away from my office and everything connected with it, and spent ninety per cent of my time with the superintendents and the foremen and the workmen in the shipyards of the United States, and such a response as I received from every man connected with the industry is perhaps unparalleled in the history of any nation. [Applause.] I want to take this opportunity of saying that I know of not a single man in the whole shipbuilding fraternity—and there are 180 shipyards in existence in the United States—who is not fired with the spirit of intense enthusiasm and loyalty to plunge ahead and give the greatest possible effort, and during all that time there was never a single occasion when I was obliged or did say to any man connected with the industry—'You are not doing your best,' or 'You are not doing your duty.' [Applause.]

"The men at the head of that great enterprise were just as susceptible to the approval of the Director General and the American Nation as the workmen in the ranks were, and I have yet, as I said before, to find a man of high character, whether he be the King of England or the President of the United States, who is not pleased with the approval of the public in what he is doing. [Applause.]

"I must take this opportunity of paying a compliment to the workmen of the United States—I have never seen greater enthusiasm and greater effort upon the part of the workmen, indus-

trially, to win this war than I have found in the shipyards of the United States.

Our Accomplishments in Shipbuilding

"I must tell you briefly some of the accomplishments. The United States in no year prior to this war had ever constructed more than 400,000 deadweight tons of ships. General Goethals told me, when I started, that if the war continued on and during the year 1919 that 18 million tons of additional shipping to the world's then existing shipping would be necessary to maintain the armies in Europe, and that the plans for shipbuilding had to be on a basis that would give us at least 700,000 deadweight tons of ships for every month in the year 1919. It seemed a tremendous undertaking, but we continued to forge rapidly ahead until in the month of November, just ended, we placed in commission on the seas something over 500,000 deadweight tons of ships, and we will have placed in commission by the end of this year between 3,500,000 and 4,000,000 deadweight tons of shipping. [Applause.]

"When it was reported on the Fourth of July last that one hundred great ships throughout the United States had taken their plunge in the water, I felt that this war was won, because the workmen of the shipbuilding yards of the United States were going to their duty—and they have done their duty, and no credit should be given to the men at Washington like myself—I have always said that as long as I have a tongue to speak and ears to listen, I shall give the credit where credit is due. It is not the head man at Washington or at Philadelphia, the Director General or anybody else, to whom the credit for the successful accomplishments of this undertaking should be given—and if he had possessed all the talent and ability of the combined engineers in this great Society, he could not have accomplished it without the thoroughgoing and interested coöperation of every manager, superintendent and workman in the shipbuilding industry; and to them belongs the credit and let credit be given where credit is due. [Applause.]

"It has been a pleasure to be associated in such a great undertaking, to see its successful fruition and accomplishment, to have been a part of it, to have built ships to maintain our boys across the sea and carry them over. The real pleasure, however, is to build the ships and equip the ships to bring home those victorious boys of ours [applause], and when the history of this war is written it will not be the man who has built ships, it will not be the man who has invented and built airplanes, it will not be the men who have done all these things whose names will be written on the golden pages of this great epoch, but it will be, rightfully and honorably, the names of the boys who have made the supreme sacrifice on the battlefields of Flanders, that shall go down in the history and hearts of this great nation.

"I have been a fortunate man in my lifetime, in material things, health and friends, and one of the greatest pieces of good fortune in my business life was that I came to own and control one of the greatest ordnance works in the world, and that I could turn these works over for the use of our Government in the protection of this great country of ours, and I am proud of what it has accomplished, and I am sure you will not think I am boasting, but rather telling you something of interest in connection with this great industry at Bethlehem.

War Work of the Bethlehem Steel Company

"Since the beginning of the war the Bethlehem Steel Company has furnished the U. S. Navy with 60 per cent of all the steel for the ships and ammunition that they have received during the period of the war, and in addition to that it has furnished, besides the steel supplied to the Navy, one-quarter of all the steel for the merchant ships that have been built in the United States, and in addition to that we have furnished the Allies since the beginning of the war in Europe, and since the entry of the United States into the war, more than half of all the guns and munitions that went out of the United States or were furnished to our own nation. We have furnished to the Allies and to the U. S. Government more than 15,000 large field guns since the beginning of the war, or more than enough to furnish and arm all the soldiers of the United States sent to Europe. [Applause.]

"Now, I am sure that is a statement which will be of surprise to many of you people. I am proud of it, as proud of it as I could be of anything, because it was all in the nature of service to our country. I have reached the point in life, and all men reach it sooner or later, where there is nothing much left that brings real pleasure and excitement except the successful accomplishment of enterprising undertakings. And I do with pleasure and satisfaction dwell upon the work accomplished by our companies in this era that enabled the companies and the industries which I controlled to be so valuable in their service to this country at this time. In that I have been doubly fortunate. The next thing that I have been more than fortunate in, Mr. President, is to have had the approval of your Council and your members in the work which we have done. If it has reflected credit upon your Society and upon the members of the engineering profession, I am doubly happy and doubly grateful. [Applause.]

Orville Wright

"Mr. Wright is not going to speak this evening, so the less he says, the more honor you can give him. From the days of Darius Green down to a recent period, people have written and talked about the flying machine, but the Wright Brothers were the men who actually built the first successful machine and to them belongs the credit. [Applause.] And I feel that it is a proud thing to be recognized in the same manner and at the same time with a man like Orville Wright.

"I thank you for your warm, kindly welcome, and appreciate more than I can tell you the honor you have bestowed upon me; indeed, I can say I appreciate it more than any honor that has ever come to me. I shall appreciate it. This certificate of Honorary Membership which you have given me shall have a proud place in my household, and, what is more important, an imperishable place in my heart." [Loud applause.]

President Main then formally conferred the Honorary Membership upon Mr. Orville Wright, whereupon the meeting adjourned.

BROADER OPPORTUNITIES FOR THE ENGINEER

Presidential Address, 1918

BY CHARLES T. MAIN, BOSTON, MASS.

WE have probably witnessed the end of hostilities in the greatest conflict that the world has ever experienced. The people of this country, after some hesitation, undertook to assist in finishing the task which the Allies had begun at whatever cost or however long it might take.

It is now a time for great rejoicing, but the signing of the armistice is not the signing of the peace treaty. What kind of a peace we are to have will depend upon the wisdom with which the multitude of questions connected with the restoration and redistribution of territory and international relations are settled. The war will not be won satisfactorily unless the purposes for which it was fought, from our viewpoint, are assured.

At this time it may be well to recall why we have been at war.

President Wilson said, some time ago, "To make the world safe for democracy."

Lloyd George said, "We are fighting for a just and lasting peace."

Ex-President Taft said, "It is the struggle that is essential to liberty and Christian civilization."

Premier Clemenceau said, "Our victory and the victory of our allies means the liberation of civilization and liberty of human conscience."

Many other reasons have been and may be given why we were at war, but brought down to its final analysis, it is that this nation and other nations may live with the maximum of safety and with the greatest amount of liberty.

Probably most of us have a vague knowledge of the many issues involved and an indefinite conception as to the effect of the war on the political, social and business conditions of the world, but we can surely predict that there will be a remolding of all these so that our country will be one of greater unity of purpose and desire with a more spiritual and less materialistic view of life and greater unselfishness in the service of our country and mankind.

[President Main then reviewed the war activities of the Society, a brief statement of which has already gone to the membership in the brochure entitled "In the Service," and outlined the work of the Council and Committees for the year, which will be placed on record in the Transactions.—EDITOR.]

A BROADER VISION

With this review of what the men in our profession are doing in connection with the war and the collateral problems, also having in view the quick expansion and development of the work along comparatively narrow and restricted lines into circles of almost unlimited possibilities, we have seen how we can and must free ourselves from our former provincial attitude into one of universal outlook.

If this can be accomplished at this particular time and for this particular occasion, why should we not now and in the future exert our influence and direct our energies toward matters of broader interest?

As a class engineers have been extremely modest in their relations with business and public affairs. This has been a natural condition largely due to the education and training which they have received. The education has been along rather narrow and restricted lines of scientific work, leaving out almost entirely the broader studies of literature, common law, economics, business methods and the humanities. After graduation there is usually not much opportunity for broadening out, for it is necessary for a man, if he expects to keep abreast with the development of his profession, to spend nearly all of his surplus energy in reading and studying along the very lines which he followed in school.

Notwitstanding this, it is wise to carry along a course of reading on broadening subjects and to have an interest in affairs which are wholly outside the scientific line of study, and to be identified with engineering and scientific societies in order to get the broadest outlook of life possible. It is for this reason, in order to get a broader aspect of life and acquire a taste for wider reading and study, that it is of advantage for a young man who is to follow some scientific pursuit to take an academic course before he takes his scientific course.

I realize the impracticability for many men to spend so much time at considerable expense in preparation for their life work, but it is almost essential that a man should very early in his career acquire some knowledge of business principles and should endeavor to broaden himself so as to be able to fill with fair satisfaction the position that properly belongs to him in his profession and in the world.

It should be the aim of the engineer to render the best possible service considered in a broad sense. It should be based on facts and not theories or suppositions, and upon scientific laws, which if properly applied will give satisfactory results. Nothing should be taken for granted, and the work or statements of others should be carefully checked before being adopted.

The success of a man will depend upon his ability to produce results in an expeditious manner, which shall be accurate, and in which good judgment has been used, so that the finished product, if it be a physical structure, will be adapted to the use to which it is to be put and shall have been accomplished at a reasonable expenditure. If it be a plan for action it shall be clear and concise and adaptable to the purpose for which it is intended.

He should be able to understand men and to know them. He should be willing to share his knowledge with his fellow-engineers and inasmuch as he will do this through the Society, or other similar means, his interests and outlook will broaden and the return to him will be multiplied. Integrity and perseverance in work and business and fairness and justice to all will in the long run count for more than brilliancy in attainments. Withal he must have a good stock of imagination and judgment, which is sometimes called "horse sense" in the application of fundamental principles to every day problems.

The true success of a man is not measured by the accummulation of money, but by the success of accomplishment of work which adds something to the general good for mankind and for the advancement of the profession.

In his annual address President Hollis said:

> In the changes that are coming the engineer can no longer dwell within his technical shell, and he must prepare himself to become a citizen of the world, upon whose shoulders great economic and social burdens are placed.

And Professor Kimball has said:

> If we have not at this moment a clear vision of whither we are tending, now is the time of all times to take stock of ourselves and to redirect our course, whether this course is in conformity with time-honored definitions or not. Change is not necessarily synonymous with progress, but there is no progress without change. No one can doubt that the scientist and the engineer are to be the most important industrial figures of the near future. If we are faithful to our duties we shall be of greater importance politically and socially, but to accomplish this we must broaden our vision and get about our business, which is the industrial organization of our country.

Let us then bestir ourselves and show a greater interest and a broader vision of the opportunities which now lie before us and which will increase in number and importance in the near future.

IN THE PROFESSION IN GENERAL

We are living in a period of profound importance to the whole world. The social and political conditions and the ideals of some and perhaps nearly all the nations are in a state of flux. To a large extent this may be said of our own country. This state of uncertainty and uneasiness has overtaken many men in our own profession, and it seems, therefore, necessary for us to consider with great care if it will not be necessary in the near future to readjust ourselves to the new conditions.

There is a tendency to form new organizations to accomplish new objects, or with the hope of doing some things that the present organizations are doing in a better way. This is unfortunate, as it is unwise and inefficient to have so many agencies endeavoring to accomplish the same result. Consolidation rather than segregation, up to proper limits, is desirable.

In local communities some plan should be arranged, which would vary in different places, for the local organizations to combine on matters of common interest. The plan, however, is of less importance than the action itself. If the local societies and members of the same are active in service to the profession and to the community, a plan will be evolved by which these interests and activities can be made effective.

Organization

It was probably for this reason that the American Society of Civil Engineers, on June 18, 1918, created a Committee on Development and adopted resolutions creating the committee, a portion of which reads as follows:

> The development and application of the sciences in recent decades have caused profound changes in the social and industrial relationships of all peoples.
>
> Sociological and economic conditions are in a state of flux and are leading to new alinements of the elements of society.
>
> These new conditions are affecting deeply the profession of engineering in its services to society, in its varied relationships to communities and nations, and in its internal organization.
>
> A broad survey of the functions and purposes of the American Society of Civil Engineers is needed in order that an intelligent and effective readjustment may be accomplished so that the Society may take its proper place in the larger sphere of influence and usefulness now opening to the profession.
>
> Resolved, that a Committee be created to report on the purposes, field of work, scope of activity and usefulness, organization and methods of work of the American Society of Civil Engineers, and to make recommendations concerning these matters.

The purpose and scope of the work of the committee is thus in part defined:

> It is intended that the Committee on Development shall make a survey of the fields of usefulness which are or should be open to the Society, consider what functions may properly be assumed by the Society, define its purposes, formulate policies and methods of work to be recommended, and consider the needs in organization and constitution. This means taking stock and making plans. The resolutions contemplate an examination of present-day conditions and an outlook into the future. They involve considering the changing social and industrial relations of the times and the opportunities and responsibilities which devolve upon the Society and its membership. The relations of the Society to other societies and to the profession generally are also included. The outcome of the work of the Committee may be modifications in the activities, functions and methods of work, or in the emphasis in these matters, and possibly the addition of new ones.

Similar committees have been created by the American Institute of Electrical Engineers and proposed for the American Institute of Mining Engineers and our own Society. It is proposed that the various committees coöperate on subjects of common interest.

It is also suggested that it may be desirable to confer with representatives of local engineering societies throughout the country concerning the relations of such societies with the national societies.

The results of this work should be of great benefit to the whole profession in increasing solidarity, diminishing duplication of effort, more effective results in matters of common interest, a more representative opinion on subjects of general interest to the profession and public, the creation of a better feeling of fellowship and harmony and a much greater ability to assist in the inevitable evolution of industrial and social conditions which are soon to follow.

The advantages of unified command and action are most clearly demonstrated by the results obtained by the Allied armies under the supreme command of General Foch.

The Engineering Council is a step in the direction of coördinating the work which is of common interest to the profession. It has done much good work, but has not yet reached the maximum of its usefulness.

Within Our Own Society

In anticipation of the work of our Committee on Aims and Organization, there may be mentioned some details of operation in the minor workings of the Society which might be broadened to advantage.

A plan might be developed for increasing the financial resources of the Society by contributions or legacies to a fund, the income of which could be devoted to research work and for prizes and premiums to the younger members for good work and for any other meritorious object which might present itself.

A plan should be developed which will make a working connection between the general meetings and the local meetings.

The coöperation between the Publication and the Local Sections Committees can be greatly developed if the individual members will see the great opportunity which these committees have already provided in the equal status of papers read before local and general meetings of the Society. The members can further help the Publication Committee in conjunction with the Meetings Committee by an earlier announcement of prospective papers, so that a general program for the ensuing year can be prepared during the summer and be submitted to all of the local sections and coöperation solicited in carrying such a program to completion.

During recent years the increased responsibility placed upon young men has increased the difficulties of the Membership Committee in the proper grading of applicants for membership. It may be that the Committee on Aims and Organization could well give consideration to this matter.

As already indicated, another profitable investigation which the Society can undertake is a still closer relation between the Research Committee and our other committees, including the Engineering Foundation, with the industries and with the scientific schools having facilities for research work. It has been suggested that the Society act as a clearing house between the research facilities of the universities and the research requirements of the industries.

Most of the broader aspects within the Society are in line of extending the usefulness of any one activity through the medium of coördinating it with some other activity. The whole organization is capable of being rounded out and planned so as to produce the maximum of teamwork.

Consolidation of Technical Societies

In the Monthly Bulletin of the American Institute of Mining Engineers, March 1918, there appeared the following:

> The vision dwells in the minds of many that ultimately these four great societies, lightening the emphasis they place upon their differences, may see the time when, for the solidarity of the profession, for their best interests, as well as for increase of their influence on the country at large, they may become one great national association of engineers. With the gain in power and prestige inevitably following such an aggregation, freedom for individual development may be achieved through divisions along the lines of technical interests, which might either follow the present four grand divisions or be more minutely subdivided.
>
> An organization of this sort could and probably would be more strictly professional than any of the four have been hertofore, and through the prestige and power of its numbers could establish standards of ethical conduct for its members, violation of which would bring grave consequence.

This great vision is worthy of the most careful consideration and might be carried with safety to a point where the national societies would be gathered in under one executive head, without any one losing any vital portion of its individuality.

This would be a great step in advance and perhaps as far as we should go for some time to come.

Standardization

There is now opening up to the profession the most promising opportunity of furthering the work of national and international standardization. It is the beginning of a real great international movement for standardization.

All of our own standards committees are working under the general direction of the Standardization Committee, the sole duty of which committee is to see that the work of the various committees shall be in harmony with the general scheme, but not to prepare standards for any particular purpose.

The American Engineering Standards Committee has been

created for the purpose of harmonizing the standards of the various branches of the profession, and it is about ready to function.

Upon invitation of the British Engineering Standards Association, this Society is acting as an informal correspondence committee in the United States.

National Developments in Which the Profession Can Be of Assistance and Guidance

Although the military conditions with the Allies in Europe are satisfactory, there is a vast amount of work yet to be done in clearing up the whole situation, and our efforts should not be diminished until a satisfactory ending is reached.

It is now time to give careful consideration to the readjustment after the war, so that this country shall maintain its national and industrial integrity with due regard to our obligations to other countries. We were unprepared for war, which was a possibility, and we are unprepared for peace, which is a certainty.

The future will have problems and trials. The contests will not be of battle but of industry. The conquests will not be of territory or thrones but of markets.

Plans have been under consideration for some time in England, France and Germany for regaining the commerce lost during the war.

Upon our ability to resume our normal lines will depend to a large degree our prosperity at home and trade expansion abroad.

We were unprepared for war, and it has been a stupendous task to readjust our industries to a war basis. It will be no easy task to readjust ourselves for peace. In this readjustment our vision must extend beyond the state and nation out into the broad world.

"With courage we must face the future, confident that with a better understanding of our local and national problems, and with a closer and more systematic coöperation between the governing authorities and business institutions, continuing progress will be assured. These are not times for jealousies, prejudices and selfishness, but with a largeness of heart and bigness of vision we must unite in a common effort to help America achieve its manifest destiny."

Bills have already been presented to Congress which contemplate the creation of a Federal Commission on Reconstruction, the duties of which are far reaching. The Commission is to investigate and recommend to Congress what additional legislation or changes in legislation are desirable.

Under the Weeks' Bill the subjects are summarized as follows:

1 Problems affecting labor
2 Problems affecting capital and credit
3 Problems affecting public utilities
4 Problems resulting from the demobilization of our industrial and military war resources
5 Problems affecting our foreign trade
6 Problems affecting the continuance of existing industries and the establishment of new industries
7 Problems relating to agriculture
8 Problems affecting the adequate production and effective distribution of coal, gasoline, and other fuels
9 Problems relating to shipping, including shipyards, and especially in regard to the sale, continuance of ownership, or leasing of both yards and ships
10 Housing conditions and the disposition of houses constructed by the Government during the war
11 War legislation now on the statute books, with reference to its repeal, extension, or amendment
12 And in general all matters necessarily arising during the change from the activities of war to the pursuits of peace, including those that may be referred to it by the Senate or House of Representatives.

Under the Overman Bill the tasks named are as follows:

a The financing, regulation, control, and development of the merchant marine
b The development, financing, expansion, and direction of foreign trade
c The reorganization, financing, and readjustment of industries engaged in war work by way of reconverting them to normal production
d Technical education and industrial research as a means of developing and strengthening industry
e The redistribution and employment of labor in agricultural and industrial pursuits and the problems of labor growing out of demobilization
f The supply, distribution, and availability of raw materials and foodstuffs
g The conservation and development of national resources
h Inland transportation by rail and water
i The reorganiation of government departments, bureaus, commissions or offices with a view to putting the Government on an economical and efficient peace basis
k The consolidation of such acts and parts of acts of Congress which relate to the same subject-matter, but which now appear at various places in the statutes.

Nearly all of the problems suggested above are directly or indirectly engineering problems. The framing of laws would be greatly facilitated if the advice of the engineers were made available in furnishing many of the physical and technical facts upon which they should be based.

Nearly all of the problems of a municipality and largely of the state and nation are engineering in their nature and it should be the duty of all engineers to take an active interest in the conduct of public affairs in so far as the opportunity offers. It is always possible in the smaller way in the community and the opportunity will broaden if a man shows his ability and interest into fields of wider scope.

Our assistance will be needed now more than ever, for the tendency of the times is toward socialism and government ownership or control of all facilities which are used by the public. The arm of federal authority is reaching further and further into our personal life and affairs. We are moving rapidly in the transfer of authority from those who have a personal interest in its successful exercise to those who have only political advantage to gain.

This Society, other societies and Engineering Council are already working on some of the problems. We are not concerned with all of them at present, but should be soon. We should begin to look upon all of them with a broader vision, and should take a more active and helpful attitude toward public affairs and industrial relations which we have heretofore considered beyond the scope of our work.

One of the reasons why we have not accomplished more during the war has been the difficulty of making a definite connection or association with the military operations of the Government. It has been suggested that some arrangement might be made between the Government and Engineering Council, by which all kinds of engineering and kindred problems could be submitted to the Council. It is also suggested that Engineering Council offer its services to every Congressional Committee having problems of an engineering nature to report upon. If it could be brought about that the engineers would be invited to assist, it would be a very satisfactory arrangement.

There will probably be many commissions established on which an engineer member would be of great assistance in transmitting to the other members such technical information as they would need to understand the fundamentals of the technical portion of the problem and in directing the line of effort for obtaining the technical data required.

Before we can make a successful connection, however, we must have enough knowledge of their problems and enough imagination to be able to suggest along what lines we can be of assistance.

While we are holding our convention, the National Council of the Chamber of Commerce of the United States is being held in Atlantic City, for the purpose of formulating plans for reconstruction of business.

Readjustment of Labor and Treatment of Employees

Probably the greatest problem before the nation is the redistribution and readjustment of labor.

The following is quoted from a bulletin of the Chamber of Commerce of the United States with reference to "A New Service."

War conditions impose upon business and industry problems of great difficulty and unusualness, requiring thought and action.

The conditions of shortage of labor, the great pressure of demand for products, the shrinkage in the purchasing value of the wage, and the spread of democratic ideas have created the necessity for labor administration all along the line from the Government down to the small private manufacturers.

These developments have all come about so rapidly that their implications and necessary consequences have not been realized. The most far-sighted and intelligent opinion sees in these events the beginnings of revolutionary changes in industrial relations which will eventuate in a strong federal labor administration to control this vast machinery.

The employers have an unlimited opportunity at the very beginning to participate in this administration. The danger of failure is greatest from indifference and lack of understanding among employers, from an unwillingness or incapacity to learn coöperative in place of competitive methods.

The War Service Committees, under the direction of the Chamber, are working out adjustments called for by the War Industries Board as regards materials, fuel and transportation. The Committee on Industrial Relations has undertaken similarly to join with the War Labor Administration in its task of procuring the maximum utilization of our labor resources.

To investigate all experiments and developments in industrial relations both in this country and abroad and to place before the membership the results of such research. To assist the constituency of the Chamber in bettering the relationship between employer and employee by making available the records of the best experience and practice concerning wage and hours adjustment; methods of handling grievances and discipline, industrial service (improving the working and living conditions of employees and their families, housing, medical service, recreation, insurance, accident prevention, etc.); dealing with labor organizations; utilizing mediation and arbitration in disputes; securing the coöperation of employees in raising standards of efficiency; improved methods of employment management, hiring, transfer and dismissal, fitting the men to the job.

The permanent results of the activities of this committee will be educational. If successful, it will have created in the minds of employers a rational attitude, supported by facts and information, concerning the relations between themselves and those whose interests they are administering. The wage earner is just as dependent upon the intelligent and successful administration of enterprise as is the business upon the loyal and efficient service of the employees. The war has given an impetus toward democratic methods of administration both in public and private enterprise. Industrial administration must adapt itself to those conditions and conform to the prevailing ideas of the time or find itself in antagonistic relationships with all interests with whom it must deal. The employer must conceive himself to be a trustee of the interests of all involved in his enterprise and see that these interests are properly represented, lest he be confronted with opposition handicapping all his efforts. These administrative difficulties are not wholly the product of war nor will they disappear at the close of the war; indeed, it is more likely the industrial problems will increase in complexity with the coming of peace.

These quotations have been made because they describe the problems and responsibilities which are ours.

This vast and wonderful industrial organization with which we are living and struggling, is the growth of the last century. Its growth has been so rapid that neither the employer nor employee as a whole has been able to see with clear vision a just solution of the many problems of relationship one to the other. For this reason there have been misunderstandings and struggles of great intensity with the tendency of further separating the two parties, whose interests are largely in common. Protective organizations have been formed principally by the employees, whose object is primarily the betterment of the condition of the working people. Just so long as these organizations representing the employer and employee are managed and conducted for the general welfare of the community as a whole, they may be of service to the country, but when their affairs are conducted in a manner prejudicial to the interests of the community, they should be curbed.

Organized labor has its plans for the present and after-the-war period, which from all indications are very far reaching. The industries may have some plans, but they are not much in evidence.

The real issue is whether the genius of American individual enterprise is to be free, with due regard for the opportunity and welfare of all the people. The responsibility of guiding the republic rests upon such thinking men and men of experience as are members of this Society.

Many of our members are now vitally interested as employees with these great relationship problems. Some of those who are now employees will later be advanced to the position of employer, and knowledge of these problems will better fit them for advancement. By treating this matter on a very broad basis far greater progress will be made toward the establishment of satisfactory conditions than by settling down into a condition of stubbornness and refusing to look the facts in the face and endeavoring to operate under conditions which may be wholly in opposition to preconceived ideas of what is proper.

We had our labor problems before the war, they will be more complex after the war, on account of the readjustment which must take place. The bulk of the men who have gone into the service will return, many women have gone into the industries and into work heretofore done by men only, and in many instances they have surpassed all expectations. The policy to be followed by foreign countries to regain their lost or impaired commerce will have a bearing on our problems.

These and many other questions will tend to make this problem more complex.

It is hoped that as a result of this war there may be greater efficiency in industry, a better use of the productive potentialities of men and materials, more perfect business organizations, elimination of waste, the doing away with many non-essentials and extravagances, but no amount of organization, standardization and control will be of any consequence in increasing production, unless the workmen concerned will put forth the requisite effort, and unless labor stands for increased rather than decreased production, this country is on the way to industrial ruin.

As business men, employees and employers, we can individually bring influence to bear toward a fairly just and satisfactory treatment and solution of these problems, and as professional men, without prejudice, we should be qualified to discuss with impartiality these problems and act as arbiters in the settlement of many questions of doubt.

The real and great problem extends far beyond the adjustment after the war. It means the development of relationships which will enable all of our citizens to live and work together under conditions which will produce the maximum amount of happiness and contentment possible for years to come.

It is perhaps nothing more than a dream of De Constant, the realization of which is far in the future, but if we all think and work along lines which will lead up to its accomplishment, it will be aproached as years go by.

"The spirit of domination will lose more and more its prestige, while a policy of justice and conciliation will impose itself as being the only one corresponding to the aspirations and progress of humanity." (De Constant's America and Her Problems.)

Education

Another one of the most important problems in which the Society could be of great assistance is education.

The Council of this Society has been acting upon the assumption that the war may last for several years and that it would be a calamity to withdraw from our colleges and scientific schools all of the raw material for immediate use in the field, unless the crisis becomes more acute than it has yet been, but that this material should be retained for training in order to supply the loss of men which will occur if the war should go on for some years and the increased need of men trained in the sciences and industries. It petitioned Congress to enact such legislation as would enable drafted men to be assigned to special study or work and not to be called into active service until they have been fitted for the work which they can do best, unless it is absolutely necessary to have immediately a vast amount of man power in the field.

The resolutions called for "Maintaining unimpaired the engineering strength of the nation for the prosecution of military operations and for the support of the sustaining industries."

"It urges that schools of engineering as the principal sources of this training be regarded as closely allied in the material purpose with military and naval schools of the nation."

Copies of the resolutions were sent to the Secretary of War and the Provost Marshal.

A committee was appointed to ascertain the availability of technical schools and laboratories and what other opportunities there may be for industrial training.

Resolutions were passed and sent to the Secretary of War, protesting against the diversion of engineering schools from their primary function of advanced technical education, because of the persistent pressure for a training of technicians for the war.

As a result of these resolutions the Secretary of War appointed a Committee on Education and Special Training. Another result was the nationalization of scientific schools and colleges.

Committees of various kinds have been created for directing the work of special education and training for the war, but very little actual work has been done with reference to education after the war.

Bills have been passed in Congress making substantial sums available for vocational education upon joint action of the states with an equal appropriation of the allotment to the state.

If the manufacturers of the country desire to utilize this fund, it is up to them to secure the assistance of the state; otherwise the fund or that apportionment for the state not taking advanage of the opportunity will be turned back into the Treasury.

The Federal Board for Vocational Education has undertaken the work of reëducating disabled soldiers and sailors. It has made the following statement:

> In dealing with the disabled man, the Board expects to treat him throughout as a civilian needing advice and assistance, to approve his choice of occupation, unless, after careful investigation, sound opinion shows it to be in the end not advisable to train him to meet the needs of the occupation he has selected, to urge him to make the most of his opportunity to overcome his handicap by taking thoroughgoing instructions, to help him to secure desirable permanent employment, and to keep in close touch with him after he goes to work.
>
> The manufacturer should be greatly interested in this work of rehabilitation and should aid the Board in every possible way. The War Department expects to train a large number before the year is out.
>
> These reëducated men, made proficient in some trade or operation suited to their remaining capabilities, are going to constitute the most available source of skilled labor for some time to come. They will probably be the most dependable labor in the inevitable period of unrest and readjustment after the demobilization of the armies, when the country is settling back into a normal condition again. These reëducated men will form a core around which the newer labor can center. The manufacturer who has the foresight to make liberal use of these trained men is going to have an immeasurable advantage over his competitor who trusts to luck to get the help he needs out of the disbanding armies.

Very little, other than that already described, has been done with reference to education after the war. This work should be begun immediaately. Plans should be made for reconverting the scientific schools and colleges back to their peace program.

Many of our members are engaged in manufacturing and many in teaching. We have committees on Industrial and Vocational Training. There should be coöperation between the industrial plants and the schools. We can be of great assistance in the practical redevelopment of the educational systems and in the relationship between the schools and the industries, in the rehabilitation of crippled soldiers and industrial workers and the teaching of the blind, in an endeavor that every man shall have an opportunity to earn a living in a way that will carry with it some deegree of happiness.

A portion of a recent editorial in London *Engineering* reads as follows:

> Education in its broader sense should have as its main object the training of the mind towards the achievement of greater happiness and this can only be got by developing the thinking faculty so that a better perspective of life can be obtained. Thereon rests the hope for greater amity between employer and worker and a higher realization of the duties of citizenship.

The recent report by Dr. Charles R. Mann, entitled A Study of Engineering Education, prepared for the joint committee on engineering education of the National Engineering Societies, Bulletin No. 11 of the Carnegie Foundation for the Advancement of Teaching, should be read by everyone who is interested in engineering education.

The report should be of great assistance in the reorganization period. I am in accord with many of the recommendations and conclusions, particularly those mentioned in the introduction by the Joint Committee on Engineering Education, which reads as follows:

> Other significant characteristics of the report are found in the discussions of the general failure to recognize such factors as "values and cost," the importance of teaching technical subjects so as to develop character, the necessity for laboratory and industrial training throughout the courses, and the use of good English.
>
> Another point emphasized, and one of deep importance, is that of the reorganization of curricula which are commonly acknowledged to be much congested, and which it is stated will continue, "as long as departments are allowed to act as sole arbiters of the content of the courses." Plans are offered for developing particular types of curricula suited to the environment of each school.
>
> Emphasis is also given to the necessity for a broader training in the fundamentals of science as an equipment for all engineers and forming a sort of "common core" to every curriculum. With this broad training in the first and second years the student is expected to develop some natural leaning toward a specialty, and then will follow vocational guidance in the later stages of his education.

The scale for measuring the success or failure to provide proper training for engineers has been created by the practicing engineers. That scale is the improvement of character, resourcefulness, judgment, efficiency, understanding of men, and last of all, technique, as shown by students.

With the conversion of the schools and colleges to war work, intensive study became necessary. Everything except the essentials was eliminated, with more hours of work per year.

It would be a good thing if in the reorganization period much of the specialization work can be eliminated and thus a shorter time be required for college work for the bulk of the students, and if a greater portion of the year could be devoted to work, thus using the educational plants to a higher degree of efficiency, that is, with a higher load curve.

In educational, as well as in other lines of endeavor, if we have not learned a lesson of conservation of time and effort, we shall have missed some of the benefits which it is hoped will be derived from the war.

Conservation

Next in order of importance to labor in the industries is the ability to procure raw materials in sufficient quantities and at reasonable prices. I will not dwell upon this subject, but will pass to the question of power, with which we are more closely identified, and which affects directly the bulk of our people.

Many of our members have been assisting in the conservation of fuel by serving on committees or individually in attempting to assist the various fuel administrators in the country, or on committees or commissions established for the proper development and utilization of our water resources.

Considerable savings in fuel have been effected recently by more careful attention to the burning of fuel and the use of steam in prime movers, but much more has been saved in simple commonplace and common-sense ways of preventing the waste of heat and power after they have been delivered from the boiler and engine rooms to the various rooms and departments about the plant.

An example of the sort of work which the engineers can accomplish in fuel conservation is that done by the Advisory Engineering Committee to the Fuel Administrator of Massachusetts, all of the members of which, with one exception, are members of this Society, in the assisting in the establishment in every plant and building using steam for heating and power, of a fuel and power committee within its own organization, whose duties are:

1 To see that fuel is burned economically and to prevent waste of steam and power
2 To initiate and carry on a campaign of education among fuel and power users
3 To distribute among users, engineers and firemen an outline of the items of loss, and to supply information for the purpose of saving fuel and power
4 To assist local fuel committees in enforcing economies in wasteful plants

5 To enlist the services of engineers in carrying out this program.

Similar work has been done by other committees in many states.

During this work, however, we have been endeavoring to get the best results with the existing facilities. We should now be studying the vaster problems which are to be undertaken in the future for the conservation of our natural resources.

The generation and transmission of energy by electricity has changed the conditions so radically in the last few years as to require the most careful study of the proper place and manner of the production of power for all purposes.

The problem of power supply is very intimately connected with the railroad and transportation problems, and a study of one involves the study of both.

There have been very serious delays in the transportation of materials and supplies, and one of the principal reasons for coal shortage last winter was a lack of sufficient transportation facilities. It is stated that about one-quarter of all the coal used and transported is for the use of the railroads, and another large portion is required for manufacturing, lighting and power. Some of this necessarily must be used at the plants for heating and manufacturing purposes.

Much of this traffic could be eliminated by the establishment of large steam-generating plants located as near the coal mines as conditions will permit, and on tide water, where coal and oil could be brought in by vessels, by the development of hydro-electric powers, which are within reasonable distance of the market, and by the electrification of the railroads, with great trunk connecting and transmission lines. Incidentally with the further development of hydro-electric power is the saving in labor required for the mining, transportation and burning of coal.

Savings can be made by more careful study and use of the waste heat of furnaces in the form of gas for the production of power, and from steam turbines and engines by the use of steam and warm water for heating and manufacturing purposes.

Further conservation of power and fuel can be made by interconnecting transmission line between the hydroelectric companies so that the greatest possible use could be made under the varying conditions of flow of the steam at the different developments.

Still further saving of fuel can be made by the redevelopment of many of the older water-power plants, which contain inefficient wheels in efficient settings, and it may be possible in many cases to increase the capacity of the plant so as to use all of the water for a longer period of the year and waste water for a shorter period.

The conservation of flood waters, now wasting, by the construction of storage reservoirs, is receiving greater consideration. Special commissions have been appointed in some states for the study of this question, but as yet no great progress has been made so far as reservoirs for power are concerned. Most of the reservoirs for power already constructed have been built by private interests and by agreements among parties deriving benefit from such reservoirs.

The four chief reasons why this sort of development has not proceeded more rapidly are that the development expense and yearly charges of many would be so great that the returns would be insufficient to offset them and show a fair return on the investment, the inability of parties at interest to agree on some working plan for sharing the expense, that legislation has been of a discouraging nature, and because in the past all values have been measured in dollars and cents, as applied to the cost of power with not much consideration to conservation or the uses to which the power was put.

The expense of such large developments at the mouth of the mines and at tidewater, and of the development of some of the hydroelectric powers, may be too great for private interests to undertake. The uncertainties and restrictions imposed have been such as to prevent the development of some of the possible water powers. More liberal legislation is needed to encourage these undertakings in many of which the margin of profit is small and doubtful. Congress has now under consideration a water-power bill which it is hoped will encourage developments.

From now on we should consider the value of development with a broader conception of not only the net comparative cost of power, as produced by one means or another, but also in connection with the desirability of having another instrument by which the full production is assured, the value of the product being far greater in most cases than the cost of power, and with the desire to conserve our natural resources, and with a view in times of shortage, of assisting in the general stabilization of business.

It is not conceivable, however, that the business men will be willing to make expenditures for anything that will not improve their own property or conditions, and any excess expenditure required for conservation for the benefit of the general public must be met from the treasury of the public. It is conceivable and proper, however, that the individual should take a broader view of the benefits to be derived from expenditures for his own benefit.

The basis for valuations of all properties or undertakings while subject to discussion and variation of opinion, was fairly recognized three or four years ago. Estimates of initial cost, cost of operation, gross and net income were made to determine the value on a basis of dollars and cents.

During a period of war, costs and values were increased enormously, and values are not measured in dollars but in time, necessity and quick availability for the purpose of ultimately saving life and vaster amounts of property and even the safety of the nation.

After the war there must be a readjustment of values, and with this there should be a broader conception of values than that measured wholly in net returns of money.

The above outline of possible methods which might be used for the conservation of fuel is made for the purpose of describing in a general way the broader view which should be taken of this particular subject, and as an example of how the many other problems which have been summarized earlier should be attacked, not as a problem by itself to be decided in terms of money as applied directly to that particular problem, but with careful consideration of the broader bearing upon the greatest good for the community or country. Such broad consideration as this will necessitate a remolding of our former circumscribed conceptions, a broadening of our imagination and the weighing of the effect of action and consequences in the broadest and most liberal manner.

As a people we should readjust our methods of life, getting down more nearly to the fundamentals, eliminating many extravagances and wastes in our private method of living, in our local, state and national governments, in education, in the industries and in all of our activities, so that we may not rob future generations of the heritage which is rightfully theirs, and so that we, ourselves, may by elimination of many cumbersome things, get a better perspective of what is necessary and right and live with a better conception of the real things of value on this earth. If we shall not have learned a lesson which will enable us to do so, a part of our suffering will have been in vain.

In closing I desire to quote from an article prepared by Hon. Joseph I. France, which is applicable to the present time and during the period of reconstruction:

"Scholars and members of these great academies, officials of states and nations, men in the armies, men and women in all our industries and at home, must catch a vision of this process and of this plan and strike strong, increasing, shaping, fabricating blows in order that in these fires American may be welded into that new and more nearly perfect symmetry and unity which will assure to each and to all the utmost safety and the highest liberty.

"In America the new temple of liberty is not yet builded, but it is in the building, and it is for us, for each living American, an hour of opportunity and of destiny, in which we all must rededicate ourselves unreserved to sacrifice, to toil and to unwearying service until the nobler and more lofty fane is fully complete."

AIMS AND ORGANIZATION OF THE SOCIETY

Progress Report of the New Committee on Aims and Organization of the Society, Presented by Mr. L. C. Marburg, Chairman, at the Thirty-ninth Annual Meeting

THE Committee on Aims and Organization convened for its initial meeting on Monday, December 2, when the following were present: Representing the Local Sections—Earl F. Scott, Atlanta; Charles H. Repath, Los Angeles; C. H. Bierbaum, Buffalo; E. S. Carman, Cleveland; Ralph Collamore, Detroit; A. G. Duncan, Boston; John T. Faig, Cincinnati; Howard Gassman, Birmingham; Howard Gustafson, St. Louis; J. L. Henning, New Orleans; C. E. Lord, Chicago; L. V. Ludy, Indianapolis; T. C. McBride, Philadelphia; G. K. Parsons, New York; H. P. Fairfield, Worcester; C. M. Spalding, Erie; L. H. Strothman, Milwaukee; C. W. Tubby, Minnesota; A. E. Walden, Baltimore, and Robert Sibley, San Francisco. Members at Large—L. C. Marburg, Sumner B. Ely, W. F. M. Goss, L. P. Alford, Dexter S. Kimball, F. R. Low and James Hartness.

The program reproduced in the center of the page was discussed, and the proceedings of the meeting are described in the following report by Mr. L. C. Marburg, Chairman, which was delivered at the business meeting of the Society, held in the Auditorium of the Engineering Societies Building on December 4:

Committee on Aims and Organization

PROGRAM OF FIRST MEETING

December 2 to 4, 1918

A. RELATIONS OF THE MECHANICAL ENGINEER TO HIS WORK.

Note—Here should be classed all activities of the Society to be undertaken for the benefit of mechanical engineers, either individually or as a group.

1 Discussion, Recording and Dissemination of the Progress in the Art of Mechanical Engineering and Allied Sciences.
2 Conducting and Assisting Research.
3 Standardization.
4 Industrial Management.
5 Education and Special Training.
6 Legislation and Jurisdiction affecting Engineering Profession.
7 Engineering Societies' Employment Office.
8 Code of Ethics.
9 Other subjects that suggest themselves.

B. RELATIONS OF THE (MECHANICAL) ENGINEER TO THE COMMUNITY.

Note—These relations identical in principle with the relations of other engineers to the community. Here should be discussed the engineering profession's opportunity to render service to the community.

Ba. IN CONNECTION WITH LEGISLATION.
1 Protection of Health, Life and Comfort.
2 Production, Distribution and Sale of Commodities and Service (exclusive of "Public Service").
3 Industries, Utilities and Natural Resources, Owned or Controlled by Communities.
4 Legislative Changes to Secure for the Engineer Influence in Public Affairs.
5 Other subjects that suggest themselves.

Bb. IN CONNECTION WITH ADMINISTRATION.
1 Placing Engineers in Public Positions requiring Engineering Training.
2 Coöperation with Engineers in Public Positions.
3 Creation of Special Organizations in Times of Emergency.
4 Other subjects that suggest themselves.

Bc. IN CONNECTION WITH JURISDICTION.
1 Assistance in Enforcing Legislation as mentioned under *Ba*, by obtaining action against violators and helping in the securement of expert testimony.
2 Assistance in the Settlement of Disputes.
3 Other subjects that suggest themselves.

Bd. IN CONNECTION WITH PUBLIC OPINION.

C. RELATIONS OF THE MECHANICAL ENGINEER TO OTHER ENGINEERS.

Note—Under this heading should be discussed the organization of the Engineering Profession.

1 Advantages of Closer Relations.
2 Form of Closer Relations (Organization).
3 Internal Organization of the A. S. M. E.
4 Other subjects that suggest themselves.

PROGRESS REPORT OF THE COMMITTEE

At our Spring Meeting at Worcester last May, a resolution was passed expressing the opinion that the activities of The American Society of Mechanical Engineers, as demonstrated in meetings and literature, were not in harmony with the aims and purposes of the Society as expressed in the Constitution, and suggesting to the Council to take some action to have the aims and purposes of the Society restated.

Closely upon this resolution at Worcester followed the memorable resolutions of the American Society of Civil Engineers, passed by the Board of Direction on June 18 of this year, creating a Committee on Development. Extremely well they state in their preamble the considerations which make a broad survey of aims and purposes advisable. Let me quote:

> The development and application of the sciences in recent decades have caused profound changes in the social and industrial relationships of all peoples.
> The Engineer has been a leader in this progress.
> Sociological and economic conditions are in a state of flux and leading to new alinements of the elements of society.
> These new conditions are affecting deeply the profession of engineering in its services to society, in its varied relationships to communities and nations, and in its internal organization.

These are days of change; indeed, days of revolution. Overwhelming, unbelievable are the transformations taking place. Empires have fallen almost between two succeeding editions of the same afternoon paper. Only a few years ago individualism

reigned supreme in the business and life of our country; these last few months we have had our breakfasts and our dinners regulated; have been told when we may drive our automobiles, and what not. And then our railroads, our telephones and telegraphs, our express companies are operated by our Government. True enough, it has all happened under the exigencies of war; but who will say how far we will go back in times of peace? Revolutions we have witnessed and are witnessing; but not only political, economic and social revolutions; revolution even more in our habits of thought and our ideas as to the necessity of preserving the past. While we are casting off long-cherished methods of conducting the country's everyday life, we are challenging conventional ideas and preconceptions, we doubt theories held almost sacred heretofore, and we freely question not only the views of others but our own. A momentum has been acquired by this habit of thought which will carry us, if we but guide it wisely, far into the promised land of economic efficiency and social justice; not to the millennium, I am sure, but to institutions based on modern thought and present-day development instead of on conditions and beliefs a century ago.

What Is the Engineer's Part?

But dreams do not come true unless we work for them. What, then, is the engineer's part in carrying this dream to reality? What is and what should be the position of the engineer today? Look about you. You see a world on which, during the past two generations, the engineering profession has placed a stamp more marked than any other group of men, but in the management of which it plays a rather secondary part. There is an abundance of public work and public business which is of a nature familiar to the engineer and similar to the tasks he performs in his everyday activity. Much of this public work is done in such a way that no private industry or institution could copy it without fiasco, financially and otherwise.

Some of these thoughts gave impulse to the creation of the Committee on Development and to the creation of our own committee. The formation of these committees is interesting; they consist of one member from each Section and of several members at large appointed by the President. With our committee a temporary executive committee was appointed by the President to handle all business previous to the first sessions of the general committee and to prepare a program. A meeting had been planned for the last days in October in connection with the Indianapolis Mid-Western Sections Meeting, but this had to be postponed on account of the influenza epidemic. So, Monday and Tuesday of this week we had our first meetings, and no doubt you wish to know what we have accomplished. We had with us representatives from almost all the Sections. Our work, of course, has reached no final stage, but we have passed two resolutions, which I am instructed to present to you. The first one reads as follows:

Broader Scope for Society Recommended

Whereas, The engineer has been in the past too closely concerned with the purely technical side of his work, and as a consequence has not, in general, occupied a position of influence in local and national affairs, and

Whereas, By education and training he is preëminently fitted to deal with many matters of great importance in public and private life, and

Whereas, The services of the engineer in such matters will be welcome if he will qualify in this broader sense, be it therefore

Resolved, That to this end the scope of The American Society of Mechanical Engineers should be broadened to give full recognition and encouragement to the individual engineer to accept the opportunities offered in today's widening activities, such as:

1 In his relations to his own work
2 In his relations to the community
3 In his relations to other engineers.

These resolutions express the thought that opportunities await the engineer in public life, and that he will be welcome to render service to the community as soon as he will fully qualify for it. And these resolutions recommend that The American Society of Mechanical Engineers extend the scope of its activities, so as to aid its members in their preparation for the broader activities now presenting themselves. It is a resolution of a most fundamental character; it suggests that if the engineer today does not hold the position in public life which he believes he is entitled to, the fault is largely with himself.

There is this continual complaint that engineers are not receiving what is due them. All sorts of panaceas are proposed to remedy this situation. One thinks licensing of engineers is what we need, another one believes in advertising our achievements; most are looking for the trouble outside the family and not within. The resolution expresses a different attitude. It is necessary to realize the shortcomings of many, and perhaps of most, of us. They are largely the result of the character of engineering work. Most engineers are little in contact with the public in their daily occupation. Their work most frequently requires great concentration, and quite often must be kept secret. Engineers, therefore, do not come much in contact with the people the way the lawyers do, for instance, and their relations, except with other engineers, are mostly with superior or subordinate. Furthermore, the engineer's whole training is largely mathematical and educates him to a step-by-step reasoning; it rather curbs imagination—so necessary for big things.

Publication Policy Endorsed

The other resolution the Committee wishes to present to you today deals with the literature of our Society as a means of broadening the scope of our activities. It also states that the Committee on Aims and Organization is vitally interested in this literature as a means of establishing closer contact with the membership at large and of securing a fuller expression of its sentiment. The resolution reads as follows:

Whereas, One immediate and powerful means to broaden the scope of The American Society of Mechanical Engineers would be the strengthening of its literature, and

Whereas, It is vitally necessary to establish a closer point of contact between the individual member and the Committee on Aims and Organization, in order that the committee may better express the sentiment of the membership at large, therefore be it

Resolved, That the Committee on Aims and Organization supports the recommendation of the Publication Committee regarding the increase in the frequency of issue of The Journal in its contemplated improved form as a matter upon which immediate action is necessary.

The foregoing resolutions, if followed, will involve certain changes in the organization of The American Society of Mechanical Engineers which will require more careful consideration, and the Committee wishes me to say that on this subject, as on many other subjects, it is not ready to make any suggestions at this time.

On the preliminary program, discussed at the Committee meeting and here reproduced, there are many subjects of interest to us. Additional ones should, without doubt, be added. These subjects are intended just as a hook to hang a coat on. They are to serve as guides in our discussions, and they have helped us in the formation of three large sub-committees for the consideration of the main subjects under captions A, B and C. These committees will take up these broad topics, will discuss them with such members of our Society as have already devoted a great deal of thought to some of the individual subjects like standardization, research and others, and will report to the general committee at its next meeting. They will outline their suggestions as to a broadening of various fields and as to entirely new activities. The Committee members will discuss most topics with their respective Sections, and in this manner help to crystallize the views of most of our membership. The Committee hopes that suggestions will be sent freely for its guidance.

You may feel that the Committee has not produced much as a result of two days' sessions. But consider this. The Committee must approach all subjects and all views presented with an open mind. It surely must not rush into the formulation of resolutions except on some most fundamental points, for the discussion should remain in a state of flux. Our views on some of the great subjects here before us may be different a few months hence from what they are today.

May I, then, be permitted to express a few thoughts that have passed through the minds of some of us during the last few days or in connection with the preparation of the preliminary program. They are thoughts and ideas that have not taken definite form as yet, but they will occupy us much in the months to come. In doing this I am speaking not for the Committee but on my own responsibility.

Let me say that neither myself nor any one with whom I have talked so far has advanced a finished program for our Society's activity or the profession's organization. But the general belief is that a free and nation-wide discussion will lead to a crystallization of ideas and to a plan of liberal coöperation between all engineering organizations.

Type of Organization Wanted

Our Committee is called the Committee on Aims and Organization, and the preliminary program placed before our Committee, as you will note from the copies here distributed, follows this name. What, then, should be our aims? what organization will be necessary to carry them out? Let us consider for a moment along broad lines what our aims should be. As individual engineers we wish assistance in our work; we wish to help each other and our profession in many matters affecting mainly our group, rather than the community at large. And in these activities we are joining hands with other men of similar education and similar training as ourselves. But there are other aims, may I call them public aims; the desire to render service to the community in matters in which our engineering training makes us essentially fit to have an opinion and a worth-while judgment. In any such activity we must join a larger group than in our professional activities if we expect success. Just how large the group should be I am not prepared to say. But just remember this: If the group looking for public influence consists of fifty thousand highly educated men, one hundred thousand or two hundred thousand will remain outside, all familiar with the same problems and vitally interested in the same decisions which affect the fifty thousand engineers. These hundred thousand or two hundred thousand men will have to be convinced inside or outside our group. But will they be convinced by our arguments more readily when excluded from our councils? The world has talked democracy for four long years. Most everybody has done some thinking as to what this ideal really is for which so many have died. Give democracy a trial. If those who have had the benefits of education are not able to lead the economic group of which they are a part, if they cannot convince the men who have a certain understanding for the special problems to be considered, how then are they to convince the whole community? And if we do prevail in one group, we shall have a powerful array of men on our side to spread the gospel among all levels of society.

Organization of the engineering profession, then, must deal with two separate groups of aims and with two separate groups of partners with whom we wish to join. When looking at the problem in this manner, it becomes at once apparent that possibly two entirely different types of organization may be wanted, one for professional work and one for public activities. Let us follow up this thought and let us see how far existing organizations may be used. When we aim at technical discussions, when we wish to further research, standardization, the art of management, and so forth, when we wish to bring the engineers together, according to their main interests, we can, in principle, hardly much improve upon the grouping we now find in our national societies. Of course, we always see occasion for improvement here or there in the methods we are following. We need more local sections, for example, for the reason that not all members can come to headquarters to participate in technical discussions. Sections should be encouraged to coöperate with other local sections and to affiliate with local engineering societies. This has so successfully been done in several localities that it should be further encouraged. But, above all, more coöperation is needed among the national societies themselves. Just in what manner this should be done is an open question; whether by bringing all national societies together into one society or simply by closer and closer contact between them and more joint committee work, it really matters little. But more coöperation in some form is the gospel we should preach.

A Way to Get Representation

As stated before, I am far from having a ready-made program to offer, and, of course, the Committee has not as yet reached any final conclusion. But may I suggest that successful activity in public matters on the part of engineers has so far been practically limited to local all-inclusive engineering societies. I know that I am not expressing the views of all the members of the Committee when I say that the local all-inclusive engineering society is the best agent through which the engineer can render public service. But it seems so to me; first, because there are many more local problems that interest him as engineer than state or national problems; and, furthermore, because the local all-inclusive engineering unit lends itself most readily as the basis of state and national organizations for public engineering service, organizations which must adapt themselves to the existing organization of our country so that mobilization will easily be possible in cities, states and nation. There seems to be no reason why a number of such local units, located in one state, cannot appoint delegates to a state body consisting of such delegates, and thus secure a fair representation to the engineering group of the state in question. We have seen a development in this direction in Ohio. And why should we not go further and have representatives of all such local bodies joined as a national body representative of the country's engineering group. In other words, the local unit would be the basis of our whole structure for public service, as opposed to our organizations for professional aims, formed on a national basis and along lines of specialization. The local unit would be all-inclusive and would act direct in local matters while acting through delegates and representative bodies in state and national affairs. And the national societies should be represented on the national body.

No matter, however, what means may be adopted as best suited, what should be emphasized is this: The issue is not individual activity but group activity. The issue is not, as frequently expressed, that, of course, the engineer must be a good citizen like everybody else; it is not a question of voting the Republican or Democratic ticket. The division must be a different one. It is a question of making available to the community the combined training and combined experience of the group of engineers, just as I hope other groups of men will do in the days to come.

Our Duty to Understand Labor

And in the consideration of the problems that are before us, may I suggest this thought, a thought discussed quite frequently by some of us. Among all the educated classes, the engineers are the one group in closest touch with labor. It is the part of wisdom and our duty to Society to try to understand the strivings of the working classes for our own benefit and to interpret them to the rest of the community. If the British Labor Party has been able to frame a reconstruction program and to produce a document commanding the admiration of most thinking men, surely it behooves us, the engineers, the men of whom, on account of training and experience, industrial leadership might reasonably be expected, to discuss the mighty problems now before us. And just to show how old this thought is in our Society, let me read a paragraph from Dr. Thurston's Presidential Address in 1882, the third year in the existence of our Society:

> In singular and discreditable contrast with all the gain in recent and current practice in engineering stands one feature of our work which has more importance to us and to the world, and which has a more direct and controlling influence upon the material prosperity and the happiness of the nation than any modern invention or than any discovery in science. I refer to the relations of the employers to the working classes, and to the mutual interests of labor and capital. It is from us, if from any body of men, that the world should expect a complete and satisfactory practical solution of the so-called "labor problem." More is expected of us than even of our legislators. And how little has been accomplished?

We speak so frequently of reconstruction, but as on the battlefields of France this cannot mean the restoration of all the old and often unwholesome dwellings that have been destroyed, so the reconstruction that we have in mind should not mean a re-establishment of institutions superannuated long ago but only broken down in the days of stress that we have passed. Many of the old conditions we do not want again; the *status quo ante* is not desired; and even if desired could not be revived. But what we wish is a renaissance rather of our institutions, with higher ideals and a clearer purpose than we have had before.

BUSINESS MEETING

Proposed Constitutional Amendment to Provide for Representative Nominating Committee—Addresses by Presidents of Civil and Electrical Engineers—Presentation of Report by Aims and Organization Committee

The annual business meeting of the Society was held in the Auditorium of the Engineering Societies Building on Wednesday, December 4, at 10 a.m. After calling the meeting to order, President Charles T. Main announced that the Committee on Constitution and By-Laws was ready with a report on the proposed amendment to the Constitution and that it would be presented by Past-President Jesse M. Smith, chairman of the Committee.

Mr. Smith stated that the proposed amendment was designed to take from the hands of the President the appointment of a Nominating Committee for officers of the Society and put that authority into the voting membership. The committee, who had considered the amendment at length, had couched it in broad language so as to permit of one or more nominating committees being appointed, and had left the matter of details as to formation of committees, their number and procedure to be handled by by-laws.

On motion of Prof. A. M. Greene, Jr., seconded by L. C. Marburg, it was unanimously voted to submit the proposed amendment (published in The Journal, December 1918, p. 1066) to letter ballot.

At the request of President Main, the Secretary briefly commented on some of the outstanding features of the reports of the various Standing Committees of Administration, and stated that it was the urgent desire of these committees to obtain an expression of opinion on the part of the membership regarding the work of the Society. The Finance Committee, he said, was dealing with a budget larger than that of any other professional society in the world, save two, amounting to $236,000 for the coming year, which, it might be stated, was well within the income of the Society. The Meetings and Program Committee, it would be seen in their report, was extending the scope of the work of the Society so that it was really becoming a society of the industries. In close connection with their work was the recent action of the Publication Committee in recommending the purchase of the Engineering Index, ownership of which had now been acquired from its former publishers. It was proposed to further extend the usefulness of the Index by making avail of the unequaled facilities afforded by the Library. With the growth of the Society, whose membership had almost reached the 10,000 mark, and the realization of projected plans regarding its publications, its revenues would not only support all of the present activities but would make it possible to appropriate substantial sums for research work. The vote that had been taken on the proposed amendment he regarded as the most momentous in the history of the Society.

A. W. Robinson emphasized the importance of the Society's broadening its activities by taking up economic questions, such as the conservation of natural resources, coal consumption, the gasoline problem, ocean transportation and the like, and not leaning too much to mechanical details.

Addresses by Prof. A. N. Talbot and Prof. Comfort A. Adams

The latter half of the meeting was devoted to a consideration of the work of the Society's new Committee on Aims and Organization. Prior to the presentation of the preliminary report of the Committee, however, President Main called upon Prof. A. N. Talbot, President of the American Society of Civil Engineers, to address the meeting on this subject. At the conclusion of his remarks, Vice-President Charles T. Plunkett was asked to occupy the chair, whereupon L. C. Marburg, chairman of the Committee on Aims and Organization, presented its report. Abstracts of the addresses of Professor Talbot and Mr. Marburg follow this report.

Chairman Plunkett then introduced Prof. Comfort A. Adams, President of the American Institute of Electrical Engineers, who spoke briefly on the public service the engineer should render to society.

At this particular time, said Professor Adams, with the whole civilized world in a state of ferment, it certainly behooved us to take account of stock, not only to investigate our work in the technical field, not only to see whether we were serving our profession as professionals, as individuals, as a rank and file, but also, and equally important, to see whether or not we were serving society by playing our part in the great movements that were going on about us.

The American Institute of Electrical Engineers, he thought, was, if not the first, one of the first of the societies to take cognizance of the interests of its outlying members by the establishment of sections throughout the country, and this establishment of sections and branches—branches being established in the educational institutions—had proved very helpful. There were, however, many problems common to all the societies which had to do with the meeting of the demands and the interests of the rank and file of the membership, and one of the most important features of this broad task of review, development and progress of an organization should be the consideration of the interests of its members at large.

But we must go even further than that as individual societies—we must take cognizance of our relations to each other as societies. We were coming more and more to realize that there was no line of demarcation between civil, mining, mechanical and electrical engineering, and no sharp dividing line between engineering and industry, industrial management, administration, politics, economics and many other things. We were so intimately associated with these outlying fields, these broader questions of industrial economics of labor and capital, that it was impossible for us if we were to take our proper place in society, to sit down and allow lawyers and editors to handle these great questions alone, and we to stand apart and aloof. We must get into politics and take a hand in the legislation of the nation.

It had often been said that the engineer's training was such as to give him a position of special advantage, because he was dealing with the hard and fast laws of nature, which did not yield to his individual interest—he was forced to think straight. That was all very true, in so far as he was strictly a technical engineer, but much of our work got outside of that.

Moreover, the engineer was many times at a disadvantage, because he was in such close touch with the financial end of things that it sometimes outweighed the other side of his training. We were not less human than members of other professions, in all probability, in being swayed by our own immediate material interests. But we had, nevertheless, this background of law and science on which we should be building, not only an engineering structure, but we should be able to apply these same principles and these

same habits of thought to the solution of many of our economic problems.

The labor question was one of the most difficult problems before the nation in this reconstruction period. We could meet it in a progressive way, trying to face it fairly and squarely, to set aside tradition and past methods and clearing away divisions of personal interest, and realizing that the real interests of labor cannot be separate or distinct from the real interests of capital or the engineer. Or we could employ the method of suppression; but that, like the suppression of the expanding power of explosive force, was apt to result in an explosion. This was no light matter—it was not a mere conjecture—explosions of this nature had occurred in other nations, and it was not an altogether foregone conclusion that they might not occur here.

Suggestions for the Organization of Engineers, by Past-President Jesse M. Smith

Following the remarks by Dr. Talbot and Professor Adams, Past-President Jesse M. Smith said: "I have listened with very great pleasure to what the President of the American Society of Civil Engineers has said and to what the President of the American Institute of Electrical Engineers has said, and it only goes to show how very closely we are getting together as a body of engineers, without regard to specialty. In this connection I am tempted to read from a letter which I recently wrote on the question of the comprehensive organization of the Engineering Profession in America and the relations of such an organization to the present United Engineering Society.

The Charter and By-Laws of the United Engineering Society are very broad in their scope and cover many functions which have not as yet been utilized.

The U. E. S. at first only utilized one of its functions: namely that of a holding society for the American Society of Civil Engineers, American Institute of Mining Engineers, American Society of Mechanical Engineers and American Institute of Electrical Engineers, which are the "Founder Societies," by which the title to the real property owned jointly by the "Founders" might be held by one society. This function I have always considered a minor function but a very valuable one, particularly in the early days when the first steps were taken to solidify the profession.

Other functions have from time to time been utilized but none of them to their full extent as yet. I refer to the Library Board, the Engineering Foundation and the Engineering Council. The work of each of these boards has been well started and will be perfected and extended. The proper financing of these different Boards seems to me to be the principal difficulty and should be undertaken by *one society*.

Now comes what seems to me to be the *principal function* of the U. E. S.: the *purely professional function*.

In order that the profession may be truly solidified, I believe that there should be *one* American Engineering Society and that the U. E. S. and its four Founder Societies should be merged into *that one*, not only for business purposes but also for social purposes and for the general good of the profession, but principally for *purely professional purposes*.

Let me briefly outline a plan which has been revolving in the back of my head for several years.

1. Let the members of the four Founder Societies take membership in the American Engineering Society in such grades as they are qualified to occupy according to the present qualifications for membership in the Founder Societies. These qualifications are now substantially the same in each of the four Founder Societies.

2. Let all other engineers, who are members of other societies or are not members of *any* society, take membership in the American Engineering Society according to their ability to meet the qualifications established by this society.

There would thus be created a National Society of enormous membership, of 100,000 or possibly 200,000 members.

Such a society would be unwieldy for the transaction of its affairs, either professional or business, were such affairs not committed to boards or committees. Many engineers regret the passing of the smaller societies where the members came into close personal touch and the papers were freely and intimately discussed. This was true of each of the Founder Societies in their earlier days—but those days have now passed.

To meet these objections, which are real, it is proposed to form the large membership of the American Engineering Society into branches—or groups according to *Specialties in Engineering*.

Each of the four Founder Societies contains engineers of quite different specialties. For example, the Civils contain railroad engineers and hydraulic engineers; the Miners contain metallurgical engineers in iron and mining engineers of precious metals; the Mechanicals contain steam engineers and machine-tool engineers and the Electricals contain telephone engineers and power-transmission engineers, and there are still other specialties of importance in each society. Many of the specialties have no close relation to each other in a technical sense but they all are a part of the engineering profession.

Suppose, for example, there be ten or fifteen such branches or groups, which number could be increased as the demand required.

Each branch should consider *only purely professional subjects* in its own specialty and its affairs should be in charge of a committee of its *own members* elected by the *members* of the branch, and should be presided over by a vice-president, also *elected by the members of the branch*, and who should also be a member of the governing body of the society.

The governing body or Board of Directors of the society should consist of:

The President to be elected by the entire voting membership of the society.

One Vice-President to represent, and be elected by, the voting membership of each branch.

One Director to represent, and be elected by, the voting membership of each branch.

A Technical Secretary of each branch.

A General Secretary of the society.

A Treasurer of the society.

The Board of Directors should control the general affairs of the society and direct the policy of the society as well as the general policy of the branches, leaving to each branch the detail of the conduct of its own meetings.

All publications should be undertaken by the society. The proceedings of each branch should be published as a separate volume. One volume should be given to each member of the society free of cost, but he should have the right to subscribe for as many other volumes as he would care to pay for at cost price. All volumes should be available for sale to the public at more than cost price for the benefit of the society.

Membership fees in the American Engineering Society should be as low as possible in the junior grade and increase with the higher grades so that there would be ample funds from membership fees to meet the requirements of the society in all its activities.

So much in a broad way for the professional side of the question.

Now for the social side: The getting together of engineers in elbow touch for conference and social intercourse is quite as important as the professional contact.

The social and professional contact should not, however, interfere with each other and should be organized in a sense independently of each other. Members of the society should all be eligible to membership in the social organizations but should only become members of those social organizations upon the payment of a separate fee for the support of those organizations.

The American Engineering Society should encourage the formation of a series of engineering clubs in different cities which would be the centers of engineering activities in those cities and which would naturally be the centers of professional sections of the American Engineering Society in those cities.

When the Founder Societies and other engineering societies are merged into the American Engineering Society the local sections of these various societies would also naturally be merged and have their centers in local engineering clubs.

Local engineering societies might also be merged into such local sections and clubs.

A member of an engineering club in any city should be given the privileges of the engineering clubs in other cities.

Professional engineers will only become a real power in our country's affairs when they are consolidated for coöperation in professional work and become *a single unit* in all that relates to the profession at large.

In the short time remaining for discussion the addresses of the morning were briefly discussed by Dr. John A. Brashear, J. Clinton Parker, L. W. Wallace, H. H. Suplee and Spencer Miller. Dr. Brashear cited instances from his experience with Presidents Cleveland, Roosevelt and Taft, showing the interest they had taken in scientific matters submitted to them and their willingness to be of assistance. Mr. Wallace was of the opinion that engineers should make their influence so potent in economic, industrial, political and engineering matters that the public would be forced to realize that they are a body of highly trained professional men deserving of high recognition and appreciation. Mr. Miller spoke of the recognition the engineer is now receiving in Washington. He counseled brevity in any statement of aims and thought it would be fortunate if such an expression could be brought down, say, to fourteen points. The meeting then adjourned.

ENGINEERING SOCIETIES' COMMITTEES ON AIMS AND ORGANIZATION

By ARTHUR N. TALBOT,[1] URBANA, ILL.

The work given to the committees which have been formed by at least three of the Founder Societies has its purpose well expressed by the name given to the committee of The American Society of Mechanical Engineers—the Committee on Aims and Organization. The resolutions of the Board of Direction of the American Society of Civil Engineers creating the Committee on Development of that society instructs the Committee to report on the purpose, field of work, scope of activity and usefulness, organization, and methods of work of the society. It is apparent that the committees have much in common and that there should be full and free coöperation. What should be the aims and purposes of such societies, how they may best be organized for present-day conditions, and what they may be expected to accomplish are then within the scope of the work of these committees.

These are times of development. The great world war and all the attending phenomena have brought about new conditions. Men are thinking outside the lines which formerly limited their thoughts and methods. The existing state of flux in sociological and economic conditions may deeply affect the opportunities and responsibilities of the engineer. Great changes and great development may be expected to follow. It is apparent to many observers that a larger sphere of activity and usefulness will be opening to the profession of engineering, if only the engineer is ready to undertake his part now and later. And, besides, the engineers' work has developed so rapidly and so diversely in the past forty years that we hardly know where we are. Engineering societies have grown at a very rapid rate; local and specialized engineering societies have sprung up everywhere. The conditions in the more remote parts of the country may differ materially from those in and around New York. In all there are some 35,000 members of the four national engineering societies. How many there are in the hundreds of local and specialized engineering societies, is not known. It is considered by some that the number of men who may justly claim the right to be classed as engineers runs up to more than 100,000.

In view of all this is it not well to seek to make a survey of the aims and purposes of the engineering societies, to ask whether they are occupying all the fields of usefulness open to such societies and whether they are accomplishing all that may reasonably be expected of such organizations?

Even if the survey made by the committees should result only in broadening and intensifying and emphasizing the activities, functions and methods of work already in existence, the effort will be worth while. More likely, the study of the problems will show new opportunities and responsibilities devolving upon the societies, and especially that, whether inside or outside the field of the national engineering societies, there are matters of public and semi-public nature which should be considered by the engineering profession more fully than has been the case in the past.

In taking up this inquiry no one should feel that the consideration of aims and organization is in any way a reflection on the conduct of our societies in the past. All will agree that their record is most excellent. The accomplishments of the societies, technical and extra-technical, redound to the credit of the societies and their membership. These societies have helped to create the engineering profession. In ways that are not usually recognized the engineering society has been a benefit to the engineering profession and to the public. It has given esprit de corps to the profession. It has made its members feel self-respecting—more, it has shown many the high standing of the profession and the responsibility attached to membership in it. It has raised the standards and the standing of the engineering profession, and has assisted in establishing this standing in the eyes of the public. In such ways as this it has more than justified its existence. But may not the engineering society do even more than it has in giving standing to the engineering profession?

The engineering society has been very helpful in technical matters. In fact, in the eyes of many, the presentation and discussion of papers on technical engineering subjects should be almost the sole function of the engineering society. This is a worthy function. Engineering is and must continue to be a technical art, a technical business. Is it not likely, with the great development of the science and art of engineering, that the engineering society has not yet realized the possibilities of its usefulness in developing, recording and disseminating the technical side of engineering, the scientific substructure, the overlying elements of practice, the variform connections with business life? Especially may it not be more fruitful in contributing to engineering knowledge and in creating or developing new engineering policies, and in developing engineering practice and engineering improvments?

If one were to recount the accomplishments of the engineer in civic affairs, in governmental activity, in influence upon public policy, in the solution of industrial problems, the record would be surprising and greatly to the credit of the engineer. The accomplishments of the engineering societies along these lines are likewise very creditable. But as new conditions teach new duties, it is worth while inquiring whether the engineer and the engineering society have not now opportunities and responsibilities in the direction of public duty far beyond that which has usually been considered a sufficiency. If a need is found, means must be found for expansion, if such expansion is practicable. The problem is a complicated one. The engagements of most engineers are not like those of the lawyer. There is a great diversity of condition of service and environment, even in the same lines of engineering. It is also evident that matters affecting general public policy, to have the best effect and the greatest influence, should be discussed by all branches of engineering in every part of the country; and matters of regional, state or local interest may be handled only by those in the localities interested.

It is becoming more and more apparent that engineering is a single profession; the various branches merge and ramify into each other in numerous ways. Many engineers think that there should be one large inclusive engineering society to take the place of the several national societies—but evidently that is not a present probability. Much has been done in recent years in the way of coöperation and united effort; the United Engineering Society and the Engineering Council have unified action in commendable ways, there is a great field for their further endeavor. In any discussion of the subject it must be borne in mind that the membership of the national societies is scattered over the country; that there are numerous centers of engineering and that these are yearly becoming more important; that local engineering societies in these centers are essential elements in the life of the engineering profession; that these local societies furnish the means by which the young and growing man meets and knows other engineers and gains opportunity for development; and that the national societies may be greatly strengthened and their influence extended by closer affiliations with these local societies; and that any thorough consideration of the subject of aims and organization should endeavor to find ways and means by which the sections of the national societies may best effect close coöperation with the local societies and extend the opportunities of members and the influence of the engineering profession. The problems of the coördination and unification of the engineering profession are numerous and complicated, but nevertheless no one will doubt that every effort should be made to strengthen organization and to attempt to make the engineer a greater force in the world.

It is apparent that the subject assigned to the committees will require diligent and earnest study and consideration, and that their reports will need careful deliberation by the societies. What are the best lines for expansion and improvement and what may be accomplished for the good of the profession and the public are matters which may well tax the powers of the committees and the membership; what is practicable and what is visionary; what may be done by the engineering society and what may best be relegated to individuals or to auxiliary or separate organizations or given up entirely, must all be threshed out in detail.

[1] President American Society of Civil Engineers; Professor of Municipal and Sanitary Engineering, University of Illinois. Mem.Am.Soc.M.E.

Abstract of address delivered December 4, 1918, at the annual meeting of The American Society of Mechanical Engineers.

THE ACHIEVEMENTS OF NAVAL ENGINEERING IN THE WAR

By LIEUT.-COM. WILLIAM L. CATHCART,[1] U. S. N. R. F.

DURING these more than four years of war we have heard much in criticism of the Silent Fleets—of the mute guns of that vast Allied Armada waiting tensely, like a crouching lion, for the German High Seas Fleet, which—save for its half-hearted dash at Jutland—never came.

And yet, notwithstanding these criticisms, the ex-Kaiser, his craven commanders on land and sea, and now all Germany know that to those Silent Fleets is due primarily the shattering of their dream of world dominion—a dream whose realization meant to us and to our Allies but world despair.

This assertion of the paramount value of sea power involves no detraction from the honor fitly due those magnificent Allied armies, the white crosses of whose dead crowd all Europe. And it minimizes in no way the achievement of the superb troops of the American Expeditionary Force, who—in but half a year's hard fighting against the flower of Germany's armies—have won undying glory for our flag.

But, predominating sea power was the foundation on which all of these victories on the land were based. From the beginning, the British Fleet attained the ultimate object of all sea warfare, in making impotent the enemy's naval strength in surface warships—the only kind that count in the end—and that impotence has had a vital effect on the conduct and success of the war.

The reason is clear. Every one knows now that an army on the land or a fleet on the sea becomes helpless if its lines of communication with its base are cut. In this conflict, the Western Front was the decisive theater of war. And for the Allied armies on that front the ultimate bases of supply and reinforcement lay beyond the sea—in Great Britain, her colonies and dominions; in India and Algiers; and—most important of all—in distant America.

So, the absolutely vital lines of communication of those armies stretched like a vast network across the Seven Seas. And, if Germany's High Seas Fleet had been free to wreak its ruthless will, those lines would have been quickly cut, England would have been isolated, America powerless to aid, and long before we could have entered it—the war would have ended in bitter tragedy for all mankind that is worth while.

While the defeat of the Central Powers is thus due primarily to the early strength and continuous growth of the British Fleet, our own Navy has had no inconsiderable part in the decisive work of the war's last year. It has convoyed across 3000 miles of sea more than a third of that American Army of two million men which gave preponderating military strength in France—an achievement which, for rapidity of execution and the distance covered, is without parallel in the history of navies. During the last three months of the war, for every minute of the day and night, seven American soldiers, their equipment, and the maintenance for them, arrived in France.

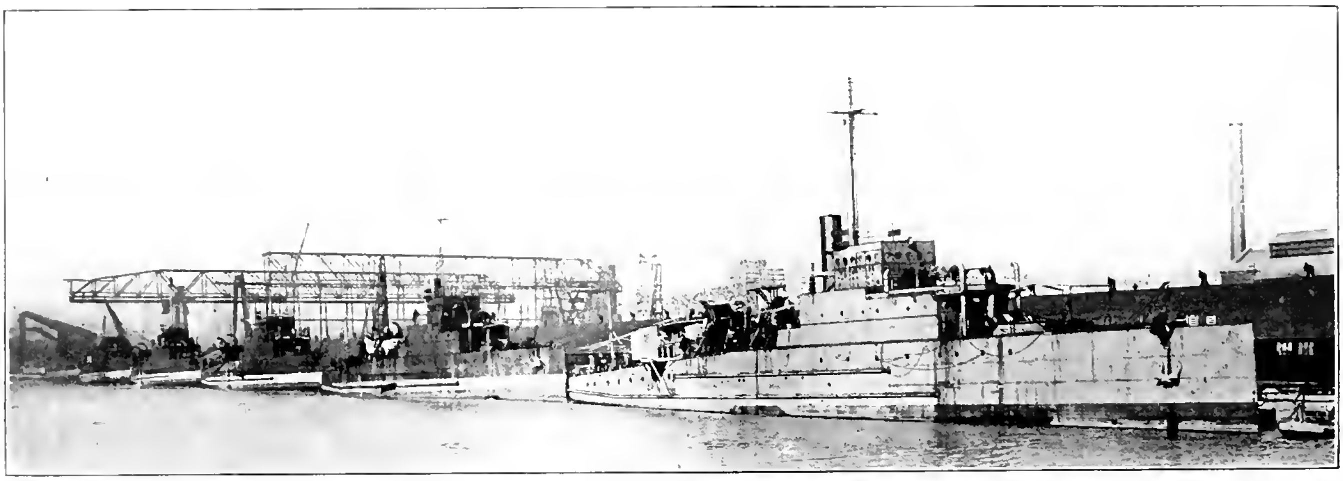


Fig. 1 The "Eagles"—Ford Boats

Our Navy in This War

From the very day of America's entry into the war our Navy grew by leaps and bounds until it became 600,000 men strong and operated about 2000 armed vessels and transports. On September 1 we had in European waters a total of about 275 ships carrying about 57,000 officers and men under command of Vice-Admiral Sims. These vessels comprised: First, a large division of dreadnaughts in the North Sea; second, cruisers serving with the British in the White Sea and the North Sea, with the British and French in the Atlantic, and with the French, Italian, and Japanese in the Mediterranean; third, about a hundred destroyers operating from several European bases; fourth, a swarm of submarine chasers dashing through British, French and Italian coastal waters; fifth, a flotilla of submarines engaged in hunting enemy boats of their own kind; sixth, a number of small patrol vessels—coast guard ships, yachts, seagoing tugs, and the like; and, finally, some naval auxiliaries, such as mine layers and repair ships.

But, the story of the Navy in this war is very far from ending with the record of its ships in European waters. For, we have maintained also a huge Atlantic Fleet whose vessels have not only guarded our coasts and the near-by ocean lanes, but have formed a great training school from which have come the picked men for European service, the gunners for many hundreds of merchant vessels carrying armed guards, and the crews for Army transports and for the Naval Overseas Transportation Service—that is, the vessels built by the Emergency Fleet Corporation.

When we remember that the maritime area of this country forms so small a part of the whole, the wonder is that, in so brief a period, 600,000 men—coming largely from interior states—could be trained for efficient service afloat in our home and foreign fleets. Sir Eric Geddes justly terms the achievement of the Bureau of Navigation in this work as "an amazing feat."

But, what is thus true of one Bureau in this war, is equally true of all in the Navy Department—the great shore establishment which stands behind the Navy afloat and without whose full efficiency, effective service by our Fleet would be impossible.

So, what follows of the record made by the Bureau of Steam Engineering should be regarded as but a sample of what all these Bureaus have done. From the beginning of the war, the entire Navy Department has been working, in a clean-cut American way, at maximum efficiency under forced draft.

[1] Bureau of Steam Engineering, Navy Department. Mem.Am.Soc.M.E.

Address (abridged) delivered at the Annual Meeting of The American Society of Mechanical Engineers, December 4, 1918.

I shall limit my lecture to the work of the Bureau of Steam Engineering, and shall be able to handle even that work only in a very general way, since the Bureau's field—which is dynamical engineering largely—covers all steam and internal-combustion engines for the Navy; the bulk of its electrical machinery and apparatus for surface ships, submarines, and aircraft; the machinery and apparatus of aircraft; the generation and supply of gas for observation balloons and dirigibles; and finally the design and supply of the entire wireless equipment of all shore stations for radio telegraphy in the United States, in our island possessions and on every vessel, merchant or naval, flying the American flag.

The Stupendous Task of the Bureau of Steam Engineering During the War

When the war began, we had a Navy of about 350 ships—commissioned, in reserve, or building. But, the fleet grew with amazing rapidity, and, at the close of the fiscal year on June 30 last, the Navy had in service, or soon to be commissioned, a total of 1959 vessels. This total comprised 570 ships of the regular Navy; 93 drawn from other Government services; 937 converted merchant ships, used as troop transports, naval auxiliaries, and in patrol; and, finally, 359 vessels built by the Emergency Fleet Corporation for the Naval Overseas Transportation Service.

The aggregate horsepower of these vessels is about 6,500,000—which is thirteen times that of our fleet during the Spanish-American War. And, further, it is more than ten times the power developed on both sides of Niagara Falls, and is also equal to about one-sixth of the primary fuel and water power now employed in land service in the United States, not including the locomotives.

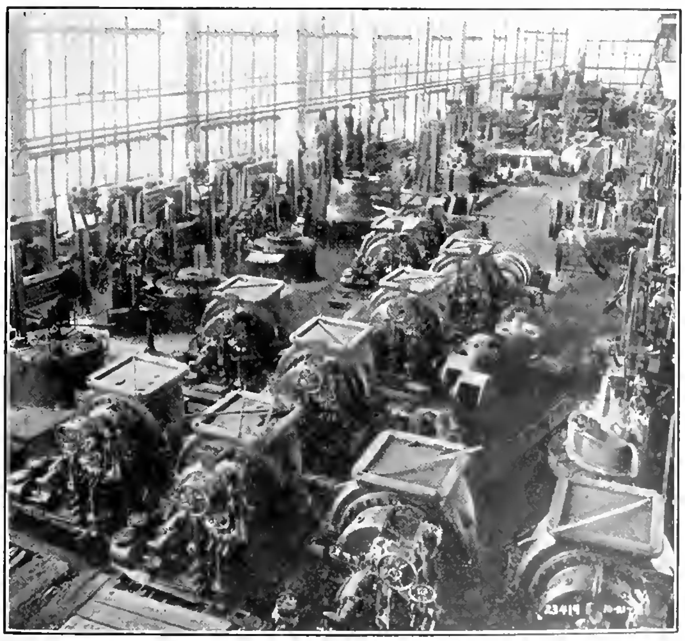


FIG. 2 MACHINERY FOR THE "EAGLES"

But the maintenance of machinery of this huge power was not all, for at the close of the fiscal year there were under construction 376 combatant and auxiliary vessels and 52 tugs for the Navy. Included in this number is a huge force of destroyers. When these vessels are completed, the present horsepower of the Navy will be increased by 70 per cent, and become 11,000,000.

Organization of the Bureau of Steam Engineering

For clearness in discussing the work of the Bureau of Steam Engineering, let me give a brief outline of its organization and principal activities.

The Engineer-in-Chief determines all questions of Bureau policy, authorizes all expenditures, and decides all important—and many minor—questions of detail.

The Assistant to the Bureau, Captain Oscar W. Koester, handles routine business in technical and administrative matters; investigates all work and expenditures in connection with the organization, building, equipment, and maintenance of the shops of the Machinery Division at Navy Yards and Repair Bases; and, when necessary, inspects and reports on the condition of the Bureau's work at private plants.

The staff of the Bureau is separated into ten divisions—one clerical, headed by the Chief Clerk; and the remainder, technical. The duties and titles of the nine latter divisions are: Design,

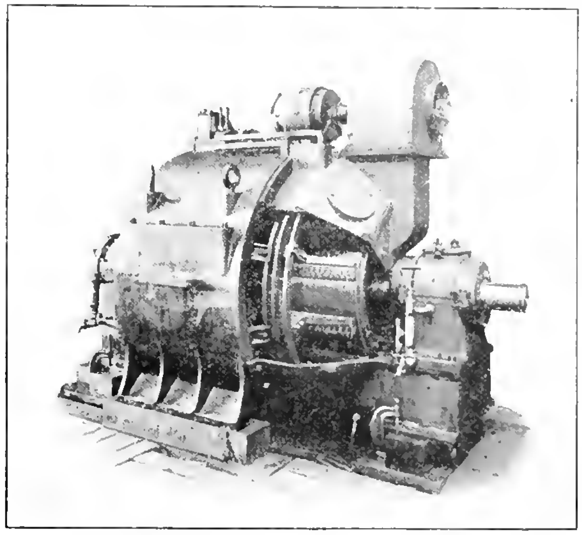


FIG. 3 MOTOR FOR SUBMARINES

Electrical, Repairs, Radio Telegraphy, Inspection, Supply, Fuel and Personnel, Aeronautics, and Logs and Records.

Each of these divisions is in charge of an officer who is an expert of high rank in his especial field. The muster roll of the Bureau's divisional heads is in this respect a roll of honor. While the work of the Bureau is thus divided, Admiral Griffin keeps in close touch with it all. His guiding hand is felt, in greater or less degree, in every detail.

Division of Design. The Division of Design is in charge of Rear-Admiral Charles W. Dyson, an officer who has long been widely known for his success in the design of naval machinery, and especially of propellers—that marine mystery of many weary years.

The duties of this Division cover a broad field. As to new vessels, for example, it recommends the type of machinery to be adopted; estimates the power required for propulsion; makes the general design of the machinery selected by the Engineer-in-Chief; draws the contract-plans and specifications; investigates the bids and alternative plans submitted by contractors, and makes recommendations; criticises the detailed plans forwarded by contractors; prepares directions for the trial of the machinery; and finally makes recommendations as to payments on the contracts.

During the last two years of the war, this comprehensive work was done for vessels of all classes—built, building, or contracted for—aggregating 9,501,440 hp., as follows:

Destroyers	6,578,000	EFC oil tankers	31,800
Battle cruisers	1,080,000	Harbor tugs	12,000
Battleships	480,000	Fuel ships	10,400
Scout cruisers	630,000	Motor tugs	2,800
200-ft. patrol boats	280,000	Ammunition ship	10,600
Mine sweepers	75,600	Oil and water barges	2,400
Sea-going tugs	48,606	Gunboat	1,600
Submarines	41,640	110-ft. patrol boats	216,000

In addition to the work on new vessels, the division passes on all alterations to the existing machinery of naval vessels and those of the Naval Overseas Transportation Service. It also specifies the materials and their characteristics for marine engineering construction, and has general supervision of all tests and experiments relating to marine propulsion at the Engineering Experiment Station at Annapolis and the Fuel Oil Testing Plant at the Philadelphia Navy Yard. Similarly, it has general supervision

of the Inspection Force at building yards—a work in which the Bureau has at this time about 60 officers engaged.

Electrical Division. When we entered the war, the Electrical Division was in charge of Commander Guy W. S. Castle, who has been succeeded very recently by Captain C. E. Courtney.

This Division supplies all the electric power, the wiring for all purposes, and roughly about 75 per cent of all electrical machinery and apparatus on naval vessels. Its field is therefore a

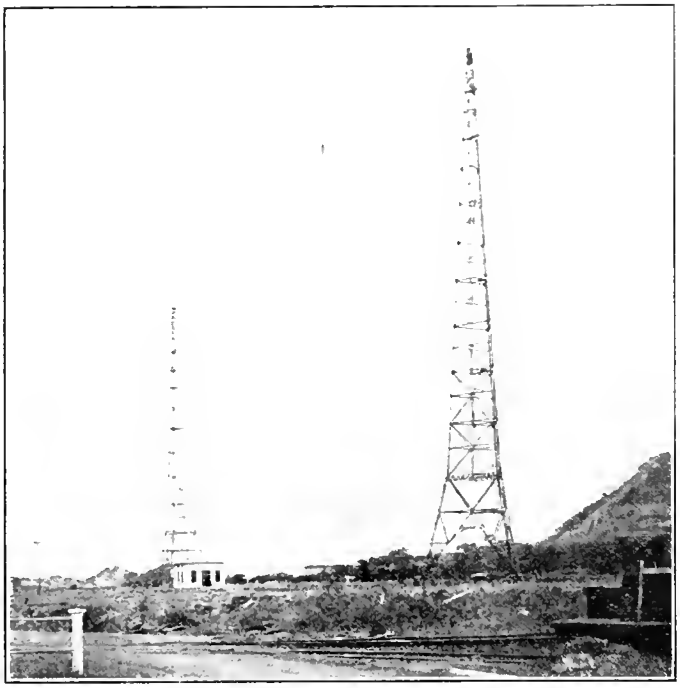


Fig. 4 U. S. Naval Radio Station, Balboa, Canal Zone

Fig. 5 Wireless Telephone Set: Top View

most important one, extending to communication systems for the control of gun fire, the electrical signals for day and night use which are so necessary for the handling of ships in company at sea and in making recognition signals, searchlights for protection against destroyer attack at night, the motors and storage batteries for the propulsion of submarines when submerged, anti-submarine and anti-aircraft devices, all interior communication systems, the multitude of other appliances in which electricity serves on shipboard, and the electrical equipment of the Machinery Division at navy yards. In this work, the Bureau has expended about $20,000,000 during the last fiscal year.

In original work, Commander Castle supervised the development of certain anti-submarine and anti-aircraft devices which are of a confidential nature. These submarine detectors have been made in quantity, not only for our own vessels, but for the British Admiralty and the French Ministry of Marine. For the anti-aircraft investigation, Dr. G. W. Stewart of the University of Iowa made for the Bureau a comprehensive study at Pensacola, Florida, of all the noises made by the engine and wings of an airplane in flight. From his results and in coöperation with the Signal Corps of the Army, a scheme of sound ranging on enemy airplanes was devised, and the necessary instruments were designed and made.

Unquestionably, the most important electrical accomplishments of the Bureau during the war have been the remodeling and improvement of the wiring for gun-fire control systems in all ships from dreadnaughts to gunboats, the installation of communication systems for the service of the guns on transports and ships carrying armed guards, and the provision of recognition signals on all vessels acquired or operated by the Navy.

Supply Division. The Supply Division is in charge of Lieutenant-Commander Charles K. Mallory, U. S. Navy (retired), a member of this Society, who—on the mobilization of the Navy for war service—was assigned to this duty as the relief of an officer on the active list.

Matters relating to engineering materials and supplies—under cognizance of the Bureau of Steam Engineering—for vessels of the Navy and for Navy Yards, are handled through this Division. The specifications for the material are drawn by the technical Division concerned, and all subsequent questions of a technical nature are referred to that Division for decision. Hence, the Supply Division is, in some respects, a sort of center of business activity for the Bureau in its contact with bidders and contractors.

Upon our entry into the war, it soon became apparent that the question of obtaining material and supplies—both for the direct use of the Navy and for those having contracts for new construction—would be of increasing importance and difficulty. Owing to the unsettled conditions as to materials, supply, and labor, it became necessary to abandon the penalty for failure to complete contracts on time, and in many cases contracts had to be changed

Fig. 6 U. S. Navy Twin Engine Dirigible, Showing Bombs in Place, Radio Telephone in Use and Antenna Wire Reeled Up

from a fixed-price basis to one which would insure the receipt by the contractors of a reasonable profit.

Under peace conditions it was unnecessary to give much attention to the matter of the ability of the contractor to deliver as required. This latter consideration, however, became more and more important in war time, and, to take care of the situation, a number of business men of ability—who were willing to devote their time to Government needs—were enrolled as officers in the Naval Reserve Force and assigned to production work in the various Inspection Districts. The work of these production of-

ficers was of inestimable value in obtaining material as required.

The Supply Division has also made a revision of the engineering allowance lists for all regular navy vessels, to insure their being on a proper war footing in this respect. It will be seen that, owing to the variety and volume of its work, this Division has had its hands full since our entry into the war, but its work has been thoroughly done throughout.

Radio Division. Commander S. C. Hooper, U. S. Navy, is in charge of the Division of Radio Telegraphy. The activities of the Bureau of Steam Engineering in this respect cover almost a worldwide field. All matters relating to radio equipment—except the actual operation by the radio personnel—on vessels operated by the Navy, on all vessels of the Army and other branches of the Government including the United States Shipping Board, and on merchant ships requisitioned by that Board, are directed by the Bureau. The number of these istallations now exceeds 4,000.

The Bureau's direction extends similarly to 50 naval radio coastal stations and 75 commercial coastal stations in this country; to others in the West Indies and the Canal Zone, in our island possessions and Alaska and Vladivostok in the Pacific; and finally to one now building for us at Bordeaux in France, which will be the most powerful wireless station in the world.

During the last fiscal year, four of the high-power radio stations on the Atlantic Coast—Sayville, Tuckerton, New Brunswick, and Marion—have been developed into efficient transmitting stations capable of continuous radio communication with Europe. And, further, the Annapolis transmitting station—the most powerful in the United States—was built and commissioned. This station and the four just noted would provide uninterrupted communication with our forces in France, if all submarine cables were cut.

The Bureau has also conducted a large amount of investigation and development of radio transmitting and receiving apparatus for aircraft. It has equipped 90 airplanes in the United States with satisfactory apparatus, has shipped 60 outfits to France and Great Britain, and has contracted for about 3000 more.

Radio telegraphic communication from aircraft in flight to stations on land is now possible at a distance of 200 miles. Similar communication from land stations to flying aircraft is practical up to distances of 50 miles, and communication from aircraft resting on the water to points on shore can be effected at a maximum distance of 40 miles.

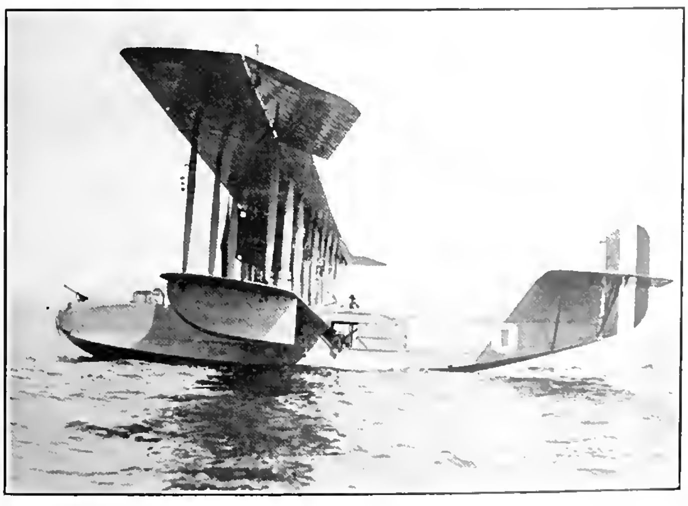


Fig. 7 U. S. Flying Boat H-16 for Patrol Service; Two Liberty Engines; Crew of Four to Five Men

The development of the radio telephone for use on aircraft has progressed to such a stage that it is now possible to communicate by this means from aircraft in flight to stations on land at a maximum distance of 60 miles. The converse of this—telephone communication from land stations to flying aircraft—is practicable at a distance of 15 miles.

Inspection Division. The Inspection Division is in charge of Commander M. A. Anderson, U. S. Navy (Retired). During the last fiscal year this Division inspected, for its own Bureau and six other Bureaus of the Navy Department, nearly 8,000,000 lb. of engineering and other material. This inspection was conducted by a force of 306 naval officers and civilian assistants who visited more than 2,000 manufacturing establishments in this work.

Fuel and Personnel. The Fuel and Personnel Division is in charge of Commander H. A. Stuart, U. S. Navy. During the greater part of the year, it was headed by Commander N. H. Wright, U. S. Navy. Fuel oil, gasoline, and lubricating oils are vital essentials of modern navies, hence, the work of this Division is of fundamental importance, especially as the Navy is now hard pressed in its effort to retain the naval oil reserves in California. However, all of the Navy's new ships are oil burners, since, during their lifetime, fuel oil for them will not fail.

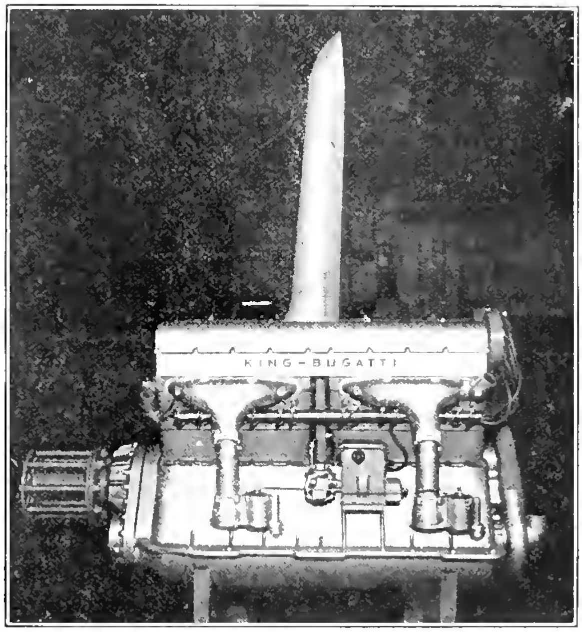


Fig. 8 King-Bugatti Aeroplane Engine, 16 Cylinders

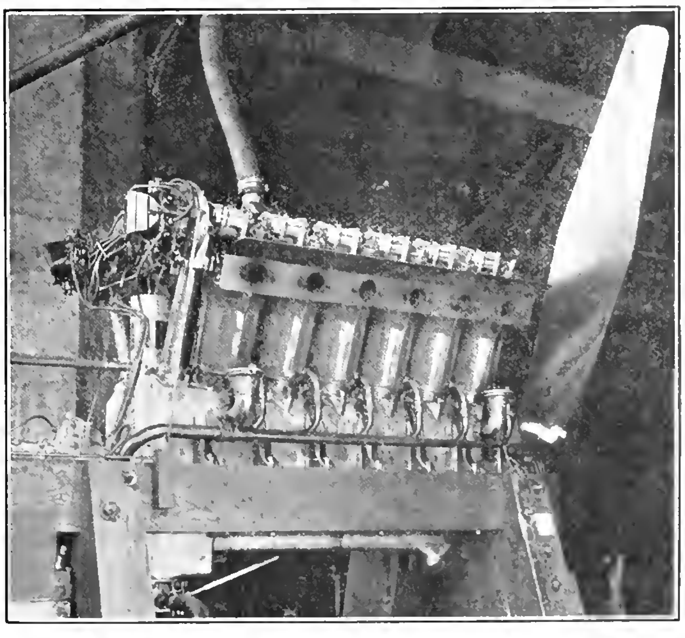


Fig. 9 Liberty Motor, 12-Cylinder, 400-hp., Standard U. S. Aeronautical Engine

This Division covers a broad field. During the last fiscal year it assisted in extending the coaling facilities in our ports and in making a comprehensive survey of the low-volatile steaming coals with the view of locating mines capable of furnishing suitable fuel for the Overseas Transportation Service. It modified the

naval specifications to permit the use, for a time, of a considerable percentage of Mexican distillate, and made preliminary investigations for establishing specifications for heavy fuel oil for transports and cargo carriers. Further, it coöperated with various Government agencies in the adoption of standard specifications for aviation gasoline.

Division of Repairs. The Division of Repairs is in charge of Commander W. A. Smead, U. S. Navy, who has been for some months in Europe. In his absence, it is headed by Lieutenant Commander Bruce.

During the war this Division has had its hands full with the repair work for the Fleet and the vessels operated by the Navy—a total of nearly 2000 by the end of last June. However, it measured up fully to its work, and no vessel of importance has been laid up for repairs.

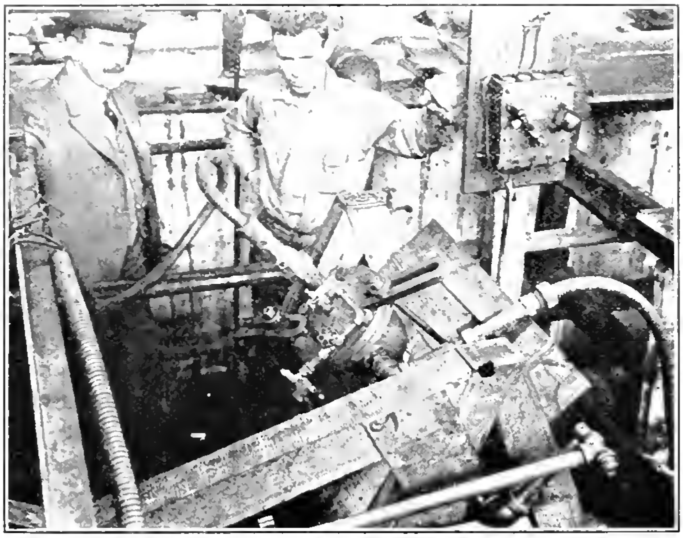


Fig. 10 Steam Trap Mounted on Rocking Platform to Determine Its Behavior on a Vessel in a Seaway

Fig. 11 Microscopic Examination of Large Metal Object. Microscope and Camera Attachment Arranged for Making Photomicrograph of a Broken Shaft Coupling

Since we had more than 250 vessels in European waters, the problem of their repair and maintenance was not simple. Spare parts had to be ready, and material wants anticipated. To this end, a stock of the most important engineering material was provided by this Division—some in this country, but the greater portion at the foreign bases—and its location and use so thoroughly systematized that it could be shipped upon cable advice.

For this work of repairs and supply, the Navy established a total of five major bases—three in France, one in Great Britain, and one at Gibraltar. There are also two minor bases, in or near the Mediterranean. The facilities of these bases were reinforced by those of six Repair Ships.

As illustrating the resources of the Repair ships—the retubing of boilers of a destroyer was undertaken without interruption of her regular patrol and convoy duty by working on one side of the boiler during her 5-day overhaul period, and completing the other side during the following period, and so on until all were finished—the vessel meanwhile being capable of 25-28 knots speed.

Division of Aeronautics. The Division of Aeronautics is in the charge of Commander A. K. Atkins, U. S. Navy. The work of this Division covers aircraft machinery generally, engineering design for this purpose, and the generation and supply of gas for observation balloons and dirigibles.

The marked military advantage to be gained by having but one type of airplane motor prompted the Navy Department to adopt the motor used by the Army. All Liberty motors for the Navy are, therefore, obtained through the Aircraft Production Board. Orders have been placed for more than 4000 of these Liberty engines, delivery to be completed by January 1, 1919. Of this number, about 1300 were received by the end of the fiscal year, and distributed to various naval air stations in this country and abroad. There have also been purchased about 500 Hispano-Suiza engines for use at naval air stations in this country.

In general engineering design the Bureau has done much work, especially with regard to the application of the Liberty motor to seaplanes. This work covered starters and priming devices; the development of a flow meter, pneumatic spark arc throttle controls, and an oil-cooling system.

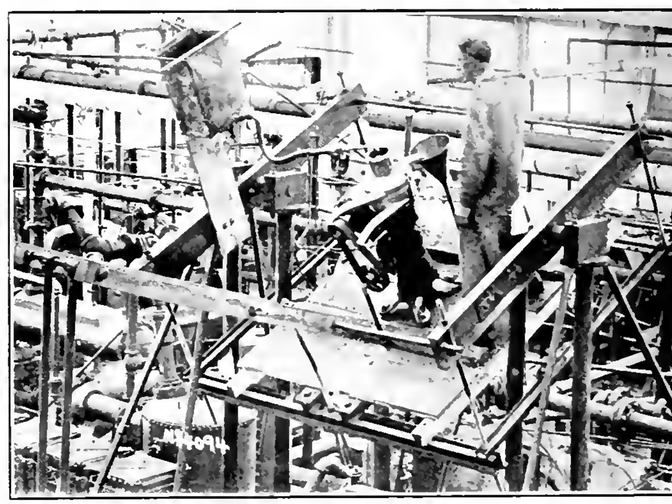


Fig. 12 Centrifugal Oil Purifier Mounted on Rocking Platform During Development Trials

Division of Logs and Records. The Division of Logs and Records is in charge of Commander W. W. White, U. S. Navy (Retired). In the effect of its work on marine engineering design and progress, the field of this Division is of great importance.

Its main functions are: the checking-up and review of the engine-room logs of naval vessels; the compilation and issuance to the seagoing personnel and naval training schools of Bureau pamphlets relating to the care and management of machinery on shipboard; the preparation and issuance to the naval service of the Confidential Bulletin of Engineering Information; and the filing and indexing of all important data regarding engineering matters, with especial reference to naval vessels.

The Electric Drive for Battleships

In those stormy days toward the end of the Civil War, Isherwood, that master engineer, designed for the United States Navy the 17-knot cruisers *Wampanoag* and her sister, which—as their trials proved—were incomparably the fastest ships, naval or merchant, at that time in the world. The jealousy and ignorance of those days of semi-sail power brought down on him a storm of

criticism, and ultimately the great Engineer-in-Chief was forced to see his peerless ships rot at their moorings.

In the years since then there has been no fit comparison with this shameful episode in our naval history, except, in less degree, the similar storm which burst on the head of the present Engineer-in-Chief, when, with high courage and far vision, he urged the introduction of the electric drive for the propelling machinery of battleships and battle cruisers.

The crux of the opposition lay apparently in commercial reasons. It is true that some eminent engineers in civil life, who had no financial interests in the matter, were wholly sincere in voicing their disapproval of what—with their inadequate knowledge of naval conditions—seemed to them a hazardous venture. But, as to others: what the basic reason for the war waged on the Bureau of Steam Engineering in opposition to the electric drive was, may well be left to those who made the attack.

Throughout the controversy the Engineer-in-Chief held unwaveringly to his decision. No arguments had power to turn him, for he had—what his critics lacked—detailed knowledge, both of naval requirements and of the performance of electricity as a driving power in naval vessels. About seven years before, the naval collier *Jupiter* had been thus equipped by his predecessor in office, Rear-Admiral Cone. As soon as she was completed, Admiral Griffin sent the Assistant to the Bureau—Commander,

FIG. 13 1ST I. P. CYLINDER OF S. S. "SANTOS," NAVY YARD, PHILADELPHIA, MAY 3, 1918

now Rear-Admiral S. S. Robison—to the Mare Island Navy Yard, with orders to try the *Jupiter's* machinery at sea in every conceivable way. The report of this officer was exhaustive, and, therefore, Admiral Griffin knew, in every detail, just how the electric drive would act in all conditions. So, from an engineering viewpoint, the contest was an unequal one.

The contract trials recently of the *New Mexico*—the first of our battleships to be fitted with the electric drive—have confirmed fully the judgment of the Engineer-in-Chief. She was tested in many more ways than her contract called for, and, in all, she has shown herself, not only wholly efficient, but—in her system of propulsion, her maneuvering power, and her underwater protection—the leading battleship of her day in the navies of the world.

I need hardly say here that the steam turbine has replaced the reciprocating engine for battleship propulsion. And, I need scarcely add that the combination of a turbine—whose maximum economy is shown at 2000 revolutions or more—and a propeller—which, in a battleship, should not exceed 180 to 200 revolutions—presents a rotational problem of some complexity.

In the electric drive the turbine operates an electric generator instead of a screw propeller, and the electric power thus developed is transmitted to motors on the propeller shafts, in much the same way as electric power is transmitted on shore. In other words, there is a central power plant—composed of boilers, turbines, and electric generators—and the power is taken from this plant to the motors on the screw shafts.

This installation possesses an advantage over the direct or geared turbine drive, in that a backing turbine is not required. The reversing is done through the motors with the same ease and certainty as in any other electric-motor installation, and with the further advantage that full power can be utilized in backing.

The elimination of the backing turbine is a matter of prime importance, since most of the accidents to turbine-driven vessels of the Navy are due to it. For example, the dreadnaught *Arizona*,

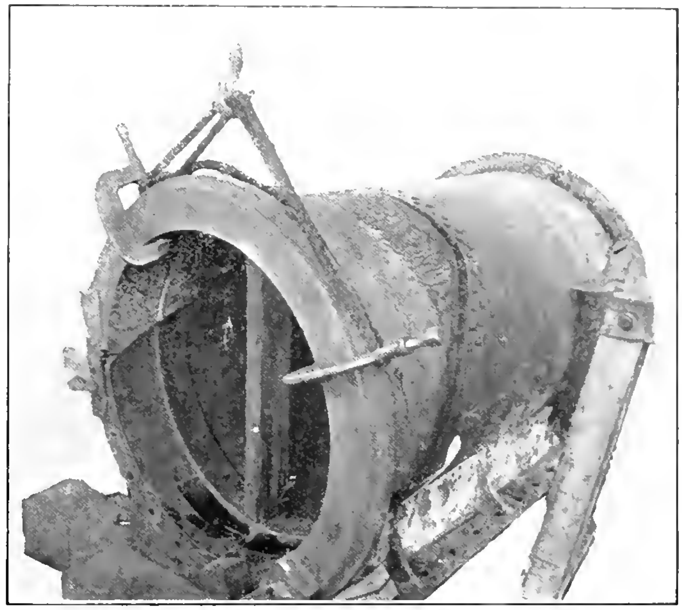


FIG. 14 1ST I. P. CYLINDER OF S. S. "SANTOS," NAVY YARD, PHILADELPHIA; READY TO WELD, MAY 29, 1918

FIG. 15 1ST I. P. CYLINDER OF S. S. "SANTOS," NAVY YARD, PHILADELPHIA; FINISHED AUGUST 15, 1918

in her first trip from New York, had been making a very fine record in straight-away steaming, but, when she began maneuvering, one of her turbines came to grief, and she had to limp back to the New York Navy Yard, with a big job of reblading to be done.

NAVY YARDS AND SHORE STATIONS

As to the immense amount of work carried on at the New York Navy Yard under the direction of Rear-Admiral George E. Burd, U. S. Navy, Industrial Manager, since April 6, 1917, Admiral

Burd and the officers serving with him have had charge of the conversion and repairs, in all departments—including the mounting of batteries in many cases—of a total of 723 vessels of all classes. Much of this work was under cognizance of the Bureau of Steam Engineering.

In addition to this, the propelling machinery—in whole or in part—of these battleships has been building there, and considerable other new construction work of a minor character. Further, there has been a great deal of electrical and radio work for vessels of all classes. The number of men employed—including the clerical, drafting, and sub-inspector force—was about 4,900.

Naval Experiment Station at Annapolis

The Naval Experiment Station at Annapolis does much of the marine-engineering research and experimental work of the Bureau.

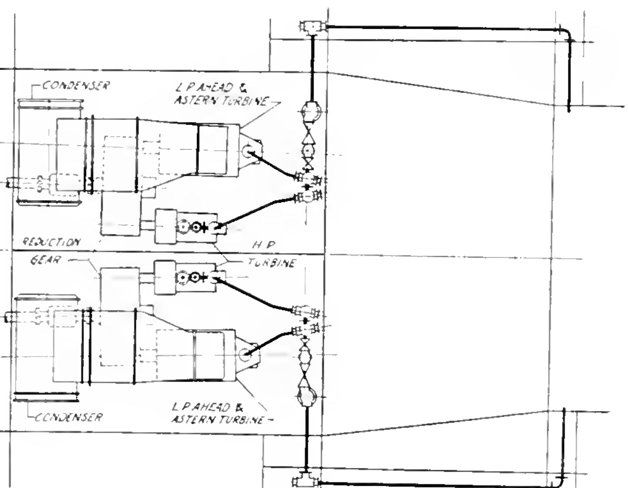


Fig. 16 Battleships, Diagrammatic Plan of Turbine Drive with Reduction Gear Showing the Arrangement of Machinery

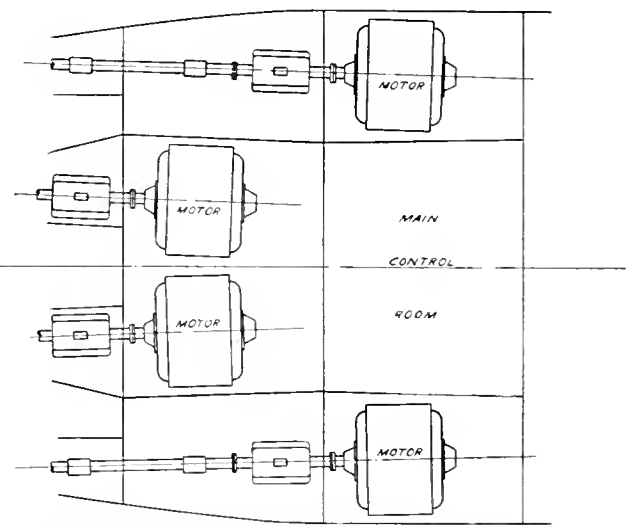


Fig. 17 Battleships, Diagrammatic Plan of Electric Drive Showing the Arrangement of Motors

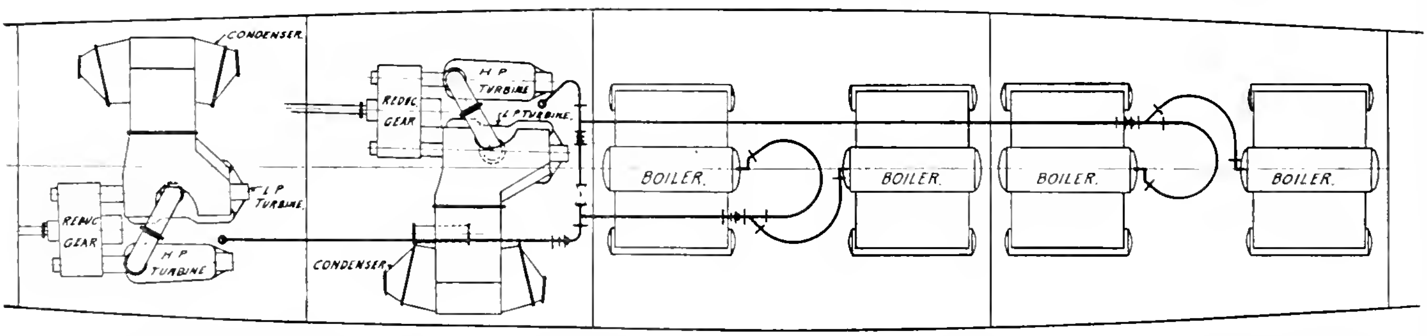


Fig. 18 Destroyers, Diagrammatic Plan of Turbine Drive with Reduction Gear Showing the Arrangement of Machinery

The Head of this Station is Rear-Admiral T. W. Kinkaid, U. S. Navy.

The services of this Station are of the greatest value, not only in the designing work of the Bureau, but in the maintenance of the machinery of the Fleet. Its chief function is the prosecution of research on, and making tests of, appliances, materials, and methods which relate to the propelling plants of naval vessels—such as forced-draft blowers, pumping machinery, feedwater heaters and coolers, refrigerating machinery, steam turbines, condensers, evaporators, boilers, coal and oil fuels, packings, and so on. The Station's activities also include much work in the metallography of steel and other metals.

Fuel-Oil Testing Plant

The Fuel Oil Testing Plant at the Philadelphia Navy Yard has also done a very considerable amount of valuable work. Its present head is Lieutenant A. M. Penn, U. S. Navy. Its field covers burners, air registers, the refractory linings for furnaces, furnace insulation, and other similar matters.

During the last fiscal year, in order to obtain comparative data of boilers of various types, a test of the White-Forster boiler was conducted at this plant. The results show that express type boilers of this kind, having a large amount of heating surface and a thick tube bank, are even more efficient at from low to moderately high rates of combustion than the straight-tube boilers now used so extensively in our Navy, but that they are slightly less efficient at very high rates. The express type has advantages also in the saving of weight, original cost, and cost of upkeep.

Repair of the German Merchant Ships Damaged by the Vandalism of Their Crews

The almost incredibly rapid repair of the German merchant vessels lying in our ports and seized by our Government when we entered the war, makes one of the most striking and dramatic stories in the history of naval engineering.

There were, in all, 103 of these German ships seized by our Government. Of this number about 50 were turned over to the Navy by the Shipping Board for Repairs. The major damage inflicted was the breaking of cast-iron parts of the main engines, chiefly the cylinders. But, in addition, some connecting rods, piston rods and boiler stays were sawed through, boilers were burned out by dry firing, and there was much minor vandalism.

The chief problem, however, was the repair of the broken cylinders, some of which were more than 9 ft. in diameter. The Bureau estimated that—with such facilities as were available for this heavy work—it would take at least eighteen months to replace the damaged cylinders by new ones. Meanwhile, there was bitter need of rapid transport for our troops to France. On the removal of that crisis, there seemed to depend the salvation of Christendom.

At this juncture, Captain Earl P. Jessop—then Engineer Officer

of the New York Navy Yard—recommended that repairs be made by welding, and, in this recommendation, he was heartily supported by Rear-Admiral George E. Burd, Industrial Manager of that Yard. The Engineer-in-Chief at once ordered Captain Oscar W. Koester, Assistant to the Bureau, to New York to investigate the situation fully. As the result of his report, the Bureau immediately issued orders to make repairs, where possible, by electric or oxy-acetylene welding, and where welding was impracticable owing to the location of the break, to resort to mechanical patching—that is, to "soft patches" which are secured by body-bound bolts.

From this stage onward, the repairs were supervised personally by Captain Koester, who, in his resourceful ability and driving power, is unsurpassed. His work went on night and day, and in five months he traveled about 14,000 miles in railroad trains from one Navy Yard or private plant to another along our Atlantic Coast. At the expiration of that period, his huge work was done and the ships were ready for service.

The rapidity of getting these ships ready for service was facilitated by one other action. On many of them, in addition to the damage done by vandalism, extensive repairs were necessary, owing to their deterioration from long idleness. As the necessary overhaul and all routine repairs could be made by a capable naval crew under able officers, the Engineer-in-Chief laid the matter before Admiral Benson, Chief of Operations, with the request that the ships be fully commissioned before repairs were begun. This was done, and thus, while the welding operations were in progress, the ships were prepared in all other respects for sea.

One other feature of this matter deserves comment, and that is the military value of this work in the transport of troops. These fifty ships were in service for about a year before hostilities ended, and this is approximately the time saved in these repairs by using welding methods. Twenty of these vessels can carry about 70,000 troops in one trip, and ten round trips a year is a conservative estimate of their performance. Representative Young of North Dakota, who crossed the Atlantic in the *Leviathan*, stated recently in the House that she had transported more than 99,000 troops up to August 20. So, it may be justly claimed that the rapidity of these repairs had a marked effect on the early end of the fighting in France.

LONG-RANGE HEAVY NAVY GUNS WITH RAILWAY MOUNT

By Lieut.-Com. D. C. Buell,[1] U. S. N. R. F.

The history of the work done in completing a mobile battery of naval guns in record time for service in France forms a remarkable record, even in an organization as noted for great achievements as the American Navy.

Owing to a change in the characteristics of certain battle cruisers, a number of 14-in. 50-caliber guns, originally built for these ships, became available during November 1917 for other service.

It was felt that if these guns could be placed upon railroad mountings they would prove a valuable adjunct to our artillery forces, since they throw a 1400-lb. projectile at a muzzle velocity of 2800 ft. per sec., giving, at high elevations, an effective range of nearly 30 miles. They throw a heavier projectile with greater accuracy and to a greater distance than any gun previously placed on mobile shore mounts.

But little preliminary discussion was necessary before the plan to use these guns in a naval railway battery was approved, and on December 26 last the Navy Bureau of Ordnance instructed the Naval Gun Factory at Washington to prepare plans and specifications for the project.

The final plans and specifications not only for the mounts, but for the locomotives, cars, and other equipment necessary to form a complete land expedition, were completed in less than 30 days, being ready to submit for bids on January 25.

The plans and specifications called for five 14-in. railway gun mounts, six locomotives, and six complete trains of cars—75 cars in all.

On completion of the plans, proposals were immediately sent out by telegraph to the leading manufacturers of the country calling for an opening of bids on the morning of February 6.

The first bids were rejected because time of delivery was not satisfactory, but as a number of manufacturing plants had representatives present when bids were opened, a better understanding of the project was possible.

A second opening of bids was set for February 13. The result of this opening was very pleasing and the contract was awarded on the afternoon of February 13; and on the same evening the contractors began the work of gathering together the necessary material for the project. The date of delivery of gun cars and locomotives was set by The Baldwin Locomotive Works for June 15, and the Standard Steel Car Company undertook to deliver the cars and special equipment by this same date.

In spite of the fact that The Baldwin Locomotive Works, noted for making, perhaps, the fastest manufacturing schedules in the country, had set June 15 as their earliest date, Mr. Vauclain and his organization speeded up this project so that the first mount was completed and moved from the Baldwin shops on the morning of April 25, 72 days from the date bids were opened and 20 days ahead of the Baldwin schedule. This mount was taken to the Army Proving Ground at Sandy Hook for its test firing; the tests were entirely satisfactory.

The last of the mounts was finished and delivered on May 25, and practically all of the cars and special equipment delivered for shipment by June 1; hardly 100 days from the time bids were opened, and only 155 days from the time the project was first considered.

A very impressing feature of the work was that there was practically no change in design necessary during construction. The original drawings were final drawings in almost every case.

Army officers who viewed the tests of the first gun were so impressed with its performance and with the speed with which the project was being completed, that the Navy Bureau of Ordnance was requested to build for the Army three additional and identical mounts.

Requisitions were prepared and material ordered for these three mounts on May 18. The first Army mount was finished complete and ready for shipment on July 17 and the second and third on July 25.

When it was seen that the first three mounts built for the Army were nearing completion, the Navy Bureau of Ordnance was requested by the Ordnance Department of the Army, on July 18, to build another lot of identical mounts. Work on these second three mounts was pushed, and the first was completed on September 16, and the remaining two a few days later.

It is to be regretted that conditions were such that these mounts built for the Army were not shipped to France in time to be erected and put into active service.

The original understanding was that the Naval Battery would operate with the British Army. By April 15 enormous quantities of material had arrived at Philadelphia Navy Yard and shipment could have commenced at that time. On May 15, with the completion of the entire project no more than two weeks distant, and no definite decision from the British as to the shipment of the guns, due to the fact that the German drive had threatened channel ports, the expedition was offered to General Pershing for use with the American Army.

On May 23 General Pershing cabled, requesting immediate shipment of the entire expedition to St. Nazaire, France. The shipment of the equipment to France was delayed because of the fact that the German submarines, which operated on this side of the Atlantic, torpedoed the S.S. *Textile*, inbound to take the guns and

[1] Bureau of Ordnance, Washington, D. C.
Presented at the Annual Meeting, New York, December 1918, of The American Society of Mechanical Engineers.

the girders to France, so that the first shipment was not made until June 20.

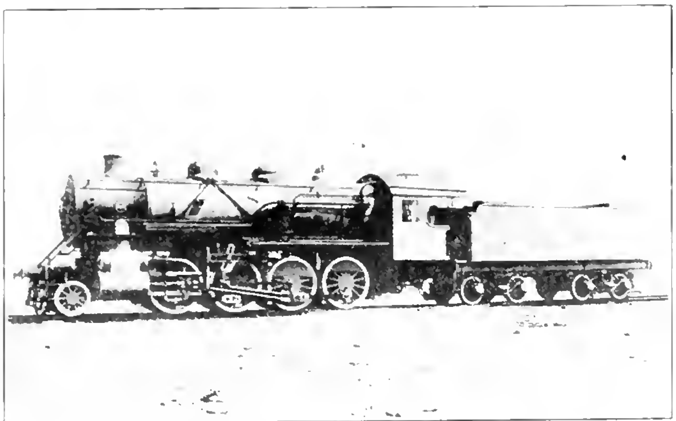


FIG. 1 ONE OF THE SIX LOCOMOTIVES CONSTRUCTED FOR THE RAILWAY MOUNT EXPEDITION
Weight of Locomotive 83 Tons. Weight of Tender 56 Tons

14. The last train left for the front on September 21, and arrived at the base on September 22.

The first gun was fied against the Germans on September 5—less than 250 days from the time the project was first thought of.

Too high commendation cannot be given to those who conceived this project. The entire equipment operated in a highly satisfactory manner, and practically without change from the original design. The question as to the guns being too heavy to transport over French railroads, proved groundless.

The pit which the French at first criticized, proved a very valuable feature when the guns were fired at a fixed target for any length of time.

It was suggested by the French that if a similar type of mount could be devised for use where it was desired to bring the gun into action quickly, it would obviate the only possible objectionable feature of the first mount. It is interesting to know that the Navy Bureau of Ordnance, anticipating this requirement, had already designed and was building another battery of 14-in. mounts before the armistice was signed.

These new mounts were designed to be fired directly from the track, at all elevations, without any preliminary preparation

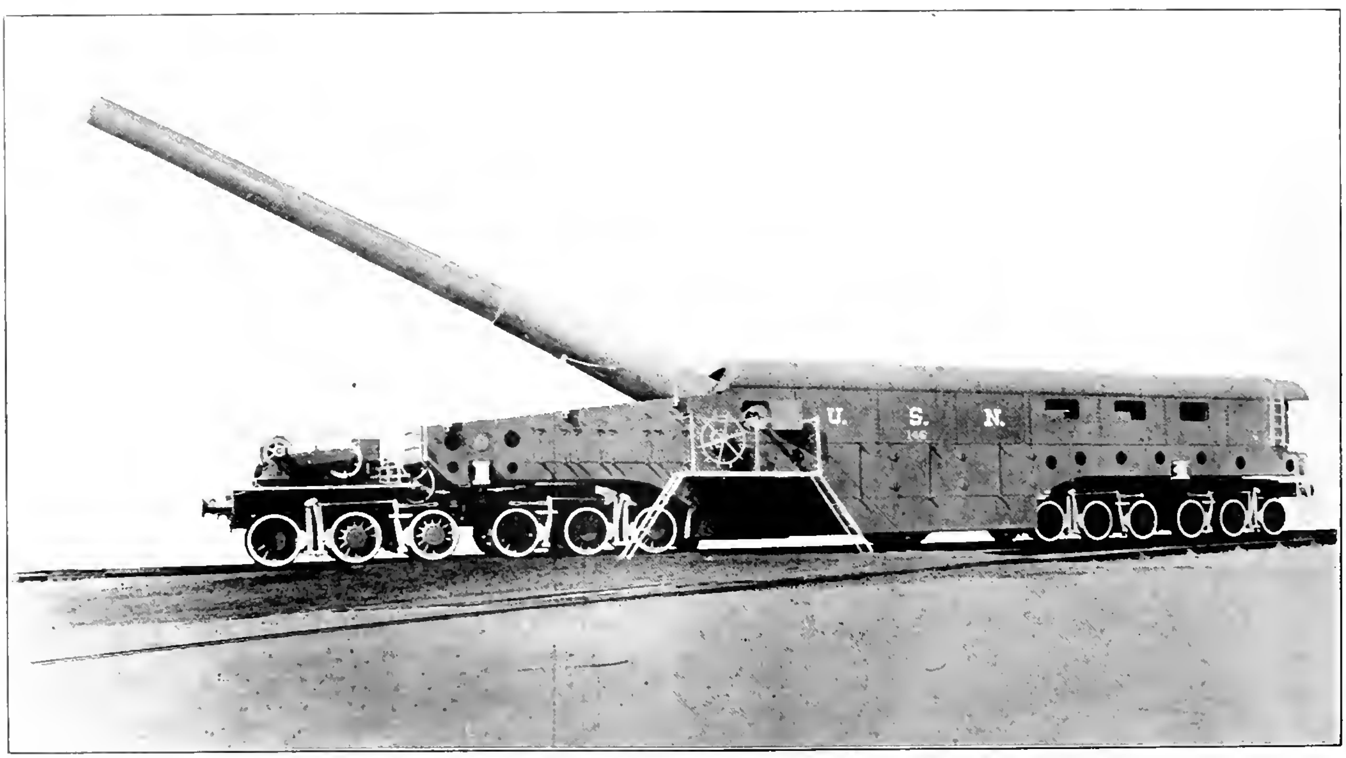


FIG. 2 ONE OF THE 14-IN. NAVAL RAILWAY GUNS DESIGNED, BUILT AND PUT INTO OPERATION BY THE BUREAU OF ORDNANCE OF THE NAVY DEPARTMENT

This first ship was followed by two others on July 4. The final shipment of spare parts, extra guns, etc., was made on July 21.

Anticipating the need of skilled men for erection work in France, 200 experienced railroad mechanics and operating men were selected from the 40,000-odd bluejackets at the Great Lakes Naval Training Station, and sent to France a little before the first ships of material sailed.

The first shipment arrived at St. Nazaire on July 8; the second and the third on July 21.

The locomotive and car erection began July 20. The erection of the first gun was begun July 30. The first gun train was completed and ready to leave St. Nazaire on August 11. The first two gun trains left for the front on August 17 and 18, respectively.

The first gun mount was ready 12 days after the girder was unloaded from the ship. The first two trains were ready 22 days after erection work started.

Trains 3 and 4 were completed, equipped, and loaded September

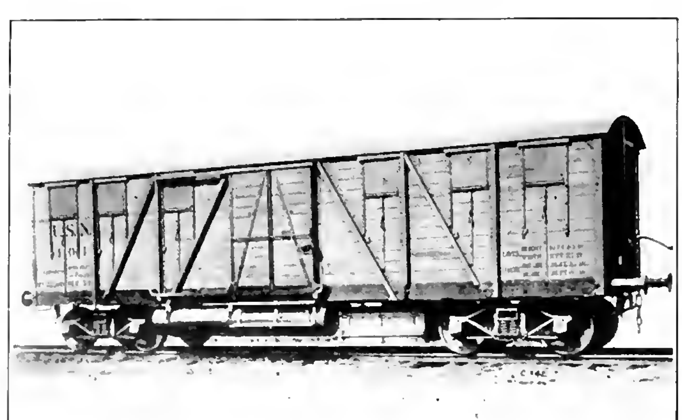


FIG. 3 ONE OF THE 75 CARS CONSTRUCTED FOR THE RAILWAY

whatsoever; had they been required they would have been ready to ship to France by February 1919.

As far as can be ascertained, there were no finer or more accurate-shooting guns in the war than these first 14-in. mounts.

Had the new mounts been added to and consolidated with the first expedition, it would have been difficult for any nation to have conceived and executed a finer battery of guns than the U. S. Naval Batteries.

After the reading of his manuscript Commander Buell showed some slides and a reel of moving pictures illustrating the details of working out the project. At his request Mr. George A. Chadwick, Mem.Am.Soc.M.E., the designer of the gun, then gave interesting particulars regarding weights, reactions, dimensions, etc., which are embodied in the following paragraphs.

Figs. 1 to 5 give a slight idea of the magnitude of this work. The gun complete weighs about 550,000 lb. The shells weigh nearly 1500 lb. each and the powder charge for a shell 484 lb.

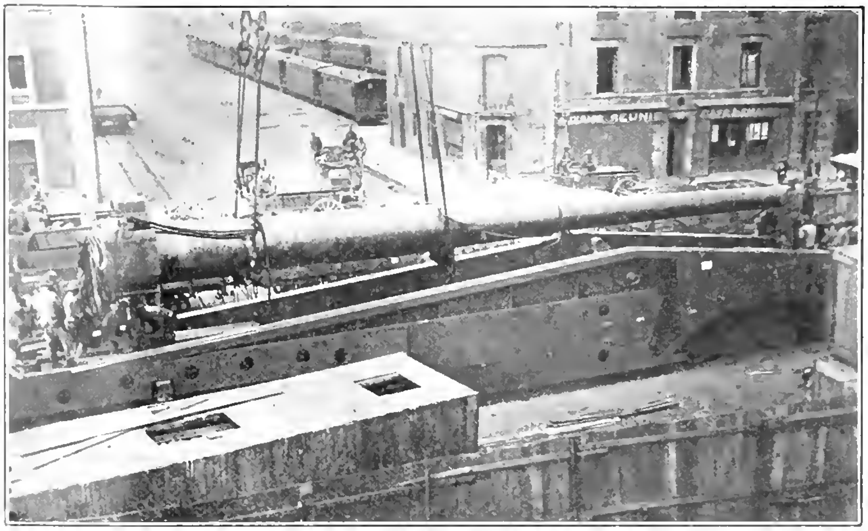


Fig. 5 Placing Gun on Girder for Transportation to Ship

There was considerable question as to what would happen when the first gun was fired, and some of the spectators even suggested where the girder would break in two. Nothing happened, however, and the work was continued without any difficulty.

The gunwork was adapted to the mount with very little change from battleship design. This allowed the use of considerable material that was on hand. A view of the girder is shown in Fig. 3.

Fig. 4 A Gun Girder Under Construction in a U. S. Naval Gun Factory

The truck axles were designed to withstand a maximum axle load of 63,000 lb. The kinetic energy of the gun is about 4,000,000 ft-lb., which is absorbed through a hydraulic brake in the recoil of 44 in. in the slide, and when firing on the rails the movement to the rear along the tracks is about 26 ft. When firing from a pit the load is transmitted to foundation members in the form of a heavy grillage construction of castings and structural-steel shapes, the load being limited to about 4 tons per sq. ft., which so far has been found to be satisfactory.

Some idea of the difficulties which arose in assembling the guns and locomotives on the other side may be gathered from the fact that it is necessary to have everything on the ground before starting to build. For this reason the material piled up in an unbelievable manner. Two switching engines had to be working day and night removing loads to the yard, unloading them with the crane and making the various moves necessary to clear up the work.

THE ENGINEERING OF MAN POWER

Keynote Sessions of the Annual Meeting. Papers and Addresses of Vital Interest

It was quite evident from the attendance, the general interest and the lively discussion which attended the reading of papers on Thursday morning and afternoon at the Keynote Session of the Annual Meeting of the Society that the Committee on Meetings had arranged a program which was in accord with the present trend of affairs in the industrial world as well as in society at large. That the Engineering of Man Power should have become the subject of a keynote session of The American Society of Mechanical Engineers is indicative of a point of view of that very perplexing problem of industrial relations which the war, and particularly the closing of the war, has forced upon a newly-awakened consciousness in the world at large.

Opening Addresses by Dr. Ira N. Hollis and Dr. L. S. Rowe[1]

The morning session was opened by the Chairman, Vice-President Plunkett, who introduced Dr. Hollis, Past-President of the Society, who had been asked by the Committee on Meetings to make the introductory remarks. Dr. Hollis recalled the incident of a year ago when members of the Society stood with bowed heads in prayer that the war upon which America had entered would be victoriously ended before a year had passed. A modern miracle, he said, had been performed by America in sending across the seas two millions of men—two millions of every nationality, fused together in the melting pot which is America and united in a common purpose and forming the finest army, morally, known to history. When these men return, he asked, are we going to measure up to their ideals of what America ought to be?

The old estimates of other countries of a dollar-mad America had been shattered by this war, as was evidenced by the free-will contributions of enormous sums to the Red Cross, to the United War Work Campaign and to other causes. "I believe," he said, "that there is one phrase which expresses American ideals,

[1] Assistant Secretary of the Treasury, Washington, D. C.

and without which none can ever understand America. . . . Service to Man. I would put that forth as the motto of America —Service—and anyone who interprets our civilization . . . through that one word will have a complete understanding of American ideals. The changing character of the papers presented in the past ten years before the Society is an indication of an appreciation and understanding of true American ideals, for as we study them, we find that they have turned more and more toward an exposition of the opportunity of the engineer to serve mankind."

Dr. Hollis' address was followed by one by the Assistant Secretary of the U. S. Treasury, Dr. L. S. Rowe, who spoke on The Engineer in Foreign Service. Dr. Rowe refered to his observations of American and other engineers in the countries of Central and South America where he had spent much time and pointed out some of the failings of the American engineers. These were not, he said, because of lack of training, or any lack of grasp of principle, or lack of inventive genius or ability to meet new situations, but because at times American engineers in foreign service do not as fully appreciate the larger responsibilities and the larger representative capacity which they must assume when engaged in great public works abroad.

One defect, said Dr. Rowe, was a certain impatience and unwillingness to make a real effort to teach a native population how to become efficient laborers. The engineer may exploit labor, or he may perform a great economic service to the country in which he is operating and create ties and influences which will be an important factor in determining the general attitude of that country toward America. In so doing the engineer is performing a diplomatic service for the United States. A further shortcoming of the American engineer abroad is his impatience to return home. The American engineer, like the American banker, or salesman, does little to learn the language or to make local acquaintances or to get into a closer contact with the people of the localities in which he is operating.

There is no representative who touches the life and progress and well-being of a country as closely as the engineer, and therefore it is of vital importance that in the early training of an engineer everything should be done to prepare him for foreign service. He should know considerable of economics, of government; and he should learn a language with a greater degree of thoroughness than he learns at present in our universities. He should be encouraged in foreign travel to the extent that he might have the benefit of a scholarship for that purpose. Thereby a group of engineers might be trained for foreign service. Here rests a great national responsibility on the engineering profession.

Dr. Rowe's address appears in more complete form elsewhere in this issue.

Industrial Organization as It Affects Executives and Workers

Charles E. Knoeppel then presented his paper, Industrial Organization as It Affects Executives and Workers.[1] From a studious survey of his experience as an executive the author emphasized as essentials in the formulation of definite laws of organization: The necessity of having an objective in the mind before beginning to work; the exclusive concentration of each man to definite functions; the avoidance of confusion and conflict of authorities; the proper division of departments in order to insure that each executive has complete control of all the factors affecting the success of his function; the creation of divisions which will develop specialists; the provision for permanency by training men to fill the positions of their superiors; the exact definition of the duties of each employee and of his relations to the others; the logical selection of personnel according to individual qualifications; and the creation of a standard manufacturing practice.

Valuable suggestions were also given in regard to the question of establishing an efficient administration. Delegating authority to subordinates, overlooking minor details, listening to wise counsel and arousing initiative in employees were recommended as important points in the exercise of industrial authority.

[1] For abstract of paper see December Journal, p. 1031.

In a written discussion of Mr. Knoeppel's paper, John F. Grace said that the 15 conditions stated in the paper were almost axiomatic, but that their application was a gigantic task for executive genius. To this end, pictures and graphs should be applied as in the manner of good advertising to instruct the workers, rather than texts. The lack of definite instruction to each worker, which had been mentioned as a major cause in the breakdown of organizations, seems largely due to the inability of managers or systematizers to define and isolate duties which are constantly overlapping. Any radical change of system affecting the majority of workers should be explained at a general meeting of the employees of the department or plant affected, by someone who understands the object and method.

C. W. Johnson, in an oral discussion, spoke of the keynote of justice, fairness in an active way to every individual in the organization. A. C. Fleckenstein[1] said that engineers engaged in production could help immeasurably the advance of industrial and efficiency engineering methods by creating in the mind of the owner of the plant a proper regard for the services of the apparently non-productive industrial engineer, an investment in whose services would render a large financial return.

Standardization and Administration of Wages

A paper by Earl Dean Howard[2] and Henry P. Kendall entitled Standardization and Administration of Wages, was read in abstract by Secretary Rice in the absence of the authors. The paper first gives particulars of the administrative machinery available before the war for dealing with industrial relations, and then of the governmental agencies since developed for that purpose. The authors then set forth certain general principles which they believe should be followed in dealing with labor problems in the future. The term standardization does not necessarily mean uniformity of wages, hours or conditions of work, but the determination of these conditions according to general principles, the justice of which is universally acknowledged. Say the authors: "The regulation of industrial standards by joint boards as suggested has the great advantage over the present system in that it eliminates at least three-fourths of the cost of friction between the particular employer and his employees. Each employer then adopts the standards which are current in his trade and knows that all his competitors are on the same basis and have no advantage over him. Even under our present system, the chief objection to any one employer's increasing wages lies in the fact that it comes out of the profits unless the increase is general among his competitors, when it is shifted to the consumer of the product. It is easy to foresee a time when the public and not the employers will have the chief interest in opposing wage advances."

Standardization is increasing in the larger industrial establishments. The administration of industrial relations, especially by a skilled person specialized for the work is no longer an experiment. It is reasonable to expect that organization of employees, fostered by the employer and given full opportunity to function legimately in matters which touch the interests of employees may develop into constructive agencies whose criticisms and suggestions may be of great value in improving the efficiency of the business. To make this plan truly successful, however the management must decide to give labor a fair share of the efficiencies and economies realized.

A further abstract of the paper is given later in this report.

In discussing the paper, H. F. J. Porter spoke of the work which Mr. Howard had done in introducing in many industrial plants methods of bringing employer and employee together with a representative of the public. These methods have been introduced into New York in the cloak and suit industry, composed of some 80,000 employees. On the Board of Control organized for the consideration of questions arising out of industrial relations are

[1] Richmond Radiator Co., New York City.

[2] Executive Secretary, Committee of Industrial Relations, Washington, D. C.

represented a group of labor unions and a group of manufacturers. These two elect a representative of the public. In large industries today there are many such organizations. A meeting to discuss the merits of this type of organization is being planned in conference with Mr. Howard, Frank P. Walsh and Hon. William H. Taft. This conference will probably result in a public meeting to put before the people of the country the work of these organizations and their recommendations.

Non-Financial Incentives in Industry

The last paper scheduled for the morning was by R. B. Wolf on Use of Non-Financial Incentives in Industry.[1] The sincerity and earnestness of Mr. Wolf's words won for him the admiration and approval of his audience, awoke in them an uncommon interest and stimulated an inspiring discussion which had to be carried over into the afternoon session, thereby delaying the afternoon schedule by fully two hours. Mr. Wolf confined himself to the subject of non-financial incentives to an extent which led some of his hearers to imagine that he had no faith in financial incentives, a misunderstanding which was subsequently cleared up by the speaker. That man does not do his best work for hire was Mr. Wolf's basis for the non-financial incentive; that is, interest in work, "the joy of the working." His plea was for the utilization of the creative agencies of labor; and to prove the practicability of their utilization he gave examples of what had been accomplished in mills under his management where interest in the work had been stimulated by "progress" records of individuals and by an appeal to the natural intelligence of the workman. To quote from a closing paragraph of the paper: "We should never lose sight of the fact that the degree of conscious self-expression which the workman can attain is in direct proportion to the ability of the organization to measure, for his benefit, the impress of his personality upon it. The most democratic industrial plant, therefore, is the one which permits the fullest possible amount of individual freedom to each member, irrespective of his position, and at the same time is so sensitively adjusted that it reflects immediately the effects of his actions. If his actions result in injury to others he will see that as a part of the whole he, himself, must also suffer."

The discussion of the paper was opened by Walter N. Polakov, who took occasion to warn the members that they should not get the impression that financial incentives were not important or even superfluous as long as non-financial incentives are at work. To illustrate his point he showed on the screen three charts indicating the preventable losses in a power plant. In chart 1, with neither financial nor non-financial incentives, the loss amounted to over 30 per cent. With non-financial incentives at play in chart 2, the loss had been reduced to 17 per cent, while in chart 3 with both financial and non-financial incentives at work the preventable losses had been wiped out. W. E. Pulis showed some slides of a similar nature in which the same facts were represented. Later in the afternoon, in reply to Mr. Polakov, Mr. Wolf said that the reason the non-financial incentive records shown by Mr. Polakov did not show as great a saving as was shown when a bonus was attached was because he had not tried the plan of giving the men the record of their accomplishment without the bonus attached to it. Without deprecating bonuses entirely, Mr. Wolf was of the opinion that they should be carefully considered. Men both union and non-union had said to him, "We don't like to be bribed to do a good job. We would like to have the privilege of doing a good job without being bribed to do it."

Irving A. Berndt,[2] in a written discussion of the paper said that he was particularly impressed and in accord with what Mr. Wolf had said concerning the necessity of providing workers with environments which attract, and providing incentives inherent in the nature of the work itself. This was fundamental and basic. "Were I to add any thought to this," he said, "it would be that the responsibility for this lies with the individual employer, manager and executive and should under no circumstances be passed on to society or to the worker himself."

Being confronted with the problem of reducing supplies taken from storerooms in a large plant—supplies used for maintenance and repair—Mr. Berndt found it possible to secure interest among the men calling for them by placing at the storeroom window a list of current prices and a weekly bulletin telling how much the supplies used by each man or group had cost, comparisons being given. The two simple records stimulated interest and the desired result was secured. He had never found a foreman, he said, unresponsive to confidence placed in him by showing him records of costs, performances and even profits. He would not consider a monetary incentive properly applied unless it included a plan for keeping each man advised of current progress and also giving him a written statement of results.

Afternoon Session—Continued Discussion of Mr. Wolf's Paper on Non-Financial Incentives

The session of the afternoon was presided over by Vice-President John Hunter, who called for additional discussion of the Wolf paper. Henry L. Gantt said that the paper was an important contribution because it emphasized democracy in industry, and also that there could be no democracy in industry unless there was common knowledge of what was going on. Mr. Wolf had obtained remarkable results by letting every man know what he was doing and what was expected of him. It was too often true that the employer did not know exactly what his employees were to do. The discussions of Messrs. Polakov and Pulis had indicated what could be accomplished when it was known exactly what men should do. In settling the problems confronting employer and employee each concern is going to solve its own by knowing more about the conditions in its own shop and what is hampering the workmen there.

Richard A. Feiss thought that there was danger of interpreting Mr. Wolf's paper as a condemnation of financial incentives. Both financial and non-financial incentives have their place and must be taken into consideration. There are no cure-alls in industry, and failures in the application of so-called efficiency methods have grown out of a loss of perspective. The object, after all, is to obtain the best possible result from the human element in industry, and that involves a psychological question. The problem of employment will be solved only by maintaining a broader vision, by remembering that the human being is a human being and must be studied from all points of view and under varying conditions. He said that Mr. Wolf's paper called attention to a single element in management and that it, with all the other elements under the existing situation, must be taken into consideration when dealing with the complex psychological question of industrial relations.

A. L. De Leeuw said that the lasting growth of labor can only be caused by making labor grow from the inside out. The effort must be made by the laboring man, and not by the employer. The employer has only helped labor in general, but has not caused it to grow. Labor has taken the stand that it can grow only by antagonizing the employer, who, at one time, held this same view of labor. Something should be done to make labor start a growth or development of itself in the proper direction. If labor has not seen these facts, should not some one hold out the hand and invite labor to move in the right direction? Has not the time come when the engineer should get in touch with labor and invite it to discuss labor questions from a standpoint of pure and simple engineering, dropping all ideas of malice, and presenting the idea that a true bargain is one which benefits both parties? "Should there not be a third party," he said, "more or less disinterested, or rather, interested in the welfare of both, who will hold out the hand to labor and invite it to develop itself, to make an organic growth from the inside outward? Would it not be well if some engineering society were to invite labor into its counsel and see that a proper organized effort can be made for labor to look at the questions, not only of its own development, but of the development of industry as a whole, making labor to realize that no real benefits can ever come to it and be lasting unless similar benefits come to the industry as a whole?"

Charles Whiting Baker brought out the point of the reaction upon the wage earner through the increased cost of living of the

[1] See the December Journal, p. 1035, for abstract of paper.

[2] Care of C. E. Knoeppel & Co., 101 Park Ave., New York City.

inflation of wages. He was followed by Hugo Diemer, who emphasized the same thought, saying that the understanding of these economic principles presupposed education of the worker, of the engineer and of the general public. He spoke then of a course in Industrial Engineering which for a number of years has been given at the Pennsylvania State College and in which it is attempted to bring out some of the human phases of engineering. His remarks were a defense of the teaching profession, and in answer to the general criticism that engineers lack training in these less mathematical and technical phases of their profession.

John Clinton Parker said that the non-financial incentive applied to himself was to build up something that would be a credit to him, and that this was an incentive which applied to every one. He was also impressed with the fact that the solution of the problem of labor was endangered by a lack of faith and a false notion of elementary economic principles.

Frank B. Gilbreth spoke of the changed conditions which were confronting industry with the close of the war. Where a soldier was returning to his former job, now held by someone whom he considered his inferior, he found that more work had been accomplished than he had been accustomed to do and that greater productive effort was to be required of him in the future. So true was this in Europe that it has resulted in the eliminations of all restrictions upon output. The realization has come that the salvation of the world lies in big outputs per man. Engineers and economists have known this for some time, but laborers have not. They have held an honest belief that restricted output was the one thing which assured every man his job. They are not going to believe this any more because the labor leader knows that it is not true. Further, the laborer will not only release all limitations upon output but he will use his craft and skill to increase output. The workingman's committee is operating in a number of places as yet unannounced and with remarkable results. They are not interfering with the management in obtaining intensive outputs but are working on such things as heating and ventilating, elimination of labor turnover, the selection of the right man for the right place, fatigue elimination, education and corporation schools.

Arthur C. Jackson drew attention to the law that investment is entitled to an income. The investment may be in the form of cash, of invention, of accumulated earnings or of the results of the continued services of an employee. There should be a standard way of measuring all of these investments, and it is the duty of the engineer to solve the problem of the fair division of the profits resulting from these investments. Wealth is not alone dependent upon money but in the end upon production. This country must continue to be an exporting country if it is to maintain its position in the countries of the world. We can only maintain a wage scale above that of our competitors by the proportion that our production exceeds the production of our competitors.

Arthur L. Williston expressed the fear that the interest stimulated in an employee by teaching him how to perform his job properly would begin to lag after the attainment of the desired degree of perfection became an old story. He considered that the employer should have a new and greater lesson to teach as the simpler ones were mastered, looking upon his workmen as progressing from stage to stage in his industry as a student progresses in college from one class to another.

In his closure Mr. Wolf said that in his plants there was no difference between capital and labor. They were all fellow-workmen. He explained how he secured the spirit of coöperation with his employees by appealing to their intelligence and sense of justice, adjusting their wages by conferences, etc. He said that the men were promoted throughout the plant in much the same way as men progress through an educational institution. He contended that there was never trouble to be had with labor if the employer went to labor in a frank spirit of open coöperation. He thought that labor leaders realize that the workman must stop focusing his attention upon the distribution of wealth and focus it upon the production of wealth, after which the compensation would surely come.

In reply to some questions from Spencer Miller, who thought that the speaker might have contradicted himself in saying that men were rewarded by promotion and also that the incentives were non-financial, Mr. Wolf once more made the point that men do not do their best work for money. "It is the record, it is the accomplishment of the man that counts, and it is fundamentally self-expression that the man wants." The financial reward is bound to follow, and the employer who gives a man a chance to use his brain power and does not give him the financial compensation that goes with it is doomed to failure.

In answer to a question as to the disposition of the saving due to the improved efforts of employees, Mr. Wolf was of the opinion that the money should be divided, that the men should be part owners of the industries. It has been because workers have not worked intelligently that employers have been able to deprive them of this division of profit. The employer has used his brain to exploit the employee; the employee first used his brain to organize against the employer. That employee must be induced to use his brain for productive work. Then he will realize, as his mental capacity increases, that his reward is bound to follow.

Accused good-naturedly by John Clinton Parker of being a labor leader, Mr. Wolf replied that all engineers were labor leaders in the big sense of the word. Some one had said that the labor problem must be worked from within outward. The point of view cannot be imposed upon the laboring man. "The greatest potential force that exists in this country today for constructive leadership and disciplining of the destructive elements is organized labor. . . . Because there is a certain esprit de corps among them, so that, if you can get them harnessed into the partnership in a constructive way, get them focused upon the production of things, the power is tremendous."

Spencer Miller delivered a vigorous and inspiring address appreciative of the awakening which had come with the war and which had been the spirit of the papers of the day, and ended by proposing a vote of thanks from the Society to Mr. Wolf.

Robert L. Sackett amplified the remarks previously made by Hugo Diemer with reference to the courses in industrial engineering at the Pennsylvania State College, and was followed by Prof. A. G. Christie who, in the absence of Charles Piez, read his paper entitled The Evolution of the Organization of the U. S. Shipping Board, Emergency Fleet Corporation, which appears later in this report.

Discussion of Paper on Employment of Labor, by Dudley R. Kennedy [1]

In presenting his paper, Employment of Labor, Dudley R. Kennedy [2] said that he had been in the business of employing labor for eight years, and was considerably impressed to hear such a discussion of the subject of human engineering as had taken place that day. He wondered if, in the newly awakened interest in human engineering we were not turning to the frills in a sudden desire to conquer the problem. Collective bargaining to him did not mean dealing with a labor union or the one labor union of this country, but dealing with the people of his factory collectively. He could not agree with many economists with regard to the cost of living, but felt that the raising of wages in and of itself continually raised the cost of living, and the man with a short pay envelope never quite caught up. He insisted that if industrial relations were to be studied in a plant, the man to do it should be the best man money could procure, and not some clerk who had read a book on management. It required the best brains available.

L. W. Wallace, discussing the paper, emphasized this same point. Robert G. Wells was equally certain of it. He said the problem of getting labor and of maintaining an adequate and efficient force was just as large as any other industrial problem and was deserving of a department reporting directly to the head of the organization. He hoped the day would come when we would cease to use the terms "labor" and "capital."

[1] See December Journal, p. 1030, for abstract of paper.
[2] American Internat'l Shipbuilding Corp'n, Hog Island, Philadelphia, Pa.

Just as business men had found that their competitors were their best friends, so labor and capital should regard one another and coöperate.

Intensive Training by the Committee on Education and Special Training

Mr. C. R. Dooley[1] then read his paper on Intensive Training. The Committee on Education and Special Training was appointed to train drafted men as specialists in required trades. The program outlined by the Committee and the methods followed by them in carrying out their work were briefly described in this paper.

It was considered that the first essential step in educating the men was to accustom them to military obedience and discipline. Their classification was not based completely upon their past experience, but consideration was also given to their latent native abilities. Lastly, and the most important, the program of the Committee called for stimulating and fostering the qualities of originality and initiative. It was pointed out that the Committee was still capable of doing valuable work in training the returned soldier for industrial work during the process of demobilization.

James W. Russell,[2] in a written discussion, spoke of the work which had been done in the intensive training of boys and women at the plant of the Curtiss Aeroplane and Motor Corporation. A balcony was cleared and at least one machine tool of the same general character as those used in the shop set up for the "school." After a few weeks' training the pupil was sent to the shop. It was found that every person who entered for training was fitted for some one of the various divisions in the school, change within the school being a simple matter when the adaptabilities had been studied. In six months, 1500 employees were promoted to various departments of the plant. It was found that the selection of the instructor had to be done carefully, as it was necessary that he have not only a good character and a skilled knowledge of his trade, but also an ability to instruct.

In a written discussion, H. E. Miles[3] said that usually the powers of the individual man drawn upon did not exceed forty or sixty per cent of his possibilities, leaving a great reservoir untapped. The war had taught us to utilize this. It had taught us to train in six weeks where years were needed formerly in the wasteful apprentice system. He believed that the value of the practice of intensive training taught by the war has been proven in many factories and was about to be accepted as a part of the essential production program of every first-rate shop.

A. A. Potter wrote: "The work of the War Department Committee on Education and Special Training will result in the establishment of intensive short courses at many of our colleges and universities for the purpose of training industrial workers, who for lack of time on account of insufficient means are unable to devote more than a few months in preparing themselves for their life work."

He felt that the following factors contributed to the success of the Committee's scheme:

1 The men were prepared for a definite need

2 The courses were carefully supervised and the stress had been laid on the necessity of teaching men and not subjects, upon the desirability of building up a man's experience and ability

3 The men were taught by doing. The concrete preceded the abstract and the student saw the practicability of such instruction.

For work of this character to be successful in peace times, an industrial incentive must be developed to take the place of the war incentive. This can best be accomplished if the various industries tell the educational institutions their needs and allow the institutions to train men for a definite job.

[1] Educational Director, Comm. of Education and Special Training, Washington, D. C.

[2] Curtiss Aeroplane & Motor Corp'n, Buffalo, N. Y.

[3] Chairman Section on Industrial Training, Council of National Defense, Washington, D. C.

A. B. Segur[1] mentioned in a written communication the work of Frank Gilbreth at Fort Sill in studying the motions of infantry and artillery for the instruction of officers in conducting themselves in the field. He said the Red Cross Institute for the Blind was availing itself of intensive methods of education in its work of fitting blinded men for well-paid positions in the industries.

Arthur A. Reimer, discussing the paper orally, said that what Mr. Dooley had done with the training of the army showed the possibilities latent in our nation—possibilities to be developed by our engineers.

Arthur L. Williston was impressed with the fact that what Mr. Dooley had been doing was the basic purpose of scientific management: to determine the right process, to select the right man, to educate the man to do the job in the right way and to create in that man the maximum incentive. All the way through the discussion of management too much emphasis had been placed upon the right process and too little on the selecting of the right man, the training of that man, and the creation of the incentive.

In the absence of F. A. Waldron, his paper, Labor Dilution as a National Necessity,[2] was read by title, and the reading of a written discussion by Charles E. Fouhy[3] omitted because of the lateness of the hour.

THE ENGINEER IN FOREIGN SERVICE

By HON. L. S. ROWE,[4] WASHINGTON, D. C.

I HAVE come to you to take counsel at this critical period in our nation's history with reference to a national and international service which you, the engineers of the country, are in a position to perform. The winning of this war carries with it heavy responsibilities, especially for the United States. Our entry into the conflict has been free from all selfish purposes and has been prompted by a spirit of service to humanity. It is for you and for me, as citizens of this country, to see to it, in our respective fields of activity, that these high standards and that these high purposes shall not remain empty words. The engineering profession can boast of a splendid record of achievement. My plea is rather for the broadening of this spirit of service in order that a larger proportion of your profession shall be equipped to serve in foreign lands and particularly our sister republics of America, in the great engineering problems which confront them.

These problems have a deep significance for the future of America. Upon their solution depends to a very considerable extent the degree to which large sections of the American continent shall be made habitable, and beyond this, the extent to which the republics of Central and South America shall fulfill the great possibilities which are before them. It is not merely a question of the development of the natural resources of these countries and their consequent increase in wealth. Larger social purposes are also involved, for with the development of these resources the condition of their laboring population will be materially improved. It is a notable and significant fact that each great engineering work in Latin America has brought with it a rise in the standard of life of considerable sections of the population.

I have seen American engineers at work in almost every part of the American continent, and I have been impressed not only by their technical preparation and ability, but by the broad statesmanship that they have shown in the handling of large masses of foreigners and in their dealings with foreign governments. But the number available for the work has been entirely too small, and I am firmly convinced that in order that the United States may constantly have an engineering reserve to meet the needs of this continent, it will be necessary to broaden the training of the engineer in order that he may set forth with something more than the technical equipment of his profession.

The opportunities presented to the engineer in the countries of Latin America, both pecuniary and from the standpoint of

[1] Industrial Engineer, Red Cross Institute for the Blind, 1060 Conway Building, Chicago, Ill.

[2] See December Journal, p. 1033, for abstract of paper.

[3] Curtiss Aeroplane and Motor Corp'n, Buffalo, N. Y.

[4] Assistant Secretary of the Treasury.

recognition, are so great and so varied that all that it will be necessary to do will be so to adjust the preliminary training and equipment of students of engineering that they will be prepared to avail themselves of these opportunities. In order to do this it is indispensable that a larger percentage of our engineers leave the engineering schools with an adequate knowledge of the Spanish language. This is the first and an indispensable requisite. There should also be instruction in Latin-American political institutions in order that the engineer may know something of the system of government in the country with which he is to be associated. But beyond these questions of technical equipment we must instil into the mind of every engineer the larger international service which he is rendering when he undertakes a great work in a foreign country, especially if such work is undertaken for the government of the country. This means a greater breadth of view combined with a certain cosmopolitanism which will assure ready adaptability to new conditions and to new requirements.

During repeated and extended tours through South America I have time and again been asked to assist in securing the services of irrigation engineers, electrical engineers, engineers for the designing and erection of public works and other important public enterprises. There has been no difficulty in finding men equipped to do such work, but there has been a very real difficulty in finding American engineers prepared to expatriate themselves for a period of years in order to undertake such work and to carry it to successful conclusion. In spite of our cosmopolitan make-up there is a lack of adaptability of the average American in adjusting himself to foreign conditions, which makes it exceedingly difficult to secure men who are willing not only to begin, but to complete large public works in foreign countries. This has been true not only in engineering, but in every other field of endeavor. American commission houses in South America must engage Swiss, Dutch and even Germans because of the unwillingness of American employees to settle down in those countries for any lengthy period. Almost every American that I have met serving in a foreign country feels that he is making a great sacrifice in consenting to expatriating himself even for a relatively short time. At the end of about six months he begins to show signs of impatience and at the end of a year his homesickness reaches a point which at times leads him to leave his work incomplete. Furthermore, there is too often a failure on his part to place himself in touch with the people of the community in which he is living and he thereby fails to exert the broader influence which would be of such great value to his country.

This defect has been less marked in the engineering profession than in any other. What we need first of all is a clear conception of the very real international importance of service in foreign countries. I am convinced that if the entire engineering profession were to realize the extent to which its members can serve in promoting the spirit of international coöperation which the President has placed before us in such eloquent terms, greater effort would be made in preparing and encouraging members in that profession to respond to the call, especially when such calls are made by our sister republics of this continent.

It is important, however, to bear in mind that whenever a member of your profession undertakes the supervision of a public work in a foreign country, he becomes in a very real sense a representative of the people of the United States. He must be able to understand the viewpoint of nations different from our own in historical and ethnic make-up. The engineer in charge of great public works has often under his immediate direction great masses of native labor and it is most important that he should show a real interest in their welfare, contributing within the measure of his power toward the increase of their efficiency and the raising of their standard of life. In a hundred different ways the members of your profession can make themselves factors of very real importance in the progress of the countries which they are called upon to serve and at the same time become to the people among whom they are called upon to labor the interpreters of the best in our American life. The responsibility is a heavy one, but the magnitude of the results is commensurate with the responsibility.

ORGANIZATION OF THE U. S. SHIPPING BOARD EMERGENCY FLEET CORPORATION

By CHARLES PIEZ,[1] PHILADELPHIA, PA.

The United States Shipping Board was created by Act of Congress, approved September 7, 1916, "for the purpose of encouraging, developing and creating a naval auxiliary and naval reserve and a merchant marine to meet the requirements of the commerce of the United States, with its Territories and possessions, and with foreign countries; to regulate carriers by water engaged in the foreign and interstate commerce of the United States; and for other purposes." The Shipping Board, under the provisions of this Act, was given the power, if in its judgment such action was necessary, to carry out the purposes of the Act, to form under the laws of the District of Columbia, *one* or *more* corporations for the purchase, construction, equipment, lease, charter, maintenance and operation of merchant vessels in the commerce of the United States, and in the exercise of the power so granted the United States Shipping Board Emergency Fleet Corporation was organized on the 16th day of April, 1917, with a capital stock of $50,000,000, all of which has been subscribed for by the United States Shipping Board on behalf of the United States. As the Shipping Board is, under the Act, charged with the responsibility of doing all things necessary to protect the interest of the United States in the Emergency Fleet Corporation, it has elected to place the control of the Corporation in the hands of a Board of seven Trustees, five of these Trustees being the five Commissioners composing the United States Shipping Board.

It is evident that by this method of control the vast responsibilities which the war has created rest in the final analysis upon the five Commissioners of the United States Shipping Board. And when it is remembered that these gentlemen have been confronted with the task of blazing new trails and establishing the fundamental policies in connection with the giant tasks of regulation, construction and operation, the troubles which made the early days of the Shipping Board a byword find ready explanation. Relief from this over-centralization of responsibility and control could, of course, be secured through the exercise of these three main functions by three separate but related and centrally controlled bodies, and the Act itself provides for just such a solution.

When Mr. Hurley took office, the by-laws of the Fleet Corporation provided that the officers were to be a President, a Vice-President, a Treasurer, a Secretary, a General Manager, and such other officers as the Trustees might determine. They further provided that the General Manager should have the general oversight and management of the business and affairs of the Corporation, and should have power to employ and discharge all clerks, employees and agents, determine their salaries, and prescribe and define their duties. In other words, the titular head of the Corporation was assigned merely nominal powers, and the General Manager, who is usually an appointed officer, was given full executive control and responsibility, but yet lacked the power to complete contracts, a most important and necessary function for speedy prosecution of the work in those early days of pressure and stress.

The Denman-Goethals controversy arose quite naturally out of this faulty scheme of organization. Mr. Hurley improved this condition tremendously when late in November the by-laws were amended so that complete power was concentrated in the President of the Corporation, with the authority to delegate it, and the General Managership was made an appointive instead of an elective office. But, in spite of this wise and necessary step, the process of decentralization above outlined would have improved the administration of both the constructing and the operating division and would have relieved mightily the pressure on a much overloaded Board.

The relationship and functions of the United States Shipping

[1] Vice-President and General Manager, U. S. Shipping Board Emergency Fleet Corporation.

Board and the two divisions of the Fleet Corporation are shown in Fig. 1.

In the popular mind the Construction Division is considered the Emergency Fleet Corporation, and as it is to the Organization of this division that this article will address itself, I will follow the popular misconception and refer to this division as the Fleet Corporation.

The Corporation began in reality as a designing and contracting organization, and for the first four months of its existence these two functions overshadowed all others. On August 3, 1917, however, all vessels in American yards, under construction or contract for either domestic or foreign account, were requisitioned, and this step brought with it the control of the construction of 413 vessels, necessitating the addition of a division of construction to the skeleton organization then existing.

But the country's needs for ships could not be satisfied with the output of the shipyards then existing, and substantially every one of the earlier contracts for vessel construction carried with it the obligation of constructing wholly new facilities. Designing vessels and contracting for their construction, which constituted the first phase of the Corporation's work, was quite naturally followed by plant and shipyard construction as the second phase. In the meantime, however, the demand for war supplies was making heavy inroads not only on the available stocks, but on the producing capacity of the industries as well, and the Emergency Fleet Corporation found itself compelled to assume increasing responsibility for furnishing all of the new yards, and many of the old ones, with the necessary raw and finished material.

In the construction of wood steamers, only a few yards, for instance, accepted contracts for the delivery of complete ships, the remaining yards undertook the construction of wood hulls only, for which the Fleet Corporation had to provide not only the lumber and fastenings, but the chains, anchors and other hull accessories as well. The Corporation had to furnish in addition the boilers, piping, engines, propelling machinery, deck machinery and all other parts of the equipment, and had to construct separate plants at which this machinery and equipment could be installed on the hulls delivered by the hull contractors.

As the construction program developed it became evident that the two main problems confronting the Corporation consisted in securing an adequate supply of labor and an adequate supply of material delivered in proper sequence. On August 1, 1917, the number of men engaged in the shipyards was in the neighborhood of fifty thousand, and that number, under the drive of our great necessity, was increased sevenfold in almost as many months. The men were brought to the shipyards by patriotic appeals, by the lure of high wages and by the probability of exemption from the draft. The problems connected with securing and building up this huge army of workers were numerous and complicated, and justified the creation of the Industrial Relations Division, with its various sections. The Division of Industrial Relations became charged not only with responsibility connected with the labor supply, its proper maintenance in health and safety, and the adjustment of minor differences and delinquencies; but it had to accept the burden of occupational draft deferments, the training and stimulation of workers, the proper allocation of the available labor supply, including the elimination of "scamping," and last, but by all odds the most difficult, the control of a proper adherence to the day rates, piece rates and classification of occupations established by the Shipbuilding Labor Adjustment Board.

But the establishment of a stable and effective labor force at each of the yards involved another problem of considerable magnitude. Unfortunately, the shipyards clustered about the fringes of the highly congested industrial centers of the seaboard and on the Great Lakes, and almost everywhere there were lacking adequate transportation facilities, adequate housing facilities, or both. Ninety-five million dollars were appropriated by Congress to relieve these conditions in the shipyards alone, and the Division of Passenger Transportation and Housing had to be developed in record time to assume charge of this highly important piece of emergency construction.

Securing an adequate supply of material in proper sequence, presented in essence just as many and as serious a set of difficulties as did the supply of labor. Beginning with the simple act of purchasing, the failure to make deliveries called very promptly for the organization of a production and expediting department, and the necessity of bringing the finished material to the completed hull presented a most interesting and difficult task in allocation, dispatching and transportation. It must be borne in mind that the Fleet Corporation accepted substantially full responsibility for supplying the raw materials, the finished materials, and the machinery for a wood ship program amounting to $450,000,000, and that, in addition, it was charged with the burden of securing all of the steel and a large part of the machinery for a steel ship program at least six times that size. Purchasing was but a minor part of a problem that involved responsibility for delay in supplying material of every character to every one of the 171 yards under contract with the Corporation.

It was considered best to concentrate in the hands of a single division the responsibility for buying, and delivering to the yards

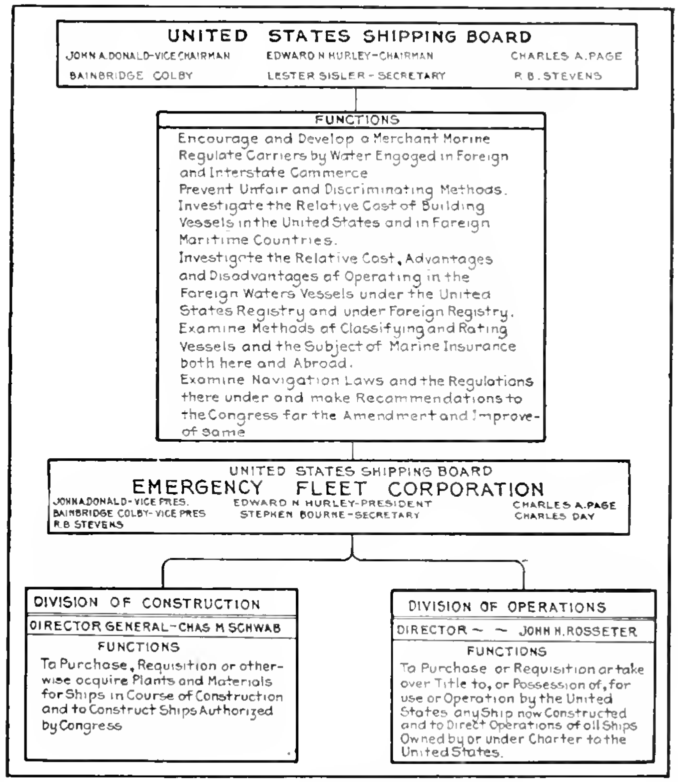


Fig. 1 Relationship and Functions of the U. S. Shipping Board and the Two Divisions of the Fleet Corporation

on time and in proper sequence, all the material the Corporation was charged with furnishing, and the functions of purchasing, of tracing and expediting, of allocating and dispatching, of inspecting and of transporting, which in the earlier days of our development were performed by three different departments, were thereupon consolidated under the control of the Supply Division. This division built up effective district organizations in the various industrial centers of the country and maintained its contact with the shipyards through representatives in the offices of the District Managers in the shipbuilding districts.

There were then, in reality, two great supply divisions, one undertaking to provide the necessary labor and the other the necessary material, and these two divisions served the four divisions that were charged with the supervision of construction: The Division of Housing and Transportation, the Division of Shipyard Plants, the Division of Steel Ship Construction and the Division of Wood Ship Construction. Each of these divisions developed its own technical department, excepting that in the case of the two-ship construction divisions a single technical department covering both naval architecture and marine engineering, for both steel and wood ships, was created and placed under the administration of the Division of Steel Ship Construction.

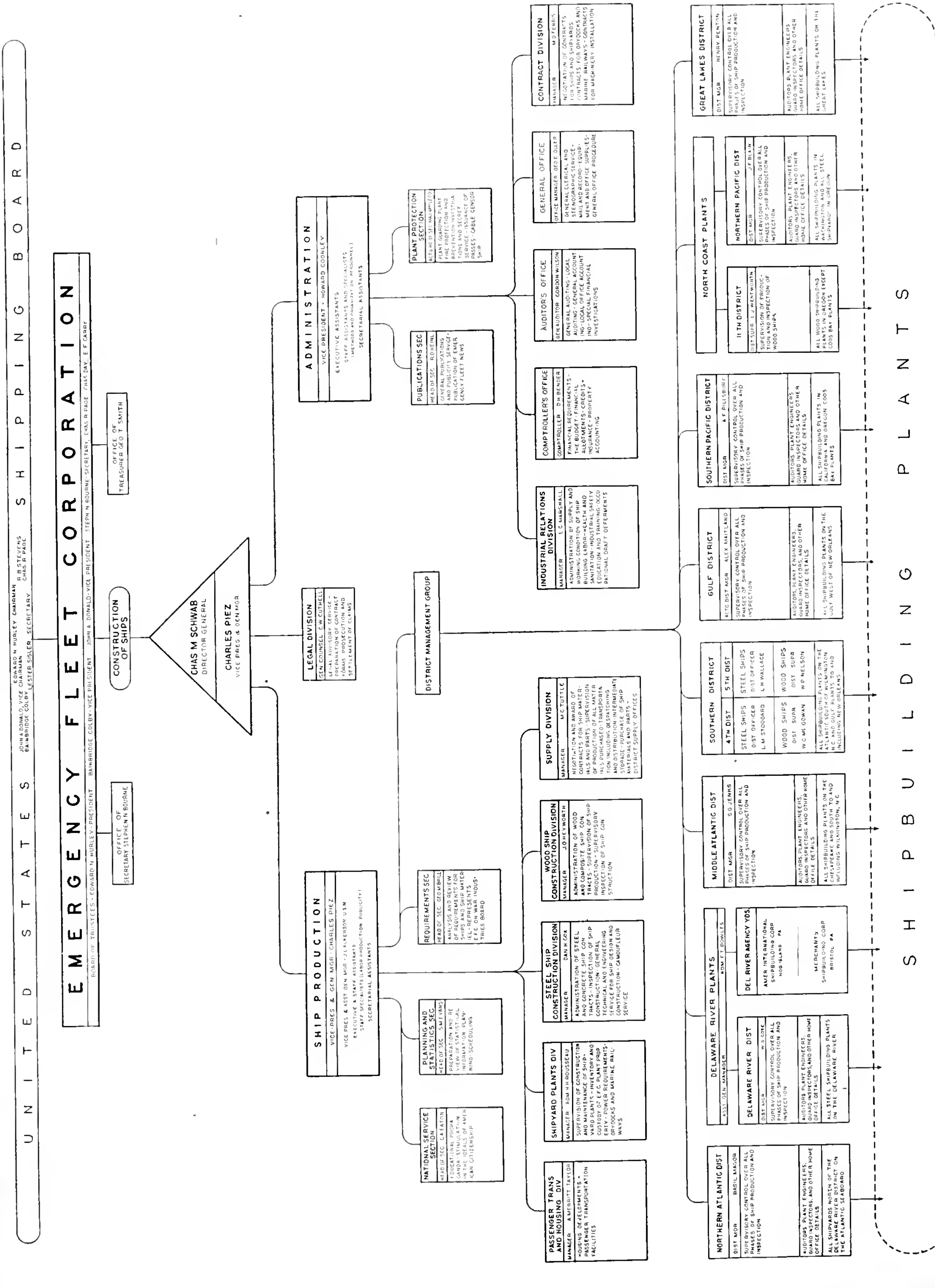


Fig. 2 Chart Showing Organization of the Emergency Fleet Corporation

For the purpose of controlling the actual construction in the field, the country was originally divided into eleven districts, in each of which there was one or more representatives of each of the construction and service divisions and sections. Later the control of all of the functions in each district was placed in the hands of a district manager who, as the direct representative of the Vice-President and General Manager, exercised in respect of the districts all of the authority which the latter exercised over the operations of the Corporation as a whole. The number of the districts was also reduced from eleven to eight.

This step of decentralization aided materially in the expedition and dispatch of affairs, particularly as the lines of direct communication between the sub-heads of the district and the corresponding division heads at the Home Office were preserved.

The various divisions and sections at the Home Office communicate directly with their appointed representatives, but send carbon copies of all directions and instructions to the District Manager, who is given the power to veto any instructions and stop any processes which, in his judgment, and from his local viewpoint and his first-hand contact with the problems affected, are inimical to the interests of the Fleet Corporation. Failing to convince the division or section at the Home Office of the soundness of his decision, appeal lies to the Vice-President and General Manager.

Time is a most essential factor in the development of any organization, and this is particularly true of those huge organizations that grew out of the necessities of the war. It took time to see and grasp the real needs; time to develop the scheme of the organization; time to pick and test the men to manage affairs; time to develop the proper team spirit, the spirit of discipline and submission to the central controlling authority.

Every division of the Fleet Corporation presented problems exceeding in number and magnitude the problems presented by an industrial or commercial enterprise doing a business of many millions a year, and every division required an organization of which the organization of the Corporation was but the pattern. The real difficulty lay not in choosing the general form of the organization as presented by the chart, Fig. 2, but in finding men who had not only the necessary experience and capacity for the job, but the proper temperament to blend quickly and harmoniously with the rest for the smooth and effective accomplishment of the task. Since the selection of the men presented the chief difficulty, we had no hesitancy in building our organization around the mental capacities and the temperamental peculiarities of the men we had available. The chart presented in Fig. 2 should not therefore be studied with the idea that it represents the last word in theoretical relationship and perfection. I have never been impressed with the value of a system chart unless I knew the men whose functions it depicted, for a chart without the personnel is like an equation with none but unknown quantities. The organization of the Fleet Corporation has been in a state of flux from the very first, and intentionally so, because it gave an opportunity for those quick changes and rearrangements which emergency conditions constantly demand. Today, with the pressure over, some of the functions will disappear, others will be consolidated and a new management adjusted to normal conditions will result.

The organization through the past six months of its career has been subjected to the constant critical study of an organization and methods section, attached to the staff of the vice-president in charge of administration, and this section has suggested administrative changes, has assisted in the definition of duties and responsibilities of the operating units, and has pointed out duplications of work and inconsistencies and overlaps in jurisdiction. It has made a study of the duties and responsibilities of different positions, and has developed a plan for bringing about uniformity in classification and salaries of employees, which is now in operation. Instructions given by the general officers of the Corporation are issued in the form of orders, which may be either general, special or technical; and these for the purpose of securing consistency and harmony with orders of a similar character previously issued are cleared through the Organization and Methods Section. The necessity of such a constant critical study of an organization which extraordinary pressure is expanding with great speed is apparent, and its value in reducing such a hastily gathered organization to a well-balanced effective unit is open to no doubt.

Coming now to a more detailed description of the organization as it existed before the signing of the armistice, complete power was delegated by the Board of Trustees to the Director General, who retained control of the policy of the Corporation, but placed control of the management in the hands of the Vice-President and General Manager. As an immediate relief to this official, the general duties and activities were divided into two main groups, one covering ship production, administered by the Vice-President and General Manager, with a Vice-President and Assistant General Manager in more immediate charge, and the other covering Administration, with a Vice-President in charge. The various sections and divisions, with their relationship and lines of authority, are so clearly indicated by the chart as to require no further comment, except that the position of the Industrial Relations Division, under the Administration group of activities, is due to a desire to more nearly balance the work of the two groups. The Industrial Relations Division serves the Production Divisions, but the relationship between the Vice-Presidents is so close and harmonious that the rather strained position of this division has resulted in neither embarrassment nor friction.

The Corporation is charged with responsibilities that involve a total expenditure of $3,880,000,000, and the construction of a fleet of vessels which, with certain emergency exceptions, will be so varied and well-balanced as to meet the requirements of our commerce with our own territories and possessions, and with foreign countries as well. The activities of the Corporation will result in an American Merchant Marine of 15,000,000 dead-weight tons, and the members of the organization who have spent many months under the high pressure of national needs look to that result for their compensation.

STANDARDIZATION AND ADMINISTRATION OF WAGES

By H. P. KENDALL,[1] NORWOOD, MASS., AND F. D. HOWARD,[2] WASHINGTON, D. C.

When the United States entered the war there was very little administrative machinery for dealing with industrial relations. These relations were affected in some slight degree by legislation touching hours of work for women, workmen's compensation acts, and other laws for the protection of workers. There was also the Department of Labor, which had very little or no authority to regulate industrial relations, but whose function was confined to publication of information and mediation of difficulties when called upon by both parties. Industrial relations were adjusted by the free competition between the employer and employee. The terms of the contract were determined by competitive industrial conditions, the relative demand and supply of labor, and the extent to which workers were organized for collective bargaining. These contractual industrial relations were largely determined by the relative bargaining strength of two parties and varied as the conditions of economic strength varied.

The system of contractual relations was in many cases modified by the benevolence or feelings of conscientious responsibility on the part of the employer on one side and by the feelings of loyalty and of ignorance of business principles on the part of the employees. These modifications were more likely to be present when the personal relations between employer and employee in small establishments were close enough to make personal relationship possible. In the larger establishments, where there could be no personal acquaintance and contact, the relationship was of necessity less influenced by other than economic considerations. Very general attempts had been made to evade this difficulty by the establishment of service departments in larger businesses, but this institutionalized benevolence outside the contract of employ-

[1] Treasurer, The Plimpton Press. Mem.Am.Soc.M.E.
[2] Executive Secretary, Committee on Industrial Relations.

ment was not always successful in eliminating the conflict of interests involved in the system of contractual relations.

The adjustment of relations by contract, especially during war times, involves difficulties too dangerous and wasteful to be tolerated. When there are swift and sudden changes in the relative supply and demand for labor the natural economic tendencies toward a new equilibrium of wages create unsettlement and unrest. It is a fundamental principle that there can be no free contract unless either party is at liberty to withhold a commodity or service for which he is bargaining. The withholding of the service of labor involves, unfortunately, the cessation of industry and is attended by waste and harm to parties not directly involved in the negotiations. Much of what is called industrial unrest is merely the natural manifestations of the bargaining process which is the fundamental part of the system.

Because the contractual relations are determined by the relative economic strength of the parties and because economic strength is created by organization, it is inevitable that the contracting parties should organize in order to secure an advantageous position by collective action for bargaining. The weakness of collective bargaining lies in the fact that it involves creating force, which may easily be abused or used for evil ends by unscrupulous men who are able to possess it.

War Labor Policies Board

The so-called labor problem was unquestionably the greatest political and economic problem of the American people prior to the war. The changes in production by machinery and the need for greater production with the coming of the war accentuated this problem and the extravagant and disproportionate wage increases have added to the unrest. The winning of the war depended on a new method of securing industrial peace so necessary to secure the required production. The War Labor Policies Board was created for that purpose, to work out a national policy and correlate the activities of the various wage-adjustment boards which were emergency instruments. The War Labor Policies Board made use of determined standards and adjudicated decisions which had met with the greatest success in both private industrial plants and in industries at large. Learning also from the British experience, it first set out to establish in one industry after the other, beginning with the most important ones from the war viewpoint, wage-adjustment boards more or less supervised by the Government agencies.

With the approach of peace, the winning of the war is no longer the supreme Government purpose, and with the close of hostilities the problem of industrial relations and industrial peace is relatively not less important, but more. It is by far the greatest problem that we face. The employing and the employed now have the opportunity to develop constructively a plan and policy for setting up standards and settling labor differences without the use of force. If industrial managers lead in this there will be no occasion for governmental interference or control. It is for us to determine the establishment of broad basic principles governing the standards and administration of wages. Such a subject, however, is far broader than mere wages. It means the entire field of industrial relations, of which wages is an important part, not the whole factor.

In order that the productive energies of the nation might not be dissipated in wasteful labor controversies, it became the first duty of the Government to provide activities to secure industrial peace. A sudden change in the condition of supply and demand brought into play tendencies to unsettle the accustomed status of wages, hours and conditions of work. This was accentuated by the same tendencies operating to change prices of commodities as manifested in the increased cost of living.

The time was too short to deal with the problem fundamentally. For the settlement of controversies the Government organized the War Labor Board, properly known as the Taft-Walsh Board, whose function it was to adjudicate disputes. In order to secure some measure of consistency in their decisions, the Board recommended a set of principles which was prescribed by its president. The principal points were the recognition of the right of the worker to organize to bargain collectively without fear of the customary measures of employers to prevent this, the living wage and the 8-hour day.

In addition, a coördinating agency was established, known as the War Labor Policy Board, composed of representatives of the purchasing departments of the Government. The functions of this board were to create uniform standards in industrial relations and uniform policies for their administration.

Post-War Labor Problems

With the end of the war, the greatest industrial problem doubtless is this: What general principles shall be followed in dealing with the labor problems of the future with all their unseen dangers and possibilities? War has changed conditions to such an extent that a return to the *status quo ante* is difficult, even though it were desirable and possible. The only alternative to the old system of allowing industrial relations to be adjusted by natural economic laws and preventing bargains seems to be that of standardization, or the conscientious and systematic regulation of these relationships by collective action, which does not necessarily mean Government administration, but which may be accomplished by voluntary collective action.

The term "standardization" does not necessarily mean uniformity of wages, hours or conditions of work. It means the determination of these conditions according to general principles, the justice of which is universally acknowledged. It is much easier to establish general principles than it is to derive the particular standards and apply them to actual situations.

The regulation of industrial standards by joint boards as suggested has the great advantage over the present system in that it eliminates at least three-fourths of the cost of friction and strife between the particular employer and his employees. Each employer then adopts the standards which are current in his trade and knows that all his competitors are on the same basis and have no advantage over him. Even under our present system, the chief objection to any one employer's increasing wages lies in the fact that it comes out of the profits unless the increase is general among his competitors, when it is shifted to the consumer of the product. It is easy to foresee a time when the public and not the employers will have the chief interest in opposing wage advances.

In many, if not most, of the cases where employment conditions are admittedly unsatisfactory, the employers are helpless to improve them on account of the pressure of competition. The plan for organizing adjustment boards provides a remedy for this by attempting to establish standards for itself which are protected against demoralization by competition.

The tendencies for industries to become more and more dependent upon each other is increasing and the consequence of this is an increasing necessity for industrial peace. The indirect effects of stoppages increase with the greater integration of industry, and the number of interests and people who suffer from labor difficulty and yet have no direct participation in them grows each year. A street-railway strike, for example, in a great city causes a collateral loss of business all out of proportion to the amount in dispute between the company and its employees. The indirect interests affected by labor disputes are therefore becoming so important as to be entitled to more consideration than formerly.

The administration of industrial relations, especially wages, by a skilled person specialized for the work is no longer an experiment. No industrial administration is complete until in some part it is sensitive or responsive to the aspirations and grievances of the employee. The efficiency of production is often affected fundamentally by action taken in other departments of the business. Moreover, the labor manager has an opportunity to interpret a business policy to be established by the working force and may frequently forestall opposition and ill-feeling by timely explanation of the reasons for such policies and standards.

There is a tendency where standards are fixed by haphazard methods or in the heat of struggle with labor unions for certain fundamentally right and efficient principles to be overlooked or

submerged. That wherever there is a standardized wage there should also be a specified measure of proficient labor performed is not to be disputed by any reasonable person; yet situations are created where this just principle is opposed by labor organizations who feel compelled to take that position because of the circumstances of the situation. Another principle, equally self-evident, is that every worker has a moral right to compensation in direct proportion to his individual accomplishment, yet for reasons which seem to them to be valid, the unions frequently set themselves squarely against piece-work or bonus systems which aim to employ this principle. Under some system of standardization it is likely that these just principles may be reëstablished with proper safeguards against abuse.

Labor to Coöperate

The war period has created a very perceptible change in attitude on the part of employers toward what is loosely termed "collective bargaining." This means that employers recognize the need for a greater sense of responsibility on the part of the employees toward the efficiency and success of the business in which they are engaged, and that in order to develop this sense of responsibility greater participation shall be granted to the workers. Moreover, the worker should be given an opportunity to learn more about the policies of the establishment and the difficulties of management. It is recognized that the indifference and even hostility of the workers to efficiency arises from their relationship to the business and the absence of reasons why they should be interested.

The Federal Labor Administration, following the President's proclamation by which the War Labor Board was created and manifested in the collective-bargaining clauses of the Quartermaster's and Ordnance contracts, gave an impetus to the general principle of participation in management which many have begun to see offers an opportunity for a general betterment of industrial relations in individual plants. The introduction of a system of organized representation of employees by the Standard Oil interests and the apparent success of the idea has stimulated general interest, and it now appears that this idea is likely to be much more generally accepted, especially by large industrial plants. That responsibility creates conservatism is a truth which has been demonstrated, and nowhere more convincingly than in industrial relations. Give employees responsibility and opportunity to exercise it, and sooner or later there must develop leadership among them which will contribute not a little to the vitality and general efficiency of the establishment.

To make this plan truly successful, however, the management must decide to give labor a fair share of the results of the efficiencies and economies realized. Too often by the introduction of new methods and labor-saving machinery the employer cannot bring himself to yield a share of the benefits to the employees, although he expects them to bear uncomplainingly the hardships which may attend the transition. The difficulties of systematically giving to the workers their share of the profits are perplexing. The subject of profit sharing is very attractive, but the difficulties have frightened many away from the subject. Any system of profit sharing should take into full account the permanent needs of the worker and attempt to satisfy them to a maximum. It is difficult to know what is the right and just method to use, but the difficulty will be largely overcome in individual establishments by the proposed plan of standardization or regulation of industrial relations.

INTENSIVE TRAINING

By C. R. Dooley,[1] Washington, D. C.

The run of the draft only partially supplies the number of trade specialists needed by the army. At the Field Artillery Replacement Depot, Camp Taylor, the Personnel Officer is able to get just one-half the required specialists from the draft, and he looks to the Committee on Education and Special Training for the balance.

The records at the camps show that less than ten per cent of the men have had a high-school education or better and that the great majority have had no special training of high degree, and lack skill or even any continuity of experience.

The Committee on Education and Special Training was appointed in February 1918 with instructions to train men for the service. First of all the men must be soldiers, disciplined to prompt and complete obedience and broken into the routine of army life; second, they must be skilled in those trade specialties needed in the army; third, they must have that originality and initiative which will enable them as soldiers to use the tools and materials at hand in meeting emergencies.

The Committee adopted a program about as follows:

1 Military training
2 Sorting and training according to ability
3 Trade fundamentals and combinations
4 Development of originality and initiative.

Two months were allowed as the length of each course and six months, April 15 to November 15, were assigned to the experiment. A total of 90,000 men were to be trained.

Administration, Organization

The Committee and executive military officers remained in Washington in charge of the planning. The United States was divided into ten districts with field military officers and district vocational directors in full charge of administrative details. They literally went from coast to coast inspecting, approving and establishing units, wiring in the results each night from April to August.

A large production chart showed the capacity necessary to be arranged for each day in order to meet the 90,000 by November 15. The great majority of school heads were willing and eager to tackle the new job. No greater evidence of American resourcefulness has been developed than that of the 140 odd schools in their radical changes of equipment, methods and policies to meet this emergency. We all agreed it could not be done, but had to be, and that was sufficient. The production chart was eagerly watched day by day until the danger line was passed, and now we are closing up the experimental period with a total of approximately 100,000 men trained in some thirty different trades.

Methods Employed

Military Training. Three hours a day were devoted to Infantry Drill, Military Courtesy, Inspection, and General Military Training, tending not only to break in green men but to develop habits of promptness, precision, order, and to establish a company spirit in place of the normal American individual spirit.

Sorting and Training According to Ability. Both the experience and the natural aptitude of each man were used as a foundation to build upon. Where these coincide the job of training is easy. Where they are opposed the best of judgment and tact must be used to determine the right classification and assignment. If a man has made a success at a given line of work the chances are favorable for giving him further special training in the same lines. On the other hand, circumstances of youth have often prevented men from following their natural talents. Such cases are by no means the exception.

For example, the Dickinson High School of Jersey City positively had the least desirable detachment of men sent by the various draft boards to any school in the second district, and I am inclined to believe to any school in the country. Over 60 per cent came from the lower east side of New York: sweat-shop workers, garment workers, toughs, men from the docks, teamsters and every kind except men from the mechanical trades; men who had never been in an industrial shop; never handled a shop tool and who seemed hopeless for training.

They were assigned to classes and our job was started. In a few days there was a remarkable change. An able commanding officer and his lieutenants took them in hand. Due to this admirable military discipline and the efficient shop instruction some

[1] Educational Director, Vocational Instruction, Committee on Education and Special Training, War Department.

360 "fighting mechanics" were delivered to the army. Another group of laborers who had never done any forging were converted into capable blacksmiths within six weeks. In another case a young man who came directly from the farm was given instruction in sheet-metal work. In six weeks' time he was making stovepipe elbows of commercial quality from patterns which he himself developed by sound principles of descriptive geometry. In this particular school the instruction was given right in the machine shop in connection with the making of the pieces and the principles of projection and intersection were learned in a manner which made them a part of this young man's consciousness rather than by merely memorizing methods.

One of the inspiring things about these and hundreds of other incidences is the fact that the men themselves are enthusiastic about continuing with some form of industrial work even after the war. Three men in patternmaking at Carnegie Institute of Technology had formerly been bank clerks and declared most emphatically that they would never leave the woodworking industry.

The creative instinct seems to be fundamental in human nature and the accomplishment of practical results without help is the most stimulating of human experiences. With this motive established, a man normally becomes hungry for more accurate and deeper scientific information in order that his creation may be more perfect and he therefore begins to teach himself and the instructor merely becomes the means for the final checking of results.

That fundamental principles are infinitely more important than even a very great assortment of specific formulæ and rules is no longer doubted, yet this has been demonstrated again and again in the army training schools so that it will bear repetition here. For example, at one of the camps a group of soldiers built and installed a complete multiple-jack switchboard for telephone service out of nothing in the world but scrap. This could not possibly have been done without a thorough understanding of the simple principles of electricity and magnetism.

Many of the jobs in the army do not completely follow the standard lines of industrial occupation, and it was therefore necessary to define the duties of the men in terms of the work to be done, which many times included certain very definite combinations of parts of standard trades. For example, the operator of a mobile machine shop for the Ordnance Department must be able to operate a small lathe, a small drill press and do small vise and bench work. Further, he must be able to do gas welding, especially on thin metal parts, and must maintain in operating condition a gas-driven electric generator and several electric motors. Such an operator is called a machinist, although obviously a machinist as ordinarily known has no knowledge of gas welding or small motor operation, and could not fill the bill.

This emphasizes the great value of the man who can handle several different trades. Obviously he cannot become thoroughly skilled in all the phases of a number of trades, but by limiting the instruction to the fundamentals several allied trades may be covered, adding greatly to a man's usefulness.

Among other things that have been shown by the war to be advantageous is that type of efficiency which reckons on the personal originality of each man rather than on the completeness of the detail of his instructions, of a type of training that is flexible and elastic rather than rigid and exact in all predetermination. The war has been won through inspiring leadership that somehow seemed to spring from the atmosphere rather than through autocratic force. And so with the soldier-mechanic, much faith is placed in his ability to meet successfully new situations if only we can give him a correct understanding of the simple fundamentals of his trade and stimulate his constructive imagination.

The war is over. Thousands of men will return to industry with keen, alert minds, disciplined to act promptly and thoroughly as members of a team rather than as individuals. Many will not be highly skilled in civil occupations and will have to be trained in special work, but they will learn quickly and will advance rapidly because of their military experience.

The Committee on Education and Special Training could operate its organization backwards, so to speak, and train the returned soldiers for industrial work during the process of demobilization if such a plan were approved.

Industrial training means vocational skill, plus imagination and initiative, plus the discipline of keen service which marks the beginning of true leadership. It is hoped that the work of the Committee has contributed to the cause of general education in establishing some evidence of the fact that military training and vocational or academic training supplement each other; and in holding up before all students the motive of production for the community rather than for individual profit.

FIRST GENERAL SESSION

Discussion of Mr. Halsey's Paper on the Extent to Which the Metric System is Used in Latin America, and also Mr. Gantt's Paper Establishing a Relation Between Efficiency and Democracy

At the General Session, held on Thursday afternoon, Vice-President-elect John A. Stevens officiated as chairman. Two papers were presented, as follows:

The Weights and Measures of Latin America, Frederick A. Halsey

Efficiency and Democracy, H. L. Gantt.

Mr. Halsey's paper represents a thorough investigation to find out, from replies to about 500 questionnaires sent by disinterested American firms to prominent firms and individuals in the twenty-odd Latin-American countries, the system of weights and measures actually used in retail buying and selling, in the clothing trade, land measures, industries, farm products, rail and ship transportation. The replies furnish proof for his statements that nowhere is the metric system used exclusively, and that in countries that have adopted the metric system, the English system is also used, together with the original Spanish units, which, it is shown, differ but little from the corresponding Anglo-Saxon units. The author is of the opinion that the metric system has been pushed to the front chiefly by German influence, and as this has now been eliminated largely, it might be opportune at this time to unify the weights and measures of North and South America and the British Empire.

The aim of the author is to disprove: 1. The theory that it is an easy and simple matter for a country to change its system of weights and measures; 2, that the adoption of the metric system does away with confusion; 3, that this system is in universal use except in the United States, the British Empire and Russia; 4, that we must adopt the metric system if we desire to do business with Spanish America; 5, that the "adoption" of this system saves time in schools; 6, that it saves time in calculations, when in reality more conversions are made necessary by it; 7, that the persistence of old units in metric units is a persistence of names but not of things, which is not so; 8, that we will use the exact metric equivalents for English sizes. Reviewing the many unsuccessful attempts made elsewhere to install the metric system, the author is convinced that if it were to be adopted here in the United States it would only lead to needless confusion.

Discussion of Mr. Halsey's Paper

The paper evoked a very lively discussion, both sides being emphatic in the expression of their opinions. As usual with this

topic there were two groups; Mr. Halsey and his supporters looked at the question from the viewpoint of the manufacturer and the machine shop, while the opposite group was influenced by the theoretical or scientific advantages that it was believed would be brought about by a change to the metric system.

James Hartness, who opened the discussion, said that while he wished to be looked upon as a pro-inch man, and felt that the industrial worker preferred to adhere to this old-established system, he had a high regard for the scientist who is naturally in favor of the decimal and metric system. Realizing, as a result of the war, the need of close coöperation between all factions, and recognizing the fact that ultimately one system of weights and measures must prevail in international dealings, and in view of the present preponderance of Anglo-Saxon influence, he thought that one way out of the difficulty was to make the meter equal to 40 inches, as had been proposed in the past.

Howard Richards, Jr., Secretary of the American Metric Association, New York, emphasized the great simplicity of the metric system of measures, in which 1000 cubic centimeters or 1 cubic decimeter equals 1 liter or 1 kilogram of water. As is well known, in the metric system the meter for measuring length, the cubic decimeter or liter for measuring capacity, and the cubic centimeter of water or gram, are the related and fundamental units. He thought the utter simplicity of these units should commend the system to all who were favorably inclined to efficiency. He exhibited a 12-page pamphlet, issued by the American Metric Association, setting forth in detail the advantages of the metric system of measures. He challenged any one present to give him offhand the length of the side of an acre square, and elicited three replies, all differing and none exact.

Mr. Richards quoted Edwin M. Herr, formerly a vice-president of the Society and now president of the Westinghouse Electric & Mfg. Co., East Pittsburgh, as having told him, a few days before, that the Westinghouse Co. could make the change to the metric system by coöperating with the other engineers.

Henry D. Sharpe considered the work of Mr. Halsey as very valuable in that it disproved the claim made that there was urgent need of adopting the metric system to hold foreign trade.

Ralph E. Flanders was in perfect accord with what Mr. Hartness had said on the value of reconciling the needs of the shop man and the desire of the scientific engineer. He therefore offered the following motion, which was seconded by Mr. Hartness:

Resolved: That it is the sense of this meeting that the possibilities of the changing of the meter to forty (40) inches be brought to the attention of the Council of this Society, and that the Council be asked to consider such action as may lead to the adoption of this change by the metric countries.

Luther D. Burlingame said he had for years been interested in the subject of measures, and was chairman of the Society's Committee on Weights and Measures. It was a revelation to him to learn from Mr. Halsey's paper the extent to which the English system was used in Latin America, and to see how closely the important units of the old Spanish system agreed with it. He therefore found himself at variance with Dr. Samuel W. Stratton, chief of the Bureau of Standards, who had contended that the metric system was the most popular one in those countries. That the English system was acceptable to the twenty Latin-American countries was, according to Mr. Burlingame, proved by the fact that the total trade between the United States and those countries during the fiscal year 1917-1918 exceeded that of the year 1913-1914 by $1,000,000,000. He quoted Henry D. Sharpe, Treas., Brown & Sharpe Mfg. Co., as having said on this subject:

Instead of a change to the metric system being a benefit to our foreign trade, it would mean confusion to our home manufacture and use, placing a burden on us which would be a serious handicap in our competition for world markets.

Referring to Mr. Flanders' motion, Mr. Burlingame indicated that certain constructive steps had just been taken by the Society's Council, and that this was one of the matters that had led President Main to depart for Europe. Pending such negotiations, he would advise not to urge the motion before the house, because Great Britain was likely to take the initiative in the matter of unifying all measures, and we could afford to postpone definite action.

Mr. Burlingame thought that the paper was timely, and indicated a possibility for securing the adoption of the Anglo-Saxon system in Latin America, for which purpose he hoped a commission would be appointed to confer with representatives of those countries.

Adolph L. De Leeuw spoke rather in favor of the English system, and thought a 40-in. meter would greatly add to the confusion. He felt that the question of change of system had not been considered with an open mind. He said we should ask ourselves three questions: 1. If we had to choose a new system, would we select the metric or the English? 2. How much would it cost to change to the metric system? 3. Would the benefits be commensurate with the cost of changing? He would like to see fair play, and have the question definitely settled, whether or not the metric system was superior to the English. He said he knew from experience that it was a task to change metric dimensions or drawings to English dimensions, but that the change from English to metric would be no less awkward.

Samuel S. Dale, editor of *Textiles*, Boston, gave a lengthy discussion in favor of making the English system the universal standard. He showed that the present Spanish tables give the same multiples as the English, while the units themselves vary only 1.4 per cent from our units. He stated that in Russia the linear measures are based on the English inch and foot. The Chinese foot is equal to 12.6 English inches, but is divided decimally. The Japanese foot is 11.93 English inches. Even before the war, 70 per cent of the world's industrial energy was based on English weights and measures, and the situation at the end of the war precluded the adoption of any but the English system as a world standard. He called attention to the fact that British committees in reporting to Parliament regarding British policy after the war, did not recommend the compulsory adoption of the metric system, but held that a universal system would have to be acceptable to the British Empire and to the United States, and that in the meantime a simplification of the British system should be effected.

Mr. Dale said further that the object of such an inquiry was to remove the defects and equalities in the English system, which were but a mote compared to the mass of radical defects in the metric system, which we were asked to adopt. He welcomed the investigation suggested as tending to counteract what he called "pro-metric propaganda" by various Government Bureaus at Washington. He stated that Senator Shafroth of Colorado had introduced a bill during the preceding month (S. 5037) providing that the use of the metric system shall be compulsory in the Government departments, except in the survey of lands, after January 1, 1920, and that it shall be the standard of the country after January 1, 1922. He hoped the people would have a voice in settling this great question of change of system, because it should not be left to the "irresponsible theorists in the bureaus at Washington." He considered that the American Institute of Weights and Measures was best fitted to improve our English system and to oppose compulsory metric legislation.

Henry M. Hobart said he believed that a 40-in. meter would be equally unpopular with all parties concerned. Also that few realized to what a great extent the metric system was already established in the world. He was convinced that while working with the metric system in Germany his efficiency was higher than when he used the English system in Great Britain and the United States. He said it was not true that the British system was used to any considerable extent in Germany, but that the metric system was in use almost universally, as an inspection of textbooks would show. He thought this was the reason why Germany could produce so much more efficiently and cheaper than could the English-speaking countries.

Instead of adopting the 40-in. meter, he thought it would be simpler to await the death of the present generation, and regretted that in the intervening twenty years America and Great Britain must be allowed to fall behind in the matter of decimal systems

until younger men, imbued with more noble emotions, came to the front and caused the metric system to be adopted in this country.

Charles W. Johnson prefaced his remarks by stating that his viewpoint was that of a machine-shop man. He reasoned that if it was true that it took a year longer to educate a child in the English system than it did in the metric, that was an advantage, because it made him think, something he was supposed to learn how to do. Hence, the English system should be retained, for it is so complicated that it would make the child think!

Mr. Johnson wished to go on record as being decidedly opposed to the exclusive use of the metric system, for the sake of the operating men in industry. He said he had as yet discovered no advocate of a complete adoption of the metric system among industries manufacturing large varieties of complicated products where repair parts must be supplied. He thought the cost of retracing 500,000 drawings, converting inches into millimeters, would be prohibitive, and would bring no corresponding advantages. The method preferred now is to use even figures or simple fractions, because they are easier to work to than extended decimals. To employ metric units on new work only, he also thought to be impractical because of the mixed system of machine tools which would be necessary; besides, there were many old standardized pieces incorporated in new designs, so that the result would be great confusion. He referred to an article in the September 1916 number of *Machinery*, entitled The Metric Agitation, as being a clear and honest exposition of the conditions as affecting the machine shop.

Mr. Johnson added that if Latin-American business men preferred shipping papers to give weights and dimensions of packages in metric units, there was no objection to that, and that metric outline and foundation plans could be readily supplied, but he could not see why the parts themselves should be fabricated according to the metric system. He said it was most inopportune to make such a change now, because in the years following the war, with taxes high and labor conditions disturbed, it would be necessary to practice economy and efficiency more than ever. To be better able to meet competition, he thought we could not afford to expend millions of dollars in trying to introduce a system the benefits of which were apparent only to men of academic minds.

Charles E. Skinner said he represented the same company as Mr. Johnson. He was in favor of having but one international system, it did not matter which; but as to adopting the metric system, he was opposed for the same reasons Mr. Johnson had given, because he said the vice-president of the Westinghouse Elec. Mfg. Co. had estimated the initial cost of retracing their million drawings would be at least $1,000,000, with no compensating advantage; and, as he would be burdened with the task, he preferred to see things left as they are. Furthermore, the English-speaking peoples now occupied the dominating place in the world, and he thought they could retain it better by adhering to their present system.

D. E. Lauderburn said he had been practicing forest engineering since 1907, and had cruised timber in both the republics of Cuba and Santo Domingo. He found that the fundamental standards in these countries were metric, that the governments were using metric weights and measures, and that the surveyors used the metric system with the additional unit *caballeria*, which represented 42 metric hectares, the same as in Mexico. He exhibited a booklet published in 1910, in Spanish and English, entitled A Brief Statistical and Geographic Review, Including Revised Map of the Dominican Republic, on which map the only scale used was: 1 millimeter = 1 kilometer, and thought that especially for drawing and reading maps metric measures were a great convenience. He also exhibited a 28 by 63½-in. chart, published by the Cuban Department of Agriculture, Commerce and Labor at Havana, December 15, 1911, and signed by four government officials, giving all required technical data regarding 367 different kinds of wood. On this sheet the height and diameter of trees were given in meters, and the structural strengths expressed in kilograms per square centimeter.

After Mr. Sharpe had made further opposition to the resolution recommending consideration by the Council of the 40-in. meter, and Mr. Flanders once more had urged its adoption, Mr. Sharpe's motion, to lay this resolution on the table, prevailed by a rising vote.

Mr. Halsey, in closing the discussion, stated that the proposal for a 40-in. meter had been made frequently, the first time by Joseph Woodworth some fifty years ago, when it would have involved little difficulty to thus modify the meter.

His study of the New York schools convinced him that the study of weights and measures, instead of requiring a year, never exceeded three weeks. He said, "The judgment of the world is that the metric is not the better system, because the great majority of the people refuse to use it." He referred to France, where the metric system was first promulgated by law in 1792. In 1812, under Napoleon's reign, the law was repealed and people were allowed to return to their old system. He said this showed what the French people thought about this system, and that in South America they did not use it because they did not like it.

Upon motion of L. P. Alford, Mr. Halsey received a unanimous vote of thanks for his paper.

Written Discussions of Mr. Halsey's Paper

John H. Wigmore, Office of the Provost Marshal General, Washington, D. C., wrote that his attitude was based on the conviction that a system of weights and measures uniform throughout the commercial world, and decimal in its nature, was the obvious requirement; that he considered the Anglo-Saxon system as unscientific and impractical, and that the undoubted inconveniences of transition would be more than made up by the great convenience and economy of the future. Also that his opinion was strengthened by information he had received showing that in the engineering schools of the United States the metric system was used in practical work.

Representative James L. Slayden, Chairman of Committee on the Library, House of Representatives, Washington, D. C., wrote that he feared it would take considerable effort to secure the introduction of a really scientific and, when known, convenient system of weights and measures. He said that stupidity, inertia and momentary selfishness all operate to defeat the general adoption of the metric system in the United States. During his long and intimate acquaintance with affairs in Mexico, he had been greatly surprised to see how easily even the natives acquired a knowledge of the metric system, which was irresistibly making its way into the dullest understanding.

John B. Moore wrote that so long as Great Britain and the United States continued to do business in Latin-American countries with their old English units, those units were bound to be retained by those countries, unless their use was prohibited or penalized. He said that a uniform decimal system appealed very strongly to one's sense of convenience. On the other hand, he fully appreciated the fact that certain vested interests would be temporarily affected by the change, as well as the fact that changes are not generally desired by those who are not actually suffering from existing conditions.

H. J. Bingham Powell wrote that during his several years of experience as a civil and mechanical engineer in Peru and Bolivia, he found that in his line of work the metric system prevailed, but that manufactured articles imported from England and the United States, such as pipes, valves, cement, etc., were designated by their original units—inches, barrels, and timber in board feet. However, in workshops inches were in use rather than millimeters. In hydraulic calculations liters or gallons were used indiscriminately, the governments not attempting to make the metric system compulsory, since it would only inconvenience the people, who were satisfied with the mixed system of measurements.

William Jay Schieffelin, New York, whose drug business was founded in 1794, wrote that Mr. Halsey's report shows the chief obstacles to the wider use of the metric system in South America to be their business dealings with the English-speaking people. It certainly was not surprising to note the slow adoption of the metric system by the illiterate and conservative natives, but that was no reason for the people of the United States to be equally slow and to shut their eyes to the lessons of the past year, which

had demonstrated how quickly the whole people of this country could be informed as to an issue, if it was for the national good, and how within a few weeks the whole people would voluntarily cease using certain commodities, or change their habits of life, if it was for the country's good.

Mr. Schieffelin thought it ought not to take long to show a person having business dealings that a simple decimal system would save time and mistakes in merchandizing. In a wholesale drug house 30 per cent of the time of clerks could be saved if the weights and measures were metric. The fact that our blindness was not only hurting ourselves, but also our southern neighbors, ought to make us doubly anxious to put this reform into force.

Finally Mr. Schieffelin disapproved of the action of a small group of men, who were opposed to the adoption of the system, assuming an officially sounding name for their organization, and allowing their secretary to style himself a Commissioner.

Dr. A. E. Kennelly, Professor of Electrical Engineering, Harvard University, wrote that he could not agree with Mr. Halsey when he claimed in Par. 13 that Latin America was not metric. It was true, he said, that the use of the old units continued long after a new system had been introduced, especially among illiterate and the Indian people, but that ultimately the simpler system was bound to survive. None of the thirty-four countries that had adopted the metric system had ever revoked its decision, and those who had visited Continental Europe and the Latin countries knew from experience that the metric system was in universal use, and that if it were not satisfactory efforts would be made for the adoption of something better. Consequently he could not approve of the suggestion made in Par. 42 that "we should adopt the Spanish and not the metric system" if we were to succeed in selling goods to Spanish America. Nor could he agree with the idea suggested in Par. 9 that we should try to unify our system with that of the British Empire and South America, because then we should have to ask the International Metric Union, with its two basic units, the meter and the gram, to come into adjustment with our systems, with its dozens of units.

Professor Kennelly further said that the world was too small to permit of an indefinite continuance of a plurality of official systems. Sooner or later one system must prevail. When a simple and internationally recognized system operated alongside a complex and local system, it was only a question of time when the complex system must disappear. In fact, practically all scientific and electrical work was already being conducted and recorded in the metric system in every country. He stated that the American Institute of Weights and Measures could perform a great service to America and the world if it would, without bias, study means for bringing about international uniformity. That this could be done without abandoning existing plants, machines or apparatus was evidenced by the experience of other countries, only the adjustment would involve considerable readjustment of ideas, records and drawings. How to reduce this expense to a minimum, and how those burdened with the cost of changing over shall be protected and insured, were questions worthy of attention by the American Institute.

Mr. Gantt Presents His Paper on Efficiency and Democracy

In his paper Mr. Gantt establishes a relation between efficiency and democracy. He claims that the word "efficiency" has fallen into disrepute in connection with industry, and this at a time when efficiency is needed more than ever. He ascribes this to the fact that in the past the efficiency engineer has devoted himself exclusively to making more efficient the business of securing dollars, instead of producing more wealth. He says the production of goods for the benefit of the community is more important than the production of wealth for the benefit of those who control the industries. Also that the product of a factory should bear only the expense used to produce it, excluding the cost of idle machinery. There should be no idle machinery.

Mr. Gantt preferred to read only an introduction to his paper entitled Keeping the War Won. In this he pointed out that on the battle front war was competition in destruction. Behind the lines it was competition in production. He quoted Prof. C. R. Mann as saying that war was eight-tenths engineering, and that the engineer was the great production factor in the commonwealth. That through the efforts of engineers the war had been prolonged four years, and that it was certainly they who had won it. The next thing was to find out what part the engineer was to play in *keeping the war won.*

He then led up to the point where he hoped the engineer would be a more influential factor in the conduct of national affairs than heretofore, because he had demonstrated that *he knows what to do and how to do it.* He showed that when the war broke out leading business men had offered their services at Washington, but had found that their usual methods of doing business did not produce the required ships and shells, for they had been trained to operate for profits instead of for production. That engineers had attacked the problem in a different and successful way, he said, would be demonstrated during the discussion of his paper.

To supply the mechanical needs growing out of the war in sufficient quantity and in short time, progress charts had been compiled by engineers to show graphically the rate of production. These charts were used extensively by the engineering department of the Navy in the construction of shipyards, as well as in various large manufacturing establishments.

Mr. Gantt said that when the war broke out in Europe every one realized the necessity for greater production per capita, and it was the same in the United States. We should continue to improve our efficiency, and no machines should be allowed to be idle, so we could help those people who could do but little. If we did this we would also have the coöperation of the workman.

The system of keeping track of work done which Mr. Gantt had originated would be illustrated by a number of speakers who would show its successful application in the Ordnance Department, the Shipping Board, Emergency Fleet Corporation, and in numerous other places and private plants. He said that while the worker was studying efficiency, the engineer should study idleness.

Discussion of Mr. Gantt's Paper

Wallace Clark, the first to discuss the paper, made clear the task confronting the U. S. Shipping Board a year ago when it devolved upon that body to supervise ships afloat and building. He said the problem was to get ships to France and to bring to the United States food and raw materials. The former was done by the U. S. Army, and the latter by the Shipping Board. This Board had first ascertained what was needed at given times. Then it had listed its ships, which aggregated about 12,000, and it was here that the efficiency chart came in, inasmuch as it enabled one to have a graphical record showing in all required detail the daily movement of every ship, and to estimate beforehand the available carrying capacity in any direction for several months ahead.

The speaker then had a few typical charts projected on the screen. The first showed the rate of import of nitrate from Chile to this country. Of this, 800,000 tons, or more than half the output, was called for in the course of the year. To this work 175 ships were detailed. Charts, apparently 11 in. by 17 in. in size, were ruled up in such a way that the vertical columns represented days, weeks and months, proceeding toward the right. The descriptive side heads for the horizontal columns were placed along the left-hand margin. From these toward the right were drawn heavy black lines of differing lengths, the length of the line indicating either the quantity required up to the date indicated, or the actual output—or both if parallel lines. In the case of the ship record there was one horizontal column for each ship. One could tell from the record the weight of cargo, how long it took each ship to make a round trip, and when it could be expected to arrive. At the end of each month the various burdens could be added up and note taken of the progress made. It was possible to observe from these charts the over-supply as well as the deficiency of about 100 necessary commodities, and this furnished the required means for regulating the activity of the ships.

Another slide showed a similar chart applied to recording the progress made on certain field-artillery mechanisms. Each mechanism had to go through 67 different operations in manufacture.

The desired output was 10 mechanisms a day, and if the lines or bars on the chart were all of equal length, that would mean 70 mechanisms completed each 7-day week. However, the charts showed that some operations were proceeding at the proper rate, some were ahead, while others lagged behind, their lines being short, and therefore demanded special effort in order to meet promised deliveries of completed sets.

A. T. Clark, another member of the U. S. Shipping Board, then exhibited some slides of charts showing the movements of over 7500 ships employed in supplying coal from Chesapeake points to New England ports. Instead of a single horizontal bar, a series of circles and special characters were placed in the horizontal column for each ship, at the required dates. A circle represented the face of a clock, a closed circle denoting a full shift of 10 hours' work. A symbol inside of an incomplete circle gave the reason for any idleness. Thus, a wavy dash meant adverse tides or bad weather.

The cards were 11 in. by 17 in., each side for six months. For each month there were six horizontal lines, A to F. The dotted line A would show at some date a forward "L," indicating the date the ship left port. Some days later, on the same level, there would appear "L" turned the opposite way, indicating arrival at the distant port. The next distance, between brackets, indicated the time spent in port. Name of ship and tons of coal or other load carried were marked in the open space between the brackets. After the second bracket was written the name of the port bound for. While in port a separate symbol signified "discharging cargo," another "discharging ballast"; the relative position of the symbol indicating whether the work had been done by day shift or night shift.

On the chart was also indicated the time consumed in discharging the cargo each time, also how the ship was held up waiting for dock accommodation, and whether the ship had to undergo repairs which may or may not have interfered with loading or discharging. At the end of the month a cost statement could be prepared of the transportation cost per ton over this route. A new chart was then made providing a vertical column for each ship. The height of this column represented the total cost, and that was made up of the various items that enter into the cost of transportation. This showed the performance of each ship, the shortest column indicating the lowest cost per ton carried.

W. H. Blakeman submitted a written discussion which was presented by Mr. Gantt. Mr. Blakeman, he said, was a shipbuilder, now connected with the Cramp Shipbuilding and Engine Co., previously employed by the American Shipbuilding Co., headed by the Emergency Fleet Corporation, to help them to standardize work in shipbuilding. After looking over the Philadelphia plant, Mr. Blakeman devised a progress chart which greatly facilitated the production.

The facts intended to be conveyed by graphical straight-line charts included the following:

1 Show the work to be done on various parts of the vessel
2 Indicate manner of doing it at the shipyard decided on
3 Indicate time of completion of all parts.

The adopted form of schedule and progress charts record:

a The work to be done in groups
b When it is to be done.

Vertical columns on the charts represented days. Horizontal columns applied to the various items of work. Along these horizontals were marked various characters and symbols showing state of progress at the date they appeared. The rate of receipt of structural material was thus apparent from the charts, the rate of erection, rivet driving, installation of equipment, etc. The Emergency Fleet Corporation was instrumental in having this simple and effective chart system introduced at 90 per cent of all the shipyards in operation in the United States.

S. B. Barrows, a representative of the Naval Aircraft Factory, Navy Yard, Philadelphia, then described and had shown on the screen a number of the Gantt type of progress charts which had proved to be very valuable in systematizing the proper rate of production of completed airplanes.

James J. Reynolds then illustrated on the screen charts devised, with the assistance of Mr. Gantt, for accelerating the production of artillery ammunition at the Frankford Arsenal. Blueprints of these charts could be sent to Washington at regular intervals, and thus information imparted without entailing the vast amount of correspondence previously required.

H. J. Swallow, of the Emergency Fleet Corporation, also had shown a number of record charts that were found necessary for procuring in due time the thousands of articles necessary in the completion of ships.

Captain Charles E. Davis illustrated the use of the Gantt progress charts as applied to the manufacture of fuses. He stated that the charts had been of great service in registering the rate of production and the relative efficiency of the departments.

John E. Mullaney showed charts used for greatly facilitating the production of complete machines, and indicating at once when a portion of the equipment was not producing its rated output.

Major Frank B. Gilbreth then made a motion, which was seconded by C. B. Johnson and carried, that Mr. Gantt be asked to submit to the Society a general progress chart for the use of all businesses, embodying his latest ideas—a chart that could be used as a standard.

Walter N. Polakov was in hearty accord with Mr. Gantt's ideals in regard to efficiency and democracy. He thought the time had now come where a reorganization of the industrial system in the United States was in order, to supersede the old business system which involved so much waste. He commended the British Ministry of Reconstruction for stating that "the work now for the world is to establish fresh and fair conditions wherein social and industrial life may thrive unhampered as never before."

He said the old standards were definitely changed, as had to be the inevitable outcome of a war waged to make democracy safe, and that a man was judged today not by the size of his bank account, but by his record of deeds. In his opinion, the task for engineers is threefold: (1) We should lead in extending credit and authority to those who know how to do things and whose records show that they have done them. (2) In industrial relations we should adopt the principle of "no secret agreements," so that workmen would know what the management does, and one manufacturer would know what the others were doing, and that the people should know what things cost. (3) We should control all our natural resources the same as public funds are controlled, and not allow needless waste. As an organized body of engineers we should set an example of a government by facts.

Mr. Gantt, in closing, said that the exhibition of many performance charts from all sorts of plants had been for the purpose of proving their wide applicability.

After the war had broken out he had gone from the Frankford Arsenal to Washington to see General Crozier to discuss questions of organization. His method of charting production appealed to the General, and it was introduced at once, so that by November 1917 about three-quarters of the production in the Ordnance Department was charted by it in detail. In addition the method was welcomed by a large number of plants throughout the country, as had been just shown.

It developed later that in November 1917 Professor Schneider, Dean of the University of Cincinnati, had also been invited to Washington by General Crozier to confer on labor problems. Early in December the Dean handed Mr. Gantt a copy of his report made early in December 1917 to General Wheeler, at that time General Crozier's first assistant, in which he had recommended for adoption by the entire War Department the production charts already successfully applied by the Ordnance Department. Mr. Gantt said that just about that time Congress met and criticism developed. Business men from all over the country went to Washington to help straighten out matters. These men were mainly financiers and salesmen not acquainted with production. They did not understand that Washington's problem was one of production and hence that an organization such as General Crozier's was built primarily for production. The organizations which they understood were built primarily for profit; but the country did not need profits, but goods.

The result was that General Crozier was ousted and his whole plan of organization of the Ordnance Department went to pieces.

Although General Crozier's plans had been thus disrupted by his successor, a start on the same lines had already been made in the U. S. Shipping Board, and from there the methods gradually spread to other Government departments, including finally the arsenals. Had the original plans of General Crozier been carried out, Mr. Gantt believed there would have resulted less trouble in the supply of ordnance and many lives lost in France would have been saved.

EFFICIENCY AND DEMOCRACY[1]

By H. L. GANTT, NEW YORK, N. Y.

WHY has the word efficiency, which should stand for so much, fallen into disrepute in this country? That it has fallen into disrepute cannot be gainsaid, both with the business man and the workman. We all recognize the importance of both individual and collective efficiency. This being true, there must have been some fatal error in the management of the campaign which at the end of twenty years has made the very name a byword.

It is not to be questioned that many men who have devoted their time to this subject have very much improved our industrial processes and the productivity of our manufacturing plants. Yet in the mind of the average business man or mechanic the term "efficiency engineer" raises a feeling of hostility.

Today we need efficiency, both individual and collective, to a far greater extent than we ever needed it before, yet it seems that we must do the work of promoting it under some other guise if we would really have it accepted and approved.

To some of us the reason seems plain, simply that we have in the past measured the "efficiency of our business" by the dollars acquired rather than by the goods produced. The efficiency engineer of the past has in too many cases devoted himself exclusively to making more efficient the business of securing dollars. In other words, he has served the business system primarily in the accumulation rather than in the production of wealth.

A business system bent on the accumulation rather than on the production of wealth, which would even curtail the production of wealth if thereby a larger measure could be brought into its own coffers, must needs finally run to the limit of its tether, and a method which makes more efficient such a system shortens the time which it has to run. An efficiency engineer who, consciously or unconsciously, served the business system in the exploitation of workmen, necessarily got the ill-will of the workman. He later got the ill-will of the business man, who found that the amount of wealth he could get by exploitation was strictly limited. I am not claiming that all efficiency engineers have done this, nor that even those who have done it have been conscious that they were producing a condition to which there must be an end. They were simply serving "business as usual," which puts more effort in harvesting the crop than in producing it.

When the great war broke out in 1914, it became evident to all those who gave it serious consideration that the production of goods for the benefit of the community, and not the production of wealth for the benefit of those who control the industries, was the task which had been set the nations engaged. It took England more than a year to learn this lesson, and we should have been fully prepared for it in 1917 when we were drawn into the maelstrom. That we were not prepared for it, and that many believed we could still continue business as usual, is now history. We have learned, however, that production for the benefit of the community was the only basis on which we could carry the war to a successful conclusion. This has been emphasized by the elimination of "non-essential" industries.

There is another reason why the term efficiency has been brought into disrepute. In the past our cost-keeping methods have always loaded on to the part of the shop which produced the goods the total expense of the shop, including the part that was idle. For instance, in a shop having two expensive machines, it was the habit to load on to the product the expense of both machines, whether the goods were produced by one or by both. Under such conditions, if one machine did the work of two, the product was still charged with the expense of both, and the full benefit from the increased efficiency was not apparent to the owner, who saw only the saving in wages. He did not see the saving in plant. He did not comprehend clearly that if he doubled the output of his machine he could double the output of his plant without additional expense. In other words, that he was also making his capital twice as efficient. It is hard to see why he did not see this, except that the system of cost keeping seemed designed to hide it. The term "efficiency" then seemed to have no connection with capital on investment, but only with labor.

Under such conditions there was but little inducement to the owner to make his machines produce more, and the reverse of an inducement to the workman, who was thereby laid off or saw his friend laid off. This fatal error which caused the opposition of the workman, and the lack of sympathy on the part of the employer, was evidently due to a false accounting system, which was devised to put all the burden of inefficiency on the workman.

When the great war started in 1914, and the wheels of industry slowed down to such an extent that it was impossible for the product turned out to bear the expense which had previously been distributed over a production three or four times as large, most people said, "These are extraordinary times; therefore we shall have to lay our cost system aside till the war is over."

Some people, however, realized that a system which is not good for an emergency, when it is most needed, has something radically wrong about it, and set to work to find out what the flaw was, and this was the answer they arrived at:

The product of a factory must bear only the expense used to produce it. It cannot bear the expense of idle machinery which did not contribute to its production. This statement is such a radical departure from the ordinary cost-keeping system that it produces a shock to the business man who has a theory that he must somehow or other get back all of his expenses. He seems to feel that he is entitled to interest on all the money he has invested, whether it produces anything or not. Under such conditions he is not seriously worried so long as he can sell his product for a price high enough to give him the profit he considers himself entitled to.

Some of the keener business men, however, have seen the flaw in this argument, and have realized that idle capital is no more entitled to wages than idle labor, and have begun seriously to study their plants to find out how they can use them to their full capacity. The result of this investigation is twofold:

a It does not result in laying off men, but gives employment to more men, which secures the good-will of the worker.

b It not only reduces the expense of maintaining machinery in idleness, but turns out a greater product from which revenue is gotten.

Some would say that this is a beautiful theory, but it doesn't work that way. I answer unhesitatingly, after more than three years' trial, that it does not work that way and that none of those people who have adopted it would for a moment think of going back to the antiquated method of cost keeping which they have given up.

The keynote of such a system is the elimination of idleness and the production of goods. Moreover, there is no antagonism in such a scheme between employer and employee, for each gets the reward for what he does.

To the conservatives this would seem almost revolutionary, and fraught with consequences of which they cannot see the end, but it is democratic and absolutely in harmony with the patriotic doctrine which is being preached. It enables us to change automatically our slogan of "business as usual" into "business for production and victory."

In a few words, then, if we eliminate our false cost-keeping methods, and put in those that are correct, we shall not only benefit both employer and employee, but go a long way toward the democratization of industry.

---

[1] Presented at the Annual Meeting, December 5, 1918, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

RAILWAY ARTILLERY

By COLONEL JAMES B. DILLARD,[1] U. S. A.

Contrary to general belief, railway artillery is not a recent development of ordnance. In 1863 a 13-in. mortar was used by the Union Army against the defenses of Richmond. It weighed 17,000 lb. and was mounted on a flat car having eight wheels. Some 4-in. artillery pieces were also used on railway mounts. In 1883 Gen. Joseph L. Brent wrote a book on the subject of railway artillery, in which he prophesied accurately its development as has occurred during the European war, and even anticipated the armored automobile and the tank.

Both the British and Boer forces in the South African war utilized naval or coast-defense guns on railway cars. In the campaign for the relief of Ladysmith the British used four 12-lb. naval guns on flat cars. Armored trains, mounting field guns, were also used.

In 1893 the Schneider Co., of France, brought out a type of disappearing carriage mounted on wheels for road transportation. The St. Chamond Co., of France, brought out a similar design, but mounted upon a railway car. The weight of this 4.7-in. gun and mount was about 20,000 lb.

In 1900 the Schneider Co. made up a 155-mm. howitzer mounted upon a car which closely resembles the design used today. The Skoda Co., Austria, brought out a design of truck mounting to secure greater mobility for light coast-defense guns calculated to travel a short distance only.

A few years later the St. Chamond Co. had improved its 1892 model, the gun still having a disappearing carriage, but well mounted on a short railway truck equipped with rail clamps to secure increased stability under firing strain. It had also a horizontal armored shield overhead for the protection of the gunner. Since then it has been found that the rail clamps are suitable only for guns smaller than 6-in., as heavy guns pull the rails and ties out of the roadbed.

About this time the Krupp works in Germany built a 4.7-in. railway gun which was simply a wheeled road gun with disappearing carriage placed on top of a flat car. Rail clamps and outriggers appear in this design; the latter consist of swinging brackets with vertical hinge pins and jack screws at the outer ends, and serve for bracing the car during firing.

In 1912 the Schneider Co. brought out a design for a 200-mm. howitzer which is now typical of our present ideas for mounting guns up to 8-in., and mortars up to 12-in. The howitzer is mounted on the usual type of barbette carriage, in that it can fire in any direction, and is placed upon a drop-frame car. A folded platform is used, also outriggers.

Fig. 1(*g*) shows an American design of about 1912 for a 4.7-in. howitzer, which is very similar to the Schneider.

In the foregoing cases the main object was to devise a mobile weapon for coast defense, but in the European war the use of railway artillery was confined to field operations, no coast-defense necessities having arisen.

Types of Cannon Used on Railways

The types of cannon mounted on railway cars are the same as those used in field and seacoast artillery, and include mortars which are 9 to 12 calibers (diameters) long; howitzers 15 to 20 calibers long, and guns which vary in length from 30 to 50 or more calibers.

Mortars are used for "plunging fire"—they are fired at angles of elevation of 45 to 65 deg., the projectile dropping nearly vertically on its objective. The mortars used by the American Army are of 12-in. bore, 9 to 15 calibers long, and their muzzle velocity ranges from 900 to 1800 ft. per sec. On railway mounts they can be fired at angles of 20 to 65 deg. The weight of projectile is 700 lb., and the maximum range is 15,500 yd. The modern trend is to abandon the mortar, because its only advantage is that it is cheaper and will perform certain limited functions as well as the howitzer.

Howitzers are fired at angles of elevation from 30 to 65 deg. The American Army uses howitzers of 6 to 16 in. bore having a muzzle velocity of from 1500 to 2000 ft. per sec. Only the 16-in. howitzer has been mounted. It fires a 1600-lb. projectile with a muzzle velocity of 2100 ft. per sec., which, at a 45-deg. elevation, gives a range of about 24,000 yd.

Guns are used for accurate work at long range. The German guns which bombarded Paris were doubtless 60 to 70 calibers long. Until the present war, guns were normally used for direct fire at elevations not exceeding 20 deg. Recently, however, they have been used at elevations up to 45 deg., to obtain the maximum range possible.

Accuracy of firing at these high elevations and long ranges is, however, small, as the German gun required a target of the size of the city of Paris and was not always able to hit even that. The range of the guns in our service, which vary from 8 to 14 in. is from 13 to 30 miles. The projectiles vary in weight from 200 lb. for the 8-in. gun to 1400 lb. for the 14-in.

The accuracy life of the mortar is estimated to be about 5000 rounds; of the howitzer, about 2000 rounds; and of the gun, about 150 rounds. After firing this number of shots, the fire becomes inaccurate owing to the wear in the barrel.

Problems of Design

The two main problems in the design of railway mounts are transportation and provision for stresses due to gun firing. The transportation problem requires that the closest consideration be given to weight, minimum railway clearances, and a full understanding of car design, especially as pertains to the trucks. To handle mounts weighing 600,000 lb. and upward a system of trucks must be utilized that combines perfect equalization of loads and flexibility.

The condition of road beds in France has limited all axle loads to not over 17 metric tons. For mounts designed for use only in the United States this might be increased to 22 tons, but so far all the railway mounts, with the exception of the 8-in. gun, have been limited to the maximum weight allowed by the French railways.

The railway clearances set by tunnels, bridges, third rails, etc., present a considerable handicap and impose several limitations upon the design. Fortunately American and French line clearances differ very little and provide for a maximum height of about 14 ft. at the center of the track and a width of 10 ft. Fig. 2 shows on the right the French, and on the left the American, clearance diagram as applied to the 8-in. gun railway mount.

The American Army has made a careful study of the clearance diagrams of all United States railways to insure that all our mounts will be capable of being used in any part of the country. With guns up to 8 in. and howitzers up to 12 in. the limitations to design set by the railway clearances are slight, but in the case of howitzers of 16 in. and up, and with guns 12 in. and up, the limitations of the clearance diagram begin to be severely felt.

The gun is elevated around its trunnions, which are usually located at the center of gravity of the tipping parts. The breech end of a 12-in. gun when tilted around its trunnions would strike the cross-ties at about 30-deg. elevation, 25 deg. elevation for the 14-in. gun, and a less elevation for the 16-in. gun. In order to secure a greater elevation it is necessary to modify the design by any one of the following methods: The gun is artificially thrown out of balance by placing a weight at the breech end. A mechanical counterbalance device, such as springs or compressed air, can also be used. In this case a column of springs or a compressed-air column is so lined up with the elevating gear as to compensate for the muzzle preponderance when the

---

[1] Engineering Division, Ordnance Department, Washington, D. C.

Lecture, with slides and motion pictures, delivered at the Annual Meeting of The American Society of Mechanical Engineers, New York, December 5, 1918.

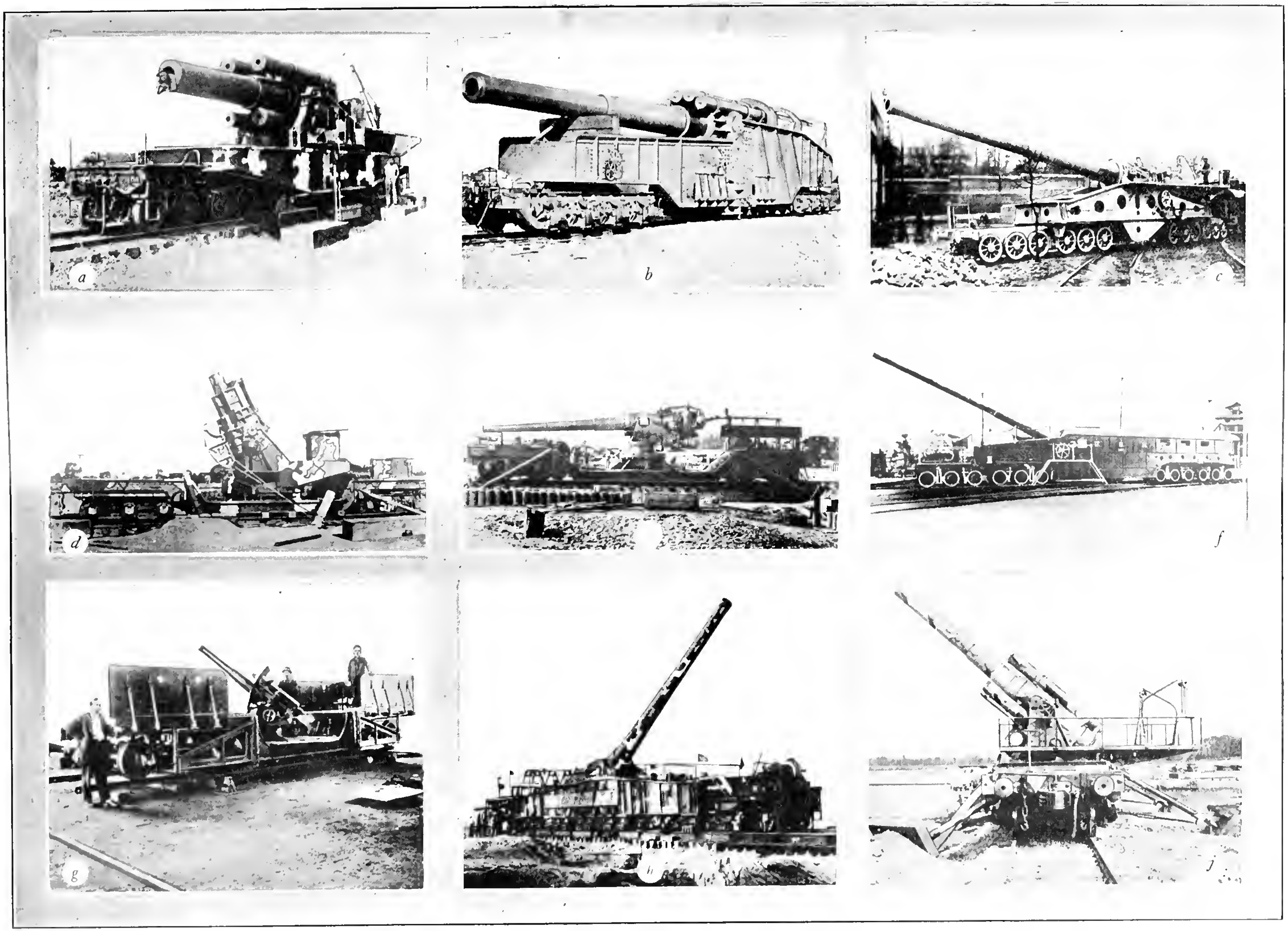


FIG. 1 FRENCH AND AMERICAN RAILWAY ARTILLERY

(*a*) 16-in. Howitzer, Model 1918, Elevation up to 65 Deg. (*b*) American 14-in., Model E, Railway Mount for Seacoast Defense. (*c*) French (St. Chamond) 340-mm. (14-in.) Railway Gun. (*d*) 12-in. Mortar Railway Mount. (*e*) 7-in. 45-caliber Navy Gun, Barbette Carriage, Mounted on Standard Drop-Frame Car. (*f*) 14-in. 50-caliber Navy Gun Railway Mount. (*g*) American 4.7 in. Railway Howitzer of 1912. (*h*) Sliding Railway Mount, French 305-mm. and American 12-in., Elevated 45 Deg. (*j*) Method of Bracing Drop-Frame Car Opposite to Firing Side.

trunnions are located to the rear of the center of gravity of the gun. A third method is to provide a top carriage carrying the trunnions of the gun and to raise this sufficiently high into firing position by means of hydraulic jacks to enable the breech to clear the ties.

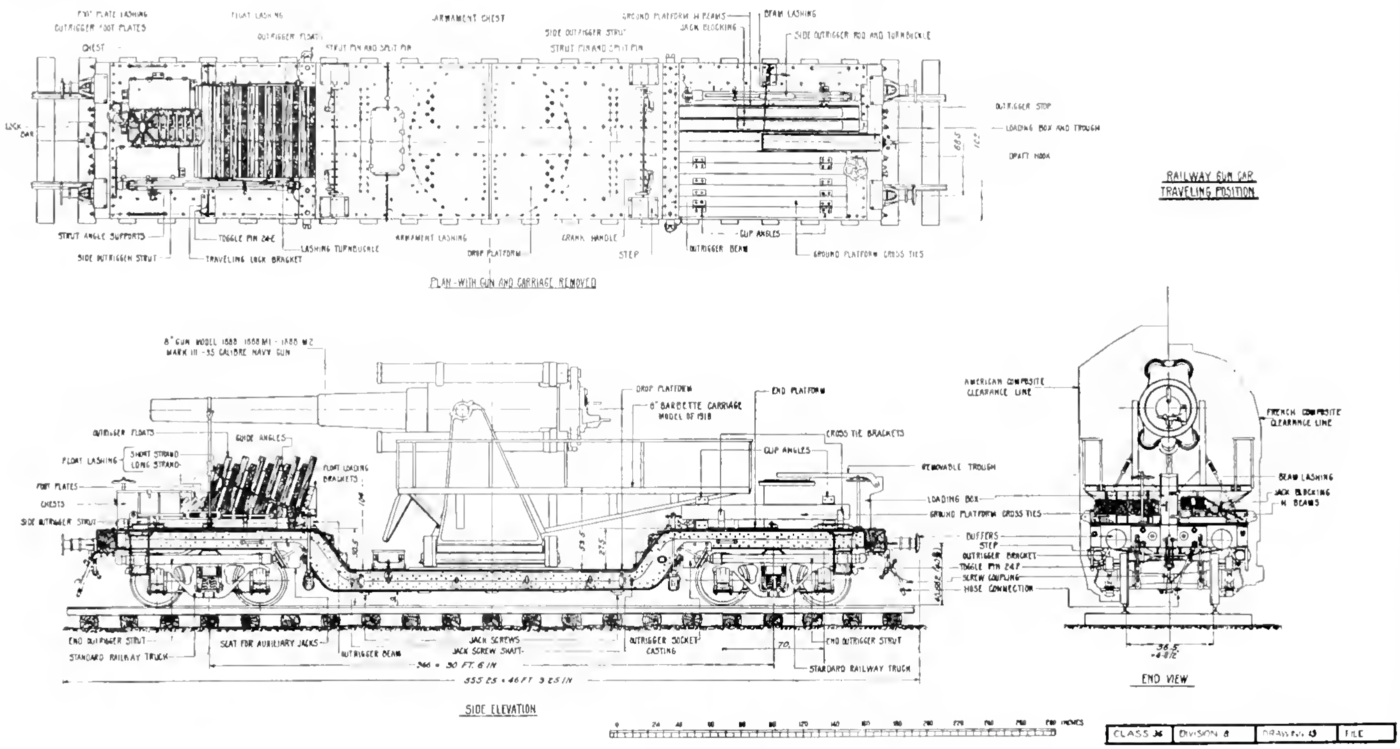


Fig. 2 8-in. 35-Caliber Navy Gun Railway Mount in Traveling Position

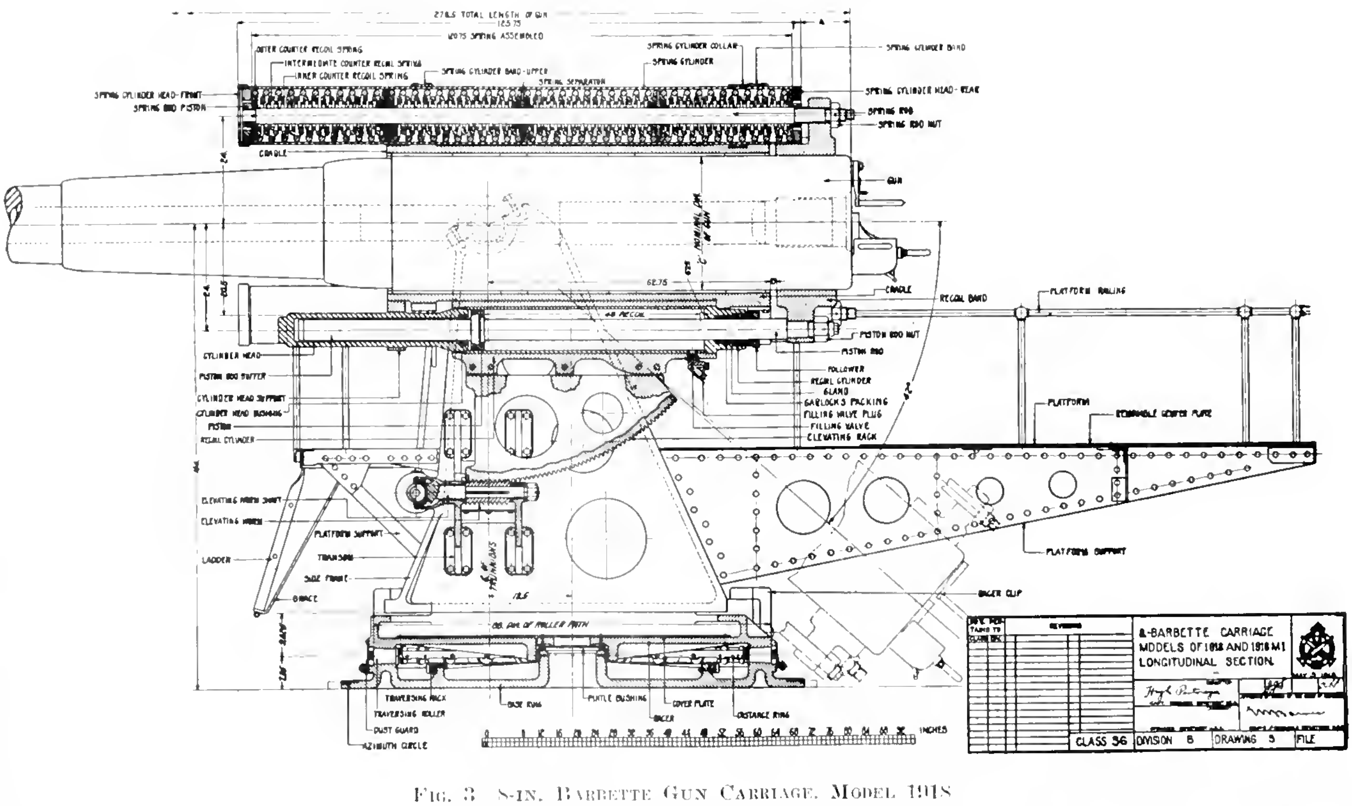


Fig. 3 8-in. Barbette Gun Carriage, Model 1918

The fourth but least desirable method is to dig a pit in the line of the railroad track, but this requires a specially constructed track to bridge over the gap caused by the excavation, besides there may not be time available to make the excavation, especially when the ground is frozen. All of these alternatives have been utilized in the various designs of railway mounts, but the simplest and best is the use of the counterweight, as there are no moving parts involved.

In providing for stresses due to gun fire, it must be remembered that the mounts should permit of elevation up to 45 deg. in order to secure the maximum range obtainable. The widest possible traverse should be aimed at, 360 deg. if possible. It is comparatively easy to obtain the elevation desired, except with the 16-in. size and upward, but it is not possible to obtain more than about 10 deg. total traverse with the railway mount unless

considerable time is allowed for preparing a firing platform other than that provided by the car itself.

For guns up to 8 in., and howitzers and mortars up to 12 in., an especially designed drop-frame flat car can be used and the barbette carriage of standard construction placed upon the car. Fig. 2 shows the 8-in. gun railway mount, model 1918, as designed by the Ordnance Department.

With larger guns various designs have been produced for use in the present war. Most of them provide for a 2- to 6-deg. traverse on either side of the center of the gun, greater change of direction being obtained by using the curved track. Even this arrangement places a handicap upon the tactical uses to which these guns may be put.

Barbette Carriages for All-around Fire

These carriages are of the standard barbette type. In fact, the carriages may be removed from the flat car and mounted upon a concrete base as is the practice in many of our seacoast forts. The carriages are always provided with recoil and counter-recoil mechanisms. The force of recoil is checked by forcing a liquid in the recoil cylinder, usually oil of about 0.85 specific gravity, through two or more orifices cut in a piston, the piston rod being attached to the breech of the gun, while the recoil cylinder is attached to the cradle.

Counter-recoil is accomplished by means of helical springs, usually about four columns, or by means of compressed air contained in an air bottle located above the center line of the gun. The 8-in. gun carriage has a spring counter-recoil mechanism as shown in Fig. 3, while the 12-in. mortar carriage has the compressed-air counter-recoil mechanism (air recuperator) illustrated in Fig. 4.

With the larger guns compressed air is preferred on account of the less bulky mechanism required. Figs. 3 and 4 show also the type of elevating mechanism used, which includes a worm and worm-wheel sector. The traversing gear consists of a turntable resting on conical rollers, which in turn rest upon a bedplate attached to the body of the car.

The design of limited-traverse railway mounts for guns and howitzers presents but few engineering difficulties. The principal one relates to the height at which the trunnions must be placed in order that the breech of the gun may not interfere with the road track. Fig. 1(*b*) is typical for this type. The trunnion of the gun rests upon girders which are supported at each end by trucks. It is evident that by means of the curved track a reasonable amount of traversing is available.

In the case of the all-around firing type of mount for large guns and howitzers, it is necessary to have some form of firing platform on account of the varying direction in which the firing stresses may act.

During 1915 the Ordnance Department started the design of the 14-in. mount, Model E, shown in Fig. 1(*b*). A base ring with a conical roller path is carried in a separate car, and is to be set into the ground. The gun and mount on its traveling trucks are run over the base ring so that center of the car is over the center of the base ring. The mount is then jacked up so that the traveling trucks may be disengaged from the girders. The mount is then lowered so that it rests upon the conical roller path, where it is free to be traversed in any direction. This arrangement has also been applied to the construction of a 16-in. howitzer railway mount.

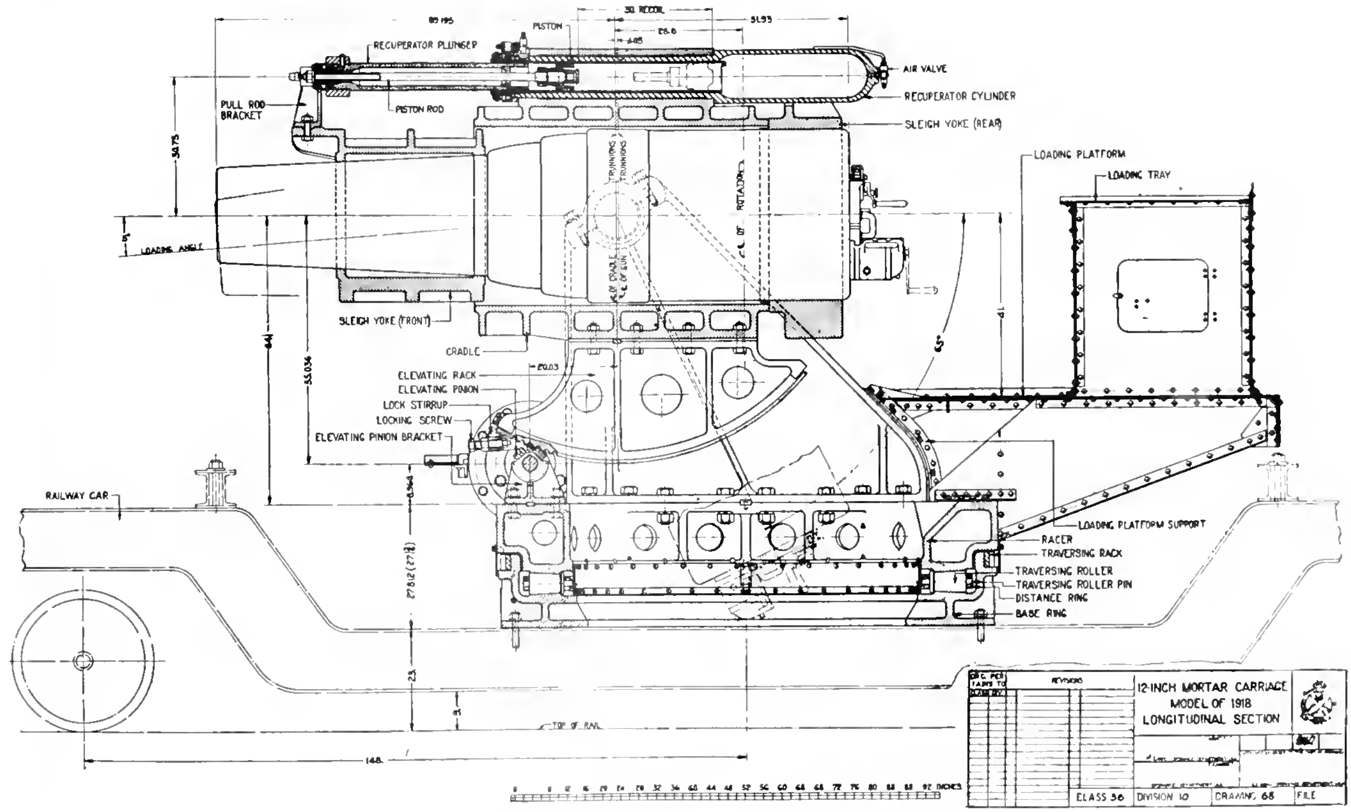


Fig. 4 12-in. Barbette Mortar Carriage, Model 1918

Foreign Types of Railway Artillery

A number of French howitzers have proved very satisfactory during the present war. They include the 190-mm. (7.6-in.) and the 240-mm. (9.6-in.) howitzer railway mounts with movable top carriages. These mounts are not provided with a traverse mechanism and therefore must be moved along a curved track to obtain azimuth setting. Due to the lack of long-range field artillery at the beginning of the war it became necessary for the French Government to construct with the greatest of rapidity considerable quantities of railway artillery, and to utilize naval and coast-defense guns already in existence. Schneider & Co. then designed what they termed a "glissement" or sliding railway mount, an example of which is shown in Fig. 1(*h*).

These mounts consist of two six- or eight-wheel railway trucks

connected by heavy girders which carry the weight of the gun. These girders are provided on the lower surface with cross-beams connected to the girders by jack-screws. Before firing, these cross-beams are lowered on firing rails thus relieving the trucks of the firing load, which is transmitted directly to the roadbed. No recoil mechanism being provided, the recoil force is taken up by the friction of the entire mount sliding backward on the firing rails.

No traversing mechanism is provided, direction in azimuth being obtained by constructing the firing track on a curve. After the shot is fired, it is necessary to move this gun forward to its original position which is done by hand through a system of sprockets and chains to turn the wheels of the trucks.

Fig. 1(*c*) shows a 340-mm. (14-in.) railway gun built by St. Chamond. The gun rests in a cradle, which is a large ribbed casting through which the gun slides in recoil. The cradle has trunnions which are carried in trunnion bearings on the top carriage, which is supported by the car frame mounted on trucks. The firing emplacement consists of a pit into which the gun recoils when firing at higher angles. Two platforms which act as a foundation for four jacks provided with large timber floats prevent the car from recoiling along the track. The shock of recoil is absorbed by hydraulic cylinders and the gun is returned to battery by an air recuperator. The top carriage can traverse about two degrees.

The 14-in. British railway gun is almost identical in design with Fig. 1(*c*). The gun is 62.5 ft. long, weighs approximately 183,000 lb. and is mounted in a cradle whose trunnions are supported by two longitudinal girders carried on two sets of four-axle trucks. The total weight of this mount is approximately 545,000 lb. With this gun a traverse of 2 deg. on either side of the center line is provided for. In order to secure a high elevation the gun is placed forward in the cradle so that it has a considerable amount of muzzle preponderance. This unbalanced weight is compensated by a pneumatic counterbalance device so that the piece may be easily elevated. The recoil mechanism consists of two hydraulic cylinders and the gun is returned to battery by a pneumatic cylinder. The elevating mechanism consists of a screw operated by a gasoline engine.

American Types of Railway Artillery

Fig. 1(*e*) shows a barbette carriage mounting a 7-in. 45-caliber gun, a design developed by the Ordnance Department. The carriage and gun were originally designed by the Navy Department and were mounted on certain battleships and cruisers. A number were available for army use and were mounted on the railway car with drop frame as shown. This car construction is now standard with the Ordnance Department for similar sizes of guns and mortars and provides for 360 deg. traverse. Fig. 1(*j*) shows the construction of this type of mount. The trucks used are Pennsylvania Railroad standard 70-ton freight-car trucks. A firing platform and outriggers are necessary to brace the mount against the ground to take up firing stresses. Each outrigger consists of a pipe attached by a ball-and-socket joint to the car frame, the lower end having a screw jack which rests on the wooden float sunk in the ground. The jacks for raising and lowering the car are built in the structural part of the frame and are operated by ratchet levers. The total vertical movement required for the insertion of the oak cross-ties in the firing platform is about one inch. The mount may be put in firing position by a gun crew in 15 to 20 minutes.

The 1918 model 8-in. gun railway mount, which uses the same barbette carriage as the 7-in. gun, Fig. 1(*e*), may be elevated from 0 deg. to 42 deg. It fires either a 200- or 300-lb. projectile at a maximum muzzle velocity of 2000 ft. per sec., and has a maximum range of about 23,000 yd.

By means of special 8-wheel trucks it is possible to transport this mount over a 60-cm. (24-in.) narrow-gage track. This 8-in. mount weighs about 180,000 lb. and it certainly is a great advantage to be able to transfer it to a narrow-gage track which is the kind used at the battle front in order to better conceal operations. On the narrow-gage track a speed up to 15 miles per hour is feasible. The Ordnance Department, who developed this mount in its entirety, considers this artillery piece to be the last word in railway mounts. It is also the only mount of its kind in existence.

Fig. 1(*e*) shows a 12-in. mortar placed upon the same car as the 7-in. and 8-in. guns, except that 6-wheel trucks are used in place of the standard 70-ton 4-wheel trucks. It is also adapted for narrow-gage track and makes a highly satisfactory piece for field and seacoast work.

Fig. 1(*h*) represents also the American sliding type of railway mount. It has neither recoil mechanism nor traveling mechanism. It is a 12-in. gun and the entire mount is about 105 ft. long and weighs 575,000 lb. It can be transported at the rate of 40 miles an hour over standard-gage road bed and will go around any curve met with in American or French railway practice. When the gun is to be used, the track is laid on a curve and the gun is turned on its objective by moving the mount back and forth by means of a gasoline engine. A special hand translating mechanism is used for spotting the mount in the exact position.

The principal parts of the car body consist of bridge girders, span bolsters connected to 8-wheel trucks, trucks, bearing stringers and sleepers, lifting wedges and loading mechanism. The gun is supported on trunnion beds, which are carried on top of the girders. The gun can be elevated from — 4 deg. to + 40 deg. The slippers consist of wooden beams placed crosswise under the car body, supported by the elevating wedges which raise and lower them into position. The bearing stringers are made up of eight lines of 12-in. steel I-beams. The lifting wedges are operated by handles, one man being placed at each handle. No special track preparation is necessary other than to lay the stringers and to see that the track is well ballasted. In the firing the entire piece slides to the rear for about 15 ft. and after each shot the mount is returned by means of the power winch and the hand translating device. The 12-in. gun used is 50 calibers in length and is one of the most powerful in existence. The muzzle velocity is 3200 ft. per sec. and the range is approximately 30 miles.

Fig. 1(*a*) illustrates what is considered the very latest type of railway artillery. This mount carries the 16-in. howitzer developed by the Ordnance Department in 1918, which is the most powerful howitzer known. The carriage embodies the features which are considered the most desirable in handling railway artillery for field-army use. The howitzer can be fired on this mount directly from the trucks on standard-gage track. The track emplacement and bearing stringers to take up the shock of recoil are done away with. The shock of fire is taken care of in the recoil and in pushing the car backward along the tracks on its own trucks. For this duty unusually heavy trucks are necessary to absorb the shock and to transmit it to the roadbed. The piston-rod pull is approximately 670,000 lb., which force is transmitted directly to the trucks. Two 12-wheel trucks are used with specially designed frames and springs. The top carriage is pivoted at its forward end, and arranged at its rear end so that 12 deg. traverse is all that is necessary for range correction, the range direction being secured by running the mount on a curved track. A gasoline winch is placed on the forward trucks which pulls the mount back to its original position by means of a cable attached to a rail clamp. Four columns of counter-recoil springs are used. The loading arrangement is the American style of gravity platform, which permits the projectile to slide into the breech.

Fig. 1(*b*) illustrates the 14-in. Navy gun railway mount built by the Navy Bureau of Ordnance. Some 14-in. 50-caliber guns that were not required aboard ships were utilized and mounted on railway trucks. Four 6-wheel trucks are used and connected by span bolsters upon which rest the body girders. Top girders support the gun and its cradle by means of the usual trunnion and bedplate. A cab, consisting of ¼-in. armor plate, encloses the body girders, as well as the breech end of the gun. The emplacement, of structural steel, is carried on special cars and is placed in position by a locomotive crane. Four jacks are used to relieve the trucks of the firing shot. Five degrees traverse

is secured in place, and 45 deg. elevation. This amount of elevation necessitates a pit of 9 ft. in depth.

Auxiliary Cars

All railway artillery operates in batteries which are made up of four gun mounts with their auxiliary cars, including ammunition firing cars, control cars and supply cars. The ammunition car is especially designed and standard for all railway artillery. It is a steel car provided with a trolley I-beam and hoist for handling ammunition. The ammunition is stored in racks, Fig. 5, which are so arranged that they can be taken down and the car used as an ordinary box car. The fire-control car is a standard Government 30-ton box car provided with windows. It is used as an office by the battery commander and contains fire-control instruments. The supply car is a standard Government 30-ton flat car on which is carried the auxiliary equipment and the supplies that are to be used with heavy railway artillery.

Tactical Uses

The uses for railway artillery are considered under two principal heads, namely, against land targets with field armies; and for coast defense. Guns, howitzers and mortars are required for these purposes.

For use with field armies the ability to bring the mount into and away from firing position is of more tactical value than an extremely wide traversing angle without moving the location of the gun. On the other hand, for sea-coast defense a wide, quick and accurate traverse without changing the location of the gun mount is an absolute essential. One of the greatest values which railway artillery can have to the United States is the ability to concentrate large numbers of guns within any given strategic area. If guns are made up in trains, they can be moved quickly from one place to another, therefore, considerable economy will be obtained in securing proper protection for any part of our coast line and for any harbor.

In the present war railway artillery was used for the following kinds of fire: (*a*) Fire for destruction; (*b*) fire of interdiction; (*c*) counter battery work; and (*d*) reprisal bombardment.

Fire for destruction includes the demolition of railway centers, depots, fortified works, bridges, etc. For this work high-angle or plunging fire is desirable in order that the projectiles may bury themselves in the ground before exploding, thus causing a large crater to be formed and securing the maximum amount of destruction. For this kind of fire the use of howitzers and mortars is indicated. If it is required to obtain a number of direct hits on a small target at a range of 20,000 to 25,000 meters, it would be better to use a considerable number of total rounds which can be obtained economically with guns having a long accuracy life, namely, howitzers and mortars. Beyond the range of howitzers, guns must be used. Rapid firing not being essential, the sliding type of gun mount is entirely satisfactory.

Interdiction firing includes destruction and interruption of traffic on lines of communication. It may be desirable to keep certain sections of a railway line out of commission or to shell sections of some important road over which supplies of men must move. In this case the target is usually small and therefore greater accuracy of fire is necessary. As time is required to repair the damage, intermittent shelling will suffice. Two to four well-placed shots a day are sufficient to keep a railway line out of commission. For this work, therefore, it has been the practice to use very long-range guns with a sliding type of railway mount.

Counter battery work includes the destruction of such enemy batteries as are out of range of the army artillery. The army artillery consists of guns of about 6-in. caliber and howitzers of about 9.5-in. caliber. The range is 15,000 to 18,000 meters, whereas all railway artillery should have a minimum range of about 23,000 meters and preferably 25,000 meters or more. A very wide traversing angle is essential on account of the probably wide variations in the position of the enemy batteries which must be reached quickly. An 8-in. gun is best for this class of work mounted upon a carriage similar to our 8-in. barbette, model 1918, previously described.

Reprisal bombardment requires the use of long-distance guns such as the German gun which shelled Paris. This gun was not, however, mounted upon a railway carriage. A sliding type of mount, combined with a recoil mechanism, would seem to be the proper mounting.

For use against heavy concrete fortifications a howitzer such as the 16-in. would be proper, as a smaller size would probably fail to have the desired destructive effect, but for the destruction of a railway bridge the use of a 16-in. howitzer would be very wasteful, as a direct hit from an 8-in. gun would be about equally effective for destroying the superstructure.

Lessons of the War

The value and economy of seacoast defense has been completely demonstrated in the present war. The absolute protection afforded the German coast line on the North Sea and the completely successful defense of the Dardanelles are the most striking examples. Considering the fortifications of the Dardanelles only, it is undoubtedly a fact that the coast defenses established there had a value to the Central Powers of many billions of dollars. In fact, it can hardly be contradicted that, had these fortifications been forced, the resistance of the Germans

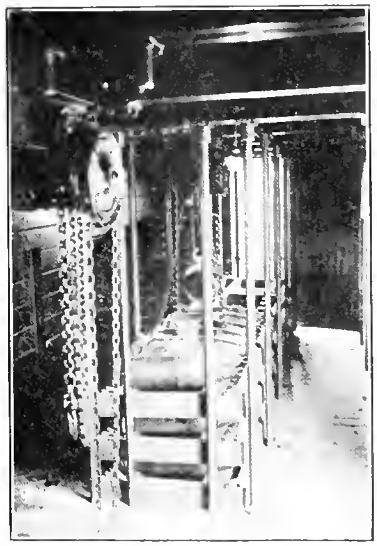


Fig. 5 Interior of Ammunition Car

would have been broken long before was actually the case. Their military value was a hundred times their actual monetary cost. It is also probable that, had the guns at the Dardanelles been mounted on railway carriages of suitable design and had comparatively inexpensive railway tracks been laid to important tactical points, it would have been almost impossible for landing parties in any force to have succeeded in effecting their object. This lesson as to the value of seacoast defenses is of the utmost importance to us, because our coast line is so extended that the cost would be considered prohibitive if adequate, fixed fortifications were to be furnished for all points whose strategic position would apparently justify such defenses.

The present state of the art of artillery design is such that guns and howitzers having a range of 22,000 meters or more are of such weight and exert such forces due to the firing of the gun that they must be mounted either on fixed carriages or on railway cars. However, in the immediate future it is evident that guns mounted upon self-propelled caterpillars will appear, and probably within the next few years railway artillery will be limited to guns of 10-in. caliber and up, and howitzers of 16-in. caliber and up. The development of this caterpillar artillery was begun by the Ordnance Department about three years ago and successful types have been built for 7.5-in. guns and for 8-in. howitzers. The next step will be the substitution of the caterpillar treads for the railroad trucks in mounts such as the 8-in. gun and 12-in. mortar.

ENGINEERING SURVEY

A Review of Progress and Attainment in Mechanical Engineering and Related Fields, as Gathered from Current Technical Periodicals and Other Sources

SUBJECTS OF THIS MONTH'S ABSTRACTS

BRIDGES

The Wilson Bridge at Lyons. On Bastille Day, July 14, 1918, was formally opened at Lyons Le Pont Wilson, so named in honor of the President of the United States. The Wilson bridge, as shown in Fig. 1, consists of four unequal elliptical arches with a short elliptical approach arch at each end and a total width between the parapets of about 66 ft. It is designed on the Séjourné system, which briefly consists of replacing the central portion of the arches regarded longitudinally by a deck of reinforced concrete, so that each span consists of two masonry arches entirely independent of each other, except in so far as they rest on the same abutments, with the intervening space filled in with the reinforced-concrete deck. Because of the conditions of the currents in the River Rhone the arches are not symmetrical in span about the center of the bridge.

For various reasons metallic centering instead of wooden was employed and each of the principal arches composed of three courses of masonry at the springings and two at the crown.

The voussoirs fit into each other after the manner of gear-wheel teeth, both in the longitudinal and in the transverse direction. The first course was laid down in eight sections supported on angle pieces, the sections being arranged symmetrically and in such a manner as not to cause the centering to suffer any deformation. The joints were filled with mortar rammed in by means of iron beetles. The filling was commenced at the highest joints, the succeeding joints being completed in succession at properly chosen intervals of time. (*The Engineer,* vol. 126, no. 3280, November 8, 1918, pp. 387-388, p figs., *dA*)

BUREAU OF STANDARDS

Abstract of Metric Manual for Soldiers. The aim of the metric manual is to give to American soldiers a grasp of the metric system which will enable them to think and work in metric units. As recommended, no tables of equivalents need be memorized. Brief tables and a vocabulary are given for reference. The units are described by actual examples likely to be encountered in military work. (Bureau of Standards Miscellaneous Publications No. 21)

The Influence of Quality of Gas and Other Factors Upon the Efficiency of Gas Mantle Lamps, R. S. McBride, W. A. Dunkley, E. C. Crittenden and A. H. Taylor. This paper describes the apparatus and methods employed and the results obtained in studying the effects of several variables such as gas pressure, gas adjustment, air adjustment, and gas quality upon the performance of various types of gas mantle lamps. Several tables and curves are given to assist in the presentation of the results. (Technologic Paper of the Bureau of Standards, No. 110)

ENGINEERING MATERIALS (See also Testing)

Rapid Recrystallization in Deformed Non-Ferrous Metals, D. Hanson. While the number of investigations on recrystallization phenomena in iron and steel is quite large, only two similar investigations on recrystallization in non-ferrous metals are mentioned by the author, namely, papers by Robin and by R. J. Anderson.

In the present experiments a device adopted by Chappell in his

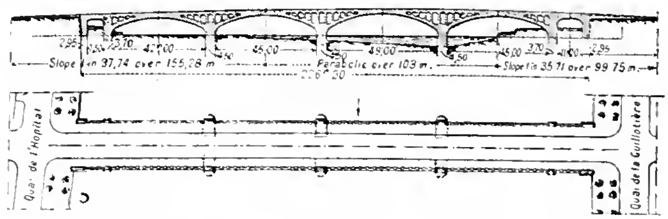


Fig. 1 Plan and Elevation of the Wilson Bridge

work on the recrystallization of iron (*Journal of the Iron and Steel Institute,* 1914, pt. 1, p. 460) has been used. This consists in cutting a test piece tapered toward the center, which, after it has been annealed, is broken in tension. In this way, with suitable tapering, varying degrees of deformation, from a maximum at the point of fracture to zero at a position between the fracture and the shoulder, are obtained. In order to obtain this the taper must be so regulated that under the breaking load of the test piece the material at the shoulder is not stressed beyond its elastic limit. The amount of taper which has proved suitable varied from metal to metal and has been determined by trial.

The paper records data secured with various metals and solid-solution alloys.

It was found in the case of aluminum and magnesium that remarkably coarse crystals had developed in the neighborhood of the shoulder where the strain was least, and that for this reason the crystal size decreased fairly regularly to the point of fracture. In the material of the shoulders which it is assumed had not been strained or in which the strain had been too slight for recrystallization to take place, the original small crystallization of the an-

nealed test piece was found, the change from coarse to fine crystals being quite abrupt.

Zinc, lead and copper exhibited essentially similar behavior. In the case of zinc, a thin sheet 0.04 in. thick was first annealed at 150 deg. cent. for half an hour, and after straining the two halves were annealed, one at 150 deg. cent. for 30 min., and the other at 300 deg. cent. for 5 min. In the case of the 150 deg. cent. annealing, recrystallization proceeded for a distance of approximately 3/4 in. from the fracture; when annealed at 300 deg. cent .for only 5 min., recrystallization occurred right up to the shoulder, and the grain size which was developed was considerable. In this case, in which the times of annealing at high and low temperature are in the reverse order to those used for aluminum, the same observation was made that, speaking generally, crystals of approximately the same size were produced in corresponding positions in the test pieces, i.e., at positions of equal deformation. The only marked effect of an increase in annealing temperature had been to extend the range of recrystallization toward the less deformed end of the specimen.

Solid-solution alloys have shown phenomena essentially similar to those of pure metals. A copper-zinc-aluminum alloy has shown appreciably the same recrystallization as pure aluminum and so has 70:30 brass. The results described in this paper suggest that the following law of annealing is probably applicable to all strained metals and solid solutions:

For every degree of deformation there is a critical recrystallization temperature at which crystal growth is extremely rapid, and the size of the crystals produced by this rapid growth is the greater the smaller the amount of deformation preceding such annealing. The rate of increase in size of the newly formed crystals with prolonged time and increased temperature of annealing is small compared with their rate of growth at the critical temperature. (Paper submitted to the Institute of Metals, on November 11, 1918, abstracted through *Engineering*, vol. 106, no. 2754, October 11, 1918, pp. 403-404, 3 figs., *ct*.t)

The Porosity and Volume Changes of Clay Firebrick at Furnace Temperatures, Geo. A. Loomis. Paper published by permission of the Director, U. S. Bureau of Standards, and reporting an investigation undertaken in order to study the fundamental properties of clay firebricks by a comparison of their changes in porosity and volume upon heating to different temperatures with the results of a specific load test and with the so-called "softening points."

The determination of these softening points is generally considered a reliable indication of the refractoriness of the material. Actually, however, it is apt to be misleading, for bricks with the higher softening point sometimes fail to withstand practical conditions of load and temperatures; while the silicious bricks low in flux with a comparatively low softening point generally stand up well under heavy loads at fairly high temperatures. Further, the softening-point determination is misleading in the case of bricks made from a coarse mixture of very refractory non-plastic clay with an inferior bond clay.

The load tests are used by the Bureau of Standards and the ball tests first applied in the laboratories of the Carnegie Steel Company are also discussed, and the methods of carrying out the tests in the present investigation discussed. The following is a summary of the results as given by the author.

1 Brick which are capable of withstanding a pressure of 40 lb. per sq. in. at 1350 deg. cent. generally show slight changes in volume or in porosity when burned at temperatures up to 1425 deg.

2 The greater number of the brick which failed to pass the load tests show rather marked changes in volume or in porosity at some temperature below 1425 deg. cent.

3 Brick which show distinct overburning by pronounced expansion at temperatures below 1400 deg. cent. invariably fail in the load test. The adoption of a definite limit for the permissible expansion within the given temperature range is particularly important for detecting inferior clay refractories. The limit for expansion should be lower than that for allowable contraction.

4 The changes in volume and in porosity of brick burned at some temperature between 1350 deg. cent. and 1425 deg. cent. serve, in a measure, as a criterion of their ability to pass the load test.

5 Most of the brick which show a porosity decrease not exceeding 5 per cent and a volume change not exceeding 3 per cent (approximately 1 per cent in linear dimensions), when burned at 1400 deg. cent. will pass the load test.

6 Brick which show a decrease in porosity exceeding 5 per cent or an expansion of contraction in excess of 3 per cent by volume (1 per cent in length) at 1400 deg. cent. failed to pass the load test in nearly all cases.

7 The use of limiting porosity and volume changes for clay firebrick burned at 1400 deg. cent. would serve as a means of eliminating from consideration a large number of brick which fail in the load tests.

8 Brick which fail in the load test—due to failure in the bond—may not show marked changes in volume or porosity in burning but often show very low cold-crushing strength.

9 No definite relationship seems to exist between the softening point of a firebrick and its ability to withstand load at high temperatures. However, all brick which softened below cone 28, whether silicious in character or not, failed completely in the load test. It seems advisable, then, to specify cone 28 as the minimum softening point for any clay firebrick. It is probable that brick containing less than 65 per cent SiO_2 should have a minimum softening point of cone 31. (*Journal of the American Ceramic Society*, vol. 1, no. 6, June 1918, pp. 384-404, 2 figs., *e*.t)

FOUNDRY

The Integrity of the Malleable Casting, Enrique Toucede. The writer claims that without present knowledge of the art of malleable casting, it is possible to produce regularly such a character of hard iron that when annealed it will yield metal of superior strength and ductility. If failure occurred, it was because the foundryman did not make sure at all times that castings were invariably sound throughout.

In proof of this, the writer offers figures showing the combined monthly average ultimate strength and elongation of some 32 different companies for a period of three months based on data from many hundreds of tests. These figures show a remarkable uniformity of the average values over that period.

It is claimed that lack of solidity, when it occurs, is mainly due to failure on the part of the founder to recognize the fact that in castings of disproportionate sections so frequently used in malleable-iron work the thinner sections solidifying more quickly than thicker ones would draw the metal from the still fluid parts before they, in turn, were able to secure their full share of metal from the risers.

The use of chills was tried to equalize cooling and while it did not always do it sufficiently to make heavy parts perfectly sound, it did serve to lessen the shrink and drive it from a place where its presence was fatal to a locality much less harmful. Nevertheless, the writer considers that the use of chills has been harmful as it kept the founder from discovering the real cure for this trouble. (Paper presented at the American Foundrymen's Convention, at Milwaukee, October 7-11, 1918, abstracted through *The Iron Age*, vol. 102, no. 20, November 14, 1918, pp. 1204-1205, *p*)

Casting Under Pressure. Description of a new process for forming castings of non-ferrous alloys. This process consists in pouring the molten alloys into metal molds and forming or congealing the castings under pressure. The castings are made in a specially constructed automatic machine by which several hundred are turned out per hour. The alloys used so far have been one of 60 per cent copper, 40 per cent zinc, with a trace of lead, and another alloy of 86.5 per cent aluminum, 12 per cent zinc, 1.5 per cent copper. A large number of fuse bodies for shrapnel have also been produced of an alloy of 80 per cent aluminum and 20 per cent zinc made to British specifications which call for an elongation of 7 per cent in 2 in. Tests have shown that this alloy actually possesses an elongation in excess of 14 per cent in 2 in. with a tensile strength of 41,440 lb. per sq. in. and an elastic limit of 30,400 lb.

In this process an alloy has been made and used consisting of aluminum, copper and iron with a low coefficient of expansion. The introduction of iron into this alloy promises to make it possible to produce very large aluminum pistons for high-power aircraft engines without running into the usual difficulties caused by the high coefficient of expansion of aluminum.

A similar alloy appears to have been used in the framework of a German Zeppelin machine. (*The Iron Age*, vol. 102, no. 19, November 7, 1918, p. 1138, *d*)

FUELS AND FIRING

SAVING COAL IN BOILER PLANTS, Henry Kreisinger. Mem.Am. Soc.M.E. A paper containing suggestions as to what can be done in the boiler room to save coal and intended especially for medium-size plants, which, as a rule, have less efficient equipment and management than large and modern plants. The paper is of particular interest, but is not suitable for abstracting. (*U. S. Bureau of Mines Technical Paper* 205, *p*)

HEATING AND VENTILATION

HOW TO IMPROVE THE HOT-AIR FURNACE is the title of Technical Paper 208, just issued by the Bureau of Mines, Department of the Interior, the author being Charles Whiting Baker.

O. P. Hood, chief mechanical engineer of the bureau, in reviewing Mr. Baker's paper, says: "Hot-air furnaces for house heating are used in such great numbers, especially the smaller sizes, that one would expect a considerable literature on the subject of

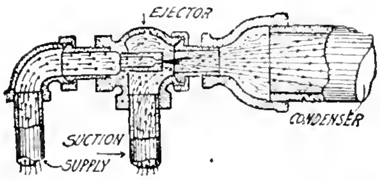


FIG. 2 STEAM EJECTOR USED IN THE MOLINE VACUUM VAPOR HEATING SYSTEM

their economical design, installation, and operation. As a matter of fact, there is much less to be found on this subject than on steam and hot-water house-heating equipment, largely because of the difficulty of measuring the output from a hot-air furnace. The quantity of heat absorbed from the fire by either hot-water or steam systems is rather easily measured by accepted methods, but it has proved a problem of some difficulty to accurately measure the quantity of heat absorbed by the hot-air furnace. Hence the problem has been much less attractive as a laboratory investigation than problems having to do with steam or hot-water apparatus. There is, however, a real need for a larger body of information about the performance of hot-air furnace installations than is now available.

"Mr. Baker's article shows how interesting such problems can be, how really worth while it is for a good engineer to give them careful and ingenious attention. The Bureau of Mines is glad to print such material, which will not only help many users of hot-air furnaces but will also tend to stimulate investigation in this fertile field.

"During the war the husbanding of fuel supplies must be a matter of vital concern to the country. The Bureau of Mines, in its efforts to bring about greater efficiency in the use of fuels, has paid much attention to the improvement of house-heating and boiler-plant equipment and methods of operating them, and has published a number of reports on the subject. Among these are Technical Paper 80, Hand-Firing Soft Coal under Power-Plant Boilers; Technical Paper 97, Saving Coal in Heating Houses; Technical Paper 199, Five Ways of Saving Coal in Heating Houses; and Technical Paper 205, Saving Coal in Boiler Plants.

"This paper, which was presented by the author before the American Society of Heating and Ventilating Engineers, at Buffalo, N. Y., in June, 1918, points out certain defects in existing types of hot-air heating plants, and suggests a number of improvements in construction and operation that will add to the comfort of the householder and lessen his coal bills. Moreover, the paper deals with a subject that, in spite of its wide interest, has received relatively little attention and is not treated in any other publication of this bureau. For these reasons, and for the further reason that general observation of the suggestions would effect an important saving in fuel, the paper is published by the Bureau of Mines."

Copies of this paper may be obtained free of charge by addressing the Director of the Bureau of Mines, Washington, D. C.

MOLINE SYSTEM OF VACUUM VAPOR HEATING. This system belongs to the class of those in which the steam pressure ordinarily carried is practically at atmosphere or slightly below, or in which the returns are open to the atmosphere and where no pump or other positive mechanical device is employed to pull back the returns. It is characterized by the use of a lock-shield globe valve on the return end of each radiator and the use of an ejector fitting to produce a pull on the return lines of greater intensity than can be secured by simply opening the return line to the atmosphere, or by connecting the air-vent line to the chimney and employing the chimney draft.

The steam ejector, which is the main characteristic feature of the system, is operated by the steam or air pressure at the end of the supply main, just before it drops down to enter the boiler return.

Fig. 2 shows how the steam or air under pressure in the steam line flows out through the nozzle of the ejector fitting, creating, by its velocity, a section around the jet, and employing this section to draw the air from the return lines to discharge the mixture into the condenser.

The article describes also the air trap used with this system. (*Heating and Ventilating Magazine*, vol. 15, no. 11, November 1918, sixth installment of a serial article, pp. 44-46. 5 figs., *d*)

INTERNAL-COMBUSTION ENGINEERING

Fuel-Injection Valves for Diesel Engines

FUEL-INJECTION VALVES IN CONSTANT-PRESSURE ENGINES, W. Stremme. Data for the calculation of needles and springs in needle valves for engines of the constant-pressure type. According to Fig. 3, the injection air which atomizes and injects the fuel enters through the atomizing chamber R. In the circular cross-section of this chamber the air acquires a certain velocity. Further, the dimensions of this air-injection chamber determine the amount of air available for the fuel injection at the instant of opening of the valve orifice. In the same chamber R are located the atomizing disks P, and the size and number of orifices in these disks determine the velocity of the air available for its intermixing with the fuel. Each atomizing disk measures the velocity of flow of the fuel-air mixture, and the more disks there are in the chamber R, the slower does the injection occur. No improvement in fuel injection can be secured by any very large increase in the number of atomizing disks.

The atomizing disks are followed by the atomizing cone, the purpose of which is likewise to give the fuel-air mixture a certain velocity of flow. The cone K regulates the valve opening and closing. The nozzle orifice S must also have a certain cross-section, since it is here that the atomization of the fuel properly takes place. All the cross-sections in the path of the flow of air inside of the fuel valve must be several times greater than the section of the nozzle. In Fig. 4, ad shows the developed cam governing the fuel-valve motion. This line ad likewise determines the duration of opening of the fuel valve. During the opening of the valve, throttling occurs over ab, due to the action of the cone on the needle; it also occurs over cd during the closing of the valve.

From point b on, the cross-sections opened up by the needle are larger than the nozzle cross-sections, and hence the curvature of the cam determined by the height h_1 has no influence on the variation of the fuel flow. An increase in the nozzle opening

displaces the point b toward b_1 and the point c toward c_1. Therefore, the amount of injection air can be increased by using a steeper shape of the cam, ab_2 and c_2d, and can be reduced by giving the cam a gentler slope, as ab_3 and c_3d. The amount of injection air may also be increased with the same cam shape by increasing the size of the holes in the atomizing disks, and contrariwise, may be reduced by reducing their size. The variation of the nozzle orifice has the greatest influence on the amount of injected air.

However, the rate of air injection can also be effectively varied

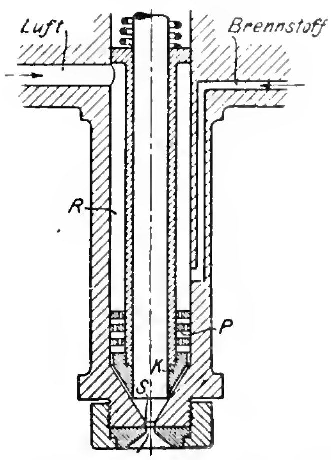


FIG. 3 DIAGRAM OF FUEL-INJECTION VALVE IN A CONSTANT-PRESSURE-TYPE ENGINE

(*Luft*, Air; *Brennstoff*, Fuel)

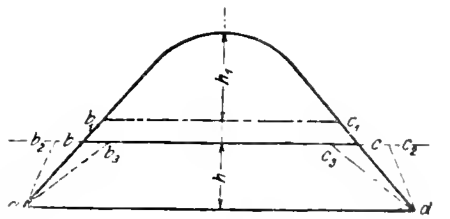


FIG. 4 DEVELOPED PROJECTION OF A CAM FOR THE VALVE SHOWN IN FIG. 3

by changing the injection pressure. The amount of air Q flowing through the nozzle is determined by the equation $Q = fv$, where f is the cross-section of the nozzle and v the velocity of the flow of air. This velocity of flow of air can be calculated from the following formula:

$$v = \sqrt{\frac{2gH}{\gamma}} = K\sqrt{H}$$

where H is the gage pressure of the injection air.

This method is used for reducing the output of stationary and marine engines in order to secure a combustion free of carbon deposits through a reduction of the injection air pressure.

If in the last equation the magnitude of $\sqrt{H}$ remains unaltered, the equation $f = Q/v$ can also be written in the form $f = cQ$. Q is here the amount of the fuel-air mixture which passes per unit of time through the cross-section f. In order to produce a good atomization of a given amount of fuel, q, it is necessary to apply a certain definite amount of injected air. Hence, Q = Fuel + Air of Injection, or $Q = q + mq = q\,(1 + m)$, and the equation $F = cQ$ becomes $F = c\,(1 + m)\,q = c_1q$. For a nozzle cross-section δ we have the equation $\delta = K_0\sqrt{q}$. Instead of the fuel consumption per second, we may use the engine output N_i. This alters the coefficient in the above equation, which becomes $\delta = K\sqrt{N_i}$.

Since the value of K is affected by many independent variables, it is impossible to give it a numerical value which would be good for all cases. Rather the exact value of K should be determined for each engine. The standardization of the fuel nozzle can be carried out only in so far as to determine for each engine the dimensions of the fuel nozzle, which, in as far as possible, corresponds in every respect to the performances desired. The value of K can be determined from the equation $\delta = K\sqrt{N_i}$. The knowledge of the value of K permits to determine the characteristics of the nozzle for engines of the same type, and this again determines the dimensions of all other parts. Fig. 5 shows the relations of the values based on the above described standardization, with reference, however, to existing engine types.

The abscissæ of Fig. 5 show the outputs of individual cylinders, and the ordinates, the values of cross-sections of the main atomizing devices referred to the nozzle cross-sections, calculated from the above formula. Curve I is the curve of the valve space. Curve II gives the relative values of the needle cross-section and Curve III the values of the cross-sections of the holes of the atomizing plates. The cross-sections of the cone passages are also roughly taken into consideration. Curve IV gives the values of the sections of the passages of the needle cone.

Engines which have been built according to such standardized proceedings need not, in the opinion of the writer, be tested out at the factory. Besides, such a standard proceeding gives at once the main dimensions of the fuel valve for engines to be built. (Original article published in *Zeitschrift des Vereines deutscher

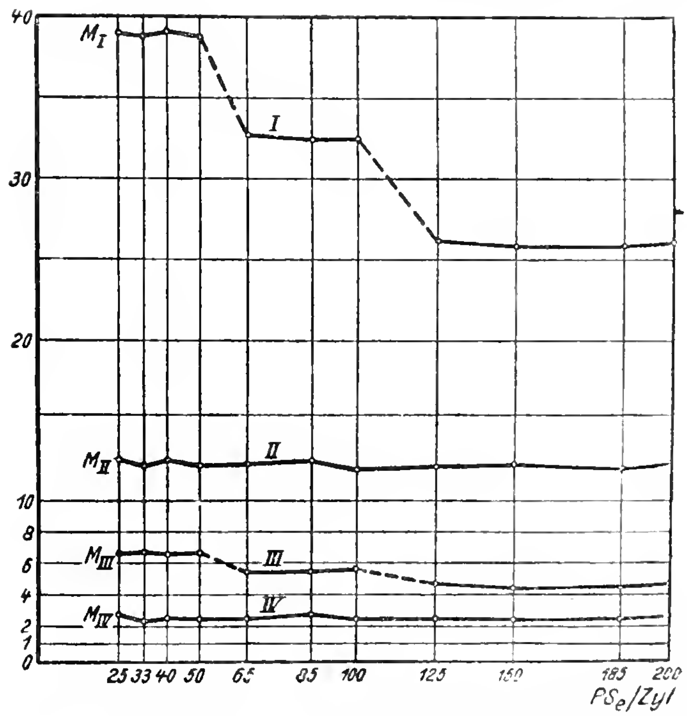


FIG. 5 RELATIVE VALUES OF CROSS-SECTIONS IN THE PATH OF AIR FLOW IN VALVE OF THE TYPE SHOWN IN FIG. 3

(*PSe/Zyl.*, Hp. per Cylinder)

Ingenieure, 1918, pp. 111 and following: abstracted through *Dingler's polytechnisches Journal*, vol. 333, no. 10, May 18, 1918, pp. 85-86, 3 figs., *p*)

LUBRICATION

Oil Consumption in Steam-Engine Lubrication

STEAM-ENGINE LUBRICATION, Hilliger. According to Schmid, in steam engines properly cared for the hourly consumption of cylinder oil in grams may be taken to be equal to $L = 1.6D_nsn$, where D_n is the diameter of the low-pressure cylinder in meters, s the stroke in meters and n the speed in r.p.m. Weiss offered for the same case the equation $L = 2D_hn$, where D_h is the diameter of the high-pressure cylinder. If the two equations were correct they should have given approximately equal values for similar engines. Table 1, however, which gives the oil consumption per hour calculated for several engines in accordance with both of these equations, shows that the values thus obtained do not agree very well with each other. Apparently, the equations cited above do not give the correct minimum values of oil consumption.

Hilliger has carried out tests with a view to determining the oil consumption of a steam engine. These tests were made on a locomobile built by the Wolf Company of Magdeburg. The cylinders were lubricated by a pressure pump which delivered 12 grams of oil per hour to the cylinders at 230 r.p.m. of the engine. The cylinders were 130 mm. (5.1 in.) bore and 260 mm. (10.2 in.) stroke. In each test the cylinder received a definite amount of oil. The lubrication was then stopped and the variation of mechanical efficiency with time determined. In order to establish accurately the quality of the cylinder lubrication it was necessary to determine the mechanical efficiency with precision. For the determination of the effective output of the locomobile, a load was used consisting of a belt-driven direct-current generator.

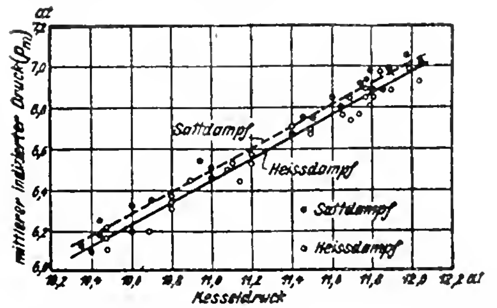


FIG. 6 RELATION BETWEEN AVERAGE INDICATED PRESSURE AND BOILER PRESSURE FOR SUPERHEATED AND SATURATED STEAM

(Ordinates: Average indicated pressure (p_m); abscissae: Boiler pressure; *Sattdampf*, Saturated steam; *Heissdampf*, Superheated steam; *at*, pressure in atmospheres.)

The indicated output of the engine was determined from the equation $N_i = 0.015 p_m n$, where p_m is the average indicated pressure in atmospheres. In the course of the tests it was found impossible to determine p_m from the indicator diagrams with sufficient precision. Because of this the governor was so adjusted that up to a speed of 245 r.p.m. it could not affect the valve gear. By plotting diagrams of equal cut-off but with variable admission pressure, it can be shown that the average indicated pressure

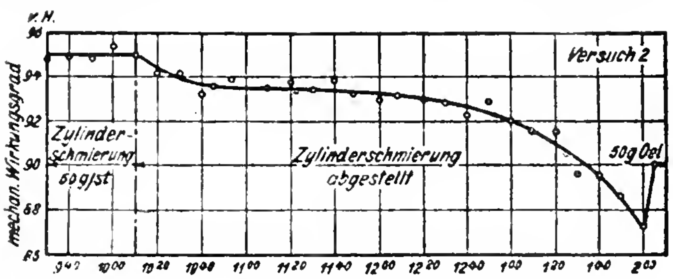


FIG. 7 VARIATION OF MECHANICAL EFFICIENCY WITH VARIATION OF SUPPLY OF OIL WITH SATURATED STEAM

(Ordinates: Mechanical efficiency, per cent; Abscissae: Time; *Zylinderschmierung 50 g/St*, Cylinder lubrication 50 grams per hour; *Zylinderschmierung abgestellt*, Oil feed to cylinder discontinued; *Versuch 2*, Test No. 2; *50 g Oel*, 50 grams of oil supplied to cylinder.)

TABLE 1 CYLINDER-OIL CONSUMPTION OF STEAM ENGINES

Cylinder diameter, mm.	Stroke, mm.	R.p.m.	Cylinder-oil consumption in grams per hour calculated according to	
			Schmid	Weiss
680 and 1000	1200	80	153	109
475 and 740	900	103	109	98
320 and 500	470	109	40	68
200	360	120	14	48

varies approximately with the boiler pressure. Since the expansion line of superheated steam is different from that of saturated steam, the relation between the average indicated pressure and the boiler pressure has to be determined separately for the two conditions of steam, and Fig. 6 shows this relation for both cases.

In the tests with the boiler pressure maintained at the same level of 11.8 atmos., the electrical output was so manipulated that in all tests the speed of rotation was 230 r.p.m. In this way the indicated output was maintained the same in all tests and the effective output can then be calculated from the equation—

$$N_e = \frac{\text{voltage} \times \text{current}}{736 \eta_{el} \eta_R}$$

where η_{el} is the electrical efficiency of the generator and η_R the efficiency of the belt drive, which latter may be taken to be equal to 0.95. The mechanical efficiency is then $\eta_{mech} = \frac{N_e}{N_i}$. The three types of oil which were used with tests, with their respective characteristics, are described in Table 2.

Fig. 7 graphically represents the data of tests with the German superheated-steam oil used with saturated steam. With regular lubrication the curve of efficiency runs about 95 per cent. With

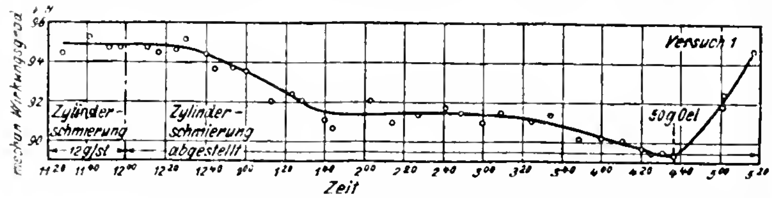


FIG. 8 VARIATION OF MECHANICAL EFFICIENCY WITH VARIATION OF SUPPLY OF OIL WITH SUPERHEATED STEAM

(Ordinates, Mechanical efficiency, per cent; abscissae, Time; *Zylinderschmierung 12 g/St*, Cylinder lubrication 12 grams per hour; *Zylinderschmierung abgestellt*, oil feed to cylinder discontinued; *Versuch 1*, Test No. 1; *50 g Oel*, 50 grams of oil supplied to cylinder.)

the supply of oil discontinued, the curve stays for a while at 95 per cent and then begins to fall off rapidly. When the efficiency has fallen five or six per cent, 50 grams (1.75 oz.) of oil are forced into the cylinder, which produces a considerable improvement in mechanical efficiency.

In tests with superheated steam the same German superheated-

TABLE 2 TYPES OF CYLINDER-OIL USED IN HILLIGER'S TESTS

Types of cylinder oil	Specific weight, kg. per liter	Flashpoint, deg. cent.	Engler viscosity at 100 deg. cent.	Freezing point, deg. cent.
American superheated steam....	0.900	300	4.5	0
German superheated steam....	0.935	270	3.5	25
German..........	0.965	235	6.5	10

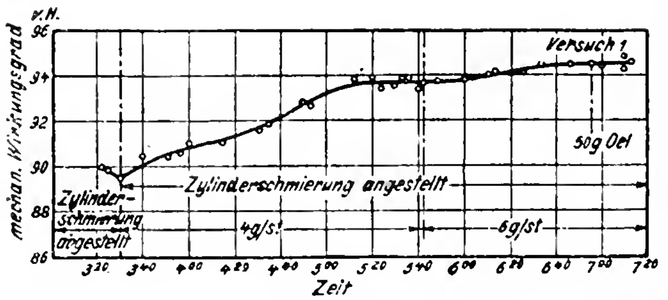


FIG. 9 EFFICIENCY CURVE WITH VARIABLE OIL FEED, SUPERHEATED STEAM

(Ordinates: Mechanical efficiency per cent; Abscissae: Time; *Zylinderschmierung abgestellt*, Oil feed to cylinder discontinued; *Zylinderschmierung angestellt*, Cylinder lubrication resumed; *g/St*, grams per hour; *Versuch 1*, Test No. 1; *50 g Oel*, 50 grams of oil supplied to cylinder.)

steam oil was used. In these tests also the efficiency did not vary during the time that oil was regularly fed to the cylinders, but fell off very soon after the supply of it was discontinued, even though at a rate not as rapid as in the case of saturated steam. Fig. 8 represents graphically the data of these tests. In order to secure a clearer insight into what has taken place with cylinder lubrication, it was necessary also to determine the minimum amount of oil with which the engine could be uniformly operated. This may be defined as the amount of oil with which the mechanical efficiency will be maintained at its highest point. Fig. 9 shows

the plot of the efficiency curve with variable oil feed. The reciprocal values of the amount of oil necessary to maintain efficient lubrication may be considered as index figures for the given oil.

Fig. 10 shows the manner in which the specific oil consumption varies with the indicated output. The values of oil consumption have been derived from marine engines of similar construction in which the oil consumption has been carefully noted. From this figure it appears that with increase in output the specific oil consumption decreases very materially, but at high outputs there is no longer any noticeable decrease in oil consumption. In the foregoing figures the oil used in lubricating the auxiliary engines,

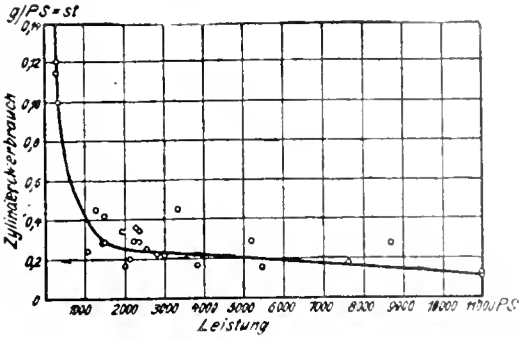


FIG. 10 VARIATION OF SPECIFIC OIL CONSUMPTION WITH INDICATED OUTPUT, MARINE ENGINES.

(Ordinates: Oil Consumption per Cylinder, in Grams per Hp-Hour; Abscissae: Cylinder Output in Hp.)

amounting to from 8 to 10 per cent of the total consumption, has also been taken into consideration.

Stationary engines of the vertical type show a higher oil consumption than marine engines. The straight-flow engines, of which quite a number have been built in recent years, show, in general, a peculiar behavior, in that the specific oil consumption decreases with the increase of output along an approximately straight-line law. At the same time, as is evident from Fig. 11, they have a very

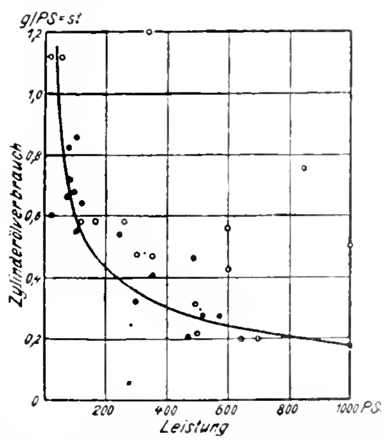


FIG. 11 VARIATION OF SPECIFIC OIL CONSUMPTION WITH INDICATED OUTPUT OF VARIOUS TYPES OF STEAM ENGINES

(Ordinates: Oil Consumption per Cylinder in Grams per Hp-Hour; Abscissae: Cylinder Output in Hp.)

high general oil consumption, due, apparently, to the large piston surface, and to the arrangement of exhaust slots. The piston in passing over the exhaust slots scatters through them a certain amount of lubricating oil which is in this way lost for further lubrication.

For horizontal stationary engines the law governing oil consumption is difficult to establish because of the variety of types of such engines. Fig. 12 gives an idea as to the values of consumption found with this type of engine. These figures give the total oil consumption; that is, in addition to the cylinder lubrication, also that used for the lubrication of the stuffing boxes on the piston rods, valve rods and connecting rods.

Finally, Fig. 13 gives a résumé of the cylinder-oil consumptions of various types of steam engines. (*Zeitschrift des Vereines deutscher Ingenieure,* 1918, Nos. 14, 15, 16, abstracted through *Dingler's polytechnisches Journal,* vol. 333, no. 14, July 13, 1918, pp. 122-124, 8 figs., *e*)

MACHINE DESIGN

ON THE THERMODYNAMICS OF SPRINGS, H. Bock (*Zeits. Instrumentenk,* 38, pp. 109-115, July, 1918). The thermal processes which ensue during the extension of elastic bodies have long been known, but although of outstanding significance for engineers, yet the data have been seldom employed by them, probably owing to the form in which they have usually been expressed. The author now attempts by means of an analogy with the p-v diagram to give a simple process whose application to the theory of springs leads to the possibility of expressing numerically the

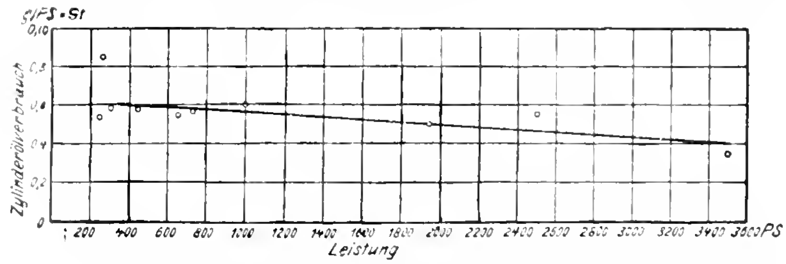


FIG. 12 VARIATION OF SPECIFIC OIL CONSUMPTION WITH INDICATED OUTPUT, HORIZONTAL STATIONARY ENGINES.

(Ordinates: Oil Consumption per Cylinder in Grams per Hp-Hour; Abscissae: Cylinder Output in Hp.)

elastic after-effect. It is shown that perfectly elastic bodies must be attended by such after-effects—a fact of considerable importance for fine springs such as chronometer spirals. The various limitations assumed are first given, and then the equation of state of a long bar is derived corresponding to that for a gas. The σ-l diagram is next plotted, where l is the length and σ the tension along this direction. Following this comes a discussion of the internal energy of the bar, together with the determination of c_1 (the specific heat at constant length corresponding to that of constant volume in the gas equation). The adiabatics of the bar is next examined, and the expression for the entropy obtained. The theoretical results are then applied to determine the energy loss when the bar is made into a spring, and the special case of energy loss in the watch spring concludes the paper. (*Science Abstracts,* Section A—Physics, vol. 21, pt. 10, no. 250, October 31, 1918, p. 436, *t*)

MACHINE SHOP

INSPECTION OF STEEL ARC WELDS, O. S. Escholz. It is stated that the four factors which determine the physical characteristics of the metallic-electrode arc welds are fusion, slag content, porosity and crystal structure.

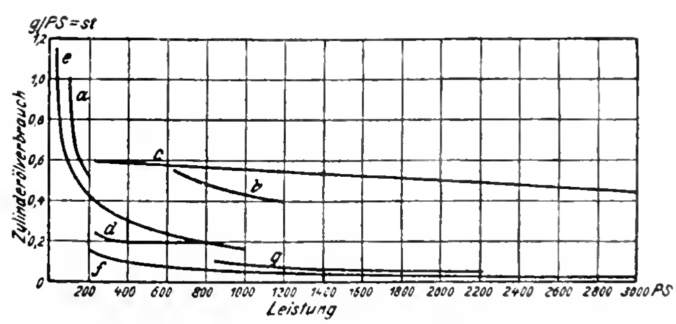


FIG. 13 VARIATION OF CYLINDER-OIL CONSUMPTION WITH INDICATED OUTPUT, STRAIGHT-FLOW ENGINES

(Ordinates: Oil Consumption per Cylinder in Grams per Hp-Hour; Abscissae: Cylinder Output in Hp.)

The writer enumerates various methods for determining the quality of the weld. The most reliable indication of the soundness of the weld is offered by the penetration tests. In the testing of small samples excellent results are made possible by the use

of X-rays, but it is difficult to manipulate with the present apparatus in large-scale production.

In penetration tests, liquids, such as kerosene, give practically as good results as gases and are much easier to apply. Because of its low volatility and high-surface tension, kerosene sprayed on a welded surface is rapidly drawn into any capillaries produced by incomplete fusion between deposited metal and weld scarf or between succeeding deposits, slag inclusions, etc. It penetrates through the weld and shows the existence of a weak structure by a stain on the emerging side.

Electric test methods by which the homogeneity of welds is determined are still in the evolutionary stages. The tests recommended are visual examination, chipping and penetration tests.

As regards the arc weld itself, the cardinal steps in its analysis are preparation of weld, electrode selection, arc-current adjustment, arc-length maintenance and heat treatment.

In this connection the writer points out that a great many companies have attempted welding with too low an arc current and the result has been a poorly fused deposit. This is due

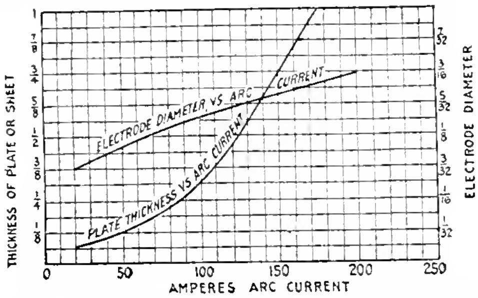


Fig. 14 Values of Arc Current to Be Used for a Given Thickness of Steel Plate and of Electrode Diameter for a Given Arc Current

largely to the overheating characteristics of most electrode holders which lead the operator to believe that the current used is in excess of the amount needed.

The approximate values of arc current to be used for a given thickness of mild-steel plate, as well as the electrode diameter for a given arc current, may be taken from the curves of Fig. 14. The variation in the strength of 1-in.-sq. welded joints as the welding current is increased is shown in Fig. 15.

In the opinion of the writer the heat treatment of a completed weld is not a necessity particularly if it has been preheated for

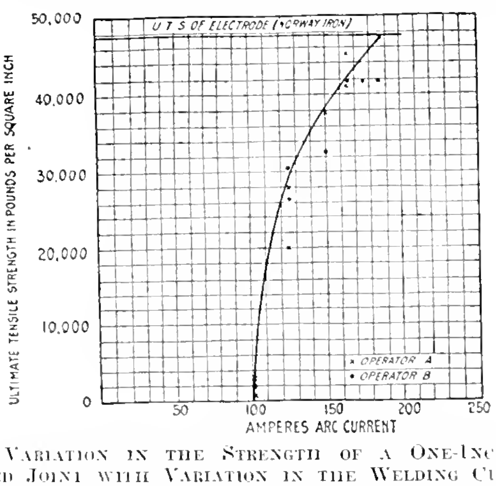


Fig. 15 Variation in the Strength of a One-Inch-Square Welded Joint with Variation in the Welding Current

preparation and then subjected to partial annealing. A uniform annealing of the structure is desirable even in the welding of the small sections of alloy and high-carbon steels, if it is to be machined or subjected to heavy vibratory stresses. (*Iron Age*, vol. 102, no. 23, December 5, 1918, pp. 1390-1391, 2 figs., *p*)

Machine Shop for Gas-Producer Work. Description of the new plant and gas producer of the Smith Gas Engineering Company at Morain City, a suburb of Dayton, Ohio.

The design of the generator is such that the heavy elements (shell and lining) are stationary, freeing the operating mechanism from severe strains. Grates and clinker bars operate through compressed-air cylinders. Coal is charged without admission of air, the stokers being driven by a variable-speed electric motor and each capable of independent starting or stopping by engagement or disengagement of its driving pawl.

The gas from the generator goes through a downcomer to a primary cooler, then to a gas pump and tar extractor. The tar-laden gas in passing through the extractor comes in contact with the diaphragm of spun glass. Friction against this material charges it with static electricity, which causes fine particles in the tar fog to cling together until they are of sufficient size to drop out of the current by gravity. This spun glass, by the way, had to be imported from Austria before the war, but is now produced in this country. (*Iron Age*, vol. 102, no. 23, December 5, 1918, pp. 1373-1378, 14 figs., *d*)

MARINE ENGINEERING

Application of Buoyancy Boxes to the S. S. "Lucia" for the U. S. Shipping Board, W. T. Donnelly, Mem.Am.Soc.M.E. Brief description of a method for providing internal buoyancy for ships or boats, with numerous plates illustrating the construction used on the S. S. *Lucia*.

At an early stage in the work it was found that ordinary methods of construction for the buoyancy boxes would not do and new ways of construction had to be developed to make the boxes capable of withstanding pressure and absolutely watertight. Every box was tested by air pressure and floated in a tank before being placed in the vessel.

Approximately 12,000 boxes, divided about equally between buoyancy boxes for ship, or cargo, were required. As regards the question of reduction of cargo space due to the presence of the boxes, it is claimed that this reduction corresponds only to the weight of the buoyancy boxes and has no necessary bearing upon the room they occupy.

The paper presents in considerable detail the buoyancy and stability calculations for the S. S. *Lucia*, together with calculations as to what would happen in case of various parts of the ship being opened by a torpedo explosion. In considering the problems of longitudinal stability, the writer uses the section-modulus method instead of the metacentric-height method such as was first employed by Professor Hovgaard, and the difference between these two is carefully pointed out.

From the mechanical engineer's point of view the details of flotation boxes are, of course, of considerable interest. Because of this Fig. 16 is reproduced giving the details of three types of boxes found necessary.

The boxes have been so standardized that a uniform size of lumber can be used for all types. The boxes actually used were made of ordinary lumber and galvanized sheet iron and the quantity of the latter was quite considerable. (Paper before the Society of Naval Architects and Marine Engineers, read at the Annual Meeting, in Philadelphia, November 14-15, 1918, 14 pp. and 10 plates of drawings, abstracted from advance copy, *dA*)

MECHANICS

Vibration of Tall Chimneys

Wind Pressure on Tall Chimneys. Data of an investigation by Professor Omori (Japan) on the movements which wind pressure induces in the top of a tall chimney. The interest of this investigation lies in the fact that it furnishes the means of determining the degree of stability possessed by tall columns having an oscillation period of more than two seconds.

The chimney was erected at Saganoseki by the Weber Chimney Company of Chicago and is made of reinforced concrete. Its height is 550 ft. above the foundation pier. It stands on a hard paleozoic formation of a very low seismic movement. The base is about 450 ft. above sea level, which brings the top to a height of about 1000 ft. where it must experience a much greater wind velocity than that registered at the surface. The external diameter

is 27 ft. 5 in. at the top and 42 ft. 8 in. at the bottom. The wall thickness is 7 in. at the top and 29.5 in. at the bottom.

The article describes the method of observation used. The oscillations of the top of the shaft as registered by the automatic recorder are reproduced on a much reduced scale in Fig. 17. The upper diagram shows the motion transverse to the direction of the wind at the time of greatest velocity during a storm (December 26) when a Robinson anemometer recorded a wind velocity of 35 meters per second (114.8 ft. per sec.). The lower curve indicates the motion parallel to the direction of wind about one-half hour later. The difference in amplitude is very pronounced. The observers on the top of the column were sensible of the greater oscillation in the direction of the component at right angles to the wind's direction than that parallel to the wind. Professor Omori attributes this peculiar behavior to the pressure period of the transverse oscillation is very slightly larger than that of the parallel, and if this difference be real it may be traceable to the position of the flue causing the shaft to oscillate more easily in the transversal direction, but the evidence is not conclusive.

The diagram of Fig. 17 shows a succession of small and large vibrations at intervals of about 10 or 12 sec., the maximum motion never being continuous for any considerable length of time. In this respect the column behaved as a huge anemometer and the duration of alternating large and small groups of vibrations may be regarded as indicating a comparatively rhythmical succession of periods of violent winds alternating with the times of cessation.

The article presents briefly data of similar observations on two other chimneys in Japan, each having a height of 100 ft.

The main conclusion reached is that wind pressure on a tall

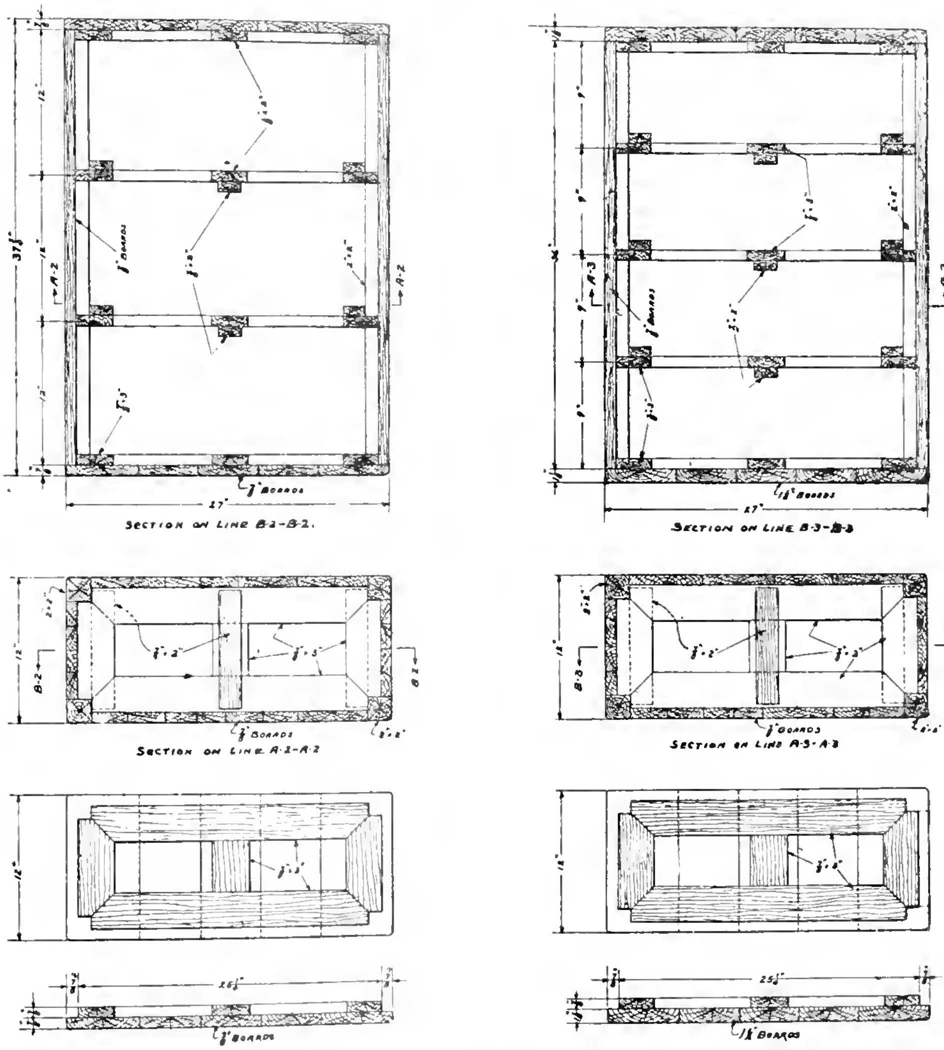


FIG. 16 DETAILS OF FLOTATION BOXES USED IN THE DONNELLY METHOD OF INCREASING BUOYANCY OF SHIPS

of the wind bending the column and rendering it more difficult for it to oscillate. The writer remarks, in this connection, that since the angle through which the column is bent (supposing it to move as one piece) is only about 30 seconds of arc, a greater variation in the time of vibration could be expected than is shown in the diagram if this damping action of the wind were real. But the constancy of periods in winds of all strengths is as remarkable as the variation in amplitudes.

Table 3 and Table 4 show the vibrations of the column in directions normal and parallel to that of the wind. One of the important facts indicated by these figures is the rapid increase in amplitude with the increase of the wind's velocity. It appears that the simple law according to which pressure varies as the square of the velocity does not hold here at all. The period of oscillation in either direction does not vary with the amplitude, at least within the range of the present experiment. The mean chimney can entail consequences as disastrous as those due to seismic motions, even in countries where such occurrences are frequent and severe. The observed motion of the Saganoseki chimney indicated a maximum acceleration of 565 mm. per sec. per sec., whereas on the occasion of the destructive Tokio earthquake of June 20, 1894, the intensity was 444 mm. per sec. per sec. Should the wind velocity reach 50 meters (164 ft.) per sec. the vibration would acquire an acceleration of more than 1000 mm. per sec. per sec. Only very near the epicenter of an earthquake is such an intensity to be anticipated. Again, a reinforced-concrete chimney of less than 200 ft. in height must be regarded as a "short column," and in such structures it is desirable to reduce the height of the center of gravity as much as possible. On the other hand, the 550-ft. Saganoseki chimney, and still more a 1000-ft. chimney already projected, must be regarded as "tall columns" that are seismically weakest, not at the base, but at

about two-thirds of the height. In the usual chimney construction the center of gravity of the whole structure is situated at about one-third of the height, while that of the upper third portion alone is nearly at the middle of its height, causing the shaft to be comparatively weak near the top. Professor Omori recommends such a distribution of the material that the center of gravity

TABLE 3 VIBRATION OF COLUMN NORMAL TO THE DIRECTION OF WIND

Date and hour, 1916	Wind velocity, m. per sec.	Range of motion, mm.	Complete period, sec.
Dec. 23, 9.00 a.m.	6.9 6.7 5.5	0.18 0.13 0.17	2.55 2.58 2.55
Dec. 23, 2.15 p.m.	4.5	0.14	2.54
Dec. 24, 2.30 p.m.	1.0	0.13	2.53
Dec. 24, 10.00 a.m.	4.5	0.46	2.56
Dec. 25, 11.00 a.m.	1.8	0.72	2.54
Dec. 26, 3.00 p.m.	35.0	186.00	2.56

TABLE 4 VIBRATION OF COLUMN PARALLEL TO THE DIRECTION OF WIND

Date and hour, 1916	Wind velocity, m. per sec.	Range of motion, mm.	Complete period, sec.
Dec. 22, 3.30 p.m.	22.0	20.00	2.56
Dec. 24, 1.00 p.m.	1.0	0.47	2.52
Dec. 24, 11.00 a.m.	1.0	0.24	2.53
Dec. 26, 3.30 p.m.	35.0	20.00	2.54

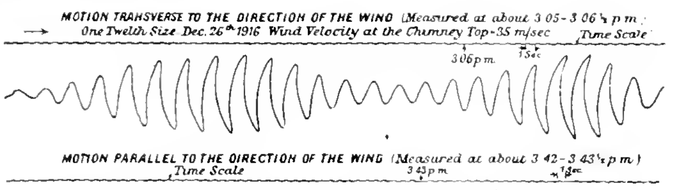


Fig. 17 Motion of a Tall Chimney Transverse (Top) and Parallel (Bottom) to the Direction of the Wind

should be at one-fourth the height of the whole structure, as well as for the upper portion alone. In such a case the chimney would possess uniform strength against an earthquake shock. But if the center of gravity of the upper third part be about the middle of this section, the effect would be to weaken the shaft at the place where the seismic motion would be most effective. (*Engineering*, vol. 106, no. 2752, September 27, 1918, pp. 334-336, 8 figs., *eA*)

On Vibrations of Beams of Variable Cross-Section, N. W. Akimoff, Mem.Am.Soc.M.E. The paper presents a review of the fundamental investigations of the best-known problems of vibratory motion of rods and proposes to revive the interest of research engineers in the method of Ritz, published about ten years ago, but comparatively unknown in many engineering circles.

The paper is mainly of a mathematical character and as such is not suitable for abstracting. The writer considers the method proposed for finding periods of vibrating bars by Professor Morrow. The principle of this method is as follows: By assuming an equation which completely satisfies the end conditions, both the vibration curve and the period of the fundamental oscillation are found to any required degree of accuracy. This method is especially valuable in finding the periods of vibration when the density and flexural rigidity of the bar are variable from point to point in its length. The author applies the Morrow method to the consideration of the cases of a clamped-free bar, free-free bar and various cases of clamped-free bars of variable breadth and depth.

From this the author proceeds to a brief reference to Professor Slocum's formula for the shearing deflection of beams of arbitrary cross-section, either variable or constant, and then goes on to the general discussion of the principles of the calculus of variations and its application to dynamical problems which serves as a basis for the presentation of the Ritz method.

The Ritz method is applied in this case to the problem of finding the fundamental tone of free vibrations of vessels, the hull of a vessel being here considered as a free-free bar of variable cross-section irregularly loaded. (Paper read at the General Meeting of the Society of Naval Architects and Marine Engineers, in Philadelphia, November 14-15, 1918, abstracted from advance copy, 30 pp., *mA*)

Thickness of Wall for Tubes Under Pressure, M. Suwalski (*Zeits. Vereines Deutsch. Ing.* 62. pp. 551-552, Aug. 17, 1918). Gives formulæ for the thickness of tube required to withstand given pressures, using the simple formula $pd = 2sk_z$, where p is the pressure in kg./cm.², d is the inner diameter, s the thickness of the tube, and k_z the tensile strength in kg./cm.². This simple equation is modified by putting $k = A(1 + d/200)$, A being a constant depending on the value of p. (*Science Abstracts*, Section A—Physics, vol. 21, pt. 10, no. 250, October 21, 1918, p. 404, *t*)

METAL-WORKING TOOLS

Machine Tools for Neville Island Gun Plant. Two new types of single-apparatus shell-turning and boring machines are being built for the Neville Island Gun Plant of the United States Steel Corporation.

The machines are practically identical as to bed and headstock. The bed is 29.9 ft. long, 5.25 ft. wide, and the turning machine has a 39-in. swing. The bed is a solid piece integral with the head. The machines are designed to turn 12-in., 14-in., 16-in. and 18-in. shells, with provision made for 20-in. shells if that size is desired.

The auxiliary carriage is provided with two tools, one for turning the straight portion and the other the curved surface at the nose at the same operation. Back of the carriage, rigidly fixed to the bed, is a forming attachment with two cam slots, one straight and one slightly diagonal controlling the tool turning the straight portion, and the other curved and engaging the tool for the curved portion at two points. As the carriage travels it carries the cutting tools that have the curved surface, being held at right angles to the surface at all times, thus eliminating any necessity for the shells being turned in steps. The action of this curved cam slot is to carry the tool through an arc as though it were operated on a pivot. (*Iron Age*, vol. 102, no. 18, October 31, 1918, pp. 1071-1074, 5 figs., *d*. Also in *Iron Trade Review*, vol. 63, no. 18, October 31, 1918, pp. 1012-1013, 2 figs., *d*)

MUNITIONS (See Metal-Working Tools)

POWER GENERATION

Wind Power for Electricity Generation, P. Schubach (*Helios*, 24. no. 17. 1918, *Elektrot. u. Maschinenbau*, 36. p. 385, Aug. 25, 1918, Abstract). The author calls attention to the rapid multiplication of wind-power installations in Denmark, and considers that their employment will become even more general in country districts as a result of the war.

Wind-velocity observations at Lindenberg Observatory have shown that in low-lying districts at sea level the mean wind velocity is 4.7 m. per sec.; at 500 m. this rises to 8.9 m. per sec., and at 1000 and 1500 m. to 9.2 and 9.4 m. per sec. respectively. The energy available, N, for the wind motor can be calculated from the formula $N = YFv^2\ (150\,g)$, where F is the projection of the total wing surface in square meters, V the wind velocity in meters per second, Y the weight of 1 m.³ of air, and g the acceleration due to gravity.

Table 5 gives the relation between size and output of wind motors for wind velocities of 5 and 7 m. per sec.

Reference is made to the wind motors of the G. R. Herzog Saxon Steel Wind-Motor Co., of Dresden. In these the dynamo is driven by means of gearing and countershaft. Auxiliary wind

wheels serve for rotating the main wheel according to the wind's direction and for adjusting to the wind's intensity. The main wheel is mounted on a wooden or iron tower in such a way that

TABLE 5 RELATION BETWEEN THE SIZE AND OUTPUT OF WIND MOTORS

Wheel Diam. in Meters	*F* in Sq. Meters	Hp. Developed 5 m. per sec. wind velocity	Hp. at 7 m. per sec. wind velocity
2.5	2.9	0.16	0.6
3.5	5.2	0.3	1.0
4	7.2	0.5	1.5
5	11	1.0	2.5
6	16.7	1.5	4
7	22.4	2.0	5
8	28.8	2.5	6
10	44	4	8
12	65	6	14

the lower edge of the wheel clears by 2 or 3 m. any obstacles there may be to the wind over a radius of 200-300 m. The irregular operation of such a motor necessitates the use of a storage battery to work in parallel with the dynamo, and this battery should be capable of supplying two days' current requirements. The cost of operation is given as 4 to 7 pfennigs per hp.-hour, or 120 to 210 shillings per hp.-year, including interest, amortization, and attendance.

Two suitable regulators are then described: these appear to be of the usual type, namely, an automatic cutout operating when the speed falls below a certain value, and a voltage-regulating centrifugal governor which operates the field resistance of the dynamo. (*Science Abstracts*, Section B—Electrical Engineering, vol. 21, pt. 10, no. 250, October 31, 1918, p. 363, *g*)

POWER PLANTS

Economic Operation of Steam Turbo-Electric Stations, C. T. Hirshfeld and C. L. Karr, Members Am.Soc.M.E. Discussion of economies which may be effected in the use of fuel through the application of proper operating methods at large turbo-generator power plants.

It is stated that in a single plant with a given load curve the fuel economy is dependent upon the following three independent factors, namely:

1 The method used in distributing the load between the main units available
2 The methods used in the boiler room for producing the steam required
3 The methods used for obtaining auxiliary power for house service.

In connection with the matter of distribution of load between main units, the paper points out that most of the steam-driven turbo-generators built in this country have steam characteristics of the general type shown in Fig. 18. The total steam consumption increases approximately according to a straight-line law until a point is reached where the rate of increase becomes more rapid, causing the plot of total steam consumption to curve upward as shown in the figure.

The steam pressure, superheat and vacuum or back pressure all have marked effects on the steam consumption or water rate of steam turbines, which latter also varies from time to time for a given unit under given conditions of pressure, superheat and vacuum. This supplementary variation may be due to deposits on blading, wear of blading, variation of clearances, settlements in bearings, and other uncontrollable factors.

It is therefore advisable to test each machine through its entire range of load once in every eight weeks at stations operating continuously. Tests at about five or six equally spaced loadings generally suffice to determine the water-rate curves with the required degree of accuracy.

As regards the method of determining load distribution, it is stated that the distribution of load between units so as to yield the minimum water rate for any given station load may be determined mathematically, but this method has not yet been reduced to a form easily understood and applied. Hence a less exact but easy-of-application cut-and-try method is described.

As regards the operation of auxiliaries, the writers arrive at the following conclusions:

1 The smallest thermal cost for auxiliary power is incurred when generated by steam with complete absorption of the exhaust in the feedwater
2 The greatest possible part of all of the auxiliary energy required can be obtained in this way when the steam drives used with the auxiliaries have the greatest possible thermal efficiency
3 Auxiliary power in excess of that obtainable with exhaust steam absorption can be procured from the main generators in electrical form at a lower thermal cost than in any other way.

To these conclusions may now be added two commonly known facts:

1 The increasing price of fuel is leading more central stations to the use of economizers
2 The greatest saving is effected with economizers when the water supplied them is at the lowest permissible temperature. This value is probably somewhere between 120 deg. and 150 deg. fahr., depending upon the types of economizer used and the care with which it is operated.

The writers show that large errors can be made in the original design of supplying auxiliary power. It is also possible to make costly errors in operation. To illustrate: Assume that in a certain station, operating at normal day load, the total amount of power used for auxiliaries and for house service of all kinds amounts to

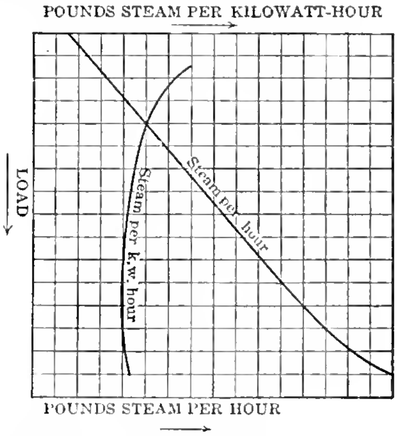


Fig. 18 Steam-Consumption Curves for Turbo-Generator

10 per cent of that sent out. This is a figure that should not be exceeded but is often equaled. Under these conditions, for every 1000 kw-hr. sent out of the station it is necessary to produce 100 kw-hr. for the operation of auxiliaries, station lights, etc.

If it be assumed that the main units are capable of producing a kilowatt-hour for 20,000 thermal units in fuel fired it is possible to show the decidedly weighty influence of the thermal cost of auxiliary power.

It has been shown that auxiliary power may cost anywhere between about 4500 and 200,000 thermal units, depending on the method used. At 4500, the auxiliary power would cost about $4500 \times 100 = 450{,}000$ thermal units in the assumed case. This would be equal to about 2.25 per cent of $20{,}000 \times 1000 = 20{,}000{,}000$ thermal units required by the main units. On the other hand, if the auxiliary power costs 200,000 units per kw-hr. the total would be $200{,}000 \times 100 = 20{,}000{,}000$, or exactly the same as that required by the main units.

With all auxiliary power taken electrically from efficient main units the cost would probably be at least 23,000 units per kw-hr. This would give a cost in the assumed case equal to $23{,}000 \times 100 = 2{,}300{,}000$, or about 11.5 per cent of that required by the main units for the generation of power leaving the station. (*U. S. Bureau of Mines Technical Paper* 204, *pg*)

RAILROAD ENGINEERING

Dimensions of Air Passages in Locomotive Grates

Heat Losses in Locomotives. Data of tests on steam locomotives carried out by the Prussian Railroad Administration in 1913. This series of articles started in 1917, but the issues previous to that from which this abstract is made are not available in this country at the present time.

The present section describes tests made to determine the losses through conduction, radiation and smokestack. These losses are usually assumed to be on the average 5 per cent. The values of line 7 in Table 6 have been obtained by planimeter summation of areas. From these average values have been derived coefficients of evaporation calculated in the usual manner.

The most interesting part of this particular series of tests was that through which it was intended to determine the relation between the free grate area to the total grate area and its influence on the rate of combustion. To do this it was necessary to determine the pressure which should be used with various dimensions of the free grate area to force through the uncovered part of the grate the amount of air necessary for good combustion. The average excess air is assumed to amount to 30 per cent. If one kilogram of coal consumed contained, for example, 0.72 kg. of carbon, 0.05 kg. of hydrogen and 0.12 kg. of oxygen, then with an average consumption of 450 kg. per sq. meter per hour and a grate area (of the test locomotive) of 2.3 sq. meters, the total amount of air necessary per second is

$$L = \frac{100\,(\frac{8}{3}\times 0.72 + 8 \times (0.05 - 0.12)\,450 \times 2.3 \times 1.3}{23 \times 1.29 \times 3600} = 2.78 \text{ cu. m.}$$

This shows that if the free grate passages constituted 23.3 per cent of the total grate area, the velocity of air flowing through the grate slots is

$$v_1 = \frac{2.78}{0.23 \times 2.3} = 5.3 \text{ m. per sec.}$$

which corresponds to a pressure of

$$h_1 = \frac{5.3^2 \times 1000}{2 \times 9.81 \times 775} = 1.85 \text{ mm. water}$$

For a free grate area of 45 per cent, the velocity becomes

$$v_2 = \frac{2.78}{0.45 \times 2.3} = 2.7 \text{ m. per sec.}$$

and the pressure

$$h_2 = \frac{2.7^2 \times 1000}{2 \times 9.81 \times 775} = 0.48 \text{ mm. water}$$

From line 11 in Table 6, it is found that the total pressure difference between the ashbox and the firebox is with upper Silesian coal between 30 and 40 mm. of water and with Westphalian coal 45 to 60 mm. The free grate area can, therefore, within the above-named limits, have only a slight influence on the total difference in pressure between the ashbox and the firebox, even under the assumption that the values of pressure calculated above may be raised somewhat through the existing subdivision of the total free cross-section of the grate.

It appears, therefore, that with the definite action of the air injector and with the definite height of the coal bed, the dimensions of the free grate area may vary within fairly wide limits without materially affecting the amount of air driven in, and hence the quality of combustion.

The lower value of the free grate usable seems to lie at about 20 per cent. If it be decreased further there appears on one hand an enhanced resistance which increases with the square of the velocity of the air; and on the other hand, the distribution of the air becomes defective which leads to the formation of slags. (*Annalen für Gewerbe und Bauwesen*, vol. 82, no. 1 973, January 1, 1918, pp. 1-4, serial article. *c*)

TABLE 6 DATA OF TESTS TO DETERMINE BEST DIMENSIONS OF SLOTS IN LOCOMOTIVE FURNACE GRATES

														Runs													
														to	from	to	from	to	from	to	from	to	from	to	from	to	from
														54	55	56	57	58	59	60	61	62	63	64	65	66	67
Number of Test	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Free grate surface in per cent = $\frac{F}{G} \times 100$	40			40		45.8				23.3				33.3		41.3		40		45.8		23.3		41.3		33.3	
Grate Dimensions in mm. { Width of slot Thickness of grate	12 12 { Double bars			12 12		15 12				10 25				10 15		15 15		12 12		15 12		10 25		15 15		10 15	
Type of Coal	Various German Coals in Good Grades																										
Lower Heat Value in large calories determined by calorimeter	6840			8142		6800		8142		6847		8100		6847	7793	6847	7900	6750	8142	6363	8100	6800	7700	7986		7500	
Amount of Coal in kg. burned per sq. m. of grate surface per hour	483	590	435	359	435	478	370	325	305	490	412	348	261	456	413	456	370	476	338	489	400	510	440	423	285	465	355
Water in kg. evaporated per sq. m. of heating surface per hour	55	52.4	50	51.2	53	54	44	45	36	54	47	47	37	53.5	50	50	48	49.6	41.2	47.5	39.5	52	46	50.2	36.7	51.1	38
Average Heat Losses in per cent { Ash Radiation Losses to the exhaust Unburnt gases	5 2 5	6.3 0.5 5	 5	5 1 5	6 1 5	7.6 2.2 5	5 2 5	5.6 1.2 5	4 1.7 5	6 1 5	6 1 5	3.5 0.4 5	5 0.5 5	5.3 1.1 5 16 0.6	7.4 0.6 5 14 1	4 1 5 16 1	7.5 0.5 5 13 2	4 1 5 17.4 3.6	11 1.5 5 12.8 11	6.5 1 5 14.2 5.3	9 1 5 10 23.1	11 0.5 5 11.5 9.6	10 0.5 5 11.7 12.3	8.6 1 5 13.8 8.2	9 1.5 5 12.5 2.8	9 1 5 11.9 11	5 1.0 5 11.7 14.6
Average Total Loss in per cent	..	..	..	..	..	..	..	..	..	..	..	..	..	28	28	27	28	31	41.3	32	48.4	37.6	39.5	36.6	30.8	37.9	37
Average Superheat in deg. cent.	..	..	..	..	..	..	..	..	..	..	..	..	..	282	366	322	311	310	281	309	285	315	295	295	280	285	282
Average Boiler Gage Pressure in atmos.	11.9	12.2	12.2	12.2	12.3	12.2	12.3	12.2	12.3	12.3	12.3	12.2	12.3	12.2	12	12.4	12.4	12	11.4	12	11.6	11.8	11.5	12	12	11.9	11.6
Average Vacuum in mm. of water { In ashbox In firebox In smokestack	10 33 100	11 37 100	11 40 100	11 39 97	10 52 116	12 40 110	7.5 30 76	6 39 100	5 38 73	13 39 105	10 33 82	8 41 102	3.5 41 72	11 36 108	4.5 57 108	7 43 98	6 60 102	6.5 41 85.5	4.5 60 85	6 37.5 81.5	2 52.5 76	5.5 47 94	2.5 70 110	9.5 56 97	13.5 50 75	4.5 42 87	4.5 34 68
Evaporation { Determined by test Calculated	6.79 ..	5.27 ..	6.85 ..	8.48 ..	7.25 ..	6.71 ..	7.06 ..	8.25 ..	7 ..	6.55 ..	6.79 ..	7.95 ..	8.42 ..	7 6.9	7.16 7.1	6.57 6.8	7.76 7.8	6.2 6.3	7.1 6.8	5.8 6.1	5.87 5.7	5.71 5.8	6.18 6.3	7.05 7	7.68 7.8	6.57 6.6	6.4 6.6

Influence of Internal Fissures in Rails

Rails and the Accident on the Long Island Railroad. On April 15, 1918, there was a derailment of a troop train on the Long Island Railroad, near Central Islip, New York.

Investigation indicated that the cause of the accident was due

to the failure of two rails in which a number of transverse fissures were present. The rails were 80 lb. in weight, A. S. C. E. section, bessemer steel, rolled by the Lackawanna Iron and Steel Company. Each rail displayed a number of transverse fissures, some of which were visible and one accidentally discovered through nicking which happened to be done in the vicinity of a transverse fissure which had not reached the periphery of the head.

The appearance of the fissures is shown by microphotographs, two of these fissures having increased in size to such an extent that they had reached the periphery of the head on the gage side. Other fissures have not become exposed externally. The rails when polished and etched were shown to be structurally very unsound and this lack in uniformity had also been observed in machining the rail sections. Portions of the cross-section were spongy; other parts were hard and machined with difficulty.

From information acquired it appears that at the time when these rails were rolled, or about 1897, the Lackawanna Iron and Steel Company used horizontal heating furnaces, soaking pits not having then been introduced.

The internal stresses in the two rails were measured, and the results are shown in the original report by means of diagrams.

It is interesting to note that from outward appearances the rails were sound looking and showed that little wear had taken place. The shapes of the heads showed but little distortion, yet within them destructive transverse fissures had developed. It is not known over what interval of time these transverse fissures had been in existence. They carried, however, the lighter traffic of the railroad for a period of time without known examples of transverse fissures having appeared. War activities increased the traffic from seven to ten times in the amount of tonnage with a considerable increase in the weight of the equipment, conditions which not unlikely contributed toward the formation of transverse fissures and accelerated their development. The investigation has, however, clearly established that the rails were of very poor metal, a metal, moreover, which appears to have been defective even at the time the rails were rolled.

The interesting features of the report are data of an investigation on the development of fissures in these rails and the distribution of internal stresses in the various parts of the cross-section.

The report comes to the conclusion that from information thus far obtained it appears that rails are strained higher than other classes of engineering materials. Another section of the report tells of annealing tests on a number of hot-forged bars of rail steel and other grades. In these annealing processes were used cooling by an air blast, quenching in oil and quenching in water. The tests with rail steel were fairly consistent, but tests on low-carbon steel and chrome-nickel steel furnished results of a paradoxical nature. The chrome-nickel bars conformed in behavior to the rail steel, while the low-carbon steel displayed opposite characteristics and contracted in length when heated and quenched, whether oil or water were used as the quenching medium.

It is claimed that a distinction may properly be made between approximate cause of the formation of transverse fissures and features which may promote or retard their inception and progress. In any event, transverse fissures are shown to be a progressive type of fracture. (Report of the Chief of the Bureau of Safety, Covering the Investigation of an Accident Which Occurred on the Long Island Railroad, near Central Islip, New York, on April 15, 1918, *Interstate Commerce Commission*, August 5, 1918. 45 pp., 70 figs., *cpA*)

STEAM ENGINEERING

A Large Turbo-Alternator Unit

45,000-KW. CROSS-COMPOUND STEAM TURBINE. Description of the turbo-generator unit recently put in service in the Brunot's Island Power Station of the Duquesne Light Company at Pittsburgh, Pa.

Essentially the unit is not radially different from others of the same type; the principle of cross-compounding in steam turbines not being new any longer. A new feature, however, is the installation of a device for cutting out one side of the turbine if for any reason its immediate removal from service becomes necessary; this device may also operate automatically. In this way a 45,000-kw. machine has the flexibility of a 22,500-kw. unit.

Each turbo-generator rotor is supported in its own bearings so that four bearings are required for each element. The bearings are self-aligned and are supported on spherical keys with sheet-metal liners of different thicknesses for horizontal or vertical adjustment. Oil for lubrication is admitted to the bearing casing at the bottom, the sides of the bearing being eccentrically relieved for a space of about 35 deg. above and below the center line to within an inch of the end, to provide a reservoir of oil along each side. The turbine is free to expand axially by sliding on its supports, which are applied directly below the horizontal joints, the turbine itself being anchored to the inboard generator pedestal.

The low-pressure rotor is composed of a central hollow drum rigidly secured to the spindle ends, on each of which are pressed two blade rings or disks carrying the low-pressure blades. The maximum mean velocity of the blades is only 515 ft. per sec., which brings the rotating stresses at 20 per cent overload to less than 20,000 lb. per sq. in., and makes it possible to use a good grade of cast steel in the blade rings. This is safer and better than using special-grade steels which are not only hard to get even in normal times, but may carry undetected flaws and are more

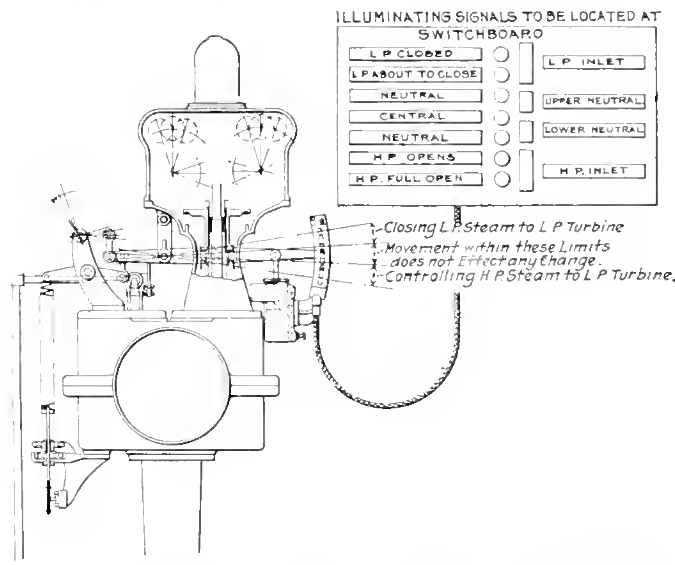


FIG. 19 LOW-PRESSURE TURBINE GOVERNOR ON THE 45,000-KW. CROSS-COMPOUND STEAM TURBINE AT DUQUESNE

subject to trouble from improper heat treatment. Phosphor-bronze blades are used except in the last three rows of the spindle, which are drop-forged steel.

Each turbine is provided with an overspeed-stop governor which will shut off steam in that unit in case the speed should rise 10 per cent above normal. Each unit also has a speed-control governor. The one on the high-pressure turbine which normally controls the steam supplied to the whole system is of the customary form. The governor on the low-pressure side, Fig. 19, has some special features.

The low-pressure governor should not be called upon to act except in the case of an emergency, and in order that the switchboard operator may be aware of the state of things, a system of signal lamps is arranged to show the position of the governor in the neutral zone. By changing the tension of the speed-changer spring, the governor may be kept in its middle position so that a normal fluctuation of frequency will not cause the governor to function. The spring on the low-pressure governor is designed to give a total speed range of 12 per cent, which is divided up as follows: Starting from the central position, if the speed rises 4 per cent, the governor is on the verge of tripping the low-pressure inlet valve. With a further rise of less than 1 per cent the valve will be tripped shut, one more per cent travel being provided for clearance. From the central position downward, should the speed decrease 2 per cent, the high-pressure valve will begin to open,

and will be full open after 3 per cent more decrease. Another 1 per cent is also provided at this end for overtravel.

The signal lamps in the switchboard gallery, Fig. 19, are controlled from the low-pressure governor by a system of contacts operated by an extension on the governor lever. As the governor moves between its inner and outer position this lever travels across the contacts, registering its position on the illuminated sign.

To review the system briefly: If the circuit breaker on the low-pressure element should open due to a short-circuit, the turbine will speed up and close the steam inlet from the high-pressure cylinders. The high-pressure turbine will continue to run, carrying its load and exhausting to atmosphere, while the low-pressure turbine, with its source of steam cut off, will fall in speed until reaching 2 per cent below normal, when the governor valve will admit high-pressure steam. In the meantime, if the line has been cleared the unit may be synchronized and reconnected to the bus bars, the gate valve opened, and the low-pressure cylinder receive its steam as before. If the low-pressure turbine for similar reasons should overspeed 10 per cent and the automatic stop operate, it will result in the automatic closing of the high- and low-pressure steam inlets, and the opening of the circuit breaker, and this half of the turbine will be entirely shut down. The high-pressure element, however, will continue to run non-condensing and carrying its load as usual. (*The Electric Journal*, vol. 15, no. 11, November 1918, pp. 435-441, 7 figs., *d*)

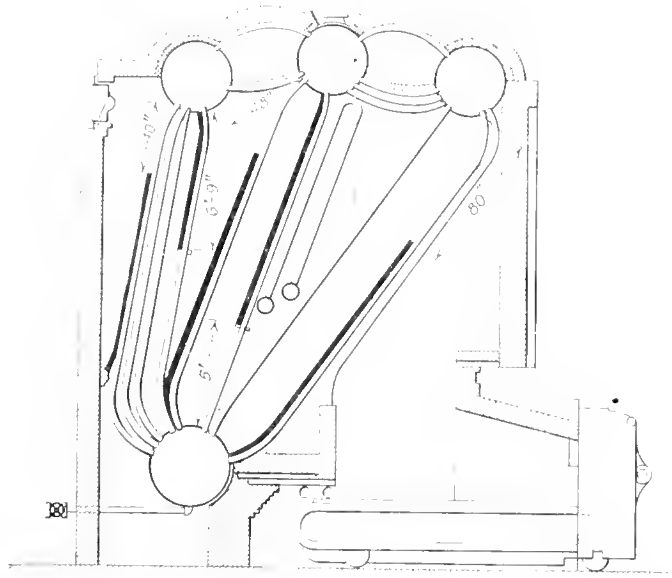


FIG. 20 BAFFLES WHICH GAVE EXCESSIVE FLUE-GAS TEMPERATURES AT 150 PER CENT RATING

DEVELOPMENT OF STEAM-BOILER BAFFLES, Albert A. Straub. Descriptions of several types of baffles with illustrations and brief criticisms. In the same articles are presented data of tests made on a type of baffle shown in Fig. 20 as applied to a Stirling boiler. Tests made with this arrangement gave excessive flue-gas temperatures at 150 per cent rating, which led to a change in location of the baffles and closing up of baffle openings as shown in Fig. 21. With this arrangement of baffles the capacity of the unit was not decreased, but the temperature of the escaping gases was decreased 60 deg. fahr. at 150 per cent rating and 70 deg. fahr. at 210 per cent rating with a corresponding effect in efficiency.

A further change was made in this baffle arrangement after the tests had been completed by placing the first baffle back of the second row of tubes and extending the last baffle down 24 in. toward the mid-drum. This change reduced the temperature of escaping gases 50 deg. fahr. at the higher ratings.

The ratio of efficiency to capacity for the unit with baffling shown in Fig. 21 is given by the curve of Fig. 22. Several other interesting tests are reported in considerable detail in the original article. (*Power*, vol. 48, no. 19, November 5, 1918, pp. 656-659, 9 figs., *de*)

AVOIDING DISTORTION IN TURBINE OPERATION, Webster Tallmadge, Mem.Am.Soc.M.E. Brief discussion of the causes of distortion and suggestions for practical methods so to operate the turbine as to avoid this occurrence. Valuable suggestions are given as to turbine and steampipe installation so designed to insure safety in this respect. (*Power*, vol. 48, no. 22, November 26, 1918, pp. 762-765, 8 figs., *p*)

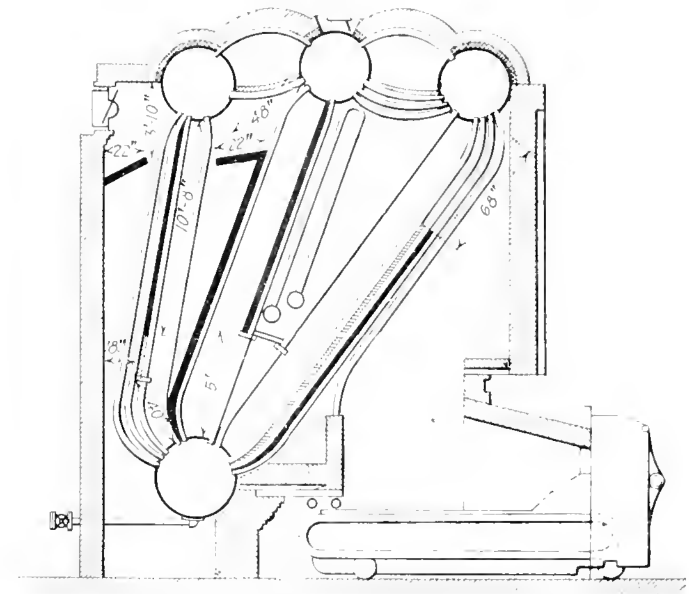


FIG. 21 BAFFLES THAT CAUSED A DECREASED FLUE-GAS TEMPERATURE

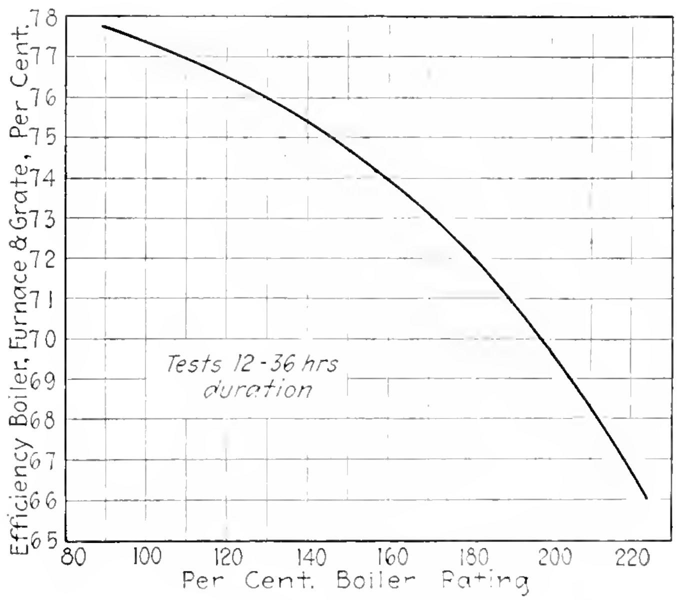


FIG. 22 RATIO OF EFFICIENCY TO CAPACITY OF BOILER BAFFLE AS SHOWN IN FIG. 21

TESTING

PHYSICAL TESTS OF ROLLED SHELL STEEL, James J. Mahon. The physical variations in rolled steel are sometimes greater than might be expected from chemical variation. This variation in physical properties is not found to enter any particular bar of the rolled ingot and at times is much more than the variation usually found between the inner and outer portions of the cross-section of the ingot. It would appear that this might be attributed to the direct rolling of the steel after a prolonged heating which leads to precipitation of the ferrite during the heating process. An investigation was made during which tests and photomicrographs were taken from a great many heats of steel and it was found that

the precipitation of ferrite in some heats was greater than in others. Heats of steel which failed on preliminary tests but in which the precipitation of ferrite was not excessive usually passed the physical requirements after forging.

Although the reheating of the material was too rapid to be classed as a heat-treating operation, it answered the purpose for such steel as was not badly affected. It was found that the ferrite was reabsorbed at a temperature of 1450 deg. fahr., but the quality of the steel was not impaired when the temperature was carried as high as 1750 deg. fahr. before cooling.

It is suggested that the weakness in the metal caused by the precipitation of ferrite might be eliminated by a double rolling operation consisting of breaking down the ingots into blooms and then reheating them before the final rolling.

FIG. 23 PHOTOMICROGRAPHS OF SHELL STEEL FROM TEST BAR TAKEN FROM A DIRECT ROLLED SECTION

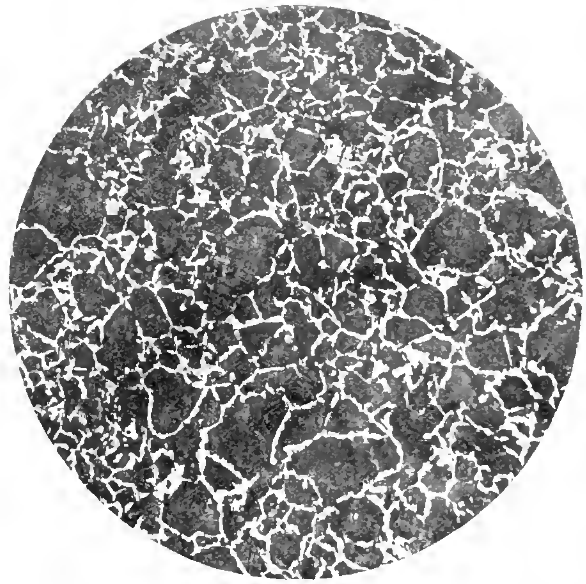


FIG. 24 PHOTOMICROGRAPHS OF SHELL STEEL FROM TEST BAR TAKEN FROM A SECTION AFTER HEAT TREATMENT AT 1450 DEG. FAHR.

In Fig. 23 the structure of the bar rolled direct from the ingot shows the weakness in steel produced by direct rolling or forging after a prolonged heating. Fig. 24 shows the structure after heat treatment at 1450 deg. fahr. Steel in the condition shown in Fig. 23 might to some extent be compared to a metal made up of alternate layers of various thicknesses of soft and hard material welded together.

From this investigation it appears that the extent of inherent weakness in such metal can be determined by the percentage of elongation to the tensile strength, and if so, the data as to percentage of yield to elongation should be a part of every specification where a good quality of steel is desired. (*The Iron Age*, vol. 102, no. 18, October 31, 1918, pp. 1082-1083, 2 figs., *e*)

VARIA

WAR SECRETS. During the visit of the Inter-Allied Petroleum Council in the latter part of November, it was revealed for the first time that a pipe line had been laid across the neck of Scotland, through which oil fuel could be pumped in a cold state at the rate of about 100 tons per hour. The pipe follows the course of the Clyde and Forth Canala, with terminals at Old Kilpatrick and at Grangemouth. At one end 16 huge tanks have been constructed with a holding capacity of a thousand tons, and at the other end the oil falls into reservoirs easily accessible to the fleet from its base at Rosyth. The pipe is 8 in. in diameter and there are two intermediate pumping stations. This is only one of the few secrets revealed since the signing of the armistice.

Another such secret is that the U. S. Navy Department proposes to use argon to inflate gas bags in balloons. This item has been taken from an official statement issued by the Navy Department. It should be added, however, that it is by no means clear what it means, since the specific gravity of argon is so close to that of air that it does not appear obvious how any lifting power can be secured by its use.

In connection with aeronautics, another important and well-kept secret has recently been revealed, and that is that the U. S. Navy has developed what is, perhaps, the largest seaplane type known. In a recent test this seaplane officially marked as NC-1 made a flight with 50 men on board.

This is the first American tri-motored seaplane, being propelled by three Liberty motors that develop a maximum of 1200 hp., giving it a cruising speed of 80 miles an hour. The flying weight of the machine is 22,000 lb., while the weight of the seaplane itself, unloaded and without a crew, is 13,000 lb.

An idea of the size of the big seaplane is shown by the fact that the wing spread is 126 ft., the breadth of the wing 12 ft., and the gap between wings 12 ft.

Recently the NC-1 made the trip from Rockaway to Washington, about 350 miles, in 5 hours and 20 minutes. The flight from Washington to Hampton Roads, 150 miles, was covered in 2 hours and 15 minutes, and the trip from Hampton Roads to New York, 300 miles, took 4 hours and 20 minutes.

Also a further development is revealed by the following statement, authorized by the War Department:

On October 15 Chauffeur R. W. Bottriell, of the 145th Air Squadron, jumped successfully with a parachute from an aeroplane at Kelly Field, San Antonio, Texas. The aeroplane was at an altitude of 4800 ft., nearly a mile high, when the jump was made. There was a strong wind blowing from the north, but Chauffeur Bottriell judged his distances nicely and landed safely in the main landing field. The pilot of the aeroplane stalled the machine slightly just before the jump was made, banking to the right so as to get the tail out of the way of the parachute when Bottriell jumped over the side. A large American flag attached to the parachute during the drop was flying during the descent.

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

REVISION OF THE A. S. M. E. BOILER CODE

SECOND only in importance to the completion of the original edition of the Boiler Code, is the work of revision of the Code that has been in progress for the past two years and is now completed. The edition of 1918, which has been revised to incorporate the interpretations that have been rendered by the Boiler Code Committee during the past four years in which the Code has been operative, and also to add provisions for new types of boiler construction as a result of the development of the art, renders the work of the Boiler Code Committee a very comprehensive review of boiler practice in this country, as well as in the Canadian provinces. Its scope has been extended to cover certain additional forms of boiler construction, which were not previously referred to, and it is the belief of the Boiler Code Committee that the Code as printed in the Edition of 1918 is the most complete and exact manual of American boiler practice that has ever been produced.

Like the work involved in the completion of the original edition of the Code early in 1915, the completion of the revision work prior to the publication of the Edition of 1918, has involved an enormous amount of investigative and research work and has demanded immense sacrifices by the individual members of the Committee in the formulation of the changes in the rules. Throughout the past year, both the Committee and the Executive Committee to the Boiler Code Committee have devoted innumerable conferences to the prosecution of the revision work and every detail of the revision has been handled with the greatest possible care in order to make certain that they were presented with the best possible judgment of the various interests involved and that they might not under any circumstances bring hardship to any branch of the industry through any possibility of misinterpretation.

The revision work was begun late in 1916, when, after the widely advertised public hearings that were held on December 8 and 9 following the Annual Meeting of that year, large numbers of boiler manufacturers, users and experts came before the Committee to recommend preferred revisions in the rules, and it has continued uninterruptedly since that time with the idea of developing the proposed modifications in time for the report thereupon at the time of the following meeting. Such, however, were the obstacles encountered in arriving at complete agreement with the various other associations and organizations interested, that it was not until late in 1918 that it was possible to approach completion. The revisions of the Power Boiler section of the Code (Part I, Section I) were completed and reported to the Council of the Society at its meeting of September 20, 1918, and there approved; the revisions of the Heating Boiler section were not, however, completed for reference to the Council until its meeting of December 3, 1918, whereupon the revisions were finally approved and the printing of the new edition ordered.

The arrangement of the revised edition of the Code (Edition of 1918) is exactly the same as that of the original edition, consisting of Part I, applying to new installations, and Part II, to existing installations. Part I is further divided into Section I, applying to power boilers, and Section II, applying to heating boilers. The rules are then followed by an Appendix which embraces explanatory notes and recommendations relative to boiler construction and repairs. While the paging of the new edition has been altered to provide for the materially increased volume of the rules as revised, the subjects and the arrangement of the paragraphs have been left unaltered throughout the book in order that references to paragraphs might remain uniform throughout for the greater convenience; this also has the advantage of requiring no alterations to the paragraph numbers in the index, so that the indexing to the original edition will apply equally well to the paragraph numbers of the new edition.

Noteworthy additions are to be noted in the diagram for the determination of the efficiencies of longitudinal and diagonal ligaments between tube holes in cylindrical tube sheets which is inserted in the form of a folder (See Fig. 13 between pages 48 and 49) and the proposed Manufacturers' Data Report form which follows page 128 of the Appendix. Another change that will be readily noted results from the revision of the safety-valve rules embracing the transfer of the Tables of Discharge Capacities for direct spring-loaded pop safety valves to the Appendix. In addition, there are a number of other revisions which will prove of interest to those engaged in the boiler industry.

The edition of 1918 of the Boiler Code is slightly larger than the original edition, embracing 128 pages of text and the two inset folders (Fig. 13 and Figs. 34 and 35); with the Index, which in the new edition avoids the divisional arrangement, there is a total of 146 pages. It is issued in pamphlet form for general distribution, being obtainable in paper cover at 50 cents per copy to members and $1.00 to non-members. Arrangements are being made to issue the Code in the near future in cloth binding for the convenience of those who desire to use it for textbook or reference purposes; the price of the cloth-bound edition will be announced later.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Departments of THE JOURNAL by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in THE JOURNAL, or brief articles of current interest to mechanical engineers.

The Sinking of the Steamship "Lucia"

TO THE EDITOR:

In response to your request, I am sending you particulars regarding the steamship *Lucia* upon which I presented a paper at the last meeting of the Society of Naval Architects and Marine Engineers.[1] The *Lucia* was an Austrian steamship with buoyancy boxes for which the design and calculations were made by the writer. The work was done at the instigation of the Ship Protection Committee created jointly by the Naval Advisory Board and the U. S. Shipping Board. This Committee consisted of Admiral H. H. Rousseau, A. M. Hunt and the writer.

The *Lucia* was torpedoed about 5 p. m., October 17, about 1250 miles off the Atlantic Coast on her way to the Mediterranean.

According to the evidence of the captain and other officers, the ship was struck in the engine-room compartment just forward of the after engine-room bulkhead on the port side, so low down that the double bottom was undoubtedly destroyed, as well as the drainage connections for the double bottom and other watertight compartments. The explosion was so low that no damage appeared to the plating on the outside of the hull, even when the ship rolled.

At the time of the attack the *Lucia* was drawing 27 ft. 6 in. forward and 28 ft. 6 in. aft, so it will be seen that the torpedo, instead of striking as is usual not more than 10 ft. below the water line, actually struck more than 20 ft. below. The engine room and hold No. 5, the next compartment aft, flooded immediately, and soundings showed water entering holds Nos. 5 and 6.

The ship floated with a slight list to port during the night of the 17th and the next day until 3.20 in the afternoon, or for something more than 22 hours.

The captain and gun crew stood aboard until shortly before the sinking, and stated that they were ready to fight the gun and resist submarine attack on the surface until that time. Nothing, however, was seen of the submarine before or after firing the torpedo.

About noon on the 18th the sea commenced to rise and the wash

[1] An abstract of this paper appears on page 56 of this issue.

of the sea dislodged and loosened the deck cargo of motor trucks. The drive of these trucks finally struck the hatch aft hold No. 6, which finally filled from the deck. The ship then settled aft, standing almost vertical before she finally went down.

It will be understood, as set forth in the paper, that the displacement of the double bottom had been depended upon for reserve buoyancy. This was partially eliminated by the unusual amount of fresh water carried, and the remainder by the destruction of the pump connections to the double bottom. The destruction of these connections also admitted water to all other compartments aft through the drainage connections, thus eliminating any buoyancy ordinarily maintained by watertight compartments.

Altogether it is to be noted that the torpedo in this instance made a perfect hit. It is hardly conceivable that it could be so precisely located by the hand of chance or coincidence.

At the time of the fitting out of the *Lucia* ships were being torpedoed at only a moderate distance from the coast, and mainly in the English Channel and approaches thereto. Had the *Lucia* been torpedoed anywhere within 100 miles of the coast she would in all probability have been safe. Attention should also be called to the fact that other vessels torpedoed in the engine room—destroying their bulkheads—have gone down in from eight to ten minutes.

While the result of this practical test of the *Lucia* is not all that was hoped for, the writer believes that when carefully considered in all its bearings, it is a very considerable contribution to the possibility of rendering ships, with the lives of their crews and their cargoes, more safe at sea.

William T. Donnelly.

New York, N. Y.

Working-Force Report—Stability Chart

To the Editor:

We have in use, in the employment department at the works of the Chester Shipbuilding Company, Chester, Pa., what we term a stability chart which may be of interest to readers of The Journal. The stability chart is another form of the turnover report and is based on the daily labor reports which are made out on blanks. The stability chart gives, by comparative colored lines, the details with regard to the working-force reports for each month.

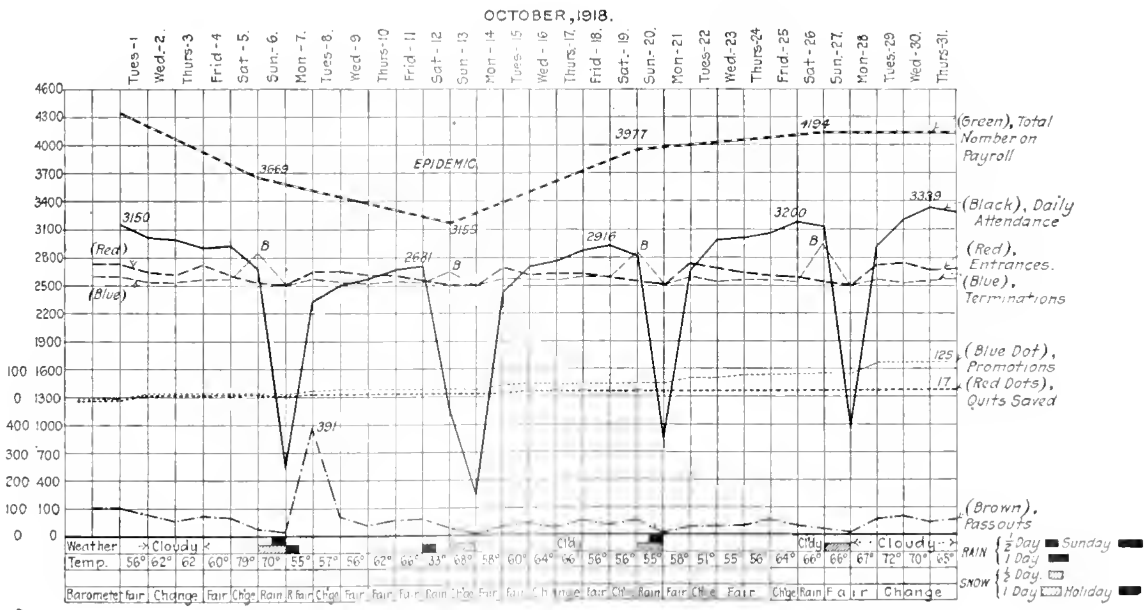
The chart uses two scales—300 men to the block for the daily attendance and payroll; 100 men to the block for all other reports.

The payroll is indicated by a green line near the top of the chart; the figures used in plotting this line are secured from the paymaster and indicate the number of pay envelopes given to the yardmen each Saturday. For that reason there is a regular gradation of line from one Saturday to the next. This line begins with the figures of the last payroll of the preceding month, and ends with the last payroll of the current month. Scale, 300 men to a block.

The figures from the black daily attendance line are secured from the daily labor reports and include both the day and night forces. As its name implies, it fluctuates from day to day, taking a decided drop on Sundays. A comparison of this line with the payroll shows the approximate number of daily absentees. This comparison of a daily with a weekly record will not be exact.

The terminations are shown in blue, the entrances in red. These two lines begin with the record of the last day of the preceding month, and are changed daily according to the number of men entered and terminated each day by the employment department. These lines usually follow each other quite closely, the terminations being greater at the end of the week, the entrances at the beginning.

The promotions in blue dot and the "quits saved" in red dot are cumulative. The lines begin at zero, and the positions of the



Stability Chart in Use at the Works of the Chester Shipbuilding Co.

lines on the last day of the month indicate the total number of promotions and quits saved during the month.

Brown ink is used for the "pass outs," a list of which is secured from the time department daily. The line begins where the line of the preceding month ended, and varies daily. The pass outs include all men who leave the yard during the day, and the number is affected by the weather to a large extent.

Sundays and holidays are indicated at the bottom of the chart, in purple and red, respectively. Columbus Day was not a holiday, yet its influence on the working force is made evident on the chart. The epidemic made its influence felt, likewise. The weather conditions and temperature are also indicated, as rain, excessive heat or extreme cold affect the working force, and likewise the stability chart.

The date and days of the week are placed at the top of the chart, making a concise report of the working force in such form that reasons and results are shown at a glance.

M. E. Hood.

Chester, Pa.

MECHANICAL ENGINEERING
THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Published Monthly by
The American Society of Mechanical Engineers
29 West Thirty-ninth Street, New York

M. E. Cooley, *President*
William H. Wiley, *Treasurer* Calvin W. Rice, *Secretary*

PUBLICATION COMMITTEE:
George A. Orrok, *Chairman* J. W. Roe
H. H. Esselstyn George J. Foran
Ralph E. Flanders

PUBLICATION STAFF:
Lester G. French, *Editor and Manager*
Leon Cammen, C. M. Sames, *Associate Editors*
Frederick Lask, *Advertising Manager*

Yearly subscription $3.00, single copies 35 cents. Postage to Canada, 50 cents additional; to foreign countries $1.00 additional.

Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

Officers and Council of the Society for 1919

PRESIDENT

Mortimer E. Cooley .... Ann Arbor, Mich.

VICE-PRESIDENTS

Terms expire December 1919

Spencer Miller .... New York, N. Y.
Max Toltz .... St. Paul, Minn.
John Hunter .... New York, N. Y.

Terms expire December 1920

Fred R. Low .... New York, N. Y.
Henry B. Sargent .... New Haven, Conn.
John A. Stevens .... Lowell, Mass.

MANAGERS

Terms expire December 1919

Robert H. Fernald .... Philadelphia, Pa.
William B. Gregory .... New Orleans, La.
C. R. Weymouth .... San Francisco, Cal.

Terms expire December 1920

Fred A. Geier .... Cincinnati, Ohio
D. Robert Yarnall .... Philadelphia, Pa.
Fred N. Bushnell .... Boston, Mass.

Terms expire December 1921

Charles L. Newcomb .... Holyoke, Mass.
Frank O. Wells .... Greenfield, Mass.
Charles Russ Richards .... Urbana, Ill.

PAST-PRESIDENTS

James Hartness .... Springfield, Vt.
John A. Brashear .... Pittsburgh, Pa.
D. S. Jacobus .... New York, N. Y.
Ira N. Hollis .... Worcester, Mass.
Charles T. Main .... Boston, Mass.

CHAIRMEN OF THE STANDING COMMITTEES OF ADMINISTRATION

Finance
Meetings and Program
Publications and Papers
Membership
Sections
Constitution and By-Laws

TREASURER

William H. Wiley .... New York, N. Y.

SECRETARY

Calvin W. Rice .... New York, N. Y.

EXECUTIVE COMMITTEE OF THE COUNCIL

Mortimer E. Cooley, *Chairman* .... Ann Arbor, Mich.

The Secretary's Letter

The Annual Meeting which has just closed developed a fine spirit and sounded a high note in respect to the ideals which the Society and its members are striving to attain. From the time of the conference of the Committee on Aims and Organization held just previous to the meeting and continuing, through the addresses and even in the papers, notably in the one by Mr. R. B. Wolf on the Non-Financial Incentives in Industry, this spirit was everywhere manifest.

The Society is in tune with the high purpose of the Nation, or to state the matter in another way, of which I have for a long time thought the engineering profession deserving, the engineer is as responsible as any other citizen for the high ideals of this Nation which President Wilson has been able to so forcefully state. It is highly creditable and encouraging to us either helping to form the Nation's ideals or being abreast of the times.

In keeping with our professions we have sent President Main to France in response to the invitation from the French engineers who are working under government auspices on reconstruction problems.

With the many tasks at home the Society needs also the constructive genius of the entire membership—first, in assisting all returning officers and men to positions. Please promptly write the Secretary of any opportunities under your observation. Second, in securing business for industries so they may be quickly adjusted to a peace basis. In either case, if you do not write the Secretary, at least notify the local committee of your city, which is one of the committees of "readjustment" for the Society. Third, in supplementing the work which our President will do abroad, and which, as we understand it is only preliminary. If you are available for foreign service, please advise the Secretary in what capacity you could best serve and the conditions under which you could go abroad.

Members will recognize that the emphasis in the above is on the things that we can do, rather than on the benefits to be derived by the individual members. While the Society is alive at all times to the necessity of improving its service to the membership, and suggestions are urgently requested in that regard, the Secretary believes that its resources should be devoted to the profession in so far as possible and that this should be the first consideration of a member, rather than what he may personally get out of the Society.

In this connection we take special pride in the purchase by the Society of *The Engineering Index,* elsewhere announced. This service we shall give regularly to the membership. We propose to make The Journal the most indispensable paper you receive.

Calvin W. Rice,
Secretary.

"Mechanical Engineering"

The first monthly publication of the Society was known as the "Proceedings," a title which correctly interpreted its contents, comprising the reports of the Annual and Spring Meetings, the New York meetings and the chronicle of its committee activities.

With the growth of the Sections, however, the material which came to the publication was considerably broader in its scope and the name was changed to "The Journal." The Sections now number 26, representative of nearly every part of the country, and other Sections are forming. Each Sections Committee is virtually an editorial committee which solicits contributions for its meetings and for later publication in THE JOURNAL—contributions which are representative of the engineering progress in the particular vicinity where the Section is located.

Added to these is the review of American and foreign periodicals which appears in THE JOURNAL, and now, beginning with this number, is the incorporation of The Engineering Index. The field of THE JOURNAL has become so broad, therefore, that the Publication Committee has decided to adopt the name "Mechanical Engineering" as correctly descriptive of its contents.

The Engineering Index

When THE JOURNAL was started in 1906, a committee, of which the late Professor Hutton was a member, was appointed by the Council to outline a plan for its development. An important feature which has since been worked out step by step by the Publication Committee was to be the reviewing and indexing of the large group of periodicals in the Library, comprising substantially the current engineering publications of the world.

The first step was taken in 1912 by the establishment of the Foreign Review, which later was extended to include English and American periodicals and a selected list of titles of articles in the technical press. During the past few months these selected titles have been greatly extended, and have covered the leading articles in mechanical engineering and related fields.

Beginning with this number of THE JOURNAL, another important step has been taken of great significance, in the purchase by this Society of the Engineering Index, published for many years by the Engineering Magazine Company and widely known among engineers and in libraries throughout the world as the leading index of current periodical literature.

The Engineering Index had its inception in the personal need felt by Prof. J. B. Johnson of Washington University, St. Louis, and who began in 1883 to index periodicals on his own account in order to keep more closely in touch with engineering progress. At that time he was a member of the Board of Managers of the Association of Engineering Societies which until within a few years has published a journal containing the papers presented before the several societies comprising the association.

At Professor Johnson's suggestion, the Index was incorporated in that journal and published by it until 1895, when its Board of Managers turned over the Index to the *Engineering Magazine*, with its greater facilities for the production of the Index.

The Index has since appeared regularly in the *Engineering Magazine,* and in *Industrial Management*, the title which the magazine now bears. It has also been issued as a separate publication for those who desire it in this form, and the items have been collated and published in yearly volumes.

It was felt by Mr. John R. Dunlap, publisher of *Engineering Magazine,* that its field had now become so specialized that the services which the Engineering Index could give would be greatly enhanced if the Index were to be conducted by an institution like this Society, with the facilities of the Engineering Societies Library at its disposal and with the possibility of coöperation with other similar organizations for its extensive development.

It requires but little imagination to picture the possibilities and the utility of such a descriptive index when brought to the point where it covers with thoroughness the whole field of engineering.

To show the spirit in which the transfer of the Index was made, two letters follow, one from the Secretary of this Society to Mr. Dunlap, and the reply from Mr. Dunlap.

DEAR MR. DUNLAP:

You have built up a distinctive service known as "The Engineering Index." You can be proud of the achievement. The Society in acquiring it, pledges to carry it on in the same spirit.

We will bring to the "Index" the facilities of the extensive Engineering Societies Library, the combined library of five great Societies, embracing over eleven hundred leading current engineering publications of all countries, and a reviewing staff of engineers specializing in bringing together the world's technical literature for a single subscription.

We propose to furnish this as an added service to all the members of The Society of Mechanical Engineers.

We accept your offer to assist us by your advice and counsel in taking over the "Index," extending it, and making it the most complete in the world.

Yours truly,

CALVIN W. RICE,
Secretary.

DEAR MR. RICE:

Thank you for your kind favor of the 29th instant, in relation to taking over THE ENGINEERING INDEX.

After having devoted more than 25 years to developing and maintaining that indispensable and priceless publication, I can promise you that engineers and specialists in every state in our Union and indeed in every quarter of the civilized world—will welcome the glad news that your Society has taken over this great work, and you are now definitely pledged to maintain and extend its invaluable service.

I have always found such ready and widespread appreciation of the INDEX, and especially its Clipping Bureau service, that I have never had any difficulty in making it pay its way—directly for the annual volumes, and indirectly for the monthly issues. Now that the publication will carry the official endorsement of your great Society, and now that you can enlist the active interest of all your members and in addition make an effective appeal for support to members of all the other great engineering societies, I confidently predict that ere long you will find it advisable to issue the INDEX as a separate monthly publication, precisely as we long ago found it necessary to publish it as an Annual.

Wishing you every success in the future development of the work, and assuring you of the cordial and continuous coöperation of myself and every member of our staff, I am,

Sincerely yours,

JOHN R. DUNLAP.

Employment Bureau of the Four Societies

The Society has the pleasure of announcing the establishment of an Employment Bureau under the auspices of the Secretaries of the four National Engineering Societies. This Bureau will have the same personal attention of the Secretary that he has always given to the employment service; and the Bureau will have the advantages which will accrue from the bringing together of the opportunities known to the four Societies.

Particular attention is being given to assisting men just about to leave the Government service or who have already left. The societies feel a special obligation to assist as a patriotic work in this reconstruction service. There will be no charge at the present time, and it is further hoped that in addition to helping members of the Society we may list all engineers who are seeking employment, and give proper references. These references will invariably be investigated, as the Bureau will be conducted solely for the benefit of well-known and reliable firms and thoroughly responsible engineers.

Department of Commerce to Manufacturers

The Department of Commerce is coöperating with American manufacturers in their efforts to study export trade problems. In this connection it has undertaken to investigate the markets for industrial machinery in Asia.

A circular letter has been sent by the Bureau to a number of prominent manufacturers offering them the opportunity to avail themselves of the facilities provided by the Bureau in supplying any desired information. It is stated that the Bureau is prepared to secure information involving any technical or commercial matters even of an intricate nature.

An appeal for donations of tools, machinery and equipment has been issued by the Tuskegee Normal and Industrial Institute for the training of colored young men and women. The Institute suffered a serious loss in the destruction by fire of its Trades Building.

Eightieth Birthday Anniversary of Captain Robert W. Hunt

THE eightieth birthday anniversary of Captain Robert W. Hunt, Past-President Am.Soc.M.E., was celebrated on December 9. Seventeen hundred invitations had been issued to a reception held in his honor at the Mid-Day Club in Chicago, and a large number of his friends availed themselves of the privilege of extending their felicitations to him at that time.

In the evening, the partners and associates in the firm of Robert W. Hunt & Co., with their wives, tendered a dinner to Captain and Mrs. Hunt, and a few of their intimate friends, at the Blackstone Hotel. There were about forty-five in attendance, and each guest received an autographed photograph of Captain Hunt, taken just a few days prior to his eightieth anniversary.

Two important announcements signalized the dinner, the first being a presentation to Captain Hunt by Mr. Samuel T. Wellman of an elaborately prepared testimonial of congratulation and affection, which had been adopted in resolution form by the officers and directors of the American Institute of Mining Engineers. The other event consisted of the announcement of the establishment of a fund guaranteed to be at least $5000, the income of which is to be offered as a prize each year to the author of the best paper on iron or steel subjects presented to the Institute. While the details of the plan have not been fully decided, still it is probable that the prize will be known as the Robert W. Hunt Prize, and the fund and its distribution will of course be managed by the Institute.

Robert Woolston Hunt was born on December 9, 1838, in Fallsington, Bucks County, Pa. His father, Dr. Robert W. Hunt, of Trenton, N. J., was graduated from Princeton College, Class of 1824, and from the University of Pennsylvania. His mother was Martha Lancaster Woolston. He spent several years learning the practical side of iron making in the rolling mills of John Burnish & Co., Pottsville, Pa., and later took a course in analytical chemistry in the laboratory of Booth, Garrett & Blair, upon the completion of which he entered the employ of the Cambria Iron Co., Johnstown, Pa., and for them on August 1, 1860, established the first laboratory in America as a direct part of an iron or steel organization.

In the fall of 1861 Mr. Hunt entered the U. S. Military Service, was in command of Camp Curtin, Harrisburg, Pa., served as mustering officer for the state of Pennsylvania, with the rank of captain, and in 1864 assisted in recruiting Lambert's Independent Mounted Company P. V., and was mustered into the United States service as a sergeant, having tossed up with a friend who had also participated in recruiting the company, as to which one should receive a lieutenant's commission. Upon being mustered out of service he returned to the employ of the Cambria Iron Co., and was sent by them to the experimental Bessemer works at Wyandotte, Mich., of which they were part owners. He was placed in charge of those works in July 1865, and so continued until May 1866, when the Cambria Company called him back to Johnstown to take charge of their steel business, they intending to at once begin the erection of a Bessemer-steel plant. This, however, was not done for several years, and in the meantime, the Cambria Company undertook the rolling of steel rails for the Pennsylvania R.R. Co. from ingots produced by the Pennsylvania Steel Co.'s works at Steelton, Pa., that company's rail mill not being completed. He had charge of the steel for this operation, and these were the first steel rails made in America on a commercial order.

Later Mr. Hunt assisted John Fritz, Cambria's chief engineer, in designing and building their Bessemer works, and assumed charge of it on its completion July 10, 1871, so continuing until August 1873, when he resigned his position. On September 1, 1873, he entered upon the duties of superintendent of the Bessemer works of John A. Griswold & Co., Troy, N. Y. In March 1875 he became general superintendent of the Albany & Rensselaer Iron & Steel Co., which had acquired the works of John A. Griswold & Co. and Erastus Corning & Co. This organization became later the Troy Steel & Iron Co., he remaining in charge until April 1888. During those years he almost completely rebuilt the various works of the company, and also erected a large blast-furnace plant of the most complete character.

Mr. Hunt has taken out several letters patent on steel and iron metallurgical processes and machinery, both individually and in conjunction with John E. Fry, Wm. R. Jones, Dr. August Wendel, and Max M. Suppes. He put in the first automatic rail-mill tables, and later the Hunt-Jones-Suppes rail-mill feed tables were used under licenses by the majority of the rail mills in the United States.

On December 5, 1866, he was married to Miss Eleanor Clark of Ecourse, Mich. In April 1888 he established the Bureau of Inspection, Tests and Consultation of Robert W. Hunt & Co., with principal offices in Chicago, Ill., to which city he removed in the spring of 1888. He served three terms as commander of the John A. Griswold Post No. 338, G. A. R., of Troy, from which office he resigned on removing from that city.

Mr. Hunt is a member of the American Institute of Mining Engineers, and was president of the Institute in 1883, and again in 1906. He was president of The American Society of Mechanical Engineers, in 1890. He is a member of the Western Society of Engineers and was its president in 1893. He is also a member of the American Society of Civil Engineers, Canadian Society of Civil Engineers, the Institute of Civil Engineers, the Institution of Mechanical Engineers, and the Iron and Steel Institute of England. He is a member of the American Society for Testing Materials, and served as its president in 1912. He is the American member of the council of the International Association for Testing Materials.

In 1912 Mr. Hunt was awarded by the John Fritz Medal Committee, representing the American Society of Civil Engineers, the American Institute of Mining Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, the John Fritz Medal, "for his contributions to the early development of the Bessemer process."

Mr. Hunt has contributed many papers to the proceedings of the several societies of which he is a member, and frequently lectures before scientific bodies. He is and has been for many years a trustee of the Rensselaer Polytechnic Institute, Troy, N. Y. In 1916 he received from that institution the honorary degree of Doctor of Engineering.

Mr. Hunt is a member of the Chicago, Chicago Engineers', Mid-Day, Saddle and Cycle, South Shore Country, Illinois Athletic, Glen View, Chicago Golf, Winnetka Country, Montreal Engineers', Engineers' of New York and Mexico City Country Clubs. He has always been interested in outdoor sports and was in his earlier life a cricket and baseball player and is now an enthusiastic golfer. M. E. C.

A Word from Capt. Hunt

In response to the Society's birthday greetings to Mr. Robert W. Hunt, Past President, Am.Soc.M.E., upon the occasion of his eightieth birthday, the Secretary has received the following note of appreciation:

DEAR SIR:

Permit me, through you, to thank the Council for their highly appreciated birthday expressions, and I beg to assure them that their action did much to add to my happiness on "the day."

With my best assurance of my personal regards to yourself, I remain,

Yours truly,
(Signed) ROBERT W. HUNT.

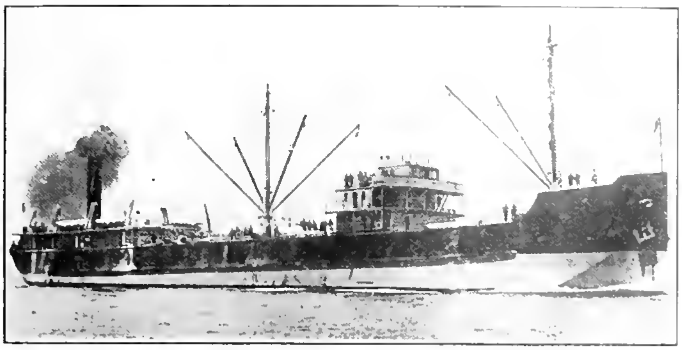
Annual Meeting Excursions

IN arranging for excursions for the Annual Meeting, it was planned to have them occur on two days, Wednesday, December 4 and Friday, December 6. On Wednesday, there were two excursions—a visit to the Hispanic Society at Broadway and 156th Street, in the morning, and in the afternoon a visit to the Brooklyn Navy Yard. A party of about 75 participated in the afternoon excursion, and arrangements were made with the Fifth Avenue Coach Company to furnish two busses, each accommodating 45 persons.

The party was received at the Navy Yard by Rear-Admiral John D. McDonald, U.S.N., and his staff, who accompanied it on the tour of inspection from start to finish. One of the most interesting features of this trip was the inspection of the electric-motor-driven, oil-burning superdreadnought *New Mexico*. Every facility for viewing the features of the work at the Navy Yard was afforded the visitors, who were very appreciative of the courtesies extended.

On Friday morning, about 50 members visited the plant of the Seaboard By-Products Coke Company, Kearny, N. J. The party was met at Summit Avenue by automobiles furnished by the Seaboard Company. This was also an interesting trip.

Over 100 members participated in the inspection of the Concrete steamship *Faith* on Friday afternoon. All the members of the party were permitted to go aboard the steamer which was at the Christopher Street dock.



Concrete Steamship "Faith"

Upon invitation of Walter S. Finlay, Jr., Mem.Am.Soc.M.E., superintendent of motive power of the Interborough Rapid Transit Company, a number of members visited the 74th Street plant and inspected the new 60,000-kw. turbine.

An invitation was extended to the members to visit the Steel Utilities, Inc., Newark, N. J., at any time during the meeting, for the purpose of inspecting their automatic spacing machine used in fabricating iron and steel.

It was requested that an excursion be arranged to the plants of the Wright-Martin Air Craft Corporation and the Eastern Asiatic Company, but owing to war conditions and other reasons, these plants were not available for inspection.

Harry J. Marks, *Chairman*,
Excursions Committee.

Excursion to Aberdeen Proving Ground

Members of the Society were the guests of the War Department, Engineering Division of the Ordnance Department, Colonel James B. Dillard, Chief, at the Aberdeen Proving Ground, December 13, at probably one of the most complete demonstrations ever given.

At the Annual Meeting, December 5, Colonel Dillard gave an illustrated address of the notable achievements of the Ordnance Department of the United States Army in the production of railway artillery, an account of which is given elsewhere in this number. Many of the guns and rifles of the largest caliber have been completely developed within the period of the war. Following the address, Colonel Dillard invited the members of the Society to the Proving Ground at Aberdeen, midway between Wilmington and Baltimore, where tests were made of guns of all kinds, caterpillar tractors, etc.

The Proving Ground contains about 35,000 acres, is 14 miles long and 6 miles wide. Construction was started Nov. 1, 1917, by 20 officers and enlisted men. A year later there were 301 officers, 4846 enlisted men, 968 civilians and 2500 workmen. In the proof of guns, carriages and ammunition, 6000 to 8000 rounds are fired daily, and the maximum capacity is 12,000 rounds per day, and this would have soon been reached if the war had continued.

Upon arriving at the Proving Ground at 10 a. m., the visitors were first taken to the Trench Warfare Range. The 3-in. and 6-in. Stokes trench mortar was first demonstrated, a total of 240 rounds being fired with 10 mortars, some with an elevation of 75 deg. With the 240-mm. French type of trench mortar 4 rounds of high-explosive shells were fired at 75 deg. elevation, and 4 rounds with the 11-in. Sutton-Armstrong trench mortor; elevation 45 deg., range 2100 yd. Then followed a salvo of 13 rounds with the 8-in. Livens gas projector, at a range of 1850 yd. Finally, 40 shots were fired with some 4-in. Stokes trench mortars, using incendiary shells, American smoke shells, and British heavy smoke shells. The entire demonstration with the roaring guns and smoke barrage was a good imitation of modern warfare.

The party then proceeded to the Main Proof Battery and observed the following guns in action:

37-mm. gun, model 1916; weight 463 lb.; range 2625 yd.; spring and oil recoil system.

75-mm. field gun, model 1897, French, on 1918 carriage; hydro-pneumatic recoil, 47 in. long; weight complete, 2850 lb.; shell 12 lb.; range, 6900 yd. A 1916 model American gun and a 1917 model British gun of the 75-mm. size were also tested.

155-mm. howitzer, model 1918, of Schneider design, and another of Filloux design, were demonstrated, firing a 95-lb. projectile a distance of 10,300 yd. and 19,000 yd. respectively. Total weight, 8200 lb.; hydro-pneumatic recoil; maximum elevation, 42 degrees.

American 4.7-in. field gun, 1906, with oil and spring recoil; shell 45 lb.; maximum elevation, 15 deg. Total weight, 8000 lb.

Bethlehem 6-in. howitzer; hydro-pneumatic recoil; projectile 90 lb.; 13,500 yd.

Vickers, Mark VI, 8-in. howitzer, hydro-pneumatic recoil system; air pressure in recuperator being 700 lb. per sq. in.; recoil 24 to 56 in. long; projectile, 200 lb.; 10,500 yd. Total weight, 10 tons.

Vickers, Mark I and II, 9.2-in. howitzer. Projectile, 290 lb. At 45 deg. elevation, range of Mark II, 12,700 yd.

At this Range are located several constant temperature magazines for the storage of powder, also other buildings in which powder charges for the various guns are made up into their proper weights.

After luncheon an inspection was made of the following artillery tractors of the caterpillar type, designed and built by the Ordnance Department:

75-mm. field gun, 1916, mounted on a standard 2½-ton Ordnance tractor; maximum speed 16.25 miles per hour.

2½-ton special tractor for 3-in. field gun.

5, 10 and 20-ton artillery tractors.

45, 75 and 120-hp. standard Holt artillery tractors.

Mark I special tractor for 8-in. howitzer.

One of the great achievements is the self-propelled howitzer, which went down a ravine at least 10 ft. below the level of the surrounding ground, went up the other embankment and felled a tree 17 in. at the butt, and within a few seconds took position and fired a round of shells.

A Ford armored tank was exhibited, driven by two standard Ford engines. One man maneuvered the tank, the other operated its Marlin anti-aircraft machine gun.

Aeroplanes and hangars attached to the Proving Ground for work in bomb dropping, experimental and proof tests were next inspected. Then the visitors were taken to the Railway Artillery Range, where the following types of railway artillery were inspected and seen in action:

5-in. and 6-in. gun carriages, models 1917 wheel mounts.

7-in. navy gun on model 1918 railway mount; glycerine and spring recoil, 19-in. long; projectile 165 lb.; charge of powder, 57.7 lb.; elevation, 15 deg.; traverse, 360 deg.; range, 17,000 yd.

8-in. Barbette carriage, 1918, for 8-in. seacoast gun, 1888; oil and spring recoil, 48 in. Fires from fixed underframe, laid on road-bed ties, car braced by outriggers; projectile, 200 lb., powder 68 lb.; 20,000 yd.; elevation 42 deg.; traverse 360 deg. Total weight of unit, 173,000 lb.

12-in. seacoast mortar, model 1890 M1, on 1918 carriage and R. R. car. Projectile, 700 lb.; powder 65 lb.; elevation, 65 deg.; traverse, 360 deg. Total weight of unit 174,000 lb.

12-in. gun on sliding mount carriage. Recoil absorbed by whole carriage sliding back 48 in. upon the I-beam under-frame. Total weight of mount, 600,000 lb.

14-in. army gun, model E, on R. R. mount. Recoil, 60 in. long. Fired either from fixed emplacement consisting of special base ring laid in roadbed which allows elevation to 30 deg., or fired directly from track by laying special tracking, which allows 22-deg. elevation. Pro-

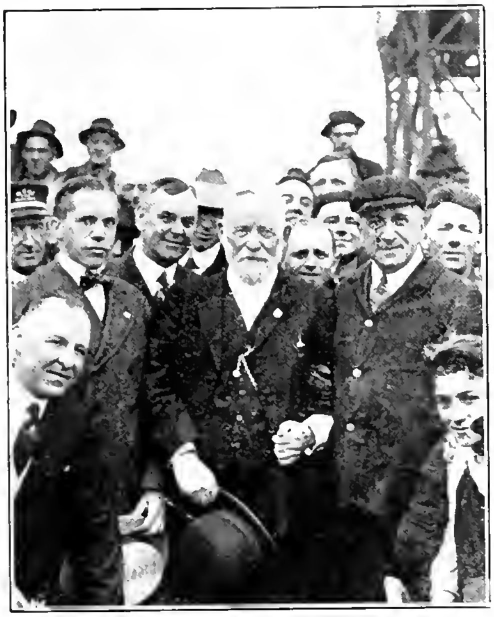
jectile, 1200 lb., powder, 450 lb.; muzzle velocity, 2900 ft. per sec.; maximum range, probably 40,000 yd. Total weight of unit, 400,000 lb.

16-in. howitzer, model E, mounted on 1918 car. Oil and spring recoil, 48 in. long. Fired either from a specially-laid emplacement in the road bed, allowing 65-deg. elevation, or fired direct from track, brakes tightened, car recoiling 25 ft. Engine-driven winch to return car after each shot. Projectile, 1660 lb. Maximum muzzle velocity, 1900 ft.-sec. Maximum range obtained at 45-deg. elevation, 24,000 yd. Total weight of unit, 300,000 lb.

The officers in charge at the Proving Ground were specially thoughtful, explaining every test before it was made. They had a special train for the party, which numbered over 300, and escorted the party back to the railway station for transfer to the main line over the Pennsylvania Railroad. This excursion will long be remembered, not only for the great interest, but also as promoting the pride of every one in the country's achievements.

Valued Portraits

The accompanying snap shot, first published in *The San Franciscan*, was recently sent us by E. C. Jones, Secretary of the San Francisco Section. It gives excellent likenesses of three of the Society's distinguished members, Charles Piez, then Vice-President of the U. S. Shipping Board (at the left); the late



Messrs. Piez, Dickie and Schwab at Morse Shipbuilding Co.'s Yards, Oakland, Cal.

George W. Dickie, whose memory will long be cherished by his hosts of friends; and our new Honorary Member, Charles M. Schwab. The photograph was taken several months ago, just after Mr. Schwab had driven the first rivet in a 10,000-ton tanker at the Morse Shipbuilding Company's yards, Oakland, Cal.

American Engineering Standards Committee

At the present time many bodies are engaged in the formulation of standards. To secure (a) greater uniformity in the rules for procedure in the different organizations, (b) more representative committees engaged in the work, (c) more consideration of all the allied interests, (d) to avoid duplication of work, (e) "standards" proposed for the same thing that differ only slightly from each other often on unimportant details, (f) to anticipate the difficulty of obtaining agreement between the proposers of overlapping standards, the American Society of Civil Engineers, The American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Society for Testing Materials, appointed a committee to consider the advisability of coöperating in Engineering Standardization. As a result of its deliberations this committee recommended that these societies form a permanent organization by appointing a standing committee to carry on this important work, throughout the entire field of engineering standardization.

This recommendation was approved by the five societies and their representatives on the proposed committee appointed. On October 19, 1918 these representatives met and organized as the American Engineering Standards Committee.

The following is the organization of the Committee:

MEMBERS

American Society of Civil Engineers

John H. Gregory, Consulting Engineer, 170 Broadway, N. Y.

Martin Schreiber, Chief Engineer, Public Service Railway Co., 80 Park Place, Newark, N. J.

Harry N. Latey, Railway Dept., General Electric Co., 30 Church St., New York City.

American Institute of Mining Engineers

George C. Stone, Chief Engineer, New Jersey Zinc Co., 55 Wall Street, New York City.

Joseph W. Richards, Professor of Metallurgy, Lehigh University, South Bethlehem, Pa.

Arthur L. Walker, Professor of Metallurgy, School of Mines, Columbia University, New York City.

American Society of Mechanical Engineers

Henry Hess, 308 Bailey Building, Philadelphia, Pa.

Henry H. Vaughan, Vice-President, Dominion Bridge Co., Montreal, Quebec, Canada.

William F. Kiesel, Jr., Asst. Mechanical Engineer, Pennsylvania Railroad, 2320 Broad St., Altoona, Pa.

American Institute of Electrical Engineers

Comfort A. Adams, Lawrence Professor of Engineering, Harvard University. Pres. Am. Ins. El. Engrs.

Harry M. Hobart, Consulting Engineer, General Electric Co., 10 Morris Ave., Schenectady, N. Y.

Nathaniel A. Carle, Chief Engineer, Public Service Electric Company, Newark, N. J.

American Society for Testing Materials

John A. Capp, Chief of Testing Laboratory, General Electric Co., Schenectady, N. Y.

Alfred W. Gibbs, Chief Mechanical Engineer, Pennsylvania Railroad Co., Philadelphia, Pa.

A. A. Stevenson, Vice-President, Standard Steel Works Co., Philadelphia, Pa.

EXECUTIVE OFFICERS

Comfort A. Adams, Chairman, 29 West 39th Street, N. Y. City.

George C. Stone, Vice-Chairman, 55 Wall Street, New York City.

Clifford B. LePage, Acting Secretary, 29 West 39th St., N. Y. C.

EXECUTIVE COMMITTEE

Comfort A. Adams, George C. Stone,
Harry N. Latey, Henry Hess,
John A. Capp.

RESEARCH COMMITTEE

The following progress reports of the Sub-Committees on Fluid Meters and on Bearing Metals were presented at a meeting of the Research Committee held on December 5, 1918:

Report of the Sub-Committee on Fluid Meters

This sub-committee, formerly known as the Sub-Committee on Flow Meters, has been at work for two years. In 1917, for the winter session, a preliminary report in six sections was prepared for discussion by the members. Discussion and correction was carried on by correspondence, and the report as a whole was revised and the work redistributed at the June meeting at Worcester. The pressure of war work prevented very much active work being done except on Section II, which covers the develop-

ment of suitable formulæ for all of the many types of flow meters.

At the present time Section I, which is an analysis of the problem, has been completed and a classification of all types of flow meters has been made.

The second section, which involves the development of formulæ and suitable constants for the application of these formulae to all conditions for the Pitot Tube, Venturi Tube, the Thin-Disk Orifice, the Thick-Disk Orifice and other similar pressure-developing devices, has been practically completed and will shortly be submitted to the members for final revision.

The sections into which the original report was divided and on which the work is based, will be restated for convenience.

Section I. Analysis of the problem.
Section II. Formulae and constants for the various elementary devices.
Section III. Accuracy and characteristics of the indicating and recording devices as pressure gages.
Section IV. The influence of installation.
Section V. Operating characteristics, cost and desirability.
Section VI. Testing methods.

In view of the situation as developed by the classification of meters under Section I, it appears that the scope of the original Sub-Committee on Steam Flow Meters was undesirably limited. We find that in classifying and examining the features of steam-flow meters, we became necessarily involved in the study of fluid meters as a whole. Upon request to the Research Committee, therefore, the title of this sub-committee has been changed to the Sub-Committee on Fluid Meters.

The general work such as in Sections I, II and III will cover the whole field; but for the present Sections IV, V and VI will concentrate on that group of fluid meters known as flow meters.

The sub-committee has requested an appropriation of $1500. for research to be carried on at two of the college laboratories, in order to check the characteristics of the primary devices with each other and with the previous experimental data. The Research Committee has recommended this appropriation. The object of this sub-committee is to prepare a textbook on the theory and use of fluid meters sufficient for standard reference.

The sub-committee originally consisted only of five members, none of whom were manufacturers. However, about two years ago it became apparent that the best work would be done by inviting the manufacturers to coöperate. To this end representatives have been appointed from the staffs of most of the principal flow-meter manufacturers and they have cordially assisted the remainder of the committee by very effective work. It will probably prove necessary to invite more manufacturers to send representatives for the committee as the work proceeds.

In all probability, another year will see that division of the work applying to flow meters very nearly completed.

Sub-Committee on Fluid Meters,
R. J. S. Pigott, *Chairman.*

Report of Sub-Committee on Bearing Metals

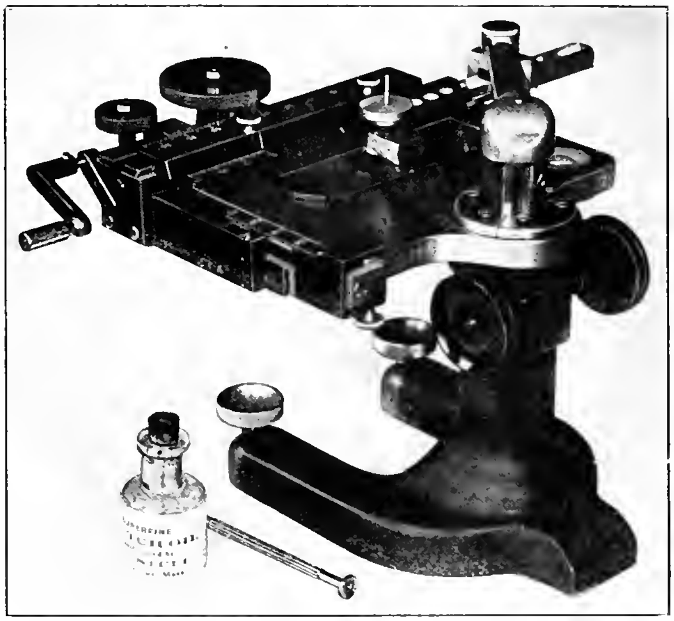
At the time our sub-committee was appointed it seemed wise to first make a complete survey of the existing literature on the subject of bearing metals. This was undertaken by instituting a search in the Engineering Societies Library under the direction of the librarian. A list of references was accordingly supplied to the members of our committee, whereupon independent work was begun with an effort to collate and harmonize the opinions and experiences as presented by the various writers.

Our efforts, however, proved unsuccessful owing to the incomplete, inaccurate and positively contradictory statements that were found upon this subject. We came to the unanimous conclusion that any further efforts in this direction would be hopeless and futile. We thereupon considered the subject of patents; we had a complete search made of the United States patents and made a complete digest of them, together with a search of the English and German patents. All this, however, was equally unsatisfactory owing to the extravagantly optimistic and misleading statements set forth in many of these documents.

For the foregoing reasons our efforts of compiling or collating data on bearing metals have been held in abeyance if not completely abandoned, and during the past year active research work has been done instead.

Microscopic and physical metallurgy has become an exceedingly interesting subject during recent years and this, perhaps, more than any other subject, has a most direct relation with bearing alloys. Recent writers on metallography have disclosed many facts directly bearing upon our subject. Microscopy, chemistry, and metallography give us the number of different crystals, their composition, size and orientation in the various alloys, but the physical property of the respective hardness of these different crystals has never been investigated.

The latter subject, therefore, seemed the most inviting problem and for that reason we have given this our undivided attention during the last year, as far as time permitted. We have now proven conclusively that it is both possible and practical to study



Instrument for Use in Studying Hardness of Individual Crystals

the individual crystals of the bearing alloys with respect to their hardness.

We have perfected an instrument by means of which we are able to pass a very sharp point over the crystals as they are presented on a highly polished surface of the alloy. The great difficulty we encountered was that of finding a suitable substance which could be ground with a sufficiently high degree of accuracy and which at the same time was able to withstand the abrasive action of the harder crystals. We experimented with various grades of steel, the metal tungsten, diamonds, sapphires and tourmaline. We believe we have found an entirely satisfactory material for all requirements in the leuco-sapphire. We have been able to grind this material to a point where we have apparent absolute sharpness with a magnification of 600 diameters.

The shape of point we have found to be most satisfactory is in the form of the corner of a cube mounted in such a manner that the diagonal of the cube is normal to the surface tested, and an edge of the cube directly in the line of motion.

We have been very fortunate in being able to secure from the experimental department of the Spencer Lens Company of this city the necessary highly skilled workmen to do this work. Results so far are very encouraging.

Sub-Committee on Bearing Metals,
C. H. Bierbaum, *Chairman*
J. A. Capp
H. Diederichs

THE NEW OFFICERS OF THE SOCIETY

President, 1918-1919

Mortimer E. Cooley

Mortimer Elwyn Cooley, Dean of the Colleges of Engineering and Architecture of the University of Michigan, and President of The American Society of Mechanical Engineers for 1918-19, was born at Canandaigua, N. Y., March 28, 1855.

He graduated from the United States Naval Academy in 1878 and soon after graduation was ordered, with his classmate, Ira N. Hollis, to the U. S. S. *Quinnebaug*, then fitting out at the Norfolk Navy Yard preparatory to a cruise in the Mediterranean. The ship sailed the following December and Cooley spent 15 months on the *Quinnebaug* and then returned to America on the U. S. S. *Alliance*.

During the winter of 1879-80 he had charge of repairs on the *Alliance* at the Norfolk Navy Yard and in the latter year went with the *Alliance* on a cruise to Newfoundland to survey the banks for sunken rocks that had been reported. On the return trip the ship touched at Boston and Norfolk and was headed for the West Indies. At Savannah the young officer was detached and ordered to the Bureau of Steam Engineering, where he remained six months, until July, 1881, in the drafting and design department.

He was then detailed to the University of Michigan for three years under a law which permitted the Secretary of the Navy to detail engineer officers as professors of "Steam Engineering and Iron Shipbuilding," and thus began his long connection with the University which has been his life work and has covered a period of nearly forty years.

It is interesting to note in this connection that mechanical engineering was taught at the University of Michigan as early as 1868, at which time Prof. DeVolson Wood, later of Stevens Institute of Technology, was professor of civil engineering. The prime mover in mechanical engineering was Prof. S. W. Robinson, afterwards at the University of Illinois and Ohio State University. While the curriculum of mechanical engineering has since remained, the degree was abolished in 1870 and not reëstablished until the time of Professor Cooley's administration 11 years later.

One of the first men with whom Mr. Cooley became acquainted in Michigan was Past-President Jesse M. Smith, who had a consulting engineer's office in Detroit. Mr. Smith and Mr. Cooley were the first two college-trained mechanical engineers in the State of Michigan. Mr. Cooley tells of the difficulties in the way of consulting practice in the early days, an instance being the protest of a large lumber company at a bill of 10 dollars a day for services in the direction of economy of fuel, on the ground that there was more fuel then could be burned, anyway, so that there was no need for economy.

After Professor Cooley's detail of three years was ended the regents of the university secured a year's extension of his time; but in 1885 he was ordered to the Pacific Station for duty, whereupon the regents asked him to resign from the Navy to accept the chair of mechanical engineering at the University. This he did and his resignation was accepted December 31, 1885. In the same year the University conferred upon him the honorary degree of M. E. He became Dean of the College of Engineering in February, 1904, and of the College of Architecture in 1913. He received the degree of LL.D. from the Michigan Agricultural College in 1907; and the degree of Eng.D. from the University of Nebraska in 1911.

When Admiral Sampson made his report on the destruction of the *Maine*, at the outbreak of the Spanish-American war, Professor Cooley wired the engineer-in-chief of the Navy, tendering his services. These were accepted and he served during the war as chief engineer of the *Yosemite*, a converted Morgan liner manned by Michigan State Naval Militia.

The *Yosemite* first convoyed a munition ship to Key West and then proceeded to the blockade off Havana. After a single night on this blockade she was ordered to convoy the *Panther* with marines from Havana to Guantanamo, where they were successfully landed, the first American troops to land on Cuban soil. The *Yosemite* was also on blockade duty off Santiago and off San Juan, and for a time off the Jamaica coast to intercept blockade runners. At San Juan she engaged in a five-hour battle with the Spanish forts, gunboats and torpedo boats, as a result of having intercepted a Spanish ship which was putting in with a cargo of munitions. The *Yosemite* fired from 250 to 300 shots and twice drove the gunboats and torpedo boats into the harbor.

During the blockade a serious fire broke out in the coal bunkers of the *Yosemite* which was so deep down in the pile of coal that the crew could not reach it with water from the pumps. Chief Engineer Cooley recalled a method of sinking piles by means of a water pipe attached to the pile, which was used on the Missouri River, and applied it successfully to quench the fire. He used a slice bar along which a hose was triced, with the nozzle near the point, and, with the water discharging through the hose, the bar and hose were easily forced into the coal and the fire extinguished.

Mr. Cooley was attached to the League Island Navy Yard for a time following the war, first as chief engineer in charge of the machinery of a number of ships and then as assistant chief engineer of the yard. After 10 months in the service his discharge was personally handed him by the commandant of the yard with the highest commendation for his efficient work.

Mr. Cooley returned to the University in 1899 and during the years following undertook a large amount of important appraisal work.

A citizens' committee, of which Governor Pingree of Detroit was chairman, appointed to appraise the Detroit street railways, asked Professor Cooley to evaluate the power plants, rolling stock, stores and supplies. This was an urgent piece of work that had to be done quickly. The appointment was made on a Friday, the staff was organized on Saturday and the report made the following Saturday. The value of the property was $2,000,000.

The state legislature of Michigan having ordered an investigation to determine whether an ad valorem basis should be substituted for the specific basis in taxing railroads, Mr. Cooley, in 1890, at the request of Governor Pingree and the State Tax Commissioner, undertook the valuation of the railways and with a force of 150 men completed the field work in 90 days.

This covered 10,000 miles of railway valued at $200,000,000, to which in the process were added the telegraph and telephone lines, plank roads and river improvements.

This investigation led the legislature to adopt the ad valorem basis of taxation which greatly increased the amount of the taxes. The railroads brought suit to enjoin collection and in 1903-4-5 the properties were reappraised under Mr. Cooley's direction at a value for the railways of $240,000,000, an increase of $40,000,000. The state finally won the suit in the U. S. Supreme Court.

In 1902 Mr. Cooley assisted in the appraisal of the mechanical equipment of Newfoundland railways and in 1903 acted as consulting engineer in the Wisconsin railroad appraisal. In 1906 he was a member of the Traction Valuation Committee, Chicago; in 1907 appraised Michigan telephone properties; in charge of appraisal of hydro- and steam-electric properties and railroads for the Michigan Railroad Commission since 1910. The total value of the property with which he has been concerned in appraising is 1¼ to 1½ billion dollars, of which 85 to 90 per cent has been for the public.

Since 1906 he has investigated public utilities in Minneapolis, Milwaukee, Cleveland, St. Louis, Boston, New York, and several other cities.

From 1907 to 1912 he acted as Chairman of the Block Signal and Train Control Board, Interstate Commerce Commission.

In 1893, at the time of the Chicago Exposition, Mr. Cooley was one of the members of the Engineering Committee; also at the time of the Pan American Exposition he was on the Committee of Awards.

For 16 years, 1895-1911, he was senior engineer officer of the Michigan State Naval Militia. Since July last he has been District Educational Director of the 7th District (Illinois, Wisconsin and Michigan) in charge of collegiate training in the Students'

Army Training Corps, organized under the General Staff, U. S. Army.

Mr. Cooley was vice-president of the American Association for the Advancement of Science (1898); director of the American Society of Civil Engineers (1913-1916); vice-president of the Society for the Promotion of Engineering Education (1908-09); president of the Michigan Engineering Society (1903). Also he is a member of various other Societies and Clubs.

He became a member of The American Society of Mechanical Engineers in 1884 and served as Vice-President during the year 1902-03, and in 1916-17 as chairman of the executive committee, Detroit Section.

Vice-Presidents, 1918-1920

Fred R. Low

Fred R. Low, a Vice-President of the Society for two years, was born at Chelsea, Mass., April 3, 1860, and received his education in the public schools of that city.

He worked as a clerk in the Boston office of the Western Union Telegraph Company, where he learned telegraphing and stenography. He then became stenographer for Thomas Pray, Jr., editor of the *Boston Journal of Commerce*, leaving this position to take charge of the steam engineering section of the paper. He did some indicator work, testing, etc., among the New England mills.

In 1888 Mr. Low became Editor of *Power*, the position which he still holds. In this position he has won distinction not only for the publication itself but as an authority on power-plant subjects and one whose advice is often sought in relation to engineering matters. Last September, the thirtieth anniversary of his editorship was celebrated and Mr. James H. McGraw, the head of the McGraw-Hill organization, publishers of *Power*, said: "*Power* was founded on a great idea; the idea offered a great opportunity for a man to develop it; Fred Low proved to be the happy man and developed the idea into a great publication and at the same time developed himself into a great editor."

In the early days of *Power*, Mr. Low filled a most useful service by lecturing to stationary engineers' organizations throughout the country upon elementary power-plant topics and publishing one of these lectures each month. There can be no doubt but that this work helped greatly to elevate the engineers of many plants in an educational way.

Mr. Low was elected to membership in the Society in 1886 and has served on the following committees of the Society: Publication, Public Relations, Boiler Code, Power Test, Aims and Organization, and is the representative of the Society on the Joint Committee for the Classification of Technical Literature. Mr. Low is the author of books on The Compound Engine, Condensers, The Steam Engine Indicator and also of The Power Catechism.

Henry B. Sargent

Henry Bradford Sargent, a manufacturer of New Haven, Conn., was born in New York City, March 4, 1851. His ancestors emigrated from England before 1670, and his family began manufacturing in 1814 at Leicester, Mass.

He graduated in 1871 from Sheffield Scientific School, Yale University and entered the service of Sargent & Company, manufacturers of small hardware and tools, New Haven. He worked his way up in this organization and became assistant superintendent; was elected vice-president of the company in 1887, and soon after became general manager of the extensive works. For many years he was the acting chief executive of the company, and in 1917 he was made president.

For many years Mr. Sargent has been a trustee of Yale University, he is a member of the Yale Engineering Society, the Connecticut Academy of Arts and Sciences, and The Franklin Institute, Philadelphia. He has been a member of this Society since 1898, and was made a member of the Local Sections Committee during the administration of President Hollis. He served for several years on the Committee of the New Haven Section, and as Chairman was active in the organization of the Connecticut Section.

For three years he was a member of the New Haven City Government, and has been director of the Connecticut Manufacturers' Association, director of the largest local bank and a member of various other national and local associations.

John A. Stevens

John A. Stevens, consulting mechanical engineer of Lowell, Mass., was born at Galva, Ill., in 1868. He was graduated from the East Saginaw High School and studied one year at the University of Michigan. He served a three years' apprenticeship in the machinists' trade with Mitts and Merrill, Saginaw, Mich., after which he was engineer on several of the lake steamers. At the age of 27 he was granted an unlimited engineer's license for ocean steamships.

In 1893 he came East to enter the employ of the International Navigation Company of New York and he served as engineer on board some of their largest ships. On the *St. Paul* of this line, he was first assistant engineer. In 1896 he accepted the position of chief engineer with the Merrimack Mfg. Co., Lowell, Mass., and was very successful in improving the various steam-power installations of this company, making boiler trials, economy tests, etc.

In 1909 he continued this work for the company, but left its employ to go into private consulting engineering practice. He has been granted a number of patents for water-tube steam boilers and superheaters.

He was appointed by Governor Guild in 1907 on the Massachusetts Board of Boiler Rules and after serving three years he was appointed by Governor Draper to serve a similar term. Mr. Stevens became a member of this Society in 1902 and was one of the seven members originally selected to serve on the Society's Committee "to formulate standard specifications for the construction of steam boilers and other pressure vessels and for the care of the same in service," now known as the Boiler Code Committee, and he has served actively on this committee as chairman, continuously since its organization in 1911. He served as one of the Managers of the Society from 1915 to 1918.

Besides membership in this Society, Mr. Stevens is a member of the Society of Naval Architects and Marine Engineers and of the National Association of Cotton Manufacturers. In May 1918 he was presented a medal by the latter association for his paper on the Evolution of the Steam Turbine in the Textile Industry.

Managers, 1918-1921

Charles L. Newcomb

Charles Leonard Newcomb, a Manager of the Society, was born in West Willington, Conn., August 7, 1854. His early life was divided between working in a glass factory during the winter months and on a farm during the summer months, and he had slight opportunity for attending the district school of the locality.

He was at an early age employed with the Hall Thread Co., South Willington, Conn. Later he was an apprentice in the Murless Foundry and at the Seinor Machine Shop and afterwards was employed as a machinist with the Rock Mfg. Co., Rockville, Conn.

In 1874 he entered the employ of Pratt & Whitney Co., Hartford, Conn. In 1880 he graduated from the Worcester Polytechnic Institute with the degree of B. S. and later was employed as superintendent of the American Electric Light Co., New Britain, Conn., which afterwards became the Thomson-Houston Electric Co. of Lynn, Mass.

In 1881 he entered the employ of Deane Steam Pump Company of Holyoke, Mass., as superintendent, and was made general-manager when the company was acquired in 1899 by the International Steam Pump Company. He continued in the service of this company in the same capacity after it was merged into the Worthington Pump & Machinery Corporation in May 1916.

Mr. Newcomb as a mechanical engineer specialized in steam and hydraulic engineering and has been a very active factor in

the upbuilding of the Deane Works. During his residence in Holyoke, he acted as consulting engineer for various manufacturers of the State, and was employed as an expert in various lines of engineering work. He has been associated with many valuations of plants. Especially of note is the case of the Holyoke Water Power Company, Gas and Electric Branch, which was taken over as a municipal plant by the city of Holyoke.

Mr. Newcomb has been active in the upbuilding of Holyoke and identified with its municipal affairs in various ways. He assisted in organizing the National Founders' Association in January, 1898, and he was elected its first vice-president. He was also a member of a committee of three who drew up the constitution and by-laws adopted by this association. He was also a member of the committee which drew up the constitution and by-laws of the National Metal Trades Association, organized during 1899, and was its first vice-president. He was elected to membership in this Society in 1883.

Frank O. Wells

Frank O. Wells was born in Shelburne Falls, Mass., January 6, 1855, and went to school there. In 1874 he entered the employ of the Wiley & Russell Mfg. Co., as a workman and five years later organized with his brother, Frederick E. Wells, the Wells Brothers Company. From this small beginning the firm grew into one of the leading tap and die industries of the country, later merging with the Wiley & Russell Mfg. Co., and forming the present Greenfield Tap & Die Corporation, Greenfield, Mass., of which Mr. Wells is president.

Mr. Wells has been associated with many public interests. He was one of the first to study the problem of making gages and to manufacture them on a war basis. Long before war was declared by the United States he pressed the necessity of the Government's making provision for special tools, gages and fixtures in order that contracts for ammunition might be placed immediately when the need arose.

In 1903 Mr. Wells became a member of the Society. He is on the Society's Committee for the Standardization of Screw Thread Tolerances, and has also been appointed a member of the National Screw Thread Commission as one of the Society's representatives.

Charles Russ Richards

Charles Russ Richards was born at Clarks Hill, Ind., March 23, 1871. He was educated in the public schools of Indiana and at Purdue University, where he received the degree of Bachelor of Mechanical Engineering in 1890, and the degree of Mechanical Engineer in 1891. In 1895 he received the degree of Master of Mechanical Engineering from Cornell University.

While Dean Richards has served in various capacities as a consulting engineer, he has devoted most of his attention to the problems of engineering education.

In 1891 he was instructor in mechanical engineering at the Colorado Agricultural College; in 1892 adjunct professor at the University of Nebraska where he continued as professor of mechanical engineering up to 1911. In 1909 he became the first Dean of the State College of Engineering at this University. In September 1911 he accepted the professorship of mechanical engineering at the University of Illinois, and from June 1913 to September 1915 he served as Acting Dean of the College of Engineering and Director of the Engineering Experiment Station at this University. In March, 1917, after Dean W. F. M. Goss had resigned, Professor Richards was appointed as his successor.

At the University of Illinois, under the general direction of Dean Richards, the work in the college shops has been completely reorganized so that they have been converted into laboratories to provide instruction in the principles of industrial management in the art of manufacturing, to illustrate the effect of the shop processes on the materials of instruction, and to do experimental and research work in connection with the cutting of metals and in the general field of engineering production. It is felt that the methods employed in these laboratories constitute a distinct contribution to the field of engineering education.

Dean Richards has served as consulting engineer in connection with power-plant and water-works problems and the appraisal of public utilities. He has been interested in engineering research relating to fuels, steam engineering, air compression, and gas-power engineering.

He was elected to membership in the Society in 1892. He is chairman of the Bureau of Mines Sub-committee on Fuels which was appointed by the Society, and is a member of the Society's Committee on Local Sections and of the Fuel Division of the Power Test Committee. He is also a representative of this Society on the Engineering Council's Committee on Fuel Conservation, which was appointed to coöperate with the United States Fuel Administration and the Bureau of Mines during the war, and he is a member of the Special War Committee of the Society for the Promotion of Engineering Education and the representative of this Society on the Joint Committee on Engineering Education. He is also a member of the Technical Committee on Coal for Gas, By-Products and Public Utilities appointed by Governor Frank O. Lowden of Illinois, to study problems connected with the utilization of central-western bituminous coal in the manufacture of illuminating gas.

Council Notes

At the meeting of the Council on December 3, 1918, preceding the 39th Annual Meeting, the following members were present: President Charles T. Main presiding, Spencer Miller, William H. Wiley, *Treasurer*, Ira N. Hollis, John A. Stevens, F. N. Bushnell, James Hartness, R. H. Fernald, Arthur M. Greene, Jr., John A. Brashear, Jesse M. Smith, John Hunter, C. T. Plunkett, D. S. Jacobus, Worcester R. Warner, and the Chairman of the Committees on Administration, George A. Orrok, L. P. Alford, Hosea Webster, Henry Hess, Chairman of the Standardization Committee, Calvin W. Rice, *Secretary*, and by invitation, F. R. Low, representing the Power Test Committee.

Special Orders

Honorary Membership. The Secretary read the report of Tellers on the ballots for Honorary Membership of Charles M. Schwab and Orville Wright, and the President declared them elected.

F. R. Hutton Memorial. Jesse M. Smith, for the Committee on a Memorial to the late Prof. F. R. Hutton, presented a design of plaque by Victor D. Brenner, which was accepted and the committee charged to complete the memorial.

Business from the President

Fuel Conservation. It was voted to appoint a committee to consider the preservation of the fuel conservation data collected by the U. S. Fuel Administration.

Executive Committee

Paris Engineering Congress. The appointment was made of President Main, to represent the Society at the Engineering Congress called by the Société des Ingénieurs Civils de France, to be held in Paris in December 1918.

Standing Committees

Research. An additional appropriation was granted this committee for the use of the Sub-Committees on Flow Meters and Bearing Metals.

Special Committees

Aims and Organization. Mr. Alford, representing the Committee on Aims and Organization, reported the resolutions which are published elsewhere in this issue.

War Industries Readjustment. The report of the Chairman of this committee was received.

Administration. This committee was discharged with thanks and its work of administration of the Society's offices placed in the hands of the Finance Committee.

Engineering Resources. In consistency with the action of the Engineering Council, discharging its Committee on American Engineering Service, this committee was discharged with thanks.

Professional Committees

Boiler Code. Upon recommendation of the entire Boiler Code Committee, the publication of the Revised Code was authorized.

The appointment of S. W. Miller on the Sub-Committee on Welding of the Boiler Code Committee was approved, as also was the appointment of John C. McCabe, Chairman, E. C. Fisher and John R. Allen, as a sub-committee to obtain data on the strength of cast-iron sections in boilers.

Power Test Code Committee. The Advisory Board and the Main Committee of the Power Test Code Committee were combined as one Board, and the following sub-committees were approved:

1. General Instructions
2. Definitions and Values
3. Fuels
4. Boilers
5. Steam Engines
6. Steam Turbines
7. Displacement Pumps
8. Centrifugal Pumps
9. Displacement Compressors and Blowers
10. Centrifugal and Turbo-Compressors
11. Complete Steam Power Plants
12. Condenser Units and Feedwater Heaters
13. Refrigerating Machines and Plants
14. Evaporating Apparatus
15. Locomotives
16. Gas Producers
17. Gas and Oil Engines

F. R. Low was appointed Chairman of the Power Test Code Committee.

Refrigeration. The Committee on a Standard Tonnage Basis for Refrigeration was discharged with thanks.

Appointments. Joseph Harrington as a member of the Committee on Feed Water Heaters, John A. Stevens as Acting-Chairman of the Committee on Cost of Electric Power, and C. E. LePage as Honorary Vice-President to represent the Society at the meeting of the Society for Promotion of Engineering Education, Boston, Mass., December 5 and 6.

War Tribute of Engineers. It was voted to appoint a committee to consider a suitable memorial as the Engineers' tribute to those members who lost their lives in the War.

Award of Merit

The establishment of an Order of Merit was approved, and the appointment of a committee to draw up rules and requirements ordered. This Order will be awarded, under vote of the Council, to persons who fulfill the requirements, and who by exceptional genius and accomplishment of engineering results have benefited mankind.

Retirement of the President

The Council gave a rising vote of thanks to the retiring President, Charles T. Main, for his devoted attention to the duties of his office during the past year, together with an expression of the best wishes for a successful and pleasureable outcome both professionally and personally in his trip to France.

Calvin W. Rice,
Secretary.

The first meeting of the Council for the year 1918-1919 was held on adjournment of the Annual Meeting on Friday, December 6, 1918. Present: C. T. Plunkett, retiring Vice-President, who presented the new President, Mortimer E. Cooley, the new Vice-Presidents, F. R. Low, Henry B. Sargent, John A. Stevens; the new Managers, Charles L. Newcomb, F. O. Wells, Charles Russ Richards; others present were Spencer Miller, D. Robert Yarnall, Ira N. Hollis, D. S. Jacobus, Jesse M. Smith, *Chairman Committee on Constitution and By-Laws*, George M. Forrest, *Chairman Finance Committee*, Hosea Webster, *Chairman Membership Committee*, and Calvin W. Rice, *Secretary*.

Special Orders

A cable was sent to Past-President Charles T. Main, en route to France as the representative of the Society at the French Engineering Congress.

President Cooley was asked to represent the Council and convey a message of congratulation to Past-President Robert W. Hunt on the occasion of the celebration of his eightieth birthday.

Standing Committees of Administration

Local Sections. A resolution from the conference of Local Sections delegates assembled at the Annual Meeting, recommending that the Mid-Western Sections participate in the preparation of the professional program for the next Spring Meeting was referred to the Committee on Meetings and Program.

Washington Section. Spencer Miller, Vice-President, and the Secretary were delegated to represent the Council at a get-together meeting of the Washington members on December 9, and to give expression to the appreciation of the Council for the splendid work which Washington engineers had contributed in connection with the war.

Field Secretary. On account of the rapid growth of the Sections movement in the Society, and to provide a close contact between the local sections and headquarters, the appointment of a Field Secretary was authorized.

Standing Committees

Research Committee. Communications concerning (1) research on fatigue of metals, (2) approval of plans of the committee to issue a questionnaire, (3) appropriations for the Sub-Committee on Flow Meters—now designated Fluid Meters and (4) appropriation for the Committee on Bearing Metals, were received and favorable action taken.

Professional Committees

Power Test Code. A. M. Hunt was appointed a member of the Committee, to fill the vacancy caused by the death of Wm. Kent.

Boiler Code. The Council recorded its congratulations and sincere appreciation of the splendid work which has been accomplished by the Boiler Code Committee, and the ever-increasing and far-reaching value of the Code.

Special Committees

Aims and Organization. Resolutions recommending a committee on coöperation of employer and employee were favorably received.

Appointments

I. E. Moultrop was reappointed to represent this Society on the Board of Trustees of United Engineering Society.

W. F. M. Goss was nominated as the representative of this Society on The Engineering Foundation.

John A. Brashear was elected as the representative of this Society on the John Fritz Medal Board of Award.

Adjournment was taken to meet Friday, January 17, 1919, in New York.

Calvin W. Rice,
Secretary.

R. Gregg
Atlanta

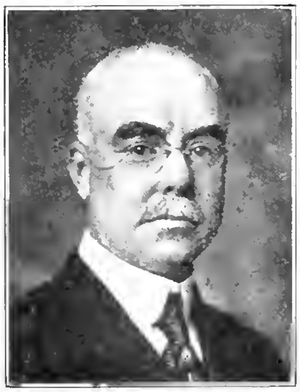
A. E. Walden
Baltimore

W. P. Caine
Birmingham

W. G. Starkweather
Boston

E. L. Fletcher
Bridgeport

H. B. Alverson
Buffalo



C. E. Lord
Chicago

A. S. M. E. LOCAL SECTIONS ORGANIZATION

Section	When Organized	Number of Members
Atlanta	1913	41
Baltimore	1916	101
Birmingham	1915	45
Boston	1909	514
Buffalo	1915	122
Chicago	1913	496
Cincinnati	1912	160
Cleveland	1918	249
Connecticut	1917	480
Detroit	1916	240
Erie	1917	27

G. W. Galbraith
Cincinnati

E. S. Carman
Cleveland

J. A. Norcross
Connecticut and New Haven

E. C. Fisher
Detroit

M. W. Sherwood
Erie

C. S. Blake
Hartford

L. W. WALLACE
Indianapolis

C. McGUIRE
Los Angeles

C. K. DECHERD
Meriden

W. M. WHITE
Milwaukee

CHAIRMEN OF EXECUTIVE COMMITTEES

1918-19

J. A. TEACH
Minnesota

H. L. HUTSON
New Orleans

W. W. MACON
New York

SECTION	WHEN ORGANIZED	NUMBER OF MEMBERS
INDIANAPOLIS	1916	83
LOS ANGELES	1915	69
MILWAUKEE	1913	167
MINNESOTA	1913	95
NEW ORLEANS	1916	36
NEW YORK	1910	2260
ONTARIO	1917	48
PHILADELPHIA	1912	637
ST. LOUIS	1910	100
SAN FRANCISCO	1910	143
WORCESTER	1915	125

R. W. ANOUS
Ontario

C. N. LAUER
Philadelphia

L. GUSTAFSON
St. Louis

E. C. JONES
San Francisco

H. L. THOMPSON
Waterbury

E. C. MAYO
Worcester

AMONG THE LOCAL SECTIONS

THE Annual Conference of Local Sections delegates was held in New York on Tuesday, December 3, in connection with the Annual Meeting. All of the twenty-two sections were represented.

The conference was opened by Mr. D. R. Yarnall, *Chairman* of the Committee on Local Sections, who reviewed the annual report of the national committee as published in the December issue of THE JOURNAL. Following this each of the delegates was asked to hand in his written report, and to supplement it by oral remarks. The reports will be summarized in the February issue.

Some valuable observations and suggestions were made in the oral discussion: for example, the delegate from Milwaukee suggested that the Society publish a handbook containing technical data including actions and reports of the various committees of the Society upon standards and standarization, together with the logarithmic tables and other mathematical data.

The member from Baltimore suggested that if the national society submitted to the sections very definite and limited questions for discussion the results would be of great value. There are many subjects of legislation in connection with the education of engineers, ethical standards of engineering, etc., on which such definite questions could be founded.

Chicago suggested coöperation with the New York office in the matter of reëmployment of engineers who come back from the service.

Cleveland and Indianapolis recommended that the mid-western sections be permitted to participate in the preparation for the professional program for the next Spring Meeting, and this recommendation was made the subject of resolutions which were later presented to the Council.

The delegate from Los Angeles reported a plan for the publication of experimental data obtained in several universities in that Section. He suggested that the Society's Research and Standardization Committees outline subjects upon which information was required.

The New York delegate called attention to some of the problems which confront a section of over 2200 members. The largest of these is so to organize the section that the men at large know each other and will attend the meetings. He suggested interchange of meeting notices between sections to invite traveling members to become interested in section activities.

The delegate from Ontario requested information on how to keep up the interest in a small section in a distant place, and said he would like to hear discussion on the things which were found vital and had made meetings a success.

The delegate from St. Louis suggested that standards be outlined showing the sections just what they could do in the matter of members, meetings, papers, research, standardization, etc.

A running account of the written and verbal reports of the delegates is being prepared, and will be mailed out to the Sections and upon request to anyone else interested.

Following the presentation of these reports, the conference took up a discussion of two important matters respecting the Sections Committee—the proposed change in the Constitution providing for the regular Nominating Committee to be elected by the voting membership; and the activities of the national Committee on Increase of Membership. The discussion on the former subject culminated in a resolution to the Council that it was the sense of the Conference that the regular Nominating Committee should be composed of one representative from each Section and seven members at large, to be appointed by the Council. Mr. Jesse M. Smith, *Chairman* of the Constitution and By-Laws Committee, was present during this discussion.

Professor Arthur L. Williston, *Chairman* of the Increase of Membership Committee was present by invitation, and expressed his interest in seeing how universal is the sentiment of confidence in the Local Sections, and the belief that the sections are going to play a larger and more important part in the life of the Society. He thought this was true, without question. He considered that the life and strength of the Society depends on the quality and enthusiasm of the men constantly coming into the organization, and there is no way in which men who have the welfare of the Society at heart can serve it more effectively or permanently than by interesting the right kind of engineers to show the same interest and devotion to the Society that they themselves have.

It seemed to him that the executive committees of the sections and the sub-committees coöperating with them were by far the most important part of the Increase of Membership organization.

A significant note which extended through the whole discussion was the possibility of developing through the Local Sections the relation of the engineer to the community; for example, the delegate from Atlanta called attention to the Engineering Committee in that city appointed each year by the mayor to advise the civic administration on engineering problems. This committee is made up of a representative from each of the four national societies, and the Atlanta Section is represented.

He considered it a departure from ordinary political practice, and undoubtedly a step forward. He said it might mean the recognition of the need and usefulness of engineering ability in the close coöperation with political administration whereby the principle of service may become more and more a tangible reality and less an academic ideal.

"To this end," he concluded, "the membership of the Atlanta Section is constantly striving and we bespeak for ourselves the continuation of the close coöperation and friendly advice on the part of the Local Sections Committee and the membership of the Society."

Washington Section to be Organized

WHAT promises to become an important section of the Society is in process of formation at Washington, D. C. The preliminary meeting for the organization was held at Washington, December 9, 1918, following the Annual Meeting in New York. This was called by a temporary committee consisting of Lieut.-Col. John J. Swan, Major A. D. Blake, George A. Weschler, H. L. Whittemore and Ernest Hartford.

In the afternoon an excursion was arranged to the Bureau of Standards in which about 60 participated. Supper was later enjoyed at Cushman's restaurant, following which there were several addresses, an exhibit and motion pictures of the Browning gun, and a general discussion of the question of the Washington section. A petition to the Council for a local section was signed and the following Local Committee chosen: S. W. Stratton, *Chairman;* George A. Weschler, Secretary; Major J. Henry Klinck, Arthur E. Johnson and Herbert L. Whittemore.

Officials of the Society present were Spencer Miller, Vice-President; William H. Wiley, Treasurer, and Calvin W. Rice, Secretary. Mr. Miller was delegated by the Council to attend as representative and to convey its greetings.

Mr. Rice first spoke, giving practical suggestions from his experience with regard to the organization of a section of the Society. Mr. Miller expressed the pleasure of the Council at the prospect of a Washington section as it was realized how fully the Washington members had contributed to the work of the Government during the war. He said that the war had distinctly shown what a people can do that is bound together with a spirit of righteousness and coöperation, that it can perform miracles if it wants to, and that he hoped that the Washington section would likewise bear splendid fruit in papers that would enrich the Transactions of the Society. He tendered the greetings of the Council and congratulated the section on its large initial attendance.

ARMY RESEARCH WORK

Major O. B. Zimmerman, of the Research and Development Branch of the Army Staff, explained the nature of the work of his branch, covering the supply, purchase and inspection of mobile army equipment, and later imparted some interesting in-

formation regarding the newly-announced substitute for gasoline, named "Liberty Fuel."

Mobile army equipment supplies, said Major Zimmerman, covered that which was used by the engineers in the field of operations.

Equipment and supplies were needed in vast quantities beyond the possibility of using available military equipment and it was therefore necessary to meet the demand by supplying this equipment which was designed and built primarily for commercial needs.

As viewed from the standpoint of the military requirements it was recognized that commercial equipment had certain characteristic deficiencies which were not evident when viewed from peace requirements.

The mention of a few of these characteristics will illustrate the work which naturally fell to the lot of the Research and Development Division and to similar bodies in the Army, where the characteristics were such as to require alterations in order to adapt the apparatus to the needs of the Army, the changes were made with great care so as not to cause too much delay in manufacture.

Portability required great attention to permit frequent and quick changes in location in the field. Much commercial equipment had not received attention from this point of view. Both weight and volume were likewise affected.

Efficiency of motive power was required to the greatest practical extent to avoid carrying unnecessary lubricants and fuels. The majority of appliances in the smaller units were not developed with marked attention to best of materials, efficiency or economy and their commercial ratings were often widely at variance with delivered capacities. Shop test methods were often sadly in need of standardization and Army methods of rating and testing had to be devised.

Enclosure against exposure, while sufficient under normal commercial conditions, was often not sufficient for protection in the field against mud, dust, rain, sun and cold and hence the alterations were necessary to cover these conditions.

These few points will suffice to indicate the general nature of problems connected with equipment serving the purposes of water supply, forestry, road construction, shops, transport, quarrying, crushing, construction, etc.

A considerable group of officers were giving efficient and effective work along these lines and when possible to recount in detail what they accomplished their work will be most gratifying to the engineering profession.

One problem only will emphasize the activities along chemical and physical chemical lines namely that of developing "Liberty Fuel."

Liberty Fuel

This novel fuel consists of over 80 per cent of kerosene, the remainder being chemicals freely obtainable in quantity. This fuel was compounded by officers in the General Engineer Depot, Research Division (which now is operating as a part of the Purchase, Storage and Traffic Division, General Staff) with the object of meeting the anticipated shortage of motor fuel for war purposes planned for the campaign of 1919. The laboratory work on this fuel was completed at the Bureau of Standards. The object was to transform the heavier hydrocarbon oils into lighter ones so that they could be carbureted like gasoline, by a process different from the well-known Burton and Rittman processes. The complete treatment used in the production of "Liberty Fuel" was not to be disclosed until the rights and privileges of the Government and interested individuals were definitely fixed. He said that at the present time the cost of the new fuel should be less than that of gasoline. The process of manufacture was simple and similar to that produced by fractional distillation of native oils. Various grades of oils could be turned out suitable for all types of internal-combustion engines. He said that to Capt. E. C. Weisgerber was due a great deal of the credit for solving the problem by devising a new and independent chemical process. The new fuel had undergone a series of very exhaustive tests in all conceivable types of military and other power engines. The power developed was measured and declared by the Bureau of Standards to be equal in all respects to the results obtained with commercial gasoline. The fuel could be used in any engine built for gasoline or kerosene. The temperature of the engine was lower than with gasoline, which facilitated better lubrication and longer life of the engine.

Although the weight per gallon of the new fuel was greater in the ratio of 7.07 lb. for "Liberty Fuel" against 5.93 lb. for export aviation gasoline, the heat units per gallon were as 124,800 to 112,300 for the gasoline. It was reported that the thermal efficiency was higher in the new fuel, and that the horsepower developed also was greater. Airplanes could remain longer in the air for an equivalent quantity of fuel. Motorcycles showed a marked increase in mileage over that when gasoline was used. Also he said that the superiority of the new fuel was attributed to the lesser heat lost in exhaust and cooling jacket, leaving more heat available for useful transformation into power.

Major Zimmerman thought that this successful solution of the problem of a substitute fuel was an excellent example of the value of coöperation between the War Department and the Bureau of Standards, and that without this valuable assistance the solution of the problem would have been delayed, and he therefore decided to publicly express the thanks of the Department to Dr. Stratton and his able assistants for their coöperation, and his hope that such coöperation would always exist.

Bureau of Standards

Dr. S. W. Stratton, Director of the Bureau of Standards then told the meeting something of the work being done at the Bureau, of its standardization work, of tests being made and specifications written for all sorts of materials used in the industries and by the various Departments of the Government. During the war at least 95 per cent of the Bureau's work had had some connection with military departments. He related how master gages were calibrated by means of light waves, how in spectroscopy plates were stained so as to be more sensitive to the red and longer waves, which plates were very useful in aviation photography. That similar improvements were made in electrical sound ranging. Reference was also made to the airplane motor building that had been erected on the grounds of the Bureau to test the performance of motors under conditions duplicating those of an airplane 25,000 ft. above ground, a 25-ton refrigerating plant being used in this case to cool the air which was at a pressure of only 16 in. of mercury.

Dr. Stratton explained also how the heat resistance of refractories was improved, so that we did not have to depend any longer on the supply from abroad, and were able to make spark plugs that would be durable. The crucibles used in making glass had to be perfected in the same way, with the result that glass parts were finally available at a cost of $9 apiece against $55 for the imported article. That in fact it was believed that these various discoveries in glass manufacture made this country independent of European sources of supply. Another material which was perfected with the assistance of the Bureau was cotton, which was so treated as to take the place of linen in airplane construction, after the supply of linen had become low. In closing Dr. Stratton recalled the pleasant relations established with all military departments, invention boards, etc., and was glad that the Bureau had been able to render services to all departments that had called upon it for scientific assistance.

General Remarks

Major Wiley spoke briefly of the six years which he spent in Congress as one of the few engineers that have been members of that body. He thought Congress did not treat Washington as well as it should, and it did not understand scientific men. He said the Washington Society of Engineers had done good work, and he felt sure that this new Washington section would have an equally brilliant future. That this organization was something they had wanted for a long time, to be able to reach Congress when necessary.

Lieut.-Col. Scrugham reviewed briefly the prominent part taken by members of the A.S.M.E. in the conduct of war operations. He said the machine-tool business had jumped from about 50 millions to 500 millions during the last year and that it was surprising that the Ordnance Department organization stood the strain as well as it did.

Meetings of Sections

ATLANTA SECTION

The Local Section had a very good attendance at its regular monthly meeting held Tuesday, November 26, in the Lecture Room of the Carnegie Library.

The meeting was given over to the discussion of local affairs, and also the organization and possibilities of the proposed American Engineering Society. The members also expressed themselves in regard to the business to come before the meeting of the Committee on Aims and Organization, in order that our delegates would have the benefit of the members' views.

W. J. NEVILLE,
Secretary.

BALTIMORE SECTION

The first fall meeting of the Baltimore Section was held at the Engineers' Club on November 20. The first paper of the evening was read by A. E. Walden, Mem.Am.Soc.M.E., on The Design of Hopper Bottoms for Coal Bins. He stated that he had found in his experience that frequently the cost of bins was unduly high on account of the heavy steel called for in the hopper bottom and its supports. The effect of dropping loads from grab buckets on the hopper bottom was discussed. Mr. Walden then proceeded to analyze the forces present and showed how to determine the stresses in the bottom by graphical methods. The effect of supporting studs and girders was also discussed. The angle of the bottom must be sharp enough to prevent arching. The down spout should be of No. 10 or No. 12 gage iron with vertical seam. Spiral riveted seams retard the coal flow. The bottoms are usually lined with concrete to provide a wearing surface that can be readily renewed. The use of reinforcing plates and angle stiffeners was also discussed.

In the discussion which followed, attention was called to the reinforced concrete bunker of catenary form. One objection to this was the banking of coal between openings.

The second paper of the evening was on Marine Practice in Valves and Piping by A. G. Christie, Mem.Am.Soc.M.E. It consisted of a series of comments on certain marine practices as seen from the viewpoint of a central station man. The effect of various factors on marine practice was noted and a discussion of present practice followed. The author made a strong plea for standardization in marine valves. The use of steel piping on shipboard was also discussed.

In the discussion which followed the following subjects were treated: the expansion of steel bends, the galvanizing of piping and other means of preventing corrosion and also valves for superheat.

A. G. CHRISTIE,
Secretary.

CHICAGO SECTION

The Chicago Section of the A.S.M.E. and the Mechanical Section of the Western Society of Engineers held the first dinner meeting of the season in the Red Room of the Hotel La Salle Friday, December 13. The address of the evening was given by D. L. Derrom, of Winslow Brothers Company, on Shell Manufacture. Mr. Derrom has had extensive experience in munitions manufacture in Canada as well as here, and is a recognized expert on the subject. The address was illustrated with lantern slides showing the processes and with moving pictures of the operations.

A. L. RICE,
Secretary.

CINCINNATI SECTION

A joint meeting of the Cincinnati Section and the Engineers' Club was held in the club rooms on November 21, the subject being A Discussion of the Readjustment of Industries to Peace Conditions.

A. J. Baker, Mem.Am.Soc.M.E., and also a member of the Machine Tool Section of the War Industries Board, opened the discussion by giving some of his experiences as a member of that Board. Mr. Baker also spoke of the tremendous expansion in the building of machine tools in England and stated that the United States would have to expect very strong competition in the building of machine tools from that source. He also gave some of the labor costs in England.

Professor Magee, of the Department of Economics, of the University of Cincinnati, then spoke of the conditions that obtained immediately after the Civil War and contrasted those with the conditions that are likely to obtain from now on.

JOHN T. FAIG,
Secretary.

CLEVELAND SECTION

Our newly-organized Cleveland Section took an important initiative in a special meeting called for Friday, November 29, at the Cleveland Engineering Society rooms, to discuss and recommend a plan whereby the various branches of engineering may be united under one head both nationally and locally.

This suggested plan of coördination has since been received at headquarters and referred to the Council, which voted to invite the Cleveland Section to send three representatives to its meeting in January to present the case to them.

J. H. HERRON,
Secretary.

ERIE SECTION

The Erie Section held a meeting at the Shriners Club on November 25, at which E. J. Armstrong, Mem.Am.Soc.M.E., of the Ball Engine Company, delivered an address on The Glacial History of Lake Erie.

The address treated of the working hypothesis now generally accepted regarding causes of diminished temperature making glacial conditions possible. Three distinct glacial periods of which there is evidence were discussed. Mr. Armstrong pointed out on maps the areas of successive great lake basins and outlets to the ocean prior to the present St. Lawrence River, stating apparent reasons for variations in the size of the gorge cut by the Niagara River and the probable rate of erosion as indicated by United States surveys.

M. W. SHERWOOD,
Chairman.

ONTARIO SECTION

A meeting of the Section was held at the Engineers' Club Friday evening, November 29. An address on The Main Pumping Station of the Toronto Water Works was given by John Milne, Mechanical Engineer, of the Department of Works. The lecture was illustrated by slides of much interest.

C. B. HAMILTON, JR.,
Secretary.

PROVIDENCE ENGINEERING SOCIETY

The Municipal Section held a meeting in the Society's rooms on November 26, at which an address was delivered by Harlow C. Clark of New York, Editor of *Aera*, the official magazine of the American Electric Railway Association.

The subject of the address was The Relation of Electric Street Railways to Municipalities and the Future of Electric Railways.

The Machine Shop Section held a meeting on December 10 which was addressed by George H. North, Superintendent of the Cartridge Case Plant. Mr. North spoke on The Manufacture of Cartridge Cases, describing the tools, equipment and processes. An interesting exhibit illustrating the various operations was shown.

On December 27 the Chemical Section held a meeting in the Society rooms. The speaker of the evening was Walter M. Russell, Superintendent of Manufacturing at the Providence Gas Company, who delivered an address on "Recovery of Light Oil Products at the Providence Gas Company."

W. H. MacKay of the Emergency Fleet Corporation, addressed the Society on December 17, the subject being Marine Engineering and Up-to-Date Methods of Repairing Ships.

W. A. KENNEDY,
Secretary.

SAN FRANCISCO SECTION

The first of a series of meetings planned began with an after-luncheon meeting at the Engineers' Club on Monday, December 16, where a short paper was read on The Use of Pulverized Coal by M. C. M. Hatch. Chief Engineer of the Locomotive Pulverized Fuel Company of New York.

On December 19 the Section held a meeting at the Engineers' Club, the subject being Why is the Internal Combustion Engine not Used More Extensively for Marine Propulsion?

J. H. Hanson, President of the Scandia Pacific Oil Engine Company, read a short paper on this subject, illustrated by about forty lantern slides, covering the history and development of the Diesel engine, and showing some of the more recent installations on ocean-going vessels.

George A. Dow, President of the Dow Pump & Diesel Engine Company, read a paper on the Diesel Oil Engines on board the Motorship *Libby Maine*.

A paper was also read by Bruce Lloyd, Marine Engineer for the Concrete Ship Section of the Emergency Fleet Corporation, which covered the attitude of ship owners toward the use of the internal combustion engine as power for the propulsion of ships, together with some remarks about the difficulties that have been encountered in the installations which have been under his personal supervision, and also, descriptions of the performances of ships that have been equipped with these engines.

GEORGE L. HURST,
Secretary.

NECROLOGY

DIED IN THE SERVICE

Lawrence H. Bertsch, Captain, Engineering Division, Ordnance Department, U. S. Army.

William J. Plank, Cadet, Air Service, U. S. Army.

WILLIAM SICKLES ACKERMAN

William S. Ackerman, engineer and architect, died on November 11 of heart failure, after a brief illness. He was engaged at the time in the service of the Ordnance Department, U. S. A., as supervising engineer of the Government Carbocoal plant being erected at Russell, near Clinchfield, Va.

Mr. Ackerman was born in November, 1868, in Paterson, N. J. He received his technical education at the Stevens Institute of Technology, where he graduated in 1891, with the degree of M.E. His earlier work was in the West, where he acted as Colorado agent for the Ingersoll-Sargent Drill Co. as draftsman and mechanical engineer for the Standard Smelting and Refining Co. of Durango, Colo., and as assistant superintendent of the Pelican-Dives Mining Company at Silver Plume, Colo. From 1893 to 1897 he was chief engineer of the National Lead Co. He then formed the partnership of Ackerman & Ross, Engineers and Architects, which in 1902, on the retirement of Mr. Ross, became Ackerman & Partridge. The work done by these firms covered nearly every branch of the profession. It included: Carnegie libraries at Washington, D. C., Atlanta, Ga., San Diego, Cal., Port Jervis, N. Y., and Bucknell University, Lewiston, Penn., Engineering and Chemical laboratories at Stevens Institute, etc., court houses, banks, office buildings, schools and factories in

WILLIAM S. ACKERMAN

many states. Perhaps the most notable of these from a scientific standpoint was the Morton Memorial Laboratory at Stevens Institute of Technology. Mr. Ackerman made a special study of the requirements of a chemical laboratory and put forward a design containing so many new and admirable features that it has served as a model for many of the more recent laboratories.

On the dissolution of the firm of Ackerman & Partridge in 1905, Mr. Ackerman went into consulting practice in mill construction and power plants and in 1907 became a member of the Passaic Valley Surveys Commission, which he served in the capacity of secretary, until 1913, when he returned to private practice. In 1916 he went with the O'Rourke Engineering Construction Company as expert in patent litigation. While so engaged he offered his services to the Army Ordnance Department, and by a singular coincidence, died in service at the plant in Virginia on the day the Armistice was declared.

Mr. Ackerman was a member of the New Jersey chapter of the American Institute of Architects, and the Alumni Association of the Stevens Institute of Technology, of which he was president in 1902. He was a former member of the American Institute of Mining Engineers. He became a member of the Society in 1891.

LAWRENCE HOWARD BERTSCH

Lawrence H. Bertsch, Captain in the Engineering Division of the Ordnance Department, U. S. Army, died at the Walter Reid Hospital, Washington, D. C., on Sunday, October 13, after a four-days' illness of influenza followed by pneumonia.

Captain Bertsch was born in Cambridge City, Ind., on October 18, 1879. He attended Earlham College, Richmond, Ind., from 1898 to 1901. In 1902 he received his A. B. degree from Indiana University and the following year entered the University of Michigan, from which he was graduated with the degree of M. E. in 1907. From then until his enlistment in June 1918 in the U. S. Army he was associated with Bertsch & Co., Cambridge City, Ind., manufacturers

LAWRENCE H. BERTSCH

of shears, punches, rolls and presses. He served in various capacities in office and plant, including those of sales manager, superintendent, general manager, chief engineer and finally as vice-president of the company.

He became a member of the Society in 1918. He was also a member of the Engineering Society of Indiana.

EMIL BREZINSKY

Emil Brezinsky was born in New York City on March 4, 1867. He was educated in the public schools of Minneapolis and attended the University of Minnesota. He served his apprenticeship with the Wilford Mfg. Co., Minneapolis. From 1898 to 1907 he was connected with the Allis-Chalmers Co., Milwaukee, as draftsman, and later as chief draftsman on mill construction, power-plant work and in designing and superintending of construction work. He was next associated with the Minneapolis Steel & Machinery Co. in the engine and mechanical department as chief draftsman and assistant engineer; he also designed and developed gas and steam engines, and from 1910 to 1912 was acting chief engineer of the company.

Mr. Brezinsky spent a number of years in Russia representing the Allis-Chalmers Co., and later the International Engineering & Trading Co. At the time of his death in February 1918 he was connected with the Strong-Scott Manufacturing Co., Minneapolis.

Mr. Brezinsky became a member of the Society in 1912.

HAROLD H. HILL

Harold H. Hill was born in 1875, in Detroit, Mich. He was graduated from Cornell University in 1897 with the degree of M. E. His apprenticeship was spent with the Akron, Bedford and Cleveland Railroad Co., Cuyahoga Falls, Ohio. He obtained his drawing-room and shop experience with the American Ball Bearing Co., Cleveland, Ohio. He was next employed by E. H. Jones & Co., Cleveland, as erecting engineer, leaving that firm to represent in Cleveland the B. F. Sturtevant Co., of Boston, Mass.

In 1901 he became associated with the Eric City Iron Works, Cleveland, as mechanical engineer and district sales agent, acting also as contracting engineer. At the time of his death, October 28,

1917, he was holding the position of district sales manager of the company.

Mr. Hill became an associate of the Society in 1904 and a member in 1915.

JOHN S. HUNTER

John S. Hunter was morn in Manchester, Conn., on June 14, 1834. He was educated in Rockville and in the public schools of Pennsylvania. He served his apprenticeship with the Woodruff & Beach Iron Works, Hartford.

For eleven years he was in charge of the Hartford Pumping Station, later becoming a member of the firm of Hunter & Sanford, machinists. Seven years later the Hartford Foundry and Machine Co. was organized and Mr. Hunter was chosen as president. During his connection with the company he built the largest pumping engine in the world, which was installed for the St. Louis Water Works in 1873. For a number of years Mr. Hunter was with the Henry R. Worthington Co., New York, erecting steam pumps for city water works. He was appointed a member of the Board of Water Commissioners of Hartford in 1870 and served three years. By reappointment he became a member of the board again in 1894 and was president from 1895 to 1899. In 1904 he was appointed fire commissioner and served three years.

Mr. Hunter became a member of the Society in 1889. He died on May 7, 1918.

CADET WILLIAM J. PLANK

William J. Plank was born on November 1, 1887, in Jetmore, Kan. He was graduated from the University of Kansas in 1911 with the degree of A. B.; in 1913 he received his M. E. degree and shortly afterwards was appointed through Civil Service to the shops of the mechanical division of the Panama Canal Commission. His duties consisted of general drafting work dealing with construction equipment. He also acted as instructor in mechanical drawing to a class of about thirty apprentices. In April 1916 he was transferred to the planning department of the drafting room.

In the early part of 1918 he enlisted in the Air Service of the Army and was assigned to the School of Military Aeronautics, Austin, Tex., and later transferred to the flying field at Sacramento, Cal.

Cadet Plank died on November 12, 1918, of pneumonia. He became a junior member of the Society in 1916.

GEORG GUSTAV ROHLIG

George G. Rohlig was born on May 7, 1872, in Eisenach, Thuringa, Germany. He came to this country when about sixteen years of age and started work in the Botany Worsted Mills, Passaic, N. J., returning to Europe a few years later. He studied in technical universities at Winterthur and Zurich, Switzerland, and at the Royal Polytechnic High School, Stuttgart, Germany, receiving his engineering degree and thereafter being associated for a period with Leipziger Wollkammerie, Hoboken les Anvers, Succursale, on work having to do with textile machines. His drafting-room experience he gained while with Kammgarnspinnerei, Stoehr & Co., Plagwitz-Leipzig, Germany. He served his apprenticeship in the woolen and worsted mills of Belgium and England, thus laying the foundation of his great technical knowledge in the milling industry.

Upon his return to this country he again became associated with the Botany Worsted Mills as assistant superintendent in charge of the manufacturing. He also assisted in the various enlargements of the mills and since 1903 was director and general superintendent of the company, holding this position at the time of his death, October 29, 1918.

Mr. Rohlig became a member of the Society in 1909.

HORACE MILLIKIN SMITH

Horace M. Smith was born on November 1, 1880, in Terre Haute, Ind., and received his early education there. He was graduated from St. Albans Military Academy and later attended Massachusetts Institute of Technology. He served an apprenticeship with the Niles Tools Works Co., Hamilton, Ohio, as draftsman and also with the American Soda Fountain Co. in the same capacity. In 1904 he became associated with the Liquid Carbonic Co., Chicago, Ill., as a designer and traveling erecting engineer and was advanced rapidly until in 1908 he was given full charge of the iron foundry, the brass foundry and the machine shops. At the time of his death he was chief engineer of the company.

Mr. Smith was an authority on all matters pertaining to the carbonated-drink and bottling industry and the inventor of several devices which have resulted in a practical revolution of that business.

Mr. Smith became a member of the Society in 1913. He died on November 12, 1918.

FLOYD G. TEN BROECK

Floyd G. Ten Broeck was born in Elmira, N. Y., on August 28, 1872, and received his early education in that city. Later he attended Cornell University and was graduated in 1895 with the degree of M. E. His first position was with the Osborn Engineering Co. and dealt with shop engineering. From 1897 to 1899 he was connected with Miliken Brothers and also with R. P. and J. H. Statts, where he obtained his drafting experience. In 1899 he became associated with Westinghouse, Church, Kerr & Co. in the design and erection of mills and power plants, leaving that firm to open private consulting offices in New York City in 1902. For the last sixteen years Mr. Ten Broeck was manager of the engineering department of the West Virginia Pulp & Paper Co., New York.

Mr. Ten Broeck became a member of the Society in 1903. He died on November 1, 1918.

SAMUEL F. TRIPP

Samuel F. Tripp was born in New Bedford, Mass., on November 14, 1866. He was educated in the public schools of New Bedford and later attended the New York evening schools and the Polytechnic Institute of Brooklyn. He also took a course in the International Correspondence Schools of Scranton, Pa.

At the age of eighteen he accompanied his father on a trip to California and while there entered the employ of the Arctic Whale Oil Co., where he worked for two years. His next position was with the Corliss Steam Engine Co., Providence, R. I., as erecting engineer, where he had charge of the installation of engines in the plant of the Waterbury Electric Light Co., Waterbury, Conn., and of repair work on engines in many cities of Rhode Island and Massachusetts. He then entered the employ of the Jones & Laughlin Co., Pittsburgh, Pa., and had charge of the erecting of shafting, being employed for about two years in various mills throughout New England. He was reëmployed by the Corliss Co. and placed in charge of erecting boilers, handling the installation of boilers in Elizabeth, N. J., New York and Baltimore.

In 1891 Mr. Tripp became associated with the Third Avenue Railroad Co., New York, and was put in charge of the erecting of the engines at the Sixty-fifth Street and Bayard Street power stations. In 1901 when the motive power of the Third Avenue System was changed from cable to underground electric the cable power stations were shut down and Mr. Tripp was transferred to the Ninety-sixth Street power station of the Metropolitan Street Railway Co. as engineer in charge. From April 1914 until the Ninety-sixth Street station was discontinued Mr. Tripp in addition to his duties as engineer of that plant was also employed to superintend mechanical construction work at the Seventy-fourth Street power station of the Interborough Rapid Transit Co., having charge of all mechanical equipment in connection with the 30,000-kw. turbines installed in that plant. At the time of his death, September 29, 1918, he was field engineer in charge of mechanical construction connected with the 60,000-kw. turbine now being constructed at Seventy-fourth Street.

Mr. Tripp was a member of the National Society of Stationary Engineers. He became an associate member of the Society in 1915.

PHILIP WALLIS

Philip Wallis was graduated from the Stevens Institute of Technology in 1879. He was first employed by the Clark Bridge Co. as draftsman. His next position was as instructor in mechanical drawing at the Maryland Institute Night School of Design. In the latter part of 1880 he was made assistant in the testing department of the Chicago, Burlington & Quincy Railroad and the following year became engineer of tests in charge of the physical laboratory of that company. In 1886 he became connected with the Long Island Railroad Co. as superintendent of equipment.

Mr. Wallis became a member of the Society in 1886. He died on March 3, 1918.

CHARLES SMITH WHITNEY

Charles S. Whitney was born on August 25, 1881, in North Attleboro, Mass. He received his early education in the public schools of Boston. His technical education he obtained through many years of intensive study by correspondence and through lectures.

He served an apprenticeship of two years with the Holtzer-Cabot Electrical Co., Brookline, Mass., as electrical machinist and draftsman. In 1899 he became assistant to the mechanical superintendent of the Massachusetts General Hospital, Boston. His next position was as construction foreman with the Elektron Manufacturing Co. In 1903 he became associated with the General Accident, Fire and Life Insurance Corporation as elevator inspector, and two years later became senior inspector. In 1912 he was appointed engineer in charge of inspection work and in 1914 became chief engineer in complete charge of all engineering work for the corporation. The following year he was made executive superintendent and at the time of his death, on October 31, 1918, was holding this position.

Mr. Whitney became an associate member of the Society in 1916.

ROLL OF HONOR

At the Annual Meeting was distributed a Roll of Honor of 1397 names of members in active service in the Great War, corrected to November 11, 1918, the date of the signing of the armistice. Since that date additional names have come to hand and are published below, together with those names appearing in the pamphlet but not as yet published in THE JOURNAL.

ADAMS, JAMES F., Captain, Inspection Division, Ordnance Department, U. S. Army.
AKERLOW, G. W., Captain, Quartermaster Corps, U. S. Army.
BANE, T. H., Colonel, Air Service, Military Aeronautics, U. S. Army.
BAYLIS, R. V., Lieutenant, Ordnance Department, U. S. Army.
BEROLSHEIMER, H., Second Lieutenant, Field Artillery, U. S. Army.
BLACK, JOHN S., Major, Ordnance Department, U. S. Army.
BLOHM, A. H., Second Lieutenant, Ordnance Department, U. S. Army; assigned to Ordnance Motor Instruction School, Raritan Arsenal, N. J.
BODENSTEIN, W. E., Second Lieutenant, Chemical Warfare Service, U. S. Army.
BRANDT, H. A., Lieutenant (Junior Grade), U. S. Naval Reserve Force.
BRECKENRIDGE, A. L., Chief Machinist's Mate, Mine Filling Depot, Construction Unit, U. S. Navy.
BROOM, B. A., First Lieutenant, Engineers' Corps, U. S. Army; assigned to Co. 7, Engineer Officers' Training School, Camp Humphreys, Va.
BUCKLEY, A. T., Chief Machinist's Mate, U. S. Naval Steam Engineering School, U. S. Naval Auxiliary.
BUTLER, ROLAND G., Second Lieutenant, Field Artillery, U. S. Army.
BUTTERFIELD, THOMAS E., Captain, Coast Artillery, U. S. Army.
CARSE, HERBERT E., Lieutenant, U. S. Naval Reserve Force.
CHERRINGTON, G. H., Major, Ordnance Department, U. S. Army.
CHRISTIE, W. T., Corporal, Engineers' Corps, U. S. Army; Engineer Officers' Training School, Camp Humphreys, Va.
COLLINS, S. W., Private, 322d Aero Squadron, Air Service, U. S. A.
CROSS, W. J., First Lieutenant, Engineers' Corps, U. S. Army; Engineer Officers' Training School, Camp Humphreys, Va.
CUNNINGHAM, F., First Lieuttnant, Quartermaster Corps, U. S. Army.
CUNNINGHAM, JAMES D., Second Lieutenant, Air Service (Production), U. S. Army.
CURTISS, C. R., Captain, Chemical Warfare Service, U. S. Army.
DEW, D. H., Second Lieutenant, Engineers' Corps, U. S. Army; assigned to Engineer Officers' Training School, Camp Humphreys, Va.
DOUGHTY, J. H., Captain, Tank Corps, American Expeditionary Forces, France.
DOWNES, N. W., First Lieutenant, Engineers' Corps, U. S. Army.
ELLIOTT, A. H., Captain, Engineers' Corps, U. S. Army.
FORD, WINTHROP D., Ensign, U. S. Navy; assigned to U. S. S. *Harrisburg*.
FOSTER, ROBERT J., Second Lieutenant, Chemical Warfare Section, U. S. Army.
FRANCIS, HARRIS S., Lieutenant, Ordnance Department, U. S. Army.
FREEMAN, H. S., Chief Machinist's Mate, U. S. Naval Reserve Force.
GLIMM, W. F., JR., Candidate; Engineer Officers' Training School, Camp Humphreys, Va.
GOODSPEED, C. B., Captain, Ordnance Department, American Expeditionary Forces, France.
HAB, HENRY A., JR., Captain, Chemical Warfare Service, U. S. Army.
HARDER, L. F., Captain, Co. C, 302d Engineers, 77th Division, American Expeditionary Forces, France.
HAZELTON, W. S., Captain, Ordnance Department, U. S. Army.
HILL, A. S., Captain, Production Division, Ordnance Department, U. S. Army.
HOLMBERG, A. W., Sergeant, Spruce Production Division, Air Service, Aircraft Production, U. S. Army.
HORN, N. E., Second Lieutenant, Air Service (Aeronautics), U. S. Army.
HOWELL, F. B., Engineering Division, Ordnance Department, U. S. Army.
IMBRIE, W. M., Captain, Engineers' Corps, U. S. Army; assigned to Camp Humphreys, Va.
JOHNSON, A. C., First Lieutenant, Engineering Division, Ordnance Department, U. S. Army.
JOHNSON, J. B., Field Artillery, U. S. Army; assigned to Central Officers' Training School, Camp Taylor, Ky.
JONES, W. T., Private, Coast Artillery Corps, U. S. Army.
KELLER, E. E., Motor truck engine (D); 39 623.
KLOTZ, HARRY J., Second Lieutenant, Air Service, Aeronautics, U. S. Army.
LADD, G. T., Lieutenant-Commander, Bureau of Ordnance, U. S. Naval Reserve Force.
LETELLIER, L. S., Second Lieutenant, Infantry, U. S. Army.
LEWIS, H. L., First Lieutenant, Ordnance Department, U. S. Army.
LOMAX, J. T., First Lieutenant, Chemical Warfare Service, U. S. Army.
LYNCH, THOMAS M., Major, Quartermaster Corps, U. S. Army.
MCLAREN, GEORGE C., Canadian Expeditionary Forces, France.
MATHEWSON, JAMES S., Private, Coast Artillery Training School, Coast Artillery, U. S. Army.
MILLER, A. S., Lieutenant-Colonel, Ordnance Department, U. S. Army.
MONTGOMERY, STAFFORD, Captain, Ordnance Department, U. S. Army.
NEDDERMANN, T. J., Coast Artillery, U. S. Army; stationed at Fort Tilden, N. Y.
ORR, BURTON S., Corporal, Co. 7, Engineer Officers' Training Camp, Engineers' Corps, U. S. Army.
PAINTER, W., Second Lieutenant, Air Service (Aeronautics), U. S. Army.
PRYOR, F. L., Lieutenant-Commander, U. S. Navy.
REDSTROM, E. R., Second Lieutenant, Ordnance Department, American Expeditionary Forces, France.
REED, JAMES, Commander, Construction Corps, U. S. Navy.
RUSTERHOLZ, R. W., Captain, Air Service, American Expeditionary Forces, France.
RYDER, E. R., Sergeant, Meteorological Section, Signal Corps, U. S. Army.
RYDER, M. P., Private, Air Service, Aeronautics, U. S. Army.
SAALFRANK, R. B., Lieutenant, Motor Transport Corps, U. S. Army.
SANBORN, FRANK E., Captain, Sanitary Corps, Medical Department, U. S. Army.
SEARS, H. R., Private, 24th Co., 6th Battalion, 160th Depot Brigade, Infantry, U. S. Army.
SERMULIN, FRED E., Military Specialist Co., American Expeditionary Forces, France.
SHERWOOD, H. P., Second Lieutenant, Chemical Warfare Service, U. S. Army.
SLEFFEL, C. C., Lieutenant, U. S. Naval Reserve Force.
SMITHE, F. B., Second Lieutenant, Heavy Coast Artillery, U. S. Army.
SPRUANCE, W. C., Lieutenant-Colonel, Ordnance Department, U. S. Army.
SWAN, JOHN J., Lieutenant-Colonel, Personnel Branch of the Operations Division, General Staff, U. S. Army.
SYMONDS, RALPH F., First Lieutenant, Tank Section, Ordnance Department, U. S. Army.
TAFEL, T., JR., 3rd Training Detachment, Radio Officers' Training School, Signal Corps, U. S. Army; stationed at Yale University.
TAYLOR, WALTER C., First Lieutenant, 11th Engineers (Railway), General Headquarters, American Expeditionary Forces, France.
TERRIBERRY, G. G., Candidate, Field Artillery Corps, Officers' Training School, 12th Training Battery, Camp Taylor, Ky.
VANDERBILT, CORNELIUS, Brigadier-General, U. S. Army.
VENNEMA, A. W., Second Lieutenant, Chemical Warfare Service, U. S. Army.
WALKER, FRANCIS J., JR., First Lieutenant, Fourth Anti-Aircraft Battalion, American Expeditionary Forces, France.
WALKER, K. G., Second Lieutenant, Air Service, U. S. Army.
WARNER, R. M., First Lieutenant, Ordnance Department, U. S. Army.
WESTWATER, ANDREW, Lieutenant, U. S. Naval Reserve Force.
WEISS, ERWIN A., Sergeant, Engineering Division, Ordnance Department, U. S. Army.
WEISS, LOUIS T., Sergeant, Motor Transport Corps, American Expeditionary Forces, France.
WENZLIK, RICHARD H., U. S. Naval Training Station, Great Lakes, Ill.
WILKE, ERWIN L., Ensign, U. S. Naval Reserve Force; assigned to Naval Experimental Station, New London, Conn.
WILLIAMS, H. J., First Lieutenant, Ordnance Department, U. S. Army.
WILLIAMS, PAUL, First Lieutenant, Inspection Division, Ordnance Department, U. S. Army.
WILLIAMS, SAMUEL C., First Lieutenant, Ordnance Department, American Expeditionary Forces, France.
WILSON, HENRY L., Lieutenant, Quartermaster Corps, American Expeditionary Forces, France.
WITHINGTON, SIDNEY, First Lieutenant, Co. 2, Section B, Engineer Officers' Training Camp, Camp Humphreys, Va.
WORTHINGTON, EDWARD H., First Lieutenant, Army Intelligence School, American Expeditionary Forces, France.
WRIGHT, A. MILES, Candidate, Engineer Officers' Training Camp, Camp Humphreys, Va.
WUERTH, E. A., Private, Field Artillery, U. S. Army; Replacement Depot, Camp Jackson, S. C.
YAGER, JOHN E., Private, Signal Corps, 4th Co., Section B, Students' Army Training Corps, University of Michigan.
YOUNG, C. D., Lieutenant-Colonel, Transportation Corps, U. S. Army.
ZACH, I. M., Candidate, Engineer Officers' Training School, Camp Humphreys, Va.

LIBRARY NOTES AND BOOK REVIEWS

AERO ENGINES, MAGNETOS AND CARBURETORS. By Harold Pollard. The Macmillan Co., New York, 1918. Cloth, 4 x 6 in., 84 pp., 15 illus., 15 pl. $1.

A brief manual, written in simple language and intended for beginners, which makes no pretense to be an exhaustive technical treatment of its subject.

AUTOMOTIVE MAGNETO IGNITION. Its Principle and Application, with Special Reference to Aviation Engines. By Mich. E. Toepel. First edition. Spon and Chamberlain, New York, 1918. Cloth, 4 x 8 in., 103 pp., illus., charts, diags. $2.

Presents the subject in the form of questions and answers covering the general principles of magneto ignition. References to specific types of apparatus have been avoided. Numerous illustrations and wiring diagrams are included.

CENTRAL STATION HEATING. By Byron T. Gifford. Second edition. Heating and Ventilating Magazine Company, New York, 1918. Cloth, 6 x 9 in., 278 pp., 34 illus., tables. $3.

Particular attention has been directed in this edition to the regulations adopted by the various state governments for the control of public utilities, especially to the methods of cost accounting necessitated by rate and valuation investigations. The discussion of high-pressure steam distribution has been expanded and the entire book has been revised.

COAL AND ITS SCIENTIFIC USES. By William A. Bone. (Monographs on Industrial Chemistry.) Longmans, Green and Co., New York, 1918. Cloth, 6 x 9 in., 491 pp., illus., pl., charts, diags., tables. $7.

The author, who was chairman of the British Association Fuel Economy Committee in 1915-17, has tried to give in essential outlines an account of the present state of science and practice in relation to coal and its various uses.

Beginning with an account of the general and scientific aspects of the coal question from a British point of view, there follows a review of the present state of science regarding the origin and chemistry of coal, including its distillation, oxidation and combustion. The latter part of the book considers the principal economic and industrial uses of coal as a fuel, and closes with an account of surface combustion.

The monograph is intended to provide a succinct account of the statistical, chemical and technical aspects of the subject as a whole, without unnecessary details, for use by the scientific public, and especially by that section interested in the chemical side of the subject.

CONVEYANCE AND DISTRIBUTION OF WATER FOR WATER SUPPLY. Aqueducts, Pipe-lines and Distributing Systems. A Practical Treatise for Water-Works Engineers and Superintendents. By Edward Wegmann. D. Van Nostrand Co., New York, 1918. Cloth, 6 x 9 in., 663 pp., 367 illus., 8 pl. $5.

By restricting himself to the conveyance and distribution of water, the author has been able, within the limits of a single volume, to discuss the subject in sufficient detail to be of practical value to engineers and superintendents of water works. Beginning with a chapter on the consumption of water, the flow of water in aqueducts and pipes is next discussed. Then follow chapters on the design and construction of pipes, aqueducts, service reservoirs, stand-pipes and tanks, fire protection and high-pressure systems. The remaining chapters take up maintenance and operation, the cleaning of aqueducts and mains, thawing frozen pipes, leakage, electrolysis, pipe tools and the detection and prevention of water waste.

DAVISON'S TEXTILE BLUE BOOK, UNITED STATES AND CANADA. Cotton, Woolen, Silk, Jute, Flax and Linen Manufacturers; Dyers, Bleachers and Print Works; Commission Merchants; Converters and Brokers; Yarn, Cotton, Waste, Linter Dealers; Mattress Manufacturers; Wool, Rag and Mill Remnant Dealers; Raw, Thrown and Spun Silk Dealers, etc. With a full classified Directory of Cotton and Woolen Mills and a Textile Supply Directory. Thirty-first annual edition, July 1918 to July 1919. Davison Publishing Co., New York (copyright 1918). Cloth, 7 x 9 in., 1471 pp., 7 maps. $5.

This directory covers the textile manufacturers, dyers, bleachers, printers, commission merchants, dealers, and makers of textile mill supplies in the United States and Canada. The various lists are carefully classified for quick reference. The capitalization, officers, equipment, products and railroad connections of each mill are given. Maps showing the location of the textile mills of the country are included.

ELECTRIC WELDING. A Comprehensive Treatise on the Practice of the Various Resistance and Arc-Welding Processes, Covering Descriptions of the Machines and Apparatus Used and the Applications, both in Manufacturing and Repair Work. By Douglas T. Hamilton and Erik Oberg. First edition. The Industrial Press, New York, 1918. 294 pp., 217 illus., 2 tables. $2.50.

A summary of present practice. The authors announce that they have had the assistance of the most prominent American firms engaged in this work, and that they have thus been able to present information on the latest improvements and discoveries.

ENGINEERING DIRECTORY. Buyers' Reference Section. 1918 edition. A Comprehensive Directory of Manufacturers of Mill, Steam, Mine, Plumbing, Heating and Lighting Supplies, Machinery and Tools. The Crawford Publishing Co., Chicago (copyright 1918). Cloth, 8 x 11 in., 566 pp.

This volume contains a list of American manufacturers, trade names and brands of industrial and engineering supplies and machinery, arranged under approximately four thousand subject headings, and a directory of manufacturers. An extensive cross index to the classification is provided.

THE J. E. ALDRED LECTURES OF ENGINEERING PRACTICE, 1917-18. The Johns Hopkins University, Department of Engineering. The Johns Hopkins Press, Baltimore, 1918. Paper, 6 x 9 in., 263 pp., illus., 2 folded pl., 1 map.

A presentation of the tangible and obvious features and principles of present engineering practice, intended to instruct the undergraduate students of the University in every-day working methods of design, construction, and operation.

MAP READING AND TOPOGRAPHICAL SKETCHING. By Edwin R. Stuart. First edition. McGraw-Hill Book Co., Inc., New York, 1918. Cloth, 5 x 8 in., 139 pp., 46 illus., 1 map. $1.

This textbook represents the results of the author's thirteen years of experience in the practice and teaching of topographic surveying and sketching at the United States Military Academy.

PRACTICAL SURVEYING AND FIELD WORK. Including the Mechanical Forms of Office Calculations with Examples Completely Worked Out. By Victor G. Salmon. J. B. Lippincott Co., Philadelphia, 1918. Cloth, 5 x 8 in., 204 pp., 87 illus., 3 folded diag.

The author has endeavored to supply to students a series of calculations which, in connection with well-known textbooks, will equip the young surveyor for the practice of the profession. The work consists mainly of solutions to questions set in examinations for qualification as surveyors in the South African colonies. It is not intended as a textbook, and includes only so much theory as is necessary to explain the examples.

THE RESULT OF MUNICIPAL ELECTRIC LIGHTING IN MASSACHUSETTS. By Edmond Earle Lincoln. (Hart, Schaffner & Marx Prize Essays, No. 27). Houghton, Mifflin Co., Boston and New York, 1918. Cloth, 5 x 8 in., 484 pp., 14 charts, 1 map, 58 tables. $3.

As a contribution to the discussion on the advantages and disadvantages of public ownership, the author has prepared this impartial, comparative study of results in one well-established business in a specific locality where adequate records covering

a period of years can be secured. The aim of the book is to suggest and exemplify those methods of approach and investigation which may most profitably be followed in future studies of the problems of municipal and state ownership. It is based on a careful, personal statistical study of the annual returns made by the plants to the Massachusetts Board of Gas and Electric Commissioners and a personal survey of the plants themselves.

Screw Propellers. An Estimation of Power for Propulsion of Ships. Also Airship Propellers. By Rear Admiral Charles W. Dyson, U. S. N. Second edition, rewritten. John Wiley & Sons, Inc., New York, 1918. Cloth, 325 pp., 62 illus., 32 pl., 18 tables, 2 vols. (text and atlas). $7.50.

The first edition of this work on propeller design suffered, the author states, from two serious faults; one being the vagueness of the method for determining the thrust-deduction factor and the other being the method of applying it in determining the characteristics of the propeller. These have both been eliminated to a great degree in this edition and other improvements have been introduced in the text. The author's ideas on cavitation are now fully presented. A chapter on airplane-propeller design has been added.

Steel Shipbuilder's Handbook. By C. W. Cook. Longmans, Green & Co., New York, 1918. Flexible cloth, 4½ x 7¼ in., 123 pp., 4 folding plates. $1.50 net.

The author, who is associate professor of naval architecture at the University of Southern California, has prepared this convenient pocket-size work for the use of men working in shipyards and for students in shipbuilding classes, the purpose being to acquaint them with the meanings of the terms used in steel ship construction. About 1600 names of parts, tools, operations, trades, abbreviations, etc., are defined, and drawing of some 300 parts are shown on folding plates.

Structural Service Book. Volume I. A revised Reprint from the 12 Issues for 1917 of the *Journal of the American Institute of Architects*, Structural Service Department. D. Knickerbacker Boyd, Editor. The Journal of the American Institute of Architects, Washington, 1918. Cloth, 9 x 12 in., 226 pp., including Industrial section. $3.50.

The first volume of an annual review of structural activities throughout the United States with particular references to the standards adopted or under consideration by the various societies, associations or other agencies whose work concerns itself in any way with the materials which enter into building construction, the methods and safety of their production, manufacture and erection.

The material is classified and indexed for ready reference. Under each heading are given lists of references to publications giving general information, describing recommended practice and adopted standards.

Seven Hundred French Terms for American Field Artillerymen. By Edward Bliss Reed, with a Foreword by Lieut. Col. Robert M. Danford. Second edition. Yale University Press, New Haven. Cloth, 4 x 5 in., 66 pp. $0.50.

A brief vest-pocket vocabulary of the French words most frequently used in field artillery.

Shop Management and Systems. A Treatise on the Organization of Machine-Building Plants and the Systematic Methods that Are Essential to Efficient Administration. By Franklin D. Jones and Edward K. Hammond. First edition. The Industrial Press, New York, 1918. Cloth, 6 x 9 in., 307 pp., 159 illus. $2.50.

The purpose of this volume is to give definite information on various systems that have been adopted, particularly in machine-building plants, to insure orderly and effective methods of procedure in the administration of manufacturing, designing and purchasing departments. Concrete examples, rather than theoretical ones, fill the greater part of the book, and show exact details of different systems and their application under various conditions.

Sir William Ramsay. Memorials of His Life and Work. By Sir William A. Tilden. London, 1918. Cloth, 6 x 9 in., 311 pp., 4 pl., 4 por. $4.

Sir William Tilden has written an interesting, readable account of Ramsay's career which does justice to his scientific work and gives at the same time a pleasant picture of the man himself. He has had the advantage of Lady Ramsay's coöperation, and has made use of the letters preserved by her and other members of the family.

Steel Shipbuilders' Handbook. An Encyclopedia of the Names of Parts, Tools, Operations, Trades, Abbreviations, etc., used in the Building of Steel Ships. By C. W. Cook. Longmans, Green and Co., New York, 1918. Flexible cloth, 5 x 7 in., 123 pp., 4 folded plates. $1.50.

This handbook is intended to help the men now obtaining employment in shipyards to understand the unfamiliar terminology and processes of steel ship building. It gives, in a compact volume of pocket size, an alphabetical list of definitions of some 1600 names, and plates illustrating about 300 parts of steel ships. The definitions have been collected from standard textbooks and a study of the methods now used in American shipyards.

Studies on Solution in Its Relation to Light Absorption, Conductivity, Viscosity, and Hydrolysis. A Report Upon a Number of Experimental Investigations Carried Out in the Laboratory of the Late Professor Harry C. Jones. Compiled by Paul B. Davis. Carnegie Institute, Washington, D. C., 1918. Paper, 7 x 10 in., 144 pp., 25 illus., 116 tables. $2.

The report represents the various lines of investigation pursued under Professor Jones's direction during 1915-16, all having some bearing upon the conceptions of solution in general and of solution in particular which have been developed by that laboratory.

The Submarine in War and Peace. Its Developments and Its Possibilities. By Simon Lake. J. B. Lippincott Co., Philadelphia, 1918. Cloth, 6 x 9 in., 302 pp., 18 illus, 53 pl., 1 portrait, 1 map, 1 folded diag. $3.

Mr. Lake's endeavor has been to provide an interesting popular account of the mechanical principles of the submarine, the history of its development, its actual operation, the difficulty of combating it and its industrial possibilities.

Vacuum Tubes in Wireless Communication. A Practical Textbook for Operators and Experimenters. By Elmer E. Bucher. Wireless Press, Inc., New York (copyright, 1918). Cloth, 6 x 9 in., 174 pp., 219 illus. $1.75.

The author explains over 100 different circuits for the practical use of vacuum tubes, which have been used from time to time in the laboratory and commercial practice, and gives a brief and simple explanation of the manner in which vacuum-tube circuits act.

Waterworks Handbook. Compiled by Alfred Douglas Flinn, Robert Spurr Weston and Clinton Lathrop Bogert. Second edition. McGraw-Hill Book Co., Inc., New York, 1918. Flexible cloth, 6 x 9 in., 824 pp., 411 illus., 313 tables. $6.

The new edition of this compilation of information for designers and operators of waterworks differs only in minor matters from the first one, published in 1916. All errors which have been found have been corrected, some small additions of new material have been made and a few portions have been rewritten to utilize recent information.

The Zinc Industry. By Ernest A. Smith. Longmans, Green and Co., New York, 1918. Cloth, 6 x 9 in., 223 pp., illus., 2 diag., 4 pl., 1 map., tables. $3.50.

The author of this volume of the series of Monographs on Industrial Chemistry has written a general survey of the development of the zinc industry and its present and possible future position in relation to the various metal industries of Great Britain. The rise and progress of the industry, the new materials and their sources, marketing of ores and metal, smelting, physical and chemical properties, industrial applications and alloys are considered, and a bibliography of the more important publications is appended.

Library Accessions

American Society for Testing Materials. A.S.T.M. Standards, 1918. *Philadelphia, 1918.* Purchase.

Archives des Sciences Physiques et Naturelles. Tables générales des Auteurs et des Matières. 1879-1910. *Genève, 1917.* Purchase.

Carbolic Acid and its Production from Benzol. By Geo. H. Stevens. *Newark, 1916.* Gift of author.

Chemistry of Photography. By Raphael Meldola. *London, 1891.* Gift of Samuel Wein.

Cleaning and Electro-plating of Metals. By H. H. Reama. *New York, 1917.* Gift of Samuel Wein.

Cutting Lubricants and Cooling Liquids and on Skin Diseases Produced by Lubricants. Memorandum. *London, 1918.* Gift of Great Britain. Department of Scientific and Industrial Research.

Education of Mine Employees. By H. H. Stock. (Illinois Miners' and Mechanics' Institutes. Bulletin No. 1.) *Urbana, 1917.* Gift of A. D. Flinn.

Efficiency in the Use of Oil Fuel. A handbook for boiler plant and locomotive engineers. *Washington, 1918.* Gift of Bureau of Mines.

English Catalogue of Books, 1917. *London, 1918.* Purchase.

Federal Valuation of the Railroads in the United States. Statement prepared by Thomas W. Hulme, vice-chairman, of the Developments in connection with Federal Valuation as of Sept. 20, 1918. Gift of Clemens Herschel.

List of Inspected Mechanical Appliances, July 1918. *Chicago, 1918.* Exchange.

Arthur D. Little Company, Industrial Research Laboratories. Descriptive booklet. *Cambridge, 1918.* Gift of company.

McGraw Electric Railway List, August 1918. *New York, 1918.* Purchase.

Memorial of Amos P. Brown. By R. A. F. Penrose, Jr. (Reprinted from the *Bulletin of the Geological Society of America*, v. 29, pp. 13-17, 1918.) Gift of author.

Oil and Petroleum Manual for 1918. By Walter R. Skinner. *London, 1918.* Purchase.

Organization of War Transportation Control. Railroad Committee, Chamber of Commerce of the United States. *Washington, D. C., 1918.* Gift of Railroad Committee.

Principles of Mechanics. Ed. 4. *London, 1794.* Gift of Charles Macdonald.

TRADE CATALOGUES

Coppus Engineering & Equipment Company. Worcester, Mass. Turbo Blower for undergrate draft and other industrial purposes. Descriptive booklet.

Fellows Gear Shaper Company. Springfield, Vermont. Internal Gear, design and operation. Descriptive catalogue, 1918.

Gem Stopper Company. Philadelphia, Pa. Bulletin No. 8. Universal acid carboy stoppers, asbestos gaskets and metal fasteners. 1918.

General Fire Extinguisher Co. Providence, R. I. The Grinnell Sypho chemical sprinkler system. Descriptive booklet. 1917.

Hires Turner Glass Company. Philadelphia, Pa. Bulletin No. 2. Wire Glass and Why.

Jeffrey Mfg. Co. Columbus, Ohio. Bulletin no. 246. Jeffrey Pit car loader.

Jones & Lamson Machine Company. Springfield, Vt. The Fay automatic lathe; a machine for the automatic turning of work held on centers or on centered arbors. 1918.

Luitwieler Pumping Engine Co. Rochester, N. Y. Illustrations and descriptions of non-pulsating power pumps.

Sypho Chemical Sprinkler Corporation. New York, N. Y. The combination of a system and a service. 1916.
——— Service of Protection. 1916.

PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by January 15 in order to appear in the February issue.

CHANGES OF POSITION

James P. Calderwood, formerly associated with the engineering and inspection division of the Travelers Insurance Company, Hartford, Conn., has become professor of gas and steam engineering, The Kansas State Agricultural College, Manhattan, Kan.

Charles H. Stoddard has severed his connection with the Moore Shipbuilding Company, of Oakland, Cal., of which he was chief engineer, and has accepted the position of consulting marine engineer with the Heine Safety Boiler Company, Phoenixville, Pa.

August Ulmann, Jr., until recently associated with Walter Kidde and Company, Philadelphia, Pa., in the capacity of construction engineer, has assumed the duties of power engineer with the National Aniline and Chemical Company, Marcus Hook, Pa.

Fred E. Rogers, Jr., formerly with the J. G. White Company, New York, has accepted the position of sales engineer with the Fafnir Bearing Company.

A. E. Norrman, formerly professor at the Technical University, Helsingfors, Finland, has recently accepted a position as engineer with the F. W. Horne Company in Tokyo, Japan, importers of American machinery.

C. H. Bean has resigned as assistant superintendent of motive power of Armour and Company, and has accepted a position as chemical engineer on the advisory board of the Calco Chemical Company, Bound Brook, N. J.

Charles W. E. Clarke has become associated with Dwight P. Robinson and Company, Inc., constructing and consulting engineers, who have recently opened offices at 61 Broadway, New York. Mr. Clarke was formerly affiliated with the Stone and Webster Engineering Corporation, Boston, Mass.

C. T. Henderson has resigned as chief engineer of the Submarine Boat Corporation, Port Newark Terminal, Newark, N. J., and has become identified with the Hercules Engineering Corporation, New York, as its chief engineer, also acting as president of the Electrolytic Engineering Corporation at the same address.

O. C. Bornholt, formerly factory manager, Holley Brothers Company, Detroit, Mich., has become mechanical engineer of the Buick Motor Company, Flint, Mich.

John J. Eyre has resigned his position with the Worthington Pump and Machinery Corporation, to accept the position of factory engineer with the Sturtevant Aeroplane Company, Boston, Mass.

Byron T. Mottinger has severed his connection as general superintendent of power at the Fort Dodge, Des Moines and Southern Railroad, Boone, Ia., to become associated as chief engineer and master mechanic with the Quaker City Rubber Company, Wissinoming, Philadelphia, Pa.

ANNOUNCEMENTS

M. William Ehrlich, after ten months' service at the U. S. Government Explosives Plant, Nitro, W. Va., as engineer on progress for the Thompson-Starrett Company, has become associated with the George H. Gibson Company, New York, engineering and editorial specialists.

C. W. Koiner is engaged in war work at the United States Shipping Board, Emergency Fleet Corporation in the Power Section, Division of Shipyard Plants.

John R. Freeman, Past-President, Am.Soc. M.E., has resigned as president of the Providence Gas Company, effective January 1, in order that he may be free for another trip to China, where he will supervise surveys and plans for the modernizing of the Grand Canal.

H. B. Viele has received a commission as Ensign, U. S. N. R. F., to be assigned for engineering duties only.

Edwin L. King has been elected secretary-treasurer of the Pratt and Cady Company, Hartford, Conn. He succeeds to the treasurership of the late Bishop White and retains the position of secretary.

Lieut.-Colonel Thos. B. Whitted has recently been released from duty with the United States Army. Colonel Whitted, then a Captain in the E. O. R. C., was called to the colors in April 1917 and after a few weeks was ordered to duty with the American Expeditionary Forces, and for nearly a year was in immediate charge of all purchases for the Corps of Engineers in France. He was rewarded with a Majority for this work, and at his own request was sent to front line duty with troops, from which he was relieved in July 1918, promoted to Lieutenant-Colonel and ordered to the United States to bring over a new Regiment of Sappers.

APPOINTMENTS

Albert M. Brown has been appointed district manager of sales, Philadelphia, Pa., of the Chicago Pneumatic Company. Mr. Brown has been located in the New York offices of the company as assistant manager of the compressor sales division.

Gershom Smith, formerly comptroller of the Pennsylvania Steel Company, and more recently vice-president of the Tabulating Machine Company, after seven months in the office of the Quartermaster-General at Washington, has been appointed consulting accountant in the engineering firm of George W. Goethals and Company, Inc., New York.

H. de B. Parsons has been appointed civilian engineer, Aircraft Production, Approvals Department, U. S. A.

Harold C. White has been appointed factory manager of The Harris Manufacturing Company, of Stockton, Cal. During the last three years Mr. White has been actively engaged in the reorganization of the plants of the Holt Manufacturing Company, of Stockton, Cal., and at Peoria, Ill.

AUTHORS

Lieut.-Colonel E. C. Peck, Engineering Bureau, Ordnance Department, has contributed an article on Types of Reamers and Their Use to the December issue of *Machinery*.

E. A. Uehling is the author of an article entitled Combustion in Its Relation to Boilers, in the December 3 number of *Power*.

EMPLOYMENT BULLETIN

THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping any one desiring engineering services. The Society acts only as a clearing house in these matters.

POSITIONS AVAILABLE

Stamps should be inclosed for transmittal of applications to advertisers; non-members must accompany applications with a letter of reference or introduction from a member; such reference letter will be filed with the Society records.

PRODUCTION, PLANNING AND SCHEDULING ENGINEERS, to act as assistant shop superintendents in Hull Division. Salary to start $6.00 per day. Location, New York. A-0513.

SALES ENGINEER, young, with experience in power-plant equipment. Technical graduate preferred Excellent prospects. Location, Philadelphia, Pa. A-0524.

ASSISTANT TO DIRECTOR, Engineering Experiment Station. Some practical editorial experience required; initiative and ability to carry out work with minimum supervision. Salary dependng largely upon age, experience and training of man. A-0558.

SUPERINTENDENT, for barrel-manufacturing division. Absolutely essential to have had experience on barrels of light-gage steel, also on oxy-acetylene. Splendid opportunity for right man. Location, Massachusetts. A-0579.

U. S. NAVY STEAM ENGINEERING SCHOOL: U. S. Navy Department has perfected plans for the enrollment and training of considerable numbers of engineering officers. A school for this purpose, the U. S. Navy Steam Engineering School, has been established by the Department at Hoboken, N. J. Open to men between the ages of 21 and 40 who meet the physical requirements of the Navy, thorough ability and officer-like character and who have completed the mechanical or electrical engineering course at certain recognized technical schools, or who possess an education and experience judged to be an equivalent thereof. Enrollment men properly qualified may be made at any Naval Enrolling office, notation being made of the applicant's qualifications and desire to be detailed to this school. Men already in the Naval Service and properly qualified should apply for admission to the course to the Commanding Officer. Enroll at any naval enrolling office. For information write Assistant to District Enrolling Officer, 102, New Orleans, La. A-0660.

MECHANICAL ENGINEER, with good record, thoroughly experienced in design of high-grade steam engines and boilers, particularly of the marine type; able to handle draftsmen. Give age, experience in detail, salary desired. Location, Pennsylvania. A-0838.

CHIEF ENGINEER, familiar with design of structural and plate work, hoisting and conveying machinery of the heaviest type. Must have executive ability of the highest order. Give age, experience in detail and salary wanted. Location, Pennsylvania. A-0839.

MECHANICAL ENGINEER, to take charge of engineering office of chemical plant. State qualifications and salary desired. Location, New Jersey. A-0840.

MEN, young, to assist master mechanic of rolling mills. Would like men with technical education but not absolutely essential. Work necessitates knowledge of industrial plant equipment; preferably steel-mill equipment. Future prospects good. Give complete history of experience and salary expected. A-0842.

SALESMAN, to handle line of rotary, centrifugal and force pumps, selling to jobbing trade. State fully experience and qualifications, will be treated confidentially. Engagement first of the year. Location, Buffalo, N. Y. A-0847.

MAN, between ages of 30 and 40, with successful experience as an industrial executive; who anticipates the trend of industrial developments, including material markets, labor conditions, management methods, domestic sales opportunities in new fields, etc. One familiar with metal-stamping industry preferred. Good opportunity for right man. Reply by letter, giving age, education in detail, married or single, experience, present and expected salary. A-0848.

CHIEF ENGINEER, American, good education, practical experience, unimpeachable character and exceptional ability, with mature judgment and good personality. Must have executive as well as constructive capacity. Will be required to assume control of engineering department in manufacture of precision machine tools, keep in touch with the demands of customers and the output of competitors, so far as matters of design are concerned. Mere inventor cannot fill the requirements. Position will be made attractive to right man. If in a big position already, will not interfere with plans. Location, New England. A-0849.

DRAFTSMAN AND TRACER, on ship and yacht hull work. Two men for office of naval architects and marine engineers. Preferably men with previous experience along these lines. Location, New York. A-0850.

INSTRUCTOR in mechanical engineering for Southern University, to teach shop-work and drawing, possibly mechanism. Salary $1,600 per year. In reply state age, education, experience, photograph and copies of letters of recommendation. A-0851.

ORGANIZING ENGINEER, young, for high-grade time study and intensive management work. Bro d and expanding field for able man, large rubber factory. Location, Ohio. A-0852.

MECHANICAL DRAFTSMAN, by old established concern in small town. Living conditions excellent. Permanent position to right party. Give full information in first letter. A-0853.

INSTRUCTOR in mechanical engineering. Technical graduate with both teaching and practical experience. Give complete statement of qualifications, late photograph, height and weight. Salary $1,500 to $2,000. Location, District of Columbia. A-0854.

MECHANICAL ENGINEER, progressive; familiar with the engineering and operating of briquetting plants. A-0857.

DRAFTSMAN, first class on power-station design. Location, Providence, R. I. A-0858.

DISTRICT REPRESENTATIVE AND SALES ENGINEER, familiar and in touch with power-plant installations, furnace construction and general engineering products in Cleveland, Detroit and Cincinnati. Must be engineer of good standing, having sales ability and wide acquaintance in the engineering profession. Headquarters, New York. A-0859.

MAN, technically trained, to take charge of industrial furnace department for company manufacturing oil and gas-burning furnaces, used for tempering tools and steel, also for forging. A man big enough to take complete charge and direct the designing, development work, planning, estimating, and sales engineering of this department. Need technical man to handle propositions for specifications and estimates. Location Massachusetts. A-0860.

SUPERINTENDENT, for well-organized plant manufacturing high-grade printing machinery. Must be experienced executive and thoroughly versed in modern methods of interchangeable manufacturing. Give age, nationality, experience and salary expected. Location, near New York. A-0862.

MEN, young, educated in mechanical lines, particularly with a knowledge of internal-combustion engines, to develop into sales engineers. Location New York. A-0863.

WORKS ENGINEER, and maintenance of machinery operation of steam. Electric power-plant construction and maintenance of building and equipment. Permanent position with old-established concern. Location, Corning, New York. A-0864.

PRODUCTION AND PLANNING ENGINEER. Salary from $3,000 to $4,000, depending upon the ability of the applicant. A-0867.

SALES ENGINEER. Preferably one with technical education, but must have full knowledge of power-plant practice. Oldest and largest concern manufacturing high-grade power-plant equipment requires two additional men in the field. State last position held, giving full details and minimum salary to start. A-0868.

MECHANICAL DRAFTSMAN, with technical training or equivalent. Experienced in layout and detail of combined mechanical and structural work, able to handle machinery on cranes, conveyors, swing bridges or sluice gates, etc. Must be thoroughly capable, able to work without constant supervision, and to produce results quickly. A-0869.

ASSISTANT FOREMAN, for maintenance department. Young man just out of college or a mechanical engineering graduate with slight experience, large manufacturing company. Location, New England. A-0870.

DESIGNING ENGINEER, for large industrial plant, building excavating machinery. Prefer technical graduate with experience on similar class of work. Salary dependent on ability of man. Location middle-west. A-0872.

DRAFTSMAN AND DETAILERS, for industrial plant lay-out work, preferably men with experience in elevating and conveying machinery. State age, education, nationality, previous experience and salary desired. A-0873.

MECHANICAL DRAFTSMAN, with from one to three years' experience on designing of machine tools, jigs and fixtures. Technical graduate preferred. Salary depending upon ability and experience. Excellent opportunity for right man. Location, Connecticut. A-0874.

DESIGNING MECHANICAL ENGINEER, thoroughly experienced in coal and ore-handling equipments; shipbuilding and wharf cranes; conveying machinery, etc. High-grade technical man wanted to take charge of design. State education, nationality, salary desired. Information confidential. Location, Canada. A-0876.

ENGINEER, with some experience in the thermodynamic design and calculation of steam turbines. Prefer young, capable man, to work into responsible position. A-0877.

MAN, of wide experience in same line as No. 0877. A-0878.

ENGINEER of good executive ability and some experience on steam turbines, to handle a variety of work under direction of the chief engineer. A-0879.

STEAM TURBINE DRAFTSMAN, capable of doing development and improvement work. Give full information as to training and experience. Location New England. A-0880.

DESIGNING ENGINEER, experienced on high-pressure steam engines of the poppet valve and kindred types. Location, St. Louis. A-0882.

MECHANICAL ENGINEER, for field work. Must have technical training, preferably college graduate with at least 10 years' experience in construction and operation of power-plant machinery, including steam engines, steam and hydraulic turbines and internal-combustion engines. Preference given to practical man

with sales experience and wide knowledge of industrial plant equipment gained through operation or inspection work. Give age, training and experience. Salary $2,000 to $3,000. Apply by letter. A-0883.

TECHNICAL WRITER, preferably former assistant editor on engineering publication, or instructor in college of mechanical engineering. Should have ability to make technical subjects clear to non-technical readers. Knowledge of a wide variety of machinery, its construction and operation, through extensive reading and practical experience, together with ability for editorial work, are essential qualifications. Reply in detail, giving training, experience and age, with salary desired. Apply by letter. A-0884.

TECHNICAL MANAGER, as assistant to branch sales manager. Should be mechanical engineer with about five years' experience in design, construction and operation of various classes of prime movers. Executive and sales ability in handling work of a number of engineers in the field essential. Sound theoretical training and broad knowledge of mechanical equipment required, in order that man selected may conduct technical educational campaign throughout sales and engineering organization. State age and give training and experience. Salary $2,000 to $3,000. Apply by letter. A-0885.

MECHANICAL ENGINEER, young. College education and some ability and training in research work. Salary would be from $150 to $200 per month. Location New Jersey. A-0886.

CHIEF ENGINEER, with unusual ability to organize an engineering force for development of design, planning and efficiency experimental work, etc., for large manufacturing company is marketing an article enjoying an international market. Only high-grade successful men will be considered. Splendid opportunity for right man. Apply by letter. A-0887.

PLANT MANAGER, with broad experience in operating lines. Must have unusual ability to handle men. Will be expected to take over an organization of not less than 4000 men in manufacturing a high-grade commercial article in New England territory. Experience required will be along mechanical lines. Must be employed at present time and receiving not less than $8000 per year. Splendid opportunity for right man from standpoint of advancement and emolument. Only very successful operators will be considered. Apply by letter. A-0888.

MEN AVAILABLE

Only members of the Society are listed in the published notices of this section. Copy for notices should be on hand by the 12th of the month, and the form of notice should be such that the initial words indicate the classification. Notices are not repeated in consecutive issues.

MECHANICAL ENGINEER, experienced in power-plant work, heating, sanitary drainage, and fire protection systems in design, layout, purchase of material, and supervision of installation; desires position abroad, preferably in reconstruction work in France or Belgium. American born, age 25. Minimum salary $3,600. A-1.

PRODUCTION ENGINEER, M.E. Columbia 1915; 3½ years' practical experience in shop as inspector, drafting room and office work; production man, conversant with bookkeeping and accounting, desires position, offering good prospects, preferably in or around New York City. Minimum salary $2,500. A-2.

MECHANICAL ENGINEER, age 25, technical graduate; 3 years' experience in design and manufacture of riveted plate metal. Also plant layout and machinery installations. Now Lieutenant in Research Division, Chemical Warfare Service. A-3.

FUEL ENGINEER, graduate M.E., 10 years' experience in combustion work and economical utilization of coal for industrial purposes. Withes to be connected with consulting engineering firm in fuel work. At present time in Government service. A-4.

TECHNICAL GRADUATE, 7 years' experience, power plant and general plant engineering, layout, installation and maintenance, turbines, condensors, boilers, stokers, conveyors, switchboard, gas producers, heating and ventilating systems. Married. Salary $200 per month. Philadelphia preferred. At present employed. A-5.

CHIEF ENGINEER OR CHIEF DRAFTSMAN, member, graduate M.E., resourceful, inventive designer. Shop experience. Age 44 years. New York or Newark preferred. Willing to invest in small or medium concern. A-6.

SUPERINTENDENT OR ASSISTANT, 18 years' experience in mechanical and executive positions, from tool-maker to superintendent inclusive, in high speed production of interchangeable parts. American, 26 years old, married. Will consider any location. A-7.

MECHANICAL ENGINEER, French, 48; extensive engineering, designing and operative experience in United States, Central and South America; steam and gas engine, marine and stationary, mining machinery, machine tools; 10 years' locomotive construction and supervision. Would like connection with firm having interests in Europe or South America. Now employed by U. S. Ordnance. End of war necessitates change. Highest references. A-8.

SPECIALIST IN MARINE, OIL AND GAS engine design with 17 years' practical experience in development and research work. Extensive training in the fine points of both the technical and business side of combustion engineering, competent to handle men and to perfect engine designs along proven lines that will eliminate waste of time and money. Excellent man for assisting war-plants that contemplate shifting over output into new lines. Salary $4,800 per year. A-9.

ENGINEERING EXECUTIVE, now in military service in charge large group on important war research, will be available for industrial service February 1. University training, supplemented by 10 years' successful engineering experience, the last seven as industrial engineer for ten million dollar corporation in charge of staff handling problems of production and business organization. Age 32, married, excellent health. Prefer location in New York or New England in community offering good home and school advantages. Initial salary $5,000, with good opportunity for advancement, and preferably a chance to later acquire an interest in the business if connection is mutually satisfactory. A-10.

TECHNICAL M.E. graduate, 1915, with three years' practical shop experience, desires position, preferably in sales work, or assistant to manager. At present employed by the Navy Department. A-11.

PRODUCTION ENGINEER, graduate M.E. Cornell University, age 28. Now engaged in war work. Captain, Ordnance Department. Available January 1. Desires position as superintendent or assistant superintendent, or similar executive position. Salary $3,000 to $3,600. A-12.

MEMBER, 15 years' experience with consulting engineer in designing and erecting special machinery, laying out industrial plants, blast furnaces, steel mills, buildings, etc. Also experienced in purchasing and exporting mechanical equipment. Now employed. Location, Philadelphia, or the vicinity. A-13.

CONVEYING ENGINEER, two years field engineer and construction foreman for Philadelphia concern; 8 years construction, estimating and sales engineer, now production superintendent for ordnance department U. S. A. and immediately available. A-14.

EXECUTIVE, ELECTRICAL AND MECHANICAL ENGINEER, age 43, married, desires an executive position; capable as an ordnance manager, or efficiency engineer; 15 years' experience in research and efficiency work in executive position; available at once. Least salary, $6,500. A-15.

WORKS MANAGER OR SUPERINTENDENT, age 41, married, graduate engineer, experience from apprentice to works manager in large organizations and modern methods of manufacture of munitions, heavy machinery, engines, single-purpose machines and tools, accustomed to handling all classes of labor. Desires permanent position with large concern where prospects are good. Personal reason for wishing change. A-16.

MECHANICAL ENGINEER. Age 44. Born in Russia, speaks, reads and writes English, Russian and Polish, also some German; technically trained, 13 years' shop practice experience as mechanic; 28 years' total continuous American experience in general mechanical engineering; railway specialist in design and construction of heavy machinery and in design of passenger equipment and structures. Desires position in connection with reconstruction of Russia. Now employed. A-17.

MECHANICAL ENGINEER, equipment to handle responsible position; 25 years' actual experience covering design and construction of shops, power plants, layouts and transmissions, thoroughly conversant with blower systems for heating, ventilating and designing jigs, fixtures, special tools and gages; some experience with automatics. Age 50 years; married. New York preferred. A-18.

GRADUATE M.E. 1917, mechanical and production engineering experience. Location, New York or Long Island preferred. A-19.

FOREIGN TRADE: Technical man, speaking five languages, varied experience in organizing and operating industries, making investigations of trade requirements and possibilities in Europe and the Latin Americas; establishing agencies and directing their activities, permanent connections with a large organization, contemplating the establishment of foreign relations. A-20.

MECHANICAL ENGINEER, master mechanic thoroughly experienced in tools, process, design, etc., on internal-combustion engines; efficiency work, planning and scheduling; plant layout, design and maintenance; 30 years old, American. New York City or vicinity preferred. A-21.

MECHANICAL ENGINEER; power-plant work a specialty. Age 24. Desires location with consulting engineers in Chicago or middle west or with manufacturing concern. Also in the members' exchange; desires to invest money and enter business with a consulting engineer or small concern in the middle west. prefer power-plant work. A-22.

EXECUTIVE ENGINEER, university graduate capable of taking charge of engineering, designing or experimental department; 7 years' experience in design and construction of internal-combustion engines. Practical shop experience and thoroughly acquainted with modern manufacturing methods and systems. A-23.

GENERAL OR WORKS MANAGER. Graduate Worcester Poly. Institute. Age 45, married. Broad selling and manufacturing experience as sales executive and works manager. Special ability in reorganization and the handling of men. Competent to fill very responsible executive position. Temporarily employed in War Dept. Service now available. Location, New York City or vicinity preferred. A-24.

MANAGER of ship yard or large machine works. Many years' experience as general sales manager, managing executive, consulting mechanical and electrical engineer. Employed at present as industrial manager of large and important plant U. S. Navy. Skilled in marine electric propulsion. Only high-grade connection will be considered. Salary $6,000 to $7,500. A-25.

MECHANICAL ENGINEER, 8 years' technical graduate, employed as master mechanic of large industrial plant in charge of power generation and distribution, maintenance and repair of all mechanical and electrical equipment, and repair shops; 2 years drafting and designing. Broad experience with internal-combustion machinery, modern steam turbo-generating plant and mining and milling machinery. Can handle men successfully and produce results to bring costs down to a

possible minimum. Available January 1, 1919. 34 years old, married. A-26.

ENGINEER-EXECUTIVE. Twelve years' experience in the design, construction and operation of industrial plants and public utilities; specialized in the problems of management. Desires position as manager or assistant. Location, New York City or vicinity. At present employed as assistant manager and chief engineer of large corporation. A-27.

AMERICAN, with wide experience in the manufacture of heavy machinery, such as steam shovels, dredgers, pile drivers, cranes and mining machinery, desires position with old established concern. 39 years of age. Salary not less than $3,000. A-28.

MECHANICAL ENGINEER in Government service desires position as assistant to superintendent of progressive manufacturing establishment. Graduate of high-grade technical institution with 3½ years' practical experience. Location in vicinity of Philadelphia preferred. A-29.

MEMBER, 20 years' experience marine engines, turbines, boilers, power plants and auxiliaries, ice machines, etc. Naval architecture, structural and electrical engineering. Now employed by large shipbuilding corporation in machinery fabrication department but desires permanent connection with concern who can offer advancement in keeping with ability. A-30.

HEATING, VENTILATING AND POWER PLANT ENGINEER. Technical graduate desires position as designing engineer or superintendent. At present employed in cantonment construction as mechanical superintendent for contractor. Previous experience designing engineer and chief draftsman in charge of design of mechanical equipment of buildings. Thoroughly conversant with all modern types of heating, ventilating, plumbing and power plant construction. Salary $2,500 to $3,000. Prefer location in East or Middle West. A-31.

M.E. AND C.E. GRADUATE ENGINEER, experienced in sugar engineering, automobiles, tractors, small arms, research engineering, design and production, formerly professor of machine design, now Captain, Ordnance Dept., U. S. A., supervising inspector. Wishes position as chief, production or operating engineer or as professor of mechanical engineering in well-established technical school, or position in France or England. A-32.

TECHNICAL EXECUTIVE AND OPERATING MANAGER with broad standard gage steam-railway operating experience, desires position abroad. American parentage. Technical graduate of two universities, receiving degrees in mechanical engineering and railway engineering. Age 35, unmarried. Experience as practical railway shop expert, designer of locomotives and cars, operating superintendent in the organization and management of steam railway lines, valuation and appraisal of railway property. Now in U. S. military railway service. Good personality, resourceful and dependable. Excellent references. Salary $8,000. A-33.

INDUSTRIAL ENGINEER, 20 years' experience in designing, purchasing, construction, production, manufacturing and maintenance work. Previously chief engineer of large paper manufacturing corporation, operating twenty-five mills. Recently mechanical engineer for contracting company, buying, laying out and installing mechanical equipment for ammonium-nitrate, shell-loading and acid-manufacturing plant. Married. Located in New England but willing to go anywhere for reasonable salary. A-34.

TECHIICAL GRADUATE. Age 28, Captain in supply branch, U. S. A., during war emergency; desires position as assistant to production or works manager of progressive manufacturing concern. Broad training in production with modern methods of centralized graphic control. Electrical and automobile manufacturing experience. Salary about $3,000. A-35.

MECHANICAL ENGINEER, now employed making technical investigations and analyses of reports for the Ordnance Department, U. S. A., seeks connection with scientific management firm in New York City. A-36.

MANAGER OR ASSISTANT MANAGER, technical graduate, U. S. Army officer. Age 29. General manufacturing experience. Active and aggressive executive. Successful record in handling men. Practical knowledge shop methods, plant maintenance, construction, engineering, employment and safety, incentive wage emethods and general office work. Married. Prefer connection as assistant manager of large concern or factory manager small concern. Salary $5,000. A-37.

COMBUSTION ENGINEER. Expert in analysis, management, operation and maintenance of large boiler operations. Experienced in modern equipment and operations up to 60,000 hp.; age 35, technically trained, progressive, excellent references. Would like to locate with firm or corporation having large power house or chain of power houses. Salary $5,000 per year. A-38.

MECHANICAL ENGINEER, experienced executive, technical graduate, 20 years' experience, including special research work, design, construction, maintenance, general supervision and operation of industrial plants. A-39.

ELECTRICAL AND MECHANICAL ENGINEER, age 32 years, married; graduatae of Cornell University and University of Utah; 10 years' experience in generation, transmission, application and sale of energy, management of power concerns; desires position requiring executive capability. Foreign service entirely acceptable. A-40.

CORNELL GRADUATE with 15 years' experience desires connection with tractor or threshing machinery concern as works manager. Experienced in efficiency methods and up-to-date organization; salary dependent on condition and location. A-41.

GRADUATE M.E., 2 years' experience drafting and surveying, 2 years in army as officer. Speaks French, German slightly. Desires position preferably with concern expecting to do engineering work in France. A-42.

EXECUTIVE, mechanical or power superintendent or mechanical engineer. Age 35, married, with wide general mechanical and electrical experience in large industrial plants, chemical plants, paper mills and power plants, with record showing marked improvement in operation and operating costs. Present salary $4,000 per year. Will consider salary of $5,000 with chance of advancement. A-43.

SUPERINTENDENT. Excellent mechanical and manufacturing experience. Age 45. A-44.

ORDNANCE OFFICER, First Lieutenant in Engineering Division. Technical graduate of prominent engineering college. Age 25, married, experienced in mechanical and production engineering in varied line of manufacturing. Qualified to sell mechanical equipment. Willing to go anywhere and especially in reconstruction and development work abroad.

SALES OR PRODUCTION ENGINEER. Army officer expecting discharge at an early date desires connection with progressive concern. Age 28, married, technical graduate. Civilian experience covers 6½ years' designing, manufacturing and selling pumping and filter-plant machinery. Can furnish references from prominent engineers and manufacturers. Minimum salary $3,600. A-46.

FACTORY SUPERINTENDENT, M.E. graduate with several years' experience in manufacturing, filling and casing for export, plain and lithographed cans; thoroughly familiar with dies, special can machinery, soldering machines and conveying systems. Salary to start $3,500. A-47.

M.E. GRADUATE, 33 years old, extensive experience in manufacturing plants, desires position with good live company where advancemens is assured provided work is satisfactory. Holds Captain's commission in Ordnance Department. Reliable and with understanding of proper coördination of departments. A-48.

MECHANICAL ENGINEER, M.I.T. 1917, shop and general engineering experience, desires opening as assistant to mechanical or efficiency engineer. A-49.

DESIGNING ENGINEER, experienced on tools and special machinery for ordnance and aeroplane-engine work, also valves, fittings, boiler accessories and pipage systems. Production experience with 3 years thorough shop training. Technically trained. Age 27. Will go anywhere. Salary considered $2,400. A-50.

MECHANICAL ENGINEER. Technical graduate 1915. Experienced as designer of automobiles starting, lighting and ignition equipment, Army Ordnance. At present with the Government as designer and experimental engineer having had charge of design, manufacture and testing of experimental war material. Desires position preferably production in an executive capacity. Salary $225 per month. A-51.

EXECUTIVE ENGINEER, 18 years' experience in design, construction and operation of textile plants, technical graduate, married, open to engagement with permanent construction company or high-class manufacturing concern. Salary $7,000 or will consider a proposition taking interest in small business. Middle west or New England preferred. A-52.

MECHANICAL ENGINEER, at present constructing large sugar mill in tropics; at liberty December; desires connection with firm doing work in tropics and needing man capable of bringing to a finish big construction. Sugar mill or power plants. Can design and estimate as well as superintend this class of construction. Salary $6,000. Married, age 32. A-53.

SALES EXECUTIVE, with executive, engineering, sales and business ability, can handle general sales department, including advertising, of medium-size manufacturing concern or district office for large concern. 32 years old, married and U. S. native born. Considerable experience in Canadian market. A-54.

ENGINEER EXPERT, both in training and experience; specialized in machinery construction as applied to building operations and ship construction, and production experience. Can furnish the best of credentials. At present employed with Navy Dept. Bureau of Construction and Repair, available any time during 1919; prepared to accept foreign service. A-55.

FACTORY MANAGER OR SUPERINTENDENT, mechanical engineer with 18 years' practical experience in manufacture of light and heavy machinery; twelve years an executive organizer, expert in manufacture of interchangeable machinery, able to originate, design and build automatic or semi-automatic machinery for automobile or printing press. Past experience covers layout of entire plant, purchase and installation of equipment. Would consider representation abroad; thoroughly familiar with European countries and conversant with French language. 38 years old, married. Salary $6,000. A-56.

CONSTRUCTION ENGINEER, 12 years' experience design and construction of factories, large buildings and shipyards, including the mechanical, electrical and civil engineering features. Responsible charge of construction of over $12,000,000 worth of work for private interests including preparation, letting and adjustment of contracts; experience in maintenance and operation of completed structures and power plants. Cornell graduate, M.E., age 34, leaving Government position held during war and desires to make permanent connection with factory or construction company. Earned $7,000 to $8,000 per year before war. Will consider less on agreeable work with prospects of advancement. Particularly interested in labor problems. Location near New York City preferred. A-57.

POWER SPECIALIST, 10 years' unusual experience in design, construction and operation of steam, hydroelectric and internal-combustion engine power houses; high-tension distribution, electric substation work and the application of industrial power to machine-tool equipment. Recently in charge of 50 men on the design and construction, and 1000 men

on all mechanical and electrical work at a 12-way, 8800 ton tractor employed by the Emergency Fleet Corporation. Executive engineer of good personality, age 30, married, M.E. degree; open for employment January 1, 1919, with contractor, consulting engineer or manufacturer. A-58.

EXECUTIVE, DESIGNER, Harvard A.B., 1909, Cornell, M.E., 1911. Age 32, married; 7 years' practical experience in shop, drafting room, industrial plant and isolated field work in connection with internal-combustion and steam engines; gas producers and boiler plants. Experienced in organization work and recently state boiler-plant conservation work for U. S. Fuel Administration. Desires management of small business with partnership or stock interest. Minimum salary $3000. A-59.

MECHANICAL ENGINEER, graduate, 5 years' experience in development and manufacture of machine tools, instruments and steel-plate work, as designer, estimator, plant engineer. Desires executive position. At present with the Government in executive engineering capacity. New York or Boston district preferred. A-60.

MECHANICAL ENGINEER. Technical graduate. 17 years' experience in the design, construction, testing and operation of steam power plants, 11½ years' as designer, builder and superintendent of power plants and stationary steam equipment with two of the largest eastern railroad systems. At present employed as engineer with public utility operating and engineering corporation. Desires to return to steam railroad work or enter permanent employ of strong manufacturing company. A-61.

SUPERINTENDENT OR PRODUCTION ENGINEER, age 44. Mechanical engineering graduate, 16 years' experience in industrial engineering lines, 8 years with present employer in supervision of rate setting, production planning. Costs, pay roll, shop accounting, etc. for shop employing 600 to 900 people. Position in which an interest in business could be obtained preferred. Location Chicago. A-62.

AUTOMOBILE AND AIRPLANT ENGINE EXPERT just released from Army, wants position with school or manufacturing concern. Graduate M.E. Cornell University, 1909. Thorough knowledge of carburetion, ignition, starting and lighting systems, storage batteries, etc. Also experience in experimental work of various kinds. Salary not less than $3000. A-63.

SUPERINTENDENT OR CHIEF ENGINEER of power plant, or power engineer for manufacturing plant; 14 years' experience since graduation. American, 36 years. Design, construction operation and maintenance of steam plants and substations a specialty. Salary $3000. Eastern States. A-64.

POWER ENGINEER, 7 years' experience in construction, operation, reconstruction and design of power plants, buildings, and equipment. Covering boilers, stokers, turbines, oil engines and refrigeration equipment. Supervising engineer for consulting engineering firm of New York before entering U. S. Navy as Ensign. Desires to cover the purchase of equipment, direction of field work, and organization of plants on an efficient and economical basis. Salary on entering service $3000. Willing to go anywhere. Available about February 1. A-65.

SALES ENGINEER. Member, with New York office will accept manufacturers' account or representative for special or plant equipment. Broad selling experience combined with practical manufacturing shop knowledge. Resourceful. Bank reference. A-66.

ASSISTANT ENGINEER OR SUPERINTENDENT; technical graduate, age 28, married. 5 years' general shop, maintenance and construction work; one year experimenting with powdered coal. Desires permanent position with large manufacturing corporation. Active and energetic. Now employed. Location preferably East or Middle West. A-67.

DRAFTSMAN AND SALESMAN specializing in iron and bronze; 1½ years chief estimator leading car works; 3½ years chief estimator engineer, design, manufacture, sale and installation conveying apparatus of all types. At present commissioned officer U. S. Army, Ordnance Dept. design and production work. Available about January 15. A-68.

INDUSTRIAL PLANT ENGINEER. Age 40, married. Technical education; 16 years' wide experience in industrial plant engineering and management consulting, designing, construction, organizing, maintenance, shipyards, paper and pulp mills, power plants. Desires position as engineering manager or works engineer. Executive ability with broad knowledge of plant management and organization. A-69.

MANAGER with broad manufacturing experience and successful record desires big, difficult executive position. A-70.

MECHANICAL ENGINEER desires staff connection with firm of industrial engineers, to undertake for clients power-plant investigations, schedule process steam demands, and effect fuel economies. A-71.

PRODUCTION ENGINEER, graduate mechanical engineer, age 27. Experience in supervising including routing, scheduling and developing progress charts and reports; following up machine-shop production and operations from time of casting ingot to shipment. One year's experience as chief inspector of small arms. Philadelphia or vicinity preferred. A-72.

SUPERINTENDENT, mechanical or production engineer; energetic, progressive American, married; technical education with broad experience in shop, drawing room and production on small interchangeable parts. Ability to produce results. At present employed. Available at early date. A-73.

GRADUATE UNITED STATES NAVAL ACADEMY, honorable resignation from the U. S. Navy; age 36, married; 6 years' civilian executive engineering experience, followed by enrollment in U. S. Naval Reserve Force. At present stationed in China. Would like to get in touch with firms who are either now operating or who contemplate starting in any part of the Far East. A-75.

MECHANICAL ENGINEER, officer in the Engineers Corps, U. S. Army, age 33, desires position affording opportunity for exercise of executive ability. Technical training and experience in construction and operation industrial plants. Thoroughly familiar with power plants and power-plant equipment; experienced in machine design; broad general business training. Minimum salary $300 month. Available about January 1. A-75.

COMBINATION ENGINEER desires position with company whose fuel consumption is sufficient to require services of first-class man. Technical training, wide experience in practical problems of design and operation of furnaces for special work, machine designer. Available on release from military service on or about January 1. A-76.

MECHANICAL ENGINEER, age 25, married; M. I. T. graduate with 2½ years' practical experience in industrial and power-plant engineering. Desires to become connected with concern that can offer future in return for hard work, energy, and initiative. Willing to make moderate start if future is assured. Now employed. Location preferably in the East. A-77.

MECHANICAL ENGINEER, technical graduate, age 24. Release from active duty in Naval Reserve in December. Experienced foundry engineer, metallurgist, and metallographist. Will consider position as estimator for foundry or steel-works equipment, or sales engineer and special representative for manufacturer. Varied experience in the engineering field and natural curiosity and ingenuity gives qualifications for position as assistant to work manager or superintendent. A-78.

PRODUCTION ENGINEER, desires position where opportunity is given to show initiative and accomplish constructive work. Experience in plant management and reorganization; association with leading industrial engineers and executive experience in several large plants as superintendent and production engineer. Technical graduate, age 28 years. A-79.

ADVISORY ENGINEER, 25 years experience in design of blast furnaces, steel plants, hydraulic machinery, sugar mills, machine shops, foundries, boiler shops, power plants, and heavy machinery as well as supervising the erection and construction, including laying out foundations and placing and erecting buildings and machinery. A-80.

NAVAL AVIATION ENGINEER OFFICER; M.E., Stevens, 1909; age 31; served apprenticeship in machine shop of gasoline-engine manufacturer. Has held position of draftsman, efficiency and plant engineer; employment supervisor, factory superintendent and mechanical engineer with well-known manufacturing concerns. A-81.

COMBUSTION ENGINEER, 10 years' experience with coal, gas and oil firing, wishes to make change. A-82.

MECHANICAL ENGINEER with 7 years' broad mechanical manufacturing experience, desires position with possibilities as superintendent or manager, upon release from active duty as commissioned officer in Ordnance Department. Can furnish best references. A-83.

MECHANICAL ENGINEER with 15 years' experience in design of heavy machinery, plant and building construction, thoroughly familiar with shop and field methods; desires permanent connection with definite opportunities for advancement. Technically trained, with experience as machinist. Age 36, married. A-84.

ELECTRICAL, MECHANICAL DRAFTSMAN, graduate Rose Polytechnic Institute, 1915. In charge drafting, last three years on work including shell machinery, oil-well equipment, hydraulic pumps, safety work. Would like opportunity leading to works management, efficiency or sales engineer. A-85.

DIESEL ENGINEER SPECIALIST, with 3 years' experience erecting, testing, design, and computation of Diesel engines. M.E. Mass. Inst. Tech. Now holds responsible technical position. Desires change from advanced experimental work on Diesels to position involving standard practice. A-86.

ENGINEER, just discharged with rank of lieutenant, Engineer Corps; 3½ years' prior experience in power-plant and distribution systems, design and construction in all their electrical, mechanical, and structural details. Age 26, married; available at once. Salary $2400. A-87.

PRODUCTION OR MECHANICAL ENGINEER would like to become permanently established with live or growing concern; inventive and executive ability, age 31, married. Excellent references. At liberty the first of the year. A-88.

MECHANICAL AND CIVIL ENGINEER, several years in charge of engineering department with large manufacturing company, desires to make change. Experience has been in estimating and designing with close connection with production. Also in charge of building design construction and plant extension. Preference, assistant to manager of large and growing plant. Would consider car specialty concern of recognized standing. A-89.

GRADUATE MECHANICAL ENGINEER, just released from 15 months' military service, captain artillery, now interested in steam power-plant proposition, or manufacturing, operating or consulting opportunities. A-90.

MECHANICAL OR PLANT ENGINEER, 3 years at engineering college, 5 years apprentice engineering works, 12 years' practical experience. Last 5 years in charge of engineering department of large manufacturing establishment. Married; 35 years of age. A-91.

MECHANICAL ENGINEER, technical graduate, desires position as manager where executive ability is necessary, with an extensive knowl-

edge of modern scientific and production management methods. Held positions of superintendent and factory manager and with consulting industrial engineers. Only a high-grade proposition will be considered. A-92.

PRODUCTION MANAGER. Mechanical engineering graduate, familiar with practical machine-shop and foundry work and relating office methods. Desires position with progressive manufacturing firm requiring an energetic and tactful executive. At present in Government service, available the first of the year. Excellent references. 30 years old, married. Salary $3000. A-93.

MECHANICAL AND SALES ENGINEER, age 36, married, 19 years' experience. Available on January 1, 1919, familiar with European business practice. Desires agency for South America or Europe, flour-mill and grain-elevator machinery; Diesel-oil engine, marine or stationary, gas producer for bituminous coal gas or steam engine. Salary and commission preferred. Can lay out plants and superintend erection or installation of same. A-94.

YOUNG MECHANICAL AND CHEMICAL ENGINEER, desires to change position. Experienced in construction, operation, and maintenance of industrial works. References. Location wherever desirable. A-95.

MECHANICAL ENGINEER, desires connection in sales engineering or executive capacity. American, in excellent health. Graduate University of Michigan in engineering and naval architecture. Unusual combination of successful selling, technical and business experience in both mechanical and marine fields. Former member Chicago firm mechanical and electrical engineers; also business manager large real estate and contracting firm. At present employed on Government shipbuilding work, but seeks permanent connection. Will go anywhere, and available on reasonably short notice. A-96.

MECHANICAL ENGINEER, University technical education, desires connection of executive nature with manufacturing concern, preferably in early stages of development. Several years' experience directing work in office, plant and field along lines of plant construction, design and installation of mechanical equipment, plant operation and sales. At present holding commission in Government service. Will consider position in foreign field. A-97.

MECHANICAL ENGINEER, technical graduate, desires position in executive department of engineering or manufacturing concern; 12 years' experience covering design, construction and manufacturing. American, age 35; married; energetic and trustworthy. Employed at present but available on short notice. A-98.

MECHANICAL ENGINEER, desires position as technical executive. American and British training and experience, in hoisting machinery and structural engineering. Student of modern organization and production methods. At present chief draftsman of large concern. Desires position in South America or Europe with up-to-date plant or in developing freight-handling facilities at ocean terminals. A-99.

MECHANICAL ENGINEER, technical graduate, 14 years' general engineering experience, including machine design, executive staff work, supervision of heavy construction, machinery installation and manufacturing, desires position requiring executive ability as resident engineer or manager. Only a high-grade proposition will be considered. A-100.

STEAM TURBINE DESIGNER, age 43, expert designer of steam engines and turbines and highly trained mechanical and electrical engineer; now employed by the Navy Department wishes to return to commercial work in an executive position. A-101.

MAJOR ENGINEER, R.C., about to return from active service as major of engineers abroad, desires connection with firm of consulting engineers or employment as manager or superintendent. Familiar with power and refrigerative plants, factory, layout and management, machine-tool design, and manufacture of duplicate machinery. A-102.

MECHANICAL ENGINEER, GENERAL SUPERINTENDENT, 30 years old, technical and practical experience. Machine-shop practice as tool-room superintendent; designer of special machinery, chief draftsman, special fixtures, tools, etc.; experienced in systematizing cost accounting, equipment developing experimenting. At present production superintendent. Originator of devices for manufacturing; has initiative, resourcefulness; seeks position of responsibility and permanency after January 15, 1919. T-103.

GENERAL OR WORKS MANAGER. Authority on modern employment and personnel problems. Graduate mechanical engineer and B.A. in economics; 20 years' experience including cost accounting, production management, purchasing and superintendence. Now holding professorship as head of department in large engineering college and consulting practice. Author of well-known books on industrial organization and management. Major of Ordnance since July 1917, having had charge of important equipment, production, and inspection work in ammunition and artillery. A-104.

MECHANICAL ENGINEER, technical degree, age 31, not married; 8 years' experience on general structural design, inspection work, construction of large mining plants, also buying and selling of machinery. Four years spent in South America, good knowledge of business conditions in that country. Desires to join firm where technical knowledge of foreign business would be of service. A-105.

MAINTENANCE AND CONSTRUCTION ENGINEER familiar with superintendence of building construction, installing automatic machinery, heat-treating furnace, fuse-oil storage equipment. Available on short notice. A-106.

ENGINEER, experienced in design, construction and operation of power plants, accustomed to take full charge of both office and field work; experience also covers design of special machinery and industrial layouts, special investigation in power problems, etc., desires location in vicinity of New York City. A-107.

GRADUATE MECHANICAL ENGINEER, with 2 years' experience on electrical and mechanical equipment. Discharged Army officer. Position desired with an industrial establishment as assistant to works manager or with industrial engineer. A-108.

EXECUTIVE ENGINEER, office and field executive in general engineering and contracting company. 20 years' broad experience covering the purchase, installation and maintenance of mechanical and electrical equipment for power, contracting and industrial concerns. Sales manager of electrical apparatus. Now in Government position. Available at once. Seeks responsible permanent connection. Technical graduate. Married. Salary $5,000. A-109.

MECHANICAL, CONSTRUCTION, PRODUCTION WORKS and plant-maintenance engineer, 32 years old, single, technical college education; several years varied engineering experience, in this country and abroad such as steel construction, power plants, foundry, machine and forge shops, preparing plans and specifications, estimates, etc., speak several foreign languages, considered good shop and office organizer and executive. Formerly captain U. S. A., recently discharged. Can present best reference. A-110.

PLANT ENGINEER, technical executive or assistant executive of any kind, requiring position of promise and responsibility as technical graduate; eight years' experience in executive capacity, covering manufacturing, plant testing, consulting engineer and teaching in machine design and power plants; at present 1st Lt. in U. S. Army, Ord. Dept., on design and manufacture of field carriages. 29 years of age, married. Location preferably New York or vicinity; salary $2,600-$3,600. A-111.

TECHNICAL GRADUATE age 26, 2 years' practical shop and 2 years' drafting experience. At present as leading draftsman in charge of work. References furnished as to ability, character, etc. Location, preferably Eastern States. A-112.

MECHANICAL ENGINEER. Graduate of Coöperative engineering course, University of Cincinnati, 1913, Junior Member, age 28, married. Now lieutenant in United States Army and will be available for civilian position about January 10, 1919. Four years' experience in consulting office, including two years as executive. Experience covers all details of mechanical, electrical and sanitary equipment for industrial buildings and design, construction and operation of steam power plants. Consulting practice chiefly in connection with paper mill work. Desires position in similar capacity with industrial engineer or architect, or other executive capacity in line with qualifications. Preferably in Middle West. A-113.

FACTORY EXECUTIVE who for some time has devoted his services to the U. S. Government on special work, would like to correspond with well-established concern. Experience consists of 21 years' in principal capacity with several well-known concerns in this country and Europe, in the manufacture and development of high-grade intricate mechanical devices, requiring extreme accuracy, interchangeability of parts, together with a very efficient organization, highest type of men, tools and equipment. A-114.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER JANUARY 21

Below is a list of candidates who have filed applications since the date of the last issue of The Journal. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate or Associate-Member, those in the third class under Associate-Member or Junior, and those in the fourth under Junior grade only. Applications for change of grading are also posted. The total number of applications received and listed below is 163.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by January 21, and provided satisfactory replies have been received from the required number of references, they will be balloted upon by the Council.

NEW APPLICATIONS
FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

California

DARRAH, William A., Plant Manager, Noble Electric Steel Co., Heroult

HEYLMAN, Frederic C., Chief of the Mechanical Department, Shell Company of California, Martinez

JESSURUN, David, Superintendent, The Anaheim Sugar Co., Anaheim

JONES, Edward S., Assistant Engineer, Gas Department, Pacific Gas & Electric Company, Sacramento

KOEBIG, A. H., Consulting Engineer, Los Angeles

MARTIN, Jesse C. Jr., Mechanical Engineer, J. C. Martin Company, San Francisco

Connecticut

ADT, HOWARD E., Treasurer & General Manager, The Geometric Tool Company, New Haven

BRANCHERRY, JOSEPH M., Production Engineer, Colts Patent Arms Company, Hartford

GAINES, WILBUR H., Superintendent, Factory "H," International Silver Co., Meriden

HAMMOND, GUY L., President & Treasurer, Block Rock Mfg. Company, Bridgeport

LAWRENCE, WILLIAM E., Head of Model Department & Designing Engineer, Marlin Rockwell Corporation, New Haven

RUST, CHARLES E., Supervisor of Apprentice Training School at the Bullard Engineering Works, Inc., Bridgeport

Delaware

BRUCE, ROBERT G., Mechanical Engineer, E. I. du Pont de Nemours & Co., Wilmington

District of Columbia

BALL, C. WINTHROP, Chief Draftsman, Engineering Division, Ordnance Department Aircraft Armament Section, Washington

STOVER, HARVEY D., Lieutenant Ordnance Engineer, Engineering Division, Aircraft Armament Section, Washington

STUART, KENNETH E., Member, Engineering Committee National Research Council, Washington

Illinois

EKLIND, CARL E., Chief Draftsman, Car Construction Department, Atchison, Topeka & Santa Fe Railway Company, Chicago

HELT, HARRY C., Assistant to Superintendent Engineering and Planning, Small Arms Division, Rock Island Arsenal, Rock Island

JAMES, SYDNEY V., Mechanical Engineer, Underwriters' Laboratories, Chicago

MORRISON, MONTFORD, Consulting Engineer, Victor Electric Corporation, Chicago

ROGERS, FRANKLIN G., Sales Engineer, Under-Feed Stoker Co. of America, Chicago

Indiana

CREAGER, EDWIN F., Works Manager, Remy Electric Division, Anderson

TEST, ELLIS W., Chief Mechanical Engineer, Haskell & Barker Car Company, Inc., Michigan City

Kentucky

WARE, ARTHUR L., Mechanical and Mining Engineer, Hazard

Maryland

EISERT, HERMANN, Mechanical Engineer, C. L. Reeder, Baltimore

HIGGINS, MAX S., General Manager, New York Central Iron Works Co., Inc., Hagerstown

Massachusetts

COYNE, JAMES F., Garage Manager, Seekonk

HAWLEY, THOMAS, President, Hawley School of Engineering, Boston

VAN LAW, CARLOS W., Consulting Engineer, Boston

Michigan

FENKELL, GEORGE H., Superintendent & General Manager, Board of Water Commissions, Detroit

HUNT, HORACE S., Administrative Engineer for Michigan, United States Fuel Administration, Detroit

Missouri

MARTINDALE, GERALD S., Construction Engineer, Curtis & Co. Mfg. Co., St. Louis

New Jersey

ANDERSON, RICHARD T., Branch Manager, Crocker-Wheeler Company, Newark

BRADY, THOMAS, Superintendent, Elevator Supplies Company, Inc., Hoboken

FORIS, JULIUS, Tool & Machine Designer, The Singer Sewing Machine Manufacturing Company, Elizabeth

KORTGARD, FREDERICK H., Foreman Engineer, Jersey City Power Station, U. S. Railroad Administration, Hudson & Manhattan R. R., Jersey City

McCLYMONT, JAMES, 2nd Vice-President, Hall Printing Press Company, Dunellen

New York

BARNSLEY, HERBERT J., Chief Draftsman, Jenkins Brothers, New York.

BORGSTEDT, HENNING N., Sales Engineer, De La Vergne Machine Company, New York

BYER, HENRY E., Chief Engineer, Condenser Department, Ingersoll Rand Company, New York

CHAMBLISS, HARDEE, Major, Ordnance Department, U. S. A., Laurel Hill Detachment, Laurel Hill, Long Island

CHURCHILL, WILLIAM L., Consulting Engineer (Industrial Efficiency), New York

COURTLAND, WILLIAM A., Vice-President & Engineer, H. W. Cotton, Inc., New York

ERDMAN, ALBERT W., Lieutenant-Colonel, Ordnance Department, U. S. A., Schenectady

ESTEP, FRANK L., Chief Engineer, Perin-Marshall Company, New York

HICKS, OSCAR P., Sales Engineer, Mathews Gravity Carrier Company, New York

LIPKE, LEOPOLD H., General Manager, Gotham Machine & Tool Company, Inc., Brooklyn

LISETZKY, PETER A., Chief Engineer, Gun Carriage Plant, New York Air Brake Company, Watertown

MARTIN, KINGSLEY L., President, The Engineer Company, New York

PASCALE, PASQUALE, Designing Engineer, Galvanizing Corporation of America, Brooklyn

RANKIN, WILLIAM J. A., Cableway & Logging Engineer, Lidgerwood Manufacturing Company, New York

RAYMOND, FRANK S., Draftsman, Watervliet Arsenal, Watervliet

RICHARDS, HORATIO R. H., First Assistant Production Engineer, Standard Shipbuilding Corporation, Shooters Island

ROBB, EDWARD H., Chief Draftsman & Assistant to Engineer, Long Island Railroad, Richmond Hill, Long Island

ROSSIRE, HENRY L., Production Manager, U. S. Ordnance Department, New York District, New York

STEVENS, JOHN E., Mechanical Engineer, General Briquetting Company, New York

STRUNK, WALTER C., Assistant Engineer, Interborough Rapid Transit Company, New York

SUTHERLAND, KENNETH W., Chief Assistant Inspection Officer, Department of Gages & Standards, British War Mission, New York

Ohio

BAKER, WALTER C., Consulting Engineer, The Standard Parts Company, Cleveland

CUNNINGHAM, GEORGE F., Designing Draftsman, Ohio Blower Company, Cleveland

DIBBLEE, WALTER A., District Manager, Inspection Division, Ordnance Department, U. S. A., Cincinnati

FIELD, J. A., Planning Engineer, The B. F. Goodrich Company, Akron

MARSHALL, EDWARD M., Combustion Engineer, Union Gas & Electric Company, Cincinnati

Pennsylvania

BATTEY, WILLIAM A., Vice-President, Pennsylvania Crusher Company, Philadelphia

FORKER, JOHN N., Chief Draftsman, The Koppers Company, Pittsburgh

GRAHAM, ALVIN K., General Manager, Erie Bolt & Nut Company, Erie

HARTMAN, WILLIAM H., Chief Engineer, Pennsylvania Crusher Company, Philadelphia

KENNEDY, MATTHEW G., Assistant to Electrical Engineer, The United Gas Improvement Company, Philadelphia

LATIMER, JOHN, Superintendent of Meters, Bureau of Waters, Philadelphia

RITTMAN, WALTER F., Consulting Engineer, Pittsburgh

SUCZEK, ROBERT, Consulting Engineer, C. H. Wheeler Manufacturing Company, Philadelphia

Tennessee

HENSON, WALTER A., Vice-President, Osage Cotton Oil Company, Chattanooga

Texas

GILLESPIE, SOLOMON E., Assistant Engineer, The Murray Company, Dallas

Vermont

WINESTOCK, OTTO C., Inventive Industrial Research, Perkinsville

Washington

GODFREY, FOSKETT H., Superintending Engineers Constructing Quartermaster, Camp Lewis

THOMPSON, WALDO E. Mill Builder, Tacoma

WENK, MORRIS, Engineering Draftsman, G. M. Standifer Construction Corporation, Vancouver

Canada

CARTER, WILLIAM, Manager, Ingersoll Rand Company, Montreal

JONES, THOMAS M. Chief Engineer & Manager, The Bawden Pump Company, Ltd., Toronto

McKEE, GEORGE M., General Manager, The Donnacona Paper Company, Ltd., Donnacona, Quebec

Hayti

HOLLY, ROBERT A., Assistant Engineer, Stewart's Engineering Corporation, Port-Au-Prince

FOR CONSIDERATION AS ASSOCIATE OR ASSOCIATE-MEMBER

Connecticut

CAMPBELL, JAMES A., Assistant Scheduling Supervisor, Winchester Repeating Arms Company, New Haven

MORRISEY, RICHARD E., Component Engineer, Colts Patent Fire Arms Company, Meriden

District of Columbia

LEILICH, FRANK T., Captain of Engineers, U. S. A., Washington

Connecticut

SHRINER, EDWARD C., JR., 2nd Lieutenant, Ordnance Department, U. S. A., Assistant Supervisor on Fuses, Adapters and Bosters, Bridgeport

New Jersey

GERBER, LIPMAN S., 1st Lieutenant, Ordnance Department, 511th Casual Company, Camp Merritt

SOBEN, ADOLPH F., Designer, Splitdorf Electric Company, Newark

New York

HALLSTED, SEYMOUR J., Chief Engineer, The Griscom-Russell Company, New York

Pennsylvania

BUCKLEY, JAMES E., Turbine Designer, Bethlehem Shipbuilding Corporation, Bethlehem

DONEGAN, JOHN J., Foreman, Forge Department, Frankford Arsenal, Philadelphia

WILLIAMS, JOHN F., Construction Engineer, Atlantic Refining Company, Philadelphia

Rhode Island

SPRAGUE, FRANK D., Lieutenant, U. S. N. R. F., Exp. Officer, Torpedo Station, Newport

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

Connecticut

BALSOR, FREDERICK N., Assistant Resident Inspector of Engineering Material, U. S. Navy, care Ashcroft Manufacturing Company, Bridgeport

COOK, HARMON T., Works Manager, The Torrington Co., Torrington

District of Columbia

LANG, HERBERT H., Supervising Inspector, Ordnance Department, U. S. Army, Washington

LAMBERT, STANLEY M., Assistant Branch Head, War Department, Estimates & Requirements Division, Washington

Illinois

FISKE, ROGERS A., First Assistant to Officer in Charge of Production, Rock Island Arsenal, Rock Island

RICE, PERRY W., Manager, Chicago Branch, Pratt & Whitney Company, Chicago

Massachusetts

NICKERSON, HAROLD L., Superintendent of Production & Employment Manager, Walden-Worcester, Inc., Worcester

Nebraska

LUEBS, AUGUST A., Instructor Mechanical Engineering, University of Nebraska, Lincoln

New York

KEEFE, Daniel C., Mechanical Engineer, Ingersoll-Rand Company, New York
SIMPSON, Robert E., Jr., Check Inspector, Gas Defense Plant, U. S. A., Long Island

Ohio

PATCHELL, Frederick J., Assistant Chief, Materials Engineering Department, Bureau Aircraft Production, Dayton

Pennsylvania

HILL, David B., Mechanical Draftsman, Ordnance Department, Frankford Arsenal, Frankford
KARN, Fred S., Sales Engineer, Dravo-Doyle Company, Pittsburgh

Virginia

LEFEBVRE, Gordon, Maintenance Engineer, Du Pont Company, Hopewell

West Virginia

RINKE, George R., Chief Engineer, West Virginia Traction & Electric Company, Morgantown

Canada

HASTIE, Christopher, Surveyor, Lloyd's Register of Shipping, Vancouver, B. C.
PARKIN, John H., Mechanical Engineer, British Acetones Toronto, Ltd., Toronto, Ontario

France

STEINS, Carleton K., 1st Lieutenant, Engineers, U. S. A., Co. "O," 35th Regiment, American Expeditionary Forces.

FOR CONSIDERATION AS JUNIOR

California

BERCAW, Corliss A., Chief Quartermaster, Aviation, U. S. N. R. F., Whittier
CHRISTIAN, Joseph D., Mechanical Engineer, P. H. Reardon, San Francisco

Connecticut

DURKEE, Chauncey H., 1st Lieutenant, Ordnance Department, U. S. A., Colt's Patent Fire Arms Manufacturing Company, Hartford
WHITAKER, John A., Assistant Chief Draftsman, Colt's Patent Fire Arms Manufacturing Company, Meriden

District of Columbia

McCUTCHEN, Brunson S., Captain, Ordnance, U. S. A., Washington
SORENSON, James C., Designer, Ordnance Office, U. S. Army, Washington

Illinois

HABERSTROH, Herbert N., Selling Engineer, Celite Products Company, Chicago

Louisiana

FREELAND, Emile C., Assistant Research Chemist, Louisiana Sugar Experiment Station, New Orleans

Maryland

BROWN, Ernest G., 2nd Lieutenant, Ordnance Department, U. S. A., Aberdeen Proving Grounds, Aberdeen
WELLS, Burling D., 1st Lieutenant, Chemical Warfare Service, Edgewood Arsenal, Edgewood

Massachusetts

ALDRIN, Edwin E., 1st Lieutenant, Instructor in Aeronautics, Massachusetts Institute of Technology, Cambridge

Michigan

HIGGINBOTTOM, Herbert, Jr., Tool and Gauge Designer, Packard Motor Car Company, Detroit

Minnesota

GREENBERG, Morris, Instructor Exp. Engineering Department, University of Minnesota, St. Paul

Missouri

SHANKS, Everett C., Assistant Superintendent Machine Shops, Curtis & Co. Mfg. Co., St. Louis

New Jersey

BEARDSLEY, Harry I., Supervising Mechanical Designer, Crocker-Wheeler Company, Ampere
DeLORME, Alfred C., Engineer in Charge of Specification, Splitdorf Electric Company, Newark
DERR, Carl W., Ensign, U. S. N. R. F., Jersey City
KOLB, Robert P., Chief Machinist's Mate, U. S. N., Steam Engineering School, Stevens Institute, Hoboken
MILLER, Frank W., Jr., 2nd Lieutenant, Ordnance Department, Commanding Officer 502nd Casual Company, Camp Merritt
PRANGE, Charles H., Draftsman, Federal Shipbuilding Company, Kearny

New York

ANDREW, Harold O., Captain, Ordnance Department, U. S. A., General Chemical Company, Laurel Hill, Long Island
FULFORD, Lester E., Captain, Chemical Warfare Service, U. S. A., New York
MARX, George, Jr., Ensign, U. S. N. R. F., New York
ROHMANN, Charles E., Sub-Inspector of Ordnance, Bureau of Ordnance, U. S. Navy Department, New Jersey Inspection District, Brooklyn
STEVENS, Raymond S., Manager of Production Service Department, Gas Defense Plant, Long Island City, Long Island
TAVENER, Charles H., Aeronautical Engineer & Mathematical Designer, Curtiss Engineering Corporation, Garden City, L. I.

Ohio

McCULLOUGH, James T., Aeronautical Mechanical Engineer, Bureau Aircraft Production, Dayton

Pennsylvania

CHADWICK, Joseph J., Mechanical Draftsman, Traylor Engineering & Manufacturing Company, Allentown
PARSONS, Seely S., 1st Lieutenant, Ordnance Department, Philadelphia

Rhode Island

FIELD, Ernest G., Providence
SPARKS, Earl C., Superintendent, Gorham Manufacturing Company, Phillipsdale

Virginia

GRIEBEL, Frederick W., Machinist, Newport News Shipbuilding & Dry Dock Company, Newport News

West Virginia

BLOUNT, Robert E., Assistant to W. C. Thatcher, Supervising Engineer, Area "K," Nitro

Brazil

JUNIOR, Francisco A., Industrial Railway Engineer, Tinidicio F. Amaro, St. Paulo

France

BARRON, David H., 2nd Lieutenant, U. S. A., Co. "I," 34th Engineers, American Expeditionary Forces.

West Indies

ROBERTS, Samuel B., Assistant Engineer, Bartram Brothers, Inc., Santo Domingo, Dominion Republic

CHANGE OF GRADING

PROMOTION FROM ASSOCIATE-MEMBER

Connecticut

BUXBAUM, William, Superintendent Tool Department, Winchester Repeating Arms Company, New Haven

Illinois

ROLLINS, Lewis M., General Superintendent, Armour Mechanical Company, Chicago

Massachusetts

SHAW, Benjamin C., Assistant Superintendent, Boston Duck Company, Bondsville

New York

STRATTON, David V., Consulting Engineer, New York

Pennsylvania

HAMILTON, Walter C., 1st Lieutenant, Ordnance Department, U. S. R., Frankford Arsenal, Philadelphia

PROMOTION FROM JUNIOR

Connecticut

ANDERSON, John W., Engineer, Electric Boat Company, Groton

District of Columbia

HUNT, James L., 1st Lieutenant, Engineering Division, Ordnance Department, U. S. A., Washington

Illinois

LANGSTROTH, Clifford B., Captain, Ordnance Department, Rock Island Arsenal, Rock Island

Michigan

BREEDLOVE, Lincoln B., 1st Lieutenant, Mobile Repair Unit, 14th Division, Camp Custer

Minnesota

BOYD, Ford E., Mechanical Engineer, Oliver Iron Mining Company, Duluth

New Jersey

DARROW, Herbert V., Assistant Mechanical & Electrical Engineer, T. A. Gillespie Loading Company, South Amboy

New York

BLUM, Joseph K., Secretary & Treasurer, K-B Pulverizer Company, Inc., New York
DAHLSTRAND, Josef Y., Chief Engineer, Kerr Turbine Company, Wellsville
HAVILAND, John R., Sales Engineer, Furman-Fisher Corporation, New York
TRUMP, Charles C., Vice-President & Secretary, Humphrey Gas Pump Company, Syracuse

Ohio

ROCKWELL, Willard F., Vice-President in charge of manufacturing, The Torbensen Axle Company, Cleveland

Canada

HEINEMANN, Adelbert L., Engineer of Tests, Ordnance Department, U. S. A., Canadian Allis-Chalmers, Ltd., Toronto

SUMMARY

New Applications	146
Applications for change of grading:	
Promotion from Associate-Member	5
Promotion from Junior	12
Total	163

SUMMARY SHOWING AVERAGE AGE AND POSITIONS OF APPLICANTS ON BALLOT, DECEMBER 14, 1918

Average age of applicants:	
Members	41
Associates	39
Associate-Members	34
Juniors	26
Chief Engineers	2
Commercial Engineer	1
Consulting Engineers	2
Designers	4
Draftsman	1
Chief Draftsman	1
Assistant Chief Draftsman	1
Efficiency Engineer	1
Electrical Engineer	1
Executives (Pres., Vice Pres., Secy., Mgrs.)	8
Hydraulic Engineer	1
Instructor	1
Maintenance Engineer	1
Master Mechanic	1
Mechanical Engineers	5
Assistant Mechanical Engineers	4
Plant Engineer	1
Assistant Plant Engineer	1
Production Engineers	2
Sales Engineers	2
Steam Engineer	1
Senior Engineer	1
Superintendents	6
Assistant Superintendent	1
Miscellaneous	5

UNITED STATES GOVERNMENT SERVICE

Majors	2
Lieut. Colonel	1

THE ENGINEERING INDEX

Published Monthly by The American Society of Mechanical Engineers

The Engineering Index was Founded in 1884 by the Association of Engineering Societies; Published from 1895 to 1918, inclusive, by The Engineering Magazine Company; and Acquired January 1919 by The American Society of Mechanical Engineers

The following pages form a descriptive Index to articles on engineering and related subjects in current periodicals. In its preparation the Society's engineering staff regularly examines all of the technical journals and society publications received by the Engineering Societies Library, which form one of the greatest and most complete collections of scientific periodicals in the world, comprising upward of 1100 distinct publications in some ten languages. Cross-references are freely introduced in the Index, and in all cases where the titles of articles are not sufficiently descriptive, explanatory sentences are appended. The main abbreviations used in the items are given at the bottom of this page.

PHOTOSTATIC COPIES OF ARTICLES LISTED

The Society is prepared to supply photostatic copies (white printing on brown background) of any of the articles listed. Copies of the periodicals themselves, or clippings of articles, cannot be supplied.

Price of each print (up to 11 x 14 in. in size), 25 cents plus postage. A separate print is required for each page of the larger-size periodicals, but where possible two pages will be photographed together on the same print. Bill will be mailed with the prints.

Those holding coupon books for clippings formerly issued by The Engineering Magazine Company may use the coupons in payment for photostatic prints. In ordering, state plainly

(1) Page number of Index on which item appears
(2) Title of article
(3) Name of periodical.

Orders should be sent to

Harrison W. Craver, *Director*,
Engineering Societies Library,
29 West 39th Street, New York City.

DIVISIONS OF THE ENGINEERING INDEX

Mechanical Engineering

AIR MACHINERY

Air Conditioning

Air Conditioning, Charles L. Hubbard. Domestic Eng., vol. 85, nos. 3 and 4, Oct. 19 and 26, 1918, pp. 82-84, 2 figs. and 118-120, 5 figs. Possibilities of this branch of heating and ventilating engineering and how it may save coal and raise efficiency of employees in industrial plant.

Pneumatic Tools in Winter

Effects of the Use of Pneumatic Tools on the Nervous System, Francis M. Barnes. Safety Eng., vol. 36, no. 4, Oct. 1918, pp. 239-240. Recommends warming chisel in cold weather, enlarging or covering shank to prevent cramp in hand muscles, and condemns practice of blocking exhaust outlet, thereby forcing current of cold air over fingers. From Proc. Seventh Annual Safety Congress.

CORROSION

A Case of Corrosion Caused by Electrolytic Action in a Westinghouse-Leblanc Air Pump (Un cas de corrosion à allure électrolytique dans une pompe à air Westinghouse-Leblanc), L. Conge. Revue Générale de l'Electricité, vol. 4, no. 15, Oct. 12, 1918, pp. 539-540, 2 figs. States that no pipe or machine element intended to operate exposed to direct action of any kind of water should be composed of metals capable of forming a voltaic couple.

FOUNDRIES

Brass Foundry

A Brass Foundry With Automatic Ventilation, Charles Vickers. Foundry, vol. 46, no. 316, Dec. 1918, pp. 568-574, 11 figs. Description of foundry with its ventilation arrangements.

Coreroom

Modern Coreroom for Malleable Foundry, Donald S. Barrows. Iron Age, vol. 102, no. 21, Nov. 21, 1918, pp. 1254-1255, 5 figs. Designed and constructed for 50,000-ton foundry, provides for economical handling of raw materials and finished cores. Abstract of paper before Am. Foundrymen's Assn., Oct. 1918. Also in Foundry, vol. 46, no. 316, Dec. 1918, pp. 577-578, 5 figs.

Die Casting

Die-Casting of Aluminum, H. Rix and H. Whitaker. Sci. Am. Supp., vol. 86, no. 2237, Nov. 16, 1918, pp 314-315. Advantages; heat treatment; material for dies; cost of process. Paper before Inst. of Metals.

Furnaces

Continuous Tunnel Furnace in Malleable Industry, Philip d'H. Dressler. Foundry, vol. 46, no. 316, Dec. 1918, pp. 566-567, 5 figs. Discussion of paper by H. E. Diller on Experiments in Annealing Malleable Iron, at annual meeting of Am. Foundrymen's Assn., Milwaukee, Oct. 1918.

Electric Furnace in the Steel Foundry, W. E. Moore. Iron Age, vol. 102, no. 20, Nov. 14, 1918, pp. 1206-1207. Comparison of electric and converter costs; relation to power station; future of electric steel foundries. From paper before Am. Foundrymen's Assn., Milwaukee, Oct. 1918.

Oil-Burning Cupola Operations Analyzed, John Howe Hall. Foundry, vol. 46, no. 316, Dec. 1918, p. 558. Results attained in melting iron for 3-ton converter plant point to saving in fuel and labor with more steady output. From paper before Am. Foundrymen's Assn., Milwaukee, Oct. 1918.

Ladles

Suggest Standard Sleeves and Nozzles. Brick & Clay Rec., vol. 53, no. 11, Nov. 19, 1918, pp. 882-883, 21 figs. Standard dimensions for round-face and straight-face nozzle brick for foundry ladles proposed by Am. Face Brick Assn., also dimensions of sleeves for foundry ladles proposed by a committee of

Note.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
New York (N. Y.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

steel men and founders in joint assembly with a committee of manufacturers of sleeve and nozzle brick.

Malleable Iron

Malleable Iron Castings, P. A. Paulson. Iron Age, vol. 102, no. 21, Nov. 21, 1918, p. 1266. Advantages over steel castings for agricultural purposes. From paper presented at Am. Foundrymen's Assn., Milwaukee, Oct. 1918.

The Integrity of the Malleable Casting, Enrique Touceda. Iron Age, vol. 102, no. 20, Nov. 14, 1918, pp. 1204-1205. Possibility of obtaining thoroughly sound castings; use of chills detrimental; effect of war on industry. From paper before Am. Foundrymen's Assn., Milwaukee, Oct. 1918.

Molding

How Marine Cylinders Are Molded and Cast, F. H. Bell. Can. Machy., vol. 20, no. 22, Nov. 28, 1918, pp. 611-614, 7 figs. Description of method used in a Toronto plant.

Pit Molding an Intricate Condenser Casting. Foundry, vol. 46, no. 316, Dec. 1918, pp. 552-557, 10 figs. Structural difficulties, experienced more generally in light work, attended production of this 34,900-lb. casting.

Patterns

The Engineer in Relation to the Foundry, E. S. Carman. Iron Age, vol. 102, no. 20, Nov. 14, 1918, pp. 1200-1202, 13 figs. Machine designs not adapted to advanced foundry practice; comparison of correct and incorrect patterns for floor molding. From paper before Am. Foundrymen's Assn., Milwaukee, Oct. 1918.

Pouring

A Modern Pouring System. Iron Age, vol. 102, no. 20, Nov. 14, 1918, p. 1203, 3 figs. New type of pouring device and hand crane.

Sand

Improving Foundry Sand Mixtures, Henry B. Hanley. Iron Age, vol. 102, no. 19, Nov. 7, 1918, pp. 1146-1148, 3 figs. Use of sand-mixing machine; time required for mixing; effect of sea coal and fireclay. From paper before Am. Fdrys. Assoc., Milwaukee, October 1918. Also in Foundry, vol. 46, no. 316, Dec. 1918, pp. 559-562, 5 figs.

Semi-Steel

Methods of Manufacturing Semi-Steel for Projectiles (Sui vari metodi di fabbricazione della ghisa per proiettili), Giulio Sirovich. Ingegneria Italiana, vol. 2, no. 4, Sept. 26, 1918, pp. 178-180.

Urgent Shell Need Found Foundries Ready. Foundry, vol. 46, no. 316, Dec. 1918, pp. 581-587, 15 figs. Manufacturing operations and practices developed in American foundries would have furnished tonnage of semi-steel shell beyond all prospective requirements.

Supervision

A Foundry Supervision System, Paul R. Ramp. Iron Age, vol. 102, no. 23, Dec. 5, 1918, pp. 1383-1385, 2 figs. Routine set of reports designed to provide quick and accurate gage of current costs and operations. From p per before Am. Foundrymen's Assn., Milwaukee, Oct. 1918.

See also ELECTRICAL ENGINEERING, Power Applications (Furnaces).

FUELS AND FIRING

Ash

Clinker and Ash in Fuel. Times Eng. Supp., no. 527, Sept. 1918, p. 186. Methods employed for curtailing labor entailed in removing large and hard masses of clinker.

The Fusibility of Coal Ash and the Determination of the Softening Temperature, Arno C. Fieldner, Albert E. Hall and Alexander L. Field. Department of Interior, Bureau of Mines, Bul. 129, 1918, 146 pp., 38 figs. Review of literature on subject; effect of various oxidizing, reducing, and neutral atmospheres such as are found in various parts of fuel bed on softening temperature of ash when molded in form of Seger cones; development of method for determining fusibility whereby ash is caused to soften and form slags in which iron exists in approximately same state of oxidation as when in fuel-bed clinkers.

Boiler Firing

Combustion in Its Relation to Boilers, E. A. Uehling. Power, vol. 48, no. 23, Dec. 3, 1918, pp. 804-806. Describes requirements for complete combustion and discusses combustion efficiency and absorption efficiency.

Generation of Heat and Its Absorption by Boiler, Henry Misostow. Nat. Engr., vol. 22, no. 10, Oct. 1918, pp. 518-522, 4 figs., and (discussion) pp. 522-525. Conditions which will realize an efficient commercial combustion and suggestions to utilize heat indications in securing good performance in boiler room. Paper before Nat. Assn. of Stationary Engrs.

The Firing of Steam Boilers. English Mechanic & World of Sci., vol. 108, no. 2796, Oct. 25, 1918, p. 155. Report of German patent comprising an air chamber divided by two transverse partitions and placed immediately below top portion of endless chain grate. From Zeitschrift für Dampfkessel und Maschinenenbetrieb, July 5. 1918.

Coal, Combustion Characteristics

Combustion Characteristics of Coals, Joseph G. Worker. Elec. Rev., vol. 73, no. 22, Nov. 30, 1918, pp. 849-851. Combustion characteristics of coals and their influence upon choice of stoker equipment; load conditions also important factor.

Conservation

Coal Conservation. Times Eng. Supp., no. 527, Sept. 1918, p. 187. Abstract of report of Coal Conservation Committee of Ministry of Reconstruction.

England's Fuel Rationing Order. Heat. & Vent. Mag., vol. 15, no. 11, Nov. 1918, pp. 17-21. Provisions of new regulation limiting supply of coal, gas and electricity to domestic consumers.

Fuel Regulation during the War, P. B. Noyes and D. M. Myers. Nat. Engr., vol. 22, no. 10, Oct. 1918, pp. 481-492. Discussion by Federal Government officials before Nat. Assn. of Stationary Engrs.

Industrial Coal Economy, David Wilson. Machy. Market, no. 939, Nov. 1, 1918, pp. 19-20. Suggestions based on the experience of the author who is technical advisor to Coal Controller. Paper before Assn. of Engrs.-in-charge. (To be continued.) Also in Elecn., vol. 81, no. 2110, Oct. 25, 1918, p. 540.

Proposed Coal-Rationing Rules for the United States. Heat. & Vent. Mag., vol. 15, no. 11, Nov. 1918, pp. 21-23. Allowances designed for heating, cooking and hot-water service in residences, flats and apartment houses. Final draft of report of Committee on Fuel Conservation, Am. Soc. of Heating and Vent. Engrs.

Rational Utilization of Commercial Fuels (Sur l'utilisation rationnelle des combustibles dont dispose actuellement l'industrie). Revue Générale de l'Electricité, vol. 4, no. 14, Oct. 5, 1918, pp. 505-511. Report of the Ministry of Armament and War Manufactories. From Bulletin des Usines de Guerre, Aug. 26 and Sept. 2, 1918, pp. 137-140 and 145-147.

Gasoline

Substitute for Gasoline Tested. Motor Age, vol. 34, no. 23, Dec. 5, 1918, p. 15. Excerpts of tests made by Bureau of Standards on secret product said to be composed of inexpensive and easily obtainable materials.

Hand-Fired Plants

Fuel Economy in Hand-Fired Power Plants. Power Plant Eng., vol. 22, no. 23, Dec. 1, 1918, pp. 953-956, 4 figs. Settings, stacks and breechings. Fourth article.

Load Factor

Coal Consumption Rates in Various Central Stations and Industrial Plants. Elec. Rev., vol. 73, no. 22, Nov. 30, 1918, pp. 846-848, 2 figs. Result of study by Hydro-Electric Commission of Ontario proves superiority of large power plant and emphasizes economy of high load factor.

Oil Fuel

California Petroleum as a Fuel Oil, Thomas J. Boyer. Nat. Engr., vol. 22, no. 10, Oct. 1918, pp. 525-533, 13 figs., and (discussion) pp. 533-534. Account of development; study of use in steam-boiler practice and suggestions for satisfactory operation; test in a water-works pumping station. Paper before Nat. Assn. of Stationary Engrs.

Pulverized Coal

First Pulverized Coal Installation in Western Canada, H. R. Collins. Min. & Eng. Rec., vol. 23, nos. 17 and 18, Sept. 30, 1918, pp. 177-179. Features of pulverizing plant.

Pulverized Fuel, E. R. Knowles. Steam, vol. 22, no. 5, Nov. 1918, pp. 128-133, 10 figs. Temperatures attainable; disadvantages of pulverized coal as fuel; requirements for successful burning. (Concluded.)

Pulverized Fuel in the Oneida Street Plant of the Milwaukee Elec. Ry. & Light Co., F. Dornbrook. Nat. Engr., vol. 22, no. 10, Oct. 1918, pp. 535-537, and (discussion) pp. 537-539. Results obtained with trial installation. Paper before Nat. Assn. of Stationary Engrs.

Pulverizing Coal, J. Cunliffe. Eng. & Cement World, vol. 13, no. 10, Nov. 15, 1918, pp. 56-58. Waste resulting from burning coal in lumps; preparation, application and burning of pulverized coal.

Waste Heat

Waste Heat from Steel Furnaces, Thomas B. Mackenzie. Times Eng. Supp., no. 527, Sept. 1918, p. 195. Method of utilizing waste heat from open-hearth furnaces in generation of steam. Paper before Iron & Steel Inst.

HANDLING OF MATERIALS

Coal

Coal-Handling Plant of Virginian Railway, E. F. Case. Ry. Rev., vol. 63, no. 21, Nov. 23, 1918, pp. 731-735, 9 figs. Account of extensive additions to this railroad's plant at Sewall's Point, Va.

Excavation Material

Comparison of Excavation Haulage by Motor Trucks, Industrial Railways and Teams. Eng. News-Rec., vol. 81, no. 22, Nov. 28, 1918, pp. 993-996, 1 fig. Detailed cost accounts on construction of Brooklyn Army Supply Base show that trucks are more economical than teams and less economical but more flexible than railways.

Grain

Car Equipment for Loading or Unloading Grain (Installations pour le transport des grains montées sur wagons). Génie Civil, vol. 73, no. 14, Oct. 5, 1918, pp. 261-263, 11 figs. Two systems: by air pressure, and by suction.

Ore

Large Ore Storage in a Limited Space, F. L. Prentiss. Iron Age, vol. 102, no. 22, Nov. 28, 1918, pp. 1311-1313, 4 figs. Double bin system of Iroquois Iron Co. solves material-handling problems and results in short haul to skip cars.

Sand

Pneumatic Car Provides Efficient Method of Handling Sand, W. L. Whitlock. Elec. Ry. Jl., vol. 52, no. 22, Nov. 30, 1918, pp. 967-968, 5 figs. By use of new sand car, crew of regular car takes care of sand transportation which formerly required services of three additional men.

HEAT TREATING

Malleable Cast Iron

Experiments in Annealing Malleable Cast-Iron, H. E. Diller. Foundry, vol. 46, no. 316, Dec. 1918, pp. 564-566, 4 figs. Results of several laboratory experiments show that malleable iron can be annealed in tunnel furnace in 48 hours or less. From paper before Am. Foundrymen's Assn., Milwaukee, Oct. 1918.

Quenching, Steel

Warping of Steel by Repeated Quenching, J. H. Whiteley. Iron Age, vol. 102, no. 21, Nov. 21, 1918, pp. 1256-1257, 6 figs. How the metal contracts; direction of its flow; interesting features revealed by microscope. From paper before Iron and Steel Inst., London, Sept. 1918.

HEATING AND VENTILATION

Equipment

Care of Heating and Ventilating Equipment, Harold L. Alt. Power, vol. 48, no. 21, Nov. 19, 1918, pp. 736-738, 3 figs. Down-draft furnace. Also in Power, vol. 48, no. 23, Dec. 3, 1918, pp. 801-803, 5 figs.

Factory Heating

Factory Heating, Charles L. Hubbard. Steam, vol. 22, no. 5, Nov. 1918, pp. 123-127, 9 figs. System of heating with hot water under forced circulation. (To be continued.)

Some Factory Heating Problems, B. C. Moore. Wood-Worker, vol. 37, no. 9, Nov. 1918, pp. 26-27. Considerations of the economical value of keeping a factory heated night and day.

Hot-Air Furnace

How to Improve the Hot-Air Furnace, Charles Whiting Baker. Department of Interior, Bureau of Mines, Tech. Paper 208, 20 figs. Recommends practice of adding auxiliary cold-air duct by which air supply to furnace may be taken from inside the house, instead of from outdoors, during very cold or windy weather.

House Heating

Economical Heating of Cottages and Small Houses, Frederick Grant. Domestic Eng., vol. 85, no. 5, Nov. 2, 1918, pp. 160-162, 4 figs. Suggests features of design for both hot-water and steam-heating systems.

Office-Building Heating

Fuel Economy in the Singer Building, Norman King. Power, vol. 48, no. 20, Nov. 12, 1918, pp. 710-711. Some figures on costs and economies.

Vapor Heating

Modern Practice in Vapor Heating. Heat. & Vent. Mag., vol. 15, no. 11, Nov. 1918, pp. 44-46, 5 figs. The Moline system. Sixth article.

Ventilation

A Discussion of Ventilating Practices, Charles A. Mitke. Coal Industry, vol. 1, no. 10, Oct. 1918, pp. 379-381. Analysis of working conditions as affected by ventilation; installation of mechanical ventilation. Paper before Nat. Safety Congress.

No Quarrel Necessary Between Natural and Mechanical Ventilation Advocates. Heat. & Vent. Mag., vol. 15, no. 11, Nov. 1918, pp. 37-40. Clear and well-defined field for each method depending upon required air conditions with given type of occupancy and occupation. From reply by E. Vernon Hill to newspaper article.

See also ELECTRICAL ENGINEERING, Power Applications (Heating); MECHANICAL ENGINEERING, Air Machinery (Air Conditioning).

HOISTING AND CONVEYING

Cranes

Handling Shipbuilding Material at Atlanta Shipyard. Eng. News-Rec., vol. 81, no. 23, Dec. 5, 1918, pp. 1020-1022, 8 figs. Planned for direct routing; three craneways in fabricating yard; shape shop in open; turret cranes at shipbuilding berths; assembly yard.

Hoisting and Conveying Machinery (Des appareils de manutention dans l'industrie en général), F. Séba. Revue Générale de l'Electricité, vol. 4, nos. 12 and 14, Sept. 21, and Oct. 5, 1918, pp. 423-433 and 493-504, 39 figs. Sept. 21: construction and arrangement of bridge cranes, traversing jib hoists, ceiling hoists, and foundry hoists. Oct. 5: traveling cranes with auxiliary crab, rollers, rails, gear shafts, drums, cables and grab hoists.

Some Heavy Fitting-Out Cranes—1. Fixed Cranes at Kearny and Hog Island Yards. Eng. News-Rec., vol. 81, nos. 20 and 21, Nov. 14 and 21, 1918, pp. 885-890, 6 figs.; 937-941, 6 figs. 100-ton trolley bridge spanning slipway supplemented by portal cranes; platform derrick of unusual capacity and reach uses single-motor hoisting engine at Hell Gate arch-erection plant. Nov. 21: 11 Cantilever and Jib Travelers at Newark Bay and Bristol; double cantilever bridge traveling along pier commands line of ships on either side; provision for extension; friction draft gear buffers; tower jib crane fitted with special safety devices.

Drums

Drum Shapes as Affecting the Mine Hoist Duty Cycle and Motor Rating, F. L. Stone. Proc. Am. Inst. Elec. Engrs., vol. 37, no. 10, Oct. 1918, pp. 1203-1221, 22 figs. Points out that the problem of drum shape consists in varying diameter of different parts of winding drum so that load may be accelerated and retarded at beginning and end of its travel with minimum consumption of power, and gives numerical examples of performance of various drum shapes under assumed conditions.

Electric Hoisting Machines

Electric Hoisting Machines (Les machines d'extraction à commande électrique), G. Rouet. Revue Général de l'Electricité, vol. 4, no. 13, Sept. 28, 1918, pp. 451-457, 9 figs. Comparison between Léonard and three-phase types.

Ropes

Ropes for Hoisting Coal from Mines, M. W. Reed. Coal Industry, vol. 1, no. 10, Oct. 1918, pp. 388-391. Discussion concerning strength, elasticity, bending stress, starting, stopping, corrosion, clips and sockets for hoisting ropes; care and life of hoisting ropes. Paper before Nat. Safety Congress.

See also MECHANICAL ENGINEERING, Handling of Materials, Lubrication (Cranes), Machinery, Special (Hoisting Jacks)

HYDRAULIC MACHINERY

Flow of Water

A Proposed Hydraulic Experiment, Lord Rayleigh. Lond. Edinburgh & Dublin Phil. Mag., vol. 36, no. 214, Oct. 1918, pp. 315-316, 1 fig. Observation of flow of liquid between two cylinders revolving about their axes in opposite directions for the purpose of testing Froude's explanation regarding phenomena which take place when fluid passing along uniform pipe arrives at place where pipe expands.

Flow of Water in Wash Water Troughs for Rapid Sand Filters. Eng. & Contracting, vol. 50, no. 20, Nov. 13, 1918, pp. 461-462, 2 figs. From description in Cornell Civil Engineer of experiments made by Ernest C. Fortier and Frank V. Fields to determine surface curves for flow of water in wash water troughs and to develop formula for assistance of designers of troughs.

Flow of Water Through One- and One-Half-Inch Pipe and Valves, Frederick W. Greve, Jr. Purdue Univ., Bul. 1, Eng. Experiment Station, vol. 2, no. 2, July 1918, 21 pp. 16 figs. Tables and formulae for determining head losses incurred with use of pipes and valves.

Hydraulic Experiments with Valves, Orifices, Hose, Nozzles, and Orifice Buckets, Arthur N. Talbot, Fred B. Seely, Virgil R. Fleming and Melvin L. Enger. Univ. of Illinois Bul., vol. 15, no. 37, May 13, 1918, Bul. 105, 80 pp., 28 figs. Loss of hydraulic head in small valves; flow of water through submerged orifices; fire streams from small hose and nozzles; orifice bucket for measuring water.

Tides

Power from the Tides, J. O. Boving. Times Eng. Supp., no. 529, Nov. 1918, pp. 232-233, 6 figs. Design of turbines which author thinks will render utilization of tidal power economically feasible.

Water Hammer

Causes of Shock in Hydraulic Mains, Alfred Towler. Machy. Market, no. 942, Nov. 22, 1918, pp. 17-18. Broad consideration of cause and effect in principle of violent collision as determined by momentum. Paper before Leeds Assn. Engrs.

Maxima Excess Pressures Produced by Water Hammer (Etude sur les maxima de surpression dans les phénomènes de coups de bélier), Maurice Gariel. Revue Générale de l'Electricité, vol. 4, nos. 11 and 12, Sept. 21 and Oct. 5, 1918, pp. 403-411, 6 figs., and 483, 490, 4 figs. Analysis of modern theory of water hammer leads author to establish that Michaud's formula for maximum excess pressure applies to great majority of turbine installations; that Joukowski-Alliévi's formula applies to conduits of uniform dimensions when opening closes in less than $2\ L/a$ (where L is length in meters and a velocity of propagation of wave); and Sparre's formula in cases of non-uniform conduits and extremely rapid shut-off. Oct. 5: Investigations of phenomena of pressure waves developed in conduit by sudden release at opening and account of experimental verification of theoretical conclusions.

Waterwheels

Principles of Waterwheel Design, David R. Shearer. Power, vol. 48, no. 21, Nov. 19, 1918, pp. 732-734, 5 figs. Some of underlying principles simply illustrated, referring particularly to relation between velocity of water and the peripheral velocity of wheel.

INTERNAL-COMBUSTION ENGINES

Heavy-Oil Engines

The Diesel Engine, Its Fuels and Uses, Herbert Haas. Automotive Eng., vol. 3, no. 9, Oct. 1918, pp. 418-424. General characteristics of oil engines; three general types; various cycles and comparison of advantages of each; comparative economies; detail of construction. (To be continued.) Also in Jl. Soc. Automotive Engrs., vol. 3, no. 5, Nov. 1918, pp. 299-308, 5 figs.

The Heavy Oil Engine, Charles E. Lucke. Int. Mar. Eng., vol. 23, no. 11, Nov., 1918, pp. 625-629 (Conclusion of article.)

The Semi-Diesel Engine. Times Eng. Supp., no. 529, Nov. 1918, p. 245. Characteristics and design.

The Semi-Diesel Oil Engine, James Richardson. Engineering, vol. 106, no. 2756, Oct. 25, 1918, pp. 461-464, 12 figs. Review of many types of semi-Diesel engines. Paper before Diesel Engine Users' Asso., Oct. 24, 1918.

High-Speed Engine

Modern Types of Engines, Harry R. Ricardo, Machy. Market, no. 941, Nov. 15, 1918, pp. 17-18. Features of high-speed engine design and points upon which designers have concentrated their attention. Paper before North-East Coast Instn. of Engrs. & Shipbuilders. (To be continued.) Also in Int. Mar. Engr., vol. 23, no. 11, Nov. 1918, pp. 650-651.

Magnetos

Operation of Internal-Combustion-Engine Magnetos (Sul Funzionamento dei magneti di accensione dei motori a scoppio), Emilio Biffi. L'Elettrotecnica, vol. 5, nos. 22, 24 and 28, Aug. 5 and 25, Oct. 5, 1918, pp. 302-306, 326-332 and 386-392, 26 figs. Aug. 5 and 25: theory of the magneto-generator. Oct. 5: theory of formation of spark in secondary coil. (To be continued.)

Marine Engines

Two versus Four-Cycle Internal Combustion Marine Engines, Giovanni Chiesa. Engineering, vol. 106, no. 2757, Nov. 1, 1918, pp. 482-486, 6 figs. Purpose of article is to coordinate arguments which have been alleged for and against both types in their best form of construction and to endeavor to draw conclusion after careful consideration of all points of question.

Mixture

Mixing the Mixture, Robert Miller. Motor Boat, vol. 15, no. 22, Nov. 25, 1918, pp. 11-14, 6 figs. Points out importance of securing uniform mixture in cylinder in order to secure chemical combination and considers the problem of direct injection.

Pistons

Piston Design, Harry R. Ricardo. Automobile Engr., vol. 8, no. 119, Oct. 1918, pp. 274-278, 12 figs. Design in which connection between ring-carrying portion of piston and slipper surface is severed, so that heat can only be conducted to slipper surfaces by way of main webs, these being so constructed that heat from crown is distributed evenly over surface of slippers. Also in Autocar, vol. 41, no. 1201, Oct. 26, 1918, pp. 409-410, 3 figs.

Spark Plugs

Note on the Effect of Temperature on the Resistances of Spark Plug Insulations, J. D. Morgan. Engineering, vol. 106, no. 2758, Nov. 8, 1918, pp. 513-514, 3 figs. Description of an investigation.

See also AERONAUTICS, Engines; MECHANICAL ENGINEERING, Motor-Car Engineering (Engines, Gasoline, Kerosene, Kerosene Burning).

LUBRICATION

Cranes, Electric

Electric Crane Lubrication, Geo. R. Rowland. Lubrication, vol. 5, no. 12, Oct. 1918, pp. 2-10, 10 figs. Ring oiling system which consists of oil reservoir and brass ring attached to and revolving with shaft.

Cutting Tools

Cutting Lubricants and Cooling Liquids. Shipbuilding & Shipping Rec., vol. 12, no. 19, Nov. 7, 1918, pp. 445-446. Enumeration of factors upon which selection of suitable cutting lubricant or cooling liquid depends and suggestions in regard to their manipulation. From report issued by Advisory Council of Department of Scientific & Indus. Research.

Economy

Lubricant Economy, D. Street. Can. Machy., vol. 20, no. 22, Nov. 28, 1918, p. 617. Necessity for practicing economy and suggestions for reducing waste.

Steam Cylinders

Problems of Steam Cylinder Lubrication (III), W. F. Osborne. Blast Furnace, vol. 6, no. 10, Oct. 1918, pp. 414-416. Factors affecting operation and lubrication of compound engines.

See also MECHANICAL ENGINEERING, Motor-Car Engineering (Lubrication).

MACHINE ELEMENTS AND DESIGN

Bearings

Saving Power by Efficient Bearings, F. H. Lenox. Textile World Jl., vol. 54, no. 23, Dec. 7, 1918, pp. 91-95, 4 figs. Equipment method and results of experiments to determine power required to overcome friction of shaft bearings.

Bolts and Screws

S. A. E. Standard Screws and Bolts. Jl. Soc. Automotive Engrs., vol. 3, no. 5, Nov. 1918, pp. 333-335, 1 fig. Brief account of development of standards and comparison of standard screw-thread pitches used in five inch-systems most generally adopted in American and British practice,—B. W. S., B. S. F., U. S. S., S. A. E. Reg., S. A. E. Fine.

Crankshafts

Problems of Crankshaft Design, Otto M. Burkhardt. Aerial Age, vol. 8, no. 7, Oct. 28, 1918, pp. 376-379, 15 figs. Mathematical analysis of three groups of forces necessary to induce and maintain speeds of 3000 r.p.m. or more: pressures due to gaseous mixture, inertia forces and centrifugal forces. Paper before Eng. Soc. of Buffalo.

Gears

The Internal Gear. Pamphlet published by Fellows Gear Shaper Co., 92 pp., 55 figs. Popular presentation of the comparative tooth action of internal and external gear teeth, together with directions for cutting, and samples of applications.

See also MECHANICAL ENGINEERING, Internal-Combustion Engines (Pistons), Power Transmission.

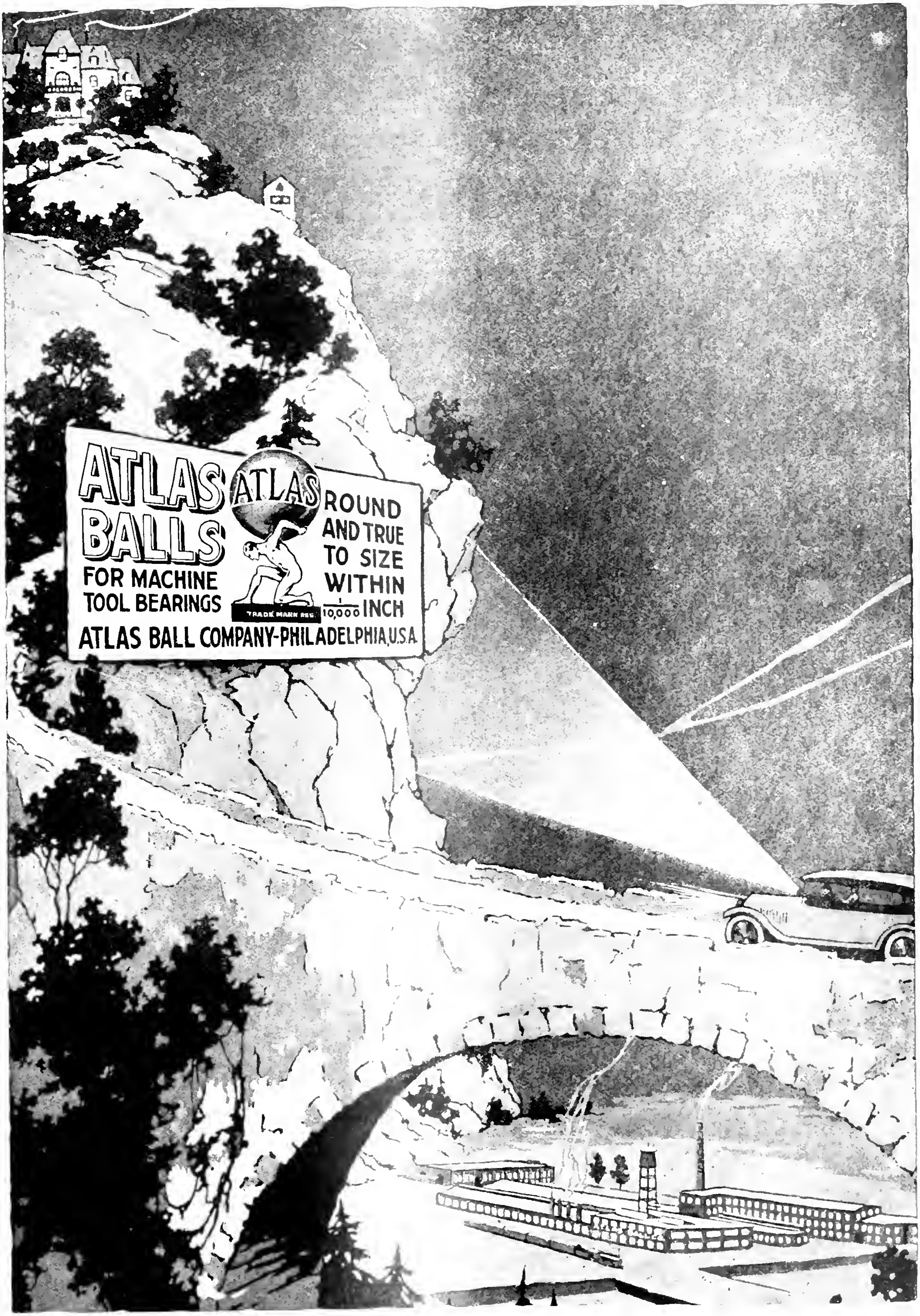
MACHINE SHOP

Tool Making

Tooling Up Single Spindle Automatics and Lathes. Can. Machy., vol. 20, no. 19, Nov. 7, 1918, pp. 536-537, 6 figs. Operations for British 101 fuse body.

Grinding

Grinding: Its Utility in the Modern Shop, D. Street. Can. Machy., vol. 20, no. 22, Nov.


ATLAS BALLS
FOR MACHINE TOOL BEARINGS
ATLAS
TRADE MARK REG.
ROUND AND TRUE TO SIZE WITHIN 1/10,000 INCH
ATLAS BALL COMPANY-PHILADELPHIA, U.S.A.

28, 1918, p. 623. Convenience of substituting grinding for tooling in certain machine operations.

Belting

Belting Speeds: Saw Speeds; Bearing Alloys, G. F. Cosgrove. Wood-Worker, vol. 37, no. 9, Nov. 1918, pp. 28-29. Account of experiments made with gang ripping machines with saws located above stock to be ripped, feed being by means of a grooved traveling bed which carries the stock beneath saws.

Drill Sharpening

Central Plant for Sharpening Drill Steels Saves Money in Quarrying. Eng. News-Rec., vol. 81, no. 21, Nov. 21, 1918, pp. 929-930, 3 figs. Sharpening shop with two men replaces five smithies; steel conveyor, oil-fired furnaces and concrete quenching vat.

Gages

Making Thread Gages, T. H. Fenner. Can. Machy., vol. 20, no. 19, Nov. 7, 1918, pp. 529-532, 7 figs. Description of plant and methods of a Canadian firm.

Milling

Continuous Milling, A. Thomas. Automobile Engr., vol. 8, no. 119, Oct. 1918, pp. 296-298, 12 figs. Notes on operation of Becker machine.

Operation

Scientific Organization of the Machine Shop (Organisation Scientifique de l'usinage), P. Denis. Génie Civil, vol. 73, nos. 12, 13 and 14, Sept. 21, 28 and Oct. 5, 1918, pp. 227-230, 246-251 and 268-271, 23 figs. Methodical execution of turning, countersinking and drilling. Sept. 21: selection of most economical cutting speed by construction of individual tool curves showing cutting speed against volume of material removed by tool at that speed before it needs resharpening. Sept. 28: further study of tool curves and their utilization in determining the most effective thermal treatment for tools used in cutting operations. Oct. 5: numerical illustrations and résumé of conclusions reached.

Punch Press

Safe Punch Press Operation, W. W. Roach. Safety Eng., vol. 36, no. 4, Oct. 1918, pp. 231-233. Discusses installation and use of mechanical guards, introduction of safe practices and education of press operators. From Proc. Seventh Annual Safety Congress.

Square Holes

Generating a Square Hole with a Gear-Shaper Cutter, Douglas T. Hamilton. Am. Mach., vol. 49, no. 21, Nov. 21, 1918, pp. 949-950, 2 figs.

Tool Department

Supervising a Large Tool Department, C. W. Starker. Indus. Management, vol. 56, no. 6, Dec. 1918, pp. 481-486. Step toward greater economy in tool department. Methods developed in tool department to coordinate requirements and minimize tool expense.

Tractor

Manufacturing the Caterpillar Tractor, Frank A. Stanley. Am. Mach., vol. 49, nos. 20, 22 and 23, Nov. 14, 28 and Dec. 5, 1918, pp. 897-901, 14 figs; 977-980, 9 figs. and 1040-1042, 12 figs. Milling work. Nov. 28: making connecting rods; Dec. 5: small parts.

See also MECHANICAL ENGINEERING, Lubrication (Cutting Tools), Welding; RAILROAD ENGINEERING, Shops.

MACHINERY, METAL-WORKING

Boring Bar

Making Boring Bars for Big Guns, M. E. Hoag. Am. Mach., vol. 49, no. 22, Nov. 28, 1918, pp. 987-988, 4 figs. Describing boring of hole 12 feet long 1¼ inches in diameter.

Grinder

Heald Cylinder Grinder. Am. Mach., vol. 49, no. 23, Dec. 5, 1918, pp. 1053-1054, 2 figs. Description of machine built by Heald Machine Co., Worcester, Mass., with principal dimensions.

Lathe

Amalgamated Shell-Turning Lathe. Am. Mach., vol. 49, no. 19, Nov. 7, 1918, p. 869, 1 fig. Short description with principal dimensions.

Slotting Machine

A New Slotting Machine of the Milling Type, J. V. Hunter. Am. Mach., vol. 49, no. 21, 1918, pp. 953-956, 9 figs. Description with principal data of new machine tool brought out by Racine Tool and Machine Co., Racine, Wis.

MACHINERY, SPECIAL

Chain

The Manufacture of Diamond Transmission Chain, J. V. Hunter. Am. Mach., vol. 49, nos. 19 and 23, Nov. 7 and Dec. 5, 1918, pp. 845-848, 9 figs, and 1027-1031, 16 figs. Making rollers; Dec. 5: Making block chain.

Rapid Development of Electric Cast Steel Anchor Chain Industry, W. L. Merrill. Int. Mar. Eng., vol. 23, no. 11, Nov. 1918, pp. 630-634, 8 figs. Electric welding versus hand welding; tests and results. Abstract of article in Gen. Elec. Rev.

Clocks

Studies in Clocks and Time-Keeping: No. 1. Theory of the Maintenance of Motion, R. A. Sampson. Proc. Roy. Soc. of Edinburgh, vol. 38, parts 1 and 2, session 1917-1918, pp. 75-114, 11 figs., and 169-218. Practical details of three clocks, Riefler, synchronome, and Cottingham; theoretical discussions on maintenance of motion, air resistance, barometric error, escapement error, temperature compensation, and other points connected with exact timekeeping. No. 2: Tables of the Circular Equation.

Evaporators

Lillie Multiple Evaporator. Steam, vol. 22, no. 5, Nov. 1918, pp. 142-143, 3 figs. Evaporator in which liquid is spread over heating surfaces in thin films.

Hoisting Jacks

Hydraulic Car Lift Gives Increased Output to Shops, Homer MacNutt. Elec. Ry. Jl., vol. 52, no. 21, Nov. 23, 1918, pp. 927-928, 4 figs. Description with illustrations of hydraulic hoisting jack.

Quarrying Machines

Labor-Saving Methods and Machines in Limestone Quarrying. Eng. & Contracting, vol. 50, no. 21, Nov. 20, 1918, pp. 478-479. From pamphlet by Oliver Bowles issued by U. S. Bureau of Mines.

Quenching Machine

A Quenching Machine for Hardening Small Drawing Dies. Am. Mach., vol. 49, no. 23, Dec. 5, 1918, pp. 1045-1046, 4 figs. Description of machine developed by S. A. Potter Tool and Machine Works, 70 East 130th St., New York.

Road Finisher

Road Finisher Produces Denser Concrete. Cement & Eng. News, vol. 30, no. 11, Nov. 1918, p. 34, 2 figs. Machine which subjects mixture to continuous agitation by tamper.

Scales

Modern 150-Ton Track Scale Now in Use, Frank C. Perkins. Can. Machy., vol. 20, no. 19, Nov. 7, 1918, pp. 544-547, 9 figs. Mechanism of design in which plate-steel fulcrums are used.

Screens, Gravel

Comparative Analysis of Gravel Screens, Raymond W. Dull. Cement & Eng. News, vol. 30, no. 11, Nov. 1918, pp. 21-23, 10 figs. Considers gravity, cylinder, overhung conical, and inclined conical types.

Shorthand Machine

Manufacturing a Shorthand Machine, M. E. Hoag. Am. Mach., vol. 49, nos. 19, 20 and 21, Nov. 7, 14 and 21, 1918, pp. 853-854, 8 figs., 902-904, 8 figs, and 946-947, 8 figs. Describing mechanical features of machine, some tools and dies. (First article.)

Tool Setter

Alignment-Tester and Microscopic Tool-Setter. Engineering, vol. 106, no. 2754, Oct. 11, 1918, pp. 398-399, 7 figs. Description of an instrument constructed by Cambridge Scientific Instrument Company, Limited, Cambridge.

See also CIVIL ENGINEERING, Roads and Pavements (Mixers).

MATERIALS OF CONSTRUCTION AND TESTING OF MATERIALS

Asphalt

Standardization of Required Consistency for Asphalt, J. R. Draney. Contract Rec., vol. 32, no. 46, Nov. 13, 1918, p. 910. Quotes present variations and suggests possible specifications.

Boiler Plate

Materials of Steam Boiler Construction, A. J. Dixon. Boiler Maker, vol. 18, no. 11, Nov. 1918, pp. 317-319. Action of carbon in boiler plate; dangers of free use of cast iron; laminar structure of wrought iron. From Power.

Cracks

Prevention of Season and Corrosion Cracks, W. B. Price. Am. Mach., vol. 49, no. 19, Nov. 7, 1918, pp. 848-850, 7 figs. Paper before Am. Soc. for Testing Materials, Atlantic City, June 1918.

Monel Metal

Note on Monel Metal, John Arnott. Engineering, vol. 106, no. 2756, Oct. 25, 1918, p. 451, 3 figs. Composition, microstructure, strength of rolled materials, effect of annealing strength at high temperature, use.

Silica Brick

Silica Brick Tests. Eng. & Cement World, vol. 13, no. 10, Nov. 15, 1918, p. 62. Brief report of experiments conducted in France which revealed that notable quantities of iron oxide do not sensibly lower fusing point of silica, even when lime is present.

See also CIVIL ENGINEERING, Materials of Construction; AERONAUTICS, Materials of Construction.

MEASUREMENTS AND MEASURING APPARATUS

Depth Gage

A Micrometer Depth Gauge, C. H. Copland. Model Engr., vol. 39, no. 914, Oct. 31, 1918, pp. 239-240, 6 figs. General arrangement and details of gage intended for use on munition or other fine work.

Hardness

The Institution of Mechanical Engineers. Engineering, vol. 106, no. 2756, Oct. 25, 1918, pp. 469-472, 5 figs. Discussion of three papers on hardness testing, "A Law Governing the Resistance to Penetration of Metals When Tested with a 10-mm. Steel Ball; and a New Hardness Scale in Energy Units," by Prof. C. A. Edwards, "The Value of the Indentation Method in the Determination of Hardness," by R. G. C. Batson, and "The Ludwik Hardness Test," by W. C. Unwin, all read at meeting of Inst., Oct. 1918.

The Ludwik Hardness Test, W. C. Unwin. Engineering, vol. 106, no. 2756, Oct. 25, 1918, p. 478. Paper before Inst. of Mech. Engrs., Oct. 1918.

The Resistance of Metals to Penetration Under Impact, C. A. Edwards. Engineering, vol. 126, no. 3276, Oct. 11, 1918, pp. 314. Abstract of paper before Inst. of Mech. Engrs., June 1918.

Value of the Indentation Method in the Determination of Hardness, R. G. C. Batson. Engineering, vol. 106, no. 2756, Oct. 25, 1918, pp. 475-477, 6 figs. Paper before Inst. of Mech. Engrs., Oct. 1918.

Heat Measurement

Heat-Measuring Instruments, C. E. Clewell. Am. Mach., vol. 49, no. 23, Dec. 5, 1918, pp. 1021-1025, 12 figs. Principal types of pyrometers; features connected with their use; typical uses; cases of practical installations of pyrometers illustrated.

Indicators

Indicator Cord Connections, R. T. Strohm. Southern Engr., vol. 30, no. 4, Dec. 1918, pp. 40-41, 7 figs. Collection of methods used by engineers to connect cord to reducing motion.

Minimeter

The Minimeter for Fine Measuring, Frank C. Perkins. Can. Machy., vol. 20, no. 21, Nov. 21, 1918, pp. 592-593, 5 figs. Principle and forms of Hirth apparatus for measuring threads, balls, cylindrical parts and grooves, also for inside measuring of various diameters.

Permeability

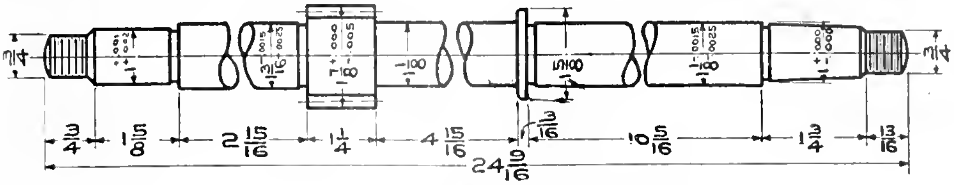
Determination of Permeability of Balloon Fabrics, Junius David Edwards. Aeronautics, vol. 15, no. 261, Oct. 16, 1918, pp. 358-364, 7 figs. Theory of process; volume-loss methods; penetration methods; experimental apparatus; effect of experimental conditions on apparent permeability; operating directions and calculations. From Aviation & Aeronautical Eng.

Variance

Variance of Measuring Instruments and Its Relation to Accuracy and Sensitivity, Frederick J. Schlink. Jl. Franklin Inst., vol. 186, no. 6, Dec. 1918, pp. 743-747. Abstract of notes from U. S. Bureau of Standards.

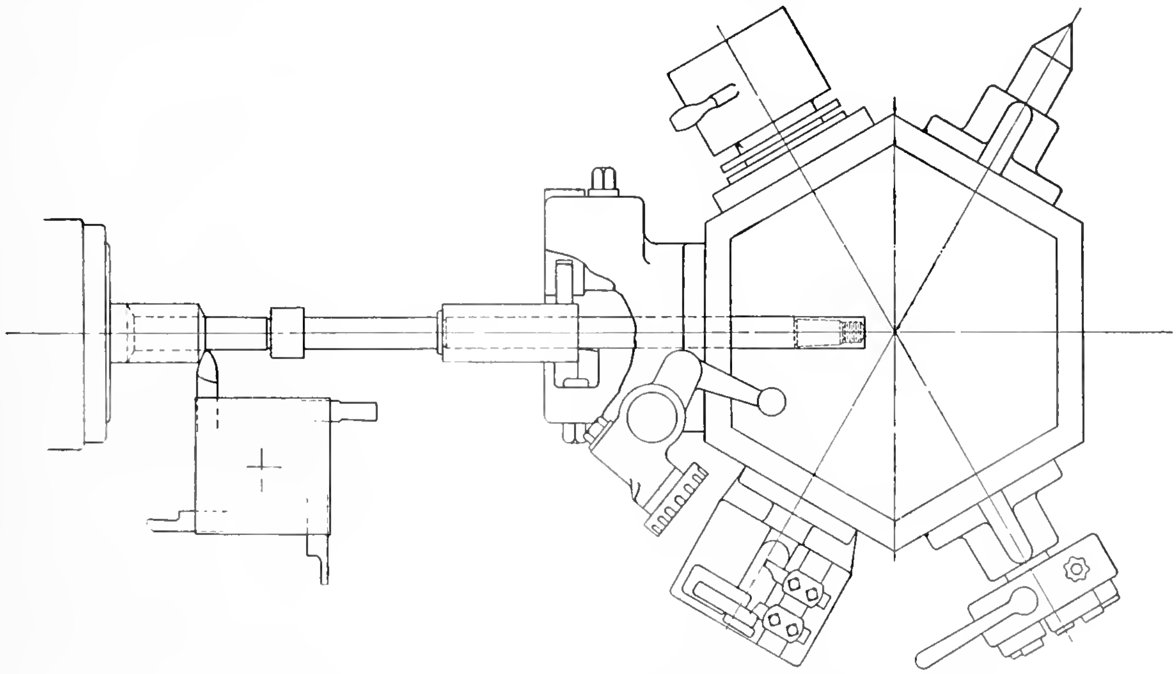
Viscosity

On the Measurement of the Viscosity of Liquids (Sur la mesure de la viscosité des huiles), C. Chéneveau. Journal de Physique, vol. 7, May-June 1917, pp. 109-114, 1 fig. Apparatus for measuring absolute viscosity by application of Poiseuille's law.



Follow This Thru

YOU will spend your time profitably by analyzing each operation in producing this shaft on the No. 2-A Universal Hollow Hexagon Turret Lathe.



1st Operation:—Turn the 1⅛ in. diameter with the turning tool. At the same time, with a cutter in the square turret, form the 1⅝ in. shoulder and turn the 1⅛ in. diameter behind the shoulder. With another square turret cutter, turn the 1⅞ in. and 1 3-16 in. diameter. The two turrets finishing their work simultaneously.

2nd Operation:—Turn the ¾ in. diameter.
3rd Operation:—Center Shaft.
4th Operation:—Turn the 1 in. tapered diameter with taper attachment and nick with square turrent cutter.
5th Operation:—Thread ¾ in. diameter.
6th Operation:—Cut off.

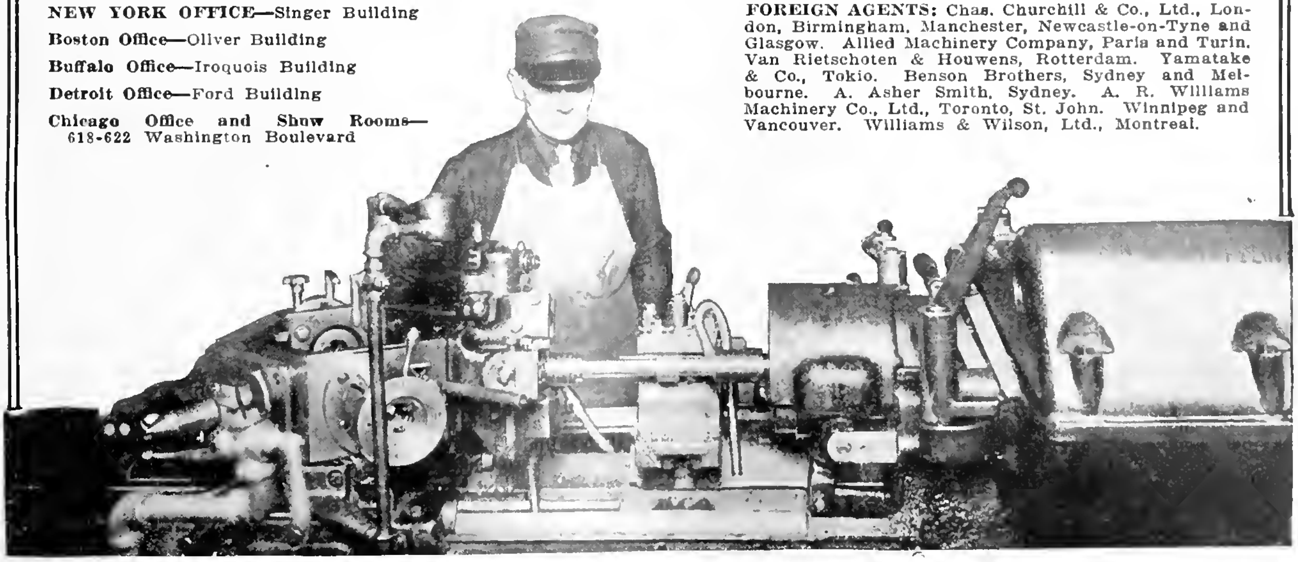
Warner & Swasey turret lathes will mean sure profits to you. Send blueprints for an analysis like the shaft job here.

THE WARNER & SWASEY COMPANY

CLEVELAND, OHIO, U. S. A.

NEW YORK OFFICE—Singer Building
Boston Office—Oliver Building
Buffalo Office—Iroquois Building
Detroit Office—Ford Building
Chicago Office and Show Rooms—618-622 Washington Boulevard

FOREIGN AGENTS: Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. Allied Machinery Company, Paris and Turin. Van Rietschoten & Houwens, Rotterdam. Yamatake & Co., Tokio. Benson Brothers, Sydney and Melbourne. A. Asher Smith, Sydney. A. R. Williams Machinery Co., Ltd., Toronto, St. John. Winnipeg and Vancouver. Williams & Wilson, Ltd., Montreal.



MECHANICS

Beams

Curved Beams. James J. Guest. Proc. Roy. Soc., vol. 95, no. A665, Sept. 2, 1918, pp. 1-21, 6 figs. Determination of stresses produced by bending moment in uniform curved beams of several special sections; method of estimating maximum stress applicable to sections considered and approximately to any other section not having extraordinary features.

The Buckling of Deep Beams. J. Prescott. Lond. Edinburgh & Dublin Phil. Mag., vol. 36, no. 214, Oct. 1918, pp. 297-314, 7 figs. Attempt to develop mathematical theory of side buckling of beam having a depth much greater than its breadth by assuming buckling has actually occurred and finding value of couples at end which will maintain buckled state of beam.

Elasticity

Elastic Solids Under Body Forces. D. N. Mallik. Lond. Edinburgh & Dublin Phil. Mag., vol. 36, no. 214, Oct. 1918, pp. 321-326. Derives from equation of equilibrium of isotropic solid under body forces mathematical expression for its displacement.

Theory of Elastic Phenomena Taking Place in Punching and Drawing of Plastic Blocks (Théorie du poinçonnage et de l'écoulement des blocs plastiques: phase elastique de ces phénomènes). J. Boussinesq. Comptes rendus des séances de l'Académie des Sciences, vol. 167, no. 15, Oct. 7, 1918, pp. 505-510. Studies general case of cylindrical block. Supplement to four previous communications (Comptes rendus, vol. 167, July 29, Aug. 5, 12, 19, pp. 186, 221, 253, 285) on the verification of Trosca's formulæ.

Shafts

The Periods of Lateral Vibration of Loaded Shafts—The Rational Derivation of Dunkerley's Empirical Rule for Determining Whirling Speeds. H. H. Jeffcott. Proc. Roy. Soc., vol. 95, no. A666, Oct. 7, 1918, pp. 106-115. Derives Dunkerley's rule by investigating conditions in uniform and light shaft freely supported by bearings at its ends, and loaded with discrete masses m_1, m_2, ... m_n, of negligible moment of inertia at definite points along its length. Then by considering several successively higher whirling speeds of loaded shaft, the degree of approximation of Dunkerley's rule is determined.

Springs

A New Theory of Plate Springs. David Landau and Percy H. Parr. Jl. Franklin Inst., vol. 186, no. 6, Dec. 1918, pp. 699-721, 8 figs. Mathematical study of effect of tapering ends of leaves on strength of spring. Continued from vol. 185, April 1918, p. 481. (To be continued.)

Tubes

Contribution to Our Knowledge on Calculation of Stresses in Tubes (Bidrag till Kännedom om tubers beräkning). Folke L:son Grange. Teknisk Tidskrift, Väg—och Vatten-Byggnadskonst, year 48, no. 10, Oct. 1918, pp. 145-147, 4 figs.

MOTOR-CAR ENGINEERING

Design

Aeronautical Experience Will Profoundly Affect Motor Car Practice. A. A. Remington. Automotive Ind., vol. 39, no. 18, Oct. 31, 1918, p. 776. Emphasizes necessity for greater standardization and more research work. Presidential address before British Instn. Automobile Engrs.

Post-War Chassis. Automobile Engr., vol. 8, no. 119, Oct. 1918, pp. 279-280. Possible effects of aircraft engine experience and other factors bearing upon design. (To be continued.)

Engines, Gasoline

The "American" Sleeve-Valve Motor. Auto. vol. 23, no. 44, Nov. 1, 1918, pp. 820-822, 6 figs. How sleeves are operated; suggestion to overcome tendency not to get rid of exhaust, by offsetting forward sleeve exhaust port from its present direct opposition to inlet and narrowing and deepening both it and others corresponding in cylinder wall and in head.

Engines, Kerosene

Beaver Kerosene Tractor Engines. Automotive Industries, vol. 39, no. 20, Nov. 14, 1918, pp. 839 and 862, 2 figs. Horsepower and torque curves of 4¾ × 6-in. engine and record of 5 hr. endurance test on full-open throttle at 900 r.p.m.

Fuel Consumption

Tests for Reducing Fuel Consumption on Motor Vehicles (Forsog paa Besparelse af Brændselsolie ved Automobilkorsel). Paul Bergsoe. Ingeniøren, year 27, no. 85, Oct. 23, 1918, pp. 557-558.

Gas Fuel

Coal Gas for Motor Vehicles. Times Eng. Supp., no. 527, Sept. 1918, p. 187. Modifications for running under compressed charges introduced by London General Omnibus Co.

Kerosene Burning (see Engines, Kerosene)

Kerosene Vaporization. L. E. French. Automotive Industries, vol. 39, no. 20, Nov. 14, 1918, p. 845, 2 figs. Apparatus embodying tube and hot-spot systems of vaporizing heavy fuel for internal-combustion engines, the two effects being automatically balanced.

The Bellem-Bregeras Kerosene Atomizer. Auto. vol. 23, no. 45, Nov. 8, 1918, p. 845, 2 figs. Theoretical value and practical performance results.

Lubrication

Lubrication and Fuel Tests. P. J. Dasey. Automotive Ind., vol. 39, no. 21, Nov. 21, 1918, pp. 875-877, 4 figs. Deals with tests made on a Buda tractor-type engine. Devorik's new synthetic gasoline. Paper before section of Soc. Automotive Engrs.

Single-Feed System Oils Car from Seat. Automotive Ind., vol. 39, no. 17, Oct. 24, 1918, p. 719. Multiple-plunger hand pump and reservoir constructed to supply oil under pressure to all points on chassis.

Steam Vehicles

Solid Fuels for Steam Vehicles. Motor Traction, vol. 27, no. 709, Oct. 2, 1918, pp. 243-244. Review of tests conducted by coal controller to prove that other fuels than Welsh coal could be used.

Tractors

Heider Friction Drive Tractor. Automotive Industries, vol. 39, no. 20, Nov. 14, 1918, pp. 831-832, 4 figs. Friction drive which enables a considerable number of tractor speeds and belt speeds to be obtained without use of shifting gears.

Wheels

Front Wheel Wobble. Walter Boyle. Motor Traction, vol. 27, no. 712, Oct. 23, 1918, pp. 305-306, 2 figs. Sketch of method to give trailing effort to front wheels by tilting steering heads.

See also CIVIL ENGINEERING, Roads and Pavements (Maintenance), (Wood Roads); ORGANIZATION AND MANAGEMENT, Transportation; MECHANICAL ENGINEERING, Fuels and Firing (Gasoline), Internal-Combustion Engines; AERONAUTICS, Auxiliary Services.

PIPE

Tile

Tile Pipe Versus Iron Pipe for Drains. Osborne Smith. Contract Rec., vol. 32, no. 44, Oct. 30, 1918, p. 873. Brief account of author's experience and suggestions in regard to jointing.

POWER GENERATION

Canada

Utilizing Canada's Water Powers. J. B. Challies. Can. Mfr., vol. 38, no. 8, Aug. 1918, pp. 25-27. Future possibilities and requirements for their realization. From paper before Can. Soc. Civil Engrs.

POWER PLANTS

Boiler Inspection

Ontario Boiler Inspection Office. Power, vol. 48, no. 20, Nov. 12, 1918, pp. 698-699, 13 figs. Examples of dangerous conditions found in boilers described and illustrated.

Boiler Operation

Boiler Room Efficiency. A. H. Blackburn. Power Plant Eng., vol. 22, no. 22, Nov. 15, 1918, pp. 919-920. Analysis of fuel; losses in boiler room; instruments; coal handling. Abstract of paper before Annual Convention of Smoke Prevention Assn.

Economic Operation of Steam Turbo-Electric Stations. C. T. Hirshfeld and C. L. Karr. Department of Interior, Bureau of Mines, Tech. Paper 204, 29 pp., 5 figs. Analysis of methods used in boiler room for producing steam required and distributing load between main units available. Discussion of economic source for auxiliary power and conclusion that auxiliary power in excess of that obtainable with exhaust steam absorption can be procured from main generators in electrical form at lower thermal cost than in any other way.

Economical Working of Boiler Plant. P. D. Kirkman. Machy. Market, no. 942, Nov. 22, 1918, p. 18. List of modern efficiency apparatus and of items to be studied in connection with waste and efficiency. Address to Manchester Branch of British Assn. of Textile Managers.

Economy in Boiler Operation. Thomas M. Gray. Southern Engr., vol. 30, no. 4, Dec. 1918, pp. 42-43, 1 fig. Advantages and disadvantages of high furnace temperatures; conditions produced by forcing boilers considerably beyond their rating; sampling and analyzing of flue gases.

Boiler Settings

Boiler Setting Radiation and Air Leakage. E. S. Hight. Elec. World, vol. 72, no. 21, Nov. 23, 1918, pp. 974-975, 1 fig. Results of experiments to determine best method of covering boiler settings to bring about reduction in radiation and escape of air; type of covering which saves $1000 per 500-hp. battery per year.

Central Stations

A Kilowatt Hour and the Coal Required to Produce It. B. H. Blaisdell. Elec. Eng., vol. 52, no. 2, Aug. 1918, pp. 26-28. Waste inherent in present system of generating power and remarks on some of the losses due to imperfect manipulation. Paper before Manila Section of Nat. Elec. Light Assn.

Increasing the Economy of Central-Station Operation. J. W. Andree. Elec. World, vol. 72, no. 19, Nov. 9, 1918, pp. 881-882. Overhauling water conduits and prime movers; burning natural gas to save fuel oil; other proved methods.

Coke-Oven Plants

Power Plants at By-Product Coke-Ovens. F. E. Harris. Ir. & Cl. Trds. Rev., vol. 96, no. 2617, April 26, 1918, pp. 450-452, 2 figs. Discusses requirements and how to obtain satisfactory results.

Condensers

Condensers and Condenser Engineering Practice. D. D. Pendleton. Power, vol. 48, no. 20 and 21, Nov. 12 and 19, 1918, pp. 720-722 and 756-757. Abstract of paper presented at twelfth annual convention of Assn. of Iron and Steel Elec. Eng., Baltimore, Sept. 1918.

Cost

Improving Factory Steam Plants (V). H. A. Wilcox. Power Plant Eng., vol. 22, no. 22, Nov. 15, 1918, pp. 915-918, 2 figs. Test to determine proper division of costs; schedule of operation for power department.

Economizers

Exact Data on the Running of Steam Boiler Plants. D. Brownlie. Engineering, vol. 106, no. 2757, Nov. 1, 1918, pp. 481-482. Economizers. First article.

Efficiency

Steam Plant Efficiency. Coal Trade Jl., year 50, no. 49, Dec. 4, 1918, pp. 1433-1434. Suggestions addressed operating officers, superintendents, chief engineers, motive power department officials and men in charge of stationary power, heating and pumping plants by U. S. Railroad Administration.

Exhaust Steam

Maintenance of a Proper Heat Balance. R. N. Ehrhart. Power, vol. 48, no. 20, Nov. 12, 1918, pp. 692-694, 4 figs. Describing band and automatic control of exhaust steam from auxiliaries so that quantity of exhaust steam available for feed heating may at all times be proportioned to load on main units, thus preventing waste of exhaust at light loads.

High-Pressure Steam

The Use of High-Pressure and High-Temperature Steam in Large Power Stations. J. H. Shaw. Inst. E. E., Nov. 1918, pp. 1-10, 5 figs. From the point of view of the engineer interested in the generation of electricity. Also in Machy. Market, no. 942, Nov. 22, 1918, pp. 19-20.

Individual Plants

New General Electric Steam Turbine Shop. F. L. Prentiss. Iron Age, vol. 102, no. 20, Nov. 14, 1918, pp. 1195-1199, 6 figs. Construction and other features in large plant designed for heavy machine work; production methods followed.

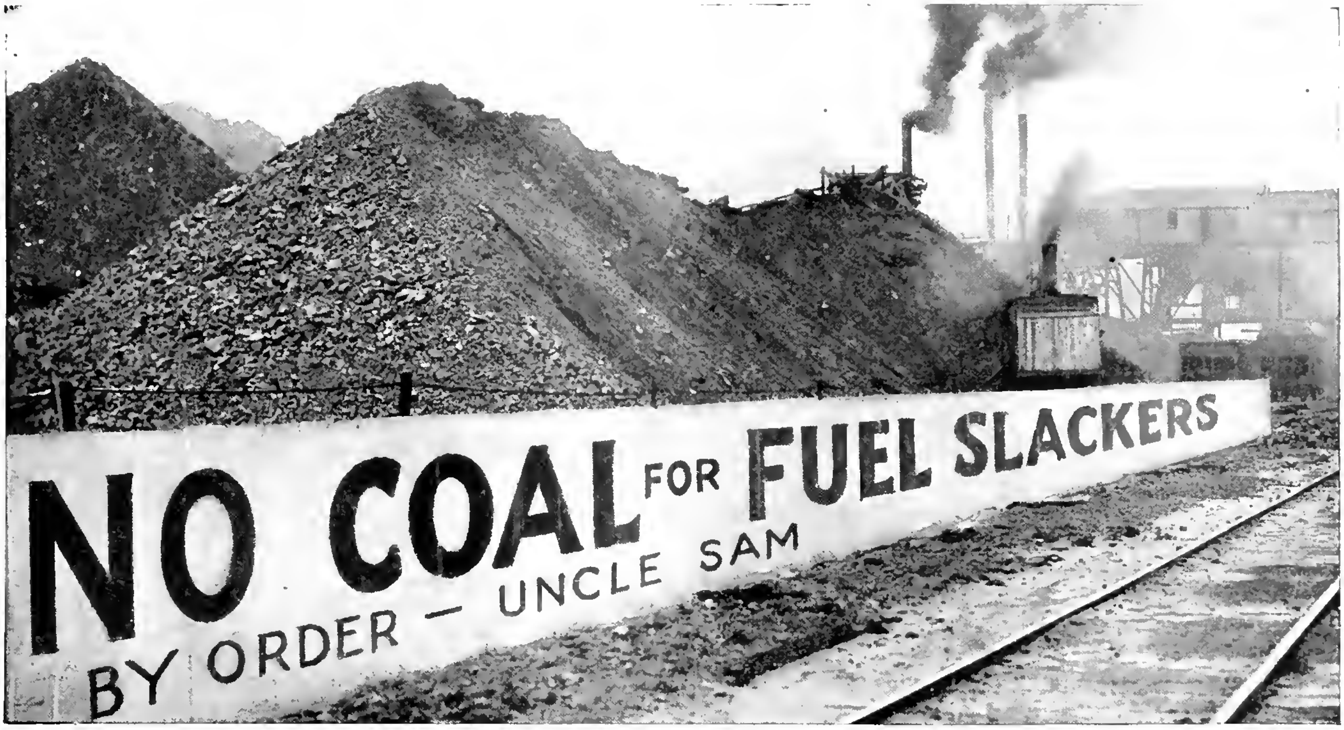
Plant Arrangement and Cost of Construction. Elec. World, vol. 72, no. 19, Nov. 9, 1918, pp. 888-890, 3 figs. Features of latest station of Turners Falls Power & Electric Co., may become one of most important steam plants in New England. (Second article.)

Instruments

Power Plant Management—(IV) The Use of Instruments. Robert June. Refrigerating World, vol. 53, no. 10, Oct. 1918, pp. 23-26, 7 figs. Importance of using recording instruments; graphs showing draft required at different combustion rates for various fuels, loss due to unconsumed carbon contained in CO_2 in flue gases, and loss due to heat carried away by chimney gases for varying percentages of CO_2.

Power Industry

Conditions in the Power Industry. Ludwig W. Schmidt. Power, vol. 48, no. 23, Dec. 3,



How "85% Magnesia" Saves the Nation's Coal Pile

If every steam pipe and every boiler were properly protected from heat losses by an efficient heat insulation, *enough coal would be saved* to furnish, not only to our vital industries, but to every coal user in the country, an *ample supply for all his needs.*

Are You a Fuel-slacker?

Are you heeding the urgent call of the Fuel Administration for the utmost economy in coal consumption, or are you robbing the nation's coal pile in order to cover your own neglect? Sooner or later you must answer this question. *What will your answer be?*

The Fuel Administration Says:

"The Fuel Administration realizes that *adequate insulating covering* is essential to the conservation of our all too scant fuel production."

It also says:

"Covering these surfaces with '85% Magnesia'...2" thick will save 80 per cent of the heat."

Are You Prepared?

Dare you say that every steam pipe and boiler in your plant is so thoroughly protected against heat wastage by the best possible insulation, that further economy is impossible? Is there no waste from your valves, flanges, or fittings? Is every feed water pipe, every feed heater, every auxiliary installation, similarly protected?

The Time for "85% Magnesia" is Now

"85% Magnesia" properly applied will bring down your coal losses due to heat-leakage to an irreducible minimum. This fuel economy not only benefits the nation but puts good money into your own pocket.

Not only does "85% Magnesia" save from 80% to 95% of all the heat that would otherwise be wasted, but its marvelous *durability* makes it the most paying investment in your plant:—(1) Because it saves its own cost in a few months; (2) Because this saving continues indefinitely—there is no known time-limit to the life of this insulation.

If you haven't "85% Magnesia" coverings throughout your Plant, *install them now*—not only on pipes and boilers, but on valves, fittings, flanges and feed heaters. If you already have insufficient thickness of Magnesia, overlay it with another thickness, according to the exact Table in the Magnesia Association Specification, compiled and indorsed by the Mellon Institute of Industrial Research, which gives exact rules for application of this master heat-insulation—*sent on request.*

Also write for Table showing monthly saving in dollars and cents by the use of "85% Magnesia."

MAGNESIA ASSOCIATION *of* AMERICA

721 Bulletin Bldg.
Philadelphia
Penna.

EXECUTIVE COMMITTEE, Wm. A. Macan, *Chairman*

George D. Crabbs . . The Philip Carey Co. . Cincinnati, Ohio
Alvin M. Ehret Ehret Magnesia Mfg. Co. . Valley Forge, Penna.
J. R. Swift . . The Franklin Mfg. Co. . Franklin, Penna.
R. V. Mattison, Jr. Keasbey & Mattison Co. . Ambler, Penna.

1918, pp. 798-800. Digest of reports of U. S. consuls on power situation in various parts of world and influence of war upon this industry.

The Power Plant Problem in South China, Harold B. Wilson. Power, vol. 48, no. 21, Nov. 19, 1918, pp. 747-748. Only pioneer work has been done and there is opportunity for America in this field.

Scale

Heat Loss Due to Scale. Can. Mfr., vol. 38, no. 8, Aug. 1918, p. 31, 1 fig. Chart showing approximate annual loss with coal at different prices.

Screens, Water

Screening Condensing Water Efficiently and Economically, Henry J. Edsall. Steam, vol. 22, no. 5, Nov. 1918, pp. 133-137, 7 figs. Describes traveling screens with automatic cleaning features.

Stack Losses

Steam Plant Efficiency, Henry Kreisinger. Coal Trade Jl., year 50, no. 47, Nov. 20, 1918, pp. 1392-1393. Causes of high ash loss; methods of determining stack losses; causes of large excess of air and remedy. (To be concluded.)

Temperature Regulation

Automatic Temperature Regulation as a Fuel Conservation Measure. Heat. & Vent. Mag., vol. 15, no. 11, Nov. 1918, pp. 40-43. Advanced report of a Committee on Automatic Heat Control, as furnished to Fuel Administration. For presentation at annual meeting of Am. Soc. of Heating and Vent. Engrs., New York, Jan. 1918.

Water Softening

Home-Made Water Softening Plant, H. D. Odell. Power, vol. 48, no. 21, Nov. 19, 1918, pp. 728-731, 3 figs. Description of home-made water-softening plant and experiences with it.

Wire-Making Plants

Power Generation for Wire Making. Power Plant Eng., vol. 22, no. 22, Nov. 15, 1918, pp. 907-914, 15 figs. Description of plants of John A. Roebling Sons Co., Trenton, N. J.

See also ELECTRICAL ENGINEERING, Generating Stations.

POWER TRANSMISSION

Gears

Saving Coal at the Gear and Wheel Tread, C. W. Squier. Elec. Ry. Jl., vol. 52, no. 20, Nov. 16, 1918, pp. 876-878, 7 figs. Discussion of losses in gearing; showing how correct gear ratio with low armature speed will save power; comparing gearless and geared motors and two and four motor equipments.

PRODUCER GAS

Machine Shop for Gas Producer Work. Iron Age, vol. 102, no. 23, Dec. 5, 1918, pp. 1373-1378, 14 figs. Features of new plant of Smith Gas Engineering Co., Dayton, Ohio. Producer operation for power purposes.

REFRIGERATION

Ammonia Compression

Improving a Refrigerating Plant, E. W. Miller. Refrigerating World, vol. 53, no. 9, Sept. 1918, pp. 25-26, 1 fig. Account of work done in installation consisting of a 50-ton horizontal double-acting compressor, a 150-hp. combination fire- and water-tube boiler, pumps and a 50-kw. generating unit.

The Ammonia Compression Refrigerating System (XXII), W. S. Doan. Refrigerating World, vol. 53, no. 9 and 10, Sept. and Oct. 1918, pp. 31-32, 3 figs. and 31-32, 3 figs. Troubles likely to develop in piston-rod stuffing box and manner of overcoming them.

Ammonia Leakage

Finding "Lost" Ammonia in Refrigerating Plants, E. W. Miller. Power, vol. 48, no. 21, Nov. 19, 1918, pp. 734-735. Common causes for leakage of ammonia.

Ice Plants

Ice Plant Troubles, E. W. Miller. Southern Engr., vol. 30, no. 4, Dec. 1918, pp. 48-50. Outline of conditions in actual case and suggestions on economical operation.

Operation

Making a Neglected Refrigerating Plant Give Capacity, E. W. Miller. Power, vol. 48, no. 23, Dec. 3, 1918, pp. 810-811, 1 fig. What was done to make comparatively new plant give rated capacity.

Small Machines

Small Refrigerating Machines, John E. Starr. Refrigerating World, vol. 53, no. 9, Sept. 1918, pp. 11-12. Difficulties presented by small machines in addition to the difficulties existing in all machines.

RESEARCH

The National Engineering Societies and the National Research Council, Geo. Ellery Hale. Proc. Am. Inst. Elec. Engrs., vol. 37, no. 10, Oct. 1918, pp. 1223-1236. War duties; present organization of research information service; international coöperation in research.

See also ELECTRICAL ENGINEERING, Measurements and Tests (Official Testing Laboratories).

STANDARDS AND STANDARDIZATION

Metric System

The Metric System, Harry Allcock. Surveyor, vol. 54, no. 1399, Nov. 8, 1918, p. 227. Criticism of arguments presented by Committee on Commercial and Industrial Policy After the War in their report against early introduction of metric system.

Use of the Metric System in the United States. Sci., vol. 48, no. 1248, Nov. 29, 1918, pp. 540-541. Resolution adopted by United States Section of International High Commission regarding use of metric system in U. S. in order to foster Pan-American commercial relations.

Screw Threads

Inaugural Presidential Address to the Manchester Association of Engineers. Steamship, vol. 20, no. 353, Nov. 1918, pp. 112-115. Consideration of various aspects of problem of standardizing screw threads and other industrial products.

STEAM ENGINEERING

Boilers

Safe Working Pressure for Steam Boilers, H. F. Gauss. Power, vol. 48, no. 22, Nov. 26, 1918, pp. 772-774. Simple treatment dealing with efficiency of riveted joints, bursting and safe working pressures for boilers, and permissible pressure on stayed surfaces.

How to Design and Lay Out a Boiler (I), Wm. C. Strott. Boiler Maker, vol. 18, no. 11, Nov. 1918, pp. 311-313, 4 figs. Formula for safe working pressure; maximum ultimate tensile strength for steel; factors of safety. (To be continued.)

Exhaust Steam

Commercial Value of Exhaust Steam, Frederick C. Ruck. Nat. Engr., vol. 22, no. 10, Oct. 1918, pp. 498-507. Data from actual observations and practical experience covering a period of several years. Paper before Nat. Assn. of Stationary Engrs.

Turbine Gives Additional Line Shaft Power. Blast Furnace, vol. 6, no. 10, Oct. 1918, pp. 430-432, 1 fig. Possibilities for expansion by use of exhaust steam in low-pressure turbines; efficiency of reduction gears.

Straight-Flow Engines

Details of Construction of Straight-Flow Steam Engines (Constructie-details van gelijkstroom-stoommachines), D. A. De Fremery. De Ingenieur, year 33, no. 42, Oct. 19, 1918, pp. 807-817, 23 figs.

Turbines

Avoiding Distortion in Turbine Operation, Webster Tallmadge. Power, vol. 48, no. 22, Nov. 26, 1918, pp. 762-765, 8 figs. Explaining some of careless treatments afforded steam turbines through ignorance and thoughtlessness and how to avoid them.

Care in the Operation of Small Turbines, J. A. MacMurchy. Power, vol. 48, no. 21, Nov. 19, 1918, pp. 744-745. Parts of small steam turbine which should receive particular attention.

The Steam Turbine (IX). Southern Engr., vol. 30, no. 4, Dec. 1918, pp. 52-53, 3 figs. Installation, operation and maintenance of Terry steam turbine. (To be continued.)

See also MECHANICAL ENGINEERING, Lubrication (Steam Cylinders), Motor-Car Engineering (Steam Vehicles).

THERMODYNAMICS

Heat-Transmission Tables

New Heat Transmission Tables (II), William R. Jones. Heat. & Vent. Mag., vol. 15, no. 11, Nov. 1918, pp. 24-29. Compilation of factors as given by leading authorities covering latest types of construction.

Specific Heats

The General Character of Specific Heats at High Temperatures, Walter P. White. Proc. Nat. Academy of Sci., vol. 4, no. 11, Nov. 1918, pp. 343-346. Experimental determination of specific heats of three forms of silica and two silicates for temperatures up to 1300.

WELDING

Electric Welding

A New Type of Portable Arc Welder. Eng. & Cement World, vol. 13, no. 10, Nov. 15, 1918, p. 64, 2 figs. Arrangement consisting of Lincoln 150-ampere arc-welding generator direct-connected to Wington G. L. 5 gasoline engine and intended for mounting on automobile truck.

Boiler and Other Repairs by Electric Welding. Can. Machy., vol. 20, no. 21, Nov. 21, 1918, pp. 596-599, 4 figs. Development of art and conditions necessary to insure satisfactory results. Paper before Inst. of Marine Engrs.

Electric Arc Welding, Robert E. Kinkead. Power, vol. 48, no. 22, Nov. 26, 1918, pp. 791-792. General descriptive article. Paper before Cleveland Eng. Soc.

Electric Welding—A New Industry, H. A. Horner. Proc. Am. Inst. Elec. Engrs., vol. 37, no. 10, Oct. 1918, pp. 1185-1195, 29 figs. Brief review of uses of electric spot and arc welding in the United States prior to formation of Electric Welding Committee of Emergency Fleet Corporation; developments in apparatus in last six months; activities of Welding Committee in applying electric welding process to shipbuilding industry.

Electric Welding for Shipbuilding Purposes, W. S. Abell. Shipbuilding & Shipping Rec., vol. 12, no. 20, Nov. 14, 1918, pp. 471-474. Summary of investigations undertaken and of development of industry. Paper before North-East Coast Instn. Engrs. & Shipbuilders.

Electric Welding for Ships. Times Eng. Supp., no. 529, Nov. 1918, p. 239. Results of tests in regard to strength, elasticity, alternating stress and other factors affecting reliability of welded joints.

Electric Welding Nomenclature and Symbols. Ry. Rev., vol. 63, no. 20, Nov. 16, 1918, pp. 702-707, 34 figs. Scheme developed for Emergency Fleet Corporation to indicate types of welds in ship construction.

Electric Welding on the Rock Island Lines, E. Wanamaker. Boiler Maker, vol. 18, no. 11, Nov. 1918, pp. 308-310. Gives actual results which show reduction in maintenance cost. Before Western Ry. Club.

Inspection of Steel Arc Welds, O. S. Escholtz. Iron Age, vol. 102, no. 23, Dec. 5, 1918, pp. 1390-1391, 2 figs. Factors determining their character; penetration and electrical tests; analysis of welds and their heat treatment.

Nomenclature for Electric Welding, H. G. Knox. Engineering, vol. 106, no. 2758, Nov. 8, 1918, pp. 522-526, 27 figs. From paper before Engrs.' Club of Philadelphia, June 26, 1918.

The Welding of Steel, B. K. Smith. Am. Mach., vol. 49, no. 23, Dec. 5, 1918, pp. 1025-1026. From paper before Northwestern Welders' Assn., Minneapolis, Oct. 1918.

Heat Treatment

Treatment of Metals After Welding. Can. Mfr., vol. 38, no. 8, Aug. 1918, pp. 29-30. Practical guide as to correct temperature to which metal should be heated and order of procedure. Prepared by l'Air Liquide Society, Toronto.

Oxyacetylene Welding

Defective Oxy-Acetylene Welds, D. Richardson. Flighr, vol. 10, no. 42, Oct. 17, 1918, pp. 1175-1176. Brief considerations on six causes of defective welds: impure acetylene, irregular delivery of gases, faulty manipulation of blowpipe, faulty filling materials, faulty preparation and adjustment, and faulty after-treatment of welds. Paper before British Acetylene Assn.

Oxy-Acetylene Pipe Welding and Cutting. Gas Age, vol. 42, no. 11, Dec. 2, 1918, pp. 471-474, 7 figs. Résumé of standard practice. (To be continued.)

The Oxy-Acetylene Flame and Blowpipe Efficiency, Arthur Stephenson. Acetylene & Welding Jl., vol. 15, no. 181, Oct. 1918, pp. 174-179, 2 figs. Volumes of air, oxygen and nitrogen required in flame; factor governing heating value per unit volume consumed; conditions which limit temperature of flame. (To be continued.)

The Steel Ship and Oxy-Acetylene Welding, J. F. Springer. Inst. Mar.-Eng., vol. 23, no. 12, Dec. 1918, pp. 699-701. Behavior of steel when heated. Restorative measures.

VARIA

Alignment Charts

Construction of Alinement Charts, Ralph E. Turner. Power Plant Eng., vol. 22, no. 23, Dec. 1, 1918, pp. 956-961, 7 figs. Working formulæ of three variables into simple alinement charts.

China

China a Market for the American Machine

Tool, L. W. Schmidt. Am. Mach., vol. 49, no. 20, Nov. 14, 1918, pp. 893-896. Electric power and industrial development; possibilities for American trade; difficulties to overcome.

Engineers' Act on Status of

Draft of Proposed Act for Engineers. Jl. Eng. Inst. Can., vol. 1, no. 7, Nov. 1918, pp. 331-332. Wording of Act proposed in province of Saskatchewan defining the status of the engineer.

Handles

The Uses of Wood (VII), Hu Maxwell. Am. Forestry, vol. 24, no. 299, Nov. 1918, pp. 679-687, 15 figs. Woods used in manufacture of handles.

Logging

Filling the Allies' Rush Order for Airplane Spruce, Nathan A. Bowers. Eng. News-Rec., vol. 81, no. 23, Dec. 5, 1918, pp. 1023-1031, 11 figs. Best talent of country assembled to develop methods new to logging and sawmill practice; 13 railroads built and 100,000 workers coördinated.

Pliers

Manufacturing Drop-Forged Pliers, Ellsworth Sheldon. Am. Mach., vol. 49, no. 20, Nov. 14 1918, pp. 889-893, 14 figs. Describing operations involved in manufacture of drop-forged pliers.

Electrical Engineering

ELECTROCHEMISTRY

Electrolytes

The Abnormality of Strong Electrolytes. II. The Electrical Conductivity of Non-Aqueous Solutions, Jnanendra Chandra Ghosh. Jl. Chem. Soc., vols. 113 and 114, no. 670, Aug. 1918, pp. 627-638. Application to non-aqueous solutions of author's equation derived from modification of Maxwell's equation of distribution of velocities.

Reduction of Metals

Electric-Furnace Reduction of Certain Metals Susceptible of Industrial Utilization (Sur la preparation au four électrique de quelques métaux susceptibles d'utilisation industrielle), Jean Escard. Revue Générale de l'Electricité, vol. 4, no. 11, Sept. 14, 1918, pp. 375-386, 3 figs. Notes on reduction of barium, calcium, glucinum, cobalt, nickel, titanium, manganese, chromium, molybdenum, tungsten, vanadium.

ELECTROPHYSICS

Distribution, Electrostatic

The Electron Theory of Metallic Conductors Applied to Electrostatic Distribution Problems, L. Silberstein. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 215, Nov. 1918, pp. 413-420. General expression for equilibrium distribution in terms of total charge and potential of external field, and application of general formula to cases of full spherical conductors and hollow sphere.

Electrospherical Functions

Electrospherical Functions Expressed as Determinants (Les fonctions électrosphériques sous forme de déterminants), Pierre Humbert. Comptes rendus des séances de l'Académie des Sciences, vol. 167, no. 12, Sept. 16, 1918, pp. 428-430. Expresses three electrospherical polynomials in terms of determinants of order p for the first two and the order $p+1$, for the last. Also in Revue Générale de l'Electricité, vol. 4, no. 18, Nov. 2, 1918, pp. 651-652; Annales de Physique, vol. 9, series 9, 1918.

Periodic Currents

Oscillating Energy (Energie oscillante), G. Szarvady. Revue Générale de l'Electricité, vol. 4, no. 12, Sept. 21, 1918, pp. 411-422, 2 figs. Application of Ohm's law and Kirchhoff's laws to watt currents and wattless components of electromotive forces and intensities of periodic currents.

Saturation

On the Calculation of Magnetic and Electric Saturation Values, J. R. Ashworth. Lond. Edinburgh & Dublin Phil. Mag., vol. 36, no. 214, Oct. 1918, pp. 351-360. Deduces $I_0 = \sqrt{(R/R^1)}$ where I_0 is limiting intensity of magnetization, R the gas constant and R^1 the reciprocal of the product of susceptibility into absolute temperature; also ($i_0 = \sqrt{(R/S)}$, where i_0 is maximum current density a conductor can carry, S ratio of resistivity to absolute temperature and V the velocity of electron as it passes along conductor.

Vacuum Phenomena

Rectification by Vacuum Discharge (in Japanese), T. Kujirai. Denki Gakkwai Zasshi, no. 361, Aug. 31, 1918.

Theory of Coolidge Tube (Sur la théorie du fonctionnement du tube Coolidge à radiateur), A. Dauvillier, Revue Générale de l'Electricité, vol. 4, no. 13, Sept. 28, 1918, pp. 443-445. Explains increase in resistance by presence of large quantity of oxygen liberated at focus and by partial oxidation of filament, together with formation of double layer which diminishes electronic emission.

Vibration, Mechanical, Generating Electrical Energy

Experiments on the Effect of the Vibration of a Stretched Wire Forming Part of a Closed Electric Circuit, Henry Jackson. Proc. Roy. Soc., vol. 95, no. A665, Sept. 2, 1918, pp. 51-57. Experiments with sensitive telephone detector which in author's judgment confirm Marran's suggestion that a mechanical vibration or note produces electricity.

GENERATING STATIONS

Alternators in Parallel

Synchronizing Alternators Coupled in Parallel (La mise en phase dans le couplage en parallèle des alternateurs), Eilvind Styff. Revue Générale de l'Electricité, vol. 4, no. 13, Sept. 28, 1918, pp. 460-465, 11 figs. Schemes of connections and diagrams of electromotive forces. From Elektrotechnische Zeitschrift, vol. 38, Sept. 20, 1917, p. 461.

Turbo-Alternators

Accidents to Steam Turbo-Alternators (Au sujet des accidents aux turbo-alternateurs à vapeur), P. Boucherot. Revue Générale de l'Electricité, vol. 4, no. 13, Sept. 28, 1918, pp. 457-460. Report of Sub-Committee of Union of Electrical Syndicates proposing as a result of studies (1) modifications in present designs of turbo-alternators, (2) modifications in usual specifications, and (3) dispositions to reduce loss when accident occurs.

The Production of Electricity by Steam Power, Alex. Dow. Elecn., vol. 81, no. 2111, Nov. 1, 1918, pp. 555-557. Abstract of address before Am. Electrochemical Soc.

GENERATORS AND MOTORS

Direct-Current Motors

Weight of Direct-Current Motors, A. Brunt. Elec. Eng., vol. 52, no. 2, Aug. 1918, pp. 28-29, 2 figs. Requirements of direct-current motors and graphs showing relation between weight and torque for commutating-pole and non-commutating-pole motors, and also between weight and torque for various makes of apparatus.

Induction Motors

Changing Speed of Induction Motors. Power Plant Eng., vol. 22, no. 22, Nov. 15, 1918, pp. 926-928, 2 figs. Possible speed changes of induction motors to suit conditions in power plants.

Rolling-Mill Motors

Standardizing Large Rolling Mill Motors, K. Pauly. Blast Furnace, vol. 6, no. 10, Oct. 1918, pp. 411-414, 1 fig. Suggests motors be rated on continuous capacity at some particular temperature in order to avoid present difficulties of users of large rolling-mill motors. Paper before Assn. Iron & Steel Elec. Engrs.

Single-Phase Generators

Armature Reaction and Wave Form of a Single-Phase Generator (in Japanese), G. Shimizu. Denki Gakkwai Zasshi, no. 362, Sept. 10, 1918.

Starting Resistances

Method for Determining Resistance Used for Starting Various Types of Motors, B. W. Jones. Power, vol. 48, no. 21, Nov. 19, 1918, pp. 740-741, 6 figs. A simple method for determining the ohmic value of resistance used for starting series-, shunt- and compound-wound direct-current motors and wound-rotor induction motors under various load conditions.

Synchronous Motors

For and Against Synchronous Motors, Will Brown. Elec. World, vol. 72, no. 21, Nov. 23, 1918, pp. 982-984, 4 figs. Four objections that have been frequently made to using synchronous motors; discussion showing how conditions have changed; synchronous motors and unity power factors.

Temperature Rise

Guarantees for Temperature Rise in Electrical Machinery, with Special Reference to Large Turbo-Generators, A. E. Du Pasquier. Tran. South African Inst. Elec. Engrs., vol. 9, part 7, July 1918, pp. 127-137 and (discussion) pp. 137-140. Urges that there is no good reason for restricting temperature rises, providing suitable materials are obtainable for withstanding the heat conditions that may arise.

See also MECHANICAL ENGINEERING, Fuels and Firing (Load Factor), Power Plants (Central Stations).

LIGHTING AND LAMP MANUFACTURE

Arc-Lamp Globes

Renovation of Discolored Arc-Lamp Globes, Alfred Herz. Elec. World, vol. 72, no. 20, Nov. 16, 1918, pp. 935-936, 2 figs. Description of a system of removing stain by heat treatment.

MEASUREMENTS AND TESTS

Galvanometers

The Einthoven Galvanometer, Samuel D. Cohen. Wireless World, vol. 6, no. 68, Nov. 1918, pp. 437-438. Special simple construction of Einthoven type used by writer for measuring radio receiving currents. From Elec. Experimenter.

Insulation Measurement

Electrolytic Method of Measuring Electrostatic Field of Insulators (La mesure du champ électrostatic dans les isolateurs, d'après la méthode électrolytique), W. Estorff. Revue Générale de l'Electricité, vol. 4, no. 12, Sept. 21, 1918, pp. 433-434, 1 fig. A small line is placed between electrodes in electrolyte and ratio of resistances of distances between line and each electrode is determined by Wheatstone bridge operating circuit with alternating current; correction coefficient for air values is determined in similar manner. From Elektrotechnische Zeitschrift, vol. 39, Feb. 7, 14 and 21, pp. 53, 62 and 76, 28 figs.

Some Notes on Leakage Indicators, G. W. Stubbings. Electricity, vol. 32, no. 1451, Aug. 30, 1918, pp. 453-454, 1 fig. Principle of instruments measuring state of insulation of a complete electrical system.

Meters

The Demand-Meter Situation, C. F. Mathes. Elec. World, vol. 72, no. 22, Nov. 30, 1918, pp. 1024-1026. Critical discussion of demand meters, pointing the advantages that are gained through use of well-known types of these instruments and remedies for some of the troubles encountered in their practical application.

Official Testing Laboratories

British Electrical Proving House. Times Eng. Supp., no. 527, Sept. 1918, p. 197. Essentials of schemed testing institution, with authoritative credentials, to deal with types of apparatus rather than with individual specimens.

Test-Ring Method

Test Ring Method for Determining Transformer Ratio and Phase Error, H. S. Baker. Elec. Rev., vol. 73, no. 20, Nov. 16, 1918, pp. 766-769, 6 figs. Use of special watt meter and current transformer for current transformer testing. From paper before Am. Inst. of Elec. Engrs.

POWER APPLICATIONS

Cement Industry

Electric Motors in the Cement Industry, R. B. Williamson. Proc. Am. Inst. Elec. Engrs., vol. 37, no. 11, Nov. 1918, pp. 1237-1273, 9 figs. Outline of various kinds of machinery used, and data as to power requirements; description of types of motor best suited to each application together with starting characteristics, overload capacity, torque and other features. Also in Elec. Rev., vol. 73, nos. 20 and 21, Nov. 23 and 26, 1918, pp. 770-771 and 813-814.

Coal Mining

Explosionproof Equipments of Colliery Motors and Accessories (in Japanese). Denki Gakkwai Zasshi, no. 363, Oct. 10, 1918.

The Use of Electric Power in the Mining of Anthracite Coal, J. B. Crane. Proc. Am. Inst. Elec. Engrs., vol. 37, no. 10, Oct. 1918, pp. 1197-1202, 7 figs. Power cost and current consumption of anthracite mines, also of bituminous mines; estimates of additional coal obtainable by electrification of anthracite mines, illustrations showing representative installations of electric drive.

Furnaces

Notes on Electric-Furnace Problems, J. L.

McK. Yardley. Bul. Am. Inst. Min. Engrs., no. 142, Oct. 1918, pp. 1593-1598, 4 figs. Analysis made to determine maximum capacity and aproximate performance of a new furnace designed to operate at 160 volts on a 60-cycle current.

Power Factor of the Electric-Arc Furnace (Fattore di potenza dei forni elettrici ad arco), O. Scarpa. Revista Tecnica d'Elettricita, no. 1891, Oct. 25, 1918, pp. 105-106. Presents formula for power factor of arc including power factor of furnace and ohmic resistance of electrodes.

Technical Analysis of Industrial Electric Furnaces: Classification, Choice of Apparatus, Installation and Operation (Considération techniques sur les fours électriques industriels; classification, choix des appareils, installation, mode d'emploi et conduite) Jean Escard. Revue Générale de l'Electricité, vol. 4, no. 16, Oct. 19, 1918, pp. 575-591, 31 figs. Electric arc furnaces; electric resistance furnaces; induction furnaces; electrothermotic and aluminum furnaces.

The Electric Furnace After the War, Francis A. J. Fitzgerald. Elec. Rev., vol. 73, no. 19, Nov. 9, 1918, pp. 726-727, 2 figs. Effect of the war upon electric furnaces; new uses to replace war's needs; tendencies in furnace design.

Heating

Electric Heat for Drying and Baking. George J. Kirkgasser. Indus. Management. vol. 56, no. 6, Dec. 1918, pp. 489-495, 11 figs. Types of industrial apparatus that have had rapid development during past five years.

Electric Thermal Storage Heaters for Rooms. English Mechanic & World of Sci., vol. 108, no. 2796, Oct. 25, 1918, pp. 155-156. Summary of report used by Committee of Swiss Electrotechnical Union. From Schweizerischer Elektrotechnischer Verein, Bul. June 1918.

Electrically Heated Industrial Appliances and Devices, George J. Kirkgasser. Indus. Management, vol. 56, no. 5, Nov. 1918, pp. 417-423, 32 figs. Outlines most important applications classified for 18 different industries, and shows many of simpler devices.

Iron-Ore Mining

Central Station Service Used in Operation of New Jersey Iron Ore Mines. L. R. W. Allison. Elec. Rec., vol. 24, no. 4, Oct. 1918, pp. 24-26, 5 figs. Installation where energy generated at steam station is transmitted to mines at 33,000 volts for operation of pumps, air compressors, hoists, etc., involving consumption of 600,000 kw-hr. per month.

Lime Plant

A Modern Motor-Driven Lime Plant. Cement & Eng. News, vol. 30, no. 11, Nov. 1918, pp. 19-20, 4 figs. Processes in electrically-driven plant utilizing waste marble.

Pumping

Electricity Supersedes Steam in Los Angeles. Eng. & Cement World, vol. 13, no. 10, Nov. 15, 1918, pp. 18-19, 3 figs. Electrical operation of pumping plants, it is said, will effect an annual saving of 18,000 bbl. of fuel oil. Also in Elec. Rev., vol. 73, no. 19, Nov. 9, 1918, pp. 723-725, 3 figs.

High Efficiencies Shown by Motor-Driven Water Works Pumps, Geo. H. Gibson. Can. Engr., vol. 35, no. 19, Nov. 7, 1918, pp. 412-413, 2 figs. Data on two 12-in. centrifugal pumps.

Rolling Mills

Electrically Driven Mills at Bethlehem, J. T. Sturtevant. Blast Furnace, vol. 6, no. 10, Oct. 1918, pp. 417-419, 10 figs. Layout, equipment, power consumption and tonnage on eleven installations at Lehigh plant, where G. E. induction motors are used.

Ship Propulsion

Electricity's Part in Building and Navigating of Ships, H. A. Hornor. Elec. Eng., vol. 52, no. 2, Aug. 1918, pp. 15-22, 20 figs. Considerations entering into selection of propulsion: commercial angle, first cost, efficiency, safety, upkeep, cost of operation, etc.; propelling machinery of various ships. (Concluded.)

Silk Industry

Electric Drive Applied to Silk Industry, Charles T. Guilford. Elec. Rev., vol. 73, no. 22, Nov. 30, 1918, pp. 855-857, 4 figs. Advantages of central-station service for this work; selection of motors and drives; interesting data on present installations.

Sugar Mills

Complete Electrification of Sugar Mills, Clarence G. Hadley. Elec. World, vol. 72, no. 22, Nov. 30, 1918, pp. 1022-1024, 2 figs. Extensive application of motors in this industry of recent origin; satisfactory results obtained in new Cuban mills, showing possibilities that may arise in this field as it is developed.

See also CIVIL ENGINEERING, Earthwork, Rock Excavation, etc.; MECHANICAL ENGINEERING, Hoisting and Conveying (Electric Hoisting Machines), Welding (Electric Welding); METALLURGY, Alloys, Ferrous.

TELEGRAPHY AND TELEPHONY

Radio Telegraphy and Telephony

A Combination Circuit for Tube and Crystal. Wireless Age, vol. 6, no. 2, Nov. 1918, p. 21, 1 fig. Combined or individual use of vacuum tube and crystal rectifier.

A New Protective Condenser. Wireless Age, vol. 6, no. 2, Nov. 1918, p. 34, 1 fig. Designed to protect electrical transmission lines from effect of high-frequency disturbances.

A Novel Radio Telegraph Aerial. Wireless Age, vol. 6, no. 2, Nov. 1918, p. 20, 1 fig. Type having series of coils inserted in antenna from earth to free end.

A Thermionic Valve Slopemeter. E. V. Appleton. Wireless World, vol. 6, no. 68, Nov. 1918, pp. 458-460, 3 figs. Derives formula to compute slopes of grid voltage-anode current and plate voltage-anode current curves at any particular operating plant.

Marconi's Improved Radio Transmitter. Wireless Age, vol. 6, no. 2, Nov. 1918, pp. 19-20, 3 figs. Method of producing continuous oscillations by overlapping wave trains.

Method for Exhausting Vacuum Tubes. Wireless Age, vol. 6, no. 2, Nov. 1918, pp. 20-21, 1 fig. Apparatus which provides for heating anode by vigorous bombardment of electrons without endangering filament, this being method to drive gases from plate.

Propagation of Electric Currents in an Antenna (Propagation des courants électriques dans une antenne), H. Chireix. Revue Générale de l'Electricité, vol. 4, no. 11, Sept. 14, 1918, pp. 363-374, 9 figs. Formulae (1) in general case of non-homogenous antennae, (2) when antenna consists of one branch, (3) when it consists of two, and (4) when it consists of three branches having different self-inductances and different capacities.

Solid-Contact Detectors (Contribution à l'étude des détecteurs à contacts solides). René Audubert. Journal de Physique, vol. 7, May-June 1918, pp. 127-128. Study of physical phenomena which probably take place in the action of crystal detectors used in wireless telegraphy. (To be continued.)

Some Aspects of Radio Telephony in Japan, Eitaro Yokoyama. Wireless World, vol. 6, no. 68, Nov. 1918, pp. 430-435, 8 figs. Account of recent discoveries; evolution of a rarefied gas discharger. (To be continued.)

The Radioelectric Installation at Stavanger, Norway (Stavanger Radio), Olaf Moe. Teknisk Ukeblad, year 65, no. 43, Oct. 25, 1918, pp. 505-514, 23 figs. (To be continued.)

Telephony (Wire)

How to Locate Telephone Troubles. J. Bernard Hecht. Telephony, vol. 75, nos. 21, 22 and 23, Nov. 23, 30 and Dec. 7, 1918, pp. 32-34, 3 figs.; 13-16, 10 figs, and 16-18, 2 figs. Rural line telephones and their circuits. Suggestions to managers, wire chiefs and troublemen of local battery exchanges. (Continuation of serial.)

Wave-Length and Weakening of Telephone Circuits (Longueur d'onde et affaiblissement des circuits téléphoniques), Pomey. Revue Générale de l'Electricité, vol. 4, no. 8, Aug. 24, 1918, pp. 251-253. Simplification of author's formula for constant B given in Aug. 3 issue.

TRANSFORMERS, CONVERTERS, FREQUENCY CHANGERS

Transformers, A. C.

Study of the Calculations Involved in the Design of Large Capacity Transformers for Use with Electric Furnaces (Etude sur le calcul de transformateurs à forte intensité pour fours électriques). R. Jacquot. Revue Générale de l'Electricité, vol. 4, no. 15, Oct. 12, 1918, pp. 523-536, 9 figs. Explains sudden variations in efficiency and voltage drop by conditions of varying load and suggests practical and economical modifications. (To be continued.)

Rectifiers

Three-Phased Current Rectifier (Convertitore di correnti trifasi in correnti continue). O. M. Corbino. L'Elettrotecnica, vol. 5, no. 28, Oct. 5, 1918, pp. 392-394, 3 figs. Apparatus operating by rotary mercury jet.

Substations

Electric Railway Substations for Automatic Transformation (Sottostazioni di trasformazione automatiche per l'alimentazione de ferrovie elettriche). A. Gusmano. L'Elettrotecnica, vol. 5, no. 31, Nov. 5, 1918, pp. 444-446, 6 figs. Principles of system followed in America.

Permanence in Outdoor Substations, S. B. Hood. Elec. World, vol. 72, no. 20, Nov. 19, 1918, pp. 928-930, 6 figs. Discussion of standard design used in all sizes from 300 kva. to 2250 kva. in order to eliminate fire losses prevalent in modern structures; increase in cost to secure permanence held to be negligible.

Remote Controlled Substations Described, W. T. Snyder. Blast Furnace, vol. 6, no. 10, Oct. 1918, pp. 408-410, 2 figs. Control for central station and motor-generator substation located about 2200 ft. from main power station, feeding 250-volt direct-current transmission line. Paper before Assn. Iron & Steel Elec. Engrs.

Transformers, D. C.

Size and Working Cost of Machines for Continuous-Current Transformation, Thomas Carter. Elecn., vol. 81, no. 2108, Oct. 11, 1918, 4 figs. Methods of continuous-current transformation; differences between three schemes; conclusions in regard to cost and method of operation; curves of overall efficiency of transformer; schemes for variable-speed motors.

Frequency Changer

Radio Frequency Changers, E. E. Bucher. Wireless Age, vol. 6, no. 2, Nov. 1918, pp. 10-13, 8 figs. Reported progress in their application to wireless telegraphic and telephonic communication. (To be continued.)

TRANSMISSION, DISTRIBUTION, CONTROL

Distribution, Three-Phase

Economic Increase Made in Distribution Capacity, S. Bingham Hood. Elec. World, vol. 72, no. 22, Nov. 30, 1918, pp. 1030-1032, 7 figs. Saving of copper and transformers by replacing old overloaded 2300-volt system with 2300-2400-volt star-connected, three-phase, common-neutral primary and interconnected secondary.

How to Remedy Inconveniences of Excessive Overload in Three-Phase Network (Comment peut-on remédier aux inconvénients d'une très forte surcharge dans un réseau triphasé), E. Piernet. Revue Générale de l'Electricité, vol. 4, no. 15, Oct. 12, 1918, pp. 540-544, 2 figs. Proposes adjustment of step-up and step-down transformers so as to be able to dispose of voltage U so long as delivered power does not exceed a certain limit and of voltage $U\sqrt{3}$ when delivered power exceeds this limit.

Interconnection

More Light on New England Interconnection. Elec. World, vol. 72, no. 22, Nov. 30, 1918, pp. 1027-1029, 1 fig. Estimated savings to be exceeded; convenient energy-exchange arrangements; railroad electrification possible without buying new generators; price at which tie-line energy can be sold. From paper by L. L. Elden before Boston Section of Am. Inst. of Elec. Engrs.

Relays

Factors to Consider in Applying Relays, E. A. Hester. Elec. World, vol. 72, no. 20, Nov. 16, 1918, pp. 931-934, 9 figs. Determination of short-circuit current connections and settings suitable for radial and parallel feeder systems; protection against high-resistance grounds on balance systems.

Relay Protective Devices, C. J. Monk. Tran. South African Inst. Elec. Engrs., vol. 9, part 7, July 1918, pp. 140-143, 1 fig. Proposes short method of obtaining approximate circuit currents by observing voltage drop between two stations at normal load, according to equation: short-circuit current = normal voltage times load current divided by voltage drop. Discussion of paper published in Jl. of Inst., Oct. 1917.

Switches

An Automatic Three-Phase Switch, W. Ernst. Elecn., vol. 81, no. 2108, Oct. 11, 1918, pp. 491, 4 figs. Abstract of article in Elektrotechnische Zeitschrift, No. 4, 1918.

Safety Features in Switching Installations, M. M. Samuels and F. Bechoff. Elec. World, vol. 72, no. 19, Nov. 9, 1918, pp. 878-880, 9 figs. Review of existing alarm systems used to indicate switch positions and overheating of apparatus; weak points in installations and suggestions designed to bring about their improvement.

Transmission Lines

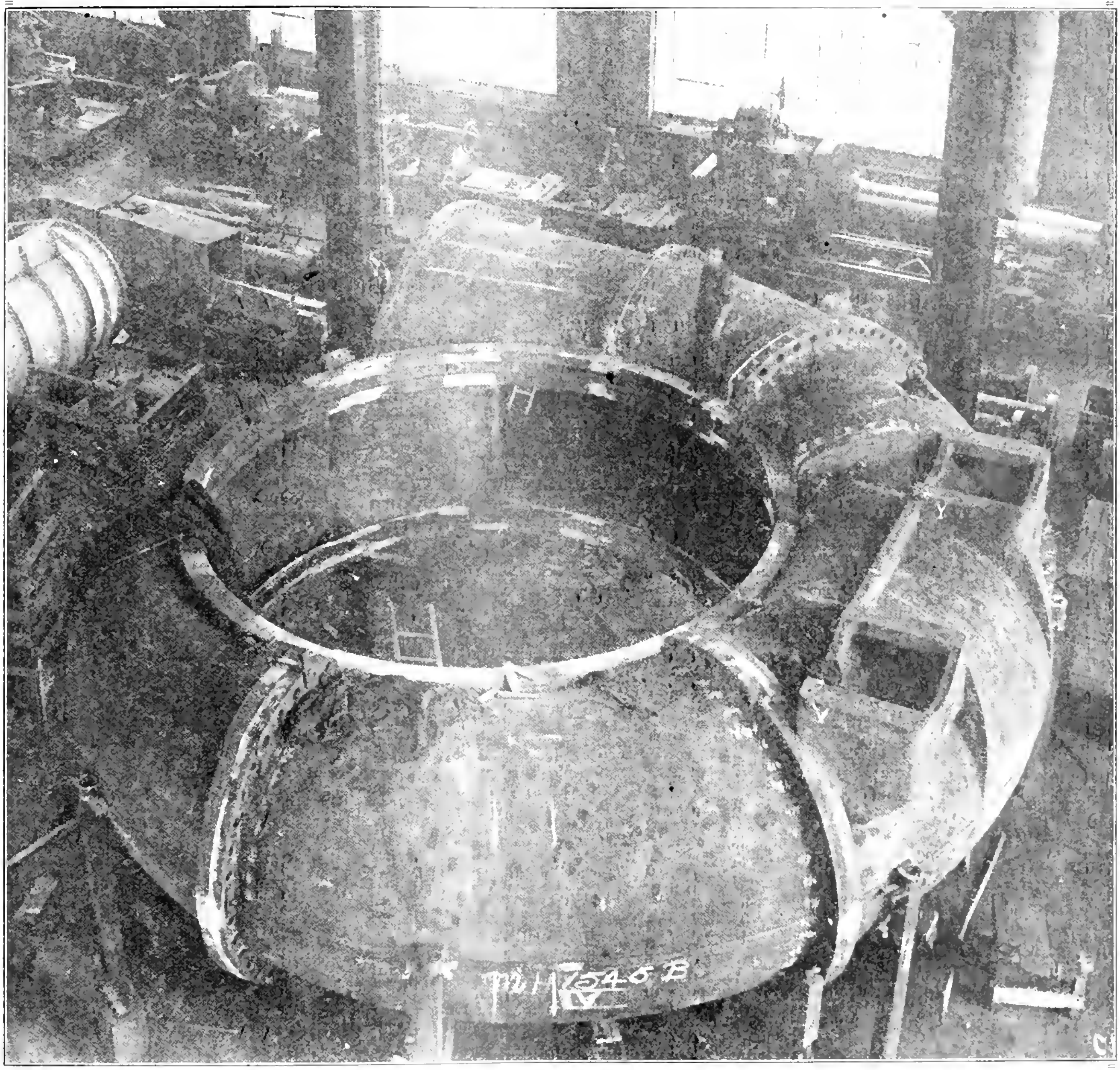
Locating Troubles in Electric Lines (Note sur les essais et mesures relatifs aux lignes électriques), Louis Puget. Revue Générale de l'Electricité, vol. 4, no. 16, Oct. 19, 1918, pp. 563-565, 2 figs. Method for measuring resistance of line and locating a ground, which author claims to have found serviceable in his experience with underground lines. The methods given are applicable to overhead lines as well.

110,000-Volt Transmission Line over the St. Lawrence River, S. Svenningson. Proc. Am. Inst. Elec. Engrs., vol. 37, no. 11, Nov.

I. P. Morris Hydraulic Turbines

The Wm. Cramp & Sons Ship & Engine Building Co.

Richmond and Norris Sts., Philadelphia



THE MOST POWERFUL TURBINE EVER BUILT

Cast iron volute casing of **37,500 H. P.** Turbine for The Niagara Falls Power Company. The turbine is designed to develop the above power under a head of 214 feet, at a speed of 150 R. P. M. We have two of these units now under construction in our shops.

1918, pp. 1275-1284, 3 figs. Account of investigation leading to construction of 350-ft. towers to support transmission wires on a span of 4800 ft.; design of towers and insulators; provisions for protection from ice and method of sag calculations.

WIRING

House Wiring

Three- and Four-Way Switch Circuits, Terrell Croft. Elec. Eng., vol. 52, no. 2, Aug. 1918, pp. 23-25, 5 figs. Cottage wiring: unusual wiring; two-location control. (Concluded.)

Civil Engineering

BRIDGES

Concrete Bridges

Bridging the James River at Richmond, Va. Cement & Eng. News, vol. 30, no. 11, Nov. 1918, pp. 15-16. General dimensions of structure consisting of 18 reinforced-concrete arch spans.

Reinforced Concrete Bridges and Their Architectural Treatment, F. G. Engholm. Contract Rec., vol. 32, no. 45, Nov. 6, 1918, pp. 880-883, 6 figs. Recommends considerations of fitness, proportion and adaptability in design, and moderate use of decorations.

Reinforced-Concrete Trestles. Sci. Am. Supp., vol. 86, no. 2238, Nov. 23, 1918, p. 324, 3 figs. Viaducts recently constructed by Can. Pac. Ry.

Design

New Impact Formulæ Needed in Designing Bridges of Various Types, J. A. L. Waddell. Eng. News-Rec., vol. 81, no. 21, Nov. 21, 1918, pp. 924-928, 2 figs. Scarcity of experimental knowledge of impact shown by review of tests and studies; group of formulæ proposed; lower impact allowances for solid-floor bridges and concrete arches.

The Principal Bridges of the World. Sci. Am. Supp., vol. 86, nos. 2235 and 2236, Nov. 2 and 9, 1918, pp. 286-288 and 294. Comparison of their size, importance and principles of design.

Highway Bridges

Standardization of Detail in Highway Bridge Design, M. W. Torkelson. Cement & Eng. News, vol. 30, no. 11, Nov. 1918, pp. 33-34. Practice of Wisconsin Highway Commission.

Lift Bridges

Scherzer Lift-Bridge at Keadby (Ponte levatoio tipo Scherzer a Keadby). Ingegneria Italiana, vol. 2, no. 37, Sept. 5, 1918, pp. 131-134, 7 figs. Plans, dimensions and details of mechanism. From Génie Civil, Jan. 19, 1918.

Railroad Bridges

Special Foundation Work for a Railroad Bridge, J. H. Merriam. Ry. Age, vol. 65, no. 22, Nov. 29, 1918, pp. 951-953, 6 figs. New Burlington structure over Platte River is supported entirely on concrete piles.

Wilson Bridge

The Wilson Bridge at Lyons. Engineer, vol. 126, no. 3280, Nov. 8, 1918, pp. 387-388, 9 figs. Drawings, illustrations and description of le pont Wilson, formally opened at Lyons July 14, 1918, and named in honor of President Wilson.

BUILDING AND CONSTRUCTION

Churches

Steel Construction Characterizes Chicago Church. Eng. News-Rec., vol. 81, no. 19, Nov. 7, 1918, pp. 860-863, 5 figs. Cantilever trusses carry front wall and gallery; dome trusses are supported by girders on tall four-post tower having no interior bracing.

Concrete Pedestal Pile

The McArthur Concrete Pedestal Pile. Contract Rec., vol. 32, no. 42, Oct. 16, 1918, pp. 830-831, 2 figs. Process followed in construction of pile consisting of a 16-in. cylindrical shaft, with an enlarged base.

Fire-Resistive Construction

Fire Resistive Construction Committee Report. Eng. & Cement World, vol. 13, no. 10, Nov. 15, 1918, pp. 13-14, 1 fig. Specifications drawn by joint conference of representatives from ten American technical societies and the Can. Soc. of Civil Engrs.

Railroad Station

Toronto's Union Station Nears Completion. Contract Rec., vol. 32, no. 41, Oct. 9, 1918, pp. 805-808, 9 figs. Waterproofing; roof; elevators.

Reservoirs, Oil

Circular Earth Embankment Lined with Concrete Forms Oil Reservoir, E. D. Cole. Eng. News-Rec., vol. 81, no. 21, Nov. 21, 1918, pp. 932-936, 3 figs. Type originated in California; introduced into Texas fields on account of lack of steel; concrete roof carried on wood frame also because of lack of steel.

Reinforced Concrete Fuel-Oil Tanks. Can. Engr., vol. 35, no. 17, Oct. 24, 1918, p. 376, 2 figs. Dimensions and process of executing work.

Reservoirs, Water

Newton, Mass., Water Reservoir, Edwin H. Rogers, Eng. Cement World, vol. 13, no. 10, Nov. 15, 1918, pp. 9-12, 3 figs. Details of its four rectangular sections and circular gate chamber at center, in which are installed a steel distributing tank and pipes from force main to different sections and overflow pipes and drains. From Proc. Boston Soc. Civil Engrs.

Reinforced Concrete Reservoirs, Montevideo. Engineering, vol. 106, no. 2756, Oct. 25, 1918, pp. 453-455, 43 figs. Description of two 6,500,000-gal. reservoirs constructed for City of Montevideo, Uruguay, R. C. Parsons, Engineer. Drawings of principal features.

Scaffolds and Falsework

Safe Construction of Scaffolds and Falsework, T. F. Foltz. Contract Rec., vol. 32, no. 42, Oct. 16, 1918, pp. 826-829. Outlines general construction of pole, suspended, outrigger, carpenters' bracket and painters' scaffolds, and indicates their general construction requirements. Paper before Nat. Safety Council.

Submerged Structures

Essentials of Proper Construction, J. W. Rollins. Contract Rec., vol. 32, no. 44, Oct. 30, 1918, pp. 870-873. Requirements of concrete for submerged structures.

See also ORGANIZATION AND MANAGEMENT, Lighting.

CEMENT AND CONCRETE

Agregate

Clean Aggregates Obtained under Difficult Conditions, C. P. Mowry. Cement & Eng. News, vol. 30, no. 11, Nov. 1918, pp. 31-32, 3 figs. Arrangement and working of a western plant.

Proportioning the Materials of Mortars and Concretes by Surface Areas of Aggregates, L. N. Edwards. Surveyor, vol. 54, no. 1398, Nov. 1, 1918, pp. 209-210. Results of tests made by Toronto Department of Works with object of developing surface-area method of proportioning and securing information relative to (1) surface area of aggregates of varying granulometric composition, (2) quantity of water necessary to produce a "normal" uniform consistency of mortar for varying sands and cement constant, and (3) strength of mortar attained by varying proportion of cement in mix. Paper before Am. Soc. for Testing Materials.

Economical Production of Washed Sand and Gravel. Eng. & Cement World, vol. 13, no. 10, Nov. 15, 1918, pp. 52-54, 2 figs. Description of Gilbert screen.

Cement Gun

Cement Gun Used for Repairing Pit Stacks. Blast Furnace, vol. 6, no. 10, Oct. 1918, pp. 399-401, 5 figs. Steel reinforcement placed on old shell and gunite applied.

Cold-Weather Concreting

Cold Weather Concreting. Eng. & Cement World, vol. 13, no. 10, Nov. 15, 1918, pp. 20-24, 8 figs. Effect of low temperatures on concrete work; suggestions of Portland Cement Assn. in regard to heating materials and protecting work.

Disintegration

Conclusions on Causes of Concrete Disintegration, A. Blackie. Eng. & Contracting, vol. 50, no. 21, Nov. 20, 1918, pp. 503-505. From paper before Eng. Ins. of Canada.

Form Units

One Set of Tool Forms Used Three Times Completes Concrete Foundry, J. M. Villadsen. Eng. News-Rec., vol. 81, no. 21, Nov. 21, 1918, pp. 950-951, 3 figs. Form units assembled on ground with reinforcement in place erected by derrick; concrete placed by telescoping chute.

François and Portier Cementation Processes

Cementation Processes of François and Portier, A. H. Krynauw. Contract Rec., vol. 52, no. 44, Oct. 30, 1918, pp. 864-865. Conditions most suitable for hard setting in shortest time when cement is pumped under pressure into fissures; cases in which cementation has been successfully applied; comparison between two processes. Paper before Chem. Metallurgical & Min. Soc.

Moisture

Effect of Water on Strength of Concrete. Contract Rec., vol. 52, no. 44, Oct. 30, 1918, p. 865, 1 fig. Diagram presenting amount of water used in per cent of quantity giving maximum strength against per cent of maximum strength. Drawn from results of experimental tests.

Saturation of Concrete Reduces Strength and Elasticity, M. B. Lagaard. Eng. News-Rec., vol. 81, no. 20, Nov. 14, 1918, pp. 908-910, 6 figs. Tests, made at University of Minnesota, show that moisture content of specimens serves to counteract benefits of moist curing.

See also CIVIL ENGINEERING, Building and Construction, Harbors.

EARTHWORK, ROCK, EXCAVATION, ETC.

Blasting

Drilling and Blasting in Construction of Halifax Ocean Terminals Railway. Eng. & Contracting, vol. 50, no. 21, Nov. 20, 1918, pp. 480-481. Description of some features of work. From paper by B. H. Smith before Eng. Inst. of Canada.

Quarry Blasting with Electricity, A. S. Anderson. Du Pont Magazine, vol. 9, no. 6, Dec. 1918, pp. 26-27, 3 figs. Ways of producing current and precaution to be observed.

Park Construction

Construction Plans Developed for the Bronx River Parkway Reservation, L. G. Holleran. Eng. News-Rec., vol. 81, no. 20, Nov. 14, 1918, pp. 899-903, 4 figs. Designs of Park Commission contemplate development of 1400 acres by grading and planting; numerous structures proposed; work to be done by day labor.

Quarrying

Quarry Economics, Oliver Bowles. Eng. & Cement World, vol. 13, no. 10, Nov. 15, 1918, pp. 49-50. Labor requirements of various drills; waste of labor through inefficient blasting; effect of physical character of rock.

HARBORS

Concrete Construction

The Use of Reinforced Concrete Construction in Harbor Work, A. F. Dyer. Jl. Eng. Inst. Can., vol. 1, no. 6, Oct. 1918, pp. 242-251, 11 figs. Descriptions derived from articles and papers published in technical journals and proceedings of technical societies. Also in Eng. & Contracting, vol. 50, no. 21, Nov. 20, 1918, pp. 483-485.

Piers

Compression Strengths of Large Brick Piers. Eng. & Cement World, vol. 13, no. 10, Nov. 15, 1918, p. 25. Summary of conclusions based on past records and recent investigation by Bureau of Standards, composed of tests on piers 2 ft. 6 in. sq. by 10 ft. high in which three grades of brick were used.

Ports

Railway Construction in Connection with the Halifax Ocean Terminals, R. H. Smith. Jl. Eng. Inst. Can., vol. 1, no. 6, Oct. 1918, pp. 281-288. Methods employed and difficulties overcome in construction operations which necessitated considerable excavation work and presented other difficulties.

St. John Harbor, Alex. Gray. Jl. Eng. Inst. Can., vol. 1, no. 6, Oct. 1918, pp. 273-278, 15 figs. Outstanding features in harbor and type of construction used in wharves.

The Port of Honduras. Times Eng. Supp., no. 527, Sept. 1918, p. 193. Projected improvements.

Sea Walls

Drive Inclined Precast Concrete Slabs for Sea Wall. Eng. News-Rec., vol. 81, no. 20, Nov. 14, 1918, pp. 897-898, 3 figs. Account of new type of beach protection replacing vertical concrete wall at Long Beach, Cal.

Pneumatic Caisson Method of Quay Wall Construction at Halifax. Eng. & Contracting, vol. 50, no. 21, Nov. 20, 1918, pp. 489-490, 2 figs. From paper by J. J. MacDonald before Eng. Inst. of Canada.

MATERIALS OF CONSTRUCTION

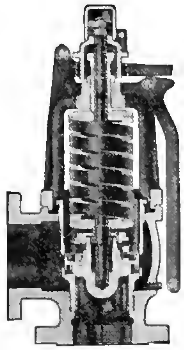
Timber

Decay in Mill-Roof Timber, R. J. Blair. Textile World Jl., vol. 54, no. 23, Dec. 7,

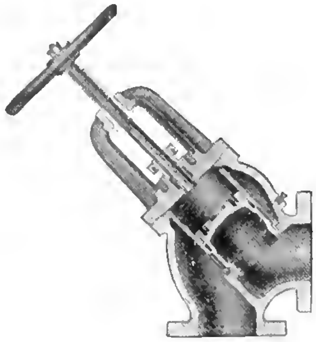
CRANE VALVES

that comply with the

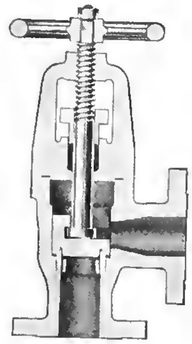
A. S. M. E. BOILER CODE



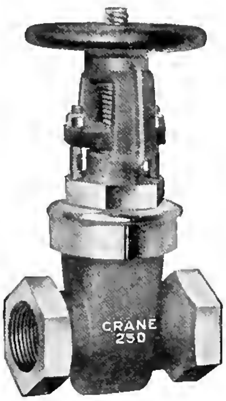
No. 1117 Flanged
No. 1116 Screwed
Pop Safety Valve
Iron or Steel
2" to 4½"



No. 30E
Automatic Stop Check Valve
Iron or Steel
2½" to 10"

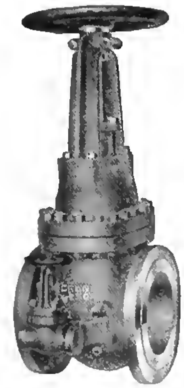


No. 391 Flanged
Blow-Off Valve
Iron or Steel
1½" to 2½"

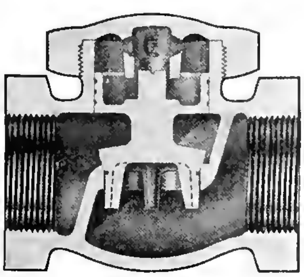


No. 68E Brass
Water Column Gate Valve
¾" to 2"

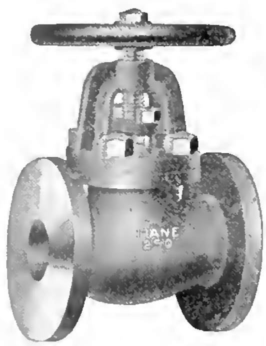
Boilers equipped with these valves represent the best engineering practice.



No. 9E Gate Valve
Iron or Steel
All Sizes



No. 92E Brass
Boiler Feed Check
¼" to 3"



No. 87E Brass
Boiler Feed Stop
1½" to 3"

No. 317 All Iron
Blow-Off Cock
1" to 2½"

Sales Offices, Warehouses and Showrooms:

Boston, Springfield, Bridgeport, New York, Brooklyn, Philadelphia, Newark, Camden, Baltimore, Washington, Syracuse, Buffalo, Savannah, Atlanta, Knoxville, Birmingham, Memphis, Little Rock, Muskogee, Oklahoma City, Wichita, St. Louis, Kansas City, Terre Haute, Cincinnati, Indianapolis, Detroit

FOUNDED BY R. T. CRANE, 1855

CRANE CO.
836 S. MICHIGAN AVE.
CHICAGO

Chicago, Grand Rapids, Davenport, Des Moines, Omaha, Sioux City, St. Paul, Minneapolis, Duluth, Fargo, Watertown, Aberdeen, Great Falls, Spokane, Seattle, Tacoma, Portland, Pocatello, Salt Lake City, Ogden, Sacramento, Oakland, San Francisco, Los Angeles, Winnipeg, Vancouver

Works: Chicago and Bridgeport.

1918, pp. 95-101, 4 figs. How it occurs and how it can be prevented. (To be continued.)

See also CIVIL ENGINEERING, Cement and Concrete.

MUNICIPAL ENGINEERING

Town Planning

The Problem of City Development, An Economic Survey, A. G. Dalzell. Jl. Eng. Inst. Can., vol. 1, no. 7, Nov. 1918, pp. 319-330, 16 figs. Comparison of rectangular and diagonal systems of city outline and study of conditions in Vancouver.

Town Planning in Halifax and Vicinity, H. L. Seymour. Jl. Eng. Inst. Can., vol. 1, no. 6, Oct. 1918, pp. 262-268, 3 figs. Schemes indicating width of streets, open spaces, building lines and character of buildings.

ROADS AND PAVEMENTS

Canada

Canadian Highway Construction, Harry Stewardson. Contract Rec., vol. 32, no. 46, Nov. 13, 1918, pp. 899-901. Considers how to distribute cost of construction and maintenance so that necessary money can be secured and necessary expense fairly placed upon people who use roads and communities which receive benefits.

Highway Work in Ontario. Good Roads, vol. 16, no. 20, Nov. 16, 1918, pp. 185-186 and 191. Progress made in Canadian Province.

Roadway Improvements in Ontario, W. A. MacLean. Contract Rec., vol. 32, no. 41, Oct. 9, 1918, pp. 813-819, 10 figs. Extracts from annual report of Department of Public Highways for 1917.

Concrete

Concrete Road Construction, William W. Cox. Good Roads, vol. 16, no. 18, Nov. 2, 1918, pp. 165-166 and 169, 1 fig. Precautions and care to be observed. Paper before Mich. State Good Roads Assn.

Vertical Movements in Concrete Pavements and a Suggestion Towards Their Elimination, J. W. Lowell. Eng. & Contracting, vol. 50, no. 19, Nov. 6, 1918, pp. 441-443, 4 figs. From paper before Am. Concrete Inst.

Cost Keeping

Better System of Highway Cost Keeping, J. J. Tobin and A. R. Losh. Contract Rec., vol. 32, nos. 44, 45 and 46, Oct. 30 and Nov. 6 and 13, 1918, pp. 866-869, 886-888 and 903-906, 4 figs. Study of principles governing cost keeping and application of these principles to highway work. Detail of cost accounts and necessary codes.

France

Principles Upon Which the French Highways Are Built, Frank W. Harris. Eng. News-Rec., vol. 81, no. 21, Nov. 21, 1918, pp. 935, 1 fig. Roman system of direct lines between strategic points followed; great attention is given to drainage.

Location

Putting the Right Road in the Right Place, Rodman Wiley. Am. City, vol. 19, no. 5, Nov. 1918, pp. 356-358, 4 figs. European practice in locating road; importance of exercising good judgment in grading and surfacing. Paper before Ky. Highway Engrs. Assn.

Macadam

Capacity of Macadam Roads for War Business Increased. Eng. News-Rec., vol. 81, no. 22, Nov. 28, 1918, pp. 990-992, 5 figs. Three-foot concrete shoulders added at each side without closing highways to traffic; war labor conserved by using convicts for construction.

Oiled Macadam Roads Resurfaced with Concrete, E. A. Burt. Eng. News-Rec., vol. 81, no 21, Nov. 21, 1918, pp. 943-944, 3 figs. Los Angeles County, California, builds roads in two sections to keep traffic moving; center joint keeps autos on own side; cost figures.

Tar-Macadam v. Granite Macadam, Ellis W. Jones. Surveyor, vol. 54, no. 1399, Nov. 8, 1918, p. 220. Author's experience and recommendation that roads which have to carry from 600 to 1,000 tons a day should be maintained with tar-macadam.

Maintenance

Motor Vehicles and Their Influence Upon Road Construction, W. A. Maclean. Surveyor, vol. 54, no 1399, Nov. 8, 1918, pp. 221-222. Record of Deputy Minister of Public Highways for Ontario.

Road Maintenance Methods and Devices Effect Saving of Material, Labor and Fuel. Eng. News-Rec., vol. 81, no. 22, Nov. 28, 1918, pp. 981-984, 5 figs. Bureau of Maintenance and Repair, New York State Highways Department, working through nine division engineers, endeavors to keep war-time traffic roads open and still conserve material.

Mixers

Direct Charging of Concrete Mixers. Mun. Jl., vol. 45, no. 20, Nov. 16, 1918, p. 392. Feature of construction of concrete pavement in ten-mile section of Delaware road.

Two Mixers on Variable Road Work. Eng. & Cement World, vol. 13, no. 10, Nov. 15, 1918, pp. 31-32, 2 figs. Methods followed in construction of a Western road.

Snow Removal

Snow Removal on Trunk Line Highways, Chas. J. Bennett. Good Roads, vol. 16, no. 20, Nov. 16, 1918, pp. 188-189. Study of the problem and suggestion for its solution. Before conference On Snow Removal from Trunk Highways, Automobile Club of America.

Surfacing

How to Get the Best Surface on a Concrete Road, A. H. Hunter. Cement & Eng. News, vol. 30, no. 11, Nov. 1918, pp. 25-28, 2 figs. Suggestions in regard to application of forms, building of expansion joints and use of roller and belt.

Resurfacing Part of Buffalo-Albany Turnpike with Concrete, A. S. Hinman. Cement & Eng. News, vol. 30, no. 11, Nov. 1918, pp. 35-36, 3 figs. Method of carrying on work without closing traffic.

Wood Roads

Gasoline Consumption Tests Demonstrate Value of Hard, Smooth-Surfaced Roads, A. N. Johnson. Eng. News-Rec., vol. 81, no. 19, Nov. 7, 1918, pp. 843-850, 8 figs. Gasoline saving which would pay for construction of hard surface in few years is indicated between earth and smooth concrete, where daily motor traffic of 500 can be expected. Results of some tests and description of methods employed.

Paved Roadways Aid Plant Efficiency, H. Colin Campbell. Indus. Management, vol. 56, no. 6, Dec. 1918, pp. 471-472, 4 figs. Plea for better roadways around factory buildings.

The Measure of a Good Road, Robert C. Barnett. Eng. & Contracting, vol. 50, no. 19, Nov. 6, 1918, pp. 438-440, 3 figs. Mathematical treatment of thesis. Assumptions of good road: 1. A straight line is shortest distance between two points; 2. A plane of uniform slope is best grade between two points; 3. A hard, smooth surface offers less tractive resistance than rough or yielding one.

The Vital Importance of the Highway, S. M. Williams. Am. City, vol. 19, no. 5, Nov. 1918, pp. 354-355, 1 fig. Plea for establishment of Federal Highway Commission.

See also MECHANICAL ENGINEERING, Machinery, Special (Road Finisher)

SEWAGE DISPOSAL

Dilution

Sewage Disposal by Dilution. Times Eng. Supp., no. 527, Sept. 1918, p. 188. Experimental investigation of Royal Commission on Sewage Disposal into self-purifying capacity of rivers.

Direct Oxidation

Sewage Treatment in Easton. Mun. Jl., vol. 45, no. 20, Nov. 16, 1918, pp. 386-388, 4 figs. Details and method of operation of plant of 1,000,000 gal. capacity of "direct oxidation" type.

Sewer Pipe

Incrustation in Vancouver Sewer Pipe, A. G. Dalzell. Can. Engr., vol. 35, no. 19, Nov. 7, 1918, pp. 403-406, 3 figs. Objectionable features which have developed in machine-made concrete pipe, 8 to 30 in. in diameter.

Sludge Dewatering

Two Important Sludge Problems, Arthur J. Martin. Contract Rec., vol. 32, no. 48, Nov. 27, 1918, pp. 941-942. Suggestions in regard to use of compressed air and removal of water contained in sludge.

WATER SUPPLY

Consumption

Water Consumption in New York State Cities and Its Effect on Coal Consumption. Am. City, vol. 19, no. 5, Nov. 1918, pp. 376-378. From a report compiled by the State Bureau of Municipal Information of the New York State Conference of Mayors.

Mains in Winter

Waterworks Operation. Mun. Jl., vol. 45, no. 21, Nov. 23, 1918, pp. 408-410. Methods of thawing water mains and services.

Pollution

Sanitary Aspects of Water Supplies at Army Cantonments, James T. B. Bowles. Eng. & Contracting, vol. 50, no. 20, Nov. 13, 1918, p. 460. From Sept. Jl. of Am. Waterworks Assn.

Railway Water Supply

New Water Treating Plants for the Burlington. Ry. Rev., vol. 63, no. 19, Nov. 9, 1918, pp. 661-666, 10 figs. Use of reinforced-concrete tanks on Casper division; various conditions of water supply; different types of construction.

Railway Water Supply from Wells. Ry. Rev., vol. 63, no. 19, Nov. 9, 1918, pp. 669-671. From report of committee on sources of railway water supply, to Am. Ry. Bridge and Building Assn., Chicago, Oct. 15, 1918, by C. R. Knowles, chairman.

Sand Filters

Coagulants Versus Sand Filters as Aid to Water Purification in the Field, H. S. Briggs and E. R. Marie. Contract Rec., vol. 32, no. 46, Nov. 13, 1918, pp. 906-908. Description of installation embodying alum process. From Roy. Engrs. Jl.

Drifting Sand Filter, Toronto Island, Geo. G. Nasmith and N. J. Howard. Can. Engr., vol. 35, no. 17, Oct. 24, 1918, pp. 359-364, 6 figs. Report of bacteriological and physical tests performed on section comprising five filter units.

Toronto's Drifting Sand Filter. Mun. Jl., vol. 45, no. 20, Nov. 16, 1918, pp. 390-392. Construction and operation; bacteriological and physical tests; conclusions as to efficiency of plant.

WATERWAYS

Dams

High-Pressure Gates in Dams for Water-Works and Irrigation Reviewed, D. W. Cole. Eng. News-Rec., vol. 81, no. 20, Nov. 14, 1918, pp. 880-884, 5 figs. From sluice gates in Sudbury Dam of Boston Water-Works through various stages of gate development in high dams of U. S. Reclamation Service. From paper presented at Idaho conference of engineers in 1918.

Modifications in the Character of a Water Stream Produced by Construction of a Dam (Modifications apportées au régime d'un cours après l'établissement d'un barrage), K. Zorayan. Revue Génerale de l'Electricité, vol. 4, no. 7, Aug. 17, 1918, pp. 226-229, 5 figs. Chart for tracing output curve knowing the declivity of a water course and the height of water in dam.

Gates

Some Experiences with Large-Capacity Reservoir Outlets, James M. Gaylord. Eng. News-Rec., vol. 81, no. 21, Nov. 21, 1918, pp. 945-950, 2 figs. Specially designed gates control discharge of immense volumes of water under pressures above 200 ft.; difficulties and how they have been overcome. Paper before Colorado Assn. of members of Am. Soc. of Civil Engrs.

Run-Off

Progress Report of Committee on Run-Off. Jl. Boston Soc. Civil Engrs., vol. 5, no. 9, Nov. 1918, pp. 387-422, 3 figs. Use of the current meter in stream gaging; 0.2 and 0.8 method in power canals; precipitation, evaporation and run-off; effects of ice on river discharge; methods to be used in compilation of data.

Stream Regulation

Stream Regulations in Quebec Province, Olivier Lefebre. Can. Engr., vol. 35, no. 19, Nov. 7, 1918, pp. 399-402 and 411, 5 figs. Account of increase in water power by using Lakes St. Francis and Aylmer as storage basins and indications of possible developments. From Annual Report of Quebec Streams Commission.

See also MECHANICAL ENGINEERING, Hydraulic Machinery.

Mining Engineering

ALLOYS, FERROUS

Electric Furnace

Two-Ton Electric Furnace Makes Alloys. Can. Machy., vol. 20, no. 20, Nov. 14, 1918, pp. 563-565, 10 figs. Equipment of plant using Héroult furnaces for non-ferrous alloys.

BASE MATERIALS

Serpentine

The Origin of Serpentine, a Historical and Comparative Study, W. N. Benson. Am. Jl. of Sci., vol. 46, Dec. 1918, pp. 693-731, 4 figs. Concludes from examination of geological data that ultrabasic masses in chrysolite or antigorite-serpentine are alteration product of originally intrusive peridotite often more or less pyroxenic, and that in some cases the hydration was brought about by agency of waters emanating from same magma that produced periodite, the change having been completed by end of one orogenic period of vulcanicity.

COAL AND COKE

Anthracite

Anthracite Production and Resources of the United States, Eli T. Connor. Can. Min. Inst., bul. no. 80, Dec. 1918, pp. 1001-1005. Map. Excerpts from address at 20th annual meeting of the Institute. Progress of the anthracite industry since 1895.

Breakers and Washeries

Hazards and Safeguards in Anthracite Breakers and Washeries, D. K. Glover. Safety Eng., vol. 36, no. 4, Oct. 1918, pp. 234-236. Recommends clearance of 7 ft. from center of track on each side. From Proc. Seventh Annual Safety Congress.

Coke Ovens

Economic Considerations in Coke-Oven Practice, W. Colquhoun. Ir. & Cl Trds. Rev., vol. 97, no. 2646, Nov. 15, 1918, pp. 541-543. Advantages of by-product coke-ovens. Abstract of paper and discussion read before Midland Inst. of Min., Civ. & Mech. Engrs.

Instantaneous Combustion

Instantaneous Combustion of Coal and Gas at Bedford Collieries, Leigh, F. N. Siddall. Trans. Manchester Geol. & Min. Soc., vol. 35, part 10, Aug. 1918, pp. 318-325, 3 figs., and (discussion) pp. 325-327. Account of conditions in shaft before and after occurrence of an outburst.

Kentucky

The Hazard Coal Field, P. M. Sherwin. Coal Age, vol. 14, no. 23, Dec. 5, 1918, pp. 1031-1034, 11 figs. Known chiefly for its hardness and low ash content. Describes region.

Shoveling Machines

Shoveling Machines for Coal Mines. Coal Industry, vol. 1, no. 10, Oct. 1918, pp. 382-384, 4 figs. Development of mines; method of operating shoveling machines; tests under different conditions.

See also ELECTRICAL ENGINEERING, Power Applications (Coal Mining).

EXPLOSIVES

Permissible Explosives for Mine Use, J. H. Squires. Coal Industry, vol. 1, no. 10, Oct. 1918, pp. 375-379, 9 figs. Definition of permissible explosives and description of tests and appliances necessary to determine classification.

IRON

Alsace-Lorraine

Iron Ore Supplies of Alsace-Lorraine, Sidney Paige. Iron Age, vol. 102, no. 19, Nov. 7, 1918, pp. 1149-1150. From symposium on "Certain Ore Resources of the World" prepared for meeting of Iron and Steel section, Am. Inst. of Min. Engrs., Milwaukee, October 1918.

Briquetting

Present Knowledge and Practice in Briquetting Iron Ores (V), Guy Barrett and T. B. Rogerson. Automotive Eng., vol. 3, no. 9, Oct. 1918, p. 425. The Greenwalt, West and other general processes; general observations on briquetting, its applications, cost under various processes, disadvantages and possibilities. (Concluded.)

See also ELECTRICAL ENGINEERING, Power Applications (Iron-Ore Mining).

LEAD

Flotation

The Development of Galena Flotation at the Central Mine, Broken Hill, R. J. Harvey. Instn. Min. & Met., bul. 170, Nov. 14, 1918, pp. 1-17, 7 figs. Experimental work and results.

MAJOR INDUSTRIAL MATERIALS

Manganese

Manganese Deposits in the Colorado River Region. Salt Lake Min. Rev., vol. 20, no. 15, Nov. 15, 1918, p. 30. Replacement deposits; methods and cost of mining. (Concluded.)

Sulphur

Sulphur Deposits of the Trans Pecos Region in Texas, Kirby Thomas. Eng. & Min. Jl., vol. 106, no. 23, Dec. 7, 1918, pp. 979-981, 3 figs. Origin, character of deposits, methods of mining, etc.

MINES AND MINING

Bounces

An Unusual Bounce Condition, A. C. Watts. Coal Age, vol. 14, no. 23, Dec. 5, 1918, pp. 1028-1030, 4 figs. Bounces occurred with annoying frequency. A fault was driven through and analysis made of existing conditions.

Cementing of Wells

Cement Plugging for Exclusion of Bottom Water in the Augusta Field, Kansas. Bul. Am. Inst. Min. Engrs., no. 142, Oct. 1918, pp. 1613-1620, 6 figs. Results obtained from preliminary cementing of wells in effort to cut off bottom water.

Field Tests

Field Tests for the Common Metals in Minerals. Univ. Ariz., bul. no. 93, Min. Tech. Series, no. 21, pp. 1-20. Compiled to be used as a text for lectures on "Prospector's Mineralogy."

Gas Detector

Improved Mine-Gas Detector. Min. & Eng. Rec., vol. 23, nos. 17 & 18, Sept. 30, 1918, pp. 180-181, 1 fig. Apparatus, developed by Bureau of Mines, for determining presence of inflammable gases and proportion of gas present.

Mine Timbers

Preservative Treatment of Mine Timbers as a Conservation Measure, Kurt C. Barth. Cl. Age, vol. 14, no. 23, Dec. 5, 1918, pp. 1025-1027. Three methods of application available.

Minerals Control Act

Will the Government Fulfill Its Obligations to Those Who Undertook Mineral Developments at Its Request? Mfrs. Rec., vol. 74, no. 23, Dec. 5, 1918, pp. 73-74. Discusses the Minerals Control Act and necessary protection to make the United States more self-sustained as a nation.

Rescue Apparatus

New Form of Oxygen Mine Rescue Apparatus, H. V. Manning. Min. & Eng. Rec., vol. 23, nos. 17 & 18, Sept. 30, 1918, pp. 179-180, 2 figs. Apparatus, developed by Bureau of Mines, for use poisonous or irrespirable atmospheres in mines after fires or explosions.

Stone-Dust Removal

Sprayer for Stone-Dusting in Mines, A. Rushton. Tran. Manchester Geol. & Min. Soc., vol. 35, part 10, Aug. 1918, pp. 327-329. Features of ejector which blows stone dust into atmosphere of mine by means of compressed air. Stone dust is carried from atmosphere of mine in the same way as coal dust.

Temperature Measurements

Measurement of Temperature at Great Depths (Mesure de la temperature dans les sondages à toute profondeur), M. Verzat. L'Echo des Mines et de la Métallurgie, no. 2582, July 14, 1918, p. 343. Account of the measurement of temperature at a depth of 1616 meters made by the Cie. des Mines du Sud de la Mure.

Timbering

Safe and Efficient Mine Timbering, Robert Z. Virgin. Coal Industry, vol. 1, no. 10, Oct. 1918, pp. 369-372, 12 figs. Explains and illustrates different methods and analyzes each with regard to safety and efficiency.

Transfer Chutes

Driving and Timbering Transfer Chutes, C. T. Rice. Eng. & Min. Jl., vol. 106, no. 23, Dec. 7, 1918, pp. 991-993, 3 figs. Method employed in the Coeur d'Alene district.

See also MECHANICAL ENGINEERING, Hoisting and Conveying.

MINOR INDUSTRIAL MATERIALS

Antimony, Strontium, etc.

Antimony, Graphite, Nickel, Potash, Strontium, Tin, E. S. Boalich and W. O. Castello. Cal. State Min. Bur., report no. 5, Mar. 1918, 44 pp. Properties, occurrence and uses of these substances.

Tungsten

Tungsten, Molybdenum and Vanadium, E. S. Boalich and W. O. Castello. Cal. State Min. Bur., report no. 4, Mar. 1918, 34 pp. Properties, ores, occurrence and uses of these minerals.

Wolfram Ore and Tungsten. Chem. News, vol. 117, no. 3059, Oct. 25, 1918, pp. 337-338. Report of Departmental Committee on the Eng. Trades after the War. From Jl. Roy. Soc. of Arts, vol. 66, no. 3436.

OIL

Water Troubles

Water Troubles in the Mid-Continent Oil Fields and Their Remedies, Dorsey Hager and G. W. McPherson. Bul. Am. Inst. Min. Engrs., no. 142, Oct. 1918, pp. 1620-1627, 2 figs. Classification of troubles and account of results obtained by shutting off water.

PRECIOUS MINERALS

Kalgoorlie

Kalgoorlie Goldfield. Aust. Min. Std., vol. 60, no. 1564, Oct. 31, 1918, pp. 705 and 707. Report of J. B. Jaquet on circumstances connected with certain earth tremors, presence of methane gas, systems of working, etc.

RARE MINERALS

Wilsonium

Wilsonium, Henri Bonaparte. Min. & Eng. Rec., vol. 23, nos. 17 and 18, Sept. 30, 1918, pp. 176-177. Chemical and physical nature and occurrence of new mineral named in honor of President Wilson by its discoverer, Franklin Heath.

TIN

Metallurgy

Effect of Heating and Heating and Quenching Cornish Tin Ores Before Crushing, Arthur Yates. Instn. Min. & Metallurgy, bul. 170, Nov. 14, 1918, pp. 1-3. Summary of investigation made in the laboratories of the Royal School of Mines.

Ore Handling

Installation for Mechanical Handling of Tin Ore at Boeboes Valley on the Banka (Installaties voor machinale ontginning van tinerts in de Boeboes-vallei op Banka), A. Van der Ham. De Ingenieur, vol. 33, no. 41, Oct. 12, 1918, pp. 789-802, 19 figs.

Tin Conservation

A Symposium on the Conservation of Tin. A.I.M.E. bul. no. 144, Dec. 1918, pp. 1729-1764. Eight short papers.

Conserving Tin in Different Solder Mixtures, Milton L. Lissberger. Foundry, vol. 46, no. 316, Dec. 1918, pp. 579-580. Experiments indicate that the ideal alloy should contain 46 per cent tin and 54 per cent lead; preventing tin waste. From paper before Milwaukee meeting of Inst. of Metals Division of Am. Inst. of Min. Engrs.

TRANSPORTATION

Dump Cars

Dumps and Dump Hoppers, C. L. Miller. Coal Industry, vol. 1, no. 10, Oct. 1918, pp. 373-374, 2 figs. Suggestions for making layouts addressed to mining engineers having no other data at hand than details of mine car.

Metallurgy

ALUMINUM

Aluminum and Its Alloys, Dr. Rosenhain. Aeronautics, vol. 15, no. 259, Oct. 2, 1918, pp. 321-322. Uses and possibilities in aircraft. Lecture at British Sci. Products Exhibition.

Aluminum and Its Light Alloys—VI. Bibliography, Paul D. Merian. Chem. & Metallurgical Eng., vol. 19, No. 10, Nov. 15, 1918, pp. 729-732. Composition; applications; electrical; vessels; deoxidation; aluminothermy; chemical properties; corrosion; alternbility; physical properties; electrical conductivity; thermoelectromotive force characteristics; conductivity; effect of temperature on properties. (To be continued.)

BLAST FURNACES

Fuel Economy in Blast Furnace Practice, T. C. Hutchinson. Blast Furnace, vol. 6, no. 10, Oct. 1918, pp. 419-420, 3 figs. Discussion concerning results obtained with working furnace model built for determination of efficient distribution of charge. Paper before British Iron & Steel Inst. (Concluded.)

COPPER

Bronzes

The Constitution of the Tin Bronzes, Samuel L. Hoyt. A.I.M.E., Bul., no. 144, Dec. 1918, pp. 1721-1727, 14 figs. Notes on progress made in establishing what happens over the upper heat effect.

Gases, Reducing

The Action of Reducing Gases on Hot Solid

Copper, Norman B. Pilling. Bul. Am. Inst. Min. Engrs., no. 142, Oct. 1918, pp. 1567-1580, 21 figs. Studies nature of action and conditions under which it occurs and gives graphs (obtained by experimentation) showing permeability of copper to H, steam, CO and CO_2.

Lead in Copper

The Spectroscopic Determination of Lead in Copper, C. W. Hill and G. P. Luckey. Bul. Am. Inst. Min. Engrs., no. 142, Oct. 1918, pp. 1581-1592, 4 figs. Details of apparatus and its standardization, and comparison of accuracy of quantitative spectroscopic method for determining small amounts of lead with that of standard electrolytic determination. Variations and other applications of method are found in Proc. Am. Electrochem. Soc. (1918), 32, 191, and in Met. & Chem. Engr. (1917), 17, 659.

Utah Copper Plant

The Utah Copper Enterprise, T. A. Rickard. Min. & Sci. Press, vol. 117, no. 22, Nov. 30, 1918, pp. 713-724, 16 figs. Flow sheet of mill; plan and section of Richards-Janney classifier as used in mill; flow sheet of primary and secondary crushing plants. (To be continued.)

FLOTATION

Mill Practice at Flotation Plant of Utah Leasing Co., H. H. Adams. Salt Lake Min. Rev., vol. 20, no. 15, Nov. 15, 1918, pp. 21-25, 4 figs. Work of reclaiming metal contents from old tailing dumps.

IRON AND STEEL

Cast Iron

The Prevention of Growth in Gray Cast Iron, J. E. Hurst. Iron Age, vol. 102, no. 19, Nov. 7, 1918, pp. 1144-1145, 3 figs. Causes of phenomenon; effect of entrance of oxidizing gases and formation of case; application of dies and permanent molds. Paper before Iron and Steel Inst., London, September, 1918. Also in Engineering, vol. 106, no. 2754, Oct. 11, 1918, p. 415, 3 figs.

Electrical Resistance

Electrical Resistance of Hardened Steel, E. D. Campbell. Engineering, vol. 106, no. 2757, Nov. 1, 1918, pp. 509, 2 figs. On rate of change at 100 deg. cent., and of ordinary temperatures in electrical resistance of hardened steel. Paper before Iron and Steel Inst.

Ingots

Making Sand-Cast Forging Ingots, W. L. Booth. Iron Age, vol. 102, no. 19, Nov. 7, 1918, pp. 1139-1140, 2 figs. Development of practice on Pacific Coast; replacing Eastern ingots; advantages claimed for sand mold. From article in October issue of Metal Trades.

Internal Stresses

Internal Stresses Developed in Metals and Alloys by Sudden Cooling (Efforts internes développés dans les métaux et alliages par l'effect d'un refroidissement rapide), M. Portevin. Comptes rendus des séances de l'Académie des Sciences, vol. 167, no. 15, Oct. 7, 1918, pp. 531-533. Measurements of dimensional variations in steel specimens. Also in Revue Générale de l'Electricité, vol. 4, no. 18, Nov. 2, 1918, p. 652.

Open-Hearth Furnaces

The Principles of Open-Hearth Furnace Design, Charles H. F. Bagley. Engineering, vol. 106, no. 2754, Oct. 11, 1918, pp. 400-401, 2 figs. From paper before Iron and Steel Inst., Sept. 1918.

Rolling Mills

Blooming Mill Now Rolling Plates. Iron Trade Rev., vol. 63, no. 23, Dec. 5, 1918, pp. 1285-1288, 4 figs. Transformation at Baldt Works, New Castle, Del. How the plan was worked out.

Electric Rolling Mill Plant. Engineer, vol. 126, no. 3276, Oct. 11, 1918, pp. 312-314, 17 figs. Principles of speed control.

The Predetermination of Power Demands of Rolling Mills (Om bestämning och förutberäkning av energiatgangen vid valsverk), Frithiof Holmgren. Bihang till Jern-Kontorets Annaler, year 19, no. 10, Oct. 15, 1918, pp. 489-515, 6 figs.

Diagonals for Designing Rolls for Billet Mills, A. R. Mitchell. Iron Age, vol. 102, no. 20, Nov. 14, 1918, facing page 1198. Tables for determining dimensions of passes when width and corner radii of billets are given.

Steel Hardening

Further Experiments on Spontaneous Generation of Heat in Recently Hardened Steel, Charles F. Brush, Robert A. Hadfield and S. A. Main. Proc. Roy. Soc., vol. 95, no. A666, Oct. 7, 1918, pp. 120-138, 7 figs. Recapitulation of previous investigations; account of recent experimental work which was confined mainly to variations of heat treatment of one particular nickel-chromium steel; presentation of empirical law which seems to regulate approximately gradual diminution of evolution of heat.

See also MECHANICAL ENGINEERING, Fuels and Firing (Waste Heat), Heat Treating.

OCCLUDED GASES

Gases in Metals. Times Eng. Supp., no. 529, Nov. 1918, p. 243. Influence on mechanical properties; opinions of scientists, industrial research workers and manufacturers. Conference of Faraday Soc.

WASTE RECUPERATION

Recuperation and Utilization of Waste of Copper, Zinc, Lead, Tin, Aluminum and Their Alloys (La recupération et l'utilisazion des déchets de cuivre, zinc, plomb, étain, aluminium et de leurs alliages), Paul Raous. Génie Civil, vol. 73, no. 13, Sept. 28, 1918, pp. 251-255, 5 figs. Electrolytic processes for recuperation of tin; recuperation of aluminum; electrolytic separation of metals entering in an alloy. (Concluded.)

See also ELECTRICAL ENGINEERING, Power Applications (Furnaces).

Aeronautics

AEROPLANE PARTS

Stick Control

The Warner Duplex Stick Control. Aerial Age, vol. 8, no. 13, Dec. 9, 1918, p. 661, 3 figs. Brief description of hand and knee grips for use of pilots.

Tail

A Gotha Biplane Tail. Flight, vol. 10, no. 40, Oct. 3, 1918, pp. 1107-1108, 1 fig. Design consisting of two horizontal approximately triangular planes, top plane being supported on cabane of steel tubes, while sides of bottom plane are bolted to sides of body.

AEROSTATICS

Military

Military Aerostatics, H. K. Black. Aerial Age, vol. 8, nos. 6, 7 and 9, Oct. 21 and 28, and Nov. 11, 1918, p. 325, 1 fig., 371, 1 fig. and 475, 2 figs. Oct. 21: Balloon baskets. Oct. 28 and Nov. 11: Equipment of basket. (Continuation of serial.)

AIRCRAFT PRODUCTION

U. S. Navy

Naval Aircraft Factory at Philadelphia. Indus. Management, vol. 56, no. 6, Dec. 1918, pp. 465-470, 13 figs. Story of great industrial achievement of United States Navy.

APPLICATIONS

Exploration

The Possibility of Aerial Reconnaissance in the Himalaya, A. M. Kellas. Aeronautics, vol. 15, no. 257, Sept. 18, 1918, pp. 275-277. Fundamental facts and requirements of undertaking. Paper before Roy. Geog. Soc.

AUXILIARY SERVICES

Trucks

Building for the Aviation Service, M. E. Hoag. Am. Mach., vol. 49, no. 23, Dec. 5, 1918, pp. 1043-1044, 7 figs. Building a 3½-ton special truck for U. S. Aviation Signal Service. First article.

DYNAMICS

Ceiling

Elementary Considerations on the Ceiling of an Airplane (Données élémentaires sur le plafond d'un avion), André Lainé. l'Aérophile, year 26, nos. 17-18, Sept. 1-15, 1918, pp. 264-265. Points out convenience of high ceiling and means of attaining it.

On an Experience of the Flyer Gilbert (Sur une expérience du pilote Gilbert), F. Roux. l'Aérophile, year 26, nos. 17-18, Sept. 1-15, 1918, p. 263, 1 fig. How it happened that Eugène Gilbert maintained his plane stationary in air while machine was running at full speed.

Stability

Lateral Stability in Aeroplanes, C. Levick. Aerial Age, vol. 8, no. 13, Dec. 9, 1918, p. 660, 3 figs. Computation of effect of a roll on a machine in terms of dihedral angle of aerofoils. Also in Flight, vol. 10, no. 42, Oct. 17, 1918, p. 1165, 3 figs.

ENGINES

Austro-Daimler

The 200-Hp. Austro-Daimler Aero Engine. Engineer, vol. 126, nos. 3279 and 3280, Nov. 1 and 8, 1918, pp. 376-379, 10 figs, 393-394, 7 figs. Description of details, with principal data and illustrations. Also in Flight, vol. 10, nos. 44 and 45, Oct. 31 and Nov. 7, 1918, pp. 1217-1222, 10 figs., and 1255-1259, 12 figs.; Engineering, vol. 106, no. 2757, Nov. 1, 1918, pp. 488-492, 17 figs.; Aeronautics, vol. 15, no. 263, Oct. 30, 1918, pp. 403-417, 27 figs.

Design

The Design of Airplane Engines (II), John Wallace. Automotive Eng., vol. 3, no. 9, Oct. 1918, pp. 415-417 and 401, 3 figs. Comparison of rotary and fixed radial motors; trend of modern design; cooling of cylinders; indicator diagram; compression ratio. From Aeronautics. (Continuation of serial.)

History

Outline of History of Aviation Engine Production, H. H. Emmons. Aerial Age, vol. 8, no. 13, Dec. 9, 1918, pp. 662-665, 2 figs. Elementary training engines; development of Liberty 12; methods of production. Also in Motor Age, vol. 34, no. 23, Dec. 5, 1918, pp. 18-19 and 30, 3 figs.

Liberty

American Liberty Motor (Le moteur Américain Liberty). l'Aérophile, year 26, nos. 17-18, Sept. 1-15, 1918, p. 271. Abstract of description authorized by War Department. Also in Sci. Am., vol. 99, no. 23, Dec. 7, 1918, pp. 455 and 466, 4 figs.

Maybach

The 300-Hp. Maybach Aircraft Engine. Automotive Ind., vol. 39, nos. 18, 20 and 21, Oct. 31, Nov. 14 and 21, 1918, pp. 755-759, 8 figs., 840-843, 9 figs., 882-887, 5 figs. Technical description of largest German Aircraft engine model. Issued by Tech. Department, Aircraft Production, Ministry of Munitions. Nov. 14: Lubricating System; details of oil pumps; cooling and ignition systems; carburetor and fuel feed system. Nov. 21: Results of horsepower and fuel consumption tests; table of engine dimensions; general analysis of weights; chemical and physical analysis of material in various parts. Also in Automobile Engr., vol. 8, no. 119, Oct. 1918, pp. 285-295, 27 figs.; Flight, vol. 10, no. 39, Sept. 26, 1918, pp. 1084-1087, 2 figs.

Panhard

The Panhard—300 Hp. (Direct Type Aviation Motor), E. H. Sherbondy. Aerial Age, vol. 8, no. 6, Oct. 21, 1918, pp. 308-309, 5 figs. Motor with two rows, each of six cylinders, inclined 60 deg. to each other.

GLIDERS

An Interesting Biplane Glider, F. J. Camm. Aeronautics, vol. 15, no. 262, Oct. 25, 1918, p. 393. Chief dimensions and process of construction.

HISTORY

Langley

What Langley Did for the Science of Aviation (II). Automotive Ind., vol. 39, no. 17 and 18, Oct. 24 and 31, 1918, pp. 714-718 and 728, 10 figs., and 761-765, 7 figs. Experiments with rubber-driven models and others using compressed air, carbonic acid gas and electric batteries; adoption of steam as source of power. Oct. 31: Experiments with quarter-size and man-carrying aerodromes. (To be continued.)

INSTRUMENTS

Barograph

German Barograph No. 1623, Range 0 to 8000 m. Flight, vol. 10, no. 42, Oct. 17, 1918, pp. 1167-1168, 6 figs. General remarks on details of construction. Also in Aeronautics, vol. 15, Oct. 23, 1918, pp. 382-384, 6 figs.

Instruments for Air Use, W. A. Robson. Sci. Am. Supp., vol. 86, no. 2235, Nov. 2, 1918, p. 285. From Flight.

MATERIALS OF CONSTRUCTION

Steel Tubes

Steel Tubes, Tube Manipulation, and Tubular Structures for Aircraft, W. W. Hackett and A. G. Hackett. Flight, vol. 10, no. 44, Oct. 31, 1918, pp. 1233-1235. Tapered tubes; tubular liners or reinforcements; tubular joints in aircraft construction; tests on soldered joints; brazing; welding; rust prevention. (Concluded.) Also in Automotive Eng., vol. 3, no. 9, Oct. 1918, p. 396 and (discussion) pp. 397-398.

See also MECHANICAL ENGINEERING, Measurements (Permeability).

METEOROLOGY

Meteorology in Relation to Aeronautics (I), W. H. Dines. Sci. Am. Supp., vol. 86, no. 2239, Nov. 30, 1918, pp. 351-352. Review of data required by an aviator when in the air. Paper before Aeronautical Soc. of Gt. Britain. From Aeronautical Jl.

MILITARY AIRCRAFT

British

Some Recent Types of Allied Military Planes. Automotive Ind., vol. 39, no. 17, Oct. 24, 1918, pp. 706-707, 4 figs. General features of Spad single-seater tractor scout, Vickers F B-14, long-distance reconnaissance tractor biplane, Sopwith "Hippo" two-seater fighter, and Avro training machine.

German

German Aircraft Times Eng Supp., no. 527, Sept. 1918, p. 198. Abstract of five reports of Technical Department, Aircraft Production, Ministry of Munitions, describing Maybach engine, Rumpler two-seater biplane, Hannoveraner biplane, an armored machine, and Pfalz scout.

MODELS

Model Construction

Model Aeroplane Building as a Step to Aeronautical Engineering. Aerial Age, vol. 8, nos. 6, 7, 8 and 9, Oct. 21, 28 and Nov. 4, 11, 1918, p. 377, 7 figs., 389, 1 fig., 433 and 483, 1 fig. Oct. 21: Construction of vertical stabilizer. Oct. 28: Designing and building of a man-carrying aeroplane. Nov. 4 and 11: Calculation of sustaining power and resistance of wings and explanation of table giving aerodynamic laboratory tests. (Continuation of serial.)

Model Aeroplanes (XVI), F. J. Camm. Aeronautics, vol. 15, no. 258 and 261, Sept. 25, Oct 16, 1918, p. 300, 1 fig., 369, 2 figs. Details of a tractor monoplane. Oct. 16: Notes on attaching elastic and on manner of flying model.

Model Testing

The Theoretical Basis of Model Strength Tests for Aeroplane Structures, W. L. Cowley and H. Levy. Aerial Age, vol. 8, no. 6, Oct. 21, 1918, pp. 322-323. Application of principle of homogeneity of dimensions to determination of strength of structure.

PLANES

A. E. G.

A. E. G. Armoured Aeroplane. Engineering, vol. 106, no. 2754, Oct. 11, 1918, pp. 416-417, 15 figs. Principal data and description, with details of construction illustrated.

The Fokker Biplane, Type D VII. Flight, vol. 10, nos. 40, 41 and 42, Oct. 3, 10, and 17, 1918, pp. 1109-1116, 1142-1144 and 1161-1164, 23 figs. Data relating to performance and detailed particulars of weights. Issued by Technical Department, Aircraft Production, Ministry of Munitions. Also in Aerial Age, vol. 8, no. 8, Nov. 4, 1918, pp. 424-427, 20 figs.; l'Aérophile, year 26, nos. 17-18, Sept. 1, 1918, pp. 257-262, 10 figs.; Aeronautics, vol. 15, no. 259, Oct. 2, 1918, pp. 310-316, 23 figs.

A. R.

The French A. R. Biplane. Aerial Age, vol. 8, no. 7, Oct. 28, 1918, pp. 374-375, 6 figs. Particulars of two-strutter biplane of 13.3 m. span which has its fuselage supported between planes on ash struts.

Berg

The Austrian Berg Single-Seater. Flight, vol. 10, no. 44, Oct. 31, 1918, pp. 1225-1227, 7 figs. Mounting of 200-hp. Austro-Daimler engine with which plane is equipped; tanks; instruments; control; undercarriage. (Continuation of serial.)

Continental

The Continental Kb 3T Training Tractor, John F. McMahon. Aerial Age, vol. 8, no. 6, Oct 21, 1918, pp. 316-317 and 345, 4 figs. General specifications of machine designed for cheap construction by the Continental Aircraft Corporation.

Halberstadt

Report on the Halberstadt Fighter. Flight, vol 10, no. 41, Oct. 10, 1918, pp. 1133-1141, 38 figs. Details of performance and construction. Issued by Technical Department, Aircraft Production, Ministry of Munitions. Supplementing brief description given in issue of Aug. 1. Also in Engineer, vol. 126, no. 3276, Oct. 11, 1918, pp. 302-304, 25 figs.

Pfalz

Report on the Pfalz Single-Seater (G141). Aeronautics, vol. 15, no. 257, Sept. 18, 1918, pp. 270-271, 22 figs. Particulars and performance of German scout with streamline-shaped fuselage. By Technical Department, Aircraft Production, Ministry of Munitions.

Roland

The Roland Chaser D II, G. Douglas Wardrop. Aerial Age, vol. 8, no. 6, Oct. 21, 1918, pp. 310-312, 9 figs. Construction of fuselage, planes, tail, engine, and undercarriage.

Siemens-Schuckert

A New German Chaser. Flight, vol. 10, no 39, Sept. 26, 1918, p. 1083, 2 figs. Characteristics of Siemens-Schuckert biplane.

Sopwith

The Sopwith "Camel." Automotive Ind., vol. 39, no 19, Nov. 7, 1918, pp. 790-791, 6 figs. Description of late model of British scout plane. Translated from German aircraft publication.

Zeppelin

The Zeppelin Biplane, Jean Lagorgette. Sci. Am. Supp., vol. 86, nos. 2237 and 2238, Nov 16 and 23, 1918, pp. 316-319 and 334-335, 8 figs. Description of German bombing machine 134 ft. long. From Aeroplane.

PRODUCTION

Standardization

Effect of Changes on Airplane Output. Ind. Man., vol. 56, no. 5, Nov. 1918, pp. 375-377. Manufacturers must abandon idea of standardized production.

PROPELLERS

Analysis

Notes on Airscrew Analysis (III), M. A. S. Riach. Aeronautics, vol. 15, no. 257, Sept. 18, 1918, pp. 265-266. Outlines process by which experimental results on airscrews are analyzed and compared with their respective calculated performances. (Concluded.)

Calculations

Calculating Airplane Propeller Strength and Efficiency (II), F. W. Caldwell. Automotive Eng., vol. 3, no. 9, Oct. 1918, pp. 402-405. Limit of ceiling, comparison of conventional designs; calculations of efficiency during climbing; calculations for propeller chart. (Concluded.)

SPECIFICATIONS, AEROPLANE

U. S. Navy

Navy Department Airplane Specifications. Jl. Soc. Automotive Engrs., vol. 3, no. 5, Nov. 1918, pp. 325-329. Issued for use in connection with contracts and submission to Navy of new and undemonstrated designs.

TRANSATLANTIC FLIGHT

Transatlantic Flight, Frithiof G. Ericson. Jl. Soc. Automotive Engrs., vol. 3, no. 5, Nov. 1918, pp. 319-321. Favorable routes; requirements of airplane; flight endurance. From Aviation.

Marine Engineering

AUXILIARY MACHINERY

Boats

Boat Lowering Appliances. J. R. Hodge. Tran. Inst. Marine Engrs., vol. 30, Aug. 1918, pp. 123-127, 4 figs and (discussion) 127-136, 1 fig. Type of disengaging gear designed to deal simultaneously and automatically at both ends of boat, to free it from davit falls or tackles as soon as boat is water-borne.

General Rules and Regulations Prescribed by the Board of Supervising Inspectors as Amended at Board Meeting of January, 1918. Department of Commerce, Steamboat-Inspection Service, Aug. 1, 1918, 147 pp., 5 figs. Rules for boiler plate, boilers and attachments, boats and their appliances, steamers, barges and duties of inspectors; list of instruments, machines and equipments approved for use on vessels.

Diving Bell

Diving Bell in Use at Halifax Ocean Terminals, J. J. Mac Donald. Jl. Eng. Inst. Can., vol. 1, no. 6, Oct. 1918, pp. 252-262, 14 figs. Outline of function design, construction and operation; formulation of principles of design proposed as applicable to future work; survey of fields of activity where plant of this type promises applicability.

SALVAGE

Salvage Methods

Salvage of Wrecked Ships (Le sauvetage des navires coulés), A. Poidloué. Génie Civil, vol. 73, no. 13, Sept. 28, 1918, pp. 241-244, 6 figs. Review of processes used and considerations on probability of future developments.

Turning Vessel

Salvaging the Steamship St. Paul, Charles M. Horton. Int. Mar. Eng., vol. 23, no. 11, Nov. 1918, pp. 644-648, 6 figs. Methods used in turning vessel; character of problems solved; placing patch under difficulties.

SHIPS

Canada

A Canadian Shipbuilding Industry, Thomas Cantley. Can. Min. Inst., bul. no. 80, Dec. 1918, pp. 995-1000. Excerpts from paper at 20th annual meeting of the Institute. The question of developing steel shipbuilding in Canada.

Concrete Ships

Concrete Ship Design, R. J. Wig. Eng. & Cement World, vol. 13, no. 10, Nov. 15, 1918, pp. 15-17, 9 figs. Summary of conclusions on advisability of constructing concrete ships reached by Concrete Ship Department, Emergency Fleet Corporation. From Special Report to Chairman of Shipping Board. Also in Eng. News-Rec., vol. 81, no. 20, Nov. 14, 1918, pp. 903-904, 3 figs.

Different Types of Framing in Two New Government Reinforced-Concrete Ships. Eng. News-Rec., vol. 81, no. 22, Nov. 28, 1918, pp. 986-989, 6 figs. 7500-ton oil tanker has close-spaced frames with vertical and horizontal reinforcing in shell, while 2500-ton schooner barge has long-span framing system with diagonal shell reinforcement.

Reinforced-Concrete Barges (Barca de hormigon armado), Julio Murúa. Revista de Obras Publicas, year 66, no. 2245, Oct. 3, 1918, pp. 493-497, 10 figs. Calculations of design for 60-ft. barge.

Reinforced Concrete Vessels, Walter Pollock. Can. Engr., vol. 35, no. 17, Oct. 24, 1918, pp. 367-373, 5 figs. Considerations of design and ideals aimed by builders; strength; advantages and disadvantages; classification rules; structural details of hull, steelwork and fittings. Paper before British Instn. of Naval Architects.

Duct Keels

Improvements in the Construction of Ships, E. F. Spanner. Shipbuilding and Shipping Rec., vol. 12, no. 9, Nov. 7, 1918, pp. 451-452. Discusses question of duct keels. Before Instn. Engrs. & Shipbuilders.

Isherwood Framing

Large Freighters of Isherwood Framing Adapted to Bridge-Shop Fabrication. Eng. News-Rec., vol. 81, no. 19, Nov. 7, 1918, pp. 853-857, 4 figs. Problems worked out by coöperation of naval architect and engineer of barge shop; 200 tons weight saved; time gained in detailing; all molded work done in large shop at shipyard.

Reduction Gearing

Italian Reduction-Geared Turbine Cargo-Steamship "Ansaldo I." Shipbuilding & Shipping Rec., vol. 12, nos. 19 and 20, Nov. 7 and 14, 1918, pp. 447-450, 13 figs., 470-471, 4 figs. Principal dimensions, plans and photographs.

Resistance

Effect of Appendages on Resistance and Propulsion. Shipbuilding & Shipping Rec., vol. 12, no. 19, Nov. 7, 1918, pp. 452-453, 2 figs. Account of Luke's experiments with various angles of bossing, with outward- and inward-turning screws; values of wake fractions and hull efficiencies; resistance compared with resistance of naked model. (Concluded.)

Rolling

The Rolling of Ships. Sci. Am. Supp., vol. 86, no. 2236, Nov. 9, 1918, p. 299. Factors upon which natural period of roll of a ship depends; results obtained by Froude with his apparatus to record angles of roll. From Shipping World.

Standardized Ships

Structural Steel Standardized Cargo Vessels, Henry R. Sutphen. Inst. Mar. Eng., vol. 23, no. 12, Dec. 1918, pp. 695-698, 1 fig. How quantity production was met.

Stresses

Investigation of Shearing Force and Bending Moment on Ship Structures, A. M. Robb. Int. Mar. Eng., vol. 23, no. 11, Nov. 1918, pp. 637-642, 8 figs. Moderate amplitudes of heave; sagging bending moment; pitching treated graphically; effect of rotational acceleration. (Second article.)

Tow Boats

Plans and Specifications of New Wood Tow Boats. Inst. Mar. Eng., vol. 23, no. 12, Dec. 1918, pp. 673-674, plate, 1 fig. Built for hard service.

Wooden Ships

Building Wooden Ships for the Emergency Fleet Corporation, E. A. Suverkrop. Am. Mach., vol. 49, no. 20, Nov. 14, 1918, pp. 883-887, 11 figs. Planking and interior work. Third article.

YARDS

Canada

Canadian Vickers Shipbuilding Works at Montreal. Engineering, vol. 106, no. 2754, Oct. 11, 1918, pp. 395-396, 12 figs. Illustrated description of shipbuilding in Canada.

Departamental Organization

Effective Arrangement of Departments in Shipyard Organization, G. F. S. Mann. Int. Mar. Eng., vol. 23, no. 11, Nov. 1918, pp. 615-617. Shipyard divisions; relations between organization departments and production departments; duties of chief engineer.

New Lake Shipyard has Side-Launching Ways Under Cover. Eng. News-Rec., vol. 81, no. 19, Nov. 7, 1918, pp. 839-841, 3 figs. Ships built at Ferguson yard fabricated in company's shops two miles away; berths covered with cantilever roof served by semi-gantry crane.

Great Lakes

Great Lakes Yards Lead Coast Districts in Building Ocean-Going Ships. Eng. News-Rec., vol. 81, no. 22, Nov. 28, 1918, pp. 978-980, 4 figs. Canal-size steamers produced in large numbers; spirit of coöperation; yard capacity doubled; no outside fabrication; equipment of varied character; labor shortage.

Shooter's Island

Methods Used at Shooter's Island for Constructing Standard Ships, Charles M. Horton. Int. Mar. Eng., vol. 23, no. 11, Nov. 1918, pp. 618-624, 13 figs. Serving individual ways; method for increasing output: well-lighted boiler shop; handy plate-lifting clamp.

See also ELECTRICAL ENGINEERING, Power Applications (Ship Propulsion); MECHANICAL ENGINEERING, Internal-Combustion Engines (Marine Engines).

Organization and Management

ACCOUNTING

Army

Accounting Systems in Army Camps, E. J. Holmes. Jl. Actcy., vol. 26, no. 6, Dec. 1918, pp. 429-435. Explains the system used by the U. S. Army in connection with the disbursement of funds appropriated by Congress.

Carrying on with the Accountants in the American Expeditionary Forces, C. B. Holloway. Jl. Actcy., vol. 26, no. 6, Dec. 1918, pp. 412-416. Specific operations carried on by the accounting personnel.

Cost Accounting

Cost Accounting to Aid Production (III), G. Charter Harrison. Indus. Management, vol. 56, nos. 5 and 6, Nov. and Dec. 1918, pp. 456-463, 2 figs. and 391-398, 1 fig. Emphasizes necessity of cost-accounting system and illustrates its planning with diagram showing basic features of simple system for a business manufacturing various kinds of standard machines. (Continuation of serial.)

Duties of a Factory Cost Accountant, Joseph Gill. Jl. Actcy., vol. 26, no. 6, Dec. 1918, pp. 441-449. A thesis presented at the May examinations of the Am. Inst. of Accountants. Routine work of cost accountants.

Setting Production Standards for Industrial Accounting and Engineering, F. J. Knieppel. Jl. of Accountancy, vol. 26, no. 5, Nov. 1918, pp. 361-375. Explains methods of determining four basic standards.

Inventories

Verification of Inventories, A. L. Philbrick. Jl. Actcy., vol. 26, no. 6, Dec. 1918, pp. 417-428. Briefly outlines the work of the auditor and his responsibilities. Difficulties involved in the verification of the inventory.

Mail Order

Mail Order Accounting, Harry L. Cavanagh. Jl. Actcy., vol. 26, no. 6, Dec. 1918, pp. 436-440. A thesis presented at the May examinations of the Am. Inst. of Accountants.

Power House

Economics of the Power House, L. W. Alwyn-Schmidt. Power Plant Eng., vol. 22, no. 23, Dec. 1, 1918, pp. 949-952. Problem of power-house accounting approached from point of view of economist.

EDUCATION

Training of Employees

Packard Training Schools for Employees, D. G. Stanbrough. Indus. Management, vol. 56, no. 5, Nov. 1918, pp. 378-382, 13 figs. Four schools operated; for men, women, instructors for women and for job setters and foremen.

Vestibule School of Lincoln Motor Co., J. M. Eaton. Indus. Management, vol. 56, no. 6, Dec. 1918, pp. 452-455, 10 figs. Equipment of training rooms; system of instruction in machine-shop practice.

Soldiers

Vocational Training for Returned Soldiers. Jl. Eng. Inst. Can., vol. 1, no. 7, Nov. 1918, pp. 333-334. Work being done at Toronto and McGill Universities.

University

The Khaki University. Can. Min. Inst., bul. no. 80, Dec. 1918, pp. 985-989. Letter from F. D. Adams giving an account of the work and plans for future development.

FACTORY MANAGEMENT

Boiler Shop

Business Equipment in the Boiler Shop, Edwin L. Seabrook. Boiler Maker, vol. 18, no. 11, Nov. 1918, pp. 305-307. Suggests items of business conduct in boiler making plant.

Employment Manager

The Employment Manager, Edward D. Jones. Wood-Worker, vol. 37, no. 9, Nov. 1918, pp. 38-39. Organization and direction of course offered gratis to representatives of manufacturers by Management Division of War Industries Board.

The Employment Manager in Our Shipyards, Edward B. Jones. Int. Mar. Eng., vol. 23, no. 11, Nov. 1918, pp. 612-614. Duties of general executive; importance of schools; wage system and ideal service; psychology of mass action.

Foremen

Instructions to Assistant Foremen, George H. Shepard. Indus. Man., vol. 56, no. 5, Nov. 1918, pp. 403-407. Prepared by plant working extensively on governmental orders to inspire and guide minor executives.

Industrial Organization

After-War Economics of Engineering. Times Eng. Supp., no. 529, Nov. 1918, pp. 225-226. Sugests that plants review their methods of manufacture and adopt convenient modifications when necessary. Illustrations of practical procedure by reference to foundry work

Industrial Organization as it Affects Executives and Workers, Charles E. Knoeppel. Jl. Am. Soc. Engrs., vol. 40, no. 12, Dec. 1918, pp. 1031-1033. Proposes rules of efficient organization for practical guidance of executives in developing system of industrial relationship. Presented at annual meeting of the Soc.

Management—The Solution of the Shipbuilding Problem, W. L. Churchill. Indus. Management, vol. 56, no. 5, Nov. 1918, pp. 361-366, 2 figs. Based on study of conditions in 20 shipyards and pointing to management as developed recently in other industries as proper solution to problems.

Practical System in Factory Operations, M. H. Potter. Can. Machy., vol. 20, no. 20, Nov. 14, 1918, pp. 559-560, 6 figs. Forms of charts developed from investigation of actual case.

Scientific Management Simplified, Malcolm Keir. Sci. Monthly, vol. 7, no. 6, Dec. 1918, pp. 525-529. Adaptability of scientific management to industry; fundamental elements of scientific management.

Industries

New Industries, H. W. Gepp. Aust. Min. Std., vol. 60, no. 1564, Oct. 31, 1918, pp. 686-688. Address with discussion before Soc. of Chem. Ind., Melbourne. Essential factors in the successful development of new industries in a young country.

Mechanical Department

Coördination in the Mechanical Department, W. U. Appleton. Ry. Rev., vol. 63, no. 22, Nov. 30, 1918, pp. 773-774. Recommendations for system and harmony within department and with other departments. Paper before Canadian Ry. Club, Oct. 1918.

Rate Setting

Mastering Power Production, Walter N. Polakov. Ind. Man., vol. 56, no. 5, Nov. 1918, pp. 399-403, 6 figs. Conservation of labor, power and fuel in relation to rates. Tenth article.

Time Studies for Rate Settings on Gisbolt Boring Mills, Dwight V. Merrick. Indus. Management, vol. 56, no. 5, Nov. 1918, pp. 409-411, 1 fig. Fifth article.

Routing

About the Handling of Mill Work (II), Chas. Cloukey. Wood-Worker, vol. 37, no. 9, Nov. 1918, pp. 23-24, 1 fig. Part which routing of work through mill has in economical production.

Task Setting

The Human Factor in Task Setting, W. E. Camp. Indus. Management, vol. 56, no. 5, Nov. 1918, pp. 372-374, 1 fig. Chief conditions that affect factor; how they are evaluated; how to predetermine proper allowance.

Tool Department

Continuous Tooling. Times Eng. Supp., no. 527, Sept. 1918, p. 183. Suggests a means of obtaining increased output from machine-shop tools.

Tool Department of Winchester Works. Iron Age, vol. 102, no. 19, Nov. 7, 1918, pp. 1129-1133, 4 figs. Virtually on factory production basis, workers being trained for single type operation; preparation section's important functions.

See also MARINE ENGINEERING, Yards; AERONAUTICS, Production.

FINANCE AND COST

Capital

Capital: Its Waste and Its Conservation, Archibald P. Main. Gas Jl., vol. 144, no. 2894, Oct. 29, 1918, pp. 249-251, and (discussion) pp. 251-252. Means by which author judges British industry can make best use of available credit and financial accommodation. Paper before Soc. of British Gas Industries.

INSPECTION

Graphic Control

Graphic Production Control, C. E. Knoeppel. Indus. Management, vol. 56, nos. 5 and 6, Nov. and Dec. 1918, pp. 383-390, 17 figs, 496-502, 14 figs. Controlling materials and operations. Fourth Article.

Production Records

Keeping Close Track of Shop Operation, Robert I. Clegg. Iron Age, vol. 102, no. 21, Nov. 21, 1918, pp. 1251-1253, 6 figs. Records of production and labor bulletined to management; reports with alarm-clock attachment.

Supervision

Mechanical Department Supervision, Frank McManamy. Ry. Mach. Eng., vol. 92, no. 11, Nov. 1918, pp. 597-598. Better supervision and more of it needed to keep up shop output. From paper before New York Ry. Club.

See also MECHANICAL ENGINEERING, Foundries (Supervision).

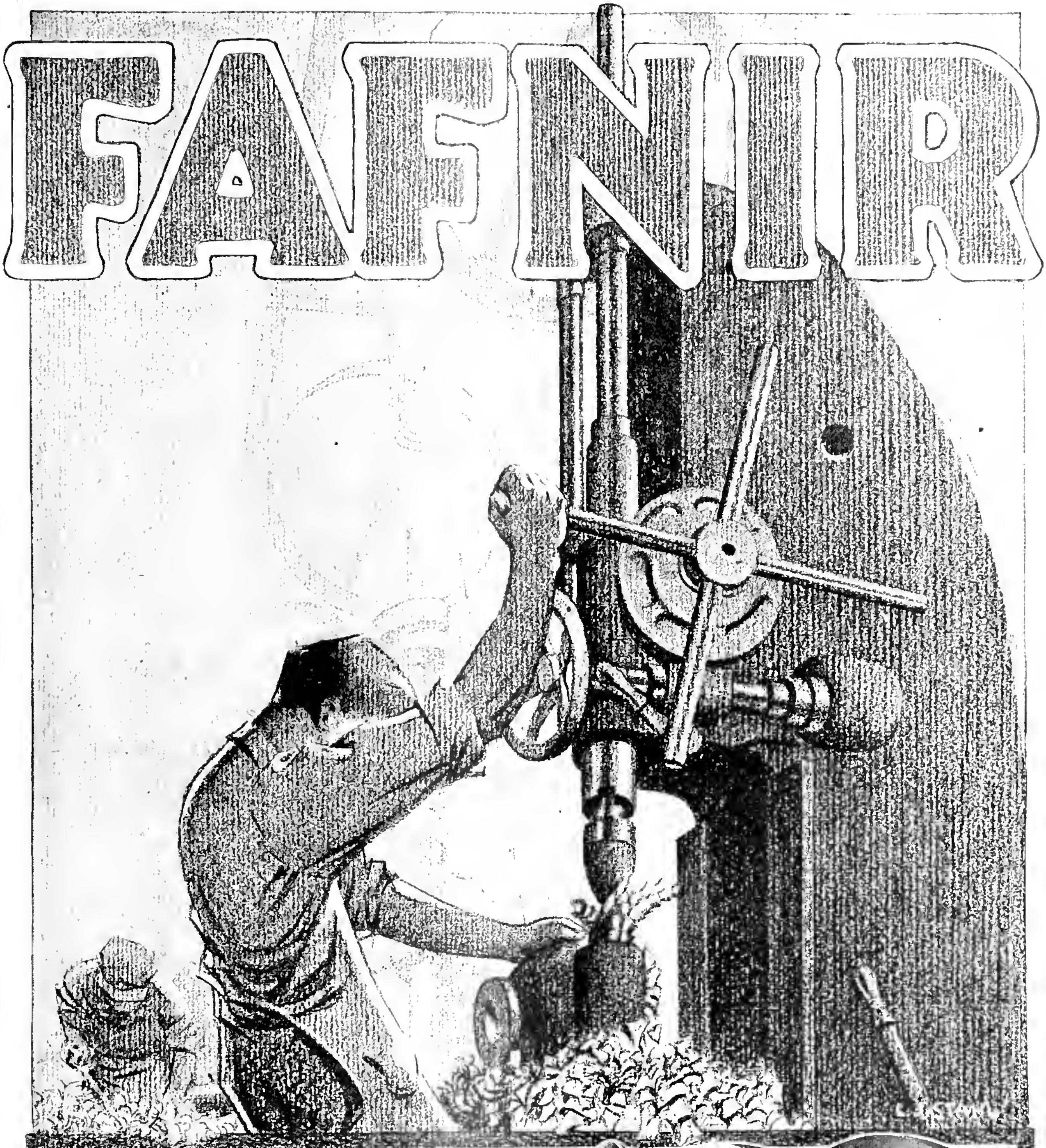
LABOR

Bargaining (including collective systems)

Agreement vs. Bargaining, Harry Tipper. Automotive Ind., vol. 39, no. 19, Nov. 7, 1918, pp. 784-785. Claims confidence between employer and employee is impossible so long as both base their relations upon their ability to take advantage of a bargain.

Handling Employment Relations Without Help from the Outside. Automotive Ind., vol. 39, no. 17, Oct. 24, 1918, pp. 722-723, 1 fig. Collective-bargaining plan for handling all matters relating to wages, hours of labor, discipline, discharges and grievances.

Important Phases of the Labor Problem, Magnus W. Alexander. Iron Age, vol. 102, nos. 21 and 22, Nov. 21 and 28, 1918, pp.



DRILL THRUST

One of the chief sources of possible power loss experienced in connection with the operation of heavy duty drills is found in the excessive friction which results when inadequate provision is made for carrying the severe thrust load reacting upward through the spindle. For this application the ball bearing is far more efficient than any other type.

Fafnir Thrust Ball Bearings are standard in the products of many prominent drill manufacturers.

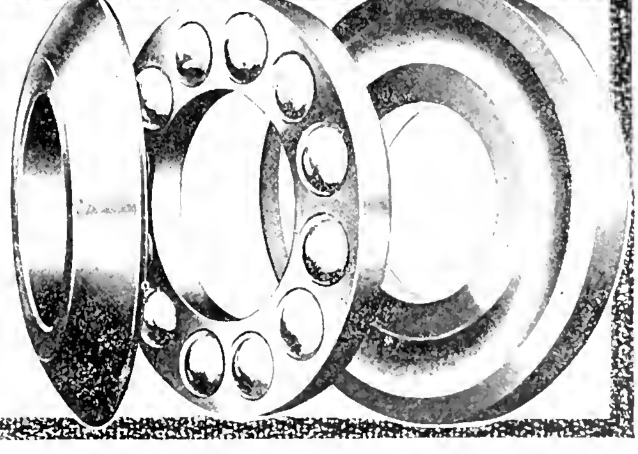
THE FAFNIR BEARING COMPANY

Conrad Patent Licensee

New Britain, Conn.

DETROIT Office: 752 David Whitney Bldg.

CHICAGO Office: 1919 So. Michigan Ave.



1258-1261 and 1322-1325. Problems of pensions and insurance; profit sharing in industry; adjustment of labor disputes; working conditions; hours of work. Nov. 21: Recruiting of men; collective bargaining discussed.

Bonuses

Paying Bonuses to Power Plant Employees, Frederick L. Ray. Nat. Engr., vol. 22, no. 10, Oct. 1918, pp. 493-495, and (discussion) pp. 495-497. Account of system followed by Milwaukee Elec. Ry. & Light Co. Paper before Nat. Assn. of Stationary Engrs.

British Labor Administration

Labor Administration, Edward T. Elbourne. Engineer, vol. 126, nos. 3276, 3278, 3279, 3280, Oct. 11 and 25, Nov. 1 and 8, 1918, pp. 299-300, 348-350, 2 figs., 365-367, 4 figs., 388-390, 1 fig. Oct. 25: Women; Nov. 1: Time office (men); Nov. 8: Methods of Remuneration.

Dilution

Labor Dilution as a National Necessity, Frederick A. Waldron. Jl. Am. Soc. Mech. Engrs., vol. 40, no. 12, Dec. 1918, pp. 1033-1035. After referring to work done by British Bureau of Labor Dilution writer outlines scope of labor dilution as necessary application to national recources of U. S. Presented at annual meeting of society.

Employment Department

Employment Department Routine of the Curtiss Aeroplane & Motor Corp., Charles E. Fouhy. Ind. Man., vol. 56, no. 5, Nov. 1918, pp. 412-416, 17 figs. Routine and forms of employment department.

Industrial Relations

Employment of Labor, Dudley R. Kennedy. Jl. Am. Soc. Mech. Engrs., vol. 40, no. 12, Dec. 1918, pp. 1030-1031. Activities of Industrial Relations Department of Hog Island plant in connection with securing and maintaining a force of 35,000 employees and providing for their needs and comfort. Presented at annual meeting of society.

Fundamental Factors in Sound Industrial Relations, H. T. Wailer. Ind. Management, vol. 56, no. 5, Nov. 1918, pp. 367-371, 8 figs. Seven factors discussed by author and illustrated by cartoons interpreting vital truth.

Use of Non-Financial Incentives in Industry, Robert B. Wolf. Jl. Am. Soc. Mech. Engrs., vol. 40, no. 12, Dec. 1918, pp. 1035-1038, 2 figs. Account of instances where personal interest has been developed in workmen by supplying foremen with information upon costs, methods of operation, possibilities in direction of economy and efficiency, etc. Presented at annual meeting of society.

Lunch Rooms

Feeding Employees at a Steel Plant. Iron Age, vol. 102, no. 19, Nov. 7, 1918, pp. 1136-1138, 2 figs. Reasons for abolishing dinner pail; management of lunchroom; auxiliary room for foreigners; commissary.

National War Labor Board

The War Labor Board and the Living Wage, Frank P. Walsh. Survey, vol. 41, no. 10, Dec. 7, 1918, pp. 301-303. Account of origin of National War Labor Board, its purpose and achievements.

Profit Sharing

A Tested Profit Sharing Plan, Dale Wolf. Indus. Management, vol. 56, no. 6, Dec. 1918, pp. 486-488, 3 figs. Average of 46 per cent of company's profits are distributed to employees.

Soldiers

Returned Soldiers Make Very Good Welders, W. F. Sutherland. Can. Machy., vol. 20, no. 22, Nov. 28, 1918, pp. 618-619, 2 figs. Outline of work done by training school.

The Employment of the Returned Soldier. Can. Machy., vol. 20, no. 20, Nov. 14, 1918, pp. 561-562. Résumé of problem as viewed by English correspondent. From Times Eng. Supp.

The Industrial Restoration of Disabled Soldiers, Bert J. Morris. Indus. Management, vol. 56, no. 6, Dec. 1918, pp. 477-481, 4 figs. Review of accomplishments of other nations and notes on organizations preparing to reëducate American soldiers.

Turnover

Interpreting Labor Turnover, Luther D. Burlingame. Am. Mach., vol. 49, no. 19, Nov. 7, 1918, pp. 855-858, 1 fig. Discusses real meaning and how it should be computed.

Women

Women in the Machine Shop, S. A. Hand. Am. Mach., vol. 49, no. 23, Dec. 5, 1918, pp. 1035-1037, 9 figs. Successful experience of large firm of machine tool builders in employment of women workers.

Women Workers

Women in the Service of the Railways, Pauline Goldmark. Ry. Age, vol. 65, no. 23, Dec. 6, 1918, pp. 1016-1018. Used in a great variety of work. Address before Labor Reconstruction Conference, Academy of Political Science, N. Y.

LEGAL

Boiler Contracts

Construing Boiler Contracts, A. L. H. Street. Power, vol. 48, no. 22, Nov. 26, 1918, pp. 765-766. Case reported in the Maryland Court of Appeals, bearing on obligations of manufacturer under contract for installation of boilers according to particular specifications.

Casual Employment

What Constitutes Casual Employment? Chesla C. Sherlock. Am. Mach., vol. 49, no. 19, Nov. 7, 1918, pp. 850-852. Discussion of certain legal interpretations.

Contributory Negligence

Disobedience of Orders by Employees and Its Relation to Compensation, Chesla C. Sherlock. Am. Mach., vol. 49, no. 22, Nov. 28, 1918, pp. 980-982. Review of some court decisions.

Floors, Slippery (accidents from)

Injuries Caused by Slippery Floors, Chesla C. Sherlock. Power, vol. 48, no. 22, Nov. 26, 1918, pp. 790. Some court decisions.

Simple Tools (accidents from)

Liability in the Use of Simple Tools, Chesla C. Sherlock. Am. Mach., vol. 49, no. 21, Nov. 21, 1918, pp. 939-940. Some legal aspects of employers' liability in use of simple tools.

LIGHTING

Leather Industry

Need for Improved Lighting in the Leather Industry, F. H. Bernhard. Elec. Rev., vol. 73, no. 20, Nov. 16, 1918, pp. 759-765, 7 figs. Tenth of series of articles on lighting in industries.

Lighting (General)

Daylight vs. Sunlight in Sawtooth-Roof Construction, W. S. Brown. Jl. Am. Soc. Mech. Engrs., vol. 40, no. 12, Dec. 1918, pp 1025-1029, 5 figs. Empirical research of amount of direct sunlight and intensity of daylight to be admitted on working plane in sawtooth construction; equation to determine time of admission of direct sunlight and number of hours of its duration with given orientation of sawtooth buildings and slope of lighting area; influence of size and slope of sawtooth lighting area on relative intensity of daylight from northern sky; examples illustrating manner of computing amount of diffused light entering building under several conditions. Presented at annual meeting of the Soc.

Elements of Illuminating Engineering (III), Ward Harrison. Elec. Eng., vol. 52, no. 2, Aug. 1918, pp. 30-34, 4 figs. Essentials in illumination design—coefficients of utilization, location of light sources, and recommended minimum spacings and minimum heights above plan of illumination for various units.

Lighting in Its Relation to the Eye, C. E. Ferree and G. Rand. Proc. Am. Phil. Soc., vol. 57, no. 5, 1918, pp. 440-478, 9 figs. Report of work of sub-committee on Hygiene of the Eye of Am. Medical Assn., involving an extensive experimentation on effect of different lighting conditions on eye, and investigation of factors in lighting situation causing eye to lose in efficiency and experience discomfort.

Some Modern Methods of Lighting, Geo. H. Stickney. Nat. Engr., vol. 22, no. 10, Oct. 1918, pp. 469-477, 7 figs., and (discussion) pp. 477-479 Analysis of elements of lighting systems required by factories, offices and stores. Paper before Nat. Assn. of Stationary Engrs.

War-Time Lighting Economies. Elec. World, vol. 72, no. 19, Nov. 9, pp. 885-887. Salient features of report prepared by War Service Committee of Illuminating Engineering Society for U. S. Fuel Administration; fallacies to be avoided; making maximum use of daylight.

Reflecting and Diffusing Light

Reflecting and Diffusing Light, Ward Harrison. Textile World Jl., vol. 54, nos. 18, 20, 21 and 22, Nov. 2, 16, 23 and 30, 1918, pp. 61 and 71, 4 figs., 25-27, 1 fig., 59-63, 5 figs., and 33, 5 figs. Properties of accessories necessary for good industrial illumination.

Steel Mills

Better Lighting of Iron and Steel Mills and Fabricating Plants, F. H. Bernhard. Elec. Rev., vol. 73, no. 22, Nov. 30, 1918, pp. 841-845, 7 figs. Eleventh of series of articles on improvement of lighting in industries.

PUBLIC REGULATION

Government Trading

The Functions of the Government in Relation to Industry, W. L. Hichens. Iron & Steel Trades Jl., nos. 3099 and 3100, Nov. 2 and 9, 1918, pp. 488-489 and 514. Examination of advisability of carrying out suggestions that the Government engage in trading undertakings.

RECONSTRUCTION

Electrical Industry

Problems of the Reconstruction Era. Elec. World, vol. 72, no. 19, Nov. 9, 1918, pp. 877-878. Taking effective part in great world war, this country will necessarily be powerful factor in succeeding period; closer coöperation in electrical industry advocated.

Export Trade

Reconstructing Our Business Fabric. Shipping, vol. 5, no. 8, Nov. 23, 1918, pp. 15-16, 1 fig. Steps being taken and progress made to take advantage of present opportunity United States has of developing internationally.

SAFETY ENGINEERING

Boiler Rooms

Boiler Room Rules. Eng. & Cement World, vol. 13, no. 10, Nov. 15, 1918, p. 66. Suggestions to boiler-room attendants on the care of oilers and prevention of accidents. From Safety Bul.

Boiler Shops

Accident Prevention in Boiler Shops. Boiler Maker, vol. 18, no. 11, Nov. 1918, pp. 315-317, 5 figs. Account of what Bethlehem Steel Co. has accomplished and consideration of causes of accidents.

Disease Prevention

Engineers and Disease Prevention. Times Eng. Supp., no. 529, Nov. 1918, p. 231. Points out part engineers can play.

First Aid

Standardization of First Aid Methods, C. H. Connor. Safety Eng., vol. 36, no. 4, Oct. 1918, pp. 237-238. From Proc. Seventh Annual Safety Congress.

Foundries

Injuries from Molten Metal, Chesla C. Sherlock. Iron Age, vol. 102, no. 21, Nov. 21, 1918, pp. 1262-1262. Ordinary perils; defective tools and appliances; basis of foundryman's responsibility.

Water-Supply Protection

Protection of Water Mains, Fire Hydrants and Valves in Winnipeg, Thomas H. Hooper. Mun. Jl., vol. 45, no. 21, Nov. 23, 1918, p. 410. From Quarterly of Nat. Fire Protection Assn.

Woodworking Industry

Infections and Blood Poisoning in the Woodworking Industry, Leroy Philip Kuhn. Safety Eng., vol. 36, no. 4, Oct. 1918, pp. 228-230. From Proc. Seventh Annual Safety Congress.

SALVAGE

Salvaging and Utilizing Wastes and Scrap in Industry, W. Rockwood Conover. Indus. Management, vol. 56, no. 6, Dec. 1918, pp. 449-451. Significance of salvaging; reclaiming practice for number of classes of materials and wastes.

TRANSPORTATION

Comparative Methods

Light-Traffic Railway vs. Highway and Motor Truck, Clement C. Williams. Eng. News-Rec., vol. 81, no. 22, Nov. 28, 1918, pp. 984-985. Analyses of operating expenses, fixed charges and amount and kind of traffic should be made for each case.

Motor Trucks

Highway-Motor Truck Problem as Viewed by User, Manufacturer and Engineer. Eng. News-Rec., vol. 81, no. 22, Nov. 28, 1918, pp. 968-977, 2 figs. Three views. Limitations to be Placed on Trucks, from User's Viewpoint, by George H. Pride; Factors that Will Govern Future Road Design, by Edward L. Viets; Highways and Truck Loads they Can Economically Sustain, by H. Eltinge Breed.

Motor Truck Transportation Growing Rapidly. Ry. Rev., vol. 63, no. 22, Nov. 30, 1918, pp. 763-769, 11 figs. Formerly regarded as competitive, inter-city motor-truck traffic is now encouraged by railroads.

Industrial Technology

Alcohol

Industrial Alcohol. Times Eng. Supp., no. 529, Nov. 1918, p. 228. Possible sources of supply.

Asphalt

Chemical Constitution of Artificial Asphalts (La constitution chimique des asphaltes artificiels). Génie Civil, vol. 73, no. 13, Sept. 28, 1918, p. 256. Results of experiments with petroleum residues, lignite, tars and schist. From Zeitschrift fur angewandte Chemie, June 11 and 18.

Coal Distillation

Distillation at Low Temperature. Gas Age, vol. 42, no. 11, Dec. 2, 1918, pp. 466-467. Discusses advantages of "coalite" process. From Journal des Usines a Gaz.

Low Thermal Distillation of Coals, G. W. Traer. Coal Industry, vol. 1, no. 10, Oct. 1918, pp. 393-395. Details of experimental plant; characteristics of semi-coke or charcoal; how to make a coke of suitable structure. Am. Inst. Min. Engrs. paper.

Dust Precipitation

Electrostatic Dust Precipitation, William H. Easton. Indus. Management, vol. 56, no. 6, Dec. 1918, pp. 473-475, 5 figs. Dust-laden gases become ionized when passing through field around grounded tubes inside which fine wires are charged with current at 50,000 to 100,000 volts.

Gas Manufacture

Coal Conservation in Relation to Gas Manufacture, Tim Duxbury. Gas Jl., vol. 144, no. 2895, Nov. 5, 1918, pp. 302-305 and (discussion) pp. 305-308. Results of experience with vertical retorts. Paper before Manchester Instn. of Gas Engrs. Also in Gas World, vol. 69, no. 1789, Nov. 2, 1918, pp. 262-263, 1 fig.

Economizing Coal in Gas Manufacture, Frederick Shewring. Gas World, vol. 69, no. 1789, Nov. 2, 1918, p. 261. Comments on steaming retorts.

Inclined Retort Plant at Rome, N. Y., A Success, S. Bent. Russell. Gas Age, vol. 42, no. 11, Dec. 2, 1918, pp. 463-466, 4 figs. Views and mechanism details of plant having daily capacity of 500,000 cu. ft. of gas.

Institution of Gas Engineers. Gas Investigation Committee. Gas Jl., vol. 144, nos. 2894 and 2895, Oct. 29 and Nov. 5, 1918, pp. 235-249, 3 figs. and (discussion) pp. 291-299. Report of sub-committee appointed to investigate relative efficiency in use of different grades and compositions of gas.

Glass

Substitutes for Glass. Sci. Am. Supp., vol. 86, no. 2235, Nov. 2, 1918, p. 283. Composition of siloxide and artificial mica; possibilities of derivatives of cellulose, oiled cotton cloth and vitro-cellulose. From La Nature.

Leather

Recent Developments in Leather Chemistry, Henry R. Proctor. Jl. Roy. Soc. of Arts, vol. 66, no. 3442, Nov. 8, 1918, pp. 776-781. Discussion of chemical and physical changes taking place in tanning process.

Naphthalene and Benzol

Estimation of Naphthalene in Coal Gas, Harold G. Colman. Gas Jl., vol. 144, no. 2894, Oct. 29, 1918, pp. 231-232. Modifications in Colman-Smith's method (vol. 75, p. 798.)

Notes on Benzol and Naphthalene Recovery, Harold E. Copp. Gas Jl., vol. 144, no. 2895, Nov. 5, 1918, pp. 311-313, 2 figs. Results obtained with plant installed at gas works. Paper before Midland Assn. of Gas Engrs. and Mgrs. Also in Gas World, vol. 69, no. 1789, Nov. 2, 1918, pp. 265-266.

Nitric Acid

Nitric Acid as a By-Product of Internal Combustion Engines, A. W. H. Griepe. Am. Gas Eng. Jl., vol. 109, no. 21, Nov. 23, 1918, pp. 487-489, 7 figs. and p. 492. Process to precipitate nitric oxide as by-product of internal-combustion engines, flue gases, illuminating gas, furnace gas, blast-furnace gas, natural gas, etc.

Oxygen and Hydrogen

Electrolytic Oxygen and Hydrogen. Travelers' Standard, vol. 6, no. 7, July 1918, pp. 137-145. Method of producing oxygen and hydrogen and their respective industrial applications.

Potash

Recovery of Potash from Blast Furnaces, Linn Bradley. Iron Age, vol. 102, no. 19, Nov. 7, 1918, pp. 1151-1153. From paper before Fourth Nat. Expos. of Chem. Ind., New York, September 1918.

Stoneware

Chemical Stoneware, Fred A. Whitaker. Brick & Clay Rec., vol. 53, no. 11, Nov. 19, 1918, pp. 875-877, 10 figs. Account of development of industry in United States.

Water Gas

Applications of Peat for the Production of Water Gas (Tyrs Anvendelse til Fremstilling af Vandagas). Ingenioren, year 27, no. 86, Oct. 26, 1918, pp. 561-562.

Railroad Engineering

BRITISH

British Railways

British Railways Under War Conditions. Engineer, vol. 126, no. 3280, Nov. 8, 1918, pp. 390-391. What they cost the country. Eighth article.

ELECTRIC RAILROADS

(Not including Street and Interurban Lines)

Argentine Railways

Electric Traction on the Central Argentine Railway. Ry. Gaz., vol. 29, no. 18, Nov. 1, 1918, pp. 466-469, 4 figs. Cables; substations. (Continuation of serial.) Also in Engineer, vol. 126, no. 3279, Nov. 1, 1918, pp. 367-370, 12 figs.

Energy Consumption

Energy Consumption of Cars Is Affected by Temperature Changes, M. B. Rosevear. Elec. Ry. Jl., vol. 52, no. 22, Nov. 30, 1918, pp. 958-960, 2 figs. That power required for car operation is affected by variations in schedule speed, number of passengers carried and temperature is shown by extended study made by Public Service Railway, Newark, N. J.

Substations

Automatic Substations and Direct-Current Railway Systems (Les sous-stations automatiques et les réseaux de traction à courant continu). Revue Générale de l'Electricité, vol. 4, no. 11, Sept. 14, 1918, pp. 386-392, 7 figs. Details of operation; scheme of connections for 600-volt systems; tables of results obtained in actual installations.

See also ELECTRICAL ENGINEERING, Transformers (Substations).

ELECTRIFICATION

Montreal Tunnel

Montreal Tunnel Zone Electrification, William G. Gordon. Elec. Ry. Jl., vol. 52, no. 22, Nov. 30, 1918, pp. 962-965, 5 figs. Summary of details of rolling stock, overhead and substation equipment; design and construction problems. Abstract of paper before Am. Inst. of Elec. Engrs., Toronto, Nov. 1918.

EQUIPMENT

Ditcher

Electrically Operated Ditcher Effects Big Saving, Charles W. Ford. Elec. Ry. Jl., vol. 52, no. 22, Nov. 30, 1918, pp. 960-961, 5 figs. This is first electric machine built for ditching purposes; operates at 1200 or 1500 volts with 30-hp. motor.

LABOR

British Railways

British Railways Under War Conditions. Engineer, vol. 126, no. 3279, Nov. 1, 1918, pp. 371-372. Railwaymen's war bonus. Seventh article.

MAINTENANCE

Maintenance of Way Records and Reports. Ry. Rev., vol. 63, no. 19, Nov. 9, 1918, pp. 667-668. Methods being worked out by Railroad Administration for establishing accurate records; will standardize reports.

Pacific Electric's New Car Storage and Repair Facilities, Clifford A. Elliott. Elec. Ry. Jl., vol. 52, no. 21, Nov. 23, 1918, pp. 914-917, 11 figs. Description of three divisional storage track layouts with car houses and repair shops.

LOCOMOTIVES

Boiler for Mallet Locomotive

Large Boiler for New Mallet Locomotive. Boiler Maker, vol. 18, no. 11, Nov. 1918, pp. 303-304, 4 figs. Sections and elevations of boiler built for heavy grades, having firebox length of 181 1-16 in. and designed for 215-lb. working pressure.

Feedwater Heating

Locomotive Feed Water Heating, H. S. Vincent. Ry. Mech. Engr., vol. 92, no. 12, Dec. 1918, serial 1st part, pp. 645-649, 8 figs. Discussion of exhaust steam and waste gas methods of preheating.

French Compound

Recent Locomotives for the French State Railways, F. C. Coleman. Ry. Age, vol. 65, no. 20, Nov. 15, 1918, pp. 861-863, 4 figs. Principal data and descriptions of four-cylinder compound pacific type and simple consolidation type built in Great Britain.

Rock Island Heavy

2-10-2 Type Locomotive for the Rock Island Lines. Ry. Age, vol. 65, no. 23, Dec. 6, 1918, pp. 992-994, 6 figs. Novel and interesting features.

Santa Fe Heavy

A. T. & S. F. 4-8-2 Type of Locomotives. Ry. Mech. Engr., vol. 92, no. 12, Dec. 1918, pp. 649-652, 3 figs. Heaviest of type yet built. Principal dimensions and data.

Santa Fe Passenger

Mountain Type Locomotive for the Santa Fe. Ry. Rev., vol. 63, no. 20, Nov. 16, 1918, pp. 697-698, 3 figs. Description and principal data of heavy fast passenger locomotive. Also in Ry. Age, vol. 65, no. 22, Nov. 29, 1918, pp. 957-959, 1 fig.

Standard

Data for Standard Locomotives. Ry. Mech. Eng., vol. 92, no. 11, Nov. 1918, pp. 607-610, 12 figs. Tonnage rating charts and clearance and weight diagrams for government locomotives now built.

Standard Switcher

Standard Six-Wheel Switcher. Ry. Mech. Eng., vol. 92, no. 11, Nov. 1918, pp. 593-596, 5 figs. Principal data and description with drawings.

Superheating

Superheater Locomotive Performance. Ry. Mech. Engr., vol. 92, no. 12, Dec. 1918, pp. 652-655, 1 fig. Abstract of committee report presented at the 1918 Convention of the Traveling Engrs. Assn., with discussion.

Virginian Heavy Grade Pusher

Virginian 2-10-10-2 Locomotives. Ry. Mech. Eng., vol. 92, no. 11, Nov. 1918, pp. 600-604, 6 figs. Principal data and description with drawings. Built for heavy grade pusher service.

NEW CONSTRUCTION

American-Built Railroad Cutoff will Relieve Traffic Congestion in France, Robert K. Tomlin, Jr. Eng. News-Rec., vol. 81, no. 19, Nov. 7, 1918, pp. 832-835, 14 figs. A 5¾-mile double-track line for Expeditionary forces; big embankment chief feature; bridge half a mile long.

OPERATION AND MANAGEMENT

British Operation

Presidential Address to the Institution of Civil Engineers, John A. F. Aspinall. Ry. Gaz., vol. 29, no. 19, Nov. 8, 1918, pp. 487-494. British railway engineering and operation; immediate problems to be faced.

Fuel Conservation

Conservation of Fuel on the Railroads. Ry. Age, vol. 65, no. 21, Nov. 22, 1918, pp. 913-916. Abstracts of papers presented by railway men before New York Ry. Club.

Work of the Fuel Conservation Section, E. C. Schmidt. Ry. Rev., vol. 63, no. 22, Nov. 30, 1918, pp. 769-772. Organization and work of this department of Railroad Administration.

Supervision of Locomotives, British

District Supervision of Locomotives on British Railways, W. Patterson. Ry. Gaz., vol. 29, no. 18, Nov. 1, 1918, pp. 469-471. Review of work in a typical district with a staff of about 500 persons and sheds to which are allotted 150 engines.

Traffic Control

Controlling the Freight Traffic, North-Eastern Railway. Engineer, vol. 126, no. 3276, Oct. 11, 1918, pp. 305-306, 3 figs. Description of traffic control of North-Eastern Railway, and control board.

See also CIVIL ENGINEERING, Water Supply.

PERMANENT WAY AND BUILDINGS

Floor Slabs and Culverts

Railway Practice in Design of Concrete Floor Slabs and Flat Top Culverts. Eng. & Contracting, vol. 50, no. 21, Nov. 20, 1918, pp. 511-512. Results of questionnaire by George H. Tinker. From Oct. Bulletin of Am. Ry. Eng. Assn.

Relocation of Lines

New York Central Relocates Lines to Cross Barge Canal at the Tonawandas. Eng. News-Rec., vol. 81, no. 20, Nov. 14, 1918, pp. 893-896, 2 figs. Detour two miles long around hearts of cities at once combines bridges over waterway and solves difficult problem of eliminating grade crossings and occupation of main business streets.

See also CIVIL ENGINEERING, Bridges, Building and Construction.

RAILS

Transverse Fissures

Transverse Fissures and Phosphorus Streaks in Rails, G. F. Comstock. Ry. Age, vol. 65, no. 22, Nov. 29, 1918, pp. 961-963, 2 figs. New evidence of influence of segregation and of advantage of reheating blooms. Abstract of paper before Am. Inst. of Min. Engrs.

Transverse Fissures Cause Rail Failures. Ry. Age, vol. 65, no. 23, Dec. 6, 1918, pp. 1007-1009. Abstract of James E. Howard's report of the rail failure at Central Islip, N. Y.

ROLLING STOCK

Cleaning

Passenger Car Cleaning on the Canadian Pacific Railway, E. Eley. Can. Ry. Club, vol. 17, no. 6, Sept. 1918, pp. 19-22, and (discussion) pp. 23-31. Nature and amount of work required by different classes of cars.

Coal Cars

Design of Seventy-Ton Coal Car with Tandem Hoppers. Ry. Mech. Eng., vol. 92, no. 11, Nov. 1918, pp. 611-613, 5 figs. Principal data with description and drawings.

Flat Cars

Shipping Large Marine Boilers. Boiler Maker, vol. 18, no. 11, Nov. 1918, p. 307, 1 fig. Describes special flat car for shipping Scotch boilers. From Marine Jl.

Lighting

Standards of Passenger Car Lighting. Ry. Rev., vol. 63, no. 19, Nov. 9, 1918, pp. 672-673. Specifications prepared by mechanical department of United States Railroad Administration for electric lighting of passenger equipment cars hereafter to be purchased by administration for use of roads under its control.

Refrigerator Cars

Standard U. S R. A. Refrigerator. Ry. Mech. Engr., vol. 92, no. 12, Dec. 1918, pp. 663-668, 7 figs. Latest practices in design. Also in Ry Age, vol. 65, no. 21, Nov. 22, 1918, pp. 906-910, 4 figs.

SAFETY AND SIGNALING SYSTEMS

Coupling and Uncoupling

Prevention of Accidents Due to Coupling and Uncoupling Cars. E. M. Switzer. Safety Eng., vol. 36, no. 4, Oct. 1918, pp. 262-264. From Proc. Seventh Annual Safety Congress.

Interlocking

Single Line Interlocking on the New South Wales Railways. Ry. Gaz., vol. 29, no. 19, Nov. 8, 1918, pp. 495-497, 4 figs. Outline of system of interlocking and signalling line stations.

Plant Railroad Hazards

Plant Railroad Hazards, C. H. Baltzell. Safety Eng., vol. 36, no. 4, Oct. 1918, pp. 252-256, 2 figs. Possibilities of personal injuries in plants situated on main line tracks and manner of avoiding them. From Proc. Seventh Annual Safety Congress.

Signaling

Proceedings, Annual Meeting, New York, N. Y., Sept. 19-20, 1918, Ry. Signal Assn., Jl. 23d year. No. 4, Dec. 1918, pp. 313-420, 4 figs. Addresses, committee reports, etc.

SHOPS

Boiler-Tube Fitting

Modern Locomotive Boiler Tube Practice at Doncaster Works, Great Northern Railway. Ry. Gaz., vol. 29, no. 19, Nov. 8, 1918, pp. 499-500, 4 figs. Methods employed for fitting and expanding boiler tubes and superheater flues.

Car Repairs

Car Department of the Milwaukee. Ry. Mech. Eng., vol. 92, no. 11, Nov. 1918, pp. 615-620, 9 figs. Organization and methods of handling light and heavy car repairs with samples of forms used.

Grinding

Grinding in Locomotive Shops, M. H. Williams. Ry. Mech. Eng., vol. 92, no. 11, Nov. 1918, pp. 629-632, 4 figs. Uses to which internal, cylindrical and surface grinding machines may be put with success.

Locomotive Repairs

Accuracy in Locomotive Repairs, M. H. Williams. Ry. Mech. Engr., vol. 92, no. 12, Dec. 1918, pp. 673-677, 8 figs. Methods of making and fitting repair parts for locomotives with gages and micrometers.

Repair Shops

American Railroad Repair Shops in France, Robert K. Tomlin, Jr. Am. Mach., vol. 49, no. 21, Nov. 21, pp. 933-938, 7 figs. How these shops were built by American engineers in France.

SPECIAL LINES

Logging Roads

Soldiers Build Logging Roads in Spruce Forests, W. A. Welch. Ry. Age, vol. 65, no. 19, Nov. 8, 1918, pp. 805-807, 6 figs. Description of construction of over 350 miles of new railway in Northwest for carrying airplane lumber to mills.

See also CIVIL ENGINEERING, Harbors.

Munitions and Military Engineering

Ballistics

A Field Ballistic Problem, Meade Wildrick. Jl. U. S. Artillery, vol. 49, no. 3, May-Aug. 1918, pp. 159-186, 9 figs. Numerical illustration of (1) construction of range table, (2) construction of range correction curves, (3) construction of deflection correction chart, (4) correction for variation in muzzle velocity due to a variation in weight of projectile, and (5) correction for variation in temperature of powdered charge.

Effect of the Earth's Rotation Upon the Point of Fall, Fred M. Green and C. W. Green. Jl. U. S. Artillery, vol. 49, no. 3, May-Aug. 1918, pp. 192-204, 10 figs. Derives, from consideration of effect of difference in velocity of gun and target due to earth's rotation, approximate expressions for corrections required in trajectory of projectile fired at long range.

Notes on Inclined Trajectories, F. M. Green and C. W. Green. Jl. U. S. Artillery, vol. 49, no. 3, May-Aug. 1918, pp. 187-191, 1 fig. Suggest manner of constructing table of discrepancies between results obtained by Ingalls' formula and by simplified form $\Phi = \Phi_x + \epsilon$ where Φ is the quadrantal angle of departure, Φ_x the range table angle of departure to attain range, and ϵ angle of elevation of target.

Simpson's Resection, Stanley H. Simpson. Jl. U. S. Artillery, vol. 49, no. 3, May-Aug. 1918, pp. 208-214, 3 figs. Explains method in which, angles being measured in mils, instead of plotting actual arcs, short chords of these arcs are plotted on a scale large enough to make chords practically coincident with arcs.

The Elliptic Trajectory Over the Earth, G. Greenhill. Engineering, vol. 106, no. 2754, Oct. 11, 1918. A mathematical article.

Bullets

Explosive, Expansive and Perforating Bullets, Claude Pernelle. Sci. Am. Supp., vol. 86, no. 2238, Nov. 23, 1918, pp. 332-333, 5 figs. Types used by German and Austrian armies. Translated from La Nature.

Howitzers

How the 155-Mm. Howitzer is Made, J. V. Hunter. Am. Mach., vol. 49, nos. 21 and 22, Nov. 21 and 28, 1918, pp. 941-945, 17 figs., and 983-986, 14 figs. Work on howitzer jacket after it has been rough-machined and heat-treated. Nov. 28: Making the tube.

Mobile Batteries

Railroad Men Man Mobile Battery for Navy. Ry. Age, vol. 65, no. 22, Nov. 29, 1918, pp. 967-969, 4 figs. Description of 14-inch naval guns on railway mounts which worked destruction behind German lines.

Ordnance Manufacture

Finding the "Choke Points" of Ordnance, John H. Van Deventer. Am. Mach., vol. 49, no. 22, Nov. 28, 1918, pp. 967-971, 6 figs. One of series of articles on work of Ordnance Dept.

Munitions Production by British Railways. Ry. Rev., vol. 63, no. 19, Nov. 9, 1918, pp. 671-672. Account of reorganization of railway shops in Great Britain to become one of England's chief sources of supply for munitions of war. Adapted from Board of Trade Journal, London.

The Manufacture of Guns (La fabrication des canons), Ch. Dantin. Génie Civil, vol. 73, no. 1875, July 20, 1918, pp. 41-47, 21 figs. Considerations governing choice of metal and description of manufacturing process.

What Ordnance Is and Does, John H. Van Deventer. Am. Mach., vol. 49, no. 20, Nov. 14, 1918, pp. 876-881, 7 figs. Organization of Ordnance Department and what it does. First article.

Ordnance Plant

A War-Time American Ordnance Plant. Iron Age, vol. 102, no. 22, Nov. 28, 1918, pp. 1326-1328, 5 figs. Description of new plant of Tacony Ordnance Corporation.

Shells

The Manufacture of Semi-Steel Shells. Iron Age, vol. 102, no. 22, Nov. 28, 1918, pp. 1317-1321, 32 figs. Practice as recommended by Ordnance Department; chemical, metallurgical, molding and machining details.

Spotting Board

Spotting Board, G. R. Meyer. Jl. U. S. Artillery, vol. 49, no. 3, May-Aug. 1918, pp. 205-207, 1 fig. Constructed to furnish battery commander with information as to longitudinal deviation of his shots.

See also MECHANICAL ENGINEERING, Foundries (Semi-Steel).

General Science

CHEMISTRY

Electrolytic Conductivity

Electrolytic Conductivity in Non-Aqueous Solutions. II. The Electrical Conductance of Trimethyl-Para-Tolyl-Ammonium Iodide in Water and Several Organic Solvents, Henry Jermain, Maude Creighton and D. Herbert Way. Franklin Inst. Jl., vol. 186, no. 6, Dec. 1918, pp. 675-698, 7 figs. Investigations.

Elements

Atomic Number and Frequency Differences in Spectral Series, Herbert Bell. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 214, Oct. 1918, pp. 337-347, 2 figs. Numerical tests of Rydberg's law that square root of doublet and triplet differences is proportional to atomic weights, substituting atomic number for atomic weight.

Elements in the Order of Their Atomic Weights, Raymond Szymanowitz. Chem. News, vol. 117, no. 3059, Oct. 25, 1918, pp. 339-340. Presents table which shows numbers follow scheme of sequence expressed by: X, $X + 3$, $X + 3 + 1$, $X + 3 + 1 + 3$, etc., adding 1 and 3 alternately.

Solutions

The Electrical Conductivity of Acids and Bases in Aqueous Solutions, Jnanendra Chandra Ghosh. Jl. of the Chem. Soc., vols. 113-114, no. 672, Oct. 1918, pp. 790-799. Explains abnormally high mobility of hydrogen and hydroxyl-ions in aqueous solutions on assumption that electricity is partly carried by ordinary process of convection and partly propagated through water molecules undergoing alternate dissociation and recombination; apparently high activity of strong acids and bases is also traced to this cause; modifies Ostwald equation for electrolytes where degree of dissociation is less than one.

Structure of Matter

Atomic Structure from the Physico-Chemical Standpoint, Alfred W. Stewart. Lond. Edinburgh & Dublin Phil. Mag., vol. 36, no. 214, Oct. 1918, pp. 326-336, 1 fig. Model atom proposed as having a structure accounting for all the facts known concerning elements, including radioactive transformations.

Interfacial Tension and Complex Molecules, G. N. Antonoff. Lond. Edinburgh & Dublin, Phil. Mag., vol. 36, no. 215, Nov. 1918, pp. 377-396, 5 figs. Theory of molecular attraction based on modern representation of nature

of atoms and molecules; explanation of phenomena of molecular attraction by action of forces which cause chemical affinity; deduction of relation between surface tension and molecular pressure.

Valency

Definition of Valency. F. H. Loring. Chem. News. vol. 117, no. 3058, Oct. 11, 1918, pp. 319-322. Simile to explain significance of term and nature of atoms which exercise variable valencies.

MATHEMATICS

Analytical Functions

Factoring and Prolongation of Analytical Functions (Quelques remarques sur la décomposition en facteurs primaires et le prolongement des fonctions analytiques), Emile Picard. Comptes rendus des séances de l'Académie des Sciences, vol. 167, no. 12, Sept. 16, 1918, pp. 405-408. Further comment on Weierstrass' method of decomposition. In Comptes-rendus, vol. 92, 1881, p. 690, author showed application of this method to uniform functions whose roots approach indefinitely a given line.

Conics

Involutions on the Rational Cubic. R. M. Winger. Bul. Am. Math. Soc., vol. 25, no. 1, Oct. 1918, pp. 27-34. Establishes that lines joining pairs of contacts of tangents from points of R^2 envelop conic N which touches nodal tangents (where they meet line of flexes) and has contacts with R^3 at sextactic points; also other theorems in regard to properties of hyperosculating curves of R.

Divergent Series

A Conspectus of the Modern Theory of Divergent Series. Walter B. Ford. Bul. Am. Math. Soc., vol. 25, no. 1, Oct. 1918, pp. 1-15. Review of modern theory of divergent series in regard to (1) the question as to how a sum may be assigned to a divergent series in general, and (2) the functional properties of asymptotic series; proposed limitations to form a consistent general theory of summation.

Equations

A Determinantal Equation Whose Roots are the Products of the Roots of Given Equations, William H. Metzler. Proc. Roy. Soc. of Edinburgh, vol. 38, part 1, session 1917-1918, pp. 57-60. By multiplying one by one successive equations from k linear homogeneous sets (1), (2), ... (k) in $n_1, n_2, \ldots n_k$ variables a new set is formed. The new set will contain $n = n_1 . n_2 \ldots\ldots n_k$ equations in same number of variables and its determinant when equated to zero is the proposed determinantal.

Simultaneous Linear Differential Equations Involving Partial Derivatives and Reduction of Hyper-Geometric Functions of Two Variables (Sur des équations linéares simultanées aux dérivées partielles et sur des cas de réduction des fonctions hyper-géométriques de deux variables), Paul Appell. Comptes rendus des séances de l'Académie des Sciences, vol. 167, no. 12, Sept. 16, 1918, pp. 408-413.

Solution of Partial-Derivative Equations by Means of Hermite's Polynomials (Sur les équations aux dérivées partielles vérifiées par les polynomes d'Hermite, déduits d'une exponentielle), Pierre Humbert. Comptes rendus des séances de l'Académie des Sciences, vol. 167, no. 15, Oct. 7, 1918, pp. 522-525. Application of Appell's method (Comptes rendus, vol. 167, 1918, p. 309) to variables obtained from differentiation of exponential function whose exponent is of quadratic form in X and Y.

Solutions of Differential Equations as Functions of the Constants of Integration, Gilbert Ames Bliss. Bul. Am. Math. Soc., vol. 25, no. 1, Oct. 1918, pp. 15-26. Proposes method.

Treatment of Partial-Derivative equations by Hyperspherical Polynomials (Sur les systèmes d'équations aux dérivées partielles vérifiés par les polynômes hypersphériques), J. Kampé de Fériet. Comptes rendus des séances de l'Académie des Sciences, vol. 167, no. 15, Oct. 7, 1918, pp. 519-522. Study of case of n linear equations involving partial derivatives of second order.

Fourier Series

On the Cesàro Convergence of Restricted Fourier Series, W. H. Young. Proc. Roy. Soc., vol. 95, no. A665, Sept. 2, 1918, pp. 22-29. Establishes from operations on trigonometric series Σ (a_r cos r X + b_r sin r X) that Legendre series converges (C ½) almost everywhere in interval ($0 < X < 1$), and that it converges (C ½) at every internal point X of this interval at which f (X) is continuous, or is the differential coefficient of its integral, or satisfies some other condition sufficient to insure convergence (CK), for same value of K > ½, of Fourier series of a function equal to f (cos θ) in a small interval containing point Z considered ($X = \cos\theta$ ($0 < X < 1$).

Invariants

Related Invariants of Two Rational Sextics, J. E. Rowe. Bul. Am. Math. Soc., vol. 25, no. 1, Oct. 1918, pp. 34-35 Points out relation between invariants of the R^6_2 and invariants of the R^6_2.

Isogenous Complex Functions

Note in Isogenous Complex Functions of Curves. W. C. Graustein. Bul. Am. Math. Soc., vol. 24, no. 10, July 1918, pp. 473-477. Derivation of theorem: if gradients c_1, c_2 of functions F_1, F_2 in $F = F_1 + i\,F_2$ where $F_1 = F_1 \,|[L]|$, $F_2 = F_2 \,|[L]|$ are first-degree functions of space curve L, are in general analytic, then the gradients γ_1, γ_2 of Φ_1, Φ_2 in $\Phi = \Phi_1 + i\,\Phi_2$, an arbitrary complex function of L of the first degree isogenous to F, are analytic save in points of singularity of c_1 or c_2 and points in which these vectors are indeterminate. $F\,|[L]|$ represents a function of L such that $F\,|[-L]| = -F\,|[L]|$.

Orthogonal Substitution

Note on the Construction of an Orthogonant. Thomas Muir. Proc. Roy. Soc. of Edinburgh, vol. 38, part 2, session 1917-1918, pp. 146-153. Comments of and addition of theorems to Cayley's mode of forming an orthogonal substitution.

Polynomials

A Reduction Formula for the Functions of the Second Kind Connected with the Polynomials of Applied Mathematics, Pierre Humbert. Proc. Roy. Soc. of Edinburgh, vol. 38, part 1, session 1917-1918, pp. 61-69. Method by which a polynomial B_n (Z) of degree $n-1$ satisfying certain conditions is introduced in practical computations involving Legendre's functions in order to reduce them to a form $f_{n-1}(z) = [z\,P_n\,(z) - B_n\,(z)]\,(z^2-1)$; application of this method to Lamé's functions, to extended Legendre's polynomials and to parabolic-cylinder function when n is an integer.

Probability

An Elementary Derivation of the Probability Function, Albert A. Bennett. Bul. Am. Math. Soc., vol. 24, no. 10, July 1918, pp. 477-481. Derives by means of elementary considerations equation of probability from sequence of binomial coefficients.

PHYSICS

Flame Propagation

The Propagation of Flame through Tubes of Small Diameter. William Payman and Richard Vernon Wheeler. Jl. Chem. Soc., vols. 113 & 114, no. 670, Aug. 1918, pp. 656-666, 3 figs. Report of experiments, performed in connection with work on construction of miners' safety lamp, on speed of uniform movement during propagation of flame in mixtures of methane and air through tubes of small diameter, on the passage of flame through similar tubes filled with mixtures of methane and air and open at both ends, and on the passage or projection of flame through short tubes of small diameter.

Fluorescence

On the Phenomena of Fluorescence, Desmond Geoghegan. Chem. News, vol. 117, no. 3058, Oct. 11, 1918, p. 322. Suggests experiment which, it is said, will prove that rays of light passed through a sufficient thickness of a fluorescent substance lose thereby power of exciting fluorescence when they are passed through a second layer of same substance.

Magneto-Thermal Phenomena

Magneto-thermal Phenomena (Le phénomène magnétocalorique), Pierre Weiss and Auguste Piccard. Journal de Physique, vol. 7, May-June 1917, pp. 103-109, 1 fig. Account of pronounced changes in temperature which were observed in course of experimental measurements preliminary to plotting set of isothermals for nickel. Near Curie's point temperature increased 0.7 deg. on establishing field of 15,000 gausses.

Optics

The Correction of Telescopic Objectives, T. Smith. Lond. Edinburgh & Dublin Phil. Mag., vol. 36, no. 215, Nov. 1918, pp. 405-412. Criticism of expressions for constructional data for small objectives as given by A. O. Allen in Phil. Mag. June 1918.

The Scattering of Light by Air Molecules, R. J. Strutt. Lond. Edinburgh & Dublin Phil. Mag., vol. 36, no. 214, Oct. 1918, pp. 320-321. Supplements former account of experiments (Proc. Roy. Soc. A., vol. 44, p. 453, 1918) by answering inquiry from R. W. Wood (Phil. Mag., vol. 36, p. 272, Sept. 1918) in regard to precautions taken for drying air in experiments.

Quanta Law

Researches on the Limit of the Continuous Spectrum of X-Rays (Recherches sur la limite du spectra continu des rayons X), Alex. Muller. Archives des Sciences Physiques et Naturelles, year 123, vol. 46, Aug. 1918, pp. 63-73, 1 fig. Theoretical and experimental vertification of Planck's law of quanta as generalized by Einstein by confirming the relation $e\,V = h\,\nu$ in the case of the continuous spectrum of X-rays, and for an interval from 14 to 28 kilovolts.

Radium

On Some Properties of the Active Deposit of Radium, S. Ratner. Lond. Edinburgh & Dublin Phil. Mag., vol. 36, no. 215, Nov. 1918, pp. 397-405, 2 figs. Experimental research which leads author to question whether phenomenon of recoil of RaC from RaB has ever been observed, also that proportion of recoil atoms of RaB carrying negative charge is less than 1 to 100,000.

Relativity

On the Essence of Physical Relativity, Joseph Larmor. Proc. Nat. Academy of Sci., vol. 4, no. 11, Nov. 1918, pp. 334-337. Offers objection to Leigh Page's expression (no. 4, p. 46) for translatory force required to sustain assigned varying velocity in electrostatic system of type usually investigated as model of electron.

Semi-Fluids

Mechanics of Semi-Fluids (Mécanique des semi-fluides). Comptes Rendus des Séances de l'Académie des Sciences, vol. 167, no. 7, Aug. 12, 1918, pp. 253-256. Discusses possibility of disregarding tangential action of central cylinder on annular part of the limiting surfaces.

Vibrations and Wave Motions

Diffraction of Plane Waves by a Screen Bounded by a Straight Edge, F. J. W. Whipple. Lond. Edinburgh & Dublin Phil. Mag., vol. 36, no. 215, Nov. 1918, pp. 420-424. Adaptation of R. Hargreaves' method for simple harmonic wave (Phil. Mag., vol. 36, p. 191), to diffraction of waves of arbitrary type.

Periodic Irrotational Waves of Finite Height, T. H. Havelock. Proc. Roy. Soc., vol. 95, no. A665, Sept. 2, 1918, pp. 38-51. Extension of Mitchell's form for highest wave and its generalization by means of surface conditions; method of approximation for coefficient; calculation for highest wave; values when $e^{-d} = ¾$; comparison with Stokes' series; determination of b^1; numerical examples and remarks upon coefficients.

The Interferometry of Vibrating Systems. C. Barus. Proc. Nat. Academy of Sci., vol. 4, no. 11, Nov. 1918, pp. 328-333, 4 figs. Report of experimental work.

The Sound Waves and Other Air Waves of the East London Explosion of January 19, 1917, Charles Davison. Proc. Roy. Soc. of Edinburgh, vol. 38, part 2, session 1917-1918, pp. 115-129, 1 fig. Construction of paths followed by air waves and sound waves; offered explanation for fact that inaudible air waves were observed beyond limits of sound areas by reason of their more nearly horizontal path.

OPTICAL PROJECTION FOR SCREW-THREAD INSPECTION

Analysis of Screw-Thread Elements Essential to Strength and Dependability—Description of a New and Improved Method for Their Accurate Inspection

By JAMES HARTNESS,[1] SPRINGFIELD, VT.

THE screw, one of the most important elements in mechanism and found in nearly all forms of machinery, is invaluable as a means for fastening two parts together, as a means of precision adjustment, and as a means of transmitting power.

In machines in which the weight must be kept as low as possible, as, for instance, in the airplane, it is of prime importance to have the screw as small as consistent with the strength and reliability required.

On account of the vagueness of our general knowledge of the conditions under which it takes its stress, we frequently underestimate the importance of the screw, and, through ignorance, continue practices that greatly increase the hazard of life in travel by rail, automobile or airplane, as well as lessen the reliability of performance of other pieces of machinery. A screw-thread fastening is very dependable if the two component parts are properly fitted.

While it is not possible to attain perfection in this work, an analysis of the various elements that are essential for strength and dependability, and the reduction of weight, will greatly simplify our efforts and make it possible to attain a point much nearer perfection.

Briefly stated, a screw's reliability depends upon the following elements:

a Material
b Form of profile of the thread
c Diameter of the screw
d Lead or the number of threads per inch.

After the foregoing general characteristics have been determined, we must consider the following details which depend on the methods and skill employed in production:

1 Smoothness and density of surface
2 Fit, which relates particularly to the exact relationship of the size of the two component parts
3 Precision of lead, which relates to the precision of advance of the helix or degree of precision with which the number of threads per inch are made
4 Uniformity or steadiness of advance of helix
5 Form, relating to contour of a single thread
6 Roundness, as relating to the circular path of the helix
7 Parallelism or taper.

These elements are all interrelated.

Modern practice in constructing machinery is drifting more and more toward absolute interchangeability of parts. In the older practice it was customary to fit one part to another, either by doing the final finishing at the time the parts were assembled or by selective process, such as picking out the larger screws to be used with the larger nuts or tapped holes and smaller screws to be used with smaller holes.

To a certain degree this method of fitting at the time of assembling, either by changing the sizes of the parts that go together or by selective process, is still necessary in the highest requirements of very close fits, but the trend is strongly toward perfect interchangeability.

This requires working to stated standards so that the size of the thread of the screw and nut will never exceed certain boundaries. But whether the boundary allows no freedom when the largest screw is turned into the smallest nut or a certain predetermined freedom of play, there still remains the necessity for determining how large an internal thread may be made and still be acceptable, and how small the screw may be made and still be acceptable; in other words, what is the greatest degree of looseness that can be tolerated without impairing the dependability of the screw and nut for service.

Thus far we have had no satisfactory way of specifying all of the elements that are required to make a screw dependable, but we are now finding that the projection lantern offers a better method and makes it possible to simplify specification and practice.

The Fit of Screws in Relation to Their Diameter

It will be understood that the largest percentage of screws must be made with sufficient play to make it possible to screw them together rapidly by hand, and resort to the wrench only for setting them up to full tension. This is essential for convenience of assembling, which is an important part in the production of the machine, and for the use of the product in service.

As an example we may take the bolts of the demountable tire rims of the automobile wheel. The nuts for these bolts should be a reasonably good fit. At the same time, in order to get quick interchangeability, they must not fit too close; that is, they must turn with a certain degree of freedom, yet the service they render is so important that they must be a little closer than a wringing fit, but must not be a tight wrench fit, at least at the outer end of the screw. While the limits of a screw fastening for this service are very small, the case illustrates the fact that a given degree of freedom of play is necessary, but must not exceed a certain boundary. In certain kinds of agricultural machinery, for instance, a much larger freedom may be tolerated, and in fact is desirable.

The gaging not only determines this boundary line, but also establishes another boundary line which constitutes the maximum freedom of play of the two components.

For instance, a 3/4-in. 10-pitch screw, nut or bolt measures 3/4 in. at the largest diameter (called crest of the thread) of the bolt, but since the crest is not of great importance, we measure the screw at the flanks of the thread with V-point calipers. This we call the pitch diameter, expressed P. D. The P. D. of a full-sized 3/4-in. (0.750-in.) bolt is 0.6851 in. This we call the basic diameter for this thread. In general practice it constitutes the maximum size for a close-fitting screw, and in some instances the smallest size of the nut. In other instances, the smallest nut is made a few thousandths of an inch larger in order to give a certain degree of looseness.

If the smallest nut is made to this basic size, then this figure becomes the minimum boundary of the nut and the maximum boundary of the screw.

Since it is not practicable to produce screws of exact uniformity, it is customary to allow a certain range of variation. The range of variation is expressed in thousandths of an inch of tolerance.

For instance, for fairly good work we allow a range of two and one-half thousandths of an inch, usually expressed as 0.0025 in., and sometimes given in exact size, such as in this case would be 0.6826 in., which is 0.0025 in. less than basic size, 0.6851 in.

The tolerance of variation in diameter of the nut in the same way is expressed as 0.6851 in. as minimum size plus 0.0025 in. for maximum of 0.6876 in.; or, if there is to be a neutral zone between the largest screw and the smallest nut, then the smallest screw may be any size that meets the requirements, 0.006 in. being a certain ordnance practice for neutral ground. Then the P. D.

[1] President, Jones & Lamson Machine Co.; Vice-Chairman, National Screw-Thread Commission; Past-President Am.Soc.M.E.

of nut becomes 0.6911 in. for minimum to 0.6936 in. for maximum, the tolerance of variation of product remaining the same, 0.0025 in.

In the old practice of fitting one piece to another, or even in the selective fitting, it was a comparatively easy matter to keep within certain boundaries between two pieces, but in the new practice, if the total freedom of play between two parts is 0.004 in., and the minimum freedom of play between two parts is 0.001 in., we will see that it is necessary to have 0.001 in. for the neutral space and divide up the other 0.003 in. in tolerance in variation in the sizes of the two component parts of the screw-thread fit. If the tolerance is equally divided between the two parts, this makes a total variation of 0.0015 in. that will be tolerated in the nut and 0.0015 in. tolerated in the screw.

The interchangeability system therefore imposes upon us greater precision in uniformity of production in order to get this interchangeability; but notwithstanding this important handicap, the advantages of the interchangeability system are so great as to offset the disadvantages. In fact, a high degree of interchangeability brings a reduction in cost of product and a greater reliability.

The purpose of our gaging is to guide us in manufacturing these parts and to serve as a means for finally inspecting the work before it is put into service; for if a screw, for instance, is made by one manufacturer or department and sold to or delivered to another manufacturer or department, the screw must be passed upon by suitable gages to determine whether or not it comes within specified boundaries.

Fit of Screws in Relation to the Helix and Form of Thread

The form of the United States Standard thread, originally known as the Sellers Standard, is made by a cutting tool having an included angle of 60 deg. This tool is truncated or flattened off at the end to an extent that amounts to one-eighth of its travel per revolution. The top of the thread has a similar flat, and although this describes a perfect thread, it is well known that a perfect thread is seldom found in practice. Therefore, it is our object in gaging and inspection to measure not only the diameter and the various parts of the screw, but also the truth of the helix for a given advancement per revolution, the degree of departure of the screw thread from the specified 60 deg. of angle, and, in fact, each characteristic on which its form and reliability depends.

Threads are specified as having a lead of helix expressed by the number of threads per inch. For instance, a ¾-in. United States Standard screw has 10 threads per inch. It is essential that there should be as nearly as may be exactly that number of threads per inch. If we count off 10 threads on a screw and find that we have advanced more or less than 1 in., we say the lead is not true; that it is off so many thousandths of an inch.

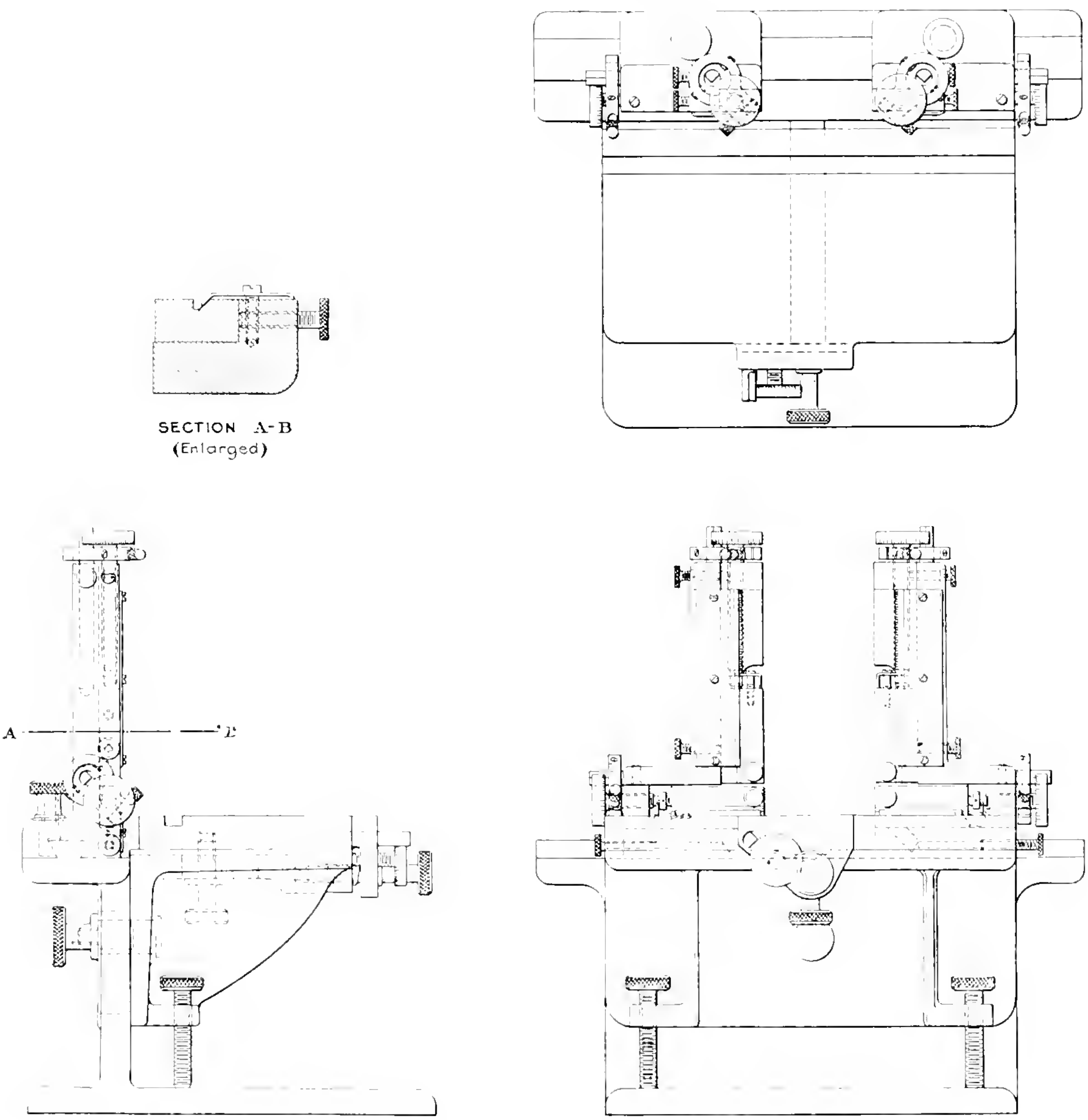


Fig. 1 Projection Machine for Inspecting Screw Threads

If the lead of a ¾-in. screw is "off" more than 0.003 in. or 0.004 in. per inch of length of engagement, it is unsuited for the best work, for when screwed into its threaded hole, which we will assume is accurate, the threads will not match; consequently, if they are of approximately the same size, the two may not screw together. But let us assume that the diameter of the inner member is enough smaller than standard to offset the difference in lead; then, although the two may screw together, they become less dependable when subjected to stress than if the threads of the two component parts matched each other; for it is obvious that there would not be an equal distribution of the stress of the work on the various threads that should be engaged.

Thus it will be seen that we not only have to consider the diameter but the lead, and in addition to this the form of the thread; that is, the form as shown by taking a profile that shows the flats of the angles of the sides. Then, since the helix may not proceed uniformly, may stagger forward, producing a thread which is known as a "drunken" thread, we must know about the degree of uniformity of this advance.

Besides this, we have to determine the roundness, for die-cut threads are frequently "out of round," due to excessive clearance of the cutting tools and inequality of distance between the two pairs of cutting edges in a die having four cutting edges.

We have also to inspect the screw for character of its surface. A die-cut thread, especially threads of 10-pitch and coarser, may be very rough and a microscope may show its surface as mountainous.

Furthermore, in addition to the measurements and character of its surface, the entire surface, including the tops and sides of the "mountains," may be, as expressed by one authority, "like a plowed field," as a result of the action of the cutting tools which, instead of cleanly removing the metal, have pushed or torn out the metal as if pulled out by the roots. This analogy, of course, is not perfect, but it gives a fairly true conception of the character of the surface, especially of a screw that has been produced by a single passing of the die.

Although some screw-cutting dies are designed to supplement the cutting process by a burnishing process which levels the "mountains" and compresses the "plowed-field" surface, the fact remains that nearly all screws of pitches coarser than 10 or 12 per inch have rough surfaces.

It is customary for the inspector to pass upon surface characteristics by close scrutiny. If it appears smooth, the screw is accepted, and if it is unduly rough for the service for which the screw is to be used, it is rejected.

Deficiencies of the Usual Gaging Methods

The process of gaging screws by the use of ring gages for the screw and the plug gage for the threaded hole is far from satisfactory for many reasons. The best practice uses at least two gages for each part. In gaging a screw, for instance, two ring gages are required. One is the upper boundary of size into which the screw must easily turn with a finger fit. The other gage is the lower one into which the screw must not enter more than one or two threads, according to the condition of the gage and the work.

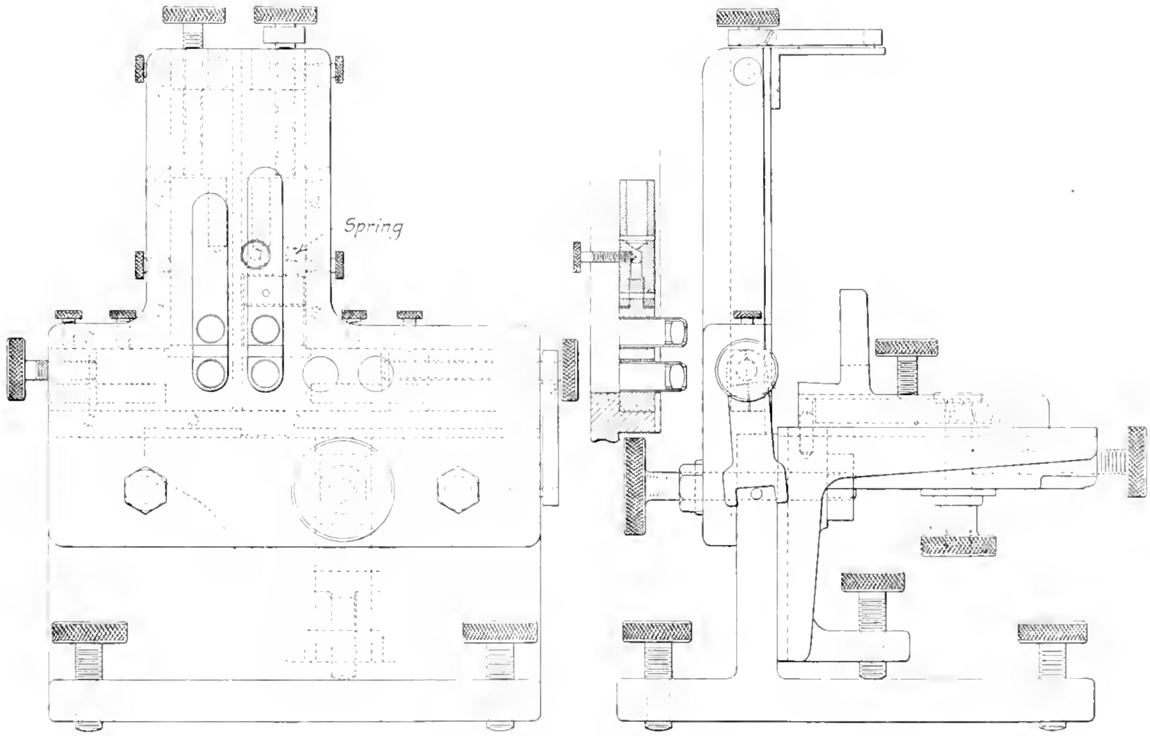


Fig. 2 Machine Designed for Smaller Range of Work

In still finer practice other gages are used to determine the lead, form and diameter of the crest and root, but in all such gaging processes the gage merely rides over the tops of the mountains, so far as the surface is concerned, and the extremes of the irregular helix, so far as the wabbling of the lead is concerned. Thus it will be seen that even with the best practice in use of the ring and plug gages, the process of gaging does not give a true indication of the dependability of a screw as a means of fastening.

A ring gage which is used for testing screws may become deceptive by the possibility of a fine, thin chip becoming lodged at some invisible point in the valley of the thread. For instance, if this is in a "no go" gage, and if the practice of the plant is to allow a screw to enter one or two turns into the "no go" gage on account of the wearing of the gage, a screw may enter until it encounters a chip of this kind; and then, since it can go no farther, it is passed as acceptable because it will not enter the "no go" gage beyond a specified distance for that particular gage.

The other elements of uncertainty readily come to the mind of one accustomed to precision measurement, and it is not necessary to go into all of these details.

In addition to the ring gages, we have the adjustable caliper in the form of the regular micrometer and the thread micrometer, and the fixed calipers, in which the points, although adjustable, remain fixed so far as the workman is concerned. These calipers, whether fixed or adjustable, give the diameter of the thread, usually measuring it on the flank, but this diameter does not give

a true indication of the roundness of the screw. For instance, if the screw is die-cut, the advance of the cutting of the die may be irregular, so that although any two opposite points in the diameter of the screw may be uniform to a certain measurement, as a matter of fact the screw has wabbled in passing through the die so that it has a series of longitudinal flutes or waves of more or less amplitude.

The caliper points for such work will find substantially a uniform diameter, although on one side one point of the caliper may be resting on a crest, while on the other side of the work the other point may be in a valley.

In the usual methods of inspecting there is also to be considered the personal equation of the inspector.

We speak of loose fits as "very loose," or with "very little shake," or still closer with "no shake."

Close fits are designated as "finger fits" when they can be turned on with the finger, as "wringing fits" when they require a little greater force, and as "wrench fits" when they require more force than can be exerted by the hands without the aid of wrench.

These are some of the shop terms that are in common use between men who are skilled in the work of making screw-thread fits of a dependable kind. They were fairly satisfactory between men skilled in this work, but they become misleading when put in general use.

To the skilled worker they meant that the fit for two component parts of a screw-thread fastening that were of known lead, shape of thread and fineness of finish, should be made to satisfy this tactile test, but the tactile test leaves the science of screw-thread gaging in a most difficult situation, especially with the modern advance in which specialization has so divided the work that the various parts of a piece of mechanism may be made in different cities. A screw, for instance, may be made in one city, and the threaded hole into which it fits be made in another city.

When we realize that for a close fit the total allowance is extremely small, and wholly disappears by the usual variation in machine product, we begin to see the difficult situation that has come with the higher development of machine construction, and we see that this tactile method, which depends so much on the personal equation of the individual inspector, leaves the producer always in doubt as to what will be acceptable, for he has no positive indication of the ruling of the purchaser.

Gages Do Not Definitely Determine Shape and Character of Thread

What has been said thus far applies merely to gaging screws that are known to be correct both in form and finish of surface. A simple plug or ring gage gives no indication of the exact form of a thread. In fact, when these gages are supplemented by others cleared at the root and crest, we are still in doubt as to the form of the effective surface. With this important element unmeasured, our gaging system is incomplete, even if it were satisfactory in other respects.

Thus far, also, we have considered the two component parts of a screw-thread fastening as if made of material that was neither elastic nor plastic. If this were true, our screw threads would be most undependable, but since it is not true, and since the threads of the two component parts may be forced together under wrench, or subjected to the stress of work, the engaging flanks of the threads of the two component parts are gradually squeezed into fitting surfaces. The stress levels the "mountains" and compresses the surface, and if the angles of the flanks of the two threads are not similar, this stress to a certain degree compresses the metal into a shape that gives perhaps a nearly perfect form of contact.

This squeezing changes the size and form of the thread surface and hence our gages cannot indicate what the shape and diameter of the screw will be when these "mountains" have been leveled and the "plowed-field" surface compressed by the action of the working stress.

Our gaging method is such that we must never exert pressure that will level down this surface, for by even the most careful use the gage wears out of shape, and it is considered very bad practice to force a gage.

Thus it will be seen that although we use our greatest care in the measurement of the screw thread as it comes from the machine in which it is produced, our gaging system makes little recognition of the shape, form and dimensions of that screw after it has been put under its working stress. It must be remembered that nearly all screws, excepting those used for precision adjustment, must be subjected to considerable stress in service, and that the end and aim of our gaging system should be to determine the fitness of a screw for its service.

Screw-Thread Requirements in Advanced Practice

The advancement of the art which has come about through the development of the bicycle, the automobile and the airplane has reached a point in which it is absolutely necessary to inspect screws in a way that will give a much better indication of their dependability. Before the art had advanced to this point where it was necessary to obtain the greatest strength for a given weight, a simpler system of gaging was satisfactory, but now, to make the most dependable airplane, a screw thread should be gaged for form, diameter, pitch, roundness and compactness of surface. The gaging should be done with full consideration of the changes that are produced in the lead, form and diameter when subjected to the working stress.

It seems probable that with the advance of requirements in machine construction we must go a step further in our gaging methods and make use of the projection lantern to help us solve our screw-thread gaging problems. The optical method of inspection and measurement of screw threads by the use of microscopic apparatus and projection lantern has been found invaluable in inspecting gages, but it has not been generally used for the inspection of the work itself.[1]

The tactile or touch method of inspection does not give us a true indication of the form of a screw, and even with a variety of instruments it gives only an approximate conception of the lead.

Notwithstanding the shortcomings of the ring and caliper types of gages, they still remain among the most practical gages in the workman's hands; and although the projection lantern brings the gaging to a definite science, and should be the basis of specifications for screw threads and the final arbiter in accepting or rejecting the product, its function is more to keep a check on the simpler forms of gages than to supplant them.

For instance, the first and last pieces of a lot of die-cut screws should be tested by the lantern. A change of dies, either through wear or important adjustment, should be checked by sending a sample screw to the lantern. This supplemented by the percentage test of the final product would be sufficient check, for it would give a definite knowledge of the character of the form, lead, roundness, etc.

The projection lantern has been developed to a point where it now gives at a glance the diameter, lead, form, and a fair indication of the roundness and smoothness of the surfaces. In order to get all of these results it is necessary to use in connection with the projection apparatus a stage and tolerance chart laid out on a large scale to conform to the desired characteristics of the screw to be inspected.

The chart is so located that the profile of one or more threads of the screw may be projected on to the chart and a comparison made between the enlarged shadow thus cast by the thread and the form of thread and tolerances outlined on the chart. (A more detailed description of the projection apparatus and chart is given later.)

[1] The work that has been done in the development of this method for testing gages is set forth in the paper of Mr. H. L. Van Keuren, presented at the 1918 Annual Meeting of the Society (see The Journal, November 1918, p. 913). Mr. Van Keuren as Chief of Gage Testing at the U. S. Bureau of Standards describes the excellent work under Dr. S. W. Stratton, Director, and also mentions the pioneer work of the National Physical Laboratory, Sir Richard Glazebrook, Director, and the progressive work of Mr. H. J. Bingham Powell at the British War Mission, New York City. For information regarding such use, see publications of these institutions.

Advantages of the Projection Method of Inspection

The advantage of the projection method is that it is possible to see at a glance how a screw will fit in its threaded hole as represented by the tolerance chart on the screen. If only one thread is projected on the screen, this is raised or lowered by variation in diameter and displaced laterally by variation in lead. The combination of these two things must be known in order to know how the screw will fit into the threaded hole. If two threads are projected we have a knowledge of the parallelism or taper of a screw.

In the Progress Report of the Committee on Limits and Tolerances in Screw Thread Fits, presented at the Spring Meeting of The American Society of Mechanical Engineers in 1918, tables will be found showing what reduction in pitch diameter must be made to offset certain errors in lead. For instance, the basic pitch diameter of the ¾-in. 10-pitch screw is 0.6851 in., and if the lead of the screw is true, the pitch diameter may be made up to this full diameter; but if the error in lead is plus or minus 0.002 in. in the length of engagement, then the pitch diameter must be reduced 0.0026 in.

Even in the best work, however, such allowances for difference in lead are seldom calculated. We merely know that if the lead is "off" we must reduce the effective diameter.

By the use of the projection apparatus and the tolerance chart all elements excepting the density of surface may be seen at a glance. The resultant effect of the displacement in lead, diameter and angle from the boundaries established on the tolerance chart indicates the fit with a definiteness that will be beneficial alike to the producer and the purchaser, for it will make it possible for the purchaser to express in words and by diagram the exact boundaries within which the product must come.

In addition to providing a measure for the lead and diameter, the tolerance chart and projection apparatus provide a way by which it is possible to indicate the extent of variation in the form of the thread that will be tolerated.

As the art of machine building advances and our methods for producing and gaging screw threads advance, we shall doubtless soon arrive at a point at which we will find it desirable to indicate the difference in lead between the two component parts of a screw-thread fit. For instance, stress of work on a bolt or nut tends to lengthen the screw and compress the nut, so that if the leads of the thread in the screw and the nut were equal when free from stress, there would be an unequal distribution of the load on the various threads engaged when the two members were under a heavy stress.

The stress on a set screw compresses the screw, and to get equal distribution of load on each thread the set screw should be long in lead when free from stress, and the lead of the bolt and nut should be longer in the nut than in the bolt.

To meet such demands the projection-lantern scheme furnishes a solution of one half of the problem, for gaging is half of producing the work. If we have a practical and ready method of gaging, it is much easier to produce the work. By the use of the projection apparatus the specifications may call for cap screws showing the displacement due to lead in one direction, and set screws in the opposite direction.

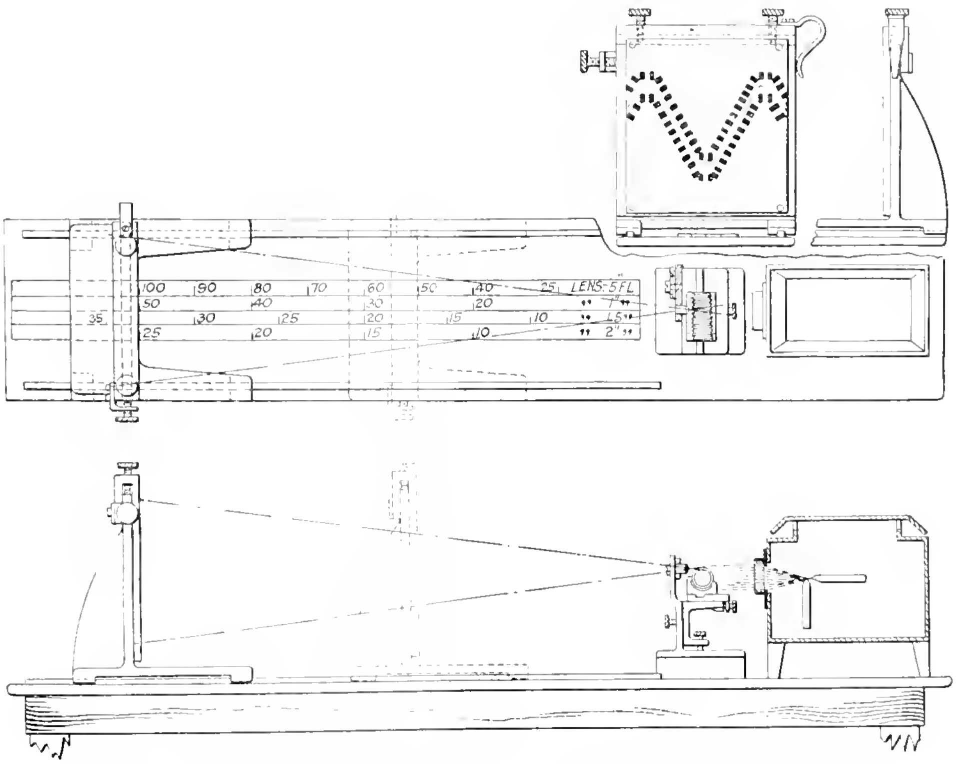


Fig. 3 Diagram Showing Essential Parts of Projection Apparatus

Measurement of Internal Threads

While the projection apparatus does not provide a solution for the measurement of the internal thread, it does provide means for measuring the tap which is used for producing the internal thread, and although it is well known that the usual way of measuring a tap does not indicate the exact nature of the threaded hole that will be produced by that tap, it is probable that a complete inspection of the tap by the projection methods will bring a closer harmony between the meaurements of the tap and the threaded hole produced by it.

Furthermore, the advance of machine construction has demanded for a number of years a greater refinement in tap making, and although the most progressive companies in this work have shown a remarkable advance in this respect, we are undoubtedly coming to a time when taps will be lapped or ground after hardening to bring them into greater uniformity.

Thus it seems that the advent of the projection lantern into the workshop for testing a certain percentage of the work produced will result in making our airplanes and other machines which operate under great tension for given dimensions more dependable and more efficient, and at the same time get a greater return for the energy that is put forth in the workshop in producing these things, for no one thing has been a greater barrier to our progress, especially in our recent war activities, than the uncertainty in our methods of specifying, producing and testing screw threads.

Description of Projection Apparatus and Chart

Fig. 1 represents a machine in use at present, excepting as it has been modified from time to time with various forms of work supports. Fig. 2 indicates a machine designed to take a smaller range of work.

Fig. 3 gives a side elevation and plan of the general scheme, although not true to proportions. The lamp house, for example, is shown too close to the object. The apparatus consists of three principal elements: the machine, which holds the work and lens; the lamp house; and the chart holder, which serves as a screen on which the profile of the thread is projected. The chart holder slides on rails to and from the work in order to get the desired number of magnifications.

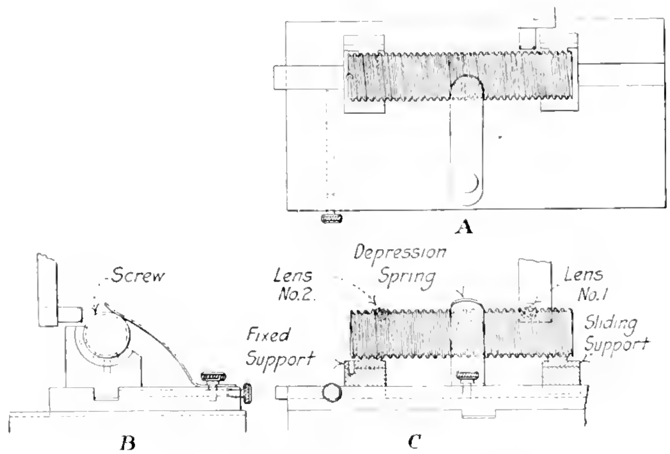


Fig. 4 Work Holder or Cradle

The general plan of operation starts with positioning the work and adjusting the light, work, lens and chart so that the image of a perfect screw thread will fall on the chart along certain lines. When we have no sample of work on which the thread is known to be satisfactory, a standard screw-thread plug may be put in the work holder and used for setting the chart. After that the work may be placed in the machine, one piece after another, and instantly its shadow will reveal its diameter, lead error and profile. If these fall within a certain range of tolerance on the chart the work is acceptable.

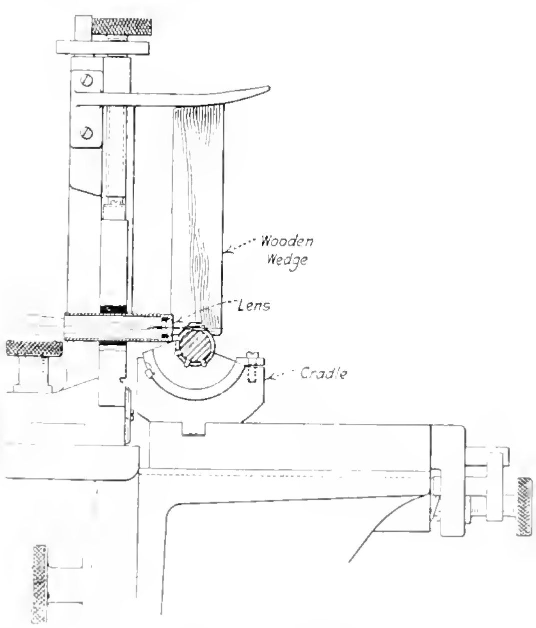


Fig. 4a Method of Holding Screw in Place for Testing

The simplest method of screw inspection projects the profile of one thread on a chart that has a maximum and minimum boundary. The maximum boundary represents the outline of the thread of the hole into which the screw must fit and the minimum represents the smallest acceptable diameter.

Work Supports. It has been found necessary, in order to meet the usual run of work, to mount the screw in one or two cradles consisting of nearly a half-circle of a nut and embracing from one to three threads of the screw, according to the character of the work. With this form of mounting, it is possible, when projecting one of the threads to a tolerance chart, to get some indication of the roundness and roughness by merely turning the screw in its cradle.

Three views of supports of this type are shown in Fig. 4 at *A*, *B* and *C*. The threads of the supports are interrupted with notches so that turning the screw in the thread will tend to carry out chips or other foreign particles that otherwise might be lodged in the thread. A spring is indicated for the purpose of giving the screw a downward pressure to hold the work firmly into its seat when it is being rotated by hand, the extent of this contact and pressure being different for different grades of work. On a $^3/_4$-in. rough screw I have used a wooden wedge which slipped readily into place and enabled me to get uniform results, as shown in Fig. 4*a*.

If the thread to be tested is very short and on a shaft or bolt of considerable length, one of the cradles may be threaded to fit the screw, and the other may fit the cylindrical body of the bolt or shaft.

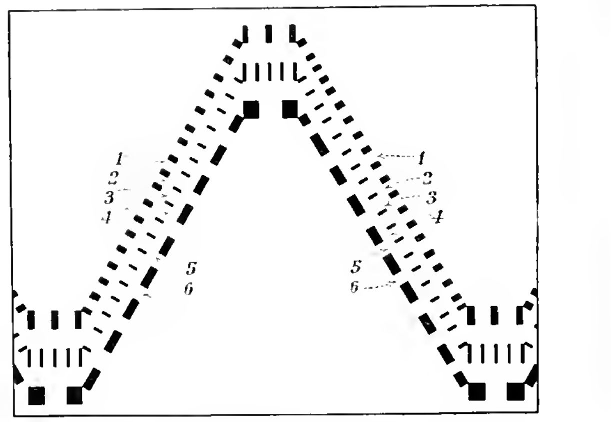


Fig. 5 Tolerance Chart (Greatly Reduced)

Although this method is subject to the uncertainties due to fine chips or other particles becoming lodged in the cradles, these things are more easily detected because the cradle is open and can be frequently inspected. Since a standard plug thread gage is the check on the adjustment of the projection apparatus, it may be dropped into the cradle at frequent intervals.

The object of using a cradle instead of single points, such as center points or single point contacts on the flanks or other parts of the screw, is to get a truer knowledge of the fit of the screw in the nut. The extent of area of contact of the cradle should be proportioned to the roughness of the work. Threads produced by the best methods of chasing on centers could use cradles with simple contact points.

Cradles are better than center points because 0.001 in. variation in diameter is fully shown on the chart, whereas by the use of center points with the projection of a single thread, 0.001 in. would show a variation on the chart of only half that amount, and although by confining the projection to one thread with parts of two valleys, a high magnification of 200 will give a displacement of 0.2 in. for each 0.001 in. of variation, the fact remains that it is desirable to get the best result with the minimum handicap. For instance, a small chip on a center point, when one is looking for an error of 0.0005 in., is more serious than if the chip were imbedded in a cradle.

The Condenser Lens may be a simple plano-convex, or it may be a combination of lenses to gather rays at a wide angle and condense them into a very small bundle of parallel rays. The essential thing, of course, is to have the rays travel in a parallel

direction when they reach the screw thread, striking the screw thread at the angle of the helix in order to present the sharpest profile for the lens.

In order to bring the screen as close as possible to the operator, I prefer to use a lens of very short focal length. For instance, for ½-in. size I am using 0.43 in. focal length, and this could be conveniently used for $\frac{5}{16}$-in., but for ¾-in. screws and larger the outside diameter of this lens would conflict with the sides of the screw, making it necessary to cut away part of each thread.

Tolerance Chart. The exact form of the chart will vary with different requirements, but I prefer a chart on which the boundaries indicated have stated gradations. For instance, for a screw thread of 10 pitch at 200 magnifications the outline of the thread form measures 20 in. between centers of crests of thread, and I produce a chart by drawing these forms in light pencil marks, in steps spaced at 0.8 in., which amounts to 0.004 in. variation of screw thread, for at 200 magnifications we have 0.2 in. per thousandth of an inch. Such a chart is shown in miniature in Fig. 5.

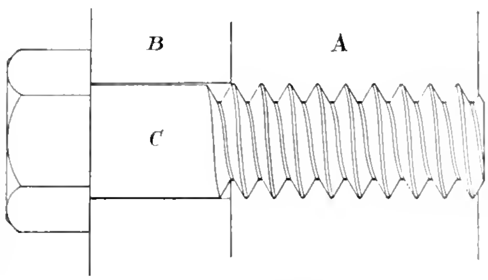


Fig. 6 Ideal Screw-Thread Fit

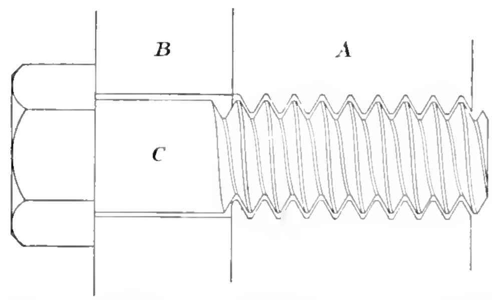


Fig. 7a Screw of Fig. 7 Placed in Central Position

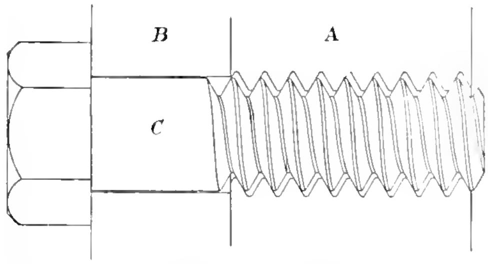


Fig. 7 Screw Smaller Than Threaded Hole

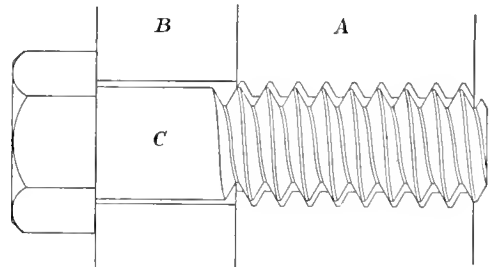


Fig. 8 Screw Standard but Threaded Hole Too Large

Inasmuch as it is not easy to locate the shadow in relation to straight lines, I use black dots having a vertical width of 0.8 in., which amounts to approximately a width of ⅜ in. on the flanks of the thread. These dots are made of different lengths so they may be readily recognized in the partial light of the projection room. The light of the projection room should be adjusted to see the black dots, even in the shadow, and yet not too light to dim the shadow.

By numbering the lines of the charts from 1 to 6, beginning at the upper and running to the lower side, we have means for recording, if necessary, the measurements of a screw. For this purpose we would set up the instrument with a standard plug gage or other perfect thread so that the shadow of this perfect thread would fall on line 5, and this would constitute the largest size that would be tolerated for free fits, the plug being the basic diameter.

Let us assume that the allowable tolerance at the pitch diameter of a 10-pitch screw is 0.008 in.; that is, that the screw may be up to the full basic standard line No. 5 or it may be 0.008 in. smaller, in which case the shadow should not proceed farther than line No. 3. Then by placing one piece of work after another in the holder, if the shadow falls within these boundaries of 3 to 5, we know its size is acceptable. If its shadow falls below line No. 5 toward No. 6, we know it is too large for that grade of fit.

Magnification of the Profile. The distance of the chart holder from the focal center of the lens must be as many times the distance from the focal center of the lens to the profile of the thread as the number of magnifications required. If the focal length of the lens were 1 in., the screen would have to stand away 200 in. to get a magnification of 200 diameters. With a 0.43-in. focal length we get 100 magnifications at 43 in. and 200 magnifications at 86 in. At a distance of 86 in. the shadow can be easily seen by the operator.

I am aware that in astronomy and other sciences using lenses, it is the novice that goes to the higher magnifications, and that the magnifications should not be greater than required, as the best result is obtained by the lowest magnification that will give the proper definition. And while I am aware that those who have been in this art for some time in testing gaging devices advise the low magnifications, it would seem to me that there may be a special reason for using large magnifications in this scheme for testing the work itself.

In this plan we have little or no occasion for projecting more than a single profile, or if we project more than one of the threads, we superimpose the shadows so that the dimensions of the chart may be kept down to about 25 in. square for the run of work of standard threads up to 8 pitch with magnification up to 200.

Characteristics of Screw-Thread Fits

Figs. 6, 7, 7*a*, 8, 9 and 10 illustrate three elements of an ordinary screw-thread fastening. *A* and *B* are pieces to be forcibly held together by a cap screw or bolt *C*. A hole is drilled in *B* large enough for the whole of the screw to pass through it, excepting the head, and *A* has a tapped hole into which the screw is turned.

Fig. 6 represents an ideal screw-thread fit in which the flanks of the thread of the screw and the threaded hole closely fit the entire length of the screw.

Fig. 7 illustrates an extreme example in which the screw is smaller than the threaded hole so that the threads engage only three-quarters of the entire depth of the full engagement.

Fig. 8 illustrates a fit in which the thread diameters are the same when measured on the pitch line, but shows an example of a threaded hole in which the crests of the thread are not up to the full size owing to the hole having been drilled larger than the root diameter of the tap which produced it.

Fig. 9 shows a screw-thread fit in which the diameter of the screw is a trifle smaller than the diameter of the threaded hole, but the threads are not equally spaced so that it is just barely possible to turn the screw into the threaded hole, for it will be

seen that the flank of the thread at x and y bears in opposite directions, while the flanks of the thread at z stand clear.

Figs. 7 and 8 show the flanks of the thread properly engaged; that is, each thread bears its proportionate part of the load; whereas, in Fig. 9, the whole load comes first on a single thread at x. In practice, of course, ordinary differences that appear in lead result in the stress crushing down the first thread at x and gradually working back until they may be distributed the entire length, but not equally.

A reversal of the difference in lead, that is, making the thread of the bolt shorter than the thread in the threaded hole, puts the burden of the work first on the thread at y, and then gradually, either through crushing down of the first threads engaged or by stretching out of the length of the bolt, brings a distribution over the other threads.

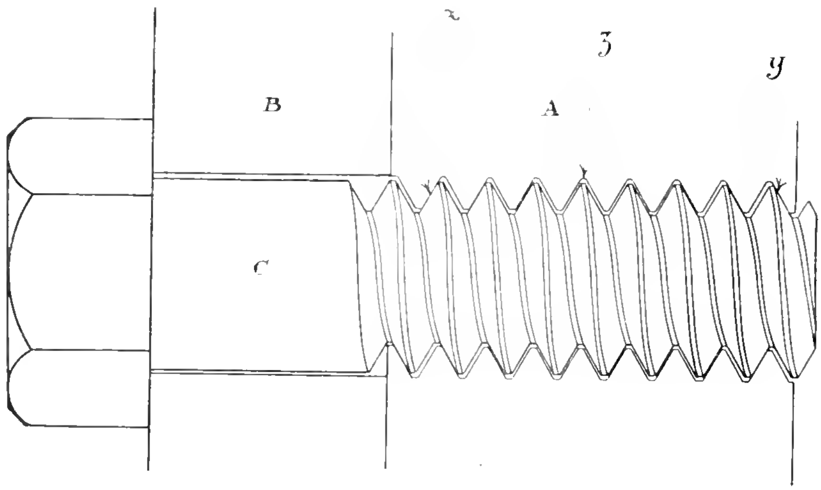


FIG. 9 LEAD OF SCREW GREATER THAN THAT OF THREADED HOLE

In making screw-thread fits we have not only the element of difference in diameter with true leads, but we have combinations of lead errors and diameter variations. It is obvious that with perfect lead the diameters must correspond to insure a depth of engagement that will prevent stripping under the working stress, and in addition to this, if the screw is one that is frequently adjusted and must have good wearing qualities, the depth of engagement must be great enough to provide ample wearing surface.

In addition to the foregoing elements, we have to consider the form of the thread. In Fig. 10 is shown a threaded hole in which the thread is of a blunter angle than the thread of the screw, and while this is not as serious a matter as may seem at first glance, for it has been found perfectly practicable for ordinary fastenings to use a 55-deg. Whitworth thread in a 60-deg. U. S. Standard, the fact remains that it is one of the elements that we must consider in determining the dependability of a screw-thread fastening, for the thread under stress must be squeezed into a shape that will produce a uniformity of contact over a fair amount of the flank surface. Our system of screw-thread gaging should take into consideration form as well as diameter and lead.

The foregoing figures illustrate the three elements, A, B and C, as they would appear when screwed together under a light stress. No attempt has been made to show the various degrees of change that take place under the enormous stresses of the work, although we are coming to a state of machine construction which demands a consideration of the form of thread when under stress. For the purpose of illustration and comparison of the optical gaging system with the tactile gaging system, that is, the system in which we see the condition of a screw as against the system in which we try to determine it by the sense of feeling, we will for the present ignore such stresses.

If we substitute Fig. 7a for Fig. 7, in which a small screw is shown in the threaded hole, but instead of being pulled to one side it stands clear, showing the amount of clearance there would be around each side of each thread—if we will take this for Fig. 7, we will find that the various fit conditions can be found by glancing at the thread at the end of the engagement; for instance, at point y or point x, as in Fig. 9.

Since the error in lead is equally divided between the opposite ends of the length of engagement, it is the end threads that tell us the story.

In the optical-projection method we so locate the screw before the lens that the shadow is thrown on the screen. A lateral displacement of the shadow will clearly indicate the lead error, and a vertical displacement a variation in diameter. The combination of the two will locate the shadow of a single profile on the chart in a way to indicate the condition at the end of a thread engagement of a given length. This tells the whole story of the resultant effect of diameter, lead and form of thread, for one of the boundaries of the chart may be considered as the interior profile of the threaded hole.

FEATURES DEVELOPED BY INSPECTION

The average run of work with the projection lantern will present some new thoughts to the inspector's mind. He will see that the lead is not uniform. In the length of a 3-in. screw the lead at one end of the screw may be shorter than at the other end. He will find that many screws are not round and some are very irregular and mountainous on the surface; not that these elements have been created by the projection apparatus, but merely that they have been brought clearly to view and should be recognized by any system of gaging that has for its ultimate purpose determining the dependability of the screw.

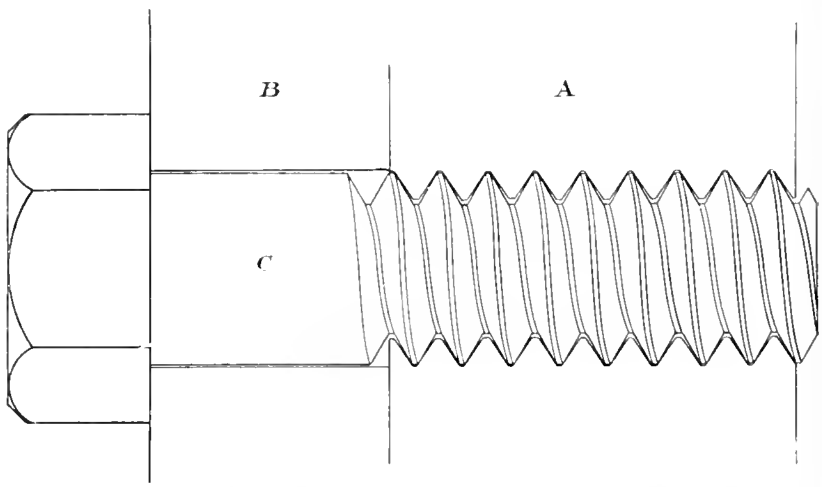


FIG. 10 THREADS OF SCREW OF DIFFERENT ANGLE FROM THREADS OF HOLE

Rotating the work in its holder brings out irregularities. If the screw is of good form, its shadow will remain stationary on the chart. If the thread is drunken, out of round or very irregular, the shadow will move. A ragged surface also appears in the unevenness of the line, and frequently the inspector is confronted with the necessity of determining what part of the line he is to designate as indicating the real working diameter of the screw.

It is not unusual to find one of the flanks of the thread, instead of presenting a straight profile, shows for instance a ridge near where the crest of the thread is rotated.

This condition has always existed in screw threads, and it is for us to recognize that the projection method merely shows how deceptive has been the gaging system which depended on the tactile sense or sense of "feel" of the gage.

In gaging this ridge would play an important part in elim-

inating shake, and yet the screw might be under size so far as its holding capacity is concerned.

When we see the displacement of the thread laterally, that is, if we assume that the profile of the thread on one side is on No. 4 boundary and the opposite side on No. 5, we will know that its lead is off to that extent, and that when turned into a nut the full length of the nut it will feel the same as a perfect thread. But as a matter of fact the slack will be taken up by opposite sides of the flank at opposite ends of the nut, while the middle may not be in contact.

Let us understand that line 5 represents the inside of the nut or at least the upper boundary for the screw. Now, in order to get a perfect indication of the fit of an inaccurate lead in a perfect nut, it is necessary for us to see that our holder which positions the work is adjusted in relation to the length of the engagement of the thread in the nut or in the threaded hole. For instance, if the lead is long or short we know that as it screws into the nut or threaded hole the difference in lead will cause the screw to fit in the nut as shown in Fig. 8, if the screw is longer than that of the nut, and on the opposite sides of the threads if the screw is shorter.

Now we must adjust our holding means so as to get a view of the thread at the end of the nut, which, of course, determines the closeness of its fit.

In Fig. 4, previously referred to, are three views, *A*, *B* and *C*, of a screw located in the cradle of a projection machine. In order to make the view projected on the chart duplicate the conditions in the nut, it is only necessary to see that the longitudinal distance between the distance of the fixed support and the lens (position No. 1) is equal to the length of engagement of the thread in the threaded hole. (If the screw were held on center points instead of on a cradle this fixed support would be one-half the length of engagement.)

It will be understood that the fixed support locates the screw in its longitudinal position as well as laterally; that the sliding support, although holding the screw in the right focal distance from the lens, adapts itself to the position of the thread which, if the lead is true, will be the same as a standard thread, and if the thread is short or long will move endwise without changing the vertical gage of the screw. The projection through the lens will then be displaced vertically if there is a difference in diameter, and displaced laterally if there is a change in the length of the lead.

The combination of these two when the distance to the fixed support is equal to the length of engagement gives a definite knowledge of the fit, and while it may be disturbing to know that the fit is not a fit in the true sense of the word, that it is a misfit is 99½ per cent. of our work, it is best to know the truth if we are to make our machines dependable.

A lens located in position No. 2 can be adjusted to throw its shadow simultaneously with lens No. 1; or a shutter may be used to alternate these two. The object of lens No. 2 would be to check the parallelism of the screw. If the vertical position of the thread projected by lens No. 2 corresponded to the vertical position of the thread projected by lens No. 1, we would know that the thread was parallel.

If it were desirable to have this test for each screw that went through the instrument, its shadow could be so located as to fall two numbers lower than the shadow from lens No. 1, so that the range of its position would be from line 1 to line 3 on the chart, Fig. 5, while the range of the other position would be from 3 to 5, and the uniformity of the average distance between these would constitute an indication of parallelism.

The essential thing in gaging the rougher screws is to see that the screw is held down in its supports with sufficient pressure to insure good contact.

MARINE PRACTICE IN VALVES AND FITTINGS

A Paper in Which the Author Suggests That Certain Features of Central-Station Practice Be Extended to Marine Practice

By A. G. CHRISTIE,[1] BALTIMORE, MD.

THIS paper consists of a series of comments on certain marine practices in regard to valves and piping, from the viewpoint of a central-station man. In recent years there has been a wide use on shipboard of such types of central-station equipment as water-tube boilers and superheaters, geared turbine units, high-vacuum condensers with rotary and ejector air pumps, and centrifugal boiler-feed pumps. Marine practice, however, has lagged behind central-station practice because of the well-known conservation of ship owners.

It has taken this world war to accelerate the adaptation to ships of much of the standard central-station apparatus. Certain factors are now at work which have considerable influence on present marine practice in valves and piping. Of these the greatest is the fabricated-ship yard. In the old-style yard the shops would make up any or or all of their fittings or valves to their special designs, each yard having its own designs which differed from those of other yards. The result of this was a constantly increasing number of special valves and types in each shipyard, with the consequent increase in cost of ship construction. The fabricated-ship yard, however, was forced to buy in the open market and in order to get deliveries had to purchase standard types and sizes. This made engineers study their valves and endeavor to standardize them. In one yard it was thus found possible to reduce the number of types by 20 per cent. It is entirely practicable to use manufacturers' standard stock patterns for nearly all valves, fittings and auxiliary equipment. This standardization, with consequent reduced costs, will be one of the deciding factors in maintaining our shipbuilding supremacy after the war. Standard valves require fewer repair parts and these are more easily procurable for renewal. Decided advantages may be gained by still further extending present standardization.

Piping

A factor which has influenced piping practice is the availability of materials. For instance, copper piping in sizes suitable for steam mains has become so scarce that open-hearth lap-welded steel pipe is often adopted in its place. The use of copper piping has long been standard practice on shipboard. This piping has considerable flexibility and generally stands up well in marine service, but it is not well adapted to superheat conditions. Steel pipe is much cheaper than copper pipe, is more readily available, and is well adapted to any pressures and temperatures that may be encountered. Some engineers fear that it may lack the flexibility of copper pipe, although steel piping in central stations is frequently subjected to strains from contraction and expansion as severe as one finds on board ship; and furthermore is frequently subjected to severe stresses due to unbalanced turbine rotors and other harmonic vibrations. The substitution of steel for copper piping is merely a matter of marine engineers becoming accustomed to designing and installing their steam systems in accordance with steel-pipe standards. In other words, it is dependent on their ability to break away from traditional practice.

[1] Associate Professor of Mechanical Engineering, Johns Hopkins University. Mem.Am.Soc.M.E.

Presented at a meeting of the Baltimore Section of The American Society of Mechanical Engineers, November 20, 1918.

Steel pipe, however, does not withstand corrosion as well as copper pipe. Galvanized steel pipe has been tried for this purpose. In time the galvanized material flakes off under the influence of heat and causes trouble. Repeated painting of such steel pipe seems to be the best protection.

Galvanized pipe should be used on sanitary systems and bilge and ballast piping. However, no advantage is gained by galvanizing the cast-iron fittings of these systems. It is also questionable whether fuel-oil piping in oil-burning ships needs to be galvanized at all.

The problem of caring for expansion has made many engineers prefer copper to steel in piping. In general, long-radius bends provide the best means for taking care of expansion difficulties. Space is limited in vessels, but much may be accomplished in the way of providing such bends if a little study is given to the subject. Some have questioned the flexibility of bends of extra heavy steel pipe. Crane Company's tables indicate that there is usually ample flexibility to care for any lengths that are generally used on shipboard.

Pipe Flanges

Expanded flanges of the Lovekin or similar types are almost universal with copper pipe. Lovekin flanges are used to some extent with steel pipe, but welded or screwed joints are more common.

Land practice in piping seems to have advanced far beyond marine practice in the use of the Van Stone joint. It is said that the first installation of this type of flange on shipboard many years ago was not a success. Apparently this has condemned this excellent joint ever since. Although giving excellent service under most exacting conditions on land, it is taboo at sea. The welded type of Van Stone joint now in use in central stations has apparently never been tried out at sea.

Fittings

With superheated steam, and in general with all steam of over 150 lb. pressure, it is advisable to use cast-steel fittings on the steam lines. For pressures of 100 to 160 lb., extra heavy cast-iron or, better still, semi-steel fittings may be used. For pressures below 100 lb. cast-iron or malleable fittings of standard pattern may be used. In screwed fittings the collar over the threaded portion should be sufficiently heavy to prevent distortion when screwing up with pipe wrenches. Malleable iron is preferred by many on account of its lesser liability to rupture under stress. However, such fittings are generally lighter than cast-iron and are sometimes deformed in screwing up.

In central stations it is very common practice to find branch outlets welded to the main pipe and in general these welded pipes have given very excellent service. This practice is apparently very little used in marine work, although it would make a weight-saving construction by doing away with many cast-iron special fittings now used.

Valves

Standard types of valves must be bought if one is to place orders in the open market under present conditions. Steel valves are used for superheat. Some shipbuilders even specify steel valves for all boiler pressures of 200 lb. or greater. If superheat is not used the valves may be extra heavy, of cast iron or semi-steel. These materials are also used for auxiliary steam lines. Bronze valves are sometimes employed in the smaller sizes, but these are very much more expensive than the extra heavy cast-iron valves and in sizes of $2\frac{1}{2}$ in. and over have no advantage over them except in lightness of weight.

Valves $2\frac{1}{2}$ in. and above must have bolted bonnets to comply with the U. S. Steamboat Inspection Rules. The marine or cross-head type of yoke is much superior to the standard cast yoke for ship purposes. It weighs less and is generally stronger and more readily repaired. It costs very little more than the cast yoke, but is not "standard" with many builders. The latter yoke can be safely used for all low-pressure services.

It is customary on board ship to use the screwed-union bonnet on 2-in. and smaller valves. This type of valve is generally more expensive than the ordinary bonnet type, but has many points of superiority such as its regrinding facilities, longer life and less liability to damage when dismantling. Valve manufacturers generally make the screwed-union bonnet valves in two weights, one to withstand 200 lb. pressure, the other for 350 lb. pressure. It is therefore necessary to use the 200-lb. valves for many low-pressure services. This has considerable advantages, for fewer types of valves need be bought and their interchangeability is increased.

Cast-iron or semi-steel valves for marine service are usually required to have a solid bronze disk with bronze seat. The stem may be of rolled phosphor bronze, rolled naval brass or manganese bronze. Gland studs and nuts should also be of bronze. Steel valves for superheat generally have monel-metal disks and seats with bronze or nickel-plated steel stems. The bronze generally used for valve bodies, disks, seats, glands, etc., is the navy composition "M" consisting of copper 87 per cent, zinc 7 per cent, tin 6 per cent, and may contain lead up to 2 per cent in place of part of the copper. The lead content must be kept as low as possible on account of the action of the salt water.

It is the practice of many marine designers to specify a flange corresponding to extra heavy standard on the sea side of all sea valves, sometimes even when these are connected to the sea chests. Usually the valve is in all other respects of standard weight. This extra heavy flange adds nothing to the strength of the valve, for its weakest point is in the neck behind this flange, which is sometimes but not always made extra heavy. Some maintain that the extra heavy flange is needed to stiffen the ship plate. This same result is secured elsewhere by adding a reinforcing ring to the ship's plates. This type of valve is a "special" to the manufacturers and hence is high-priced and often difficult to obtain on reasonable deliveries.

Shipbuilders generally have endeavored to use A.S.M.E. standards for flanges and drilling. However, some criticisms have been heard. For instance, many marine engineers do not favor the raised faces on extra heavy flanges. They prefer flat faces. The flat faces are also favored for bolting to bulkheads and to other ship plates.

The bolting specified for certain sizes in the A.S.M.E. standards has not been satisfactory to many marine designers. For instance, in the 3-in. and $3\frac{1}{2}$-in. standard-weight flanges the A.S.M.E. standard calls for four holes, while many marine designers use six holes. Also, in the 2-in. and $2\frac{1}{2}$-in. extra heavy flanges the marine engineers frequently use six holes where the A.S.M.E. standards specify four. The A.S.M.E. standards increase the holes at one jump from four to eight. There seems considerable justification for the use of the six-hole flange.

One cannot help commenting on the small use made of gate valves on ships. These are especially adapted to fuel-oil service and could be used to advantage on many water lines just as in land practice. A greater use of gate valves would relieve the existing valve shortage to an appreciable extent and also reduce friction. Reducing valves, relief valves, separators, traps, injectors, etc., can all be supplied equally well from the manufacturer's standard stock patterns made for central-station work as from special marine designs.

It is rather difficult to understand the basis for marine practice in heating systems. Live steam is usually passed through a reducing valve and supplied to the heating system at 20 to 30 lb. pressure. The advantages of exhaust steam for heating and of steam bled from the main turbine do not seem to be fully appreciated in marine practice. Such uses of steam would make operation less simple, but would result in a thermodynamic gain, especially in passenger ships and troop transports.

Inspectors are frequently required to apply tests to valves. In general, such tests are specified in Lloyds and U. S. Steamboat Inspection Rules. A satisfactory standard for inspectors is to test all high-pressure steam valves under hydraulic pressure to three times their working pressure and to test all other valves to twice the working pressure corresponding to their weight or classification.

THE CHEMICAL AND PHYSICAL CONTROL OF BOILER OPERATION

Including the Application of Simple Formulae for Estimating the Heat-Loss Items, etc.

By E. A. UEHLING,[1] PASSAIC, N. J.

THE best method for attaining the conservation of fuel has not been definitely outlined by engineers. There is, therefore, room for discussion, and it is intended to treat the subject in the present paper from the chemical and physical aspects of combustion.

Before intelligent steps can be taken to bring a given boiler plant to its maximum efficiency, it is necessary to know with what efficiency the plant is working. Scientific refinement is not necessary in every-day practice, but *scientific reasoning must be applied*, and the data upon which reasoning can be based must be observed and, wherever possible, autographically recorded.

Methods of Controlling Boiler-Plant Operation

The economical status of a boiler plant can be ascertained by either of the two distinct methods, viz.:

a The mechanical method, based on the heat utilized

b The chemical and physical method, based on the heat wasted.

The mechanical method relies on the readings of the coal weigher and the water meter or steam-flow meter. If the heat value of the fuel is known, the data obtained by these appurtenances enable one to calculate roughly what percentage of the heat in the coal fired is utilized in making steam. For obvious reason the results cannot be calculated oftener than once a day and generally once a week is considered sufficient for a control over the operation of the boiler plant. Aside from the lateness in obtaining the desired information, this method suffers in accuracy and reliability as a control from the following errors and shortcomings:

a The coal weigher cannot discriminate between coal and ash and moisture, and since these constituents are never constant and frequently vary five per cent or more in successive shipments, and since the heat value of the fuel depends on its purity, the calculated results will be that much in error

b The water passed through the meter is not all evaporated. An appreciable amount may be carried over with the steam, more may be lost through leaky blow-off cocks, and considerable is wasted by blowing off the boilers, which is not only not accounted for but actually appears on the credit side

c The steam may be superheated

d The feedwater temperature may vary appreciably.

Thus we see that a water meter and coal weigher can give only a rough, wholesale control, unless supplemented by scientific instruments and observations. The mechanical control has another and even more serious shortcoming in that it gives absolutely no clue as to why the plant as a whole is operating more or less wastefully.

The wholesale chemical and physical method of control is based on the readings of a CO_2 meter and pyrometer inserted in the main gas flue at or near the chimney. This method suffers from the following deficiencies and inaccuracies:

a The indicated and calculated results are qualitative

b The results do not represent all the heat wasted

c From the CO_2 determination in the chimney gas one is unable to discriminate between excess air through the fire and that leaking through boiler walls, as well as that leaking into the gas flue between the boilers and the point where the sampling tube must be inserted to get the gas from all the boilers. Air entering beyond the boilers does not militate against efficiency except as it may overburden the chimney and reduce the draft below that required for efficient combustion.

The wholesale chemical and physical method has the following advantages over the mechanical method:

a It can be more easily and cheaply installed

b The records show up the collective operation of the boilers continuously instead of only at the end of longer or shorter periods; one day at best

c It shows up the combustion and absorption efficiency factors separately so that the proper steps to improve the efficiency of the plant can be promptly and intelligently taken

d The value of its records is not affected by a variation in ash or moisture content of coal burned. Nor is the record affected by the waste of feedwater nor the variation in its temperature.

From the preceding consideration it becomes evident that both wholesale methods are equally handicapped as an aid to improve boiler efficiency, and that in order to obtain maximum collective boiler efficiency each boiler must be diagnosed individually. To be under proper economic control, both its combustion and absorption efficiencies must be under constant observation. Maximum boiler efficiency cannot be maintained without *knowing what every boiler is doing all the time.* To this every combustion and boiler expert will agree; but opinions will no doubt differ as to the best means for effecting this constant observation. It would appear obvious that the most direct way is the best way. Combustion is a chemical phenomenon, and should therefore be most effectively controlled by chemical means. Absorption is a physical phenomenon and is best controlled by physical means. The two principal instruments of observation are the CO_2 meter, a chemical instrument, and the pyrometer, which is a physical instrument. As a necessary auxiliary the double differential draft gage is required. Boiler draft and furnace draft are essential elements in the proper control of combustion and should be observed separately.

The slogan for the boiler room should be: *Watch your results and change your adjustments to keep the results right.* There is no such thing as a fixed adjustment in the operation of a boiler. The rate of combustion must be changed to keep the steam pressure right, the draft must be changed to keep the rate of combustion right, and the thickness of fire must be changed to keep the efficiency of combustion (per cent of CO_2) right. As the fuel and ash bed thickens, a stronger draft is necessary to keep the required rate of combustion, and there are numerous minor variables which require changes in the draft adjustments if combustion efficiency and the required boiler capacity are to be maintained, i.e., maximum CO_2 and a uniform steam pressure. To insure these results CO_2 as well as boiler and furnace draft indicators must be placed at or near the boiler front within easy view of the fireman and in close proximity to the draft-regulating wheel or lever.

Information Afforded by Recording-Instrument Charts

The three autographic records, namely, those of CO_2, temperature of the escaping gas and the boiler draft, preferably on one chart, give the engineer in charge the following information at a glance:

a Whether normal combustion efficiency has been maintained; and if not, the precise time when it became abnormal and how long it remained so. This enables him to inquire into the cause, with the confidence born of knowledge, and to apply the proper correction. The continuous record further reveals in hand-fired boilers how often the fires were replenished, how long the fire doors were left open, when the fires were cleaned and how long it took to clean them. In stoker-fired boilers changes in handling the fire are similarly revealed

b The temperature record shows whether the absorption efficiency has continued normal; if not, the variation may be due to necessary variations in the rate of driving, and if so this will be revealed by the record of the boiler draft, which is

[1] President, Uehling Instrument Company. Mem.Am.Soc.M.E.

Presented at the Annual Meeting, New York, December 3 to 6, 1918, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. The paper is here printed in abstract form and copies of the complete paper may be obtained by members gratis upon application. All papers are subject to revision.

an index to the rate of driving. Or it may be due to a breaking-down of the baffling, which is also instantly revealed by the boiler draft. The mucking-up of the heating surface is indicated by a gradual increase in the temperature of the escaping gases

e The record of the boiler draft, in addition to its contributing value to the pyrometer record, becomes in combination with the per cent of CO_2 a very good index to the rate of combustion, as the writer will endeavor to show later.

Examples of Application of Information Given by Charts to Control of Firing

Fig. 1 illustrates sections of recording-instrument charts showing various relations of these three records to each other. The CO_2 records shown in Secs. 1 and 2 are facsimile samples of records from a boiler of the Manning type burning No. 1 buckwheat coal. Sec. 1, made when the recorder was first installed, shows that the firing was irregular and that the coal bed was kept too thin, through which holes quickly developed. The average CO was scant 8 per cent. The reason for the low CO_2 being thus clearly revealed, the proper remedy at once suggested itself. The fireman was instructed to carry a little heavier fire and watch the CO_2 indicator, with the result shown in Sec. 2, which is a sample record for the same boiler after the fireman had been instructed and had learned to be guided by the CO_2 indicator in adjusting the thickness of the fire to the draft necessary to maintain the required steam pressure. So guided he had no difficulty in keeping the CO_2 at an average of about 12 per cent. Having the three principal records on the same chart their relation to one another is readily perceived, and it will be seen at a glance that the boiler draft is about 0.80 in. higher under the conditions represented by Sec. 1 than those by Sec. 2, also that the temperature shown in Sec. 1 is about 25 deg. higher than in Sec. 2.

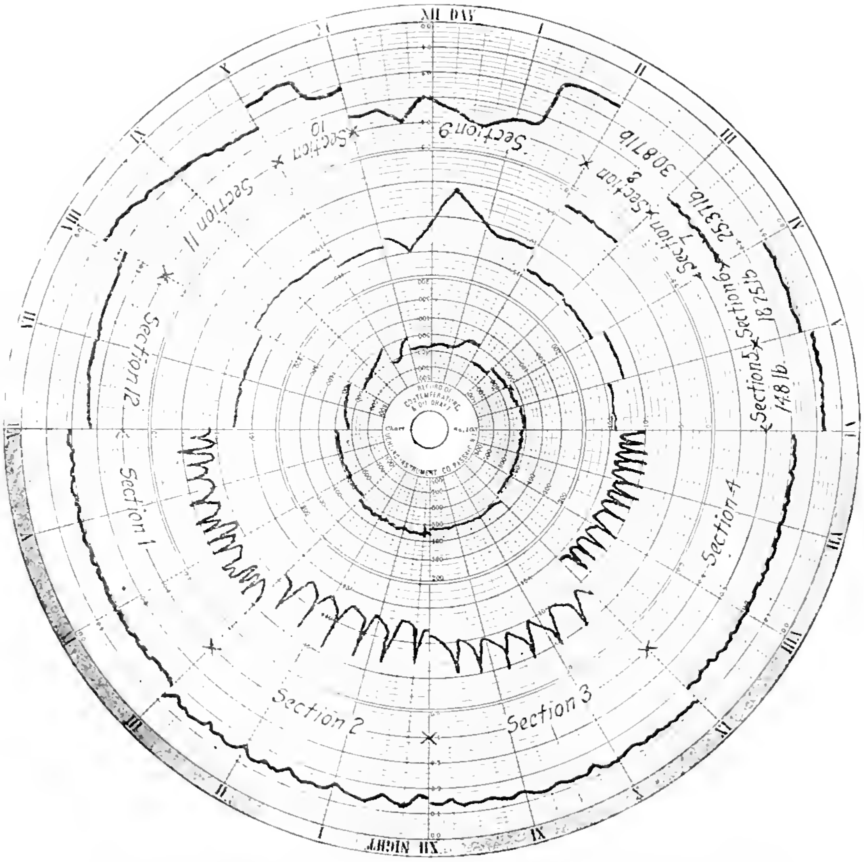


Fig. 1 Sections of Charts Recording CO_2, Stack-Gas Temperature and Boiler Draft

It will be noticed that the gases left the boiler at a temperature 25 deg. higher when containing 8 per cent of CO_2 than when they contained 12 per cent, which shows that absorption efficiency increases with combustion efficiency.

It will further be noticed that the boiler draft is about 0.12 in. with 12 per cent of CO_2 and fully 0.20 in. when only 8 per cent of CO_2 is present, which is due to the greater volume of gas per pound of carbon consumed.

Now since the boiler draft is an approximate index to the volume of gas produced per pound of carbon burned and CO_2 is a true index of the weight of carbon contained in this volume of gas, it follows that if we multiply the boiler draft by the percentage of CO_2, the product will be an approximate index to the rate of combustion. We therefore find that the indices to the rate of combustion under the conditions which are recorded in Secs. 1 and 2 were respectively $8 \times 0.20 = 1.60$, and $12 \times 0.12 = 1.44$.

This means that it was necessary to burn about $[(1.60 - 1.44)/1.44] \times 100 = 11$ per cent more coal to keep up the steam with 8 per cent of CO_2 than with 12 per cent, which corresponds very well with the improved results attained in the plant in which the records thus analyzed were produced.

Secs. 3 and 4 of Fig. 1 show records representing a water-tube boiler burning bituminous coal. Sec. 3 illustrates conditions before, and Sec. 4, after, control by aid of CO_2. A glance at the CO_2 record will show that the fires carried were too thick. The low percentage of CO_2 (about 8.75 per cent) was due principally to air infiltration, but to a considerable degree also to uneven firing producing high CO with low CO_2. Stopping up the air leaks and modifying the method of firing as illustrated by the record and using the CO_2 indicator as a guide, the fireman had no difficulty in maintaining an average of over 13 per cent of CO_2 with practically no CO.

Contrary to what was seen in Secs. 1 and 2 of the chart, both the temperature of the escaping gases and the boiler draft were higher when the conditions had been changed so as to result in the higher percentage of CO_2. This may at first seem contradictory; but a little study reveals the fact that both the boiler draft and the temperature of the escaping gases were rendered abnormally low by the flow of air (counter draft) entering through the leaky setting. It is therefore necessary to make sure that the setting is made tight before these two factors can be relied upon as indices, respectively, of absorption efficiency and rate of combustion. Furthermore, a low stack temperature cannot be relied on as an index to the former unless the gases contain a high percentage of CO_2.

In Secs. 5, 6, 7 and 8 of the chart are recorded the averages of four 24-hour tests of a large water-tube boiler burning bituminous coal fired by Roney stokers. The coal was burned at four different rates of combustion; viz., 16.7, 18.25, 25.3 and 30.8 lb. per sq. ft. of grate surface per hour. The CO_2 averaged 14.68, 13.05, 14.28 and 14.69 per cent; the boiler draft was 0.08, 0.12, 0.31 and 0.61 in. of water, and the temperature of the escaping gases averaged 483, 542, 662 and 636 deg. fahr., respectively. The efficiency attained was respectively 81.15, 77.45, 75.28 and 76.73 per cent.

These four tests demonstrate that the percentage of CO_2 can be maintained at its maximum irrespective of the rate of driving without increasing the percentage of CO, provided there is ample space for combustion. *A large combustion chamber is a most vital factor in securing combustion efficiency.*

Sec. 9 of the chart illustrates the relation the three records will take to each other if the demand for steam suddenly increases and the draft is adjusted to increase the rate of combustion to meet this increased demand, but the stoker is not speeded up sufficiently to supply the coal required. The flue-gas temperature will at once go up in response to the increased rate of combustion. The CO_2 will soon begin to drop, and if there is no CO_2 indicator

to show what is happening it will continue to drop until the fireman discovers that the grate is getting bare and the stoker speed must be increased. He does so, but gives it a little too much speed and the CO_2 goes above the safe limit. If he is a good fireman he will no doubt discover that also and finally get the right adjustment. Meanwhile considerable fuel has been wasted, first by excess air and then by incomplete combustion. With a CO_2 indicator to guide him this would not have happened.

Sec. 10 illustrates how the boiler-draft and pyrometer records will at once reveal the sudden breaking-down of a section of baffling. Sec. 11 shows how the average temperature and boiler draft would be affected if the baffling disintegrated gradually, and Sec. 12 indicates how the records would be likely to change if the boiler tubes were allowed to muck up gradually. These suppositious cases are given to show how the boiler draft and exit temperatures are affected by the same cause. Neither can be correctly interpreted without the other. Within practical limits of driving the maximum percentage of CO_2 can and should be maintained, whereas both the boiler draft and the exit temperature increase with the rate of driving. The exit gas temperatures vary from the normal from four distinct causes:

a Rate of driving
b Defective baffling
c Dirty heating surface
d Air infiltration.

The record of the boiler draft at once reveals the true cause; the pyrometer simply reveals the fact. Low exit gas temperature is generally taken to indicate absorption efficiency and the CO_2 record shows whether it is or not.

It thus appears that the three records, viz., percentage of CO_2, temperature of the escaping gases, and the boiler draft, autographically recorded, preferably on the same chart, reveal in detail all the facts necessary for effective control of the boiler operation. They give a continuous up-to-the minute history of the essential factors on which economic operation depends, and provide a ready means for interpreting the causes of irregularities and for applying the proper remedy promptly and intelligently. The three records being on the same chart, they can be quickly integrated by a polar planimeter and averaged, and thus form the best basis for a bonus system.

In addition to the three recording instruments, an Orsat apparatus is also essential—

a For determining the maximum per cent of CO_2 that can be carried without danger of an appreciable loss because of incomplete combustion
b To diagnose the boilers for air infiltration at regular intervals, or in between, if deemed necessary, and
c To check up the CO_2 meters when their indications give cause for suspecting their accuracy.

An Orsat is by itself quite inadequate as a control for the firing operations of a boiler plant, even when supplemented by sampling tanks, which combination, although better than nothing, cannot be considered more than a makeshift.

Formulæ for Calculating Heat Losses in Chimney Gases

It will now be shown how the information given by recording-instrument charts may be applied in computing the heat losses in detail. The following simple formulæ,[1] developed by the author, are based on a weight of fuel containing 1 lb. of carbon instead of on 1 lb. of fuel or combustible:

$$A_e = \frac{A_c \times 21}{P} - A_c \quad\ldots\ldots [1]$$

$$A_t = \frac{A_c \times 21}{P} = \frac{11.6 \times 21}{P} = \frac{243.6}{P} \quad\ldots\ldots [2]$$

$$L_d = (1 + A_t) S \times (T - t) \quad\ldots\ldots [3]$$

$$L_d = \left(0.24 + \frac{58.46}{P}\right) \times (T - t) \quad\ldots\ldots [4]$$

$$A_e = \frac{A_c \times 21}{P} - (A_c + N_h \times H_a) \quad\ldots\ldots [5]$$

$$L_d = \left(1 + \frac{58 + 46}{P}\right) \times (T - t) \quad\ldots\ldots [6]$$

$$L_c = 10{,}150 \times \frac{P_c}{P + P_c} \quad\ldots\ldots [7]$$

$$L_h = (8734 \times H_a) + (4.3 \times H_a)(T - t) \quad\ldots\ldots [8]$$

$$L_v = A_v\left(\frac{117}{P} + 3.8\, H_a\right) \times (T - t) \quad\ldots\ldots [9]$$

$$P_e = \frac{2100}{P(1 + 3\, H_a)} - \frac{(1 + 238\, H_a)}{1 + 3\, H_a} \quad\ldots\ldots [10]$$

$$P_o = 21 - (1 + 2.38\, H_a) \times P \quad\ldots\ldots [11]$$

$$P_m = \frac{A_c \times 21}{A_c + N_h \times H_a} = \frac{152 \times 21}{152 + 361\, H_a} = \frac{21}{1 + 2.38\, H_a} \quad\ldots [12]$$

Where

O = weight of oxygen per lb. of carbon in the fuel
H_t = weight of hydrogen per lb. of carbon in the fuel
$H_a = H_t - \frac{O}{8}$ = weight of available hydrogen per lb. of carbon in the fuel
A_c = weight of air required to burn 1 lb. of carbon
A_t = total weight of air supplied
A_e = weight of excess air supplied
N_h = weight of nitrogen in weight of air required to burn 1 lb. of hydrogen
A_v = weight of water vapor per lb. of air supplied per lb. of carbon burned
P = per cent of CO_2 in flue gas
P_c = per cent of CO in flue gas
P_e = per cent of excess air in flue gas
P_o = per cent of free oxygen in the gas
P_m = maximum theoretical per cent of CO_2 obtainable from any given fuel
$S = 0.24$ = specific heat of dry gases
T = temperature of gases on leaving the boilers, deg. fahr.
t = temperatures of air supplied for combustion, deg. fahr.
L_d = B.t.u. carried off by dry gas per lb. of carbon burned
L_c = heat value of CO contained in gas per lb. of carbon burned
L_h = B.t.u. carried off by H_2O produced by the combustion of the available hydrogen per lb. of carbon burned
L_v = B.t.u. carried off by water vapor in the air supplied to burn 1 lb. of carbon

Air contains	Per cent by weight	Per cent by volume
Oxygen....	23	21
Nitrogen..	77	79

One cubic foot of air at 62 deg. fahr. weighs 0.0761 lb.
One cubic foot of nitrogen at 62 deg. fahr. weighs 0.0742 lb.

Application of Formulæ to Data Derived from Autographic Records of CO_2

The usefulness and reliability of these formulæ are best shown by applying them to the data observed in a few authoritative boiler tests and comparing the results.

Tests A and B, Table 1, were made on a large boiler of the Stirling type rated at 2400 hp., equipped with forced draft and Roney stokers; the fuel was Pittsburgh coal. Tests C and D were made on a 210-hp. Heine boiler, hand-fired. The fuel was No. 1 Arkansas briquets in test C, and Illinois No. 3 coal in test D.

Dividing the weight of all the constituents of the coal by the weight of carbon per pound of fuel in order to reduce them to the carbon unit basis of 1 lb. gives the following values:

C	H	O	Ash	Moisture	B.t.u.
1.0	0.0683	0.1068	0.0925	0.023	17 984

The available hydrogen per pound of carbon is

$$0.0683 - \frac{0.1068}{8} = 0.055 \text{ lb.} = H_a$$

[1] The derivations of these formulae are presented in the complete paper.

TABLE 1 DATA AND RESULTS OBTAINED IN FOUR AUTHORITATIVE BOILER TESTS

Test Data	Test A	Test B	Test C	Test D
Analysis of Coal:				
Carbon, per cent.....	76.87		79.76	71.52
Hydrogen, per cent	5.31		3.91	4.53
Oxygen, per cent.....	8.32		2.70	8.18
Nitrogen, per cent..	1.11		1.58	1.52
Sulphur, per cent...	1.20		1.75	1.64
Ash, per cent......	7.19		11.04	15.70
Moisture, per cent..	1.80		0.94	8.51
B.t.u..........	13,826	...	13,885	12,857
Analysis of Gas:				
CO_2, per cent........	11.90	14.23	9.36	7.10
CO_2, per cent	0.23	0.36	0.00	0.04
O_2, per cent......	3.40	4.30	10.57	13.40
Temperatnre of gas, T, deg. fahr.	483	670	624	635
Temperature of atmosphere, t, deg. fahr..........	73	81	87	62
Total effective draft, in. of water	0.26	0.57	0.35	0.58
Furnace draft, in. of water...	0.14	0.22	0.15	0.21
Boiler draft, in. of water.....	0.12	0.35	0.20	0.37
Humidity in air, per cent saturation	62.4	64.5	..	
Carbon in ash, per cent..........	31.6	38.0	23.02	33.73
Duration of test, hours.... ...	24	30	10	10
Rated h.p. of boilers......	2400	2400	210	210
Test Results as Reported				
Efficiency, per cent........	81.15	75.78	67.33	64.20
Heat loss up chimney, per cent.	15.15	19.76	23.12	32.60
Heat loss in ash, per cent......	2.29	2.13	....	..
Heat loss by radiation, etc., per cent	1.51	2.33	9.55	3.74
Total...	100.00	100.00	100.00	100.00
Water evaporated per lb. of coal, lb.	9.95	9.01	7.9	6.2
Coal burned per hr. per sq. ft. of grate, lb................ ...	14.81	25.97	18.74	21.23
Horsepower developed.......	2225	3606	206	201
Driving, per cent of rating ..	94	152	98.3	95.5

The water of hydration per pound of carbon is

$$0.1068 + \frac{0.1068}{8} = 0.12 \text{ lb.} = W_{hy}$$

From the data obtained in Test A, the heat carried up the chimney by the dry gases, according to Formula [3], is

$$L_d = \left(0.24 + \frac{58.46}{P}\right) \times (T - t)$$

Substituting the values of P, T and t,

$$L_d = \left(0.24 + \frac{58.46}{14.91}\right) \times (483 - 73) = 1706 \text{ B.t.u.}$$

Also, the heat value of the CO contained in the gas, according to Formula [7], is

$$L_c = 10{,}150 \times \frac{P_c}{P + P_c}$$

Substituting the values of P_c and P,

$$L_c = 10{,}150 \times \frac{0.023}{14.9 + 0.23} = 10{,}150 \times 0.0151 = 153 \text{ B.t.u.}$$

From Formula [8] the heat carried off by the H_2O from the combustion of the available hydrogen, is

$$L_h = 8734\, H_a + 4.32\, H_a (T - t)$$

Substituting the values of H_a, T, and t,

$$L_h = 8734 \times 0.055 + (4.32 \times 0.055 \times 410) = 578 \text{ B.t.u.}$$

Also, the heat absorbed by the humidity in the air, according to Formula [9], is

$$L_v = A_v\left(\frac{117}{P} + 3.8\, H_a\right) \times (T - t)$$

The average temperature of the air during the test was 73 deg. and the average humidity 62.4 per cent saturation. At this temperature and saturation the water vapor carried into the furnace is 0.0106 lb. per lb. of air supplied = A_v. Substituting this value and the values of H_a, P and $(T - t)$ in Formula [9],

$$L_v = 0.0106\left(\frac{117}{14.90} + 3.8 \times 0.055\right) \times 410 = 34 \text{ B.t.u.}$$

The heat carried by the water of hydration equals

$$L_w = W_{hy} \times (0.48\, T + 1080 - t)$$

Substituting the values of W_{hy}, T and t,

$$L_w = 0.12(0.48 \times 483 + 1080 - 73) = 149 \text{ B.t.u.}$$

Substituting the value of W_m for W_{hy}, where W_m is the weight of moisture per lb. of carbon, the loss due to the moisture in the coal is

$$L_w = 0.023(0.48 - T \times 483 + 1080 - 73) = 28 \text{ B.t.u.}$$

The foregoing comprise all the items of heat wasted up the chimney with the exception of that contained in the hydrocarbons, if any, and in the soot and ash passing off with the gases, and may be enumerated as follows:

Heat-Loss Items Up the Chimney

	B.t.u.
a Heat carried to waste by the dry gases..........	1706
b Heat value of CO..............................	153
c Heat carried to waste by the H_2O from the combustion of the available hydrogen..............	578
d Heat loss due to the humidity in air..............	34
e Heat carried to waste by the water of hydration...	149
f Heat carried to waste by the moisture in the coal..	28
g Total heat in H_2O in gases......................	789
h Total heat in flue gas per lb. of carbon burned (items *a*, *b* and *g*)..........................	2648

Hence $\dfrac{2648 \times 100}{17984} = 14.72$ per cent of the heat of the coal remained in the gases as they left the boiler.

The ash contained 31.6 per cent of carbon and since the coal contained 0.0925 lb. of ash per lb. of carbon, the loss due to the heat value of the combustible in the ash is

$$0.316 \times 0.0925 \times 14{,}600 = 427 \text{ B.t.u.}$$

which represents

$$\frac{427 \times 100}{17{,}984} = 2.38 \text{ per cent of the heat in the coal.}$$

The total heat loss accounted for by the preceding calculations is therefore

	Per Cent
Heat absorbed by boiler......................	81.10
Heat loss up the chimney.....................	14.72
Heat loss through the grate..................	2.38
Heat loss from radiation, etc................	1.80
Total.................................	100.00

The heat-loss items in Test A were reported as follows:

	Per Cent
Moisture in coal............................	0.16
Hydrogen in coal............................	4.29
Heat to chimney.............................	9.11
Moisture in air.............................	0.20
Carbon monoxide	1.29
Carbon in ash...............................	2.29
Total losses accounted for..............	17.34
Absorbed by boiler..........................	81.15
Radiation, etc.	1.51
Total................................	100.00

Applying the same formulæ to the observed data of Tests B, C and D, the results given in Table 2 are obtained.

Combustion efficiency in the operation of a boiler means only that all the combustible in the fuel must be completely oxidized, but that it must be oxidized in a manner that the maximum amount of the heat liberated becomes available to the boiler. Theoretically, all the heat liberated by combustion is available to the boiler except that contained in the gases below the temperature of the water in the boiler and the latent heat of the H_2O contained in the gases. Hence combustion efficiency so far as it is under the control of the fireman $= \dfrac{\text{Available heat liberated}}{\text{Heat available in fuel}}$.

Analyzing the results of these heat-loss calculations it is found that in Test A, $1706 \times 100/2648 = 64.12$ per cent of the heat up the chimney is carried by the dry gases, and that the heat value of the CO amounts to $153 \times 100/2648 = 5.78$ per cent. The remainder, or 30.1 per cent, is carried off by the H_2O from coal and air.

TABLE 2 RESULTS OF APPLICATION OF FORMULÆ TO DATA OF TESTS B, C AND D

	Test B	Test C	Test D
a Heat carried to waste by dry gases, B.t.u.	2560	3480	4853
b Heat value of CO contained in gases, B.t.u.	251	0	57
c Heat in H_2O from combustion of available hydrogen, B.t.u.	610	497	549
d Heat loss due to humidity in air, B.t.u.	72		
e Heat carried to waste by water of hydration, B.t.u.	153	36	164
f Heat carried to waste by moisture in coal, B.t.u.	29	15	154
g Total heat in H_2O in gas, B.t.u.	864	548	867
k Total heat in flue gas per lb. of carbon burned, B.t.u.	3675	4028	5777
Heat of coal remaining in gases leaving boilers, per cent	20.43	23.17	32.14
Heat loss due to combustible in ash, B.t.u.	416	129	867
Heat loss due to combustible in ash, per cent of coal	2.31	2.47	4.82
Total Heat Loss:			
Heat absorbed by boiler, per cent	75.78	65.39	60.32
Heat loss up the chimney, per cent	20.43	23.17	32.14
Heat loss in range grates, per cent	2.31	2.47	4.82
Heat loss from radiation, etc., per cent	1.48	8.97	2.65
Total	100.00	100.00	100.00
Losses in Test Report:			
Moisture in coal, per cent	0.17		
Hydrogen in coal, per cent	4.49		
Heat to chimney, per cent	12.79		
Moisture in air, per cent	0.36		
Carbon monoxide, per cent	1.95		
Carbon in ash, per cent	2.13		
Total loss accounted for, per cent	21.89		
Heat absorbed by boiler, per cent	75.78		
Heat lost in radiation, etc., per cent	2.33		
Total	100.00		
Heat Balance in Test Report:		Per cent	Per cent
Heat absorbed by boiler (= evaporation from and at 212 deg. per lb. of combustible)		62.33	64.20
Loss due to moisture in coal (= per cent of moisture referred to combustible)		0.09	0.96
Loss due to moisture formed by burning of hydrogen (= per cent of hydrogen referred to combustible)		3.28	4.18
Loss due to heat carried away by dry chimney gases (= weight of gas per lb. of combustible)		19.75	26.60
Loss due to unconsumed hydrogen, heating of moisture and unaccounted for		9.55	3.74
Loss due to incomplete combustion of carbon			0.32
Total		100.00	100.00

TABLE 3 ANALYSIS OF HEAT ESCAPING UP THE CHIMNEY

	Test A	Test B	Test C	Test D
(1) Per cent of heat up the chimney contained in the dry gas	65.20	69.66	86.40	84.02
(2) Per cent of heat escaping up the chimney represented by CO	5.80	6.83	0.00	0.98
(3) Per cent of heat escaping up the chimney due to H_2O	29.00	23.51	13.60	15.00
(4) Per cent of heat controllable in item (1)	27.00	48.43	69.40	78.26
(5) Per cent of heat controllable in item (2)	100.00	100.00	100.00	100.00
(6) Per cent of heat controllable in item (3)	8.50	7.80	11.20	7.50
(7) Per cent of controllable heat residing in the dry gas	85.20	94.90	97.40	98.70
(8) Per cent of excess air	23.00	29.00	97.00	160.00
(9) Per cent of free oxygen in gas	4.16	4.83	10.57	13.10

Since the gases cannot be cooled below the temperature of the water in the boiler, it is evident that only the heat contained in the gases above that temperature is under control of the boiler operation.

Applying Formula [12] it is found that the theoretical maximum percentage of CO_2 obtainable from the coal used in Test A is

$$P_m = \frac{21}{1 + (2.38 \times 0.055)} = 18.57$$

The temperature of the water in the boiler corresponding to the average steam pressure carried during Test A was 384.6 deg. fahr. Applying Formula [4], the uncontrollable heat in the dry gases per pound of carbon burned is found to be

$$L_d = 0.24 + \frac{58.46}{18.57} \times 384.6 = 1246 \text{ B.t.u.}$$

or

$$\frac{(1706 - 1246) \times 100}{1706} = 27 \text{ per cent}$$

hence only 27 per cent of the heat in the dry gases in this test was controllable.

The loss due to CO is independent of the stack temperature, and since the percentage of CO in the gas can be reduced to zero, the heat loss due to its presence is 100 per cent controllable.

Since the heat loss due to the H_2O in the gases is independent of the CO_2, only that portion is controllable which is affected by the temperature of the flue gas above that of the water in the boiler.

The latent heat of evaporation is not controllable, hence the terms in the formula representing it must also be eliminated. Thus, applying the modified formula to the observed data we have for the controllable heat in H_2O:

$$\left[4.32 \times 0.055 + 0.0106 \times \left(\frac{117}{14.9} + 3.84 \times 0.055\right)\right] \times (583 - 385) + 0.48 \times (583 - 385) \times 0.143 = 67.53 \text{ B.t.u.}$$

Since the total heat carried to waste by the H_2O in the gas is 798 B.t.u., it is seen that only $\frac{67.53 \times 100}{798} = 8.5$ per cent of it is controllable.

Of the heat in the dry gas $(1706 - 1246 =) 460$ B.t.u. were controllable, hence the total controllable heat escaping amounts to $460 + 67.5 = 527.5$ B.t.u., and of this $\frac{460 \times 100}{527.5} = 87.2$ per cent resides in the dry gases.

Table 3 gives the results of the foregoing calculations for the four tests under consideration. Item (1) shows what percentage of the heat wasted up the chimney is contained in the dry gas that can be controlled to a greater or lesser degree by improving operating conditions. Item (7) shows what percentage of the controllable heat resides in the dry gases. All of which emphasizes the importance of the CO_2 and temperature records, as controlling factors in boiler operations.

The fireman must drive his boilers in accordance with the demand for steam. He has no control over the condition of the heating surface of his boilers. And since the temperature of the escaping gases depends primarily on one or both of these conditions it is not fair to him to judge his proficiency by heat wasted up the chimney, and much less fair is it to judge him on the basis of pounds of water evaporated per pound of coal burned. In Test A, for example, there was 10 per cent more water evaporated than in Test B, while the difference in furnace efficiency based on heat available was only 2.1 per cent, as demonstrated above.

The proper basis upon which to judge the proficiency of a fireman is the factor $0.24 + \frac{58.46}{P}$ after the maximum percentage of CO_2 (P) with practically complete combustion has been established for the prevailing conditions at any given plant.

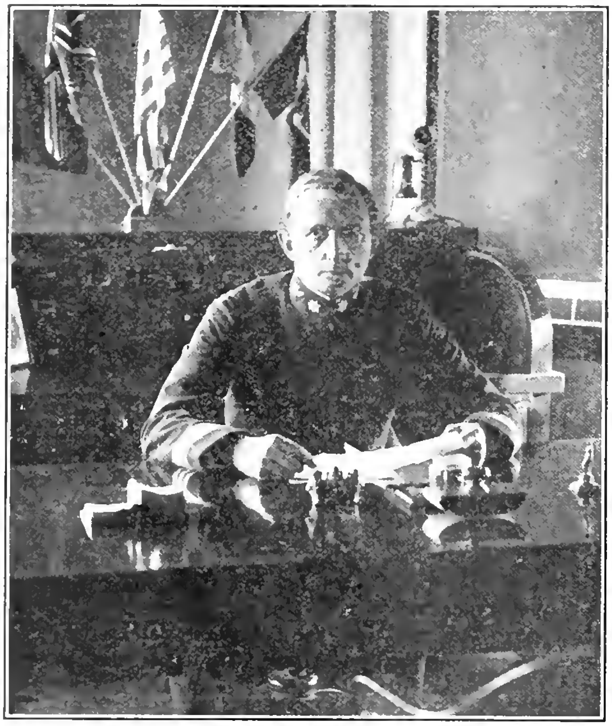
Within proper limits of CO_2 there exists no relation between the percentages of CO_2 and CO. Test B, for example, shows 0.7 per cent less CO_2 and 0.13 per cent more CO. Furthermore, it must be borne in mind that the loss due to the same percentage of CO diminishes directly as the percentage of CO_2 increases, as is shown by the factor $\frac{P_c}{P + P_c}$. It is a matter of easy calculation

(Concluded on page 199)

THE NAVAL AIRCRAFT FACTORY

IN his strikingly interesting lecture on the engineering achievements of our Navy in the war, given at the Annual Meeting, Lieut.-Commander Cathcart limited himself to a recital of the work of a single bureau of the Navy Department—the Bureau of Steam Engineering.[1] "The work of this bureau," he said, "should be regarded as but a sample of what all the bureaus of the department have done. From the beginning of the war the entire Navy Department has been working in a clean-cut American way, at maximum efficiency under forced draft."

One of the most noteworthy of its accomplishments—that of another bureau—has been the construction and organization of the great naval aircraft factory at the League Island Navy Yard, Philadelphia, and the bringing it up to quantity production in 10



Commander F. G. Coburn, Manager, Naval Aircraft Factory

months from the time work on the first building was started. It was a pioneer undertaking, attended by innumerable difficulties, which, however, were but the measure of the possibilities that it was hoped might be realized. That they were actually realized is attested by the fact that from the first the factory has been ahead of its schedule.

On July 27, 1917, Secretary Daniels authorized the construction of a government-owned aircraft factory. The site selected was a 40-acre tract of pasture land at League Island, entirely undeveloped. The original manufacturing unit was a permanent steel structure having a ground area of 160,000 sq. ft., built and equipped in three months and put in operation before the final touches had been given to the structure.

Early in January 1918 the Navy's aircraft program was expanded far beyond the manufacturing facilities of this original building and plans were developed for the enlargement of the plant to four times its original size. The augmented program required new aircraft faster than they could be provided by building an entirely balanced factory. The authorization therefore contemplated that the new extension should be an assembly plant and in proportion to its growth, privately-owned manufacturing facilities be taken off their regular commercial work and placed under contract to furnish the hulls, wings and other parts needed. Thus branches of this establishment appeared in many places throughout the East which turned their activities to a common end under the direction of the Naval Aircraft Factory.

When the armistice was signed the enlarged plant comprised, besides the original building, 400 ft. square, the new Plant No. 2, over 1000 ft. long, with a high assembly shop 200 ft. wide for the largest types of aircraft, and a one-story ell 350 ft. wide; a storehouse 200 by 175 ft.; administration building 180 by 125 ft.; lumber storage and dry kilns; boiler house; hangars, etc., comprising 25 acres of floor space and a capacity of four seaplanes per day.

At this time 3740 men and women were employed at the factory, besides 8000 by outside contractors.

The chronology of this extensive development is as follows:

July 27, 1917, Secretary Daniels authorized construction.
August 10, construction work began.
October 16, first machinery started.
November 2, first keel laid.
November 28, first plant completed.
January 25, 1918, expansion of plant ordered to four times original size.
March 27, first service machine completed.
June 1, full designed production of first plant attained.
November 4, 1918, production of two completed hulls a day and plant capacity sufficient to produce four machines a day.

In view of the special character of the undertaking, in what in this country was a little-understood field, this record of progress is in many ways unprecedented. As a patriotic accomplishment on a vast scale, it is one in which the Navy Department may well take pride; and as an example of efficient organization and able able administration it must be classed as a real achievement.

Commander F. G. Coburn, Manager

The manager selected for the undertaking, and who has so successfully carried it through to completion, is Commander F. G. Coburn, Mem.Am.Soc.M.E., who was previously stationed at the Boston Navy Yard. Members of the Society will remember the comprehensive paper presented by Commander Coburn at the Annual Meeting three years ago, on the heat treatment of wrought iron, a subject at that time but little understood. This gave the results of an elaborate investigation for the purpose of improving the strength and reliability of heavy anchor chain forged at the Boston Navy Yard for the U. S. battleships.

Commander Coburn is a graduate of Annapolis and of the Massachusetts Institute of Technology, where he qualified as a naval architect and marine engineer, with the degree of Master of Science. He served one year as a line officer in the Asiatic service, and had some 10 years' industrial experience in several of the navy yards of the country, where he became interested in scientific management and gave considerable time, also, to investigations of the methods of civil industrial plants. All of this experience, as well as initiative, visions and the ability to undertake new and great things had ample opportunity to come into play in the new project upon which he embarked.

Organization of Staff and Working Force

It is coming to be generally recognized that in any manufacturing enterprise the personnel is the most essential element. Buildings can be erected and machinery purchased, but to do effective work an organization must be built up with infinite pains and its methods of work in the different departments carefully coördinated.

What shall be said, then, of a project such as this, where the organization had to be formed at the very start, with no time for experimenting, and in a field where there were practically no men experienced in the art upon whom to draw; for what few there were in this country who had had any experience in aircraft production were already in war work in other aircraft factories.

The executive staff was first got together, selected by Manager

[1] See Mechanical Engineering, January 1919, p. 18

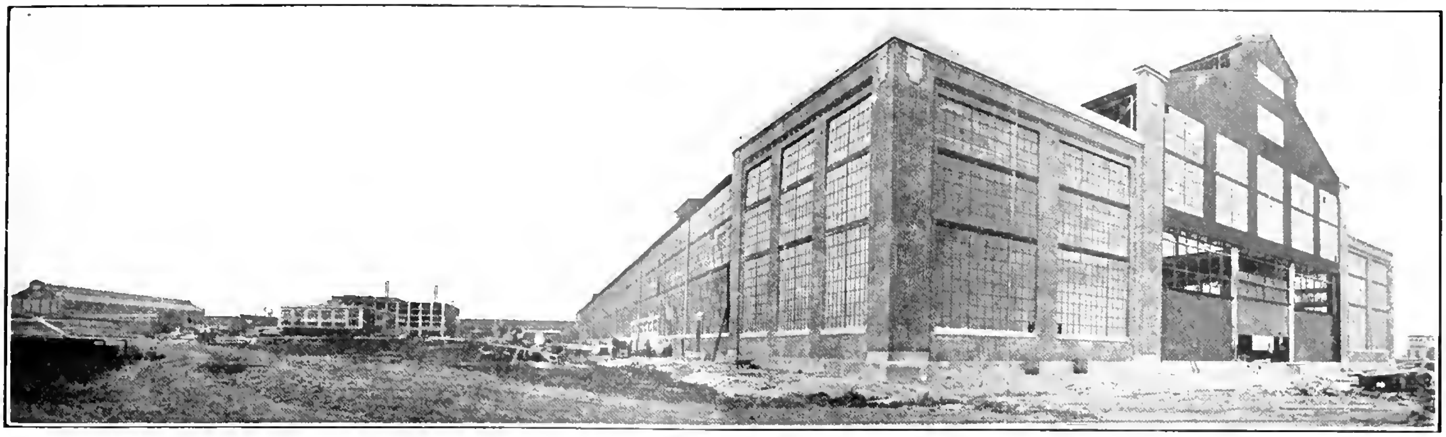


FIG. 1 PANORAMIC VIEW OF NAVAL AIRCRAFT FACTORY; ORIGINAL PLANT AT EXTREME LEFT, NEW ASSEMBLY SHOP AT RIGHT, ADMINISTRATION BUILDING AND STOREHOUSE IN THE CENTER

Coburn from civil life, as the Navy could spare but one more officer, Lieut.-Com. F. J. Daly, Pay Corps, who became Supply Officer.

Upon the employment department fell the problem of supplying man power for the factory. Civil Service rules and the regulations of the Navy had to be taken into consideration at every step. Testimony to the generally satisfactory caliber of employees secured under Civil Service, however, is found in the fact that it was necessary to hire a total of only 6035 persons to provide for the nearly 4000 at work at the cessation of hostilities and only 139 had been discharged for cause.

The story of the building up of the force is full of interest. The hulls of the seaplanes were the most difficult parts to construct and boat builders were essential, but where were they to be found with the Emergency Fleet Corporation in operation, and supposedly using every available shipbuilder? A representative of the Naval Aircraft Factory went to the Jersey coast, however, and prevailed upon nearly 80 boat builders to leave their own personal work and come to the factory to "do their bit" in helping to put the U-boat out of commission. Among them were old boat builders who owned shops near their homes and who consented to close their doors for the time being and join forces in the new undertaking. One of these was the newly-elected mayor of the small city in which he lived. Trained by long experience to do all of a job, these men readily fitted into the aircraft work after a brief course of instruction at the factory school.

Specialists in aircraft production were picked up here and there, often by chance, for other parts of the work. A Belgian soldier and former aviator who had escaped from a German prison camp, applied in person, specifying in his enthusiasm that he should work not less than 12 hours a day. A French infantryman who had previously studied motor construction in this country and was wounded at the front, returned to America, learned of the League Island factory through the War Community League at one of the Philadelphia railroad stations, and secured an important position there. And so, little by little, but nevertheless with rapidity, the force was built up and placed effectively at work.

EMPLOYMENT OF WOMEN

From its inception, the Naval Aircraft Factory employed women for clerical work and in December 1917 they were first used in the Inspection Department, to inspect screws, bolts, turnbuckles and small metal parts. This work required accuracy, good judgment and common sense, but very little previous experience or training. In order that their services might be extended to other departments where previous experience and special skill were required, a training school for women was started in May 1918. The women are placed in this school when employed, where they are given training in factory processes. They are here tried at various kinds of work and are then trained to do the thing for which it is observed they are best fitted. This is determined by a daily record of the work of each woman for one month, whose grade of work and adaptability for that work are discussed with her immediate superior; and everything possible done to make her contented and efficient.

At the close of the war activities 900 women were employed in the factory, most of them having come through the training school, equipped to serve capably in many of the departments of the works. In the mill they are employed on the spruce layout, on band saws and molding machines and as helpers. In the hull cover department they help with parts of the hull cover and also construct alone small parts, such as gun mounts and access doors. They are employed exclusively in jigging, reinforcing and sandpapering the webs preparatory to their use in the panel, or wing, assembly. In the panel shop they are used to a great extent in the construction of elevators, rudders, stabilizers and

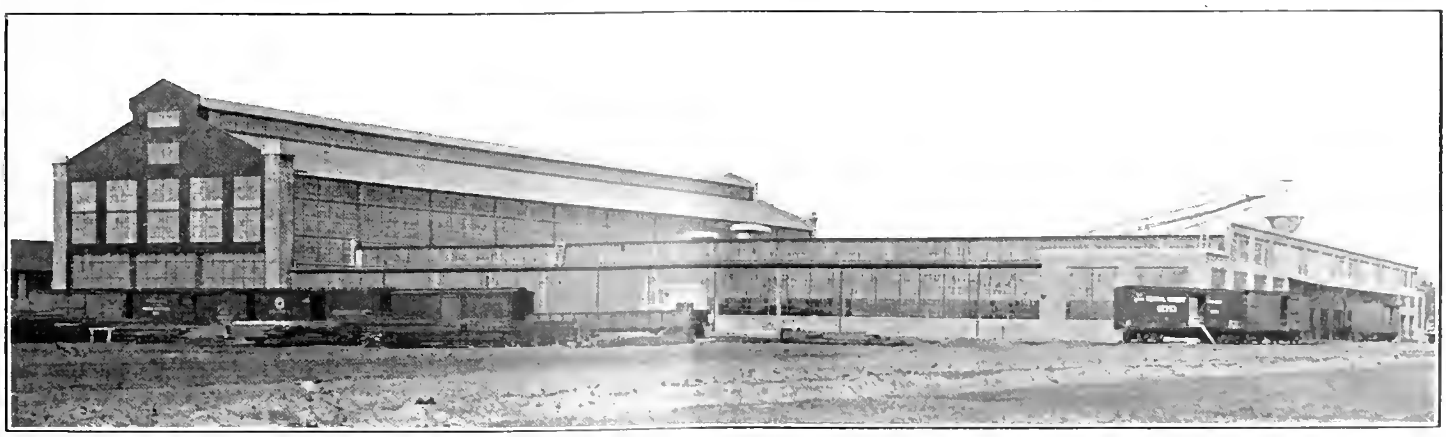
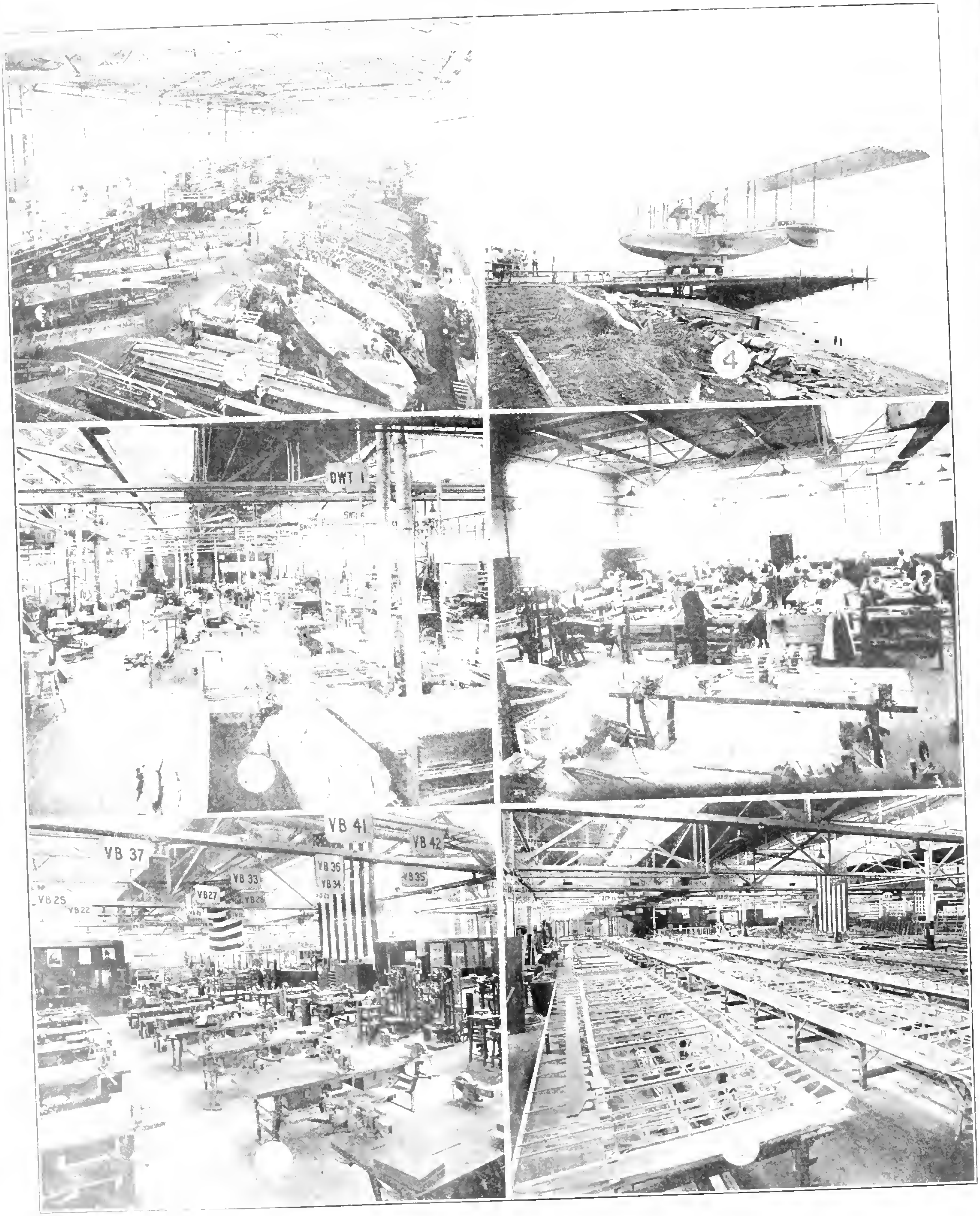


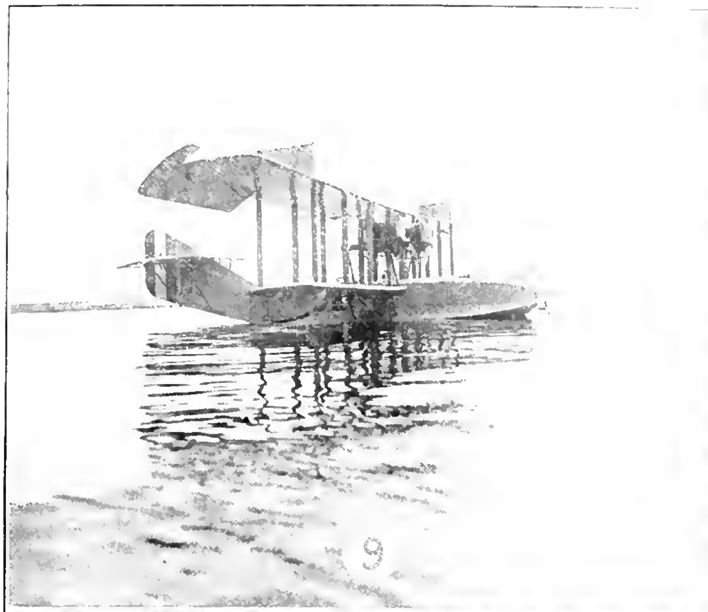
FIG. 2 PLANT NO. 1, SHOWN AT THE LEFT IN FIG. 1

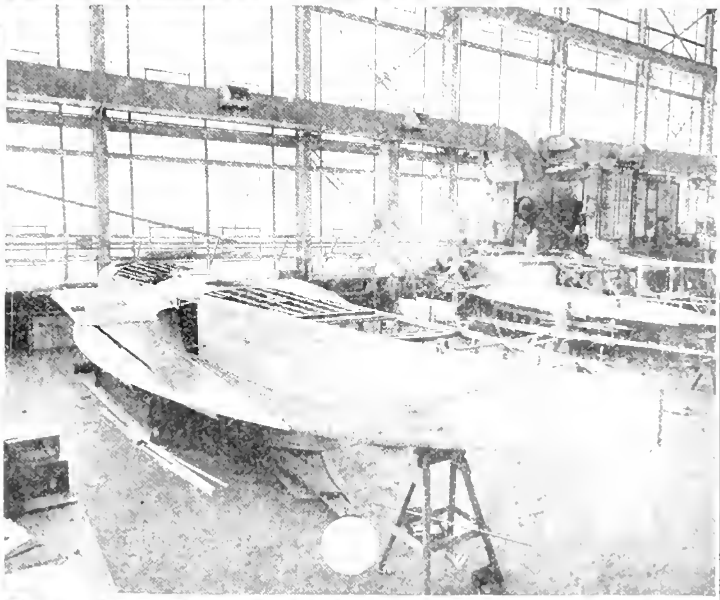


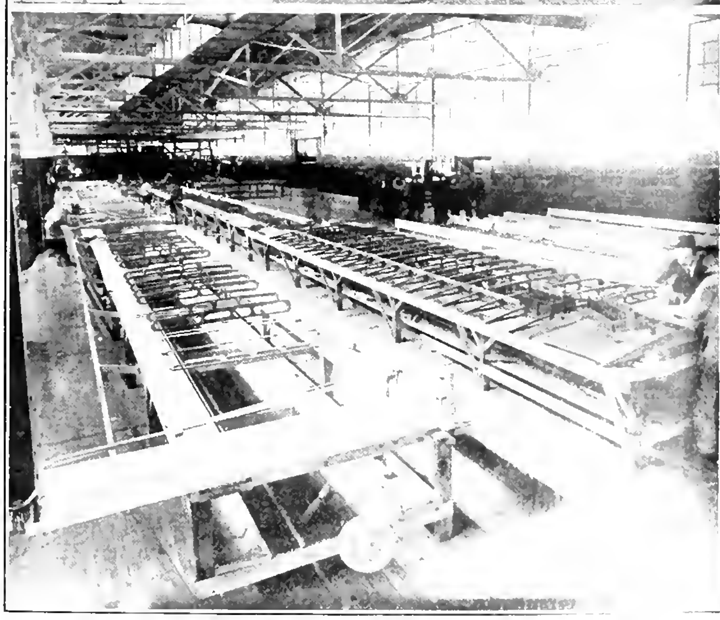
NAVAL AIRCRAFT FACTORY

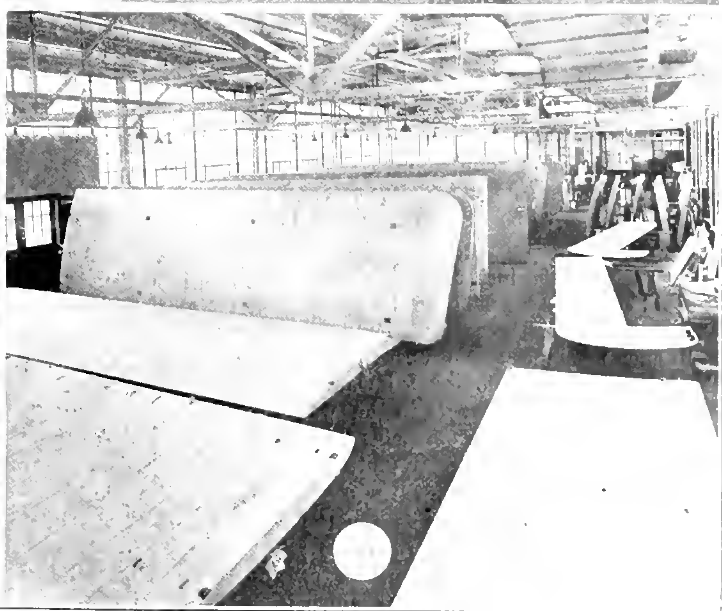
FIG. 3 ASSEMBLY AND HULL SHOP, PLANT NO. 1
FIG. 5 LUMBER MILL
FIG. 7 METAL SHOP

FIG. 4 SEAPLANE ON CRADLE
FIG. 6 TRAINING SCHOOL FOR GIRLS
FIG. 8 PANEL ASSEMBLY SHOP









NAVAL AIRCRAFT FACTORY

Fig. 9 Seaplane Afloat, Fully Loaded
Fig. 11 Propeller Shop
Fig. 13 Panel Shop

Fig. 10 Final Assembly, Plant No. 2
Fig. 12 Hull Assembly; also showing Humidifying Apparatus
Fig. 14 Dope Room for Panels

panels of all types. They then cover these parts with linen or cotton fabrics preparatory to their going to the dope room.

In the machine shop, women operate the drill presses, wrap, solder and splice wires and cables; and file and weld metal parts. In the pontoon department they help construct the wing floats; and in the boat shop they help in planking the hulls and perform small operations in hull and final assembly. Women are used to a great extent in the storerooms and tool cribs. They are used in drafting and operating the blueprint and photostat machines and also some testing machines in the engineering department.

It is interesting to note that the factory has three forewomen who have "made good" and accomplished much in expediting production.

The women work the same hours as the men, i.e., 49 hours a week, making a 9-hour day during the week and a half-day of 4 hours on Saturday. They are paid on an 8-hour basis and make time and a half for overtime and Sunday work. The factory is operated on the plan of equal pay for equal work and when a woman is able to equal the output of the men she receives the same pay. In most cases, however, the women have not yet had sufficient experience, or are not able physically to reach such an output and receive correspondingly less wages.

The working conditions are made as favorable as possible for the health and comfort of the women and particular attention was paid to this so that in spite of long hours and unusual exertion they might be able to hold their own during the period of the war with no bad post-bellum results. Necessarily the work is tedious and hard for many. They must rise early, commute long distances, walk a mile to the factory from the Navy Yard gate, and work nine hours. Nevertheless, they have done it faithfully and patriotically, making their contribution in this way to the great cause of freedom.

Contract Work

The great number of seaplanes to be constructed, and the early date set for their completion, made the building of them all in a single plant an impossibility. Not only was the time too short for the erection of the necessary buildings, but the matter of training the many workmen required would occasion a delay beyond the time allowed.

The full capacity of the Naval Aircraft Factory was therefore determined and every unit entering into the construction of hulls and wings that could be built in the plant was retained as its quota of the production program. It was decided to contract with such factories as were fitted to do the work for the balance of the program.

For this purpose, a new department was organized, termed the Contract Manufacturing Department, having as its function the distribution of work to sub-contractors. A conference between departments resulted in a schedule being compiled of all the seaplane elements which were in excess of the Aircraft capacity, such parts to be procured outside.

A careful survey was made of all plants capable of handling the work with the idea of giving each one the quantity of work it could complete by the time the entire program must be finished. Only such plants were considered as were equipped with the necessary machinery and positive assurance was required that the requisite number of skilled workmen was immediately available. By placing contracts in this way an economy in time and cost was made possible, as each plant became a specialist in the construction of its particular unit.

A number of well-equipped and reputable yacht-building concerns were awarded contracts for the construction of the boat hulls. Smaller boat shops, furniture and cabinet factories were awarded contracts for the building of panels (wings) and tail surfaces. The metal fittings, of which there are thousands, were awarded to shops equipped with modern automatic machinery and the necessary heat-treating apparatus. As previously stated, about 8000 people were engaged in the outside manufacture of these parts, which were shipped to the Aircraft Factory and there assembled.

The Engineering and Other Departments

A vital part in the successful production of the factory has been the large and well-organized Engineering Department under the direction of the Chief Engineer, Major G. R. Wadsworth of the Signal Corps. This is made up of the following divisions:

Experimental, comprising construction of new parts, material and types; assembly and erection; testing plane and engine performance and accessories.

Design, embodying inventions; experimental design; cost estimates; records and issues; production drafting, blueprinting, etc.

Specifications and Intelligence, covering technical data from periodicals and other sources; specifications of materials and processes; instruments, accessories, performance, etc.

Inspection, comprising inspection of materials at source; in stockroom; in process of manufacture; and inspection during erection, final acceptance test, and packing.

Testing, chemical and physical, metallurgical, strength of materials.

Trials of completed planes; besides several other divisions, such as *Engineering Service*, *Wood Technology* and *Photographic Work*.

The responsibilities resting on this department are very great because of the combination of strength and lightness required in aircraft, and the almost infinite care which must be exercised to secure both workability and safety. Skill in design and alertness in inspection are both vital. A staff of 125 inspectors is required for the work of inspection.

A department known as the Manufacturing Office receives the requirements of the Navy Department and accumulates all necessary data for the requisition of materials, issuance of orders to all factory departments and the scheduling of work and equipment. The clerical work of production is concentrated here to leave the executives of the manufacturing departments free for the closer supervision of actual production.

The Contract Manufacturing Department has the responsibility of keeping the large assembly plant going to capacity by supplying the component parts of the finished product for final assembly. The Supply Department uses every means of rapid transportation for the earliest possible delivery. In each of the subsidiary shops doing contract work is stationed a representative from the main factory who acts as branch manager and is responsible for results.

Standardized Seaplane

The standard seaplane manufactured at the Naval Aircraft Factory is of the flying-boat type, equipped with two Liberty motors and having a speed of 100 miles an hour and a cruising radius of 10 hours. It carries five men, four machine guns, four bombs, 500 gal. of gasoline, wireless and other equipment and weighs, with its crew, about 14,000 lb. The construction of the panels or wings, built up of a skeleton of spruce webs and piano-wire braces, is familiar to all. The webs are but 1/4 in. thick, cut out in the center and ends, and braced by small battens, less than 1/16 in. thick, which are stapled to them. Similar construction, but heavier, is followed in the boat. Tubular steel struts and tension wires reinforce the entire structure. Multiple-ply veneer less than 3/16 in. thick is used for planking. The prototype of this flying boat was the *America*, built for Mr. Rodman Wanamaker by the Curtiss Aeroplane Co. before the war for a transatlantic flight; the war broke out before the flight was attempted.

It is not the purpose of this article, however, to describe the details of construction of naval aircraft, nor to consider the intricate processes of manufacture; but rather to place on record a noteworthy accomplishment in industrial development for the prosecution of the war. The accompanying illustrations tell their story of the extent of the plant and of the volume and complexity of the work in process. L. G. F.

The first of a series of instructive bulletins on Employment Management has recently been issued by the United States Shipping Board, Emergency Fleet Corporation.

THE PATENT SITUATION IN THE UNITED STATES

AT the meeting of the New York Section held January 14, 1919, a paper was presented by Edwin J. Prindle, Mem.Am.Soc.M.E., on the Patent Situation in the United States which reviewed the recent movement to increase the efficiency of the Patent Office. Mr. Prindle is a member of the Patent Committee of the National Research Council appointed at the request of the Commissioner of Patents with the approval of the Secretary of the Interior, to investigate the Patent Office and the patent system, with a view to making recommendations for improvement in this department of the Government and in the patent system as a whole.

Since his paper was presented, the report rendered by his committee has been approved by the Commissioner of Patents, by the National Research Council and by the Engineering Council and has been released for publication. The substance of the report has been incorporated in what follows, with a preliminary explanation taken from the introductory portions of Mr. Prindle's paper. In connection with the report, it should be stated that three bills have been drafted to be presented to Congress during the early part of its next session, with the expectation of putting into effect the provisions of the report.

Introduction By Edwin J. Prindle

Various events make the patent situation in the United States of especial interest at this time. The exceedingly important part played by inventions in the war has shown the desirability of increasing the incentive to produce inventions. The intense competition which will come from the strivings of the debt-laden countries of Europe to rehabilitate themselves will result in every possible effort to stimulate their own inventors, and this will make it necessary that we see to it that our inventors have the fullest incentive consistent with a sound policy. A movement is already on foot, seeking to improve the efficiency of our Patent Office and patent system and which, directly and indirectly, will improve the inventor's position.

The present movement seeking to increase the efficiency of the Patent Office and of the patent system was started by the Society of Patent Office Examiners, at whose request the Commissioner of Patents, with the approval of the Secretary of the Interior, asked the National Research Council to appoint a committee for the purpose of investigating the Patent Office and patent system and making recommendations to those ends.

The reason for asking the National Research Council to undertake this work was that the Council is a body of such high scientific standing and so free from any suspicion of a bias or selfish interest in the subject that its recommendations would be likely to have the maximum weight with Congress for any legislation which should become necessary.

The National Research Council complied with the request and appointed a committee consisting of Dr. William F. Durand, Chairman; Drs. Leo H. Baekeland and M. I. Pupin, scientists and inventors; Drs. R. A. Millikan and S. W. Stratton, scientists; Dr. Reid Hunt, physician; and Messrs. Frederick P. Fish, Thomas Ewing and myself, patent lawyers. I was appointed as the representative of this Society. On the departure of Dr. Durand for Europe, Dr. Baekeland was appointed Acting Chairman of the committee.

This Patent Committee has made a report to the National Research Council, accompanied by carefully drafted bills ready to be introduced into Congress if the report is approved.

The United Engineering Society also appointed a Patent Committee for the same general purposes as that of the National Research Council and instructed it to coöperate with the Committee of the National Research Council and with committees of other technical societies organized for a kindred purpose.

Dr. David S. Jacobus and I were designated to represent The American Society of Mechanical Engineers on the Patent Committee of the United Engineering Society. The American Society of Civil Engineers is represented by Messrs. C. A. P. Turner and Leonard Metcalf; the American Society of Mining Engineers by Messrs. J. Parke Channing and Horace P. Winchell; and the American Society of Electrical Engineers by Messrs. Charles A. Terry and Frank N. Waterman. Mr. Terry is chairman of the committee.

REPORT OF PATENT COMMITTEE TO THE NATIONAL RESEARCH COUNCIL

THE Committee has concluded to propose a program consisting of but four features, because it believes those features are of such fundamental importance that their enactment into law would strengthen the entire system and directly and indirectly establish it upon a new and much more advantageous footing before Congress and the public; and because with a simple program, presenting comparatively little opportunity for difference of opinion as to the desirability of the changes proposed, there would be an unanimity of opinion in support of it which could not be obtained if the program were more extended.

A Single Court of Patent Appeals

The first proposal which your Committee recommends is the establishment of a single Court of Patent Appeals that will have jurisdiction of appeals in patent cases from all the United States District Courts throughout the country, in place of the nine independent Circuit Courts of Appeals in which appellate jurisdiction is now vested.

Until 1891 the Supreme Court of the United States was the appellate court in patent cases for all the lower courts. At that time the right of appeal to the Supreme Court in patent cases was taken away, and that Court now hears patent cases only upon writs of certiorari, which are never granted unless certain very unusual conditions exist.

The existence of nine appellate courts of concurrent jurisdiction in patent cases works serious hardships. While, theoretically, the law is the same in all of these courts, there has been an irresistible tendency to drift apart in the application of the law. It has even happened in a substantial number of cases that two of the appellate courts have taken a different view of one and the same patent. It is, of course, very important that the questions which always exist as to the validity and scope of a patent should be settled once and for all at the earliest possible date in the life of the patent, for, as a practical matter, 17 years (the term of a patent) is a comparatively short time in which to reduce the invention to a thoroughly commercial form, to prepare for its manufacture, and to introduce it upon the market, and it is usually necessary to determine the validity and scope of the patent in order to determine the amount of money which it is safe to invest in exploiting the invention. As things are now, whichever party succeeds in the first suit that is tried on the patent, the other party is very likely to feel that in a second trial before another court he might have better luck. He, therefore, is inclined to insist upon a second litigation. Meantime, he advertises that the questions involved were not settled in the first case. This means uncertainty on the part of the owners of the patent as to their rights and uncertainty on the part of the public as to its rights to use the invention or to determine what it must avoid in working in the same field—a really intolerable situation.

Moreover, we shall never have a uniform and definite patent law, consistently applied, until we have a single Court of Patent Appeals independent of local sentiment, realizing a responsibility to fix the principles of the law and enforcing an harmonious application of these principles on the lower courts. It would be of the utmost value to those in the United States who are engaged in industry if the present confused condition could be corrected and a single tribunal created to devote itself to crystallizing the fundamentals of the patent law and to educating the courts throughout the land to uniformity in applying these principles in special cases.

The increased expense due to such a court would be small. The aggregate amount of work to be done by the Judges of the United States Courts as a whole would not be changed to any substantial extent, because all appeals must now be heard by the present courts and Judges and, if there were a single Court of Patent Appeals, the Courts of Appeal in the nine circuits would be relieved of just as many appeals as were heard by it. The Judges in some of the circuits are much overworked, but this is not true of many of the circuits. The Chief Justice of the United States Supreme Court, in selecting these Judges, could, if he chose, take into account the work of the different circuits and whether one circuit or another could best spare a Judge.

As the law now stands, Judges from one circuit may be called upon, and not infrequently are called upon, to go into other circuits which are short-handed. In this way, any undue pressure upon the Judges in any particular circuit, by reason of the loss of any single Judge who went to the Court of Patent Appeals for six years, could be relieved.

A further advantage is that a single Court of Patent Appeals would see clearly where there were defects in the statute and in the conditions and practice in the Patent Office, and could speak with authority on all matters which affect the theory and practical working of the patent system.

The Patent Office a Separate Institution, and Independent of the Department of the Interior

The second proposal which your Committee recommends is that the Patent Office be made a separate institution, independent of the Interior or any other department.

The Patent Office was originally in the State Department, but, on the formation of the Interior Department in 1849, it was made a bureau of that Department and has been so ever since.

The only matters connected with the Patent Office with which the Secretary of the Interior has anything to do are the following: The Secretary of the Interior must submit to Congress all estimates for appropriations. All appointments, excepting those of the Commissioner, two Assistant-Commissioners, and five Examiners-in-Chief, are made by the Secretary but only on the recommendation of the Commissioner. The eight places named are Presidential appointments, but the Secretary makes recommendations to the President. All matters of disbarment or reinstatement after disbarment of attorneys are passed upon finally by the Secretary. All matters of discipline are under the Secretary's jurisdiction. The Secretary of the Interior must approve all changes in the Rules of Practice of the Patent Office, but he cannot compel the commissioner to make any change whatsoever.

No appeal lies to the Secretary from any decisions of the Commissioner, either in matters of merit or practice. All such matters, as far as they are reviewable, rest with the courts of the District of Columbia.

The Secretary of the Interior no longer signs the patents, and has no jurisdiction to grant or refuse them.

Thus it will be seen that the Secretary of the Interior is not required to know anything about patents or patent law. He is not selected because of any qualifications for the granting of patents or supervision over the Patent Office. The Secretary of the Interior has less influence over the Patent Office than over any other bureau of the Interior Department, because there are appeals to him from all the other bureaus. Nor is the Patent Office related to any other bureau of the Interior Department.

The Secretary of the Interior has recently moved out of the Patent Office building, thus severing physical contact with the Patent Office, which is but a type of the lack of mental contact between the office of the Secretary of the Interior and the Patent Office.

The experience of many Commissioners over a period of several generations has shown that, no matter how pleasant the personal relations may be, the Commissioner of Patents cannot expect any real benefit to the Patent Office to flow from its connections with the Interior Department. There is nothing in common between the interests of the Interior Department and those of the Patent Office, and, consequently, nothing to produce any advantage from the amalgamation of the Patent Office into the Interior Department.

Your Committee believes that to make the Patent Office an independent bureau would greatly increase the respect of the public and Congress and the courts for it, and would make it easier to procure enlarged appropriations and better salaries than under present conditions.

As to appropriations, under present conditions the demands of the Patent Office for equipment, personnel and salaries are necessarily subjected to comparison both by the Secretary of the Interior and by Congress with those of several other unrelated bureaus, each pressing its own demands and criticising any apparent preference. In the opinion of your Committee, this operates as a severe handicap. In estimating the needs of the Patent Office, there should be no discussion of the demands, for example, of the Pension Office or the General Land Office. As an independent institution, the needs of the Patent Office would be judged on their necessity and the appropriations be determined by considerations of general policy.

As to personnel: The enhanced dignity and independence of the Patent Office would render all positions of importance in it more attractive, and particularly would make it easier to secure and retain in office men of the necessary qualifications to fill the difficult office of Commissioner.

Increase in Force and Salaries of the Patent Office

The third proposal which your Committee recommends is a substantial increase in the force and salaries of the Patent Office. The patents granted by the United States Patent Office are of less average probable validity than formerly, because the number of applications for patents and the field of search are constantly increasing, while the examining force for many years has been insufficiently large and has not been increased proportionately. The inducements are so unattractive that 25 per cent of the examining force has resigned within the past three years. Your Committee finds that the Patent Office is suffering both from lack of examiners and from inadequate compensation.

The salaries of the Patent Office examiners have been increased only 10 per cent since they were fixed in 1848, when they were approximately the same as those of members of Congress. At the time the salaries of the Examiners-in-Chief were fixed, they were the same as those of Federal District Judges. During the past 70 years, the compensation for technical service in almost all other directions has been increased very largely. Congress, in creating new positions, is willing to pay technical men salaries more nearly approximating the usual compensation of such men in private service, but, having started a position at a given salary, is very loath to increase the salary. A Principal Examiner, to pass the entrance examination for the Patent Office, must himself have an education equivalent to that of a college graduate, and yet his salary is so low ($2700 a year) that it is practically impossible for him to give his own sons a college education.

Your Committee believes that salaries should be paid to the examiners proportionate to those paid for equally high technical work in other departments created recently; such, for example, as are paid in the Army and Navy and in the office of the Attorney General. The examiners are passing upon questions often involving millions of dollars, and they cannot be at their best in this vitally important work unless their salaries are large enough for them to live comfortably and without strain. The chances of making mistakes in the granting of patents are great enough even under the most favorable circumstances, and they should not be increased by compelling the examiners to work for inadequate salaries. The inducements should be such as to present compensation and a career which would attract and hold men of the highest ability. The payment of adequate salaries and the creation of provisions tending to hold out attractive prospects to the examiners would also tend to raise the dignity of the Patent Office and to increase its standing in the estimation of the public and of Congress and the courts, and so would tend to enhance the value to the public of the patent system.

The work of the Patent Office has grown so much more rapidly than has the examining force that the examination to determine whether or not the invention claimed in an application for patent is novel is imperatively restricted to the field of search where it is most likely that the invention will be found. Many patents are granted which would not be granted if the examiner had time to make a thorough search. One of the Assistant-Commissioners of Patents is compelled to devote a large amount of his time to speeding the work of the examiners in order to prevent further falling behind in the number of unexamined cases. Money is often invested on the strength of patents, only to find later that the patent is upset in the courts, because the Patent Office search did not go far enough to discover that the invention had already been disclosed in some earlier patent or publication. The granting of a patent with invalid claims or claims which are too broad or which are nebulous is a menace to the art to which it relates, and until such a patent has been adjudicated and its effect judicially determined, it tends to prevent manufacturing and commerce in that art. Such a patent may, in this way, cost the public many millions of dollars beside the cost of establishing its invalidity or its true breadth or meaning by litigation, and the prevention of the granting of such patents by any reasonable increase in the examining force of the Patent Office would, in many cases, be a very large saving. The inducement to inventors and investors in patents is consequently lessened, the standing of patents before the courts and the public is impaired, and the production of inventions discouraged.

Your Committee accordingly recommends a substantial increase in the salaries of the Patent Office officials, and in the number and salaries of the examiners, as provided in the draft of a bill for that purpose.

While your Committee believes the Patent Office so fully justifies its existence that it would be an exceedingly profitable investment, even though all expenses were paid from the public income, the Patent Office has always been self-supporting and the increase in salaries and examining force which the Committee recommends can easily be entirely taken care of by the Patent Office income, if necessary.

Compensation for Infringement of Patents

While an injunction can ordinarily be obtained against an infringer in a case where a patent is adjudged valid, except where it would interfere with Government work, a money recovery has not heretofore been generally possible except under most favorable circumstances. In a case where it cannot be said that the entire salability of the article depends upon the invention, it has been necessary to show just how much of the price of the article is attributable to the invention, and as it is ordinarily impossible to make such a separation, and as most patent cases are ones in which it cannot be said that the whole salability of the article depended upon the invention, it has resulted that recovery of money is seldom obtained in a patent suit.

Recently there have been two or three decisions in which the courts have taken a more liberal attitude, holding in effect that where an invention has been used by an infringer a reasonable royalty may be awarded to the patentee based on a mere estimation or on opinion evidence, even though no exact computation can be made. This is analogous to the attitude of the courts in personal injury cases and is entirely just and reasonable. While, as stated, there have been two or three decisions to this effect, it may take a generation to induce United States courts generally to adopt this position, if at all, and the Committee therefore proposes that the law be amended to provide, that as damages to the complainant, the court, on due proceedings had, may adjudge and decree to the owner payment of a reasonable royalty or other form of general damages. Such an amendment has been provided in the bill amending Section 4921, the Revised Statutes of the United States, and reading as follows:

"If proof is not offered or, in the absence of adequate proof of the amount that should be awarded as damages or profits, the court, on due proceedings had, may adjudge and decree to the owner payment of a reasonable royalty or other form of general damages."

This proposed amendment would enable the patentee in all suits where the patent has been found valid and infringed to recover at least a reasonable royalty, and would provide a money recovery in the great majority of patent suits where no recovery would otherwise be possible. The Committee believes that the comparative certainty of financial return would answer one of the most common and strongest reproaches against the patent system, namely,—that a patent does not ordinarily pay the inventor any money, and it believes that the incentive to invent would accordingly be greatly increased.

There are some cases in which it seems to many who are familiar with such matters as though the courts were inclined to go to the other extreme and award damages out of all proportion. Where a complainant has shown that profits have been made by the use of an article patented as an entirety, the infringer is liable for all the profits unless he can show—and the burden of proof is on him to show—that a portion of them is a result of some other invention used by him. If the infringer cannot show what proportion of the profits is due to such other invention, then all his profits must go to the complainant. Any rule by which the entire profits are given to a patentee in the absence of proof that they are all due to the invention of the patent sued upon, is unfortunate and sometimes very unjust. The proposed amendment to the statute would permit a court under these circumstances to do substantial justice even though it could not be mathematically exact. In other words, the amendment to the statute would enable a court to avoid awarding either too much or too little.

Conclusion

Your Committee, believing that the American Patent System is vitally useful in our system of Government, therefore recommends that the reforms herein discussed be enacted into law.

Your Committee also recommends that this report be approved by the National Research Council and that the Committee be continued for the purpose of arousing and coördinating interest in and support for the necessary legislation of various national societies, manufacturing interests, bar associations and other elements of the public.

Respectfully submitted,

L. H. Baekeland, *Acting Chairman*
William F. Durand, *Chairman* (absent in France)
M. I. Pupin
R. A. Millikan
S. W. Stratton (see reservation below)
Reid Hunt
Frederick P. Fish (see reservation below)
Thomas Ewing
Edwin J. Prindle

Approved by James T. Newton, *Commissioner of Patents*; by the National Research Council; and the Engineering Council. (See reservation in the Addendum, page 199.)

The reservation indicated above by Dr. Stratton is in respect to the establishment of the Patent Office as a separate Government institution. He is not convinced that this would be the best thing to do, since in general it is best for all Government establishments to be represented in the Cabinet.

The reservation by Mr. Fish calls for the omission of the words "if proof is not offered, or" in that portion of proposed Amendment to Section 4921 of the U. S. Statutes which deals with damages and profits, so that the sentence will read as follows: "In the absence of adequate proof of the amount that should be awarded as damages or profits, the Court, on due proceedings had, may adjudge and decree to the owner payment of a reasonable royalty or other form of general damages." He believes that no statute should directly or indirectly contemplate a condition in litigation in which "proof is not offered" and that the courts in applying the clause would be embarrased if the phrase "if proof is not offered" were in the statute.

(Concluded on page 199)

A NEW THEORY OF THE STEAM TURBINE[1]

By HAROLD MEDWAY MARTIN

(From articles published in *Engineering*)

IN THE investigation of the performance of steam turbines some notable discrepancies between theory and apparent practice were discovered, one of these being that under certain conditions the weight of steam discharged from a nozzle was actually greater than what was physically possible according to the then accepted theory. At first it was attributed to the moisture in the steam, but this explanation was discarded when it was found that to bring this theory into accord with experiment would involves the presence of anywhere between 10 and 20 per cent of moisture in the steam. Later on this anomaly was attributed to a fundamental error in the then accepted theory of the efflux of steam; namely, that the expansion of wet steam did not proceed under conditions of thermal equilibrium as was previously assumed.

The present theory is based on an assumption claimed to be proved by actual experience with steam turbines: namely, that not only is steam not in thermal equilibrium in the "saturated field" of the Mollier diagram, but it is never in thermal equilibrium until the condenser is attained. The relation between volume and pressure during the expansion of wet steam is accordingly never the same as if a state of thermal equilibrium were established.

In opening a turbine it is easy to see the difference in the appearance of the blading which has been exposed only to superheated steam and that which, on the ordinary theory, has been subjected to the action of wet steam. In the region where the steam was supersaturated a film of moisture is deposited on the blading and it is this very phenomenon that for a long time interfered with the detection of undercooling in steam turbines and steam engines. In any attempt to take the temperature of the steam by means of a thermometer a film of moisture was immediately deposited on the bulb or on the exterior of the thermometer pocket if the steam were supersaturated, and the thermometer recorded the temperature of this film and not that the surrounding vapor. Hence, for many years it has been noted that the temperature of the steam as indicated by a thermometer placed in a turbine exhaust pipe was sensibly below that corresponding to its pressure. These low readings are all the more remarkable in that experiment has shown that when a thermoscope is immersed in a current of permanent gas it tends to give too high a reading, owing to adiabatic compression of the fluid against the obstacle.

The writer mentions a possible objection against the idea that there is any large degree of undercooling in the turbine exhaust, viz., the fact that in experiments with a nozzle discharging into open air Dr. Stodola showed that once condensation commenced it proceeded with extreme rapidity. However, he calls attention to the fact that the occurrence of condensation or even its completion does not necessarily imply the simultaneous establishment of thermal equilibrium. In fact, there is evidence in favor of the view that there is a sensible lag between the two.

In the experiments of Stodola the droplets observed by him in his jets of undercooled steam were formed in a period of time of the order of one ten-thousandth of a second, while the time occupied by steam in flowing through the low-pressure end of a turbine is some hundred times as great. Were it not for the lag between condensation and thermal equilibrium, it is difficult to see how these droplets could be built up with such rapidity. Each molecule as it condenses liberates energy sufficient to raise its own temperature by some 500 or 600 deg. cent. and were this energy immediately and wholly transformed into heat, it is difficult to see how the temperature of the surface could be kept low enough to permit of the building up by further condensation of the droplets observed by Dr. Stodola.

The writer also brings forward the following interesting reasoning to prove that the instantaneous conversion into heat of the energy liberated on condensation is unlikely. He claims that the forces responsible for the attraction between the molecules of the same substances to which the phenomenon of liquefaction is due, are essentially of the same nature as the forces holding together a chemical compound, i.e., electrical. There are thus good grounds for believing that the energy liberated on the condensation of a vapor is at the outset represented by electrical disturbances and is only somewhat gradually converted into the form of heat. In support of this view he cites the paper of Wilson in the *Philosophical Transactions* for 1897, where the latter states that if the expansion of dust-free vapor was just sufficient to produce condensation the number of droplets formed was of the order of 10^8 per cu. cm., but that this number increased very rapidly if the range of expansion was increased. This affords direct proof that the additional condensation took on new nuclei and the temperature of the vapor must accordingly have been far below the equilibrium value during the whole range of expansion. The time taken for the expansion in Wilson's experiments was estimated at something over 1/50 of a second and was thus of the same order as the total time taken for steam to pass completely through a modern steam turbine, the inference being that the steam as finally discharged from such a turbine is used in a greatly undercooled and supersaturated condition.

The writer in the present paper attempts to show that if his interpretation of Wilson's results be accepted i. e., that the expansion continues with the vapor temperature far below that which would be indicated by any thermometer immersed in it), both superheat and vacuum corrections can be rationalized, while a contrary view involves wide discrepancies between theory and practice.

It is a well-known fact that in steam-turbine practice the gain made by the use of superheated instead of saturated steam is substantially more than is thermodynamically due. This was shown quite conclusively by Baumann in a paper read before the Institution of Electrical Engineers (British) in 1912. Last year an extended set of correction tables drawn up by C. H. Naylor was issued under the auspices of the British Electrical and Allied Manufacturers' Association. From these figures, combined with the heat-drop tables issued by the same association, the present author secured the following figures of relative consumptions under certain standard conditions:

TABLE 1

Superheat, deg. fahr.	0	50	100	150	200	250	300
Relative consumption	1 160	1 101	1 046	1 000	0.9592	0 9235	0 8909

From these figures and other data it would seem that the saving due to a superheat of 150 deg. fahr. is reckoned at 16 per cent instead of at 15 per cent as in Baumann's paper in 1912. This may be due to the improvement effected during recent years in average turbine efficiency, since, as the writer claims, with any given type of turbine the relative gain from using superheat should increase somewhat with the efficiency of the turbine. This is the reverse of the opinion generally held.

From this the writer proceeds to the consideration of the discrepancies between the gains and losses. To do this he takes for purposes of comparison the condition of the steam, not as supplied to the stop valve but after passing through the governor valve. In addition, the discrepancies are made larger by the fact that the ratio of blade speed to steam speed is, on the average, less the greater the amount of available heat. Furthermore, the

[1] Abstract of an important paper which appeared serially in the latter part of 1918 in *Engineering* (London). While the first installments were reported in THE JOURNAL for September, October and November 1918, it has nevertheless been deemed desirable to present in one issue a conjoint abstract of the entire investigation. Because of the lack of space one section of considerable interest abstracted in the September issue has been omitted here. This refers to the modified Callendar steam table and directions for using it.

heat which becomes available in a steam turbine differs from the adiabatic heat drop and is, in general, considerably larger. The ratio of the two, known as the reheat factor, forms the subject of an important discussion by the writer, who claims that it is substantially greater for superheated than for saturated steam when the latter is assumed to be in thermal equilibrium throughout the whole of its expansion.

Suppose a turbine to consist of an infinite number of stages. At each stage a certain portion of the total energy of the steam is converted into kinetic energy, of which a part is expended in doing useful work on the shaft, and the remainder, which is wasted in friction, is restored to the expanding steam in the form of heat; the consequence is that at each stage the pressure corresponding to a given volume of the steam is somewhat greater than it would be did the turbine work friction-free. Whether steam be used to actuate a turbine or a reciprocating engine the amount of work done down to any stage of the expansion can be represented by an ideal indicator diagram such as is shown in Fig. 1. In this the expansion line BD is that corresponding to frictionless working or to unit efficiency, while BE represents the expansion line for a turbine working with a hydraulic efficiency η. The total area of the diagram is in this case larger than before, because the energy wasted in friction, being returned to the steam as heat, makes the volume at every point of the stroke more than if unit efficiency were attained. On this larger diagram, however, only the fraction η is recovered as useful work on the shaft, whereas in the ideal case of unit efficiency the useful work done is represented by the whole of the area $ABDC$. In all cases $\eta \times ABEC$ is less than $ABDC$.

The efficiency ratio ε of the turbine is equal to the actual work done divided by that theoretically due from a perfect turbine, or

$$\varepsilon = \eta \frac{ABEC}{ABDC}$$

and the reheat factor R is defined by the relation

$$R = \frac{ABEC}{ABDC}$$

so that $\varepsilon = \eta R$, where η is known as the hydraulic efficiency of the turbine.

The actual thermodynamic head under which any turbine works is therefore not represented by the adiabatic heat drop u, but by a larger quantity U, where $U = Ru$.

From this the writer proceeds to show how to determine the value of the reheat factor corresponding to different values of the hydraulic efficiency of the turbine and comes to the expression

$$R = \frac{1}{\eta} \cdot \frac{1 - \left(\frac{1}{x}\right)^{\eta[1-(1/\gamma)]}}{1 - \left(\frac{1}{x}\right)^{[1-(1/\gamma)]}}$$

where η is the hydraulic efficiency of the turbine and x the ratio of the initial to the final pressure. From this he derives the values of the reheat factor for superheated steam throughout the whole range of its expansion for the various hydraulic efficiencies given in Table 2.

In other words, the efficiency ratio of a turbine is defined as the product of its hydraulic efficiency and the reheat factor.

In view of its use elsewhere in this discussion attention is called to the following expression for λ:

$$\lambda = \frac{1 + \frac{1}{\gamma - 1}}{\frac{1}{\gamma - 1} + k}$$

where γ is the index when the expansion is adiabatic.

Among other things the writer calls attention to the paradox following from the above expression for the reheat factor R. If the expansion be carried far enough, the efficiency ratio is independent of the hydraulic efficiency which can be shown by making $x = \infty$. Since then the efficiency ratio is equal to $R\eta$, its value is always unity if the expansion be carried to zero pressure. The following physical explanation is given: To reduce the final pressure to zero we must go down to the absolute zero of temperature. In deducing the value of R it was assumed that all the heat energy not expended in doing useful work was restored to the fluid in the form of heat. At the absolute zero of temperature the working fluid retains no heat energy and the latter has accordingly all been turned into useful work and the efficiency ratio is unity, however great the frictional losses may have been at each stage of the turbine.

The writer points out that the error in reheat factors for wet or saturated steam is considerable, because for the adiabatic expansion of such steam in thermal equilibrium the expression of the form pV^n = constant (where $n = \gamma$), is only moderately accurate. In such a case the reheat factor may be determined in

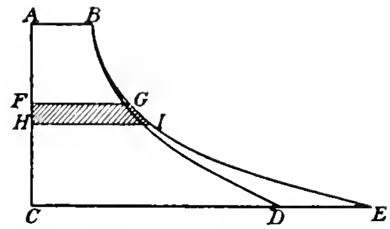


FIG. 1 IDEAL INDICATOR DIAGRAM FOR STEAM TURBINE

another way, published in *Engineering* several years ago. The writer repeats the argument presented there and gives a table

TABLE 2 REHEAT FACTOR FOR STEAM SUPERHEATED THROUGHOUT THE WHOLE RANGE OF ITS EXPANSION

Values of $x = \frac{p^0}{p^1}$	Hydraulic Efficiency η			
	0.5	0.6	0.7	0.8
1	1.0000	1.0000	1.0000	1.0000
2	1.0393	1.0312	1.0235	1 0160
4	1.0753	1.0629	1.0463	1.0310
6	1.1033	1.0809	1.0602	1 0397
8	1.1195	1.0934	1.0695	1 0454
10	1.1310	1.1024	1.0762	1.0494
15	1.1554	1.1209	1.0891	1.0585
20	1.1691	1.1313	1.0964	1.0617
25	1.1841	1 1445	1.1057	1.0692
50	1.2219	1.1718	1.1253	1.0810
100	1.2586	1.1998	1.1450	1.0932
200	1.2962	1.2279	1.1643	1.1053

showing the value of reheat factor for steam unusually dry and expanding in thermal equilibrium throughout, that is to say, with no undercooling, a condition which is, however, not realized either in a steam turbine or in a reciprocating engine. These values are given in Table 3.

The writer makes the following comparison of Tables 2 and 3. Suppose a steam turbine designed to give a hydraulic efficiency of 0.7 for the range of expansion of from 200 lb. absolute down to 1 lb. absolute. Then if the steam supply is saturated and the expansion takes place in thermal equilibrium throughout, its thermodynamic efficiency ratio will, from Table 3, be $0.7 \times 1.0559 = 0.739$ nearly. If, on the other hand, the turbine is designed to give the same hydraulic efficiency with steam supplied at 200 lb. and superheated to such an extent that the superheat is not lost when the exhaust port is reached, the efficiency ratio will be $0.7 \times 1.1643 = 0.815$ nearly. Hence, with the same hydraulic efficiency the thermodynamic efficiency ratio will be fully 10 per cent more with superheated than with saturated steam expanding in thermal equilibrium.

It will be obvious, therefore, that the adiabatic heat drop forms a somewhat fallacious foundation for estimating the saving to be effected by superheating the steam.

The writer shows next how to determine the point at which different degrees of initial superheat are lost. Assume for example that the initial pressure is 180 lb. absolute and that the

hydraulic efficiency of the turbine is 70 per cent. Suppose the superheat to be lost at, say, 80 deg. cent. The volume of the steam

TABLE 3 REHEAT FACTORS R FOR STEAM INITIALLY IN THE DRY BUT SATURATED CONDITION, AND EXPANDED FROM DIFFERENT INITIAL PRESSURES DOWN TO 1 LB. ABSOLUTE, THERMAL EQUILIBRIUM BEING MAINTAINED THROUGHOUT THE EXPANSION

Abs. Initial Pressure, lb. per sq. in.	Abs. Final Pressure, lb. per sq. in.	Hydraulic Efficiency η				
		0.5	0.6	0.7	0.8	0.9
2	1	1.0085	1.0078	1.0065	1.0046	1.0022
4	1	1.0191	1.0163	1.0129	1.0089	1.0043
6	1	1.0284	1.0217	1.0169	1.0114	1.0056
8	1	1.0316	1.0256	1.0195	1.0130	1.0062
10	1	1.0355	1.0290	1.0221	1.0148	1.0071
15	1	1.0435	1.0348	1.0264	1.0181	1.0078
20	1	1.0496	1.0394	1.0294	1.0191	1.0088
25	1	1.0537	1.0427	1.0318	1.0210	1.0104
50	1	1.0669	1.0531	1.0394	1.0261	1.0129
100	1	1.0809	1.0640	1.0475	1.0313	1.0155
200	1	1.0956	1.0755	1.0559	1.0368	1.0162

is then 54.596 cu. ft. per lb. (Callendar) and its pressure is 6.8627 lb. per sq. in.

The initial pressure being 180 lb. absolute, we have

$$x = \frac{p_1}{p_2} = \frac{180}{6.8627}$$

If ρ be the ratio of the final volume to the initial volume then, since the expansion follows the law $pV^m =$ constant (where $m = \lambda$), we have $\rho = x^1/^m$

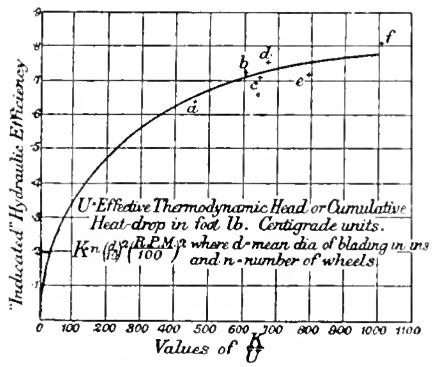


FIG. 2 "INDICATED" HYDRAULIC EFFICIENCY OF IMPULSE TURBINES IF STEAM EXPANDS IN THERMAL EQUILIBRIUM THROUGHOUT

The value of $1/m$ is given (*Engineering*, July 19, p. 53) by the relation

$$\frac{1}{\lambda} = 1 - 0.23077\,\eta = 1 - 0.23077 \times 0.7 = 0.8385$$

Whence

$$\rho = \left[\frac{180}{6.8627}\right]^{0.8385} \quad \text{and} \quad V_1 = \frac{V}{\rho} = 3.528 \text{ cu. ft. per lb.}$$

Reference to Callendar's table shows that steam at 180 lb. absolute with this specific volume has a temperature of 331.6 deg. cent., corresponding to a superheat of 142.1 deg. cent. or 255.8 deg. fahr. By determining a number of values in this way and plotting the results as curves, the temperature at which any stated initial superheat is lost can be determined. The writer gives a table showing the approximate centigrade temperatures at which superheat is lost for different hydraulic efficiencies when the initial pressure is 180 lb. absolute. With the temperatures given in such a table it is possible to calculate the total effective thermodynamic head, or, to use Professor Goudie's term, the "cumulative heat" which becomes available in a turbine when expanding steam from 180 lb. absolute to 1 lb. absolute with different hydraulic efficiencies, the steam being supposed to be in thermal equilibrium throughout. The writer gives a table of cumulative available heats when steam expands in thermal equilibrium from an initial absolute pressure of 180 lb. per sq. in. to 1 lb. absolute with different hydraulic efficiencies and different initial superheats. This table is here reproduced as Table 4. To determine from this table the theoretical steam rate for a turbine working with different superheats a correction is required because increases in the effective thermodynamic head change the ratio of blade speed to steam speed.

This correction can be effected by means of the curve plotted in Fig. 2 on the assumption that thermal equilibrium was maintained throughout the whole expansion. In this curve the "indicated" hydraulic efficiency of a number of impulse turbines is plotted against K/U, where

$$K = n\left(\frac{d}{10}\right)^2\left(\frac{\text{R.P.M.}}{100}\right)^2$$

and U denotes Ru, where u is the adiabatic heat drop. In the above expression for K the number of stages is represented by n, while d denotes the mean diameter of the blading. Since the average velocity of the steam is proportional to $\sqrt{(U/n)}$, the expression $\sqrt{(K/U)}$ is proportional to the ratio of blade speed to steam speed. According to the ordinary view the indicated hydraulic efficiency should give a parabola when plotted against $\sqrt{(K/U)}$, and consequently the curve in Fig. 2 should be an ellipse. The points lie badly on an ellipse, however, and the curve shown has been sketched in freehand. As will be shown later, a much better agreement between the curve and the experimental figures is obtained when the theory that the steam expands in thermal equilibrium is abandoned.

TABLE 4 CUMULATIVE AVAILABLE HEATS F. P. C. WHEN STEAM EXPANDS IN THERMAL EQUILIBRIUM FROM AN INITIAL ABSOLUTE PRESSURE OF 180 LB. PER SQ. IN. TO 1 LB. ABSOLUTE; WITH DIFFERENT HYDRAULIC EFFICIENCIES AND DIFFERENT INITIAL SUPERHEATS

Hydraulic Efficiency η	Initial Superheats, Deg. Fahr.						
	0	50	100	150	200	250	300
0.5	201.3	207.2	216.2	226.9	238.9	251.1	262.4
0.6	197.4	203.5	210.3	219.4	229.6	240.4	251.4
0.7	194.1	199.2	206.7	214.2	222.6	232.9	241.3
0.8	190.7	196.3	202.5	209.3	216.9	228.5	233.6
1.0	184.1	189.5	195.4	201.7	208.2	215.0	222.0

The writer proceeds to a discussion of the results in this case and compares them with the data on Baumann's correction curves. Altogether it is found that consumption with saturated steam, assuming that the expansion takes place in thermal equilibrium, should be 1.077 times as much as with steam superheated to 150 deg. fahr., but from a table given in the original article it appears that the actual consumption of superheated steam is 1.163 times as much, which would indicate that the known values of the superheat corrections are inconsistent with the hypothesis that the expansion of wet steam takes place in conditions of thermal equilibrium.

It might be said that this discrepancy is due to the higher frictional resistance which wet steam meets, but this is at variance with an observation made by Osborne Reynolds to the effect that when the motion of fluid is such that resistance is as the square of the velocity, the magnitude of this resistance is sensibly quite independent of the character of the fluid in all respects except that of density. This view has received ample experimental confirmation, for instance, in the work of Prof. C. H. Lees. This viscosity has only a small influence on the flow phenomena and it does not appear that any material difference can be due, as far as fluid friction is concerned, to water steam if superheated or wet.

While it has been known for a long time that the assumption that wet steam was in thermal equilibrium throughout the whole of its expansion is erroneous, opinions have differed as to the importance of the consequent loss from undercooling. The most

general opinion has been that once the supersaturated steam began to condense, thermal equilibrium was practically instantaneously restored and was maintained during any specimen expansion. The writer attempts to prove that this theory does not explain the observed values of the superheat corrections.

The fact that nozzles fed with wet steam discharge a greater weight than can be accounted for on the ordinary theory has been traced to supersaturation of the steam as it passes the nozzle throat, a fact which has been confirmed experimentally by Dr. Stodola.

In this connection, it is mentioned that in Stodola's tests where ordinary boiler steam was led directly to the nozzle a cloud of spray was visible close up to the nozzle discharge, but the pressure of a spray does not necessarily prove the absence of undercooling. In the first place, it is known by experiment that a nozzle will pass a greater weight of ordinary boiler steam than would be possible with undercooling absent. Further, the drops of water present cannot cool quickly even to serve as nuclei of condensation. Professor Callendar has obtained evidence of undercooling in the cylinder of an ordinary reciprocating engine where the rate of expansion is very much slower than in a turbine, a fact confirmed by other observations cited by the writer. In this connection the writer cites Lord Kelvin's theory of evaporation of drops, one of the conclusions of which is that in no case can a drop of pure water be in equilibrium with steam of the same temperature, and the fact the droplets are observed to proceed even in the mist of superheated steam is due to the fact that such drops are not drops of pure water, but have arisen from priming containing dissolved salts and thus have a lower vapor pressure than pure water.

An interesting calculation is given showing conditions in which a drop of pure water is in equilibrium with its surroundings. The final equation is

$$\log_e \frac{p}{p_s} = \frac{1}{R\,T} \cdot \frac{2\sigma}{r} \ldots\ldots\ldots\ldots\ldots\ldots [1]$$

where p denotes the pressure in equilibrium with the drop of radius r and p_s the saturation pressure due to the temperature of the drop, σ the surface tension of the film expressed in dynes per cm., T the absolute temperature in degrees centigrade and R the constant in the ordinary gas equation. From experiments (C. T. R. Wilson) on dust-free but saturated air Callendar deduces that r is equal to 5×10^{-8} cm. This quantity is of molecular dimensions, and it is natural to conclude that the nuclei involved are the double or co-aggregated molecules which are known to exist in steam, and in truly stupendous numbers, presenting in the aggregate an enormous surface. It is not suggested that these co-aggregated molecules are actually spherical in form, but merely that considered as nuclei they are equivalent to spheres of the radius stated.

In the present connection, however, the important fact is that r is constant, so that Equation [1] may be written as

$$\log_{10} \frac{p}{p_s} = \frac{3.75\,\sigma}{T}$$

and the writer gives rather complicated formulæ for σ. Table 5 gives the values of p/p_s for different temperatures.

Table 5 shows that if steam is expanded until a temperature falls, say, to 40 deg. cent., there will be no condensation of steam unless the pressure is 6.987 times that of a saturated steam at the same temperature. This fact is sometimes expressed by the statement that the density of supersaturated steam when on the verge of condensing at 40 deg. cent. is about 7.5 times as much as it ought to be, which is misleading as it is apt to convey the impression that the specific volume of supersaturated steam is inly 1/7.5 of what it would be had expansion taken place in conditions of thermal equilibrium, which is not true. Actually at 40 deg. saturated steam has a pressure of 1.0703 lb. per sq. in., and therefore no condensation will occur unless the pressure of the steam exceeds $6.787 \times 1.0703 = 7.478$ lb. per sq. in.

From the values of p/p_s in Table 5 one can find the pressure at which supersaturated steam at different temperatures condenses, and from Callendar's equations he can then get both the corresponding volume of the steam before the condensation occurs and also its total heat, likewise the entropy of the steam just before the condensation occurs, which, in its turn may be used for plotting the Wilson line of the steam chart and the cumulative heat drop or effective thermodynamic head due to an expansion without condensation down to the Wilson line and with the subsequent expansion in conditions of equilibrium.

TABLE 5

t	$\frac{p}{p_s}$	t	$\frac{p}{p_s}$	t	$\frac{p}{p_s}$
0	11.08	40	6.987	80	5 014
10	9.727	50	6.367	90	4 685
20	8.632	60	5.841	100	4.300
30	7.732	70	5.395	110	4 152

The writer proceeds to prove by a very interesting calculation that the thermal equilibrium of expanding steam cannot be immediately reëstablished when condensation takes place at the Wilson line. In fact, Wilson found that the number of droplets formed in his experiments on the expansion of supersaturated vapor increased enormously when the expansion was continued beyond the Wilson point, which indicated that the condensation was occurring not on the droplets already formed, but on new nuclei, and the temperature of the expanding vapor must accordingly have been not higher than that of the Wilson point corresponding to the pressure. There was thus a high degree of undercooling up to the very end of the expansion, but the temperature of this undercooled steam cannot be measured by means of a thermometer, as is shown elsewhere by the present writer.

This is followed by a discussion of the mechanics of condensation of vapor. The vapor condenses because of the mutual attraction between its molecules. This attraction is electrical in origin and essentially similar to that which operates in the formation of chemical compounds. Heat is a molecular motion and is subject to the general laws of transference of energy which occurs only slowly when the energy goes from the light electron to the heavy molecule. Until this transfer is effected the energy involved does not appear as heat. It has been shown above that the assumption that the steam expands in thermal equilibrium when the expansion is carried beyond the Wilson line is inconsistent with experience, which is thus in accord with Wilson's observation that the condensation which comes down during such an expansion separates on fresh nuclei. For this comparison the curve for Fig. 3 will be used. Many of the results plotted in the earlier portion of this curve were obtained in progressive trials of a steam turbine run at different speeds and with different superheats. The steam was highly superheated so that the "indicated" efficiencies could be determined without various corrections for dummy and gland leakages and for frictional losses which make the calculation of "indicated" efficiencies of a turbine so difficult in usual tests. Other points are plotted from ordinary test data corrected for internal losses. Some of the points, however, are erratic. On the whole, the curve is believed to represent fairly accurately the relative efficiency of turbines as the ratio K/U is increased.

The value of U adopted was calculated from the writer's modification of Callendar's steam chart using the equivalent reheat factors for expansions beyond the Wilson line, and he describes in considerable detail how these equivalent reheat factors were arrived at. The values of these equivalent reheat factors for various hydraulic efficiencies of the turbine are given in a table in the original article.

The term "equivalent reheat factor" can be understood from the following discussion. It is a fundamental axiom in thermal dynamics that a gas by suitable addition of heat may be caused to expand according to any law however arbitrary. It is thus possible, for example, by the use of appropriate reheat factors to make the volume and pressure of steam expanding without condensation exactly the same point for point as the volume and pressure of wet steam expanding in conditions of thermal equilibrium. The gross work done in this "equivalent" expan-

sion is the same as that done in the corresponding actual expansion of the wet steam.

Thus, when wet steam expands in conditions of thermal equilibrium the actual volume occupied by the steam depends upon the dryness fraction. Nevertheless, the relation between volume and pressure can be represented with considerable accuracy by an expression of the form $pV^n =$ constant. If at starting the steam is just dry, then according to Zeuner the expansion takes place according to the law $pV^{1.135} =$ constant, and by the methods elsewhere explained in this paper one can calculate a series of reheat factors, which, when applied to superheated or completely supersaturated steam, will give the same law of expansion.

The difference between real expansion and "equivalent" lies in the following: In the first place, the useful work done and the relation between volume and pressure for the actual expansion in thermal equilibrium can, by the use of appropriate reheat factors,

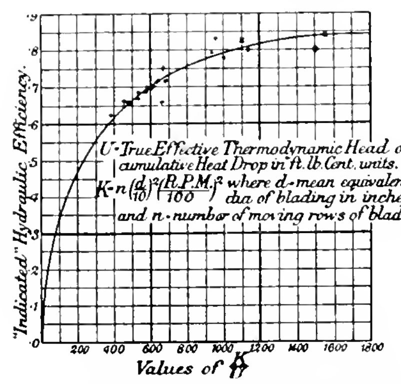


FIG. 3 "INDICATED" HYDRAULIC EFFICIENCY OF REACTION TURBINES

(Not corrected for leakage over blade tips.)

be represented by an expansion between the same limits of steam which remains completely supersaturated.

Next in the real expansion the volume occupied by the steam is diminished owing to condensation; in the equivalent expansion this real defect in the mass, actually gaseous, is replaced by an equivalent but imaginary reduction in the mass which is assumed to remain wholly in the state of vapor.

The writer then proceeds to the calculation of relative consumptions on the basis of the curve in Fig. 3 on the assumption that the steam behaves throughout as if completely superheated, which indicates the true value of the reheat factor.

From this the writer proceeds to the consideration of vacuum corrections. That the vacuum corrections are quite irrational on the ordinary theory has long been recognized, as in this theory with high-pressure turbines a reduction of the exhaust steam from 1 lb. absolute to ½ lb. absolute should reduce the consumption by some 11 per cent; whereas, experience shows that the actual improvement in the steam rate is from 5 to 6 per cent.

In this connection the writer discovered that the real discrepancy is somewhat less than these figures would imply, as no allowance has been made for the fact that the increase of vacuum involves an increase in the total effective thermodynamic head. Furthermore, the effective change in the vacuum is strictly local and materially affects only the last row of blades.

Thus, in a certain impulse turbine designed so that with normal vacuum the velocity of efflux from the last row of guide blades is slightly above the critical value, which is the speed of sound, the "use" of an important increase in the vacuum can never get back past the last row of nozzles and it is only the last wheel of the turbine that can ever get to "know" that the vacuum has been increased.

Since the whole effect of the increase of vacuum is concentrated on the last stage where both the axle and the wheel efficiencies will be reduced, the total resultant loss of efficiency of the turbine as a whole will be greater than if the increase in the thermodynamic head had been equally divided between all its stages.

The writer proceeds from this to the calculation of vacuum corrections, first considering the turbine as being operated for water and then by steam. This part of the paper, while brief, is of considerable interest as giving a clear idea of the method used by the writer, and is strongly recommended to the attention of those who can spare the time to read over the original article.

The following recapitulation of the new theory is given by the writer himself: Starting from the now accepted view that wet steam is not discharged from a nozzle in a condition of thermal equilibrium, reasons have been given for believing that in actual turbine practice, the expansion of wet steam never does occur in a condition of thermal equilibrium. Evidence of this is afforded by the condition of the steam in the exhaust branch of a turbine, where temperature measurements do not correspond with the pressure of the steam as simultaneously observed. True, the apparent defect of temperature is small, but it has been pointed out that the kinetic theory of gases requires that the readings of a thermometer immersed in undercooled steam should correspond to the pressure rather than to the temperature of this steam. That the true defect of temperature may amount to many degrees, may, it is pointed out, be inferred from Wilson's experiments on the expansion of supersaturated vapor, where, when the expansion was continued beyond the point at which moisture first separated out, the additional condensation came on new nuclei, and these new nuclei can be effective only when the defect of temperature amounts to some tens of degrees.

It was shown that on this hypothesis a rational explanation of the anomalies in superheat and vacuum corrections became possible, thus bringing theory into accord with actual experience. (*Engineering*, July 5 and 19, August 2, 9 and 23, and September 6, 1918; compare also THE JOURNAL of The American Society of Mechanical Engineers, September, October and November, pp. 784-787, 871-872 and 965-966.)

The Harvard School of Engineering has been reorganized and its courses were opened to students on January 1, and will continue during the Summer to enable the entrants to complete a full year's work by the opening of the next academic year in September. Some time ago, says the New York *Times*, Harvard University and the Massachusetts Institute of Technology agreed to combine effort in engineering instruction, making use of funds provided under the will of the late Gordon McKay. The agreement was objected to and the Massachusetts Supreme Court held that the arrangement was not in accord with the provisions of the will. The new arrangement has been approved both by the trustees of the McKay estate and by the governing boards of the university.

The instruction will be carried on entirely by a Harvard faculty, appointed by the university governing boards, and students who satisfactorily complete four years of study will receive the degree of bachelor of science. Higher degrees will be granted after additional study. Generally speaking, the work will be carried on in the classrooms and laboratories of the university, but arrangements may be made, from time to time, to utilize the facilities of other institutions, especially in the advanced technical courses. Instruction will be offered in mechanical engineering, civil engineering, sanitary engineering, electrical engineering, mining and metallurgy, and industrial chemistry.

It is provided that all grades of instruction, "from the lowest to the highest," shall be offered and shall "be kept accessible to pupils who have had no other opportunity of previous education than those which the free public schools afford." Requirements for admission to the school will be the same as those for admission to Harvard University. Admission to advanced standing and special study will be administered by the Engineering faculty.

The fees will be the same as those of the university, except that supplementary fees for additional or for laboratory courses may be charged. When funds from the McKay endowment are available, in the judgment of the President and Fellows, for the construction of new buildings for the Engineering School, such buildings will be constructed on Harvard University grounds and will bear the name of Gordon McKay.

THE PRODUCTION OF HELIUM FROM NATURAL GAS

Abstract of Address by Dr. Frederick G. Cottrell Reviewing Recent Work in the Liquefaction and Separation of Gases and the Production of Helium for Use in Balloons

On Friday evening, January 17, 1919, at the Chemists Club, the Society of Chemical Industry, the American Chemical Society and the American Electrochemical Society awarded the Perkin Medal to Dr. Frederick G. Cottrell, Chief Metallurgist of the Bureau of Mines. The medal was presented by Dr. Charles F. Chandler, senior past-president of the Society of Chemical Industry.

In accepting the medal, Dr. Cottrell spoke briefly on the subject of electrical precipitation and the patent situation leading up to the formation of the Research Corporation and its work in this and allied lines. He outlined the bill which has been introduced in both the Senate and House of Representatives at the instance of Secretary Lane of the Department of the Interior, authorizing the Federal Trade Commission to administer such patents as may be tendered to it by Government employees and others. This latter body has, during the war, been administering enemy-owned patents in much the same manner, and therefore already has the machinery and experience needed.

No matter how potentially valuable a purely scientific discovery is, it seldom benefits the public at large until it is carried through to industrial and commercial development and connects with the well-established avenues of trade. It is particularly in the case of patents on broad, fundamental projects that such an administration is of most importance.

The chief interest in the address, however, attaches to that portion which relates to the liquefaction and separation of gases and the final production, probably on a commercial scale, of the non-inflammable and buoyant gas, helium, for use in dirigible and observation balloons. It is mainly through Doctor Cottrell's work both as a scientist and in an administrative way that this has been brought about. The development came through investigations by him and others of the possibility of producing industrial oxygen at low cost by the liquefaction and distillation of air and in the application of similar principles to the production of helium from natural gas. Three development plants for this purpose are now in operation in Texas.

In the course of his remarks Doctor Cottrell referred to the recent address in New York by General Squier, Chief Signal Officer of the U. S. Army, in which the latter said that the production of helium had been so cheapened that it could now be produced at 10 cents a cu. ft. instead of the prohibitive price of \$1700 a cu. ft., which was the cost only two years ago; and in commenting, Dr. Cottrell said that if present expectations are fulfilled this cost may be still further reduced. He also emphasized the possibilities of the commercial production of oxygen for metallurgical work by the development of air-separation processes.

In this work a considerable number of well-known scientists and engineers have been engaged, including, among others, the following members of this Society: Fred E. Norton and E. A. W. Jefferies, of Worcester, Mass.; O. P. Hood, of the Bureau of Mines; Dr. Edgar Buckingham, of the Bureau of Standards, and George A. Orrok, of New York.

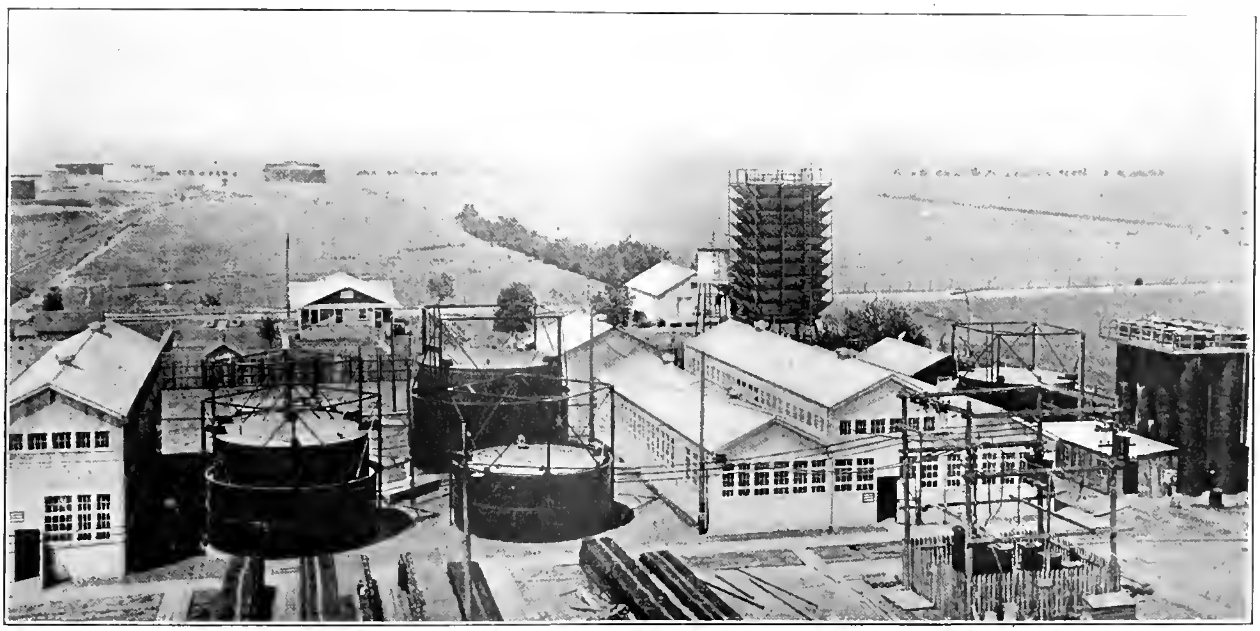


Fig. 1 U. S. Bureau of Mines Experimental Plant No. 1, at North Fort Worth, Texas

The following summarizes Doctor Cottrell's remarks:

Air Separation and Liquefaction of Oxygen

In 1904, in operating a liquid-air plant of the Hampson type at the University of California, I became greatly impressed with the ultimate possibility of producing very cheap industrial oxygen, but was equally impressed with the very crude thermodynamics which all the systems then common represented from an engineering standpoint. On assuming charge of the Metallurgical Division of the Bureau of Mines in 1916, I felt that the quest for cheap oxygen had become more than ever a large and legitimate part of my regular work; but, realizing my own limitations and the Bureau's inadequacy of material facilities, I strove to suggest, stimulate and collect inventions and developments rather than attempt to originate anything in this highly technical field.

Oxygen as sold today in steel cylinders is so expensive that it usually fails to suggest even faintly the ultimate possibilities for low-cost production, whereas on the very large scale, where unit cost of plant, overhead, sales expenses and the like are greatly reduced and compression into cylinders, transportation of the cylinders, etc., are completely eliminated, we come down to the power consumption for the actual separation as the largest and dominant factor of ultimate cost.

The final measure of theoretical efficiency is, of course, the degree to which reversibility in the thermodynamic sense has been

approached. Air is only a mixture and not a chemical compound of oxygen and nitrogen, and, therefore, no energy has to be supplied in its separation to overcome chemical affinity, but we do have to overcome what we may call the force of diffusion of the two gases in effecting their separation. In other words, we have to deal purely with that elusive second law of thermodynamics and not with the first. Thus, figured mechanically, the work necessary to separate five volumes of air at atmospheric pressure into one volume of oxygen and four volumes of nitrogen, each at atmospheric pressure, is equal to that necessary to compress the oxygen from the five volumes at 1/5 atmosphere to one volume at one atmosphere plus that to compress five volumes of nitrogen at 4/5 atmosphere into four volumes at one atmosphere, all isothermally.

In more practical engineering terms, the mechanical work necessary to separate a given amount of air into its components, oxygen and nitrogen, all at atmospheric pressure, is equivalent to that

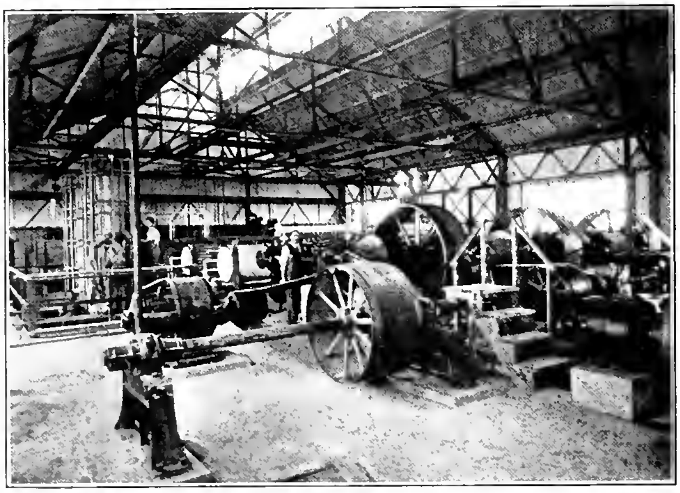


FIG. 2 INTERIOR, U. S. BUREAU OF MINES, PLANT NO. 3, J-N SYSTEM, PETROLIA

necessary to raise the same amount of air isothermally to a pressure of 9.8 lb. per sq. in. above atmospheric pressure. This figures out about 60 hp-hr. per ton of oxygen separated, or with adiabatic compression about 66 hp-hr. This is, of course, the theoretical limit for a perfect reversible cycle, which cannot be attained in practice, but we may hope to approach it to much the same degree that we have the corresponding limit in the steam engine and the air compressor, say 50 per cent as at least a legitimate goal for early endeavor. It seems doubtful whether any large-scale air-separating plants at present in service are greatly exceeding 10 per cent.

It was in March, 1916, that Director Manning of the Bureau of Mines handed me a memorandum of a conversation he had chanced to have in New York with some business men concerning a new process for air separation. The information it contained was more amusing than instructive, and I filed it with similar "clues to great inventions," and later investigated it. The trail led me back, with some little winding, to Mr. Fred E. Norton, Mem.Am.Soc.M.E., of Worcester, Mass., a graduate of '91 of the Massachusetts Institute of Technology. He had, in 1913, in connection with Mr. E. A. W. Jefferies, Mem.Am.Soc.M.E., undertaken the engineering development of a process of air separation patented by the latter and which he had made arrangements with the General Chemical Company to try out at one of their plants. Considerable work had been done when the General Chemical Company dropped the matter and Messrs. Jefferies and Norton pooled their patents as the Jefferies-Norton process and continued experimental development in a smaller way.

SUGGESTION OF THE USE OF HELIUM FOR BALLOONS

A year earlier, but quite unknown to me, Dr. R. B. Moore, of the Bureau of Mines, who had worked with Sir William Ramsay, received under date of February 28, 1915, a letter from Sir William as follows: "I have been investigating blowers, i. e., coal-damp rushes of gas for helium for our Government. There does not appear to be any in our English blowers, but I am getting samples from Canada and the States. The idea is to use helium for airships."

The importance of this proposed use of helium for balloons, and particularly for airships of the Zeppelin type, lies in the absolute inertness and non-inflammability of helium and the fact that it is of all known substances the next lightest to hydrogen, having about 92 per cent of its buoyant effect. It also shows only about one-half the rate of diffusion and consequent wastage through the balloon fabric. As the fire hazard not only from incendiary bullets in war, but also from atmospheric electricity and the power plant in both peace and war, has constituted the greatest drawback to the development of lighter-than-air craft, it is difficult to overestimate what an available supply of this gas may eventually mean in the art.

In a recent letter Dr. Moore says:

> Two or three weeks after war was declared, I attended a meeting of the American Chemical Society in Kansas City. At the general session Mr. Seibel, who had been working with Dr. Cady gave a paper on krypton and xenon in some of the natural gases of Kansas. At the end of his paper he expressed regret that at such a time, when every one was thinking of war problems his paper was of a purely scientific nature and had no practical bearing on the war. I immediately got up and said that I did not agree with Mr. Seibel; as the presence of helium in these wells could, and should, have a very practical bearing on the war; as this gas could be extracted in quantity from the natural gas and used for balloons and Zeppelins. I pointed out some of the natural advantages of helium over hydrogen, and quoted Sir William Ramsay's letter. The general attitude of those present was one of skepticism. The same day I talked to Dr. Parsons who was present at the meeting and who was returning to Washington almost immediately. I told him what had happened and told him that I believed the matter should be taken up by the Bureau at once, and presented to the War Department. He promised that he would do this as soon as he got to Washington and I know that he did take the matter up with other Bureau officials.

News of Ramsay's suggestions also reached this country through other channels and were later called to our attention. Col. G. A. Burrell, who headed the Research Department of the Gas Warfare Service at the American University, tells me that Cady's experiments had also suggested similar possibilities to him.

On June 1, 1917, Doctors Moore and Burrell, both of the Bureau of Mines, called on Colonel Chandler, in charge of the Balloon Service for the Army, and explained the whole subject to him. He was intensely interested, at once realized its potentialities and asked that a report be made to him, giving all available details. He also took up the matter with Mr. G. O. Carter, in charge of hydrogen plants for the Navy, who had had several years' practical experience in the Linde Air Products Company with the liquefaction and separation of gases by their process. Mr. Carter also immediately appreciated the importance of the subject and urged this upon the attention of his superior officers.

REPORTS BY BRITISH ADMIRALTY AND U. S. BUREAU OF MINES

About this time I was called actively into the conference and was much impressed by the weight which the British Admiralty apparently laid upon the cost of separation of gas as a determining factor in its practical availability. They had figured this out on the basis of the well-known commercial processes of gas separation by liquefaction and separation and were unable to see how they could hope for production at less than $60 to $80 per 1000 cu. ft., which they felt to be practically prohibitive.

It was at this stage that I suggested turning to Mr. Norton at least for a plan and estimate of what he thought might be accomplished along the new lines he had been following. On Monday, June 4, with Mr. T. B. Ford, then in charge of the Low-Temperature Laboratory at the Bureau of Standards, and Mr. O. P. Hood, Mem.Am.Soc.M.E., Chief Engineer of the Bureau of Mines, we spent the whole day in thrashing out the whole subject with Mr. Norton. As a result Mr. Norton was asked to act as a consulting engineer of the Bureau of Mines and prepare plans and estimates for an experimental plant.

In due course a formal report was made by the Bureau of Mines to the Army, and although this was as yet fragmentary and based on very inadequate data concerning the practical conditions to be met, the Aircraft Board recommended on July 31, 1917, an appropriation of $100,000, half each from the Army and Navy, which became available for the use of the Bureau of Mines on August 4.

A detailed survey of field conditions, to determine the best available supply of natural gas for the purpose, was at once begun by Dr. H. B. Cady, as was also the preparation by Dr. Norton of working drawings for the experimental separation plant.

Mr. Burrell next communicated with the two well-established operating companies controlling, respectively, the Linde and Claude systems of gas liquefaction and distillation, to determine whether it would be possible to work out a plan for pooling of information and facilities for this specific war purpose. Due to the questions of trade secrets and business relations, this did not, however, prove possible, though both companies expressed themselves as entirely willing to undertake independent efforts and the erection of plants of their own respective designs at cost, or even less, and have ever since most cordially furnished every facility in their power to make the work as a whole a success.

Construction of Linde, Claude and Norton Plants

Further appropriations of $500,000 and $100,000 were made by the Aircraft Board and contracts were entered into with the Linde Air Products Company and the Air Reduction Company for the Linde and Claude plants respectively, each for an estimated daily production of about 7000 cu. ft. of helium.

Some doubt remained in the minds of the Government officials regarding the Norton process and the Secretary of the Navy, feeling the need of further outside advice in the matter, requested the National Research Council to investigate the project with special regard to its theoretical soundness and also its apparent chances for practical success.

The Council appointed for this purpose a committee of five, consisting of Prof. H. N. Davis of Harvard, Dr. Edgar Buckingham, Mem.Am.Soc.M.E., and Chas. W. Waidner of the Bureau of Standards, Dr. W. F. Landis of the Air Nitrates Corporation, and Mr. S. L. G. Knox, consulting mechanical engineer, and recently Scientific Attaché to the American Embassy at Rome. This committee, after very careful comparative study of the three processes, concurred in the Aircraft Board's recommendation of the additional $100,000, which was then immediately made available by the Army and Navy.

These plants were to be located at North Fort Worth, Texas, and operate on a natural gas containing about 0.9 per cent helium by volume, of which the Lone Star Gas Company was bringing some 20,000,000 cu. ft. daily through its pipe lines from the wells at Petrolia, about 100 miles northeast of Fort Worth to that city for domestic and industrial consumption.

It was decided to locate the Norton plant at Petrolia in direct proximity to the wells, a procedure which had not been deemed practicable for the other two plants on account of their larger demands for power and water supply.

In order properly to coördinate all the different agencies concerned, the conduct of the helium work as a whole was about this time placed in the hands of a committee consisting of one representative from each of the departments chiefly concerned. Mr. G. O. Carter, Chairman, represented the Navy, Dr. H. N. Davis the Army, and Mr. Geo. A. Orrok, Mem.Am.Soc.M.E., the Interior.

The Linde plant, costing in round figures $300,000, was the first to be contracted for and have its construction started. It produced the first helium on March 1, 1918, and by September 6 had increased its yield to 7750 cu. ft. per day of 67 per cent purity, which was later repurified to about 92 per cent.

The Claude plant, costing about half as much as the Linde, commenced production some weeks later than the latter and has also gradually increased its production and purity of products.

At the time of signing the armistice the first shipment of 147,000 cu. ft. of 93 per cent helium was on the dock about to be loaded aboard ship for Europe.

Fig. 1 shows the Linde plant at North Fort Worth and Fig. 2 the Bureau of Mines' experimental station containing the Jefferies-Norton plant at Petrolia.

The Army and Navy have now jointly entered upon a larger production program under the immediate direction of the Navy and have allotted some $5,000,000 for the construction of a new pipe line and additional units of the Linde plant at Fort Worth.

A large part of the credit for the promptness with which this actual production was effected is due to Mr. Carter who was tireless in his efforts in pushing matters of priority, transportation, construction and production.

The Norton, or Bureau of Mines, plant at Petrolia was completed as far as initial construction is concerned the middle of October, and since that time has been undergoing tests and adjustments of its various parts. The multi-tubular heat interchangers and large expansion engines, which were among the new departures in this plant, have worked out very well and now seem to be performing their allotted tasks to complete satisfaction. A good deal of difficulty was at first encountered by occasional floods of oil and salt water coming over from the Lone Star Gas Company's gasoline-extraction plant, which clogged up the interchangers, making it necessary to shut down and go through the laborious process of thawing out the whole system and starting refrigeration afresh. This has now been eliminated by the installation of adequate settling chambers and traps, and tests and adjustments are proceeding upon the stills which form the last part of the equipment to be so tested. Temperatures as low as — 168 deg. cent. have since been attained in the Norton plant.

Cycles of Operation

At the conclusion of his address Dr. Cottrell showed by means of lantern slides the details of the various plants. We reproduce four diagrams from among these pictures showing the Ideal cycle, the Linde cycle, the Claude cycle, and the Norton cycle, and Dr. Cottrell has contributed a written description of the several processes for publication in MECHANICAL ENGINEERING, which here follows: G. A. O.

DESCRIPTION OF CYCLES OF OPERATION

In studying the different systems of gas liquefaction and separation it is very essential at the outset to distinguish clearly between the production of liquid as an ultimate product and the utilization of liquefaction and reëvaporation as a mere step in a separation where the ultimate products desired are still gases and at essentially the temperature of the original mixture fed to the apparatus.

In the former case a very considerable expenditure of work is represented in what we may colloquially term the refrigerative properties of the liquid delivered.

But in the second case, where the liquid is not drawn off from the apparatus and its amount therein remains constant, the part continually evaporating serves to condense nearly an equivalent amount of the incoming gases. Also the cold gases furnished by this evaporation take up heat from and cool the fresh incoming gas while they themselves are returning to room temperature.

Ideal System

Thus, we may illustrate diagrammatically, as in Fig. 3,[1] the continuous process of liquefaction and reëvaporation of a single gas. Ideal conditions would consist in perfect heat interchange horizontally between the two legs of the U-tube A and C and perfect heat insulation lengthwise along each of these and from their surroundings.

If these conditions were fulfilled and the whole system once

[1] The four cuts here shown are from a report made in the early part of this work by Mr. Norton to Mr. Burrell, outlining the problem in hand and the relation of the three processes to one another as they appeared to him.

brought to a steady state by, let us say, refrigeration of the bottom of the U-tube by some extraneous source of initial cooling, while gas was slowly passed through it, we may imagine a certain amount of liquid condensed at the bottom of the U-tube and a uniform gradient of temperature established along its two legs. Now, if the initial extraneous source of refrigeration were re-

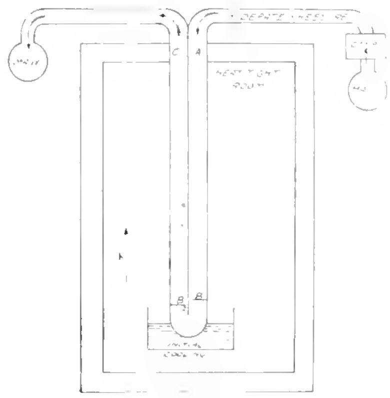


FIG. 3 IDEAL EQUAL-PRESSURE SYSTEM

moved, but gas still passed slowly into the system, the gas would progressively cool in A; liquefy at B; reëvaporate at B_2 and warm back to atmospheric temperature in passing up C. Under these ideal conditions, with a single gas, the slightest imaginable difference in pressure between A and C should serve to perpetuate the process.

Whatever heat leakage there is, however, either through the walls of the insulating chamber or down the legs of the U-tube, represents a loss not of energy itself but of its availability for the purposes in hand; i. e., of thermodynamic potential, or an

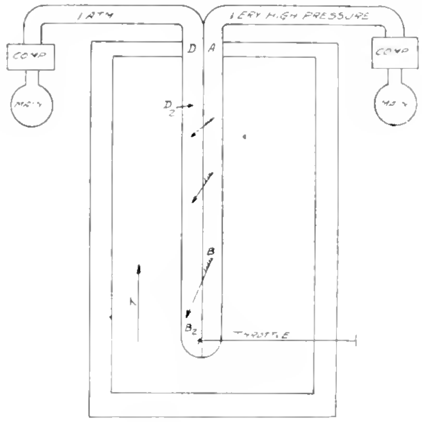


FIG. 4 LINDE SYSTEM

increase of entropy, if one prefers that terminology, the practical result being the necessity of expending mechanical work to compensate for these heat leaks. If, in addition to this, we are dealing with a mixture instead of a single pure gas, the constituents will in general liquefy and reëvaporate with varying ease, tending to set up temperature differences between adjacent parts of the two legs of the U and thus require a further expenditure of work to operate the cycle.

Looked at from the point of view of gas separation, the first of these effects represents pure loss, but the second is due, at least in part, to overcoming what we have above termed the force of diffusion in separating the gases and should thus be conuted as useful work.

The problem is, therefore, to provide just enough refrigeration *at the proper temperature and places* to cover these two demands after they themselves are reduced to as low a value as possible in the design of the apparatus and by use of the best heat insulation attainable.

The three systems for gas separation now before us differ perhaps most strikingly of all in the way in which they produce this refrigeration.

LINDE SYSTEM

In the Linde system, Fig. 4, the gas mixture to be separated is pumped at very high pressure (say 1500 to 3000 lb. per sq. in.) into leg A and simply allowed to expand through a regulating throttle to a lower pressure at B_2 and return through D, the refrigeration being usually credited to the "Joule-Thomson effect." A discussion of this latter here would carry us too far into theoretical physics, but it may help the uninitiated in such matters to intelligently picture the general effect of this process to say that the specific heat of a highly compressed gas is usually

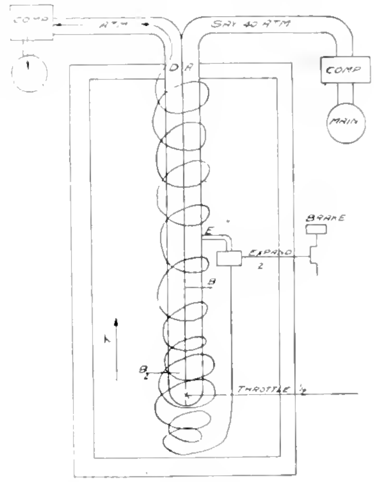


FIG. 5 CLAUDE SYSTEM

less than that of the same gas at lower pressure, so that a given weight of gas passing down leg A under high pressure in falling from one temperature to another will give up fewer calories of heat than the same weight of gas coming up the leg D will absorb between the same two temperatures. Thus it is evident that on the whole more heat will be carried out of the system by the issuing gas than is brought in by the incoming, with resulting refrigeration.

The fact that these differences of specific heat only become important at considerable pressures and the pressure created for this purpose is practically wasted at the throttle, as far as useful mechanical effect is concerned, makes this process decidedly inefficient from a thermodynamic standpoint; i. e., from the question of power consumption. Its chief merit lies in its extreme simplicity and freedom from moving parts. It is the type of system first developed both in the laboratory and commercially. As cooling proceeds, liquid finally forms at B_2. For the purpose of separating the constituents of the mixture the leg D is developed into a "column still" on the same principle as those used for rectification of ordinary liquids, but, to avoid confusion, not shown in the present cuts.

CLAUDE SYSTEM

In the Claude System, schematically represented in Fig. 5, another principle is introduced. It was early pointed out by Lord Kelvin and others that, if some sort of expansion engine could be substituted for the free-expansion throttle in systems of the Linde type, and the work of these engines expended outside the heat-tight room, greater refrigerative effect would be produced even if all the mechanical work so produced were allowed to go to waste, for in its mere production it would have already extracted an equivalent amount of heat from this room. As, for the purposes in hand, these engines must work at very low temperatures, grave mechanical difficulties were seen in the problems of lubrication, brittleness of valves, stoppage by frozen impurities from the gas and the like. George Claude of Paris was the first to solve these difficulties, at least in a commercial way, and his book,[1]

[1] Liquid Air, Oxygen and Nitrogen.

(*Continued on page 188*)

MACHINE SHOP SESSION

Papers and Discussion on Standardization Subjects at the Annual Meeting, Arranged by Sub-Committee on Machine Shop Practice

THE Sub-Committee on Machine Shop Practice carried through a timely undertaking at the Annual Meeting in its session for the discussion of papers on standardization subjects contributed from authoritative sources, both in England and America. These papers were published in the November and December numbers of THE JOURNAL, and had the following titles, which are descriptive of their contents:

THE BRITISH ENGINEERING STANDARDS ASSOCIATION, C. le Maistre, Secretary of the Association.

WORK OF THE BRITISH ENGINEERING STANDARDS ASSOCIATION ON SCREW THREADS AND LIMIT GAGES, Sir Richard Glazebrook, C. B., F. R. S., Director of the National Physical Laboratory.

PRESENT PRACTICE IN THREAD-GAGE MAKING, Frank O. Wells, Member of Congressional Screw-Thread Commission.

MEASUREMENT OF THREAD GAGES, H. L. Van Keuren, in charge of gage testing, Bureau of Standards, and Secretary of Screw-Thread Commission.

STANDARDS FOR LARGE TAPER SHANKS AND SOCKETS, Luther D. Burlingame, Brown & Sharpe Mfg. Co.

R. E. Flanders, Chairman of the Sub-Committee on Machine Shop Practice, presided, and in opening the meeting said that while the papers had been prepared under conditions incident to the war, the subject of standardization has its peace-time value as well, and particularly in relation to the international aspects of the question. It would be a misfortune for the engineers of France and the engineers of other great industrial countries each to standardize their own practice, their own work and their own product without reference to the practice, work and product of the other great engineering and productive countries. In order, therefore, that we may be kept in a current of standardization with our allies, it has been thought wise to have presented reports from authoritative sources as to the fine standardization work which has been done, particularly in Great Britain.

BRITISH ENGINEERING STANDARDS ASSOCIATION

The first paper, on The British Engineering Standards Association, was presented by Gen. L. R. Kenyon of the British War Mission, who explained the relationship of the association with the British Government. "In my country," he said, "we generally find it best—I have been a government official myself—to get along without the government in most cases. The government is apt to be rather 'red tapy' and slow in its methods, hence this matter of standardization was taken up by a number of engineers connected with the engineering societies in London. They asked the various government departments to coöperate by putting members of these departments on the committees of the association and allowing people to be sent to give evidence before the committees.

"This work began in 1901 under a slightly different name from that which it now has, and to show how modestly it started, it will be seen from Mr. le Maistre's paper that there were only seven men on the original committee, whereas now the association includes 100 different committees and sub-committees, with something like 900 members. They all work under one central authority, composed of boards nominated by the leading technical institutes in Great Britain, such as the Institution of Civil Engineers, Institution of Mechanical Engineers, Institution of Electrical Engineers, the Iron and Steel Institute, the Institute of Naval Architects, etc."

Sir Richard Glazebrook's paper was next presented by H. Bingham Powell, Director of the Joint Gage Laboratories of the British War Mission and of the U. S. Bureau of Aircraft Production. Mr. Powell said in part:

"Although Sir Richard Glazebrook is principally known as the Director of the National Physical Laboratory, he has done much other important work during the war. He has the official position of Consulting Scientist to the British Government, where his wide knowledge of physical science has been of great value.

"Quite early in his career he was demonstrator of physics at the Cavendish Laboratory of Cambridge University. He has written many books and papers for the Royal Society and other scientific and technical societies and journals; and has also been a President of the Institution of Electrical Engineers. He has taken an active part in standardization, especially in relation to screws, and it is of the latter I would now like to speak.

"Sir Richard presided over the Anglo-American Conference on screw threads held in London early in the year. That conference was not able to arrive at final decisions, but useful work was done. In concluding the proceedings, it was agreed that the principal reports of the members of Sub-Committee on Screw Threads of the British Engineering Standards Association should be published in a summarized form in the United States—to present the views held in England on the advantages and objections to the angles, forms, pitches, etc., of the various thread systems in use.

"I was charged by the committee to do this work and have presented the summary, together with some writings of my own on the subject, to the Standards Committee of your Society, and to the National Committee on Screw Threads.

"The ideas held in England may be briefly presented as follows: The British Standard Fine series of threads is becoming very popular for ordinary engineering work. It has long been felt that the British Standard Whitworth Series and the United Standard Series—which are identical except for one size, $\frac{1}{2}$-in. diameter—are too coarse for ordinary work; that is, contain too few threads per inch of length. On the other hand, they claim that the American Society of Automobile Engineers' series is unnecessarily fine for ordinary purposes.

"The British Standard Fine series is almost mathematically a mean in coarseness to these mentioned, and so would seem to meet all common requirements.

"It is most desirable, in many ways, that an international screw system should be adopted; and the feeling in England is that if we can agree in the matter of pitches, the form and angle of the thread can be allowed to take care of themselves; at least for the time being.

"Although the form of the United States Standard thread looks so different on paper from the Whitworth form, in practice there is not much difference. The square top and bottom of the United States Standard are hardly ever found in ordinary commercial screws made by taps and dies, or rolled. The crests of the thread in a tap, or in a cutting or rolling die, very soon become rounded in use by the corners overheating and falling away—thus early arriving at a radius which measurements show approaches the figure of 0.137 multiplied by the lead.

"This is the proportion laid down for the Whitworth rounding. The latter would thus appear to be about the correct rounding with which a tool maintains a stable point.

"Also, the roots of taps and cutting or rolling dies do not give a square form to the product—even if they are made of that shape—but a rounded form, similar in radius to the Whitworth. This is probably due to the fact that in such work the operation of forming the thread on the product is really partly that of extrusion; that being so, the square or sharp V root is not suitable and the metal refuses to flow completely down in it, remaining rounded, as stated.

"Thus we do not differ much over form; but should it be really considered necessary to give a complete solution to the problem, we could fix a 'zone of tolerance of form' at the root and crest of the thread, to include both the nominal square shape and also the rounded.

"About the angle of the thread: The variation of this actually found in the product is so great that the nominal difference of 5 deg. between the U. S. Standard and Whitworth threads is not

of great consequence. We have conducted many experiments in our laboratory—and in England also they have extensively investigated the point—and we find that with the same pitch the average Whitworth bolt will assemble in the U. S. nut, or vice versa; either freely or using a light wrench."

Discussion on Standardization

Henry Harrison Suplee called attention to the importance and value of standardization if rightly carried out. The great desideratum is that standardization shall be applied to details, such as rail sections, bolts, nuts, etc., rather than to the standardization of the whole design. A good example is that of aircraft work, to which General Kenyon referred. Undoubtedly this work has been unnecessarily retarded by many, many small changes, whereas standardization in details would have greatly accelerated production. At the same time standardization in the whole design would have retarded the work and perpetuated obsolete types. In the event of making improvements, the designer would be able to assemble any new design without departing radically from standardized parts. It is desirable that we should consider standardization as it relates to details, which can become almost antiquated without serious detriment, and keep it carefully away from general design where it may retard progress.

Chester B. Lord discussed the difficulties experienced in attempting to use thread gages in manufacturing operations, and said that "nothing has been more costly during the war, or done more to retard work, than the thread gage; not because it is harmful in itself, but because we have so far outstripped in our art of making threads the art and method of making gages." He emphasized the effect of drawing a thread when a bolt is stressed, by which mating threads of different shapes conform to one another, in consequence of which it is the lead rather than the shape of thread which counts. Consideration of the material on which a thread is to be cut is of the greatest importance in making a thread gage—whether open-hearth or bessemer steel, brass, copper or cast iron. He had manufactured with Whitworth, U. S. Standard and V threads as a basis on different work, and hoped later to be able to contribute a discussion in writing covering his views.

James Hartness emphasized the importance of the accomplishments of the two great institutions, the National Physical Laboratories of the British Government and the Bureau of Standards in this country. The latter came into the work a little later, and under less pressure, but has been making remarkable headway, and both are built around men who have the highest ideals and are endowed with the clearest perception with regard to gaging standards.

Commenting on the remarks by Mr. Lord, he said that while the purpose of gaging is to determine the character of the fit, we must measure the screw thread before it enters under the stress of its work. The gage, therefore, does not indicate what the fit will be when the screw is under stress. He hoped later to present a communication to the Society on this phase of the subject, and for the present would merely say that the work of the projection lantern as it has been first worked out under the auspices of the National Physical Laboratory, and as it is being carried forward by the Bureau of Standards, promises to bring us one step forward in the art of making screw threads.[1]

E. J. Bryant[2] said that in this thread-and-gage proposition we should remember that the purpose of a screw thread is to bind parts together. As a manufacturer of threads, gages and other parts, the thing which seemed to him to be vital to consider was what the standard of variation should be from the pitch or effective diameter of the thread. Knowing that, we would be able to make gages that would check the parts, and to make parts to these gages which would interchange with the parts made by other manufacturers.

[1] Mr. Hartness' communication appears in this number of Mechanical Engineering, pp. 127-135.

[2] Supt. Small Tools Division, Taft-Pierce Mfg. Co., Woonsocket, R. I.

The Engineering Standards Committee

Comfort A. Adams spoke of standardization as a basic matter of the greatest importance, and of the work of standardization contemplated by the recently organized American Engineering Standards Committee. [See Mechanical Engineering, January 1919, p. 70.—Editor.]

If a thread has been standardized, all that is necessary to designate it is to say that it is a standard thread of a certain diameter. That describes the whole thread. It is known the nation over. If it is an international standard, it is known the world over.

Another illustration is the rating of electrical machinery. It took some time to develop a satisfactory system of rating by which it would be known exactly what was meant where one said that a motor of a certain voltage, for example, had a certain horsepower. It might take many pages to describe the motor, to tell how to test it and how to check the rating; but today, in view of standardized ratings, the designating term for a motor signifies a certain definite thing which is understood not only throughout this country, but in England as well.

Standardization produces a language of marked abbreviation and results in a saving of time and misunderstandings which has been of tremendous benefit and of immeasurable importance to the engineering world.

The extent of the saving through the adoption of standards in the electrical industry is incalculable. As the world of industry develops and our relations with other nations become more and more intimate, it becomes more and more necessary that we talk the same language. Every difference in language of any kind or description creates a barrier between nations and helps to produce the misunderstandings which cause war.

With regard to the American Engineering Standards Committee, while its organization is different from that of the British Engineering Standards Association, it is hoped that it will be effective and will result in a large saving of time and bring about a better understanding in our international relations.

The operation of the Committee can best be explained by stating the order of procedure in the development of standards under the guidance of that Committee.

A standard is proposed and accepted as desirable by the Committee. It is then referred to the sponsor society, which appoints a Sectional Committee representative of that society and of other interested organizations, roughly in the proportion of their interest. The personnel of that committee is referred for approval to the American Engineering Standards Committee, and if the constitution and personnel of the Sectional Committee satisfy the main committee and its regulations in that respect, the personnel is approved, and the committee goes to work and evolves the standard, which becomes at first the standard of the sponsor society, and is published by it. Then if approved by the main committee of the American Engineering Standards Committee, the sponsor society is granted the right to have printed on the pamphlet of issue the statement—"Approved by the American Engineering Standards Committee." Thereby that standard becomes an American standard. We have been in the closest touch with the British committee, and with Mr. le Maistre, and in the future we hope that the international conferences will include the American Engineering Standards Committee.

Pioneer Mechanic Introduced

Frank O. Hoagland, representing the Pratt and Whitney Company, whose pioneer work in gages and standards is known and recognized the world over, very appropriately and courteously referred to one of the company's old employees, saying: "Many times it is of interest to see what has been done before. One of the principal difficulties is that the men who have accomplished the most do not always care to tell about it, either orally or in writing. There is a gentleman in this hall by the name of G. S. Fallow, chief gage inspector for our company, who has been with the company for more than forty years. He was there in the days when Mr. Bond and Professor Rogers tried to establish a new art.

"These gentlemen did a lot of experimental work in this coun-

try first, and then they took their measuring bar to England and had it compared with the master bar over there. There gages were being produced then because the railroads were beginning to call for nuts and cap screws that would interchange. In those days Mr. Fallow was working at the bench and lathe, and produced thread gages which stand comparison today with the latest instruments. Some of the gages were ground in 1883. It is remarkable how close they are, considering the means at hand at that time."

Considerations in the Standardization of Screw Threads

Wm. T. Magruder (written). If another set of standard sizes of screw threads is to be added to the variety now in use in engineering construction, it is to be hoped that it will be done very advisedly and with full consideration of the materials that will be employed and the uses that will be made of the threaded members. It can probably be shown that there are more miles of bolt threads cut per annum from ordinary steel bolt stock than from any other one material or for any other one use. While special threads may be desirable for automobile tool-steel threaded members and for the bronze screws of astronomical and physical instruments, the thread upon which civilization rests and progress depends is the screw thread used in bolts and screws in general engineering machinery. It is therefore of the greatest importance that standards of materials, shapes, sizes, limits, and the like should be decided on with great care and that no radical changes be made in present practice except after very serious consideration of the millions of dollars of expense and endless confusion involved in any such change. Experience gained in changing from one standardized thread to another, and later to another in engineering manufacturing work, leads me to speak positively on the subject.

Any committee having this matter in charge should decide on what may be considered to be standard engineering materials, and should then experiment upon the relative strengths and fatigues of the threads made of these materials in machines simulating actual use. By strength is not meant solely the tensile strength of the threaded member, but rather the strengths in tension, torsion and shear. One of the experiments which we have our engineering students perform at Ohio State University is to test ordinary commercial steel machine bolts by screwing the nut up with a wrench and to see that they usually fail by stripping the threads. This would indicate that the pitch was too fine or the fit too loose.

Seventeen years ago we found it impossible to get bolts and screws cut with U. S. Standard threads from any of the manufacturers located west of the Allegheny Mountains, and had to send to Worcester, Mass., to get the desired supply of standard bolts, cap screws and studs. While such is no longer the case, it would be interesting to learn how common the old, sharp-V, American thread still is and what proportion of screw-threaded members made in the Middle West are now made to a more or less approximate sharp V thread rather than to the U. S. Standard thread.

For the last four years screw-threaded members as used on munitions have been forced to the forefront of our attention. Now that we are again to allow the manufactures of peace to lead the way, more thought should be given to the commercial needs of this branch of engineering practice. The accuracy demanded and obtained in Government work does not always obtain in commercial work.

While full credit should be given to Sir Joseph Whitworth as being the first one to bring order out of screw-thread chaos and to successfully standardize British screw threads, it should be borne in mind that the Whitworth screw thread is very difficult to duplicate, an expensive thread to make as far as accurate taps and dies are concerned, and still more difficult and expensive to cut with accuracy in the lathe. It therefore seems the part of wisdom, now that the International, French and United States screw threads are all of the 60-deg. Sellers type of thread, to retain it as a standard shape—at least until something better can be devised.

E. H. Ehrman (written). Obviously the two main points of difference between the British and American screw threads for constructional bolts rest in (1) the pitches of the finer series and (2) the contour of the crests and roots.

With reference to the first point, the difference is in all probability the result of looking at the matter from different viewpoints. The British feel that one series of pitches serves satisfactorily for all grades of work, whereas in the United States we feel that requirements are better met through a dual system of pitches. Had the British held our view, or conversely, had we held the British view, the few differences that might occur in the resulting British and American series could easily have been adjusted through conference.

With reference to the second point and with special reference to the second paragraph of p. 1008 and the last paragraph of the first column of p. 1009, The Journal, November 1918, I would offer the following comment: The time has come, I believe, when we must, in a specification, do more than prescribe the profile that forms the ideal boundary between the external and internal thread. We should, I believe, specify the maximum tool profile, i.e., that profile of the tool which when new will produce a screw with the deepest root and the highest crest; as well as profiles of the "go" gages, which should be so shaped that the product gaged by them will not trespass upon the standard profile. Provision is thus made for a definite maximum clearance at the crest and root, and also for wear of the crest of the tool.

My experience with reference to the action of the thread tool at its root does not agree entirely with that of the author. Outlines of screw threads, both external and internal, on an enlarged scale of 50:1 indicate that the thread tool at its root suffers very little if any wear in service, as the crests of the thread are fairly true to the theoretical profile where it has been entirely formed by the thread tool. Where the bore of the nut has been enlarged and the outside diameter of the screw has been reduced so that the threading tool removes nothing from the crest of the resulting thread, the metal at the edges of the crest, instead of being removed, is built up or spun up, so that they are slightly higher than the surface at the middle of the crest. Observation also shows that the thread tool has under such conditions cut the thread fairly concentric with the bore of the nut and the body of the screw.

With the provisions made for clearance as cited above, I believe (1) that considerable eccentricity of the thread with reference to the bore or body diameter is permissible and (2) that much latitude may be allowed with reference to the shape of the tool crest. In fact, it is immaterial except as to the relative "life" of the thread tool, whether the crests of the tool be of the Sellers or Whitworth shape. My personal experience, however, is the ground for my preference for a thread having flattened crests and roots. The reasons for this opinion are given in a paper on the Screw Thread Situation in Great Britain and America which I read before the Society of Automotive Engineers.

Thread-Gage Making and Testing

The next papers presented were by Frank O. Wells on Present Practice in Thread-Gage Making and by H. L. Van Keuren on the Measurement of Thread Gages. These papers are both comprehensive and practical, representing as they do the most advanced practice. Considerable discussion followed.

As a preface to his paper, Mr. Van Keuren said: "Some time ago the Gage Committee of the The American Society of Mechanical Engineers recommended that there be a central place for the certification of master gages, and that as Congress had provided a fund for this purpose for the Bureau of Standards, and as the Bureau of Standards was organized and ready to handle the work, it should be the central place for the carrying on of this work. It is of interest, therefore, that members of the Society should know some of the developments which have taken place there."

H. J. Bingham Powell[1] (written). The number of gages inspected during the last few months by the U. S. Bureau of Air-

[1] Officer in Charge of the Joint Gage Laboratories of the U. S. Bureau of Aircraft Production and of the British War Mission.

craft Production and of the British War Mission is from 15,000 to 18,000 a month, and a program of a thousand gages a day was under consideration when the war terminated. Over 80 per cent of the gages were screw gages, with the low tolerances of two ten-thousandths of an inch on the pitch diameter and the same figure for the maximum lead error. The other gages were the complex form, flat and angle gages used in aircraft engines and aeroplane inspection generally. We employ girls for the work as far as possible, men only being needed for the more complex gages and where experience in gage making was necessary, such as in the visual inspection, etc. The girls have given most admirable service and have been found to be fully qualified by their patience, steady work and light touch for dealing with the very delicate instruments we use. Our instruments have been especially designed, bearing in mind the unskilled workers who had to use them, and are practically "automatic" in action.

For instance, our lead-measuring machine shows the correct reading to within two one-hundred thousandths of an inch by the swing of a galvanometer needle. Ten machines deal with 500 gages a day, with errors in readings almost unknown. The National Physical Laboratory pitch-diameter machine described by Mr. Van Keuren has been modified by us by fixing an attachment to it which puts a constant load on the wires and does away with the feel of the micrometer, a small lamp extinguishing when the reading is correct. The results given by the different pitch-diameter machines are thus obtained under identical conditions of loading of the wires and pressure on the micrometer spindle: the latter having on its barrel a divided wheel by which readings can be taken to a fraction of a ten-thousandth of an inch.

The horizontal type of the National Physical Laboratory optical projection lantern is used with a lens that gives a correct field 8 ft. in diameter. We photograph all the plug gages and the casts of ring gages by means of a special apparatus which takes less than one minute to operate. The photographs are measured for angle of thread and checked for form by placing them over suitably engraved glass screens illuminated from underneath.

To take casts of ring gages we have a special appliance that does the work in a few seconds. All this apparatus has been designed for dealing with our large number of gages with expediency and accuracy without having to employ highly skilled mechanics who in war time can be better employed elsewhere.

Data from Frankford Arsenal

C. P. Colburn[1] (written). The object of this discussion is to show how methods of precise measurement may be simplified and adapted to practical use.

Measurement of Pitch Diameter of 60-deg. Thread by 3-Wire System

The usual trigonometric formulæ for determining the correct wire size and the over wire dimension for determining pitch diameter of thread gages and taps is a problem too deep in mathematics for many shop mechanics. The formulæ here given are intended for the workman who is not a mathematician, but who finds it necessary to make calculations due to the fact that drawings are not generally arranged to show over wire measurements and the correct size of wire which should be used to obtain the best results.

The following formulæ will render equally correct results and may be used for all styles of 60-deg. threads by any one who has a knowledge of ordinary arithmetic. In both instances the size of wire used should be such that the points of tangency will lie in the pitch line.

Diameter of Wire. (See Fig. 1.) The diameter of wire which will touch the sides of the thread at the pitch line = $\frac{2}{3}$ depth of a sharp V thread. The depth is determined by dividing $\frac{1}{2}$ the decimal pitch by the tangent of $\frac{1}{2}$ the included angle, or by 0.57735.

[1] Major, Ord. Dept., U. S. A.; Gage Dept., Frankford Arsenal.

$$W = \frac{2}{3}D \qquad D = \frac{H}{\tan 30°}$$

$$W = \frac{P\ (\text{Decimal})}{1.7321}$$

where

P = pitch

W = diam. of wire

H = $\frac{1}{2}$ pitch

D = depth of sharp V

Pitch Diameter. The pitch diameter of a thread gage or a tap

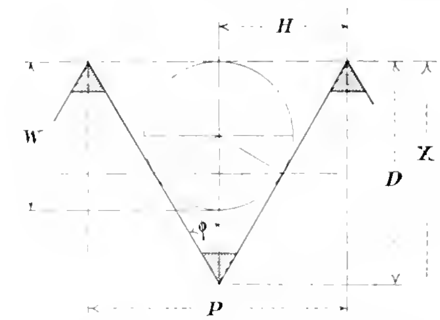


Fig. 1 Diameter of Wire to Touch Threads at Pitch Line

can be computed by substituting the measurement over the wires and the mean diameter of wire in the formula

$$PD = X - 1.5W$$

where

PD = pitch diam.

X = measurement over wires

W = mean diam. of wires.

The dimension over the wires is found by adding 1.5 times the mean diameter of the wires to the pitch diameter as given in Fig. 1. Any variations from the measurements thus found indicate over or under size at pitch diameter.

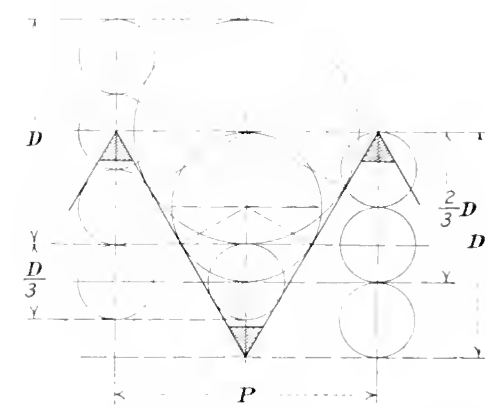


Fig. 2 Checking Angle on 60-deg. Threads with Standard Best Wires

Test for Angle of 60-Deg. Thread by Use of Wires

The angle of a 60-deg. thread can be tested by using two wires, the diameter of the larger being equal to the single depth of a sharp V thread and the smaller equal to $\frac{1}{3}$ the single depth of the sharp thread. (See Fig. 2.) Knowing the diameter of the wire, which is tangent to the sides of the thread at the pitch line, the diameter of the large wire can be found by multiplying that value by 3 and dividing by 2. The diameter of the small wire is equal to $\frac{1}{3}$ the diameter of the large wire.

When both wires are placed in the thread and touching the sides of the thread, they will be tangent to each other at the pitch line.

To make this system practical for the checking of angles, the

small wire ($D/3$) should be made in two sizes and used as a "go" and "no go" gage. The sizes of "go" and "no go" wires are determined by the allowable tolerance of the angle. The large wire being held against the angle of the thread will permit the small "go" wire to pass underneath. The "no go" wire should not pass, if the angle is within the specified tolerance.

The larger wire touches slightly below the top of the U. S. Standard thread approximately a distance equaling the flat on the top of thread. The small wire lies on the angle at the same distance from the root of the thread. This makes the approximate range of the angle test about $^3/_4$ the depth of the thread.

The writer recommends that working drawings show methods of inspection and all necessary dimensions. This will obviate many errors, usually resulting in the complete loss of the article. This method also reduces the cost of computation, which would be made once, whereas in the present practice the shop mechanic and inspector usually work separately, thus naturally increasing the cost of the product.

Luther D. Burlingame referred to the joint meeting of the Society with the Institution of Mechanical Engineers in England in 1910, when Sir Richard Glazebrook was kind enough to say that, while Great Britain had shown the way toward standardization and toward interchangeability of parts, it had been the part of America to put that into practice. Now the table is turned, and as we read of what has been accomplished at the Bureau of Standards, we find that we have ourselves been learning the advanced work which had been done in Great Britain so that the two great Anglo-Saxon peoples are working together, each to help the other in carrying these matters toward solution. We must remember, however, that the final question is not that of gages, but of knowing that the final product will be workable and satisfactory.

He said that Mr. Wells has expressed the thought that there are so many steps in the question of tolerances, that a much more complicated problem is presented than would seem on the face of it. As an aid to this, however, we have the possibility of combining the errors of lead and diameter in such a way that an increased error of diameter may be compensated for by an error in lead, and as far as we can take advantage of this condition we can increase our tolerances; but the last word will not be said in this matter until we have means of combining measurements so that we know what is the combined error of diameter and lead.

H. H. Suplee, in alluding to the praise Mr. Hartness had bestowed upon the work of the National Physical Laboratory and the Bureau of Standards, reminded his hearers that the latter was established as a result of a paper presented before this Society some 25 years ago by James W. See, of Hamilton, Ohio. Mr. See wrote a paper on standards, and after he had presented it, he recommended that there should be a Bureau of Standards established by this Government. A committee of this Society went to Washington and the Bureau of Standards was established. The National Physical Laboratory was started after that, but the whole idea of the Bureau of Standards originated in this Society.

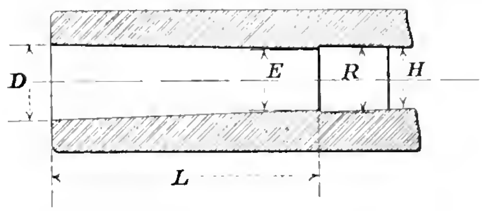
"There was a movement years ago," he wrote, "to abolish all numbered sizes for any purpose whatever, and I think it should be revived. The late James Christie was active in the promulgation of this idea, which I found quite easy to follow, because the actual size was always the thing desired, while the arbitrary number given to it was a matter of no interest whatever.

"I suggest, therefore, as an amendment to the system proposed that the number of the taper be omitted, and that the length of taper be made three times the diameter at large end, instead of twice plus four."

William Bacon. (Written.) During the past three years the Reed-Prentice Company has made a study of the subject of lathe centers and has adopted for its use a formula based on the Jarno taper.

The taper adopted is 0.6 in. per ft.; length = 2 × diameter of large end + $1^3/_4$ in., and the number of taper is designated by diameter × 8. The following table gives the dimensions for the lathes made by this company.

DIMENSIONS OF LATHE-SPINDLE TAPERS



(All dimensions in inches. No. of taper = $D \times 8$; $L = 2D + 1.75$ in., $E = D - 0.05L$; $R = E + \frac{1}{32}$ in.)

No.	Lathe Size, Inches		D	E	L	R	H
	Reed	Prentice					
9	12 engine (existing)	......	$1\frac{1}{8}$	0.925	4	$E+\frac{1}{32}$	$\frac{15}{16}$
11	12 engine (new design	12 H. S.	$1\frac{3}{8}$	1.150	$4\frac{1}{2}$	$E+\frac{1}{32}$	$1\frac{1}{8}$
12	14 engine	14 H. S.	$1\frac{1}{2}$	1.263	$4\frac{3}{4}$	$E+\frac{1}{32}$	$1\frac{1}{4}$
13	16 engine	16 H. S.	$1\frac{5}{8}$	1.375	5	$E+\frac{1}{32}$	$1\frac{3}{8}$
15	18 engine	18 H. S.	$1\frac{7}{8}$	1.600	$5\frac{1}{2}$	$E+\frac{1}{32}$	$1\frac{1}{2}$
17	20 engine	20 H. S.	$2\frac{1}{8}$	1.825	6	$E+\frac{1}{32}$	$1\frac{3}{4}$
17	22 engine	..	$2\frac{1}{8}$	1.825	6	$E+\frac{1}{32}$	$1\frac{3}{4}$
19	24 engine	24 H. S.	$2\frac{3}{8}$	2.050	$6\frac{1}{2}$	$E+\frac{1}{32}$	2
23	27 engine	27 H. S.	$2\frac{7}{8}$	2.500	$7\frac{1}{2}$	$E+\frac{1}{32}$	$2\frac{1}{2}$
23	32 engine	....	$2\frac{7}{8}$	2.500	$7\frac{1}{2}$	$E+\frac{1}{32}$	$2\frac{1}{2}$
9		No. 00 Auto.	$1\frac{1}{8}$	0.925	4	$E+\frac{1}{32}$	$\frac{15}{16}$
11		No. 0 Auto.	$1\frac{3}{8}$	1.150	$4\frac{1}{2}$	$E+\frac{1}{32}$	$1\frac{1}{8}$
14		No. 1 Auto.	$1\frac{3}{4}$	1.487	$5\frac{1}{4}$	$E+\frac{1}{32}$	$1\frac{1}{8}$
14		No. 2 Auto.	$1\frac{3}{4}$	1.487	$5\frac{1}{4}$	$E+\frac{1}{32}$	$1\frac{1}{8}$
18		No. 3 Auto.	$2\frac{1}{4}$	1.937	$6\frac{1}{4}$	$E+\frac{1}{32}$	$1\frac{1}{8}$
11	14 N. H.	...	$1\frac{3}{8}$	1.150	$4\frac{1}{2}$	$E+\frac{1}{32}$	$1\frac{1}{8}$

STANDARD TAPERS FOR SHANKS AND SOCKETS

The final paper by Luther D. Burlingame on Standards for Large Taper Shanks and Sockets, was briefly discussed.

Wilfred Lewis wrote in approval of the $^3/_4$ in. per foot taper for large taper shanks and sockets, but was not so sure about the lengths recommended—he did not see why all shanks and sockets should not be similar in every respect. He was disposed to agree with Mr. Walters of the Westinghouse Company in advising a length of three times the diameter.

He thought Mr. Burlingame had done well in his choice of sizes: 4, 5, 6, 7, and their multiples by two, making 8, 10, 12, 14; thus forming the basis for a rational progression in sizes, stepping up again to 16, 20, 24, 28, or down by division to 2, 2.5, 3, 3.5 and so on, as far as may be desired. He did not believe, however, in designating these by the numbers 19, 20, 21, etc., as proposed. No. 19, also, conflicts with No. 19 of the Jarno taper. He would prefer to designate the tapers by the sizes themselves.

The timely address by Dr. Frederick G. Cottrell, Chief Metallurgist of the Bureau of Mines, on The Liquefaction and Separation of Gases, an abstract of which appears elsewhere in this number, records one of the most important industrial developments of the past year, i. e., the low-cost production of helium for use in dirigible and observation balloons. During the period of the war, so Doctor Cottrell relates, the word "argon" was used in all correspondence as a code term for helium. While argon and helium are both inert gases, argon is too heavy for use in balloons, and is familiar because of its extensive use in the incandescent-lamp industry. It was thought, therefore, that the term would be a particularly effective camouflage, which actually proved to be the case, since there is evidence of the two words being confused in the public's mind. Doctor Cottrell urges, now that all secrecy has been abandoned, that the correct term, helium, be used whenever referring to the subject.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Departments of MECHANICAL ENGINEERING by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in THE JOURNAL, or brief articles of current interest to mechanical engineers.

"Over the Top" in France

TO THE EDITOR:

I am in receipt of your letter of the 31st ult., and will say that on my return to the States I may be able to contribute some articles from my experiences and observations over here that will be of interest for THE JOURNAL and I will try to arrange this. I am first and last for anything that will be of interest and aid to anyone in any of the engineering lines.

My regiment spent the last three months of hostilities in front-line work without a day's rest, and on two or three occasions was on duty three days and nights without rest or sleep—then a four hours' rest and back into the big game—not a murmur nor a complaint. That is a good sample of our boys as I have seen them. They have done wonders which in many other countries would call for lavish praise and commendation, but which with us was merely a part of the day's work. As one of the Corps Engineer Officers, 1st Army Corps, First Army, I saw nine different divisions go in and out, and in action in one of the most heavily fortified or organized sections of the front. Their deeds of heroism were legion and probably few of them will be chronicled; but I have seen them chronicled on the terrain of France, whether it was down the slopes of Hills 304 and 295 and over the summit of Monfaucon, or in the Bois de Cheppy—names that have stood forth in letters of fire and blood since February, 1916, when the German ambitious attempt to take Verdun started. From the Swiss border to the North Sea you will find at intervals little plots filled with crosses bearing metal disks with such names as Ferrati, Grunsky, Jones, Murphy and Schuster—damned good Americans, all of them.

When I landed in France in June things were gloomy. The German offensive was still on and going good. The Allies were standing sledge-hammer blows and had been for four years. They had seen month after month and year after year of deadly fighting and were tired. It seemed as if they must be forced to acknowledge defeat before the United States could bring her resources to bear. They knew we were sending men, and thought that they would help some by putting a regiment here and there, but they did not believe that such a thing as an American Army could be possible for another year.

The "Pershing System" had been under way for about a year when I landed in France in June, and while this "system" had not been trumpeted about, there was one man at least who knew what was being done, and that was the American Commander-in-Chief. In the dark days when the Germans swept forward to the Marne for the second time, General Pershing placed all the resources of the American Army at the disposal of Marshal Foch. No doubt our allies expected a division here and there sandwiched in between veteran troops to help some, but if the truth were acknowledged that is about all they expected. Then came Chateau-Thierry and Belleau Wood, and our allies stirred. By chance, when the Germans crossed the Marne with Paris as an objective, two of our divisions were directly between them and their objective. The Germans began their "infiltration" methods that had been netting them gains everywhere, but our divisions opened at 800 yards with a deadly, aimed rifle fire that wrecked the German system. Aimed, accurate rifle fire in the heat of battle amazed our allies.

When the accurate rifle fire had shattered attack after attack, our divisions went forward with the bayonet with an enthusiasm and an earnestness that surprised the French and disheartened the Germans. Then followed the advance from the Marne to the Vesle, and our men occupied the hottest part of the line and held their own with the French veterans. Some divisions of the famous Prussian Guards were sent in to stop the "schweinhund" Americans at all costs, but they were cut to pieces just as badly as if they had been only Landwehr divisions. It may have been that our boys had been too busy practicing the art of war to study up on the Prussian Guards and didn't know they were "famous," but my impression is they simply didn't give a rap—they were simply Boche, and being Boche were due to get cut up.

The fighting on the Marne and to the Vesle was not only a great victory, but it was more than that. Our allies were introduced to the American divisions as fighting units that could hold up their end under any conditions. The "pep" and the unbounded enthusiasm of the American soldier became infectious. A little of the tired and gloomy looks began to disappear. General Pershing had built his system around his conception of the American man as a soldier, and American manhood did not fail him.

In August the organization of the First American Army was announced. General Pershing assembled his veteran divisions and some that were comparatively new. On September 12 the world learned that the First American Army had made an independent move—a stroke against the famous St. Mihiel salient that had been a thorn in the side of France for four years. In less than a week this entire salient was wiped out and 15,000 Germans captured, together with hundreds of guns and enormous stores. Thus the First American Army made its bow to the world. While the St. Mihiel operations were conducted by the First Army, yet it was not all there by any means, but it was assembling and taking over the lines in the Argonne-Meuse sector and the heights north of Verdun, and on September 26 the First Army went "over the top" on a forty-mile front in the greatest military offensive the world has ever seen.

The pinching out of the St. Mihiel salient was only a prelude, a curtain raiser, for the "main act" that was only to end when Germany surrendered unconditionally. The sides of the St. Mihiel salient were backed by natural positions that were strong in themselves and sections of the German line from St. Mihiel to Pont-à-Mousson were lined with a network of concrete machine-gun positions ("pill boxes"), so the whole salient was a sort of fortress that had resisted all attempt at capture for four years. As for the line held by the First American Army from west of the Argonne Forest to the north of Verdun, this front was as highly organized and protected by every sort of means the Germans could devise. During the four-and-a-half years of the war this section of the line had become almost a vast graveyard—of German hopes as well as of men. Military authorities have estimated that the eight months' effort of the Germans to take Verdun in 1916 cost them 400,000 to 500,000 in killed alone, and the French half as many. Viewing the country from the heights of Monfaucon to the south to Hill 295 (Le Mort Homme) and Hill 304, the only expression I could frame to describe it was a "scene of abominable desolation" as expressed in the Bible—it was pathetic—it was awful.

Recently, since our Army has gone forward to German soil, I stood on the summit of Monfaucon and looked over the country toward Verdun where shells by the million had poured and where men by the hundreds of thousands had died—died for what? only to satisfy the insane desires of a world-power Kaiser to perpetuate a rotten dynasty. This day, in the expanse of country as far as I could see there was not a single living person or thing. The ground for miles was upheaved and torn as by a gigantic earthquake. The ruins of the destroyed towns were dead. It seemed too unreal to be true—just a dead world in which all living beings had returned to dust. There is a pathetic grandeur about these "dead" towns that have been so ruthlessly destroyed. They seem

Members who were in attendance at the Spring Meeting at Worcester will remember with pleasure the address given at that time by Lieut.-Colonel J. Edward Cassidy, U. S. A., on Conditions and Requirements of Warfare, which so electrified the audience and enthused them with regard to the accomplishments of the engineer in the war. Lieut.-Colonel Cassidy was then stationed at Camp Devens, but shortly after went abroad with the Expeditionary Forces.

to say that they have given their all for France and plead that their naked ruins be hidden from the sight of man.

But not all destroyed towns are "dead"—some proclaim their immortality and defy the human agency to destroy them. The town of Monfaucon stands on a hill some 40 meters higher than any of the surrounding country, and the ruins of the town stand forth against the skyline for a great many miles around, and seem to me to be a deathless monument that proclaims its martyrdom but still holds a taunt and a dare to the German to do his worst. Verdun, I call "The City that Could not Die." A city that was so much of a temptation to the Boche as to cause him to waste his soldiers by the hundreds of thousands, and a city that caused the French poilu to perform superhuman deeds in its defense, cannot be an ordinary city. It was a tantalizinz will-of-the-wisp, a sort of end of the rainbow, always just a little distance ahead but always out of reach—to the Germans; and to the French, something too sacred to be permitted to fall into the bloody hands of the invader. Shelled continually day after day and year after year for more than four years, until the grip of the Germans on the approaches to the city was broken forever by the First American Army, "The City that Could not Die," though torn by shells and partly wrecked, stands today and will stand for generations to come as a monument to the valor of the soldiers who defended it so well.

I trust that some writer or historian who can paint word pictures of these ravished towns and cities of France and Belgium will study them while they are yet unchanged, so as to record their history for generations yet unborn.

J. Edward Cassidy,
Lieut.-Colonel, Engineers, U. S. A.

With American Expeditionary Forces
December 1, 1918

Committee on Aims and Organization

To the Editor:

During the discussion of the report of the recently appointed Committee on Aims and Organization at the Annual Meeting, Mr. Spencer Miller—a member of the Council—urged that as a supplement to all that has been said and written on a re-aimed and reorganized A.S.M.E., there should be presented a terse statement of definite steps to be taken in effecting the desired result. "Let them give us 'fourteen' points," was his appeal, as I recall it.

Each member of the Society would probably have his own reply to such a request. No such expression of opinion should be without value in our further discussion. May I submit one group of definite suggestions, each of which appears to me to be both possible and important and some almost vital to our future progress.

Any statement of aims and purposes either for an individual or a society should be elevated in tone and broad in scope. The times invite a position of influence and a breadth of usefulness for the engineer—and especially the mechanical engineer—nowhere suggested in our official pronouncements. Hence fundamental to all genuine progress we should have:

1 *A Restatement of Our Aims and Objects.* Our present activities both in quality and scope transcend the limitations of the Constitution. It would be better if this condition could be reversed. Our Constitution should present a goal to which we could aspire rather than set limits which we have long since passed.

A growing measure of democracy must be developed in all our affairs as for instance through:

2 *Publicity.* Provide at every annual and semi-annual meeting a session at which the affairs of our Society can be discussed with reasonable informality and until everybody is reasonably satisfied; encourage the publication of several pages of such letters as this—not about technical matters but about the life of the Society—in each issue of Mechanical Engineering.

3 *Encouragement of Younger Members.* Grant junior members the right to vote and hold office. The 21-to-30-year-old men vote in city, state and nation. Young doctors vote in the American Medical Association. Why not take a chance on the young engineers? We need both their enthusiasm and their point of view. This class of members will always be in a hopeless minority.

4 *Home Rule.* Remove every possible restraint on freedom of action on the part of local branches.

5 *Popular Election of Officers.* Now that the Nominating Committee is to be elected, put some thought and energy into getting everybody into the play. No mere change in machinery will do it. The proposed system may easily give results less beneficial to the Society than the one it supersedes. Publish a 100-word sketch about each candidate for office. Let the members know for whom they are voting.

6 *Appeals.* Provide for a review of all administrative acts, such as those of the Meetings Committee in rejecting papers and of the Membership Committee in rejecting members. This machinery will not often be used, but its existence will provide a safeguard and remove one of the causes of bitter dissatisfaction in the past.

The prestige of the engineering profession will be enhanced not only as we render increased service but also as we raise our standards of professional conduct, hence we must provide:

7 *A New Code of Ethics.* At one of the sessions of the Worcester meeting a vote in favor of a more advanced code was passed.

8 *Means of Enforcing Standards of Professional Practice.* Such administrative methods are already in force with the American Institute of Architects and work satisfactorily.

Everybody admits that this is the "day of the engineer," and yet as a profession we get almost no recognition because we are cut up into organizations representing divisions and subdivisions of the engineering profession. We should come out frankly in favor of:

9 *One National Engineering Society.* Work for it in season and out of season, and above all until it is accomplished we should do nothing for our own advancement which will make its attainment more difficult.

Certain of our activities require to be taken more seriously—as for instance—

10 *Employment.* In view of some of the work on the classification of the personnel in the Army and the "hiring and firing" methods used by forward-thinking industrial concerns, the employment work of our great engineering societies has been crude indeed.

11 *Public Engineering.* The education on engineering matters which our profession affords the public through its national and its local societies is almost *nil*, as compared for instance with that rendered by the medical and even the architectural profession. Special emphasis should be placed on assistance to be rendered to public officials having engineering for their field.

12 *Engineering Internationalism.* Engineers—and our Society especially—have done much to promote friendly international relations. But the issue of the war has emphasized the importance of such work and we should lay our plans for the future along the broadest lines.

An adequate administrative machine is required for any enterprise. A single executive leader is an essential cog in any such machine. Responsibility implies authority and real authority is not conferred through a title. We need in the A.S.M.E.:

13 *A Salaried Administrator with Power.* Call him Secretary, Executive Secretary, Managing Director or what you like. He must be the working head of the Society elected by the Council and holding office while he gets results. His authority or responsibility should correspond to that of the president of a corporation.

14 "*Chairman of the Board.*" This is the function which the President of the Society, elected annually, should be given. We have never had a president who gave enough time to the work of the Society to warrant his assuming the executive and administrative leadership of its affairs. The one-year term would make success impossible.

Our Society has had a splendid part in the development of the art and science of engineering. The times demand both broad vision and indomitable purpose in the application of engineering knowledge to the needs of mankind. Given both, our association of 10,000 members may play a master rôle in the years just ahead.

Morris Llewellyn Cooke.

Philadelphia, Pa.

A Useful Industrial Diagram

To the Editor:

Many methods of showing in diagrammatic form the time-output and similar data are in general use.

The most general arrangement is that shown by Fig. 1, which illustrates monthly fluctuations in output. The output may be

in tons of castings, numbers of automobiles, or may be profit realized monthly, or anything else related to time.

As a record of the past a diagram such as this leaves nothing to be desired.

The executive, however, whether he deal with materials or dollars, is not satisfied with a mere record of what has occurred in the past, but he wants to use the past experience as a basis for consideration or production of the future. It is possible to extend the recording curve of Fig. 1 to indicate a future probability, but this is neither safe nor simple.

Plotting the same data in somewhat different form as in Fig. 2

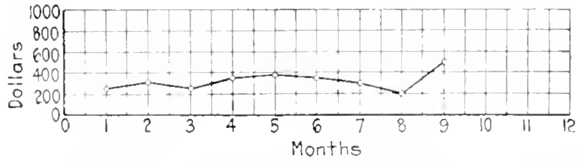


Fig. 1 Diagram Showing Monthly Fluctuations in Output

answers every question as to the past and also readily predicts the probabilities of the future.

To deal with something concrete, let us say that it is the profits of the business that are being examined, that these are being ascertained monthly, that the corresponding result for the year is desired and that the prediction is to be brought up to date or corrected each month.

In Fig. 2 each month's earnings are plotted to a curve duplicating the usual one illustrated in Fig. 1. This is the lower curve shown.

Over each month there is plotted the total profit to date. For instance, January shows \$250, February, \$300, and the total there-

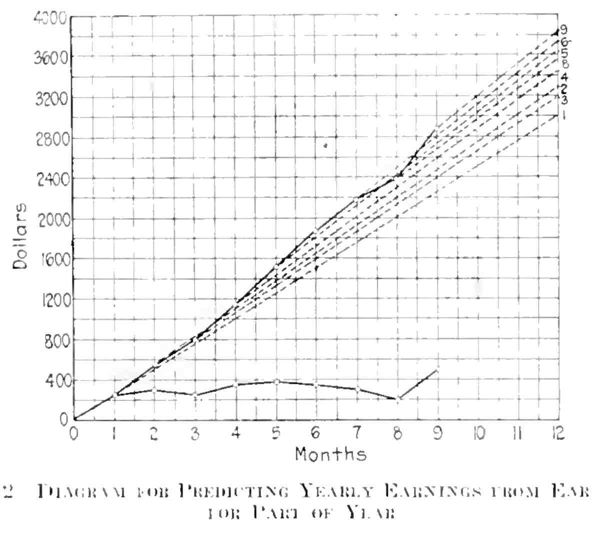


Fig. 2 Diagram for Predicting Yearly Earnings from Earnings for Part of Year

fore to date is \$550. These are shown by the upper solid curve.

To predict the probable profit for the year it is only necessary to draw a line from zero through the total earnings to date and to continue that line to the twelfth month; for example, the total profit by the end of the fourth month was \$1150; the projection shows \$3450 as the probable rate of profit for the year resulting from the first four months. An examination of the diagram shows that there is an improvement in the second and third months over the first month and an improvement in rate by the end of the fourth month over the previous months. By the eighth month, however, the rate had fallen off from that of the fifth, sixth and seventh months, as is clear from the production line for the eighth month falling below that of these previous three months. The ninth month, however, showed clearly an improvement in the rate to date.

The inclination of the lines giving the totals of each month also furnishes useful data. It is clear that if these lines all have the same slope, the increase from month to month is then equal. A lesser angle shows a decrease in monthly earnings and a greater angle shows a decrease in monthly earnings.

The most useful element of this form of plot, however, is the projection into the future and the ability that it gives to instantaneously correct the indications of previous periods by the result of the last period.

Henry Hess.

Philadelphia, Pa.

Power Supply to the A. E. F. in France

In the last of his series of articles in the *Saturday Evening Post* on "Business-Managing War," Isaac F. Marcosson describes the problem of securing power for the many industrial needs of the A. E. F. in France, and of the work in this connection by a member of this Society, Maj. Dugald C. Jackson, Professor of Electrical Engineering at the Massachusetts Institute of Technology. Mr. Marcosson writes:

It must be understood that the A. E. F. is engaged in an immense industrial activity in France. We have enormous car and locomotive erection and repair shops; we build tanks; reconstruct motor transport; salvage endless equipment; occupy hospitals almost without number; operate docks; roast and grind coffee and manufacture chocolate. All this requires power, and every service clamors for it. How do we get it? * * * * *

The general purchasing agent met the emergency by establishing what is known as a technical board, one of the many activities under his supervision. The executive head of this board is Lieut.-Col. Francis E. Drake, who as chief of the control bureau is the chairman of the technical board. The active head, however, is the chief engineer, Maj. Dugald C. Jackson, a widely known consulting engineer with much experience in public utilities in America, who was a member of the faculty of the Massachusetts Institute of Technology. Associated with him from the start has been Capt. Albert B. Cudebec, a specialist in hydroelectric construction, who with Major Jackson was one of the pioneers in American Army power production in France. Gradually they have assembled a group of more than forty engineers who in civil life built dams and irrigation projects and installed power plants from the Atlantic to the Pacific. The technical board is a sort of congress of experts which, in the face of almost innumerable obstacles, has furnished the juice to drive the Army's many-sided industries.

Since it was extremely difficult to get complete new power plants from America, the board set about to develop and adapt existing French power establishments to the American needs. Wherever an uncompleted French power station was discovered American construction gangs were put to work to complete it. Every possible makeshift was employed, all to the end that power be secured. The general purchasing agent learned that some Swiss turbines intended for Russia had not been shipped. They were immediately secured and installed by American engineers in a French power station. Our purchasing representatives scoured all Europe for installations. A complete plant was discovered in Portugal. Within sixty days it was driving machinery up in the advanced section. The technical knowledge required for all this adjusting and adapting frequently had to be supplemented by tact of the highest order, for the reason that these undertakings involved rival French commercial interests, which were jealous of their prerogatives and which had to be reconciled to the larger obligation that both France and America were being served by this expansion.

The technical board is on the job day and night and it has met emergencies with a degree of swiftness not surpassed on the firing line. Here is a concrete story that will show the kind of propositions that are put up to it: On September seventeenth last, Major Jackson received the following telegram from G-4—the army coördinator—at Tours: "Get 3000-kilowatt plant in Europe." It was intended for immediate and urgent use at a large base port that we are using. Within a week a plant had been located in England and in a month it was installed in France.

A huge map that hangs in Major Jackson's office at the Elysée Palace Hotel gives a comprehensive idea of the empire of power that we have helped to develop in France. We use power in exactly three hundred and twenty-eight localities. Each one of these installations is shown in a concrete way. The master color for steam-generating plants is green, and hydroelectric service is in blue. Whenever the service is all-American the indication is surrounded by a red circle. In addition to this every army activity has its own color. An orange square denotes a bakery; a black square a salvage depot; a green-and-white square an aviation center; three white squares reveal a tank-building plant, and so on.

This American-developed power area means a great deal more than driving machinery in A. E. F. bakeries, salvage depots, air-service stations and machine shops. It has a significance for peace not to be overestimated. Combined with the utilization of water power, which is incorporated into our general power scheme, an immense section of France is likely to be diverted after the war from agriculture to industry. The brilliant imagination of the French has caught the spirit of what adequate power means. In this inevitable evolution you see one of the many permanent results of the advent of the American Army.

ENGINEERING SURVEY

A Review of Progress and Attainment in Mechanical Engineering and Related Fields, as Gathered from Current Technical Periodicals and Other Sources

AERONAUTICS

STABILITY OF A PARACHUTE, S. Brodetsky (*Tôhoku Math. J.* 14, pp. 116-123, Aug. 1918). Investigates the equations of motion of a falling parachute with its load, assuming these to be rigidly connected and not to possess independent oscillations. The conditions for stability are that $A^2 > B$, and D, the depth of the center of gravity of the passenger below the center of gravity of the parachute itself, must lie between the values—

$$\tfrac{1}{2}(1-m)^{-1}\left\{A \pm \sqrt{A^2 - B}\right\}$$

Here $A = a/\rho$ and $B = 4\,[(1-m)/m]\,[(1-m)k_1^2 + mk_2^2 - Ad_1]$; $m = W_2/(W_1 + W_2)$, where W_1 is the weight of the umbrella and W_2 that of the passenger; $W_1k_1^2$ and $W_2k_2^2$ are respectively the moments of inertia of the umbrella and the passenger about parallel axes through their respective centers of gravity and parallel to the plane of the umbrella, a is the radius of the umbrella and ρ is a constant depending on its shape (for a circular plate ρ is probably nearly equal to 4). *Science Abstracts,* Section A—Physics, vol. 21, pt. 11, Nov. 30, 1918 (No. 251), p. 449, *t*)

CEMENT AND CONCRETE

POTASH IN CEMENT-MILL DUST, Albert R. Merz and Wm. H. Ross. In view of the importance of the recovery of potash from the flue dust of cement mills, the following information as to the nature of the recombined potash thus recovered may be of interest.

The analyses have shown that in some cases potash recovered from the dust was found to consist in part of a material insoluble in acids, while its other part was soluble in acids but insoluble in water.

Further, it was found that in the oil-fired plant of the Riverside Portland Cement Company the greater part of the potash in the dust was readily soluble in water, while in dust collected at plants where coal is used for fuel it was found that the greater part of the total potash was acid-soluble, which greatly reduces its value for use as a fertilizer.

The present article discusses the origin of the water-insoluble potash in the dust and comes to the conclusion that its presence is due first to the ash of the coal and the dust carried over mechanically, but also possibly to the fact that a certain portion of the potash has been volatilized in the process of burning and has undergone a recombination during its passage from the kiln.

As a practical suggestion it is stated to be probable that the proportion of recombined potash in those dusts which contain free carbon might be reduced to some extent if more of an oxidizing atmosphere was maintained in the kilns during the burning of the cement.

Also, the experiments described in the article lead one to believe that the addition to the raw mix of a salt of sodium, such as sodium chloride or common salt, would bring about a reduction of the recombined potash such as has actually been observed at the plant of the Security Cement and Lime Company. Further, little recombination of potash with coal ash takes place in the carbon-free mixtures when lime is present.

Finally, the greater the amount of potash volatilized the lower will be the proportion that will undergo recombination in the dust.

The article is based on work carried out at the Bureau of Soils, U. S. Department of Agriculture, Washington, D. C. (*The Journal of Industrial and Engineering Chemistry,* vol. 11, no. 1, January 1, 1919, pp. 39-45, *tpA*)

ENGINEERING MATERIALS

Testing Car-Wheel and Locomotive Tires

FALLING-WEIGHT TEST ON RAILWAY TIRES, J. H. G. Monypenny. Discussion of the reliability of the falling-weight test as showing the conditions of a railroad tire.

The writer explains that the conditions in the ingot from which the tire is rolled, namely, the roughness of the surface, especially toward the top of the ingot, are such that any object rolled from the rough part of the ingot is apt to have an imperfect surface and to be shelly and roaky. The surface of the ingot may be folded or pitted for many reasons and small holes may be present in an ingot immediately below the skin. These irregularities would be reproduced in one way or another as surface defects in the rolled tire—usually as small seams and also as laps, these latter due to negligent forging. Similar defects might be found on the inside surface of the tire, but they rarely occur there unless badly piped ingots are used.

Now, the character of the falling-weight test is such that the tire is severely distorted in certain parts, while in others it is hardly deformed at all. The test consists in placing the tire in a running position on a heavy steel block weighing from five tons up, supported on a rigid foundation. A tup generally weighing one ton is allowed to fall freely on to it from gradually increasing heights until the tire has given, without fracture, a certain minimum deflection, the amount of which depends on the diameter and thickness of the tire and the character of the steel of which it is made.

It is of importance to determine whether the small superficial cracks which have been found to have but little influence on the actual performance of the tire will affect results in the falling-weight test.

To determine this, small bars 0.45 in. in diameter were turned from tire steel. The first bar was not notched; the second bar was notched on one side only to a depth of 0.013 in. Other bars were notched similarly to the depth stated in Table 1. The bars were gripped in a vise and broken by the impact of a pendulum hammer (Izod test). The energy absorbed in breaking the bars is reported in the table. A comparison of the first two lines shows clearly how sensitive tire steel is to even a minute notch, which

would indicate that a tire having a surface defect which is in any way equivalent to a notch is liable to break prematurely under the drop test if the part containing this defect should happen to be located in the highly stressed area under the tup.

The writer says that during the past 14 years he has had many opportunities of examining tires which failed under these tests and noticed repeatedly how small a defect was required to cause

TABLE 1 DATA OF IZOD TEST ON BARS CUT FROM TIRE STEEL

Depth of notch	Energy absorbed in ft.-lb.
Unnotched	200
0.013 in.	23
0.030 in.	16
0.062 in.	7
0.125 in.	3

a high-tensile-steel tire to break, provided the defect happened to be in a critical section.

On the other hand, he claims that the question as to what influence such a defect would have on the life of a tire if it were undisclosed by the drop test, as frequently happens, can be answered easily.

Car and engine tires are machined on the inside and on the tread and flange and in many cases all over before being put into service and the majority of surface flaws would be completely removed during this operation, while flaws of this nature which have not been so removed would be visible on the machined surface.

The conclusion to which the writer arrives is that a tire should not be drop-tested in the rolled condition when it still carries the sins of the ingot and every other neglect or defect of manufacture. He urges that the drop-testing of tires should be done in such a manner that a tire is tested in the condition in which it is put into service. The only possible objection to this would be the waste of the machining costs if the tire failed to pass the test, but it would prevent the scrapping of good material which now takes place due to the condition stated above.

Attention is also called to another type of flaw, the effect of which is often overlooked. This is due to the series of stamped marks on the front of the tire. While it may be necessary for the railway companies to identify the tires they put into use, it is questionable whether it is equally necessary to have the life history of the tire from its infancy of molten steel onward stamped in half-inch letters round its face.

Steel used for tires is easily broken when notched and it would seem advisable to avoid lettering as far as possible. In fact, the writer shows in a photograph an instance where the fracture has probably been materially helped by the deep stamp marks. These stamp marks affect also the life of the tire as they are not removed during machining, but remain as very favorable places for starting points of cracks. (*Engineering*, vol. 106, no. 2759, November 15, 1918, pp. 545-547, 8 figs., *ep.A*)

Behavior of Hollow Building Tiles Under Strains

TESTS OF HOLLOW BUILDING TILES, Bernard D. Hathcock and Edward Skillman. Originally hollow building tile was used mostly for its fire-resisting properties, but, as its other advantages have become more generally recognized, its range of usefulness has been greatly broadened until today it is an important structural material. And, as a consequence of the rapid growth of its use and the relative lack of definite and reliable information of its strength, the tests described below have been made by the Bureau of Standards.

Tiles are molded of clays which are quite diversified in their properties, and, after drying, are burned in downdraft kilns at a temperature well beyond initial vitrification of the clay, but rarely high enough to complete vitrification. These methods introduce variables, especially of color and porosity, which are of great importance because of their relation to the strength properties of the tiles, and have been given consideration in the classification of the tiles of these tests. It is a well-known fact that in a downdraft kiln the upper courses of the tiles are heated to a higher temperature than the lower ones. This gives the top tile a higher degree of burning, those near mid-height a medium degree of burning, those near the bottom a low degree of burning. In general, the high-burned tiles are dark in color, the medium-burned of medium shade, and the low-burned light. However, this is not always true, for the natural color of some clays or the presence of coloring matter will cause a variation.

The tests of this paper are limited to those of compression and absorption. The total number of those performed is approximately 250, of which the majority were upon tiles in compression. Stress-strain readings were taken upon 114 of these for moduli of elasticity determinations. About 70 absorption tests were made upon samples taken from tiles previously tested in compression. All the tiles were graded according to their color as dark, medium, or light, corresponding to the variations produced as described above. The tiles tested were made, with few exceptions, from clay of the buff-burning variety, and the colors given indicate variations in the buff color.

Previous to testing the tiles, their sectional areas and weights were determined. The former was done by measuring the walls and partitions with calipers and computing the sectional area from these measurements. Then they were capped with plaster of paris, to insure a uniform bearing in the testing machine. Small brass plugs were also set in some of the tiles for compressometer readings. The type of compressometer used was the 6-in. Berry strain gage, and readings were taken with it near the four corners of every tile upon which stress-strain relations were desired. The testing machines used were of the Olsen universal type.

The absorption tests were made upon three samples selected from each tile upon which the absorption determination was desired. The tiles from which these samples were taken had been previously tested, in compression.

The results of the compression tests with moduli determinations show that the strain produced by loading a tile is approximately a linear function of the applied load until failure is approached, or in other words, the modulus of elasticity of a tile is practically constant until failure. This indicates also that there is no definite proportional limit for tile; that is, the proportional limit is coincident with failure.

Tiles were tested on end, on edge and flat, and the results show that in general a tile develops both the greatest unit strength and greatest total strength when it is laid on end. The relation between the moduli of elasticity of tiles and their compressive strengths is somewhat variable, or the tile having the highest modulus of elasticity may not have the greatest strength, but in general, if the modulus of elasticity is high it is to be expected that the compressive strength of the tiles will also be relatively high.

There was found to be no definite relation between the loads at the incipient failure and the maximum loads sustained by the tiles. In some cases the incipient failure occurred early in the tests, but in other tests no notice of failure was observed until the maximum loads were reached.

There is shown to be relationship existing between the colors of the tiles and their compressive strengths and the moduli of elasticity. The dark and medium-burned tiles have about the same relative compressive strengths and moduli of elasticity, while the same properties of light-burned tiles are on an average much lower.

From the results of the absorption tests it was found that the maximum compressive strengths vary approximately inversely with the percentages of absorption. Also the percentages of absorption of the tiles vary with their colors. In general, the darker the tiles the lower the percentages of absorption are likely to be, but this is not always true because either the material or the artificial color of the tiles may often be deceptive in this respect. (Abstract from Technologic Paper No. 120 of the Bureau of Standards; *eA*)

FUELS AND FIRING

Properties of Liberty Fuel and Results of Economy Tests. Some time ago an official statement was given to the press from a bureau of the War Department claiming that a new fuel had been invented by one of the officers of the department.

The basis of the fuel is kerosene treated with a chemical, with the result that its oxygen content is increased so that when the fuel is vaporized and admitted to the engine cylinder there is present some of the oxygen needed for the process of combustion.

Fig. 1 gives the distillation curves of different grades of Liberty fuel. It has a variable specific gravity according to its varying quality. The heat value per gallon is 127,900 B.t.u., which is somewhat higher than that of commercial gasoline. (*Power*, vol. 49, no. 1, January 7, 1919, p. 9, 2 figs., *d*)

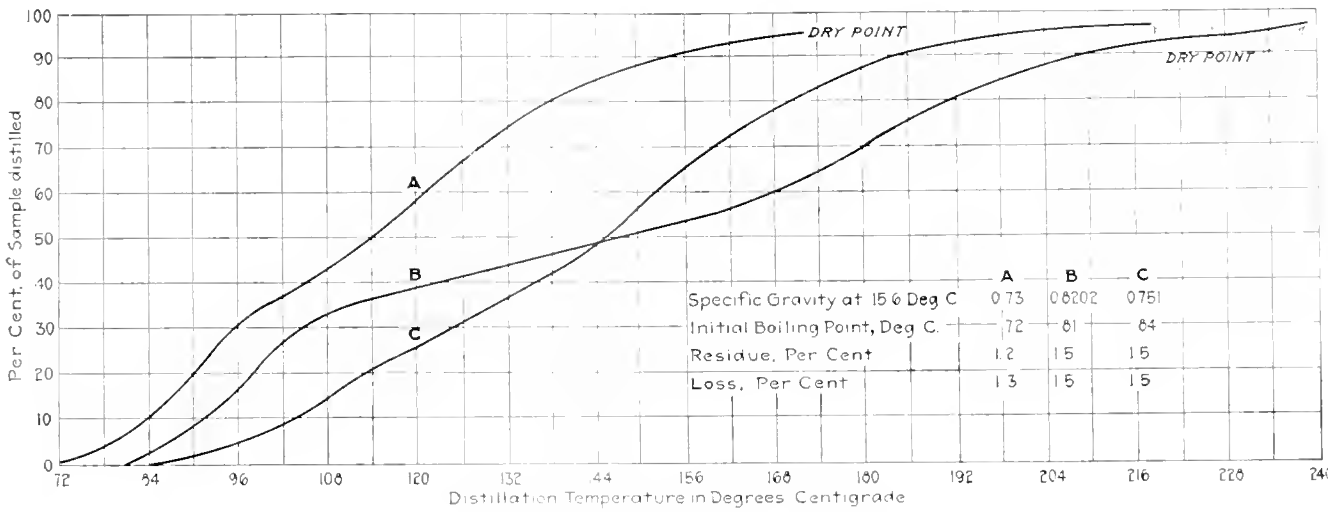


Fig. 1. Distillation Curves of Different Grades of Liberty Fuel

Note:—From data published since the appearance of the article abstracted here, it appears that the so-called Liberty fuel is a mixture, in various proportions, of kerosene and benzol, with addition of slight amounts of amyl acetate.

Efficient Burning of Indiana Coals

Burning Indiana Coal on the Chain Grate, T. A. Marsh, Mem.Am.Soc.M.E. The changes in coal distribution due to war conditions have brought Indiana coal to markets where its characteristics were not understood and the existing furnaces not suitable for efficient burning.

In Table 2 are given the analyses for standard Indiana coals which cover screenings but not run-of-mine or lump coal.

No. 3 coal, while not high in heat value, has the highest percentage of volatile matter and is excellent coal to use to get capacity in furnaces that are deficient in ignition arches or draft. It is not, however, a good coal to store both because it disintegrates easily and because of its high percentage of sulphur.

No. 4 has the greatest commercial value of all Indiana coals. Its heat value is relatively high for a western coal, the sulphur content low and the fixed carbon of such good structure that when used in by-product ovens excellent coke is produced. It is also well adapted for stoker uses, particularly with stokers that agitate the fuel bed.

From the point of view of steam production No. 5 stands at the head of Indiana coals, mainly on account of the large quantity produced, certainty of supply, uniformity and free-burning characteristics. On the other hand, as the coal has practically no clay mixture, the clinker produced is extremely vitreous. The coal is suitable for chain grates but the furnace must be such as to allow good strong ignition.

No. 6 cannot be used at all unless with a proper type of stoker, owing to the large amount of clinker produced and its vitreous structure.

As regards the design of furnaces for use with Indiana coals, the following suggestions are made:

Large grate surfaces should be provided as these coals are relatively inert. Also ample draft must be provided. These coals can be burned at combustion rates of 40 to 45 lb. per sq. ft. of grate area per hour with a draft of 0.4 to 0.5 in. over the fire.

Long, high-pitched ignition arches should also be provided and the furnace volumes should be large. In furnaces where 40 lb. of coal per hour per sq. ft. of grate area are to be burned, the furnace chamber should have a volume of 12 cu. ft. per sq. ft. of grate area, and furnaces even larger are desirable.

As regards the grates, it is claimed that large grates should be installed and the author shows a preference for grates of the chain type as they are claimed to reach excellent efficiencies at from 50 to 75 per cent of rating.

Several types of modern settings capable of producing high ratings and high efficiencies are shown in the illustrations in the original article. A prominent characteristic of all of these settings is the large volume of the furnace—from 12 to 13 cu. ft. per sq. ft. of grate area as compared with 3 to 6 cu. ft. per sq. ft. commonly found prior to 1916.

Analyses of Indiana Screenings

	No. 3 Seam	No. 4 Seam	No. 5 Seam	No. 6 Seam
Moisture	10.8	12.4	10.1	11.0
Volatile matter	35.0	33.2	33.2	31.1
Fixed carbon	36.9	44.2	42.0	41.5
Ash	17.3	10.2	14.7	16.4
B.t.u., commercial	10,400	11,069	10,820	10,540
B.t.u., dry basis	11,670	12,610	12,039	11,730
Sulphur	4.55	1.75	4.27	3.50

From this point of view it is interesting to compare Fig. 2 with Fig. 3. The former represents the designs of a furnace installed under the Stirling type of boiler 12 years ago, and the latter a recent revision of the same furnace. With the original furnace only the better grades of Indiana coals could be used. In the improved setting one continuous arch, 7 ft. 6 in. long, replaces the old sprung arch. After the revision it was found that the lower grades of Indiana coals could be nicely handled, inasmuch as the draft and grate area were adequate and the ignition was better.

From the foregoing discussion the following conclusions are evident:

1 Indiana coals are being and will be extensively used.

2 The characteristics of some of these coals are low fusing

temperature of the ash, great tendency to clinker, and large amount of clinker.

3 These coals give serious clinker trouble when the fuel bed is agitated. Continuous ash removal is preferable. With chain grates in modern furnaces, high capacities and efficiencies can be obtained from all grades of Indiana coal.

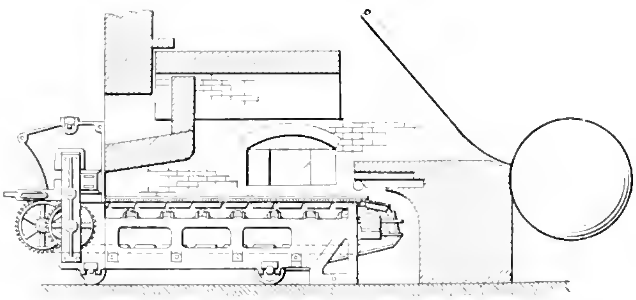


Fig. 2 Furnace Design 12 Years Ago

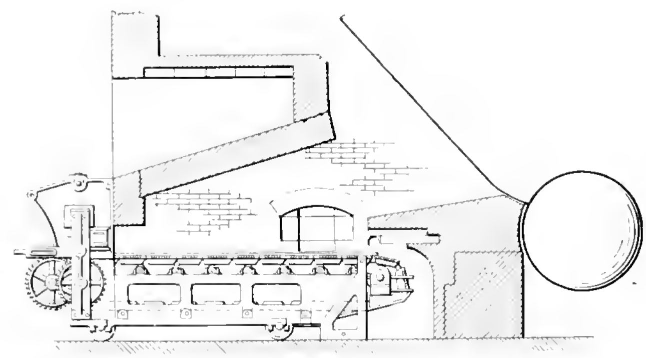


Fig. 3 Revision of Furnace Shown in Fig. 2

4 Existing furnaces permit improvement. Each should be considered in the light of modern engineering knowledge and can be revised, widening the range of coals to include all Indiana seams and increasing the capacity and efficiency under all conditions. (*Power*, vol. 49, no. 1, January 7, 1919, pp. 17-19, 7 figs., *dt*)

MACHINE SHOP

Safety Precautions in Use of Cutting Lubricants

Skin Diseases Produced by Cutting Lubricants and Cooling Liquids. This abstract is taken from Bulletin No. 2 of the Scientific and Industrial Research Department, Great Britain, entitled Memorandum on Cutting Lubricants and Cooling Liquids and on Skin Diseases Produced by Lubricants.

The skin disease produced by lubricants are mainly in the nature of oil rashes and may be due to two principal causes:

1 *Blocking of the glands of the hair follicles.* The mixture of oil and dirt blocks the minute openings of these glands and sets up inflammation around the hairs (*folliculitis*). Inflammation starting in this way may lead to suppuration or abscess formation. If many hairs are affected in this way the arm presents the appearance of a crop of red spots with a black spot as a center, or a yellow head in the case of abscess formation.

2. *Mechanical injury to the skin by metallic particles.* This may be caused by the minute metallic particles suspended in the cutting lubricant, and occurs chiefly on the hands where two surfaces are rubbed together, e.g., between fingers. Injury to the skin may also be produced on any part of the hands and arms by wiping with a cloth or rag while the hands or arms are coated with a film of fluid in which metallic particles are suspended. The cuts in the skin allow germs to enter and may lead to septic infection.

The prevention lies in keeping the worker, the lubricant and the machines clean.

Washing accommodations must be provided on a liberal scale for workers in contact with oil. Hot water, soap and scrubbing brushes are essential. Workers should be instructed not to wipe their hands on rags before washing and to avoid washing their hands in the cutting compounds.

Ether soap which dissolves oil has been found useful in preventing inflammation of the hair follicles. Dusting the arms with a powder containing equal parts of starch and zinc oxide before commencing work prevents the action of the oil on the skin.

As regards the lubricant, care must be taken in the handling of the constituents before blending to prevent such changes as formation of free fatty acids. Also the constant removal of metal particles is necessary, which, by the way, cannot be achieved either by such filtration as is provided on the machines or by centrifugal action.

Where straight oils are used their viscosity can be diminished by heat sufficiently to allow the particles to sink without affecting the value of the oil as a lubricant.

It is stated that various antiseptics (e.g., carbolic acid in a proportion of 1 to 2 per cent) have been added to the lubricants to prevent rashes, but the results obtained have not been entirely satisfactory.

Sterilization by heat has also been attempted with apparently satisfactory results, but the actual temperature required to produce this germicidal action in the oil has not yet been determined.

Workers whose hands have been affected by septic infection should not be allowed to work on machines as they are liable to infect the oil with germs, and so infect others.

Certain individuals appear to be particularly susceptible to the action of lubricants. Such persons when found should be removed from contact with oil. (Abstracted through *Mechanical World*, vol. 64, no. 1661, November 1, 1918, pp. 207-208, *gp*)

Elliptical Gears Built Up From Segments, Robt. Mawson, Mem.Am.Soc.M.E. Description of the tools and methods used in machining a special type of elliptic gearing such as used in the movement of the printing bed of the Whitlock "pony" printing press. The gears used for this purpose are built up from segments which have been cut separately and are then bolted to a flange or web.

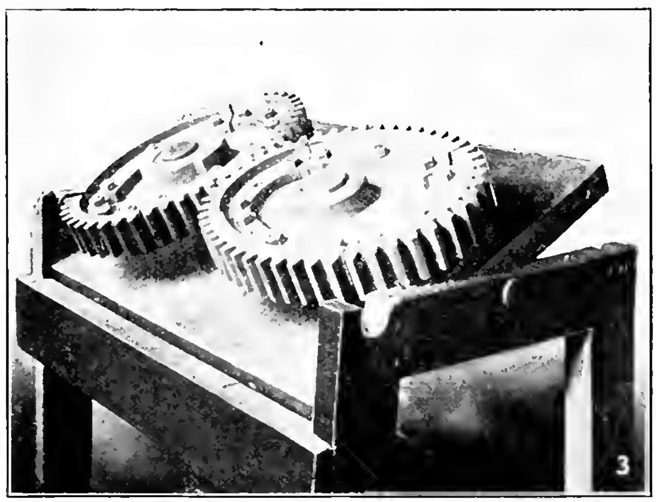


Fig. 4 Assembling Stand for Elliptical Gears

A special jig, shown in the original article, is used for drilling this web. The segments have corresponding jigs to locate the holes necessary to bolt them to the web. Finally, an assembling stand such as shown in Fig. 4 is used, and this can be set at any convenient angle to enable the operator to handle the job in the most efficient manner. The tilting baseplate has two fixed studs located at the proper center distance upon which the flanges or webs are placed and mating segments bolted to each of them. These two segments then receive such slight adjustment as may be necessary and by filing off the high spots are made to work smoothly together. Similar treatment is applied for each addi-

tional segment until the completed gears may be rotated without appreciable backlash or binding.

Since it is absolutely essential that every part of a printing press is in proper relation to every other part, the location of the keyway in these gears is determined after the gears are finished. A special feature employed in this connection is shown in the original article. (*American Machinist*, vol. 50, no. 2, January 9, 1919, pp. 61-62, 4 figs., *e*)

SOLDERS FOR ALUMINUM. The use, serviceability, method of application and composition of solders for aluminum are discussed in the light both of special tests made at the Bureau on commercial and other compositions of solders and of general experience with them. All soldered joints are subject to rapid corrosion and disintegration and are not recommended except where protection from corrosion is provided. Suitable compositions for solders are obtained by the use of tin, with addition of zinc or both zinc and aluminum within wide percentage limits. (Abstract from Bureau of Standards Circular No. 78; *p*)

MARINE ENGINEERING

Reinforced-Concrete Ship of Plate Construction

THE WALLER SYSTEM OF REINFORCED-CONCRETE SHIP CONSTRUCTION, W. Noble Twelvetrees. Description of the methods of ship construction evolved by Capt. J. H. de W. Waller of the British Admiralty, formerly a civil engineer of Dublin, as applied at the Lake Shipyard, Poole.

The characteristic feature of this system is the employment of precast plates in combination with frame members molded *in situ*.

The precast concrete plates are molded in open air on a series of concrete beds. The network of bars for each plate is assembled in a timber frame. The upper face of each plate is troweled while still green and after it has been covered with a coat of whitewash the next plate is molded upon it, the process being repeated until the stack of plates has reached the limit of height for convenient handling.

The work on the slipway is likewise quite simple. The plates forming the sides, bottom and deck of the ship are prepared and seasoned in advance, and therefore have merely to be erected and stayed in place. The only molds required are those for the longitudinal and transverse members of the framework. In order to provide secure anchorage between the several elements the plates are cast with the reinforcing bars projecting along all four sides and arrangements are made for the intermeshing and interlocking of these bars with those of adjacent plates and of members molded *in situ*.

A noteworthy feature of the vessel now under construction is the concentration of the main longitudinal reinforcement for withstanding hogging and sagging stresses in the bilges and gunwales. In fact, the vessel is designed somewhat on the lines of a through girder bridge, the principal longitudinal stresses being taken by the parallel girders constituting the sides of the vessel.

The principal transverse stresses in the deck and bottom are resisted by the transverse frames. The transverse bulkheads at the ends of the holds are built up of precast plates with counterforts extended at the foot and head to a width of 4 ft. 6 in. from the vertical axis. These counterforts are spaced 4 ft. apart transversely, and are of monolithic connection in each case with three of the transverse frames at the top and bottom of the hold. Consequently they form part of the main framework and provide secure support for the decking between or at the ends of the hatchway coamings.

Fig. 5 shows a general section through the frames. Among other things, it exhibits the curved form of the frame, which is a departure from usual practice. It is claimed, however, that this form is not only conducive to strength, but distributes more effectively the deformation of the frames and so reduces the tendency of the skin to rupture.

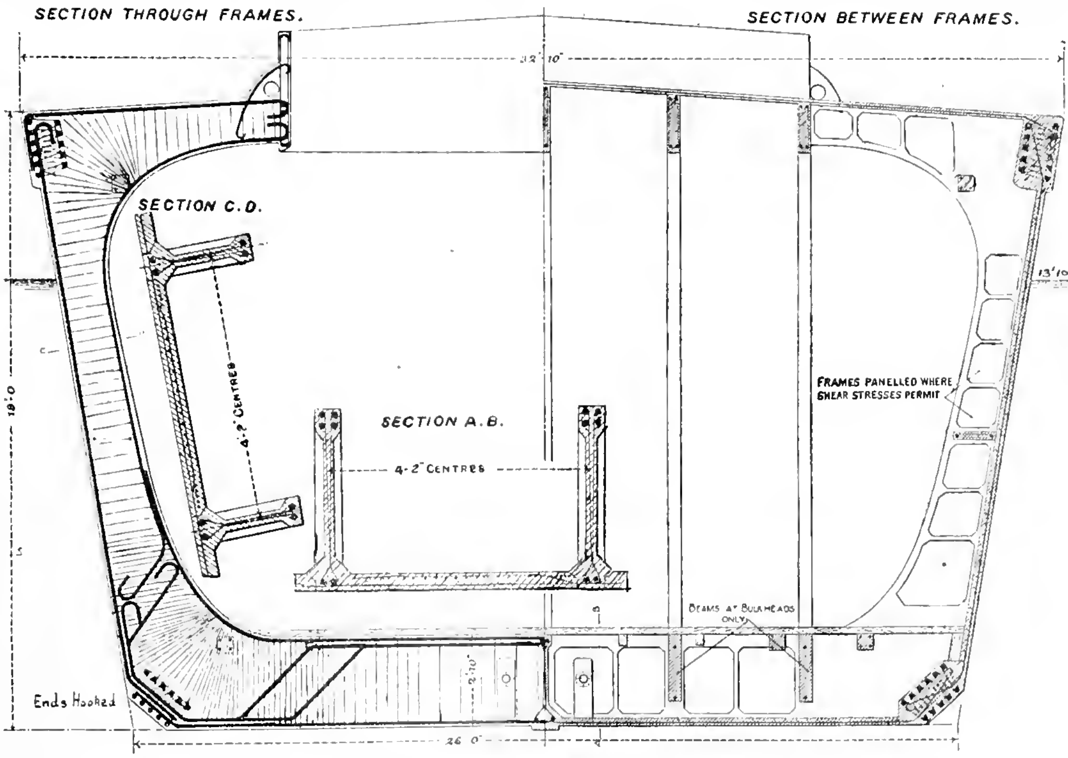


FIG. 5 SECTION THROUGH FRAMES OF WALLER TYPE OF REINFORCED-CONCRETE SHIP

The chief objection against the employment of precast units joined together by frame members molded *in situ* is that the joints may be broken by the hogging, sagging and twisting stresses on the vessel at sea. The reply of the adherents of the precast system is that joints actually exist even in vessels which are theoretically monolithic. The positions of such joints are not predetermined, however, but are governed by circumstances demanding the interruption of concreting work from time to time, and are therefore in a less favorable position than joints in the precast system, the location of which is always predetermined and selected so as to be in the most desirable places. In the Waller system, in particular, the arrangements are such that the principal stresses are assumed to be resisted entirely by the main framework which is molded on the monolithic principle, while the plates though help-

ing in resisting the shearing stresses are mainly intended to act as the skin of the vessel, being analogous to the plates of a steel ship.

It is claimed on behalf of the Waller system that a considerable saving in timber and skilled labor can be effected, because shuttering of the skin is entirely eliminated. Also, unskilled labor is economized, because the concrete of the plates is deposited at ground level, being poured quickly into open molds instead of being inserted and rammed with some difficulty between double shutters already packed with steel. It is stated that on a 1000-ton barge forty men working at once is an ample number. In a barge of 1000 tons dead-weight capacity some 200 plates are required. One plate can be cast daily on each molding bed. Therefore, if forty beds are available, the plates for the entire skin including bottom, sides and deck plates could be produced in six working days. In fact, it is believed that it will ultimately be possible to erect and concrete the hull of a 1000-ton barge in six weeks. (*Engineering*, vol. 106, no. 2760, November 22, 1918, pp. 580-583 and 586, 15 figs., *dA*)

Ship Ventilator Cowls, H. E. McCauley. Description of the processes of manufacture of ship ventilator cowls, including data on their design as used in the shops of the Sun Shipbuilding Company at Chester, Pa.

There are two types of ventilators in common use on shipboard. One has the joints crosswise on the length of the cowl between the sections that go to its make-up. This is usually called the American type of ventilator cowl. The other type of cowl is known as the European. In it the seams run lengthwise and this type is generally used for the larger sizes with mouths from 36 in. up to 84 in. in diameter or larger.

The method of laying out the templets for this type of cowl is described in the article in some detail. The article also describes and illustrates step by step the entire process of manufacture and gives an idea of the templets and forms used. (*American Machinist*, vol. 50, no. 2, January 9, 1919, pp. 47-51, 15 figs., *d*)

MEASURING INSTRUMENTS

Notes on Steam Meters, E. Claassen (*Zeits. V. reines Deutsch. Ing.* 62, pp. 521-526, Aug. 10, 1918). Though the mere provision of steam meters has a considerable indirect effect in securing steam economy, those hitherto used have conformed imperfectly to the desideratum that they should be both accurate and of rugged construction. Many types of meters yield poor accuracy, while others require skilled attention to keep them in order. Great numbers of St. John steam meters are used in America. The construction is very simple, the principle employed being that the lift of a cone opens a great or smaller steam passage according to the steam flow. In order that the lift of the cone may be directly proportional to the steam flow, the generating line of the cone's surface is made slightly curved. With a right cone, double the lift permits less than twice the flow, owing to the relatively smaller free openings; on the other hand, the increased pressure difference tends to pass more than twice the steam flow. The former factor is predominant, and to correct for it the surface of the cone is corrected by trial and error during the calibration of the meter. Calibration is therefore tedious and costly, twenty or more condensate tests often being required before sufficient accuracy can be obtained. Yet more serious is the fact that considerable errors are introduced by friction in the stuffing box through which passes the rod connecting the cone to the recording pencil. The author gives data from his own and other tests on this matter. Mere substitution of a ground spindle effects only temporary improvement if there is opportunity for scale to deposit on the metal.

One pattern of the Claassen steam meter is shown in the original article, and also the special type of packing employed. The tapered, ground-in spindle has very little friction and has proved satisfactory during 6 years' practical experience. Official test data and particulars from actual installations are given in the original. The meters are standardized by the Normal Eichungskommission (Charlottenburg). A particular meter showed the following variations from the mean constant: —2.2 per cent at 9 mm. lift; + 1.9 per cent at 43 mm. lift; and + 0.4 per cent at 58.6 mm. lift; thus the error was well within the permissible limits even at 1/7 of the maximum steam flow. A double meter used in a paper mill at Okulowka records accurately from 1000 to 11,000 kg. per hr. on one instrument, and up to 22,000 kg. per hr. when both meters are in commission.

Pressure loss in steam meters is an important factor in all except heating installations, where it is immaterial, since the energy corresponding to the pressure drop is converted into heat. The cone of the St. John meter is so heavy that it causes a pressure drop of 0.25 atmosphere, compared with 0.05 to 0.08 atmosphere in the Claassen meter. The lower the pressure drop in the meter, the more important it is to reduce friction in the packing to a minimum. The possibility of willful tampering with the packing must be borne in mind; tampering with the Claassen meter is impossible. (*Science Abstracts*, Section B—Electrical Engineering, vol. 21, pt. 11, Nov. 30, 1918 (No. 251), pp. 391-392, *g*)

MECHANICAL PROCESSES

Reversed Heads in Pressure Vessels, J. Leslie Lane. The writer questions the advisability of the use of reversed bumped head in boilers and pressure vessels generally.

The objectionable feature of such a head is that when the tank is set vertically it is next to impossible to drain it completely. Further, the dead space thus created serves as a settling chamber where oil and sediment can collect. This could be overcome only by demanding that tanks so constructed should be set horizontally.

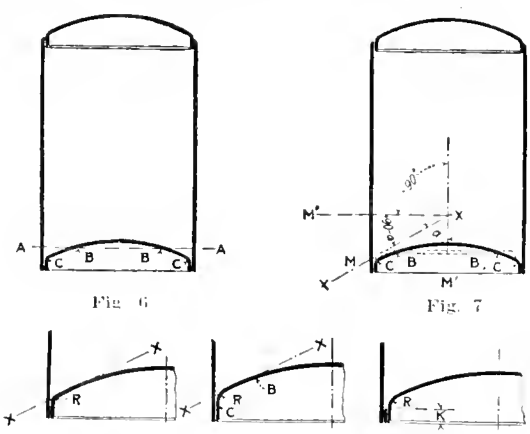


Fig. 6 Fig. 7 Fig. 8 Fig. 9 Fig. 10

Figs. 6 to 10 Diagrams Showing Action of Forces in Dished Heads

The calculation of safe pressures is a comparatively simple matter, although somewhat complicated by the presence of a bending movement at the point where the flange and the head proper join. A calculation of the capacity of a bumped head to resist collapsing pressure is more difficult, as it is somewhat analogous to buckling in bars, which latter is determined only by approximate empirical formulæ.

The writer points out that the behavior of the head under pressure depends also on the individual workmanship and the accuracy with which the head is shaped to a given radius.

If the curvature of the head is exactly the same at all points on the sphere the stresses set up in it are balanced and the flat spots needed to give the leverage for collapsing are absent. On the other hand, if there is such a leverage its action is accumulative.

Where the pressure is on the concave side such a fault tends to correct itself by forming the head to a circle; in a reversed head it tends to accentuate itself and to lead to a failure of the whole.

This makes high-grade workmanship absolutely necessary. The uncertainty as to the actual stresses present led to a stipulation that such heads shall have a minimum thickness considerably greater than would be the case if they were put in in a regular manner and the pressure applied on the concave side.

The following passage taken from the original article is of interest:

Turning to Fig. 6, observe what form the bumped head will first

assume when a distorting pressure is applied and what stresses it will develop in the shell. The problem is similar to buckling in a beam, and whatever distortion disappears will be about the neutral axis AA, no effect being noticeable at the points B where the axis cuts the head.

If the part BB is to bulge outwardly finally, it must first be flattened, the part BC of the head being distorted and assuming the shape shown in Fig. 7. This places the part BC in compression and the stress will be exerted along the tangential line XX. Without attempting to determine the exact intensity of this stress, assume it to be M pounds and resolve it into its two components, one parallel to the axis of the shell, the other at right angles to it.

Supposing that the line XX makes an angle a with the axis of the shell, then the force M' acting parallel to the axis of the drum will be $M \cos a$ and its effect will be wholly exerted on the rivets holding the head in position. The force M'' acting at right angles to the axis of the drum will be $M \cos$ (90 deg., a) and its effect will be partly exerted on stretching the metal in the part BC of the head, and in expanding the shell of the drum itself. To put the proposition in a simpler way, the action is a toggle effect, the outer rim of the head being stretched and forced out against the shell, tending to rupture it.

Just how much of this toggle effect is brought to bear on the shell of the drum depends on the radius R, where the head meets the flange. If the radius is small, as in Fig. 8, then any expansion of the head must affect the shell, for the thrust comes directly against it. On the other hand, if this radius is large, as in Fig. 9, the part BC of the head is free to spring and the stretching of the shell is minimized. This would lead to the conclusion that in reversed heads the radius at the knuckle of the flange should be considerably larger than in the case of straight dished heads of the customary type. In order to reduce still further this toggle effect, the writer believes it would be advisable to insert a filler piece between the flange of the head and the drum, as shown in Fig. 10. It need not be thick—probably one-eighth inch would be sufficient—and where possible it would be of copper. Its width K should not exceed 2½ in., in order that a clear space be left above to take care of any expansion of the head.

The writer sums up the advantages and disadvantages of the reversed head and comes to the conclusion that where safety is a necessary factor, the reversed head should not be used. (*Power*, vol. 49, no. 2, Jan. 14, 1919, pp. 61-62, 5 figs., *ptA*)

Manufacturing Marine Steam Boilers, E. A. Suverkrop, Mem.Am.Soc.M.E. Description of the processes used in the boiler shop of the Sun Shipbuilding Company, of Chester, Pa. The boilers manufactured are of the so-called Scotch type, single-ended, with three furnaces.

The article, which is profusely illustrated by photographs and line cuts, describes in general the layout of the boilers, the rolling of the shell plates to the desired curvature, the location and boring of the holes, the flanging and all subsequent operations in considerable detail.

Among other things are described in some detail the tools used by the company in the manufacture of the boilers: in particular, the rolls and the flanging press. The flanging machine also does the work of forging or upsetting the ends of the large staybolts used in these boilers.

The article is of interest in that it gives a broad view of the operations involved in the manufacture of a large marine boiler. (*American Machinist*, vol. 49, no. 26, December 26, 1918, pp. 1155-1163, 21 figs., *dA*)

MECHANICS

Hardness: Its Nature and Measurement

Hardness, James J. Guest. The paper here abstracted was presented in the form of a discussion on the paper by R. G. C. Batson entitled The Value of the Indentation Method in the Determination of Hardness, at the November 15 meeting of the Institution of Mechanical Engineers in London.

To indicate the nature of hardness the author sketched the stress-strain diagram reproduced in Fig. 11 with the curve distorted for the sake of clearness but generally typical.

In Fig. 12 is shown a tool penetrating the material. The author pointed out that the state of stress in the material would vary throughout, the states of stress at a, b, c, d, e corresponding in type to those represented at A, B, C, D, E in Fig. 11, though the stress within the material would be complex. In addition to this there would be a surface of discontinuity, as marked, through b. Outside this surface the material would possess elastic strain energy, within it there would be overstrain, involving lost energy, combined with elastic energy, and in the tool elastic energy only. The tool was supposed to be acted upon by the force P indicated.

A tool of any conical shape, as that sketched, did not involve any linear dimension, and hence in the position shown there was only a single linear dimension involved, which was the diameter d of the indent. Hence, the tool being in equilibrium under the

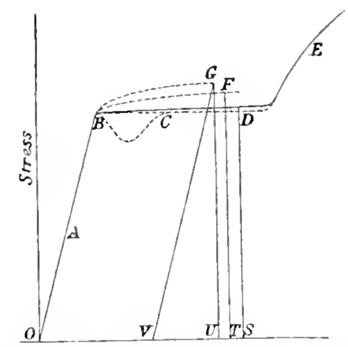


Fig. 11 Stress-Strain Diagram of Hardness Test

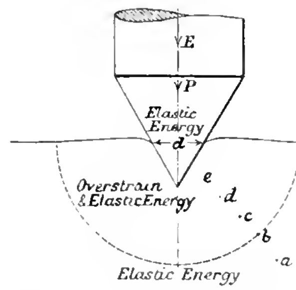


Fig. 12 Tool Penetrating Material in Hardness Test

Fig. 13 Diagram Showing Surfaces of Contact between the Tool and Material in Hardness Test with Varying Depths of Impression

force P and the reaction due to the stress condition in the material, there must be a relationship involving P, d, and certain complex stresses and elastic constants of the material, represented under the head p in the summation equation:

$$P = \Sigma A d^k p^l \ldots\ldots\ldots\ldots\ldots\ldots\ldots [1]$$

As throughout p was of the dimensions of stress, by dimensional theory the only possible values of the indices were $k = 2$ and $l = 1$, and therefore P/d^2 must be a constant for the material.

Referring again to Fig. 11, along O, A, B—the Hooke's law portion—the relationship of stress and strain was independent of time, but near and beyond B a time effect showed itself, the curve taking such forms as indicated by the broken line, the metal having a semi-viscous flow. Hence Equation [1] would not be quite true and the value of P/d^2 would not be quite independent of the time. But from the known proportions of phenomena represented typically by such curves it was clear that P/d^2 was the predominant factor in the law of indentation.

Mr. Guest then considered the case of an impact test, Fig. 12 again representing the case of a tool applied with energy E, the

corresponding summation equation for the indentation being:

$$E = \Sigma B d^m p^n \ldots\ldots\ldots\ldots\ldots\ldots\ldots [2]$$

The indices again had single values, $m = 3$ and $n^* = 1$, so that E/d^3 was necessarily a constant for the material.

The stress-strain diagram in Fig. 11 represents a slow test. The effect of a rapid application of the load is to raise a portion of the curve beyond B, as shown by the dotted curves BF, BG, and the more rapid the application of the load the higher would be the curves.

If at the point G the stress was removed, the curve fell along the line GV, the energy measured by the area $OBGV$ being destroyed, but that represented by the area GVU restored by the material. The proportion of energy reaching any element of the material varied; at points such as a in the elastic region it was practically all restored, and the proportion of energy restored gradually diminished along b, c, d, e. Except for losses—such as due to vibration—the sum of this energy (with that in the tool) appeared in the rebound energy of the hammer, so that the height to which it rebounded duly measured some complex summation determined by the elastic and stress laws of the material.

If the tool instead of being conical were of a wedge shape of indefinitely long edge, then again there would be no linear dimension involved in the tool and all the above would apply. When, however, a ball is used as a tool its diameter is involved and with varying depth of impression the similarity of the surfaces of contact between tool and material ceases, as is shown in Fig. 13. If, however, the impressions were of nearly the same magnitude, the main factor must still be of dimensions $\frac{\text{force}}{\text{length}^2}$.

The paper also contains an extensive criticism of various statements in the paper by Professor Edwards, which may be abstracted together with the original paper at a later date.

In connection with the rule that the dynamic hardness was to be measured by E/S^2, where E was the applied energy and S the spherical area of indentation, R. G. C. Batson has compared the values of the measures for the hardness obtained by dividing the applied energy by the volume of indentation V and by S^2. He plotted the quantities V and S^2 against one another, calculating them from the formulae

$$V = \frac{\pi}{3} h^2 \left(\frac{3}{2} D - h\right) \text{ and } S^2 = \pi^2 d^2 h^2$$

which he gave.

In this connection Mr. Guest calls attention to the fact that the elimination of h (depth of indentation) between these equations did not give a straight line, and the departure from straightness as represented by $\frac{2}{3}\frac{h}{D}$ is 0.067 for the data selected by Mr. Batson and 0.01 to 0.045 for the experiments with balls of various diameters made by Professor Edwards.

As regards these latter, Mr. Guest gives Table 3, in which the last two columns are added by him personally. The variation of the figures in the column E/V does not suggest dependence of the shape of the curve upon ball diameter.

TABLE 3 GUEST'S DATA ON HARDNESS TESTS

E Energy of Impact	V Volume of Indent	d Diameter of Indent	D Diameter of Ball	h Depth of Indent	S Spherical Area	C Professor Edwards' Constant	$\frac{E}{S^2}$	$\frac{E}{V}$
0.054	0.25	2.234	10.00	0.126	3.97	4.635	0.00343	0.216
0.089	0.45	2.584	10.00	0.170	5.33	4.730	0.00314	0.198
0.158	0.73	2.376	4.76	0.319	4.77	3.760	0.00697	0.217

In this connection and, in particular, in connection with the formula of J. O. Roos, Mr. Guest connected Professor Edwards' constant with the volume of indentation, writing:

$$\frac{d^4}{V} = \frac{32D}{\pi}\left(1 - \frac{h}{D}\right)^2 \left(1 - \frac{2}{3}\frac{h}{D}\right)^{-1}$$
$$= \frac{32D}{\pi}\left(1 - \frac{4}{3}\frac{h}{D} \ldots\right)$$

thus showing that C^{-4} was of the same nature as the expression of Mr. Roos, but with a different coefficient for the term h/D. That the values of C tabulated varied less than the values of E/S^2 was due to the glozing over of the effect of the variation of the diameter ratio by taking its fourth root. This, however, simultaneously reduced the whole variation of the constant and hence the gain is illusory.

As h/D was small, there was little difference between E/V, ED/S^2 and $C^{-4}D$. Now the energy summation for the ball impact might, taking h the permanent indent and D as the involved lengths, be written

$$E = rD^3 + SD^2h + tDh^2 + uh^3$$

since E increased with D and h. Putting $h = 0$, $E_0 = rD^3$ was the energy which would just not produce a permanent indent. This had some value, and as it varied with D^3 the ball method was not well adapted to make "absolute" determinations. Since, to a first approximation, $4Dh = d^2$, the above equation might be written

$$E = rD^3 + S\ 4Dd^2 + t\ 16\frac{d^4}{D}\left(1 + \frac{u}{t}\frac{h}{D}\right)$$

With a given diameter of indent a small ball penetrated further than a large one, and therefore the second term was probably zero. Hence the most important feature must be the third term. The experiment work confirmed this. The above coefficients should form the aim in experimental work.

These remarks call forth a certain amount of criticism. H. L. Heathcote said that it is the opinion of Mr. Guest that the energy of the blow was equal to the sum of certain energies on the other side, namely, the elastic energy in the denting tool and the elastic energy in the specimen plus strain energy. The speaker thought that the energy required to move the metal should also be taken into account.

When experimenting with the punch referred to in Batson's paper and applying the curve showing the relation between diameter and depression produced and the Brinell numbers, the speaker had not obtained a curve exactly parallel with the curve showing in the Brinell diameter as a function of the hardness. Both were sloping curves, with the further significant characteristic that one curve crossed the other in two places. Crossing of the curves suggested that the hardness as found with the autopunch of a hard specimen was greater and that of a soft specimen less than would be found with the Brinell test. The writer claims that the Brinell test crushed a hard specimen, disintegrating the metal, and that the impact test got its work done before the crushing and softening had taken place.

Several other interesting discussions reported in the original article cannot be abstracted because of lack of space. (*Engineering*, vol. 106, no. 2760, Nov. 22, 1918, pp. 588-591, 4 figs., *tA*)

Bureau of Standards Tests of Large Brick Piers

THE COMPRESSIVE STRENGTH OF LARGE BRICK PIERS, J. G. Bragg. The following is an abstract of the report on tests of large brick piers which were made at the Pittsburgh laboratory of the Bureau of Standards in coöperation with the National Brick Manufacturers' Association.

The purpose of this investigation was to determine the strength developed by brick piers of normal size as used in modern buildings, using in their construction such materials and grades of workmanship as are available in the United States.

The variables considered in the investigation are: (1) the quality of bricks employed with respect to grade and geographical location; (2) the quality and kind of mortar; (3) the grade of workmanship employed, and (4) the bonding of courses or method of laying the bricks.

* In the original, p is erroneously referred to here.

The investigation comprised tests on 46 piers 30 in. by 30 in. by 10 ft. in height, also 4 piers of the same cross-sectional dimensions 5 ft. in height. The bricks used in their construction are representative of four widely separated districts east of the Mississippi river and are classified according to the following 3 grades:
Grade 1, Hard-burned or best quality
Grade 2, Medium-burned or considered as common
Grade 3, Soft-burned or poorest product marketed.

Three mortars were used in the beginning and three grades of bond and workmanship were employed throughout the investigation.

The mortars used were
a 1 part cement to 3 parts sand by weight
b 1 part lime to 6 parts sand by weight
c 1 part (0.15 lime + 0.85 cement) to 3 parts sand by weight.

The different methods of bonding were as follows:
a Alternating header and stretcher courses
b Header course every 4th course
c Header course every 7th course.

Wire mesh was used in two of the 5-ft. piers to study the effect of lateral reinforcing in the horizontal joints. A more than usual number of tests of individual bricks were made in order to determine the relation of the strength of single bricks to the compressive strength of piers.

The first indication of failure observed was the same in all cases and appeared in the form of small hair-sized cracks in the individual bricks. The cracks widened and extended to other courses under additional load, finally becoming confluent and extending almost the entire length of the pier. Soon thereafter final failure occurred accompanied by a spalling off of the outer ring of bricks. Very little crushing of the bricks was apparent after failure except in the case of the softer bricks laid in cement or cement-lime mortars. The cause of incipient failure of the piers is attributed to a transverse failure of the individual bricks.

The tests show that variations in the number of header courses used does not affect the ultimate compressive strength of the pier. Failure of the individual bricks by flexure would render the header courses ineffective by such time as they would be useful in preventing an outward bulging of the masonry.

The quality of brick is shown to be a very important factor in its effect on the compressive strength of the pier. The compressive strength of half-bricks flat and on edge, also the transverse strength or moduli or rupture of the bricks, are shown to be proportional to the compressive strength of the piers.

Very little difference in strength is apparent in piers of 1:3 portland cement and sand mortar and those of 1 (15 per cent lime and 85 per cent cement): 3 sand mortar. In the last-named mortar 35 per cent by volume of the cement is replaced by lime. These piers of cement and cement-lime mortars, however, developed strengths 50 per cent to 75 per cent higher than those of pure lime mortar. There is a considerable advantage in the easier working qualities of the cement-lime mortar over the pure portland-cement mortar. In consideration of the results of these and previous tests on piers of smaller cross-sectional dimensions, from 35 per cent to 50 per cent of the cement in a 1:3 cement mortar may be replaced by hydrated lime without appreciably affecting the compressive strength of the masonry; the higher percentage to be used in piers of small cross-sectional dimensions.

A study of these and previous tests indicates that lateral reinforcing in the horizontal joints is effective only when placed in every joint.

The following empirical formulæ are given for use in computing the strength of brick piers:

$$P = Kp \quad [1] \qquad P = KR \quad [2]$$

where
P = ultimate unit compressive strength of the pier
p = unit compressive strength of single half-bricks
R = unit transverse strength or modulus of rupture of single bricks
K = a constant depending upon the kind of mortar used.

The values of K are given in Table 4 for the mortars used in this investigation.

The modulus of rupture is computed according to the formula

$$R = \frac{3}{2}\,\frac{Pl}{bD^2}$$

in which
R = modulus of rupture
P = breaking load, in pounds, of a single brick in a flatwise position supported at the ends and loaded at the center
l = distance between the supports (in these tests 7 in.)
b = breadth of specimen in inches
d = depth of specimen in inches.

TABLE 4 VALUES OF MORTARS USED IN INVESTIGATION

Mortar	Values to be determined by tests of single bricks	Value of K
1 part (0.15 lime + 0.85 cement) to 3 parts sand by weight	Unit compressive strength flat $= P$	0.26
	Unit compressive strength on edge $= p$	0.30
	Modulus of rupture from transverse test $= R$	1.25
1 part lime to 3 parts sand	Unit compressive strength flat $= P$	0.11
	Unit compressive strength on edge $= p$	0.14
	Modulus of rupture from transverse test $= R$	0.65
1 part cement to 3 parts sand	Unit compressive strength flat $= P$	0.27
	Unit compressive strength on edge $= p$	0.32
	Modulus of rupture from transverse test $= R$	1.45

The complete report includes 24 figures and numerous tables. There is also a chapter devoted to previous tests giving abstracts and tables of the results from previous investigations of the load bearing values of brick piers. (Abstract from Technologic Paper No. 111 of the Bureau of Standards; *eA*)

German Analysis of the Belt Drive

MECHANICS OF THE BELT DRIVE, Dr. Wilhelm Stiel. The original article abstracted here represents in itself an abstract of a book published by the author in 1918, in which he considers the properties and modes of operation of belt drives in general, and, in particular, the relation of forces acting during the process of power transmission by belting.

In the first place, the author considers a belt drive with extremely low velocities of translation of the belt.

The only relation between the forces acting on a belt, which must prevail under all circumstances, is the condition of equilibrium, in view of which the sum of all forces must be equal to zero. As regards external forces acting on the belt pulley (neglecting the individual properties of pulley as is done throughout this discussion), there are, in the first place, the two tangential forces S'_1 and S'_2 and the axial force A, and because of the condition of equilibrium we must always have

$$A + S'_1 + S'_2 = 0 \ldots\ldots\ldots\ldots\ldots [1]$$

with the further condition that the addition of forces, as a rule, should be carried out geometrically and that only in particular cases does an algebraical addition become permissible. If we take into consideration the general equation for the effective force

$$S_n = S'_1 - S'_2 \ldots\ldots\ldots\ldots\ldots [2]$$

then we find for the axially acting force the expression

$$A + S'_1 + S'_2 + S'_2 = 0 \ldots\ldots\ldots\ldots\ldots [3]$$

For a drive with ratio [1] we have an algebraic equation

$$A = S_n + 2S'_2 \ldots\ldots\ldots\ldots\ldots [4]$$

which has a general application provided we understand that by A is meant not the axial pressure, but the sum of the tangential forces $S'_1 + S'_2$. From this it follows that the deciding constituent of the axial pressure or the sum of tangentially acting forces is the transmitted effective force, and the prevailing tendency in the variation of the axial pressure will be an increase proportional to S_n.

A modification is introduced in this connection by the magnitude of tension on the loose side, which is mainly affected by the individual conditions of each drive, and especially by the magnitude of the initial tension.

The resultant variation of the axial pressure as a function of the useful load depends, therefore, quite materially also on whether and to what extent the arrangement of the drive is capable of maintaining the tension on the off side with the increase of load, and it appears that not only the axial pressure but the entire relation of forces acting in each belt drive is fully determined by the formula

$$S'_2 = f\,(S_n)\ldots\ldots\ldots\ldots\ldots\ldots\ldots[5]$$

which means that whenever a belt drive is investigated it is sufficient to determine the S'_2 characteristic in order to secure complete information as to the general state of that particular drive.

In the arrangement a, where there is no initial pressure, we have $S'_{2a} = 0$. Hence, in that case (Fig. 14) both the force on the tight side S'_{1a}, as well as the axial force A_a, are represented

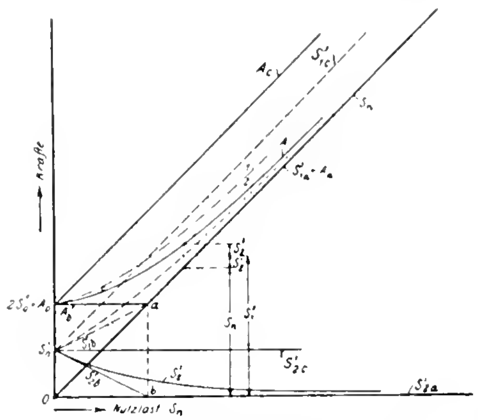


Fig. 14 Forces Acting in a Belt Transmission
Ordinates: Forces (*Kraefte*); Abscissae: Useful Loads (*Nutzlast*) S_n

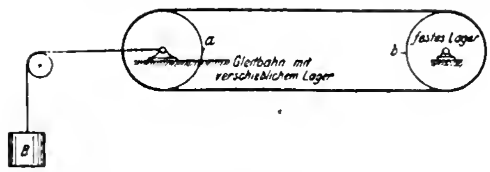


Fig. 15 Arrangement (b) of Belt Drive Giving Constant Axial Pressure
Gleitbahn mit verschieblichem Lager—Sliding support with displaceable bearing); *fester Lager*—Fixed bearing

by equal straight lines passing through the origin of coördinates, while $S'_{2a} = 0$ coincides with the axis of abscissæ. Such an arrangement satisfying the condition $S'_2 = 0$ is conceivable but difficult to execute mechanically as a belt drive. It appears, however, in all chain drives provided only we consider the chain itself as having no weight.

On the other hand, there may be an arrangement such as that devised by Bach and shown in Fig. 15, where the Grashof equation $S'_1 + S'_2 = 2S_0 =$ constant always holds good. In this arrangement, which is only of theoretical interest and can hardly have any application in practice, the axial force acts along the horizontal line A_b (Fig. 14). S'_{1b} and S'_{2b} lie along a line inclined to the horizontal at an angle arc tan ½.

Further, there may be other arrangements c in which the tension on the slack side is artificially maintained at a value different from zero, as, for example, in the Lenix drive. In such arrangements the tension on the slack side follows the horizontal straight line S'_{2c}, while the force on the tight side and the axial pressure are expressed by straight lines S'_{1c} and A_c (Fig. 14) parallel to the line of effective force.

In the usual arrangements of belt drive where the initial tension is created not by artificial devices, but exclusively by the elasticity and weight of the belt itself, the curves expressing S'_2, S'_1 and A are all located within the part of the diagram determined by the straight line corresponding to each of the arrangements a, b and c.

The writer gives some further indications as to the behavior of these curves which help to recognize their character.

First, all the curves S'_2 have as tangents at their origin S'_0 the straight line S'_{2b} having an angle of inclination arc tan ½ and asymptotically approach the axis of abscissæ.

Next, all the curves S'_1 have at their origin S'_0 as a tangent the straight line S'_{1b} rising at an angle arc tan ½ and asymptotically approach the lines of effective force S_n and S'_{1a}.

All the curves A have at their origin $A_0 = 2S'_0$ as tangent the horizontal line A_b and asymptotically approach the lines of effective force S_n and A_a.

In order to determine the actual course of the curve $S'_2 = f(S_n)$ given in equation [5], the writer applies a graphical method based essentially on the work of Kurtzbach and Barth.

The results secured in this manner are compared with those experimentally obtained by Lewis in 1886. These results are represented in the form of curves of average values (Fig. 16) and indicate a complete accord with what should be expected from Fig. 14.

These tests prove beyond doubt that the excessive axial pressures occur not only at high velocities, but also at very low velocities approaching a stationary state and even in the stationary state itself.

If it should be desired to secure an approximate expression for all of these relations one might make use of the observation to the effect that the curves of axial pressure plotted in Fig. 14 are in shape similar to hyperbolas. The curves of axial pressure have low initial tensions (such as in the order of magnitude up to $2k'_0 = 10$), are practically exactly equilateral hyperbolas and follow the equation

$$A = S_n^2 + 4\,S'^2_0$$

and since $A = S_n + 2\,S'_2$, it follows that

$$A = \sqrt{S_n^2 + 4\,S'^2_2}\ldots\ldots\ldots\ldots\ldots\ldots[7]$$

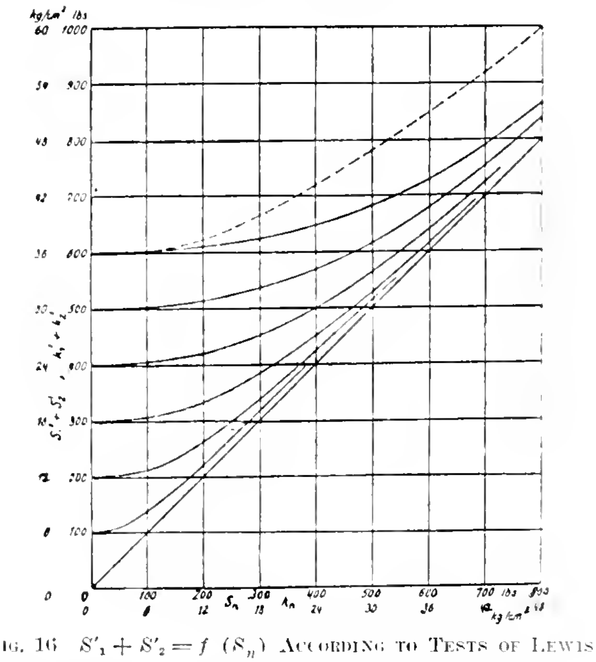


Fig. 16 $S'_1 + S'_2 = f\;(S_n)$ According to Tests of Lewis

At higher initial pressures these equations give excessively high values as may be seen from the dotted curve in Fig. 16 for $A_0 = 36$. Hence, when these curves are used they give the axial pressures correctly but are uncertain as to the way they give the variation of S'_2. The author recommends, therefore, using the hyperbolic equation [7] only for rough calculations of the axial pressure, but not for the determination of S'_2. It should also be borne in mind that equation [7] does not take into consideration the axial distance, so that it covers only normal conditions where a does not differ much from 4.

In the opinion of the author, this formula is better than the previous assumption of constant axial pressure, and the relation established by the author has, at least, the advantage of greater clearness. This relation is: The sum of the forces acting on the side of a loaded belt equals the square root of the sum of the square of the effective load and the sum of the forces acting on the side of the belt running idle. (First part of an article in *Dingler's*

polytechnisches Journal, vol. 333, no. 18, September 7, 1918, pp. 161-166, 12 figs., *p*. The second part may be abstracted in an early issue if the space is available.)

A Relation Connecting the Derivatives of Physical Quantities, Mayo Dyer Hersey. In this paper it is shown how the theory of dimensions may be used in a differential form; a procedure which appears fruitful, particularly in investigating the effect of given sources of error on the performance of measuring instruments. The examples which led to the necessity for developing this method are discussed at the end of the paper and illustrated by experimental data. (Abstract from Scientific Paper No. 331 of the Bureau of Standards; *t*)

POWER PLANTS

Generator Wreck at St. Paul. Description of the wreck of a 2000-kw. generator on December 10, 1918, in the St. Paul (Minn.) plant of the Northern States Power Company.

The trouble was caused by a workman short-circuiting a 13,000-volt feeder in Minneapolis connecting the St. Paul and Minneapolis plants. The St. Paul plant was subjected to short-circuit of such proportions and duration that the excitation (from a motor-generator set) was practically lost on the two turbo-generators then operating, and by the time another exciter was put in operation the generator end of one of the units, namely, the 2000-kw., was completely wrecked.

The steam end of the turbine remained intact, although the shaft was probably sprung and the casting supporting the turbine bearing cracked, but the generator and its bedplate were completely wrecked.

Just how the wreck occurred is not quite clear yet. One of three things may have happened:

1 The machines being subjected to this short-circuit for several minutes caused the mechanical collapse of the 2000-kw. unit.

2 The machines remained on the short-circuit until it was cleared, and the entire system, many times 3000-kw. capacity, endeavored to bring them into step.

3 The machines under this terrific short-circuit overload dropped their load, due to loss of excitation, and the 2000-kw. overspeeded until the generator exploded.

The first assumption is unlikely, as a short-circuit located at the end of a 10-mile feeder would not wreck the machine mechanically, and the latter was not burned out electrically as no smoke or blaze was noticed.

The second assumption is also unlikely, since the 1000-kw. unit was not affected. Therefore overspeeding seems to be the most probable cause. The turbines had been in service nine years, were built for 150 lb. steam pressure and no superheat, and were actually operated under 185 lb. steam pressure, 100 deg. superheat and 6 lb. back pressure. Owing to this changed steam condition, the company operating the plant had dismantled the automatic safety stop on the three type C machines, depending upon the system to lock them electrically and load changes to be handled by the regular governor operating on the primary and secondary valves. Both of these valves were opened to the maximum on the short and the machines operating at much reduced speed. When the load was dropped, owing to this loss of excitation, the generators instantly speeded up. The governor on the 1000-kw. turbine closed its valves and kept the machine at normal speed under steam. The valves of the 2000-kw. turbine did not close tight, or for some other reason the governor did not control this machine. The overspeed trip actually tripped, but as the automatic safety stop was dismantled, it was useless and the generator reached a speed where the fourteen $2\frac{1}{2}$-in. bolts per field pole were elongated and the poles struck in the stator, which twisted off the shaft and wrecked the machine. (*Power*, vol. 49, no. 2, Jan. 14, 1918, pp. 40-41, 3 figs., *d*)

RAILROAD ENGINEERING

Feedwater Heating for Locomotives

Locomotive Feedwater Heating, H. S. Vincent. Discussion of the exhaust-steam and waste-gas methods of preheating for locomotive boilers. The exhaust steam contains a greater quantity of heat than waste gases and this heat is more readily transferred to the feedwater, but only a limited amount of the steam can be diverted for heating purposes as the exhaust rate is required for helping the draft on the locomotive.

As regards waste gases, they carry off from 20 to 45 per cent of the heat in the fuel and it would seem that this great loss offers a promising field for economy. Little progress, however, has been made in this direction partly because of the slow rate of transfer

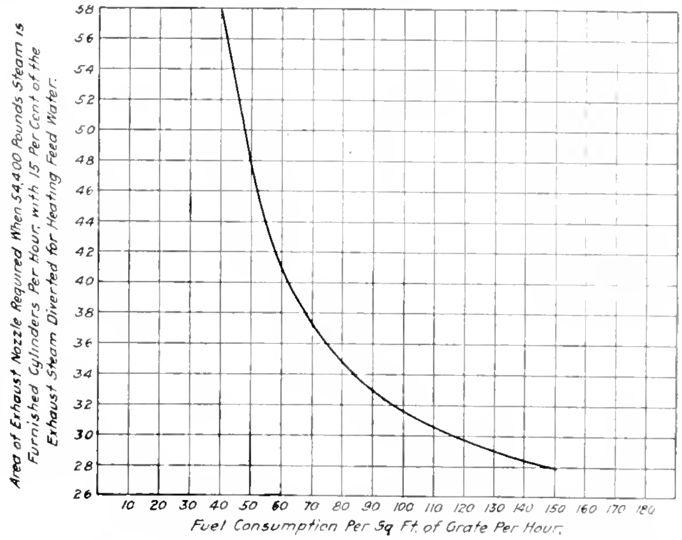


Fig. 17 Area of Nozzle in Square Inches for Various Rates of Combustion

between this heat and the feedwater and also because of other practical difficulties.

The present paper gives calculations for both types based on an equipment suitable for application to a typical high-speed passenger locomotive of which the principle dimensions and characteristics are given. The article, generally, is not well suitable for abstracting and only certain of its features will be reproduced here.

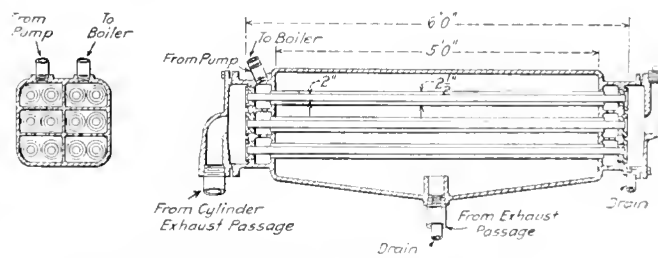


Fig. 18 A Type of Exhaust-Steam Feedwater Heater

In the first place, the author shows that the statement that a portion of the exhaust steam may be diverted for heating the feedwater without necessitating a reduction in the area of the exhaust valve, is not correct. Any decrease in the weight of steam passing through the exhaust nozzle, unless accompanied by a proportionate decrease in the amount of fuel consumed, will be detrimental, and this has been proven by extensive tests made on the locomotive above referred to.

The writer gives formulæ for determining the area of nozzle required to produce the necessary draft when diverting a predetermined proportion of the exhaust steam for such purposes as feedwater heating. Thus, in Fig. 17 are plotted the areas of nozzle in square inches for various rates of combustion, which show that these areas depend directly upon the economy given by the feedwater heater.

Fig. 18 illustrates diagrammatically the type of exhaust-steam heater in which the feedwater circulates through the annular passages between the inner and outer tubes, the heating medium flowing through the inner tube and surrounding the external surface

of the outer tube. To provide sufficient volume the pipes are arranged in pairs, six such pairs or units forming the heater. The feedwater is forced by a feed pump into the header at one end of the heater, it then flows in columns to the opposite header, traversing the entire length of the heater and flowing thence to the boiler. The heating medium (exhaust steam) is taken from any convenient point between the cylinder and the exhaust nozzle. It enters the heater at one end, flowing through the twelve internal pipes to the opposite header; exhaust steam also enters the casing and surrounds the outer pipes, the condensate being carried to any convenient point.

For a heater of the dimensions shown in Fig. 18 the total traverse of the feedwater is 30 ft. and of the exhaust steam in the inner

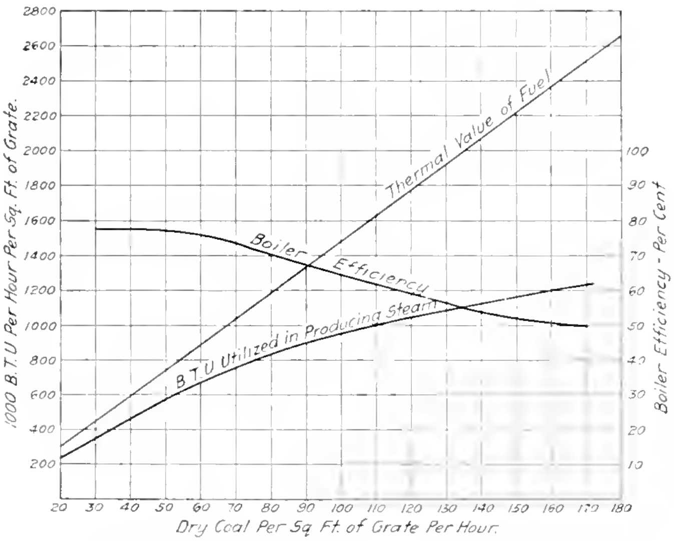


Fig. 19 Efficiency Curves of a Locomotive Boiler without a Feedwater Heater

channels, approximately 6 ft.; the total heating surface in tubes is 71.22 sq. ft. As a modern boiler-feed pump will deliver 100 lb. of water against a boiler pressure of 205 lb. for 1.75 lb. of steam, the total weight of water per hour passing through the heated is $54{,}400 \times 1.0175 = 55{,}390$ lb. or 15.35 lb. per sec.

The volume per foot of the annular space between a pair of tubes in the heater of Fig. 18 is 26.96 cu. in. and the weight of water at 60 deg. is 0.972 lb. per foot of tubes. The velocity of water passing into the heater is $15.35/0.972 = 15.75$ ft. per sec.

The pressure of the exhaust steam entering the heater is 13.7 lb. gage or 28.4 lb. absolute, the corresponding temeprature of saturated steam being 247 deg. fahr.

The writer discusses the determination of the amount of heat transmitted to the feedwater in its passage through the heater and gives a set of curves representing conductance values at different temperatures and at various feedwater velocities. Another diagram establishes the relation between the temperature of the heating medium and the total conductance at a feedwater velocity of 15.75 ft. per sec. which prevails in the case of the feedwater heater shown in Fig. 18.

As regards the economy secured with the heater, formulæ are given for determining the direct economy, which is the reduction in the number of thermal units which the boiler must supply. In addition to this, however, there is an indirect saving due to the diminished boiler losses resulting from the decreased fuel consumption and in this connection Fig. 19 is of interest, as it gives the relation between the thermal value of the fuel fired and that utilized in the production of steam; in other words, the boiler efficiency as determined from the tests of the locomotive. In this figure this boiler efficiency is plotted in relation to the unit fuel consumption per hour. In this instance for a unit fuel consumption of 120 lb. the boiler efficiency is 59 per cent and for a unit consumption of 111.5 lb. an efficiency of 61.6 per cent is secured, or an indirect economy of $61.6 - 59 = 2.6$ per cent, which added to the direct saving previously found to be 7.2 per cent gives a total economy of 9.8 per cent. This is the maximum economy obtainable with the heater in Fig. 18 when diverting 15 per cent of the exhaust steam.

The writer refers also to the feedwater heater described in a paper by George M. Basford (Mem.Am.Soc.M.E.) published in The Journal of The American Society of Mechanical Engineers for September 1917. In that heater the feedwater passes in a thin film between two spirally corrugated copper tubes. The following calculation is presented as a basis of comparison between the heater of Fig. 18 and that described by Mr. Basford.

The value of K or the conductivity of the steel tube as experimented with by Clement and Garland is 48.36 B.t.u. The value of K for copper as given in Marks' handbook is 220 B.t.u. The conductance of the steel tube is 1.204 B.t.u. Using the same thickness for the copper tube as for the steel tube experimented with, the conductance of the former is $(220 \times 1.204)/48.36 = 5.48$ B.t.u. We can combine this conductance with that of the two films as established by Clement and Garland by taking the value shown in Fig. 20 for a water velocity of 15.75 ft. per sec.

It will be observed that the curve for the conductance of the water film is approximately a straight line; while the curve for the combined conductance of tube and film drops away as the velocity of the water through the tube is increased; indicating that the conductance of the metal in the tube is not constant for all velocities.

Reading the values from the diagram, we have:

$$\frac{1}{\dfrac{1}{0.345} - \dfrac{1}{0.505}} = 1.184 \text{ B.t.u.}$$

This gives the conductance of the metal in the tube at the given velocity of the feedwater. Assuming that the conductance of the

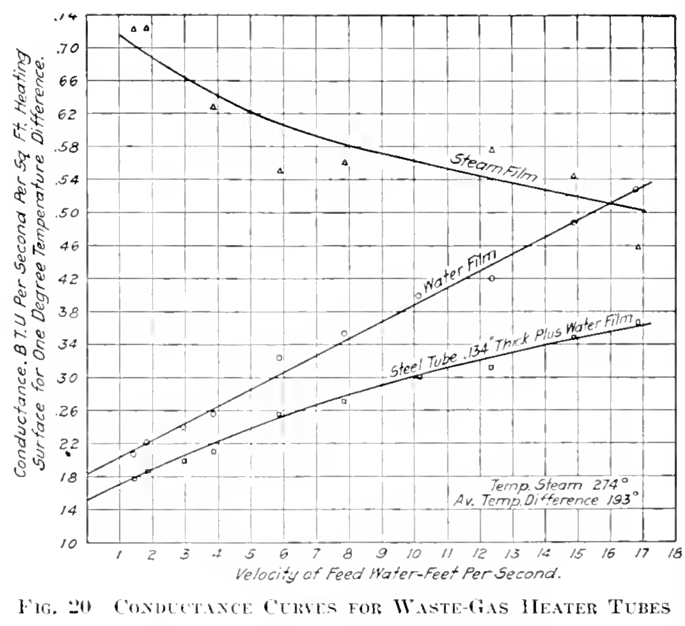


Fig. 20 Conductance Curves for Waste-Gas Heater Tubes

copper tube will decrease with the velocity in the same ratio, we have as the conductance:

$$\frac{1.184 \times 220}{48.36} = 5.39 \text{ B.t.u.}$$

Combining this conductance with that of the film, we have:

$$\frac{1}{\dfrac{1}{0.505} + \dfrac{1}{5.39} + \dfrac{1}{0.512}} = 0.234 \text{ B.t.u.}$$

The conductance in B.t.u. per sq. ft. of heating surface is then $0.234 \times 3600 = 875$, which agrees very closely with the figure given by Mr. Basford, or 900 B.t.u.

Using the latter figure, we have $900/3600 = 0.25$ B.t.u. conductance; substituting this value in equation above, we have for the heater of Fig. 18 with 30 lin. ft. traverse a final temperature of 178.05 deg. with a thermal content of 145.93 B.t.u. From the

figures given it would seem that the increased efficiency of the heater shown by Mr. Basford is due chiefly to the higher conductance of the metal used.

The foregoing abstract is from the *Railway Engineer*, vol. 92, no. 12, December 1918, pp. 645-649, 8 figs. A continuation of the article is devoted to the following discussion of feedwater heating by waste gases as the heating medium.

Because of the relatively slow absorption of the heat by water from gases, it is necessary in this type of heater to increase the heating surface quite materially over that required for an exhaust-steam heater. This is usually accomplished by employing a large number of tubes of small diameter.

Fig. 21 shows diagrammatically the heater on which the present study is based. It is composed of 320 tubes of 1 in. outside diameter, 6 ft. long, with walls 0.095 in. thick, giving a total heating surface of 407 sq. ft. The tubes are fixed at each end into headers divided into ten compartments each of which contains 32 tubes.

The feedwater enters the lower compartment of one header, flowing thence through the 32 tubes to the opposite header and in this way traversing the heater ten times before passing into the boiler.

The transmission of heat from the waste gases into the feedwater is determined by the author on the basis of the evaporative capacity of a boiler tube under similar conditions.

He finds on the basis of Bulletin 1017 published by the American Locomotive Company that the conductance of the boiler tube is 0.002325/0.523 = 0.00445 B.t.u. per sec. per sq. ft. of heating surface per degree temperature difference.

Further, with data secured by Geo. L. Fowler (Mem.Am.Soc. M.E.) the author determines the velocity of water in ft. per sec. through each pass as being 15.35/7.14 = 2.15 ft.

This is followed by an interesting discussion of the value of the resistance to heat transmission of the film on the gas side, which is of importance, because, apparently, the low heat transmission from gases to water is due mainly, if not solely, to the presence of this gas film.

Reading from Fig. 20 we find at a water velocity of 0.65 ft. per sec., a conductance through the tube and water film of 0.1635 B.t.u. per sec. The conductance of the boiler tube has been found to be 0.00445 B.t.u. As the resistance to heat transfer is the reciprocal of the conductance, we have

$$\frac{1}{\dfrac{1}{0.00445} - \dfrac{1}{0.1635}} = 0.00458 \text{ B.t.u.}$$

or the conductance of the film on the gas side.

In the Clement and Garland experiment, the thickness of the tube walls was 0.134 in., with a conductance through the metal of 1.204 B.t.u. With tubes 0.095 in. thick the conductance of the metal is $1/(6.2 \times 0.095) = 1.697$ B.t.u.

Referring again to Fig. 20, in which the conductance is plotted in relation to the velocity of the feedwater, we find, for a water velocity of 2.15 ft. per sec., a conductance of 0.227 B.t.u. Combining this with the conductance of the tube, we have

$$\frac{1}{\dfrac{1}{1.697} + \dfrac{1}{0.227}} = 0.200 \text{ B.t.u.}$$

or the total conductance of a tube 0.095 thick plus the water film. Carrying this further, knowing the conductance of the gas film, we have

$$\frac{1}{\dfrac{1}{0.200} + \dfrac{1}{0.00458}} = 0.00448 \text{ B.t.u.}$$

or the conductance of the metal, gas and water films.

In this way the total conductance is determined, which makes it possible to compute the quantity of heat transmitted to the feedwater by the heater, and when this is known it is possible to determine the economy of a given heater, which, for the heater shown in Fig. 21 is computed to be 3.4 per cent. This calculation, however, is based on two assumptions: In the first place, it has been assumed that the velocity of the gases through the heater is equal to that through the boiler tubes, and next that a feed pump is employed for forcing the water through the heater, which uses 1.75 per cent of the total amount of steam generated.

The direct economy obtained by feedwater heating with waste gases reduces the unit fuel consumption to 116 lb. and from Fig. 19 it will be seen that the ordinate for a unit fuel consumption of 116 lb. plus the boiler-efficiency curve is 60 per cent, whereas the efficiency at 120 lb. is 50 per cent. Hence the indirect economy equals 1 per cent of the total economy for the waste-gas heater 4.4 per cent.

A further economy may be secured by arranging the heaters in series with the exhaust steam as the primary heating medium and the waste gases as the secondary heating medium, the latter being possible because of the relatively great difference in the temperature of the exhaust steam and smokebox gases. The temperature of the feedwater issuing from an exhaust heater having 30 lineal ft. traverse is 163.3 deg. with the total thermal content of 131.16 B.t.u., as has been previously determined by the author. If this water, after leaving the exhaust-steam heater, be made to traverse the waste-gas heater it will attain a final temperature of 213.65 deg. with the thermal content of 181.65 B.t.u. This increase of temperature is shown by a curve in the original article. With the degree in temperature head between the waste gases and the feedwater this curve approximates a straight line.

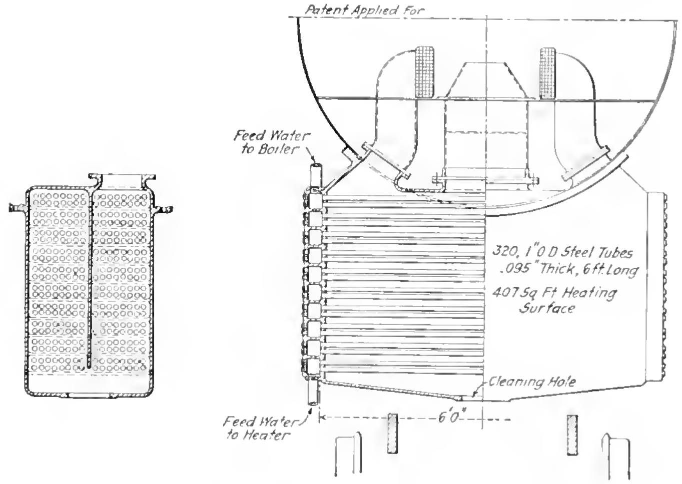


Fig. 21 Waste-Gas Feedwater Heater

The writer shows that the direct economy by series heating is 11.5 per cent, and the unit fuel consumption is reduced to 106.5 lb. to which corresponds a boiler efficiency of 62.7 per cent or an indirect saving of 3.4 per cent as shown in the diagram of Fig. 19, which, added to the direct economy, gives a total economy of 15.2 per cent.

The following conclusions are given by the writer:

Exhaust steam is superior to waste gases as a heating medium due to the low resistance of the steam film to the transmission of heat.

In a heater using exhaust steam the use of copper tubes is to be preferred to steel or iron on account of their higher conductance. Tubes should have walls as thin as is consistent with strength and wearing qualities.

Exhaust steam may be diverted for heating the feedwater without detriment to the operation of the locomotive if the area of the exhaust nozzle is decreased to give the required draft. This can be done without any increase in back pressure on the pistons.

An exhaust-steam heater such as is shown in Fig. 19, if fitted with copper tubes, will give an economy in fuel of about 11.8 per cent when using 13 per cent of the exhaust steam.

The economy of the heater using waste gases as a heating medium increases nearly in direct proportion to the heating surface. It is very difficult, however, to find space on a locomotive for a heater giving over 5 per cent economy.

High economy may be obtained by using exhaust steam and waste gases in series, but there is not sufficient room on a modern locomotive for such an application.

It is very desirable that further investigation be made of the heat-transmitting property of the gas film.

A summary of the results obtained for various types of heaters as compared with a locomotive not equipped with any but fitted with the ordinary injector is given in Table 5.

In this connection, attention is called to the fact that with the injector while the water enters the boiler at practically the same temperature as with an exhaust steam heater having 30 lineal ft. traverse, there is in the first place (injector) no economic gain, since the heat given up by the steam is equal to the heat given to the feedwater plus the external work done, which really means a loss of approximately 0.7 per cent. (Abstract made by special courtesy of the editors from an advance copy which will appear in the *Railway Mechanical Engineer*, vol. 93, no. 1, January 1919, pp. 44-47, 5 figs., *eA*)

TABLE 5 COMPARATIVE DATA OF LOCOMOTIVE BOILER PERFORMANCE WITH AND WITHOUT FEEDWATER HEATERS

	Without heater	Exhaust-steam heater		Waste-gas heater	Series heaters, waste gas and exhaust steam	
		30 lin. ft.	60 lin. ft.	60 lin. ft.	30 lin. ft.	60 lin. ft.
Boiler pressure	205	205	205	205	205	205
Total heating surface in feedwater heater	..	71.2	142.4	407	478.2	549.4
Unit fuel consumption per hour	120	111.5	107.5	116	106.5	102.3
Average temp., heating medium	..	230	230	600	230-600	230-600
Temp. feedwater entering heater	..	60	60	60	60	60
Temp. feedwater entering boiler injector	163.9	163.3	204.3	120.7	213.65	250.25
Thermal content feedwater entering heater		28.08	28.08	28.08	28.08	28.08
Thermal content feedwater entering boiler	131.7	131.16	172.27	88.76	181.65	218.76
Thermal units gained by heating	..	82.60	123.71	40.20	133.09	170.2
Direct economy by heating	..	7.2	10.7	3.4	11.5	14.5
Indirect economy by heating		2.6	3.5	1.0	3.7	5.0
Total economy by heating	..	9.8	14.2	4.4	15.2	19.5
Area exhaust nozzle required	38.19	30.2	30.8	30	30.9	31.3
Diameter of exhaust nozzle required	6.97	6.2	6.26	6.18	6.27	6.32

British View of Standardization of Railroad Equipment

Standardization of Railway Equipment. A report of great importance made by the Advisory Council of the Ministry of Reconstruction to the Minister of Reconstruction. It is based on evidence presented to the Advisory Committee by a number of experts and engineers of various companies, as well as memoranda submitted by the British Engineering Standards Association and the Locomotive Manufacturers' Association.

The report recognizes the advantages of standardization of railway equipment where it is possible, as, for example, in India, but claims that conditions in Great Britain are not suitable to its adoption because of the difference in structural and clearing gages and in tunnel dimensions.

In the existing state of things any locomotive designed to run on all the various lines would have to be a compromise and would not be the best possible for each particular railway system. However, so far as the main trunk lines are concerned, the committee is informed that a reasonably efficient engine could generally be designed for use on most of them.

The railway companies have recognized the fact that the development of the design has now reached the stage which allows of standard types being adopted when the conditions on the road are similar and have already begun to introduce standardization in so far as each company is concerned. Thus, the Committee on Locomotive Standardization set up by the Association of Railway Locomotive Engineers have now fixed on two standard engines, with the intention later to design two engines of each type, one heavy and one light, with many of the parts common to all four.

The railway companies, however, in view of the lack of material deprecate the immediate introduction of new types of standard locomotives for which new jigs, patterns and templets are required.

The report points out, however, the existence on British railways of quite unnecessary multiplication of types in certain lines. Thus the evidence before the committee showed that there are 200 different types of axle boxes and that every railroad company had adopted different types of tires, springs and axles. In fact, British railways appear to be severely handicapped by excessive freedom in the adoption of individual fitments, with the result that the working of the railroads is not as economical as it might be.

The report calls attention to the fact that British railways tend to manufacture an unusually large percentage of their supplies, including locomotives, and it is considered necessary from a business point of view to have the cost of production in the railway workshops thoroughly investigated by a competent and independent audit.

The committee also calls attention to the amount of dead weight carried on British railways. The tare of an 8-ton car built to the clearing-house regulations is 70 per cent of the load, as against the 40 to 45 per cent of the other countries.

The following recommendations are also made:

"1 That the standardization of wheels, axles, wheel centers, tires, running gear, draw gear, buffing gear, bogies, brakes and underframes be dealt with immediately by the Engineering Standards Committee, on which all interested, including private builders and makers of materials, should be represented, and that when such essential parts have been standardized the adoption of the standards should be gradually enforced.

"In view of the difficulties of standardizing complete locomotives and other rolling stock under existing circumstances, and of the excessive amount of dead weight now carried on British railways, we recommend:

"2 That a committee be formed to investigate the existing conditions of structural gages and clearances of the British railways, and the loading and unloading arrangements at works and ports, in order to ascertain how far uniformity could be introduced and tares reduced, and at what cost.

"3 That the costs of construction of locomotives and rolling stock by the railway workshops and by private firms respectively be investigated and ascertained by competent independent accountants appointed by the Government.

"In view of the great demand for rolling stock that there will be at the close of the war in this country and elsewhere, we feel that, in order to expedite delivery and to secure production at the lowest possible cost, standardization is very necessary for the export trade. We recommend, therefore:

"4 That the consulting engineers and representatives of railways financed by British capital in foreign parts in the Dominions be brought together to confer with the locomotive and wagon manufacturers in this country to determine what standardization can be effected, and that, with a view to the possibility of effecting partial international standardization, the separate Committees should take cognizance of each other's investigations." (*The Railway Gazette*, vol. 29, no. 21, November 22, 1918, pp. 548-549, *gA*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

MECHANICAL ENGINEERING
THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Published Monthly by
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
29 West Thirty-ninth Street, New York

M. E. COOLEY, *President*
WILLIAM H. WILEY, *Treasurer* CALVIN W. RICE, *Secretary*

PUBLICATION COMMITTEE:
GEORGE A. ORROK, *Chairman* J. W. ROE
H. H. ESSELSTYN GEORGE J. FORAN
RALPH E. FLANDERS

PUBLICATION STAFF:
LESTER G. FRENCH, *Editor and Manager*
LEON CAMMEN, C. M. SAMES, *Associate Editors*
FREDERICK LASK, *Advertising Manager*

Yearly subscription $3.00, single copies 35 cents. Postage to Canada, 50 cents additional; to foreign countries $1.00 additional.

Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

The Secretary's Letter

PRESIDENT COOLEY'S first address to the members was at Detroit on Saturday night, January 11, on The Unoccupied Rung in the Engineer's Ladder of Fame. Dean Cooley says he spent an entire forenoon on that title! It is needless to say the address was fascinating and "gripped" every one. It was the good fortune of Prof. A. M. Greene, Jr., Chairman of the Research Committee, and the Secretary to be present at that meeting. The two latter were making a short trip to the Sections, visiting Philadelphia, Columbus, Cleveland, Chicago and Indianapolis, to take to the members the account of the work of the Society in research, publications, library, The Engineering Index, and local sections, and in turn to learn what thoughts the members have on these activities.

Notwithstanding that the Society has a large membership, the Secretary hopes he will never fail to give personal attention to the individual member and assist him in his work. The member can always be assured that the Secretary is never "too busy" to see him and never considers a request as undeserving of his personal attention. The Secretary may be engaged at the time a member calls, or away, but in such cases the other members of the staff are equally anxious to serve and, in many cases, are more familiar with the details of the member's particular request.

The spirit of the times is forcing the whole profession to a higher sense of service, consequently the Secretary is getting inspiration from the trip.

Inquiries are made of important leaders in every city as to industrial conditions, and I am happy to report a general optimism. The best-informed men interrogated believed that such depression as we might have would be short-lived and that the cycle from the present conditions down through the depression and on to the upgrade of confidence and return of industrial activity would be completed within the year.

In one of our largest industrial centers plans are already developed for large additions to be put in as soon as weather conditions permit.

Whereas labor is now plentiful and business is what would be called dull, nevertheless there seems to be little idleness and wages are being very gradually reduced. In fact, it would seem to be necessary that all prices have got to come down before much construction can be undertaken. Also the future of the railroads has got to be determined before orders for necessary extensions can be placed.

In Detroit, preliminary but nevertheless quite complete skeleton plans for the Spring Meeting were developed and members are therefore urged to save the date, June 17 to 20, as they will be rewarded with extraordinary opportunities to see the most wonderful industrial plants in the world, as well as to participate in profitable professional sessions and delightful social reunions.

CALVIN W. RICE,
Secretary.

President Cooley's Principles in Making Committee Appointments

PRESIDENT COOLEY spent ten days at the headquarters of the Society in making up his committee appointments, conferring with the Executive Committee and with a number of members who served on committees last year to get their suggestions. The following are the President's own statements of the ideas which were uppermost in his mind in his selection of committeemen:

"In view of the large membership of the Society, I think we can well establish the policy that in general, a man shall serve on only one committee, especially if it is an important and active committee and one which makes considerable demands on his time.

"In an organization such as ours, with members distributed all over the country, it ought to be possible to plan appointments so that members of certain of the committees shall all be within convenient reaching distance of some center, not necessarily New York. For example, a committee might be selected from men who are within easy distance of Chicago and the committee could hold most of its meetings in Chicago. Another committee might center around Boston, another around St. Louis, etc.

"The Society has a large number of committees. Some of these are very active; and some, because of the war or for other reasons, are doing very little. Special war committees, in most cases, can soon be discharged; and committees inactive for other reasons than the war should either be recast or discharged. Thus the number can be kept down and the time of members and also the expense be saved.

"I would like to see more of the younger members of the Society serving on committees. The honor means much to them, and they are usually keen for the work. It is not always convenient for the older men with established businesses to find the necessary time for committee work. Their experience, however, is just what is needed, and they are perfectly splendid in the sacrifices they are willing to make in order to serve the Society.

"Offers from members to serve on committees, or suggestions from members of good committeemen, will at all times be welcomed. A list of available men from which to make selections would be a great help.

"I would also welcome suggestions for changes in the organization of committees. We should be constantly on the lookout for means to improve the work of the Society. Committeemen should not be overburdened. While this cannot always be avoided, the loads can frequently be redistributed by readjustment of the committee organization.

"It will be a great pleasure if I can help in some effective way to keep the government of the Society abreast of the activities of the times. The new Committee on Aims and Organization is making an examination of these activities in the light of present-day developments, and I am sure that as their program unfolds many good sugestions will be forthcoming.

"The responsibilities of the Society increase with its growth, and to meet them the government of the Society must be ever alert and responsive. We must be prompt to adopt new measures when they appear promising, and should not hesitate to discard the old ones when they have become obsolete."

The Cleveland Plan of Engineering Coöperation

LAST WEEK the Council of The American Society of Mechanical Engineers took favorable action upon a procedure of far-reaching importance. In effect, the purpose of the Council is to practically carry forward what has long been well nigh if not indeed a wholly universal desire among technical men for the greater unity of the entire engineering profession. While the present cautious step does not go as far as some enthusiasts may desire, it is nevertheless a decided move in the right direction.

The Council by unanimous vote recorded its willingness to enter an arrangement with the Cleveland Engineering Society whereby joint membership of mechanical engineers, duly qualified according to the respective requirements of the societies, could be effectively fostered between the two organizations. There would be a division of the dues between the two societies, a reduction of $5 being made in the total amount now paid by the active or associate member belonging to both bodies. This sum, though not large enough to be deemed a serious crippling of the receipts when first applied, would, it is confidently believed, be sufficiently attractive to bring into both societies many mechanical engineers who are at present members of but one or perhaps neither of the two bodies.

The plan further contemplates that members of The American Society of Mechanical Engineers may join the Cleveland Engineering Society without the payment of an entrance fee. On the other hand, those who are already members of the Cleveland Engineering Society may join The American Society of Mechanical Engineers—after application and election in the usual and well-known way—by payment of the difference between the entrance fee of the Cleveland Engineering Society and the initiation fee of The American Society of Mechanical Engineers for the particular grade of membership sought. Mechanical engineers not members of either society but applying for joint membership will pay an entrance or initiation fee of $25; $18 of this going to The American Society of Mechanical Engineers and $7 to the Cleveland Engineering Society. Briefly, the foregoing is the tentative proposition adopted in principle by the governing boards of both societies and each is pledged to put it into experimental operation at the earliest practicable date.

For several reasons the plan could not well be given a more auspicious test. Prominent officials of the national societies, and particularly those of The American Society of Mechanical Engineers, have heartily approved of the engineer's being an active force in public affairs, that all technically trained men should unitedly serve the respective communities where they reside, as well as take an earnest helpful interest in national problems. Coöperating as engineers, no matter whether their specialties are mechanical or electrical or civil or mining or metallurgical or of any other field of technical enterprise, they should, as it has often been urged, repay in public service whatever is possible of their educational obligations.

Cleveland offers an excellent opportunity to test out the idea in a very definite and distinctive style. There the local engineering society is very strong in numbers, something over 1200. It maintains all the facilities of a club, is open every weekday, has regular and frequent meetings for all branches of the engineering professions, keeps a critical eye upon all local transactions of consequence to engineers and energetically works in team style with the Cleveland Chamber of Commerce and with other leading civic forces.

One naturally assumes that such a plan may easily lead to other and similar arrangements between national as well as local engineering societies. Certainly the expense in fees and dues does prevent many a young engineer from receiving the benefits of membership in several societies, no matter how well he may be qualified in all other respects. There is also the additional prospect that this plan evolved by the Cleveland engineers may do much toward the institution of similar local bodies elsewhere, and these operating under the above plan with one or more of the national societies of engineers. So promising is the project that we hope for it an abundant measure of success.

R. I. C.

Progress of the Screw Thread Commission

THE Screw Thread Commission, which was appointed by the Secretary of Commerce on September 21, 1919, for a period of six months, is gradually bringing its work to a close. The purpose of the Commission as defined in Section 2 of the Act of Congress which led to the Commission's appointment is "to ascertain and establish standards for screw threads." Necessarily, such an important matter presents problems which must be viewed in an extremely broad manner and originates questions involving alike the user, the manufacturers, the tool and gage maker, those engaged in international and export trade; and to a limited extent the distributor of screw-thread products.

The members of the Commission have considered themselves judiciary in their position and have endeavored impartially to secure the best information possible from all classes of people; from those skilled in the manufacture of screw threads and who have accumulated experience; those experienced in the handling and use of manufactured products; those interested from the academic point, and especially those interested in measurements relating to specifications. These elements are always present and the Commission has endeavored to obtain the best information possible from engineers and manufacturers of these various classes.

The first step in collecting information was to formulate a series of questions thoroughly covering the subject and for this purpose the Commission held three committee meetings in September 1918, two committee meetings and two public meetings for the purpose of hearing testimony during October 1918, six committee meetings and three public meetings for the purpose of hearing testimony during November 1918, and four committee meetings during December 1918. During January 1918 eleven committee meetings were held. On January 20 and 21 the sub-committees on pitches, classification, gaging and terminology prepared their final reports. On the following day the Commission was addressed by F. G. Echols, Chairman, Tap and Die Manufacturers' Association, on Tap Tolerances. The reports of the sub-committees were submitted to the Commission as a whole and adopted by it. The Commission decided that these reports should be correlated and combined into one final report and then submitted to its members. Final reports are to be considered at a meeting of the Commission on February 17 and then made public.

Over 500 communications have been received from manufacturers and engineers who are interested in screw-thread standardization. The Commission, during the taking of testimony in the different cities, was much impressed by the frankness and interest displayed by all concerned, and by the facilities offered for obtaining information. The Commission has accumulated a large amount of information on practice relating to screw bolts of various forms of thread, on machine screws, on threads for hose couplings, brass tubing, and on pipe threads. In addition to this, it has been called upon to decide upon the classification to be provided for and the terminology; questions as to the basis for fit of screw and nut; and tolerances for various forms of fit. A great deal of interest is involved in these questions, in view of the important considerations which arise in relation to the interchangeability of one part with another.

The Commission having heard testimony and collected data covering these matters, is now considering its recommendations which it is hoped to make public early in February; and the public meeting which is to be called is for the purpose of finding whether these recommendations meet the requirements of the industry.

John Fritz Medal Awarded to General Goethals

The John Fritz Medal Board of Award Committee composed of representatives of the Societies of Civil, Mining, Mechanical and Electrical Engineers, held their annual meeting for 1919 at the Engineers' Club, New York, Friday evening, January 17, and awarded their gold medal to Major-General George W. Goethals, the builder of the Panama Canal.

The medal has previously been awarded to John Fritz, of Beth-

lehem, Pa., Lord Kelvin, George Westinghouse, Alexander Graham Bell, Thomas A. Edison, Charles T. Porter, Alfred Noble, Sir William Henry White, Robert W. Hunt, John Edson Sweet, James Douglas, Elihu Thomson, Henry M. Howe and J. Waldo Smith.

Colonel John J. Carty, now in France, has been chairman of the Board, but in his absence Ambrose Swasey, of Cleveland, presided. George H. Pegram has been elected chairman for 1919, and W. F. M. Goss, treasurer, in place of Prof. F. R. Hutton, who died during the year.

A Word About Conditions in England and France

Dear Mr. Rice:

The undersigned, together with Mr. H. L. Aldrich and Mr. A. J. Baldwin, members of the Society on the Technical Editors' trip abroad, constitute what may be called a committee without portfolio, appointed by President Main, to ascertain, if possible, something concerning the flow of engineers from peace-time pursuits into war activities in both England and France, and also to learn what steps had been taken for the return flow of engineers on the cessation of hostilities. Its appointment came in late October as the three of us were leaving the country as guests of the British Government through invitation of the British Ministry of Information to secure facts at first hand of conditions in the British Isles and at the battlefields.

Writing for myself, at least, I will say that the circumstances did not allow for collecting much informing data. As guests our time was very fully occupied in luncheons and dinners and in some plant visitations, with meeting captains of industry and soldiers and public men. We arrived in England only three days before the signing of the armistice, and naturally for the few weeks following the transition from war activities to normal activities was as indefinable as those in this country apparently were.

Volumes of literature had been published during the period of the war, largely under government auspices, looking to covering the problems of readjustment of industry, demobilization and reconstruction, but when the end of fighting actually came, it was clear that no formulæ had been so well perfected that the political or industrial machinery could immediately reverse itself. As we realize, even at this moment, the entire world, neutral as well as warring nations, has not yet recovered from the shock incident to the collapse of the Central Powers.

Just as our own engineering societies were appealed to by governmental agencies for assistance in developing war organizations, so were the officers of the corresponding organizations abroad asked to make nominations and to assist in attracting men to war work, but just as for a time was the case in this country, these war organizations had to be built up with such unprecedented speed that all possible sources of recruiting of engineering talent had to be engaged, and the engineering societies ceased early to be the main, or at least the sole, source of supply.

Very truly yours,

W. W. Macon.

Annual Report of Library Board

The Library Board of the Engineering Societies Library, which collection embraces the libraries of The American Society of Civil Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Institute of Mining Engineers, and is maintained as the joint library of the United Engineering Society, has just issued its annual report for 1918.

The Board for 1918 consisted of:

Edward D. Adams	Richard Khuen, Jr.
B. A. Behrend	Walter M. McFarland
William N. Best	Calvin W. Rice
Harrison W. Craver	Lewis D. Rights
Alfred D. Flinn	Samuel Sheldon
Alex. C. Humphreys	W. J. Slichter
Andrew M. Hunt	Jesse M. Smith
Charles Warren Hunt	E. Gybbon Spilsbury
F. L. Hutchinson	George C. Stone
John H. Janeway	Bradley Stoughton

Samuel T. Wagner

The total number of visitors during the year was 15,063, an average of 50 daily. In addition to this, over 1500 inquiries were received over the telephone and over 900 letters asking for information were answered.

The total number of searches made was 508. Work was done for almost every technical bureau of the Government, for the Naval Consulting Board, the National Research Council, for many firms manufacturing material and supplies for the Government, and for many of the Allied nations and their representatives.

Seventy-eight translations were made, as against 59 for 1917. Orders for photographic copies, 1150 in number, called for 6306 prints. In 1917, 791 orders for 1342 prints were received. This increase is partly due to wider knowledge of the Library's ability to supply copies in this way, and partly to the indexes in the monthly publications of three Founder Societies, which create a demand for copies of the articles indexed.

During the latter half of the year the Service Bureau of the Library has compiled a monthly index to mining and metallurgical literature, for the American Institute of Mining Engineers. This index the Institute publishes in its Bulletin.

The total number of accessions during the year amounted to 16,921, making the collection total, on December 31, 1918, 157,795 volumes and pamphlets, there being 38,975 of the latter.

A number of unavoidable causes have made it impossible to catalog all the accessions of the year, but the books of greatest importance and those most in demand have been given the preference, and have all been cared for. The remainder of the available time has been spent in revising those portions of the catalog which gave most trouble in daily use.

The number of volumes obtained as gifts during 1918 was unexpectedly large. The largest single gift, comprising about 8000 volumes and pamphlets, was a library of electrical literature presented jointly by the Westinghouse Electric & Manufacturing Company and the General Electric Company. This library, formerly the property of the joint Board of Patent Control established by these companies, includes sets of the most important electrical journals, a comprehensive collection of patents relating to electric power and transmission, and a unique series of records of adjudicated patent cases in that field.

Most of the new books issued by American publishers are received by the Library for review purposes, so that purchases of current volumes have been confined for the greater part to works published abroad.

The Library has also been the frequent recipient of gifts from many individuals and firms. Among the more noteworthy of these gifts are a collection of 370 pieces presented by Mr. Jesse M. Smith, containing interesting data on various patent litigations, and a collection of books on gas engineering, presented to the American Gas Institute by Dr. William Paul Gerhard, and transferred to the Library by that society, with his approval. Mr. Clemens Herschel presented a collection of bound pamphlets and papers published by him at various times, forming with those already in the Library, practically a complete collection of his contributions to engineering.

Three Founder Societies are now publishing indexes, viz.: The American Society of Civil Engineers, the American Institute of Mining Engineers and The American Society of Mechanical Engineers. The first and last of these are compiled by the respective societies, the remaining one by the Service Bureau. A committee is now considering the possibility of consolidating the preparation of two or more of these, under the direction of the Library. Such a consolidation of effort would permit the field to be covered more carefully without increased expense, would tend to standardize the methods used and would form an important step toward the realization of a complete, permanently established index.

Council Notes

A MEETING of the Council was held in the rooms of the Society on Friday, January 17, 1919. There were present: M. E. Cooley, *President*, in the chair, H. B. Sargent, F. O. Wells, Spencer Miller, F. R. Low, R. H. Fernald, C. L. Newcomb, John A. Stevens, Chas. Russ Richards, D. Robert Yarnall, John Hunter, Ira N. Hollis, John A. Brashear, Ambrose Swasey, Wm. H. Wiley, *Treasurer*, Geo. A. Orrok, *Chairman Publication Committee*, S. D. Collett, *Chairman Membership Committee*, W. E. Symons, *Chairman Finance Committee*, Calvin W. Rice, *Secretary*, and, by invitation, E. S. Carman, R. I. Clegg and J. H. Herron, of the Cleveland Local Section.

Special Orders

Joint Membership. Messrs. Carman, Clegg and Herron, members of the Cleveland Local Section, presented a proposed plan of joint membership in the Cleveland Engineering Society and this Society, with combination initiation fees and dues. After discussion in which practically all the members present participated, the following resolutions were passed:

Be It Resolved: That the Council of The American Society of Mechanical Engineers approve in principle the coöperative plan of affiliation of the Cleveland Local Section with the Cleveland Engineering Society as presented to the Council January 17, 1919, by the three Am. Soc. M. E. delegates from Cleveland, invited by the December Council.

Be It Further Resolved: That the matter be referred to the Committee on Local Sections and that this Committee be directed to prepare and propose an amendment to the Committee on Constitution and By-Laws for the general plan for such affiliation to all sections.

Be It Further Resolved: That the Committee on Local Sections be granted a special appropriation for one year's trial of the proposed plan, if in the opinion of the legal counsel of the Society such action can be taken without violating the Constitution and By-Laws of the Society.

Executive Committee

The President announced the constitution of the Executive Committee as follows: M. E. Cooley, *President, Chairman ex officio*, Chas. T. Main, Ira N. Hollis, John Hunter, D. S. Jacobus, Henry B. Sargent.

Standing Committees of Administration

Finance Committee. The President announced the appointment of Alexander Dow to serve for five years and reported the election of W. E. Symons as *Chairman* of the Committee.

Meetings and Program Committee. The date of the Spring Meeting in Detroit was approved. The meeting will be held June 17-20, 1919.

Wm. A. Viall, *Chairman*, F. H. Colvin, A. J. Gifford, J. N. Heald were approved on the Sub-Committee on Machine Shop Practice.

Publication and Papers Committee. The President announced the reappointment of Geo. A. Orrok.

Membership Committee. The President announced the reappointment of Hosea Webster.

Constitution and By-Laws Committee. The President announced the reappointment of James E. Sague.

Local Sections Committee. The President announced the appointment of Sumner B. Ely.

Mr. Yarnall presented a petition from the members of the Society in Washington, D. C., for the formation of a Local Section, which was approved.

The Secretary gave an oral report of his visit to the mid-western Sections during the month of January, on which he had been accompanied by Prof. A. M. Greene, Jr., *Chairman* of the Research Committee, who had presented the plans of the Research Committee.

Standing Committees

Library Committee. The President announced the reappointment of Jesse M. Smith. The annual report of the Library Board of the United Engineering Societies was received.

Research Committee. The President announced the reappointment of R. J. S. Pigott.

Standardization Committee. The President announced the appointment of W. S. Twining.

Professional Committees

Boiler Code Committee. Interpretations covering cases Nos. 205-207 of the Boiler Code were approved.

Special Committees

Industrial Relations. The President announced the appointment of the following Committee on Industrial Relations to give preliminary study to

a The advisability of establishing a permanent committee on relations between employer and employee;

b The best method of encouraging our membership to fulfill their high duty in that field for which their training and activities should fit them:

A. W. Burchard, *Chairman*

J. W. Lieb	H. D. Sharpe
M. W. Alexander	Chas. Cheney
Frank A. Scott	W. H. Manss

Student Branches. The President announced the appointment of Ira N. Hollis as *Acting Chairman*.

Appointments by the President

Tellers of Election. J. H. Lawrence, *Chairman*, Mancius Hutton, R. K. MacMaster.

American Association for the Advancement of Science. John A. Brashear and W. B. Gregory.

Engineering Institute of Canada. Annual meeting in February of the Engineering Institute of Canada, Dr. Ira N. Hollis, Past-President.

Washington Award, Western Society of Engineers. Chas. F. Brush.

Welding Committee, U. S. Shipping Board. F. L. Fairbanks. The report from Mr. Fairbanks recommending that the Society be represented in the new association of this committee to continue its work in research, was received.

U. S. Bureau of Standards. Wm. A. Viall, J. W. Upp and C. M. Hansen, as Honorary Vice-Presidents to represent the Society at a recent conference called in Washington on the subject of standardization of industrial safety codes.

Appointments by Council

Engineering Foundation. The term of service of W. F. M. Goss was changed to three years to comply with the by-laws of the United Engineering Society.

National Rivers and Harbors Congress. Wm. H. Wiley, Honorary Vice-President to represent the Society at the National Rivers and Harbors Congress, Washington, D. C., February 5 to 7.

Adjournment was taken to meet Friday, February 21, at a place and hour to be determined by the President.

Calvin W. Rice,
Secretary.

An elaborate report has been issued by the Board of Public Works of Detroit, Mich., on the proposed bridge to connect Belle Isle, the beautiful park and playground of Detroit, with the city to facilitate transportation to and from Belle Isle. This report contains many diagrams and illustrations. It was prepared by a consulting board appointed for the purpose, of which M. E. Cooley, President of the Society for the current year, is chairman.

Government Action on Recommendations of Committee on Standardization of Gages

THE following letter received by the Chairman of the Society's Committee on Standardization of Gages from the Director of the Bureau of Standards sets forth in interesting detail the extent to which the recommendations of the committee have been carried out by the different departments of the Government in coöperation with the Bureau, particulars of the amount of work accomplished, and opinions regarding the prospect of a continuation of the Bureau's activities in this direction which would be of great benefit to American industry during the reconstruction period and the ensuing peace conditions. A full statement of the work of this Committee and its recommendations to the Government departments appeared in THE JOURNAL of January 1918, on page 70.

DEAR SIR:

I have to reply herewith to your letter of December 28 requesting answers to six questions concerning the outcome of the recommendations of the Committee on Gages and Standards of The American Society of Mechanical Engineers.

The answers to your question are given below:

1 *How far have the recommendations been carried out by different Government Departments in coöperation with the Bureau of Standards?*

In reply to question No. 1, we have to advise as follows:

a The Ordnance Department has submitted practically all their master gages and also a considerable number of inspection gages for test at the Bureau of Standards in Washington. The Ordnance Department has further coöperated with the Bureau of Standards in making it a central point for the storage and dispatch of master gages. With this arrangement the shipment of gages to Army Inspectors of Ordnance at manufacturing plants having Government munitions contracts, has been greatly facilitated. In addition there has been organized at the Bureau of Standards a gage shop for the salvage and manufacture of master gages and inspection gages needed for exigency purposes. Up to the signing of the armistice this Gage Shop employed from 60 to 75 toolmakers and the equipment available included a complete tool shop equipment, such as precision lathes, grinding machinery for plain gages, thread grinders, and other shop accessories. In all about 60 machine tools were in use in this shop. With gages stored and with a salvage shop available at the Bureau, it was possible to supply sets of master gages revised to the latest component drawings, where otherwise it would have been necessary to send out gages which had become obsolete during the course of their manufacture. This Gage Shop was also used to very good advantage in the way of supplying inspection gages needed to prevent stoppage of production. Gages for this class of work were manufactured in anywhere from 3 days' to 2 weeks' time, whereas it would have taken several months to secure the gages in the ordinary procedure of securing bids and placing a formal order with gage manufacturers. An instance is mentioned in which this Bureau supplied 6 gages required for immediate use overseas within 4 days, whereas the best delivery obtainable from any Government arsenal or gage manufacturer was 2 weeks. The gages in question were immediately dispatched overseas by carrier.

The Gage Shop at the Bureau of Standards has also supplied various arsenals and district offices with gage-measuring apparatus, especially lead-testing machines. Further coöperation with the Ordnance Department has taken place in the development of an invention covering the manufacture of precision size blocks similar to the Swedish gages. This work has progressed to the extent of completing about 500 gages which are accurate for flatness, parallelism and size within 0.000005 in. It is expected that about 50 sets of gages will be completed about March 1.

b The Motor Transport Division, Quartermaster Department, have submitted for test and certification practically all of their master product parts and master gages. These gages have been stored at the Bureau and dispatched as required directly to manufacturers executing Government contracts for motor trucks and motor truck parts.

c The branch of the Signal Corps which was afterwards organized at the Bureau of Aircraft Production submitted a number of master gages and inspection gages for test at the Bureau of Standards at Washington before they had any inspection facilities of their own. However, practically no gages have been submitted from this branch since January 1, 1918 as the Bureau of Aircraft Production established a gage-testing laboratory in New York in collaboration with the British Ministry of Munitions in United States.

d The Navy Department has coöperated with the Bureau of Standards to the extent of investigating the methods used for measuring gages at the Bureau and in securing technical advice and information on their gaging problems. The Bureau of Standards was asked to calibrate the measuring machine at the Naval Gun Factory at Washington, D. C. The measuring machine referred to is the standard to which all naval guns are manufactured. Practically no gages have been submitted for actual measurement by the Navy Department.

2 *To what extent has the Bureau of Standards responded to the demand made by such departments?*

a Preparations were made by the Bureau of Standards at an early date to handle promptly the test of all munitions which might be submitted by various Government departments. On June 15, 1917, a special war appropriation of $150,000 for gage standardization by the Bureau of Standards was approved by Congress; and on July 8, 1917, apparatus and equipment was transferred to a special building for the testing of munition gages. The first lot of munition gages was submitted on June 16, 1917.

b During the months of June, July, August and September the Gage Laboratory was overorganized, there being more inspectors available than were required for the test of gages delivered during this period. The personnel and equipment was increased as rapidly as was consistent with information which could be obtained from time to time regarding the number of gages likely to be submitted for test from various sources. It was surprising, indeed, to learn of the organization of a separate gage laboratory by the Bureau of Aircraft Production in spite of the fact that the facilities available at this Bureau had been repeatedly called to the attention of responsible officials in charge of aircraft work, especially as the Bureau of Standards had rendered very prompt service in the test of gages submitted by the Signal Corps before they had facilities of their own. In this connection an instance will be cited where a lot of 110 thread gages were submitted on Saturday noon, were tested and delivered with a complete report to the Signal Corps Inspector on Sunday night, the Inspection force being on duty during Saturday afternoon holiday, Saturday evening and on part time the following Sunday.

c Particular pains have been taken to supply information on gages tested to all interested parties. In all lots of gages tested, 8 copies of the report showing the acceptance, rejection or measured dimensions of the gages had been written and in many cases, it has been necessary to make from 11 to 12 copies of these reports. For instance, on gages tested for the Ordnance Department, copies of the reports had been supplied to the gage manufacturer, the contractor using the gages, 2 copies to the Inspection Division, one copy to the Procurement Division, one copy to the Production Division, one copy to the Engineering Division, and one copy to the property officer.

3 *How many gages have been certified for each department? What per cent of rejections?*

a An idea of the amount of work which has been submitted at the Gage Laboratory in Washington is given in the following table which indicates the number of gages which have been received, tested, certified, or rejected:

1917	July	244	1918	May	4917
	August	473		June	5559
	September	456		July	4720
	October	737		August	4106
	November	1735		September	3207
	December	1142		October	3450
1918	January	2519		November	3270
	February	1813		December	1620
	March	3582			
	April	4688		Total	48238

In the above table about 60 per cent could be classed as plain gages (plain, plug, snap, and ring gages); about 20 per cent as profile gages (complicated templets, chamber gages and fixture gages); and about 20 per cent thread gages. Of these gages about 70 per cent were on account of the Army Ordnance Department; 10 per cent were on account of the Motor Transport Division, U. S. Army; about 5 per cent were on account of the Signal Corps; and the remaining 15 per cent were on account of other branches of the Federal Government and industrial concerns having Government contracts. In addition to the foregoing testing, the Bureau has been called upon to inspect gages used in the production of cannon at various points in the field. In this connection over 300 gages were inspected for the 75-mm. field gun at Rochester, N. Y.; and over 600 gages for the 3-in. anti-aircraft gun were inspected at Philadelphia.

b The following table shows the gages received at the various branch laboratories:

		New York	Cleveland	Bridgeport
1918	April	241	....	....
	May	459	....	....
	June	431	....	....
	July	737	276	....
	August	1434	409	48
	September	1225	424	458
	October	1541	360	462
	November	1843	430	441
	December	1665	479	454
	Total	9576	2378	1863

c With reference to the percentage of acceptance and rejection of gages the following figures taken from the test for the Ordnance Department are submitted:

Approved	70 per cent
Rejected	17 per cent
Measurement dimensions reported	13 per cent

4 *How many branches have been inaugurated and where?*

Branch Gage Sections have been inaugurated as rapidly as the need could be determined. The Branch Gage Section in New York

City was opened April 15, 1918 and includes at the present time a complete gage testing equipment with about 25 persons. The Branch Gage Section at Cleveland was opened July 1, 1918 and includes a complete gage testing equipment and, until recently, a personnel of 6 to 8 persons. The Bridgeport Branch Gage Section was opened August 20, 1918, at the request of the Ordnance Department. There is available in this branch a complete gage testing equipment and a working force of 6 people. Both the New York Branch and Cleveland Branch were initiated by this Bureau and have been well supported and fulfilled an apparent need. These Branch Laboratories were organized mainly for the purpose of taking care of the test of gages needed for exigency purposes, such as inspection gages and working gages being secured by Government contractors and needed for the maintenance of production. The inspection of master gages ordered by Government departments has been taken care of in practically all cases at the Laboratory in Washington in order that the Branch Laboratories would not be congested with this work and thereby interfere their functioning.

5 *How fast has the Bureau been able to handle certification? What periods of delay have there been, and if any delay, what were the contributory causes?*

Every effort has been made to render prompt service in the test of gages submitted. In many cases where gages were urgently needed, gages have been received, tested and the report mailed on the same day. The average time of test for the gages submitted at the Bureau of Standards and Branch Laboratories has been 3½ days. In some cases, particularly large shipments of gages have been held for test for a period of about 2 weeks but the delays in this case have most all been due to the fact that drawings were not available for the examination of the gages, and very often gages have been submitted without definite shipping instructions as to their disposal, or with information lacking as to the source of the gages or nature of the test required.

6 *During the reconstruction period and during peace conditions following, what prospect is there of having the Bureau of Standards and its branches continue in this work so as to be a continual benefit to American industry?*

The Bureau of Standards which is a branch of the Department of Commerce is a permanent institution organized for the development, construction, maintenance and custody of standards of measurements, performance and practice. There is no reason why the facilities in a way of gage testing and scientific staff, made available by war conditions, should not be continued to a large extent for the benefit to American industry during the reconstruction period and indefinitely thereafter. In the work of test and certification of gages during the war, an immense amount of data and information has been accumulated, which the Bureau intends to make available to manufacturers in the way of publications, magazine articles and technical papers.

b It is believed that manufactures have, in the execution of Government contracts, come to realize the advantages of interchangeable manufacture where production is large and that the demand for gages and measuring tools will exceed many times the demands for this material before the war.

c Up to this time the energy of the Gage Section of the Bureau of Standards has been devoted mainly to the test and certification of gages. However, it is planned to use the technical staff for the collection of information and data on the practical problems of manufacturers; for the carrying out of experiments and investigations on such problems as the design, manufacture and application of gages; and for research work in the development of new formulas, charts, methods of test, and for the organization of simple and effective pieces of apparatus for general shop use. The Gage Shop at the Bureau of Standards should be maintained for the construction of precision shop reference standards, including end measures, thread gages, various sizes of standard gages decided upon by the National Screw Thread Commission, and other forms of measuring standards. Furthermore, this shop will be of excellent service in connection with the development of new and simplified forms of shop measuring tools and apparatus, and for the test and development of special machinery for producing gages such as thread grinding machines and the like.

d It is planned to continue indefinitely the operation of the Branch Gage Section in the United Engineering Societies Building at New York City and the Branch Gage Section in the Plymouth Building in Cleveland, Ohio. Service for the testing of gages will be available in these Branch Laboratories and in the Laboratory at Washington for the testing and certification of gages submitted by manufacturers upon payment of a nominal fee. With reference to the matter of charging fees for the test of gages, it is a policy of this Bureau to make charges in case the work done is of direct benefit to one or two interested parties. However, when investigations or experiments are conducted, the result will be of general utility to manufacturers, no fee is charged. The continuation of the New York Branch and the Cleveland Branch will also serve as Headquarters for the technical staff in the field, where the application and operation of the various methods and pieces of apparatus devised and utilized by the Bureau of Standards can be explained to representatives of manufacturing concerns. These laboratories will also serve as points with which manufacturers can get in touch with the Bureau of Standards an technical problems arising in their work.

The possibilities in the utilization of the technical staff and facilities available at the Bureau of Standards in Washington, New York City and Cleveland will depend largely upon the demands made by manufacturers and by the general support given to these projects. An appropriation of $150,000 has been requested of Congress for the operation of the Gage Section for the fiscal year ending June 30, 1920, and the work of the Gage Section for the coming fiscal year will depend, of course, upon whether or not this appropriation is made available.

If additional information is desired by your Committee, I would be pleased to have prepared such articles or information as you require. It occurs to me that it might be well for your Committee to transmit part or all of the material presented in this letter to the technical press for publication, and I would like to know if such action is taken.

Respectfully,

(signed) S. W. STRATTON,
Director.

Washington, D. C.,
January 3, 1919.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A. S. M. E.

Research! What Will You Do?

THE Research Committee of the A.S.M.E. has decided to inaugurate several activities and asks the assistance of the membership of the Society in this work.

The research of the last four years in the countries of our Allies and at home has been able to circumvent the hellish devices of the Hun. The work of the layman, the pure scientist and the engineer has developed methods of detection, method of manufacture, processes and devices which were never thought of before. Many have started the solution of special problems which by a further extension may be made general. Some have started problems which have been discontinued now that the active fighting has ceased, and these by a little more work could become of great value.

In many laboratories of our technical schools and universities and of our large industries and of our private investigators there have been research problems worked out which have never been published for one reason or another, and these would be of great value to the profession if announced.

The equipment of some laboratories is especially fitted for a definite kind of research, and if this were known, problems of the nature fitted for the equipment would come naturally to these laboratories, while other problems would go to other laboratories. The knowledge of the equipment is therefore of prime importance. For this reason a survey of laboratory facilities of the whole country should be made.

Many problems are arising each day for which research information is needed. This information is required by those who have equipment and staffs for research, and for such the Research Committee cannot do much, but there are many engineers and manufacturers who are not in a position to undertake the investigation because they lack investigators and apparatus. The problems of such persons should be stated so that those prepared to undertake them can be brought in contact with those who need the data from the investigation.

These are the conditions at present, and to meet them the Research Committee has made the following plans:

1 *Research in Progress.* The Committee desires the members of the Society, the manufacturers who maintain laboratories, the directors of private laboratories and college laboratories and the directors of experiment stations to report to the Committee the research problems on which work is being done. The subjects of these investigations will then be published in MECHANICAL ENGINEERING. The Committee will give case numbers to these investigations and cross-reference them on a card index. In this way it is hoped that the profession will know what work is being done and where these investigations are being made.

2 *Results of Research.* The Committee desires that results of investigations be sent to them for publication in Mechanical Engineering, The Journal of The American Society of Mechanical Engineers. If the investigation is best presented in an article, it will be advisable to so give it. The Committee believes that there are many investigations of a restricted nature which, while not warranting a paper, should be reported in a concise statement of results, with curves or tables, and it is the wish of the Committee that our members coöperate in sending in this information. These results will be numbered in some way for reference so that one may be able to obtain the information rapidly.

3 *Problems to Be Solved.* It is asked by the Committee that those having research problems on which they desire information and on which it is possible to publish the problem will communicate the problem, and this will be properly presented in Mechanical Engineering with a case number. This will bring to the attention of those properly equipped problems on which they may work, and will bring together the person desiring research information and the laboratory equipped by staff and apparatus to do the work.

4 *Laboratory Equipment.* The Committee hopes to publish from time to time statements of the laboratory facilities of various individuals, corporations, colleges and experiment stations so that it may give to the profession a clear idea of the facilities within the various districts of our country. This it hopes will stimulate work and aid those who have problems to place them at a near-by point.

5 *Bibliography.* For those starting research, bibliographies will be prepared by the Society if the scope of the investigation is such that the Council of the A.S.M.E., on recommendation of the Research Committee, approves. On approval by the Committee the request will be made of the Council and the bibliography prepared. A copy of this will be loaned to the person beginning the research for a proper period, and at the same time a notice of the bibliography will appear in Mechanical Engineering, so that any others interested may borrow the carbon copies of the bibliography for a period of two weeks. In this way three or four carbon copies may be made of great value. The original and the carbon copies will be filed for reference in the Library of the United Engineering Societies. The bibliographies will be made from the excellent library of the U. E. S., one of the best technical libraries in the world.

These points are the initial steps in the present plans of your Research Committee. To make them successful you are asked to help. Coöperation and a united front have been successful in winning the war; they have been successful in industry and in trade. The Committee needs the help of each one, and for that purpose it hopes that you will aid in sending in data under any of the four heads. The Committee cannot know the work under way, the results, the equipment or the problems unless you send them the information. The success of this depends on each individual member, on you! Will you help?

Arthur M. Greene, Jr., *Chairman,*
Research Committee.

NEWS OF OTHER SOCIETIES

American Institute of Electrical Engineers

At a meeting of the American Institute of Electrical Engineers held on January 10 in the Engineering Societies Building, New York, Major-General George O. Squier, Chief Signal Officer of the U. S. Army, gave for the first time the history of the achievements of the country in aviation during the war. The address, which was upwards of 30,000 words in length, was given at the direction of the Secretary of War.

General Squier said that 8600 aviators had been trained in this country when the armistice was signed, while in the production of airplanes, 350 firms, employing 200,000 men and women, were engaged. Through this organization it was possible, he said, to produce 14,000 Liberty motors with an equivalent of 5,700,000 horsepower up to November 11. At this date the Army had adopted four airplane types on which production was to have started in the calendar year.

One of the striking accomplishments was the development by the Navy of the naval seaplane or flying boat NC-1. This plane has a wing span of 2400 sq. ft., is equipped with three Liberty engines with tractor screws, and when fully loaded weighs 22,000 lb. It is the largest seaplane in the world and on a recent test made a trip from Hampton, Va., to Rockaway Beach, N. Y., carrying fifty-one passengers. The fifty-first passenger, it is interesting to note, was a stowaway.

After telling how the problems of obtaining spruce, linen, and castor beans were met, General Squier declared that behind the production figures of November 11 there was mobilized in the United States an industrial army of about 350 concerns and corporations employing more than 200,000 men and women.

The Science and Research Division of the Signal Corps at the time of the beginning of the armistice had in progress sixty-four problems, he said. Among the work completed was the designing and development of a new and improved venturi-pitot tube for the use in the determination of air speed.

The satisfactory progress made with the vacuum tube has resulted in a new type of military unit known as a voice-commanded squadron, which is directed by the commander in any manner desired by voice, thus enormously increasing the squadron's efficiency as a military machine.

Aviation in the Future

"If America will but press on into the future, building upon the sound foundations now erected," continued General Squier, "she may lead the world in the development and utilization of aerial navigation for the triumphs of peace.

"By a wise policy of readjustment, utilizing immediately our machines and our surplus aviators for the rapid expansion of the aerial mail and special passenger services, it will be possible to salvage a greater percentage of the money and energy invested for strictly war purposes than for any other feature of our war activities."

Transcontinental and transatlantic flights in dirigibles soon will be a commonplace occurrence, through the more extensive use of helium, a non-inflammable gas.

Now, through the efforts of the Navy Department and the Bureau of Mines, more than 147,000 cu. ft. of helium was ready for use, with plants under construction which would be able to turn out at least 50,000 cu. ft. daily at a cost of not more than ten cents a cu. ft.

Greater safety in transcontinental and transatlantic flights will be made possible through the establishment of upper air stations by means of balloons. By this means air currents can be forecast and accurately gaged. Recent experiments have shown that above the level of 10,000 ft. 95 per cent of the winds, both in the United States and Europe, are from west to east, and often attain a velocity of 100 miles an hour. November 6, at Chattanooga, Tenn., a velocity of 154 miles an hour was discovered at an altitude of 28,000 ft. Preparations are now under way to make similar observations from ships on the sea along the proposed transatlantic route.

American Society of Civil Engineers

The 66th annual meeting of the American Society of Civil Engineers was held January 15 and 16, in the Engineering Societies Building.

As a rule at the annual meetings of the American Society of Civil Engineers only business matters are transacted and addresses of a general nature presented, but not strictly technical papers. This meeting was no exception in this respect.

Mr. Fayette Samuel Curtis, of Boston, was elected president of the society for the coming year.

A subject which evoked considerable interest and resulted in a formal unanimously adopted resolution was the matter of the summary dismissal of about 350 engineer employees of the Public Service Commission for the First District of the State of New York. The Brooklyn Engineers' Club presented to the Board of Directors a series of resolutions which vigorously protested against this act, as being both unfair to the men deprived of their jobs and liable to cripple the engineering activities of the Public Service Commission, which at the present time has on its hands the important work dealing with the construction of the great transportation system of New York City.

This matter is already under consideration by the Engineering Council, and the American Society of Civil Engineers went on record as endorsing the resolutions of the Brooklyn Engineers' Club.

Another matter of interest to the entire engineering profession was brought up before the Society in the resolution offered by R. S. Buck. In this case the society went on record as favoring a policy by which the Government would undertake at the present time extensive public works so as to reduce, or, if possible, entirely prevent the unemployment threatening this country during the transition of the industries from the war basis to the peace basis.

Brig.-Gen. R. C. Marshall, Jr., presented an extensive address dealing with the many difficulties involved in the construction of cantonments and the organization which permitted having this vast work carried out in the comparatively brief space of 90 days under war conditions. In the course of this address General Marshall stated that the experience of the War Department has shown that if it had to deal with one great united engineering society representing the entire profession instead of as at present with 19 independent organizations, the task of the War Department would have been materially lightened in several ways.

HELIUM FROM NATURAL GAS

(*Continued from page 158*)

recounting his experiences and discussing the general theory of the subject, is intensely interesting.

By use of an expansion engine, Claude was able to drop the initial gas pressure to from 400 to 600 lb. per sq. in., or even lower in some of the larger units recently erected for air separation. At these pressures the effect depended upon by the Linde system practically disappears so that, in practice, the Claude system works essentially on a wholly new principle rather than by the superposition of this upon that of the Linde process.

However, as Claude confined himself to one expansion engine,[1] it was necessary for him, with his moderate initial pressure, to locate the engine's gas intake at a level in his interchanger sufficiently low so that the exhaust would reach the lowest temperature desired in the system and still be able to absorb quite an appreciable amount of heat at this temperature.

With the one engine taking its gas from the incoming side of the U, it is also evident that for efficient liquefaction only a part of the gas can be expanded through the engine, for, if liquefaction takes place in its cylinders, expansion to that extent is lost. The remainder of the gas must, therefore, be retained under pressure in the U and cooled down and liquefied by heat exchange with the expanded gas returning as indicated by the spiral line around both legs of the U. The gas after liquefaction in leg *A* is let into leg *D* through the throttle and there under the lower pressure rapidly drops still further in temperature by its own evaporation. Here it undergoes fractional distillation as already explained above.

Jefferies-Norton System

Coming finally to the Jefferies-Norton system, Fig. 6, it will be noted that this differs from the Claude in at least three important points, viz.:

1 The system employs more than one engine (in the illustration three *AE*, *BE* and *CE*), each working through a different temperature range. The number of these temperature steps depends upon conditions, increasing with the total range of temperature to be covered and also with decreasing initial pressure employed.

2 The pressure in the outgoing leg of the U is only enough lower than in the incoming leg to allow for proper control of flow, unavoidable friction, head of liquid in the still trays and the like.

3 The engines work upon the gases after their liquefaction and distillation, thus permitting all the gas to be so treated. Incidentally, this also insures freedom from easily frozen impurities enter-

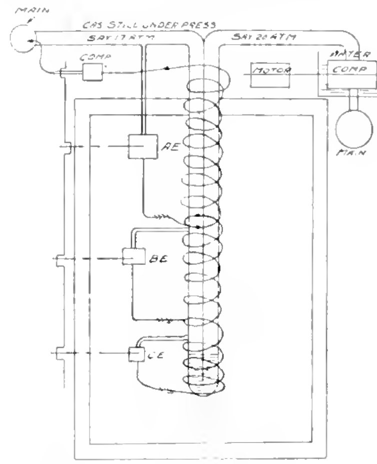


Fig. 6 Jefferies-Norton System

ing the engine valve chambers and cylinders and in many cases greatly simplifies the whole problem of initial purification of the gas to be treated. Engine *C* corresponds in a way to Claude's one-engine system but as the initial pressure used in the system can, on account of its greater efficiency, be much less than the Claude, the temperature range over which this engine works will be much less than in the former. Since, when expanding a given weight of gas between two definite pressures, the work obtainable from it (and consequently the number of calories its expansion will extract from the system) is greater the higher its temperature, engine *A* will extract the most heat from the system and deliver the most power to the crankshaft per unit of gas used and engine *C* the least, which still further emphasizes the importance of this development.

Rough analogies, though suggestive, are often dangerous to accuracy in scientific and technical explanations but without laying any great stress upon it, the following may here be helpful to those not especially familiar with this subject. It was pointed out at the start that a considerable amount of the refrigerative effort which has to be expended in any of these processes is to remove the heat which, despite the best insulation we can put on the apparatus, still leaks in from without. Now in this sense the expansion engines of the last two processes may be thought of as engaged partly in pumping out this heat from the refrigerated system back to the outside, much as mine pumps are kept busy pumping out the water which leaks into a mine. Just as water may be coming in at various levels in the mine so heat is leaking into parts of the system at all levels of temperature. The one engine of the Claude system is analogous to the mine with a single pumping station at the very bottom where all water entering at any part of the mine is allowed to drain clear to the bottom and is then all pumped from there to the surface, while the Jefferies-Norton system is analogous to the installation of several pumping stations at different levels so that water from the upper levels is pumped out over the shorter lifts, thus saving power.

The really salient feature brought out in these diagrams is perhaps the progressive approach toward the ideal of thermodynamic reversibility and the high degree to which this is fulfilled in the basic principles of the last system. There are many other interesting and important features both in the theoretical aspect of the cycle employed and in the details of mechanical construction of the plant at Petrolia which might be given if space permitted, but I fear I am already overstepping reasonable bounds in this particular.

[1] Though this is in many cases compound, having a high- and a low-pressure cylinder.

AMONG THE LOCAL SECTIONS

THE Secretary and the Chairman of the Society's Committee on Research, Prof. Arthur M. Greene, Jr., head of the Mechanical Engineering Department of Rensselaer Polytechnic Institute, have been attending meetings of the Sections and telling of the work of the Society, but more particularly, learning of the wishes of the members. As expressed in the notice sent out for the Chicago Section meeting, "C. W., otherwise known as Calvin W. Rice, will be there, and he wants us all to tell him how to run the Society."

This is the spirit of the visits to Philadelphia, Columbus, Cleveland, Detroit, Chicago, University of Illinois and Indianapolis.

At Detroit, President Cooley gave the principal talk on The Unoccupied Rung in the Engineers' Ladder of Fame.

Splendid interest was displayed in each place, showing that with the prospects of peace one may once more devote his thought to professional and society work.

Further, it was characteristic of many gatherings that men met who had never before known each other, thus directly promoting the feeling of brotherhood which is so essential and one of the principal objects of the Sections.

The Secretary will continue to go out among the Sections, going southeast in February and northeast and southwest in March.

ANNUAL MEETING CONFERENCE OF SECTIONS' DELEGATES

New York, December 4, 1918

Extracts from Reports Rendered by the Delegates

ATLANTA, Robert Gregg, *Chairman:* The Secretary appointed a special Committee of three members to put before the Legislature the matter of securing the adoption of the A.S.M.E. Boiler Code by the Legislature of Georgia.

We have held two meetings this fall, and at the October meeting Mr. Brookes presented a paper on the Code and offered several constructive suggestions looking toward the matter of securing the adoption of the A.S.M.E. Code by the Legislature of Georgia. The Secretary appointed a special Committee of three members to put this before the Legislature.

Regarding membership, we have done active work and our members rarely miss an opportunity to spread the doctrine of membership in the Society. The general attitude, however, is one of conservatism, seeking quality rather than quantity.

In public activities we have coöperated with the Resources and Conversion Section of the War Industries Board through the Society's Committee on Readjustment on War Industries. In Atlanta there is also an Engineering Committee appointed each year by the Mayor to advise the civic administration on engineering problems. This committee is made up of a representative from each of four national societies, and our Section is represented on this committee.

BALTIMORE, W. L. DeBaufre, Vice-Chairman: The Baltimore Section is organized under the constitution and by-laws as laid down by the parent Society. At a meeting of the Section in November, 1918, the Chairman and Secretary were appointed a committee to confer with representatives of the other technical societies and clubs with the object of establishing closer bonds of union between the engineers and chemists of Baltimore and vicinity.

It seems to be the consensus of opinion that it would be desirable for the national society to formulate from time to time certain very definite and limited questions on some particular feature of the relation of the mechanical engineer to his work, to legislation, to education, etc., and submit these questions to the various local sections for discussion.

BIRMINGHAM, W. P. Caine, *Chairman:* The chairman of each of the sub-committees of the Birmingham Section is a member of the Executive Committee. A committee was appointed last year to embody in our constitution the features of the model constitution adopted by the Council. They tried to retain as much of the present one as possible, and in addition to have the election of officers on the same democratic plan adopted by the Society.

It is suggested that speakers interchange between the sections. Could not the Local Sections Committee arrange a tentative tour of speakers that would assist the various program committees in arranging its year's work? Would it not also be a good plan for the Society's Research and Standardization Committees to outline just how they desire the local men to work?

The Section has undertaken the task of securing the passage of a proper bill for the protection of the public from boiler explosions and making the A.S.M.E. Boiler Code the standard of new boilers installed. The Alabama Technical Association has placed itself on record as favoring the adoption of the Boiler Code by the state legislature.

We are on record as offering our support to the City Commissioners in matters of a mechanical nature; and our services were offered to the director of the Conversion Section of the War Industries Board and to the Alabama Manufacturers and Operators Association. We find that our Section creates much more interest in the Society than was in evidence before its organization.

BOSTON, Elmer Smith, *Secretary:* Up to this year our Section included the territory within a radius of ten miles from Boston City Hall but has now been increased to a 25-mile radius, and in a southerly direction the territory extends 50 miles to include Fall River and New Bedford. The territory is particularly rich in membership material and we feel that there are fully 2000 engineers in the Boston Section territory who are eligible for membership.

The results of the efforts of the Membership Committee of the Local Section so far have not been satisfactory. The work has been carried on almost entirely by letter but a new plan is proposed which instead of letter writing will involve a personal interview with the candidate. This will preferably be done by someone personally acquainted with the prospect.

CHICAGO, Arthur L. Rice, *Secretary:* War activity has consisted in assisting in the recruiting of engineering units, men for special service, applicants for officers' training in engineer and ordnance branches, and coöperation in the sale of Liberty Loan bonds. It is hoped that in time a coöperative headquarters and engineering building may be established in Chicago.

CINCINNATI, Prof. A. L. Jenkins, Member of the Executive Committee: Papers of general nature and interest that may be illustrated with lantern slides are preferable to those that are highly technical, involving considerable mathematics. Papers of a highly technical nature, involving equations and complicated diagrams are read in abstract.

From time to time the secretary of the Local Section encloses to the local members a request for suggestions on subjects for papers and men to present them. It is the intention of the Local Committee on Papers to urge members to present papers on subjects about which they are well informed and allow them ample time for their preparation. It is hoped that this policy will tend to eliminate "lack of time" as an excuse, and after a period will begin to bear fruit.

Members are requested to present names of those whom in their opinion are eligible and who would accept membership. Prospective members are approached by members who know them personally and see that their applications are sent in.

CLEVELAND, J. H. Herron, *Secretary:* The first meeting of the Cleveland Section, which was held purely for organization purposes, took place in October; a tentative constitution was adopted, which was subsequently approved. The Cleveland Section is unique in that it is a Section of this Society organized within the Cleveland Engineering Society; in other words, it is called the Cleveland Engineering Society Section of The American Society of Mechanical Engineers. We have been opposed in Cleveland to the Section idea for some years past; we felt that we should not divide our activities, that we should work as one body in

(*Continued on page 193*)

A. S. M. E. COMMITTEE ON LOCAL SECTIONS

ANALYSIS OF ACTIVITIES FOR 1918 REPORTED BY THE DELEGATES TO THE THIRTY-NINTH ANNUAL MEETING

Section	Members Dec. 1, 1918	Chairman and Secretary, 1918	Delegate to Annual Meeting, 1918	Organization by Committees (a) Executive (b) Sub-Committees (c) Joint (d) Coöperating with National Committees	Coöperating or Affiliated Bodies (a) Coöperative (b) Affiliated	Meetings Schedule (a) Technical (b) Joint (c) Public (d) Social (e) Contemplated	Technical Subjects (a) Meetings Held (b) Contemplated	Speakers and Visitors	Public Activities	War Activities	Representative on Aims and Organization Committee
Atlanta	41	Robert Gregg Wm. J. Neville	Robert Gregg	(a) (b) On Meetings	(b) Affiliated Technical Societies of Atlanta		(a) Pulverized Coal (a) A.S.M.E. Boiler Code		Coöperation with Mayor's Engineering Committee Coöperate with War Industries Board		E. F. Scott
Baltimore	101	A. E. Walden A. G. Christie	W. L. De Baufre	(a) (b) Papers, Research							A. E. Walden,
Birmingham	45	W. P. Caine Jas. W. Moore	W. P. Caine	(a) (b) Program, Papers and Research, Membership (d) A.S.M.E. Boiler Code						War Industries Readjustment	H. M. Gassman
Boston	511	W. G. Starkweather Elmer Smith	Elmer Smith	(a) (b) Meetings, Membership, Social	(a) Engineers Club (a) All societies in annual dinner						A. G. Duncan
Buffalo	122	H. B. Alverson W. W. Boyd	C. H. Bierbaum	(a)	(a) Buffalo Engineering Society						C. H. Bierbaum
Chicago	496	C. E. Lord Arthur L. Rice	A. L. Rice	(a)) (b) Reception		2 (d) 5 (b) 2 (e)	(a) Fuel control (a) Auto power plant (a) Lawrence Avenue Tunnel (a) High pressure superheat (a) Technical Education (a) Industrial lighting (a) Fuel conservation (b) Sugar making	A. N. Talbot, Pres. A.S.C.E. C. F. Kettering, Pres. S.A.E.		Recruiting. Sold $3600 Liberty Bonds. War Industries Readjustment	C. E. Lord
Cincinnati	160	Geo. W. Galbraith J. T. Faig	A. L. Jenkins	(a) (b) Research, machine tools, industrial education, railroad engineering, gas and oil engineering, steam, electrical; membership, entertainment, papers, publicity	(b) Engineers Club of Cincinnati	3 (b)	(a) Coa (a) Shop Kinks (a) Readjustment of Industries			War Industries Readjustment	John T. Faig
Cleveland	219	E. S. Carman J. H. Herron	J. H. Herron		(b) Cleveland Engineering Society					War Industries Readjustment	E. S. Carman
Connecticut Bridgeport Hartford Meriden New Haven Waterbury	180	J. A. Norcross C. K. Decherd E. L. Fletcher C. F. MacGill Charles S. Blake M. D. Church C. K. Decherd C. M. Flagg, Jr. J. A. Norcross E. H. Lockwood Hugh L. Thompson Geo. H. Putnam	C. K. Decherd E. L. Fletcher C. S. Blake C. K. Decherd S. H. Barnum, 2d H. L. Thompson	(a) (b) Increase of Membership, Meetings, Publicity, Reception Dinner (a) (b) Increase of membership		(a) (b) (e)	(a) Coal conservation (a) Internal combustion engines (a) Battleships (a) Firearms (a) Factory Accounting, etc.	Ira N. Hollis, Past Pres. A.S.M.E. C. W. Rice, Secy. A.S.M.E. O. P. Hood, Bureau of Mines Simon Lake, etc.		War Industries Readjustment	L. P. Breckenridge
Detroit	240	E. C. Fisher F. H. Mason	F. H. Mason	(a) (b) Membership (c) Technical with D.E.S.	(a) Detroit Engineering Society	3 or 4 (e) per year	(b) Aircraft (b) Standardization (b) Heat Treatment			Coal Conservation War Industries Readjustment	R. Collamore
Erie	27	M. W. Sherwood J. St. Lawrence	M. W. Sherwood	(a)	(a) Engineers Society of N. W. Penna. (a) A.I.E.E.		(a) Industrial Management (a) Conservation of engineering materials	D. S. Kimball			C. M. Spalding

Section	Members Dec. 1, 1918	Chairman and Secretary, 1918	Delegate to Annual Meeting, 1918	Organization by Committees (a) Executive (b) Sub-Committees (c) Joint (d) Coöperating with National Committees	Coöperating or Affiliated Bodies (a) Coöperative (b) Affiliated	Meetings Schedule (a) Technical (b) Joint (c) Public (d) Social (e) Contemplated	Technical Subjects (a) Meetings Held (b) Contemplated	Speakers and Visitors	Public Activities	War Activities	Representative on Aims and Organization Committee
Indianapolis...	83	L. W. Wallace Chas. Brosman	L. W. Wallace	(c) Engineers' Club Committee	(a) Engineers' Club, S.A.E., Indiana Engineering Society, Architects' Association, Boston Tech. and Rose Tech.	(b) Every month			State Board of Advisory Engineers to Fuel Administrator		L. V. Ludy
Los Angeles...	69	Chas. H. McGuire F. J. Loyer	C. H. Repath	(a) (b) Membership, Papers, Research	(b) Joint Committee of the Technical Societies of Los Angeles	4 (e)	(a) Modern cement plant (b) Fatigue of metals		Committee on Manufactures coöperating with Los Angeles Chamber of Commerce		C. H. Repath
Milwaukee....	107	W. M. White F. H. Dorner	W. M. White	(a) (b) Increase of Membership	(b) Engineers' Society of Milwaukee				Advised City authorities *re* local ownership of lighting systems; the automobile parking problem; and traffic problems of Milwaukee River	War Industries Readjustment	L. E. Strothman
Minnesota	95	J. A. Teach Ray Mayhew	J. A. Teach	(a) (b) Increase of Membership, Papers, Auditing, Publicity (c) Duluth Committee	(a) Minnesota Joint Engineering Board	(a) Monthly	(a) By-Products Coking Industry (b) Mining and handling of ore (b) Smelting of iron ore (b) Manufacture of beet sugar				C. W. Tubby
New Orleans..	36	H. L. Hutson E. W. Carr, Jr.	J. L. Henning	(a) (b) Papers, Research, Increase of Membership	(b) Louisiana Engineering Society	(b) Monthly					J. L. Henning
New York	2260	W. W. Macon H. D. Egbert	W. C. Brinton			(e) Monthly		Marcel Knecht, Mem. French High Commission Brigadier-General L. R. Kenyon, British War Mission, etc.		Recruiting; Military Engineering Committee War Industries Readjustment	G. K. Parsons
Ontario......	48	R. W. Angus C. B. Hamilton	R. W. Angus		(a) Engineering Institute of Canada	(a) (b) (e) Factory buildings of concrete					R. W. Angus
Philadelphia...	637	C. N. Lauer J. P. Mudd	J. P. Mudd	(a) (b) Research, Membership, Public Relations, Papers, Meetings, Boundary, Organization	(b) Engineers' Club of Philadelphia (a) All other Locals	(b) (d) Monthly	(a) Large Steam Turbine Design	W. H. Blood, U. S. Shipping Board		War Industries Readjustment	T. C. McBride
St. Louis.....	100	Lewis Gustafson J. P. Morrison	V. J. Azbe	(a) (b) Papers and Research	(a) St. Louis Engineers' Club	(b) (a) Monthly				War Industries Readjustment	L. Gustafson
San Francisco..	143	E. C. Jones George L. Hurst	R. Sibley	(a) (b) Papers, Research	(b) Joint Council of the Engineering Societies of San Francisco	(e) Pulverized-fuel Diesel engine	(a) Fuel conservation		Engineer appointed on California Railroad Commission; engineer on Board of Regents of the State University; legislation affecting status of engineers	Recruiting and collation of historical data for War Department War Industries Readjustment	J. T. Whittlesey
Worcester.....	125	E. C. Mayo Chester T. Reed	E. C. Mayo			(a) Coal conservation 3 (e)		L. P. Breckenridge Chman., Fuel Conservation Committee	Federal Labor Board	Fuel Conservation	H. P. Fairfield

Cleveland, so that we could make the engineering profession as effective in its activities in Cleveland as possible. Therefore, when the Council saw fit to suggest that we might organize the Section within the Cleveland Engineering Society, we were delighted to do so and proceeded forthwith.

A section in our constitution provides for a governing body and executive committee composed of nine members. Three of this committee are members of both the Cleveland Engineering Society and the A.S.M.E., three are members of the A.S.M.E. living within the confines of Greater Cleveland; and the remaining three are selected from the section lying outside of the county in which Cleveland is situated.

We shall have possibly one meeting a month. Every third or fourth meeting we will make an all-day session.

There will be Committees on Membership, and on Meetings, which will, of course, include papers for the meetings, and probably a Committee on Research, although it is our thought that the Research Committee should work under, or our representative should be a member of the national Committee on Research.

Connecticut, E. L. Fletcher, Bridgeport
Charles S. Blake, Hartford
C. K. Decherd, Meriden and the State Section
S. H. Barnum, 2d
Hugh L. Thompson, Waterbury:

We find it always adds greatly to the interest taken in our meetings to have officers of the Society present. We believe that the organization of the Connecticut Section with branches in the several leading cities of the state is along the right lines and will be productive of great good for the Society and the profession.

Detroit, F. H. Mason, *Secretary:* We have an active joint committee consisting of members of the Detroit Section of the A.S.M.E. and the Detroit Engineering Society, which has been arranged as a technical committee to assist the Civic and Local Federal Authorities on the question of "Fuel Conservation" and coöperating with power-plant owners to the end of obtaining fuel economy in their plants.

Just prior to the declaration of war, we had a very active movement afoot here in Detroit, to take over under the general direction of the Detroit Engineering Society, a property which would be developed into a joint engineering building, the plan being to make a home for all of the engineering societies in this district, with very active coöperation between them, and it is expected that this project will be revived just as soon as general conditions will warrant, when such a project could be financed. We believe that such a movement will be directly in line with a sentiment which seems to be growing strongly among the national societies, i.e., to have a very close affiliation between the national societies, in the different localities, and in connection with local engineering societies, and there is no reason why Detroit in the very near future cannot bring about a workable plan.

Erie, M. W. Sherwood, *Chairman:* Effort can most profitably be directed, I believe, toward the securing of additional members. The existence of a strong local engineering society with an initiation fee of only a dollar and annual dues one-fifth of ours has made it difficult sometimes to convince a prospect that the advantages offered by membership in the national society justified the added expense. I believe the best argument is to present the fact that the national organization is to become a prominent factor in the reconstruction of business along new lines made necessary by the war and that new men can best help the great body of engineers, in playing their important part in this work, by joining and supporting a national organization to unify their efforts and secure, through concerted action, results which could never be achieved by any number of small organizations working independently.

The question of reaching the membership outside of the city in which the meetings of the section are usually held, is a problem that I would like to know whether other sections have solved. We occasionally get some of them out to attend meetings, but very few. We have discussed the possibility of holding one of the section meetings in Oil City, although no definite plans have been made thus far. It would be natural for those outside to feel that the section is principally for the benefit of those living where the meetings are usually held.

Indianapolis, L. W. Wallace, *Chairman:* The Local Section has a constitution and by-laws governing its operation. Since this has been formulated, there is no occasion for continuation of like committees.

The Indianapolis Section very enthusiastically entered into the idea of having a joint meeting of the Mid-Western local sections in October, 1918. We were much disappointed that it became necessary to postpone that meeting indefinitely. The unanimous expression is for the holding of that meeting early next spring. The Indianapolis Committee feels that it can be made a great success. We, therefore, strongly recommend that the Sections Committee authorize such a joint meeting as was proposed for October to be held in the Spring, possibly in March or April. We stand ready to put our efforts into the movement in order that it may be a success in every way.

The State Board of Advisory Engineers to the State Fuel Administrator was largely formed through the activities of the members of the Indianapolis Section. An engineer was placed upon the State Council of Defense through a suggestion of the Indianapolis Engineers' Club.

Los Angeles, C. H. Repath, *Representative:* The Research Committee is working out a plan for the publication and preservation of experimental data obtained in the several universities in this section. It has also been suggested that the Society's Research and Standardization Committees outline subjects on which we might obtain valuable information, as there are several mechanical-engineering laboratories at our disposal.

Our Society is represented on the Chamber of Commerce of our City by a Committee on Manufactures, to which the officials of the Chamber can refer for expert information.

Milwaukee, Fred H. Dorner, *Secretary:* The Engineers' Society of Milwaukee appointed a committee to investigate the feasibility of the city owning its own lighting-distribution system. Our society also submitted a report to the city, upon request, of the solution of the automobile-parking problem, for the city of Milwaukee.

We also appointed a committee to investigate the feasibility of closing up the Milwaukee River for lake traffic and building a 50-ft. roadway on each side of the river, with permanent arch bridges instead of the movable bridges now in use.

Minnesota, Jacob A. Teach, *Chairman:* Seventy-five per cent of our membership is concentrated in the cities of Minneapolis and St. Paul, hence the Twin Cities logically serve as the headquarters of the Minnesota Section. Since the inauguration of this Section approximately seven years ago and until the present year, our monthly meetings alternated between the two cities. That was not a good arrangement for two reasons: first, we had no place which we could claim as permanent headquarters; and, second, the average attendance at the meetings was lower than it should have been due to the inconveniently long trip the members from each city have alternately been obliged to take. To correct that situation we made arrangements at the beginning of this season to hold all our meetings at a commercial club in the district midway between the two cities.

New Orleans, E. W. Carr, Jr., *Secretary-Treasurer:* The following is a resolution passed by the Louisiana Engineering Society at their meeting on November 18, 1918:

Whereas, it has come to our knowledge through the city newspapers, that the Commissioner of Public Property of the City of New Orleans, will resign his office on December 1, 1918, and

Whereas, it is our opinion that the administrative and executive duties falling to the Commissioner of the Department of the City Government can be satisfactorily and efficiently performed by a competent and capable engineer as evidenced by the experience of more than a hundred cities in this country that have found it economical and advantageous to employ engineers as City Managers; this result being attributable to the fact that engineers are by education, training and experience qualified to administer to the physical welfare and comfort of communities, and

Whereas, some of the large problems confronting our City Government and calling for solution in the near future, as for instance,

the street railway situation, the disposal of garbage and municipal waste, the introduction of natural gas, are essentially engineering problems.

THEREFORE BE IT RESOLVED: That the Louisiana Engineering Society, both as engineers and as citizens interested in the welfare of our City, respectfully urge upon the Mayor and Commission Council of the City of New Orleans the desirability of electing as Commissioner of Public Property some qualified and competent Civil Engineer who will have an administrative voice in the solution of the economic affairs of our City.

BE IT FURTHER RESOLVED: That the Louisiana Engineering Society tender its hearty coöperation and services to the Mayor and Commission Council in the furtherance of the above object, and that the President of this Society appoint a Committee of four members to serve with himself to represent the Society in any conference on this subject.

Many members of the Louisiana Engineering Society have assisted in problems relating to the development of New Orleans as a port, as a manufacturing center, and as a residential city; to the Industrial Canal now being put through between the Mississippi River and Lake Pontchartrain; the proposed bridge or tunnel across the Mississippi River; the imminent introduction of natural gas to the city from Terrebonne fields; and the extension of our port facilities by means of public warehouses and elevators.

NEW YORK, W. C. Brinton, *Representative:* It may not be realized by delegates from other sections, especially those of smaller size, that the problem in New York is chiefly one of organization. Scarcely a move can be contemplated with our 2200 members but it becomes necessary to handle a large amount of correspondence, telephone or conference work. The New York Executive Committee believes that the number of members in New York City is large enough to justify a paid secretary who will devote most, if not all, of his time to the New York Section. The financial aspect of such a plan must of course be considered and the Executive Committee will be glad to go thoroughly into the subject with the properly constituted authorities.

It is the recommendation of the New York Section Executive Committee that there be a study made of the basic facts regarding the A.S.M.E. membership, activities and finance similar to the report "Association Data Visualized" recently published by the Y. M. C. A. covers practically every phase of the association's activities and many of the curves date back as far as 1866. The New York Section Executive Committee believes that a report of this kind would be of the very greatest assistance, not only to the New York Section but to the Council and the local sections throughout the country. It is of course assumed that work of this kind once started would be kept up so as to be available for all officers and members of committees.

The suggestion that we are working toward here in New York is one which I believe would be feasible in a number of the other cities. For instance, in Boston they have a potential membership, according to estimates, of four times their actual membership. I suppose that that holds true in New York—that our potential membership in New York is certainly four times, in my opinion, what our actual membership is. If that is true, why should not we then organize in such a way as to get in more members, and to do a larger piece of work in our community?

In other words, we feel here that in this Section we have a problem big enough to justify the time of a man all the time as secretary to the New York Section, without regard to the work that he might be able to do on the national matters also. If we can get the combined service of a man in the New York Section, and then to work in on the national problem so as to get any benefits out of the New York experiments, that we might be able to do here, available for the rest of you, I believe it would pay all the better. We do not want to take up anything of that kind unless we have the full sanction of this Committee and the Society as a whole.

ONTARIO, Professor Robert W. Angus, *Chairman:* Our secretary is keeping in touch with the manufacturers' requirements in the way of research, with a view to assisting in any possible way. We are also in touch with the Canadian Government's Industrial Research Committee's work, and hope to coöperate there as well. Our last executive meeting was almost entirely spent on a discussion of how engineers might suggest to the Government means of meeting the great problems incident upon the close of the war, and tide over the period of reconstruction and readjustment.

PHILADELPHIA, John P. Mudd, *Secretary:* The regular election of the Executive Committee of the Philadelphia Section took place at the end of the fiscal year 1917-1918. About the first of August, these men met at the Engineers' Club and began to formulate plans for the coming year. Meetings were held every week or two, until early in September.

The meetings of the Section have, as heretofore, been held on the fourth Tuesday of each month. For the last several years, joint meetings have been held with the other Societies, principally The Franklin Institute, the Philadelphia Engineers' Club, American Illuminating Engineering Society, and American Society of Heating and Ventilating Engineers. It is under contemplation to hold one of the regular meetings in Wilmington, Del. This city contains a very large number of the Philadelphia membership.

It has been our experience that the best way to arouse interest in the Society is through personal interviews.

Local matters pertaining to public relations are first brought before the council of the Associated Engineering Societies. If the council decides that any matter brought before it is of general interest the weight of the entire organization is put behind the movement and greater results are obtained than could be secured by any society alone. If the council decides adversely, the matter is referred back to the section presenting it for such action as the section sees fit to take.

In regard to boundaries we would suggest that there should be some arrangement by which members can be accredited to those sections which are already established.

We would further the suggestion that the A.S.M.E. Council hold regular meetings with the Local Sections, we can think of nothing that would be a greater stimulus to the activities of the Sections.

SAN FRANCISCO, Robert Sibley, *Representative:* With an idea of vastness of country involved and magnitude of engineering effort called forth with problems new to engineering design, members of the Society can readily appreciate how our two sections in the Far West, situated over 3000 miles from the Society headquarters, find contact with the Society as a whole extremely difficult and often find our arguments to induce our fellow-engineers to join the Society of little avail. For under such circumstances since few of our men rarely visit New York City, and since the large number of questions discussed through the journal of the Society are wholly foreign to problems that vex us for solution, it is difficult for local engineers, not members of our Society, to see wherein a fair return is to be received for the annual dues required for membership.

So those of us in the Far West who have this matter at heart see in the fuller development of the local section idea the only ultimate hope for profitable helpfulness both to the member and to the Society as a whole in its work for the betterment of the engineering profession—not alone in New York City but in the far nooks and corners of this broad country of ours. With this ideal in view it would seem that for the ultimate development of Society effort west of the Rockies there should be established as reasonably soon as circumstances will permit duly organized sections in the seaport centers such as Seattle, Portland, San Francisco, Los Angeles, and inland centers such as Spokane, Butte, and Salt Lake City. Such a development of Section activity in the Far West would contribute four vital factors in furthering engineering-society activity:

1 It would interest local members as nothing else can.
2 It would make possible enlarged membership.
3 It would make the Far West more accessible for eastern members who are now either coming to these districts of the West in ever-increasing numbers, or are en route to oriental ports where new activities are engaging our membership.
4 It would immeasurably build up a larger and more useful A.S.M.E., at least, so far as our district of the nation is concerned.

Some concrete examples of the good that has already been accomplished by the Joint Council of the Engineering Societies of San Francisco are as follows:

1 Definite dates have been fixed for the holding of individual section meetings to avoid conflicts in meeting nights.
2 The bringing about of a saving in labor and expense in secretarial work by joint use of addressograph and many economies in clerical help.
3 The joint offering of engineering talent for war service and for historical data now being called for by the War Department.
4 Joint action on necessary legislative matters such as urging the appointment of an engineer member of the California Railroad Commission, an engineer member of the Board of Regents of the State University and legislation affecting the legal status of engineers in the commonwealth of California.
5 The establishing of an effective Service Bureau in which active effort is made to secure accurate information on vacancies open in engineering activities and the placing of capable applicants in employment.
6 The holding of two to three joint meetings of all national engineering societies annually.

In the Far West we realize full well the trying stress financially upon the mother Society to meet the vast outlay necessary to put through the progress of national helpfulness the Society has undertaken. It is the firm conviction, however, of your far-western sections, that more effort and financial assistance devoted to this growing district of our country would not be a matter of charity, but the actual money returns in an immediate influx of new members would not only strengthen the Society nationally but would create an increasing financial revenue in dues that would prove a permanent gain many times the outlay involved, and in addition to this financial assistance we need more personal contact, we need the broadening assistance derivable alone from hearing men of eminence in our profession from eastern centers as well as men familiar to our localities, and we hope some means may be secured whereby the leaders when visiting our district may make themselves better known and advantage taken of their helpful council.

WORCESTER, E. C. Mayo, *Chairman:* During the Fall of 1917 one local meeting was arranged. Instead of having a number of local meetings during 1918 it was decided to devote all our energies towards the preparation of the Spring Meeting, which took place in June. During the summer and fall months of this year a large number of the local members have been interested in the conservation of coal. We were delayed in getting our new Committee for 1918-19 organized and this fact coupled with the unusual interest shown in Worcester on all war activities has taken considerable of our time and prevented any local meetings this fall.

New Year Meeting of New York Section

THE New York Section opened its 1919 season with an enthusiastic and well-attended "New Year" meeting on the afternoon and evening of January 14. The program comprised an address by L. C. Marburg, Chairman of the Society's Committee on Aims and Organization, on the work of the Committee; a paper by Edwin J. Prindle on The Patent Situation in the United States; and a series of brief addresses by W. W. Macon, H. L. Aldrich and A. J. Baldwin on their experiences abroad as members appointed by President Main to represent the Society on a delegation of technical editors who were guests of the British Government on a trip of inspection of the battlefields of Europe and of the manifold industrial activities of England in war time. Mr. Baldwin supplemented his remarks by numerous stereopticon views showing the devastation wrought by the enemy on the cathedrals, towns, factories and mine heads of Flanders and France. Geo. K. Parsons, New York Section representative on the Committee on Aims and Organization, presided over the afternoon meeting. A buffet supper was served at 6:30 p. m.

THE SOCIETY'S AIMS AND IDEALS

L. C. Marburg, Chairman of the Aims and Organization Committee, brought to the attention of the meeting the questions which his Committee is considering in view of the changes which appear to be under way in the viewpoint of engineers as well as among others in the world at large. These questions were very fully reviewed in the last number of MECHANICAL ENGINEERING in the report of Mr. Marburg's address at the Annual Meeting, and in the present address he urged upon his hearers the need for coöperative effort to help solve the problems with which the Committee is confronted; and possibly the greatest of which was that of arousing the membership to the realization of the magnitude of the task and of the necessity for a general and generous response to the Committee's efforts.

The program of the Committee is divided into three main divisions: (a) Relations of the Mechanical Engineer to His Work; (b) Relations of the (Mechanical) Engineer to the Community; (c) Relations of the Mechanical Engineer to Other Engineers.

Without changing the meanings of these headings the speaker said we might call the first one "professional aims"; the second one, "public aims"; and the third one, "organization."

Under professional aims, it is the purpose of the Committee to determine from the membership what subjects the Society is now interested in or should be interested in more than it has been in the past; for example, with regard to standardization and research it is expected to learn from the committees on these subjects what they believe ought to be done in addition to what has been done. Then, as to the scope of papers and discussions which are supposed to relate to "progress in the art of mechanical engineering and allied sciences," in what way is "allied sciences" to be interpreted? Does it include economics and welfare work and other general subjects which the Society frequently discusses? If not, should not the scope of the Society be redefined?

Shall MECHANICAL ENGINEERING be published more frequently than at present? In close connection with this is the question of the classification of literature so that articles may readily be found.

In conducting and assisting research, another topic, should the individual societies carry on this work or should it be done by united action as in Great Britain through the suggestion of the Conjoint Board of Scientific Societies?

The same thing holds also with respect to standardization. Other subjects are education and special training, and legislation and jurisdiction affecting the engineering profession.

In the second major group, the Relations of the Engineer to the Community, should engineers as a group take a greater interest in public affairs and make available to the community the experience of the group in matters with which they are familiar?

Under the final heading, Relations to Other Engineers, in what way should united action be secured? Should there be a union of the four founder societies, or should other organizations be included, including certain of the local societies? Under this heading would come also social activities—the advisability of having clubs with exchange privileges, so that an engineer from one city, connected with one club, could go to a club in another city.

At the conclusion of Mr. Marburg's address, J. E. Johnson, Jr., in response to the chairman's request for suggestions, said that the present seemed to be a time of great unrest in the engineering profession all over the country, comparable to the political unrest in Europe. As Mr. Marburg had said, it would be comparatively simple to consolidate the various societies—they were already partly consolidated, and what good had resulted? There was the Engineering Council and also the Engineering Foundation. The latter had been established to promote research, but the main thing it had done within his knowledge was to finance the National Research Council until the Government had taken it over.

Similarly, the Engineering Council was supposed to represent all the engineers, but on one important occasion, when they had been requested to coöperate with the legal and medical professions in protesting to Congress against the imposition of the unjust 8 per cent tax on professional incomes, they had done nothing, so far as he was aware.

If the engineering societies in the broad sense, along with some of the economic and other related societies, were so consolidated that membership in each would mean membership in the national

society, and every district of a given number of engineers had a head who was elected a member of the Engineering Council, meetings of the latter could be held at which the various problems could be discussed and results obtained. The funds of the Engineering Council could be put to no better purpose than to pay the traveling expenses of real representative men from all over the country to come to New York and discuss what should be done and discover means for doing it.

Charles Whiting Baker said that as a member of the Engineering Council he could assure the previous speaker that the income-tax matter had been extensively considered by that body. There was no question as to its injustice, but as to whether anything would be accomplished at that time by making a protest; and the majority of the Council felt that with the war going on it would perhaps be unwise and unpatriotic for engineers as a class to protest against any tax assessed on them, however unjust.

As to the work of the Council, it had been in session that very afternoon dealing with the matter of the abrupt dismissal of some 370 engineers engaged in rapid transit work as a result of unwarranted interference by the Board of Estimate and Apportionment, and it proposed to do everything in its power to right that wrong and let the public know what was going on.

He desired to impress on those present, however, that while the Engineering Council was created to care for just such matters, it was the duty of every Local Section of the Society and the Society itself to work for the Council.

"If something comes up in any locality where the Section can speak," said Mr. Baker, "it is the business of that Section to adopt resolutions and appoint committees to see the men who have charge of affairs—use their influence; and if, say, twenty societies adopt resolutions on the same thing, bringing into play the cumulative effect, the engineer will go forward more rapidly in doing the things he wants done than if he waits for the general movements in his own organization. Let him use his organization instead of trying to do too much to consolidate. There is danger of relying on consolidations and the force of great numbers. The fact is that oftentimes a big organization finds it difficult to do things a small one can do very well."

The discussion closed with the proposal of the following resolution by J. E. Johnson, Jr., which was duly seconded, put to vote and carried:

Resolved, That arrangements be made looking to a joint meeting of the New York sections of the four Founder Societies (not necessarily exclusive of some of the other representative societies) to be held at a later date.

Charles Whiting Baker said that if such a meeting was to be held, someone must have charge of it, and he accordingly offered the following resolution which was put to vote and carried:

Whereas, The work of the Committee on Aims and Organization is invested with matters of most fundamental and primary importance to our Society, be it

Resolved, That the New York Section Executive Committee be empowered to appoint a sub-committee to assist our representative, Mr. G. K. Parsons, to the end that the members of our Section may be fully informed and have ample opportunity to voice their ideas on Aims and Organization of the Society.

The Patent Situation in the United States

At the conclusion of the discussion, Mr. Edwin J. Prindle presented his paper on the patent situation in the United States, in which he said that the desirability of increasing the incentive to produce inventions had been shown by the exceedingly important part they had played in the war. Improvement in the efficiency of our Patent Office and patent system would work to the improvement of the inventor's position, and important among the matters that would contribute to this end would be a single court of appeals, making an independent institution of the Patent Office, increasing the force and salaries in the Patent Office, and changes in the law providing compensation for infringement of patents.

Mr. Prindle is a member of the Committee of the National Research Council appointed at the request of the Society of Patent Office Examiners to investigate the Patent Office and its system and recommend provisions for increasing the efficiency of the Patent Office. Although his paper embodied only his personal views, it may fairly be interpreted as representing also the views of the Committee. Since the paper was presented the report of the Committee has been officially approved by the National Research Council, the Engineering Council and the Commissioner of Patents, and an abstract of it is therefore given elsewhere in this number.

Trip of Technical Editors to England and France

At the evening session, W. W. Macon, who presided, explained that the delegation of which he had been a member consisted of 15 trade and technical journalists who had been invited by the British Government to come and see with their own eyes and then report to their readers the unstinted efforts Great Britain was making to insure a victory in the titanic struggle in which she and her allies were engaged. After referring to the varied forms of entertainment that had been accorded the delegation, the visits they had made to engineering works, to the Grand Fleet and the battlefields of Flanders and France, and to a projected cross-Channel flight that had to be abandoned on account of weather conditions, he introduced Mr. Aldrich as the next speaker.

Mr. Aldrich described strikingly the 14-day voyage of the party on the zigzag course made necessary by the submarine menace. Arriving in England he was first impressed with the stupendous amount of work that had been performed by women during the war. What the outcome would be when the troops returned was conjectural, but it was believed that there was much work, especially of the lighter sort, that would continue to be done by the women. In the matter of trade there was a feeling that there would be severe competition in export trade and in shipbuilding with the United States after the war, but this was tempered by the reflection that there would no doubt be room for all.

Great Britain had expended a third of her gross wealth in "carrying on" and the taxes already high would doubtless have to be supplemented by tariff imposts. The income tax was very high and began at very low incomes, but so far it had not impinged on labor, although the incomes of many of the workmen were well above the lower taxable limit.

American engineers had accomplished things believed impossible in France, both in battle and in works of construction. At St. Nazaire, on the Loire, where our troops disembarked, tidal gates maintained a 20-ft. depth of water in the river. Along the miles of water front utilized there were innumerable cranes of every size and description; in fact, the handling facilities were the most complete he had ever seen. Our engineers had fitted up a huge locomotive repair shop in which 14 engines could be assembled in a day. Many German prisoners were employed in this work.

The speaker commented on the deliberateness with which the French were accustomed to bring about changes, and instanced the case of a needed concrete reservoir that was constructed by American engineers at St. Nazaire and completed in less time than it would have ordinarily taken to obtain the necessary authority. Miles of unnecessary railway haul were similarly saved by building a cut-off around an angle in the road to Paris. In both cases the engineers had gone directly to the highest authorities and by their forcefulness had eliminated the red tape of procedure.

In the six months ending on September 1 the Americans had laid 250 miles of railway track and had constructed, in a swamp above St. Nazaire, 180 huge warehouses having a total of over 50,000,000 sq. ft. of storage space. There were over 20,000 American freight cars in France and several thousand locomotives. Thousands of motor trucks were also used, and in one day 1500 were received from America.

Mr. Baldwin, who was then presented by the Chairman, said that on the arrival of the delegation, England was without lights and in gloom. Three days later, the armistice having been signed, they went almost delirious with joy at their release from the aircraft menace.

The party had been shown the Grand Fleet—an imposing

spectacle with its boulevards of battleships and avenues of cruisers—and had, among other places, been taken to the vast shipyards of Glasgow. It had been their intention to cross the Channel in a huge airplane of 127 ft. spread and a capacity of 40 passengers—built for bombing Berlin—but weather conditions forbade.

On the Continent they rode over the battlefields in motor cars and visited practically every section from Flanders to Lorraine, passing through La Bassée, Ypres, Vimy, Souchez, Le Catalet—where the old 7th Regiment of New York and the 23d of Brooklyn were the first to cross the Hindenburg Line—Rheims, Hill 108 with its two miles of winding underground passages, and so on. Among the souvenirs he had acquired were two German shells bearing the date of their manufacture—15 years before the war, which seemed to him to be evidence of a sinister purpose long under consideration.

Mr. Baldwin then had shown the photographic views mentioned earlier in this account, and accompanied their presentation with brief descriptive comments. Continuing his address, he said that industrial conditions in Europe were much the same as in America, but more intensified. All countries were looking for export markets and the competition would be keen, but the world's shops and warehouses were empty now and there would be work for all.

In closing, he spoke of the word "dependence" as typifying the conditions prevailing in the old, dark days of Europe, out of which its peoples had struggled after long years into "independence." But our own magnificent national experiment had shown that there was something in the relations between states that transcended in importance even the concept of independence, and this was "interdependence"; and from the proceedings at Versailles he believed would issue the charter that would establish this salutary relation and insure its continuance for generations to come.

Fuel Meeting at Boston

The Boston Section held an interesting meeting on Fuel on December 19, at the Wentworth Institute. David Moffat Myers, Mem.Am.Soc.M.E., Advisory Engineer to the U. S. Fuel Administration, delivered the address of the evening on the subject of Results of Fuel Conservation. Remarks were also made by Prof. A. E. Norton of the Massachusetts Institute of Technology and by Perry Barker, consulting fuel engineer. At the close of the address a motion picture was shown, entitled Coal is King. Mr. W. W. Crosby presided.

Mr. Myers reviewed the successful results of conservation that had been effected by the Fuel Administration and showed the urgent need for a continuation of the work so successfully begun, closing with suggestions as to the broad scope which it might assume in the future. The following summary brings out these points:

As nearly as can be estimated from the reports from the states, the first six months of the active prosecution of the program resulted in an annual saving of 7,000,000 tons of coal in the power plants, 1,000,000 tons on the railroads and 4,000,000 tons in such items as the introduction of the skip-stop on electric railways, the reärrangement of power plants to avoid duplication, the substitution of central power for that produced by isolated plants where that proved advisable, and the larger utilization of water power and savings in domestic consumption. These savings were all in the direction of constructive conservation which has for its slogan "Maximum Production of Industry with Minimum Waste of Fuel." They were in addition to such savings as were effected by the curtailment or restriction of industry and were only a fair beginning of what may be done by continuing the practice of steam and fuel economies. It will be comparatively easy to increase this figure to 50,000,000 tons a year. The latter at $5 per ton would pay one-quarter of the interest on our national war debt.

It was thought by many when the Government took up the plan for inspection of power plants that there might be some resentment on the part of owners with the idea of having their private business interfered with by volunteer engineers in the service of the Fuel Administration. But owing to the patriotic spirit of helpful coöperation with the plant owner with which the state authorities and the administrative engineers and their committees introduced and carried on their work, this objection was overcome and they gained the hearty backing and good will of the manufacturers.

Letters are being received in Washington from far and wide asking that some scheme of fuel conservation applicable to power plants be adopted as a permanent measure. Many manufacturers have written appreciatively of the saving they have been able to effect as a result of instructions received from the volunteer inspectors of the Fuel Administration, or from the standard recommendations of the administration.

From the beginning of the campaign it has been in the minds of engineers that a second phase of the power-plant program might soon become appropriate. The efficiency of any process such as the production of energy is equal to the efficiency of operation multiplied by the efficiency of the equipment. That is to say, the efficiency of the man multiplied by the efficiency of the machine.

We have so far been considering almost exclusively the efficiency of the man behind the machine or the man in front of the boiler or the man on our factory committee, but up to the present time have given little or no official attention to the efficiency of the equipment. This question involves the matter of initial design and proper supervision of any changes that are contemplated in a plant in order that they may be made strictly in line with what will produce the highest efficiency in the use of fuel. Just before the armistice was signed Mr. Myers had proposed this question for discussion by the Committee of Consulting Engineers of the Engineering Council who now have the matter under advisement.

The general idea is to formulate what might be termed "A Ten Commandments of Power-Plant Design," treating only of fundamentals and not of specific design. The reason for desiring such a measure is obvious to any engineer. Time and time again we have all seen so-called "improvements" installed by manufacturers using steam-consuming or steam-generating equipment entirely unsuited to the conditions under which they are to be used. When this is done it means that for years and years to come an entirely unnecessary waste of fuel will continue owing to the ill-advised installation.

The same reasoning of course applies to new plants. Each case requires an individual diagnosis by a competent engineer and preferably one whose interest is solely that of the purchaser. At the same time, after making his diagnosis, a competent engineer will make recommendations based on certain fundamentals and it is these basic fundamentals which we now desire to formulate. The programme of conservation cannot be considered comprehensive unless it treats both of operation and equipment.

In closing, Mr. Myers told what had been done or was contemplated in issuing bulletins and moving-picture films for instruction purposes. A 50-minute film showing good and bad operation in boiler plants had been prepared, and nine engineering bulletins were announced, but most of these were now at press and not yet ready for distribution. The subjects are as follows:

Boiler and Furnace Testing
Stoker Operation
Boiler-Room Accounting Systems
Oil Burning
Fuel-Gas Analysis
Saving Fuel in Heating Systems
Saving Steam and Fuel in Industrial Plants
Burning Mixtures of Anthracite and Bituminous
Boiler-Water Treatment.

It is understood, also, that the valuable bulletin produced by the Massachusetts Advisory Committee is being reprinted for general distribution by the Washington administration.

Enlisted in the service of fuel conservation have been 1500 volunteer engineer inspectors of power plants, many of them

members of this Society, in addition to the several thousand acting on town and factory committees.

Members of the A.S.M.E. have been in charge of the power-plant program as Administrative Engineers in Massachusetts, New York, Pennsylvania, Minnesota, Missouri, Indiana, Maryland, Ohio, Illinois, Tennessee, Virginia and Florida.

The Fuel Administration has received advice and help through the Committee of Consulting Engineers of the Engineering Council in the initial creation and further development of its national plan of conservation. The average power-plant owner did not realize the possibility of important economies to be readily accomplished in his plant until the engineers working solely in the interests of humanity devised a system of education and of personal assistance to him.

From start to finish this has been the service primarily of engineers. It has been a big success, and of great value to our country in her time of need.

If the work of conservation is to be continued and further developed as a widespread permanent institution in such manner as to meet peace conditions satisfactorily, the engineers must devise suitable ways and means, for the country now looks to them with increased confidence.

We should look forward to the future recovery and utilization of the valuable by-products of coal resulting from its low temperature distillation. No raw coal containing these by-products should be burned directly under boilers. The resulting carbonized coal should be the boiler fuel of the future. This is one of the greatest steps toward true conservation of fuel ever inaugurated and should be developed as rapidly as possible.

Water powers should be further developed and utilized, although according to Steinmetz, even when these resources are utilized to the ultimate extent they can care for only a very small fraction of the power demands of the future, and coal will always of necessity remain our mainstay for heat and energy.

Coal is a national resource, a common possession of the people. It is unfair that a progressive plant owner should go to great pains and expense to use his share efficiently while his neighbor continues to waste extravagantly in a badly designed plant and by improper management.

These, briefly, constitute some of the problems before the country today and Mr. Myers expressed his confidence that they can and will be solved by engineers.

Meetings of Sections

ATLANTA SECTION

The Atlanta Section held its regular monthly meeting on Friday, December 27, in the Lecture Room of the Carnegie Library.

At this meeting our Chairman made a report covering his recent trip to New York as the Section's delegate, and our delegate to the Committee on Aims and Organization also reported.

William J. Neville,
Secretary.

BALTIMORE SECTION

A meeting of the Baltimore Section was held on December 18, at which Mr. Hess read an interesting paper on Electric Furnaces as Applied to Steel Making.

On January 27 the Secretary, Mr. Rice, attended a meeting of the Baltimore Section, and addressed the members informally.

A. G. Christie,
Secretary.

BIRMINGHAM SECTION

J. R. McWane and Oscar Wells were the speakers of the evening on January 23, when the Birmingham Section held a meeting at the Tutwiler Hotel. The addresses of these gentlemen were on the subjects of labor and finance. J. J. Greggan read an abstract of President Main's President Address, Broader Opportunities for the Engineer.

James W. Moore,
Secretary.

BOSTON SECTION

Meeting held on December 19 on Fuel. Reported elsewhere in this issue.

BUFFALO SECTION

An interesting meeting was held by the Buffalo Section at the Hotel Statler, on the evening of January 29. The address of the evening was delivered by Nathan L. Lieberman, on the subject Horse Power Requirements of Aeroplanes and Power Consumption through Parasite Resistance.

W. W. Boyd,
Secretary.

CHICAGO SECTION

A get-together meeting of the Chicago members was held on Monday evening, January 13, at the Engineers' Club. The meeting was preceded by an informal dinner, at which the members met Mr. Rice, the Secretary of the Society.

On January 27, M. J. Kermer, Mem.Am.Soc.M.E., delivered a timely address on Sugar Manufacturing.

Arthur L. Rice,
Secretary.

CONNECTICUT SECTION

Bridgeport Branch

The Bridgeport Branch held a meeting on industrial management on December 18. J. C. Spense of the North Grinding Company delivered an address on Vestibule Schools, Prof. H. B. Bogell of Yale University delivered an address on The Education of Radio Operators in Connection with Airplanes, A. W. Lebouef, Educational Director, Remington Arms U. M. C. Company, delivered an address on Shop Education.

C. F. MacGill,
Secretary.

Hartford Branch

Lieut.-Com. D. C. Buell delivered an interesting address on The 50-Caliber 14-in. Navy Guns with Railway Mount before the members of the Hartford Branch.

Maynard D. Church,
Secretary.

New Haven Branch

A meeting of the New Haven Branch was held at the Mason Laboratory on Wednesday, January 8, at 8 p. m. Douglas K. Warner, Jun.Mem.Am.Soc.M.E., read a paper on The Friction of Ball Bearings. This paper described several machines that have been used to measure the friction of ball bearings and discussed the characteristics of this kind of friction.

E. H. Lockwood,
Secretary.

Waterbury Branch

A luncheon meeting was held at the Hotel Elton on November 25, at which the officers for the fiscal year 1918-1919 were elected.

On Monday evening, January 6, there was held in the hall of the Mattatuck Historical Society a meeting to which were invited the Civil, Chemical, Electrical, Gas, Mining and Mechanical Engineers residing in that center. An interesting address was given, describing Waterbury's Water Supply.

Hugh L. Thompson,
Secretary.

DETROIT SECTION

A meeting of the Detroit Section was held on Saturday evening, January 11, at the Detroit Board of Commerce, at 8.15 p. m. There were two speakers of the evening, viz., Dean M. E. Cooley, University of Michigan, President of the Society, and Mr. Calvin W. Rice, Secretary. Dean Cooley spoke informally on An Unoccupied Rung in the Engineer's Ladder of Fame. Mr. Rice delivered an address on the subject of Broader Opportunities for the Engineer.

The meeting was preceded by an informal dinner at 6.30.

Frederick H. Mason,
Secretary.

INDIANAPOLIS SECTION

An informal meeting was arranged for January 15, to give the Indianapolis members an opportunity to meet Secretary Rice, and talk over with him problems of the Section, plans for the Spring meeting, etc.

L. W. Wallace,
Secretary.

MILWAUKEE SECTION

The regular monthly meeting of the Engineers' Society of Milwaukee was held under the auspices of the Milwaukee Section of the A.S.M.E. on Wednesday evening, January 15, at 8 o'clock, at the City Club.

Henry L. Dale, Major of Engineers, U. S. A., gave a talk on Engineering Experiences at the Front. A buffet luncheon was served for the convenience of the members.

Fred. H. Dorner,
Secretary.

MINNESOTA SECTION

An illustrated lecture was given on December 17 by Professor E. H. Comstock, School of Mines, University of Minnesota, the subject being Mining Iron Ore in Minnesota.

Professor Peter Christianson, also of the University of Minnesota, delivered the address of the evening on January 6. The meetings were held at the Section's regular meeting place, the Midway Branch of the St. Paul Association of Commerce.

Ray Mayhew,
Secretary.

NEW YORK SECTION

Meeting held on January 14. Reported elsewhere in this issue.

PHILADELPHIA SECTION

Secretary Rice attended the meeting of the Philadelphia Section held at the Engineers' Club, on Tuesday, January 28. The address of the evening was delivered by William B. Dickson, Vice-President and Treasurer of the Midvale Steel and Ordnance Company, the subject being Relations between Employer and Employee.

John P. Mudd,
Secretary.

PROVIDENCE ENGINEERING SOCIETY

The Power Section held a meeting on January 7 in the rooms of the Society, at 8 p. m. E. L. Woolley, Assistant Superintendent of the Providence plant of the Bethlehem Shipbuilding Corporation, spoke on Work Accomplished at Providence for the Emergency Destroyer Program. Mr. Woolley's address was of singular interest to members of the profession, informed for the first time of the splendid engineering achievements which of necessity were not generally known during the war.

W. A. Kennedy,
Secretary.

WASHINGTON, D. C.

An organization meeting of the members residing in the District of Columbia was held on December 9. An informal dinner was followed by a meeting at the Interior Building, which was addressed by Secretary Rice, Spencer Miller, the Council's official representative to the occasion, Dr. Stratton, Director of the Bureau of Standards, who spoke on the work of the bureau during the war, and Major O. B. Zimmerman, who read a paper on the new fuel.

At the January meeting this petition was presented to the Council, with the approval of the Committee on Local Sections, and the following Executive Committee authorized: Dr. S. W. Stratton, Chairman, George A. Weschler, Secretary, H. L. Whittemore, Arthur E. Johnson, J. K. Klinck.

Meetings of Student Branches

Now that the colleges are returning to normal conditions and the period of demobilization is taking place, Student Branch activities are being resumed. The following meetings have been held:

BUCKNELL UNIVERSITY

November 4, 1918. A business meeting was held at which the following officers were elected for the Student Branch: Prof. B. F. Burpee, honorary chairman; R. C. Corrulla, chairman and C. W. Withington, secretary.

Mr. R. C. Corrula gave a very interesting talk, after which the senior mechanical engineering students decided to attend the Annual Meeting of the A.S.M.E. to be held in New York.

Prof. F. E. Burpee gave a brief talk, which was followed by a social gathering.

January 6. Plans were made for a reception and dance to be given by the Student Branch later in the year, and also an illustrated lecture to be given during the month of January.

Mr. H. R. Pars gave a brief talk on the Annual Meeting of the A.S.M.E. in New York and the inspection trip taken by the students of Bucknell who attended the Annual Meeting.

Clyde W. Withington,
Branch Secretary.

JOHNS HOPKINS UNIVERSITY

The following officers were elected for the Student Branch, year 1918-19: Prof. A. G. Christie, honorary chairman; W. D. Cook, chairman; H. Bloomsburg, vice-chairman, and H. E. Weaver, secretary-treasurer.

Harry E. Weaver,
Branch Secretary-Treasurer.

LEHIGH UNIVERSITY

The following officers were elected for the Student Branch, year 1918-19; Prof. P. B. de Schweinitz, honorary chairman; B. P. Lauder, chairman; C. T. Hunt, secretary, and C. D. Mertz, treasurer.

P. B. de Schweinitz,
Branch Honorary Chairman.

LELAND STANFORD, JR., UNIVERSITY

November 12, 1918. Several meetings had been planned for earlier in the semester, but due to the introduction of the Students Army Training Corps into the University, the meetings had to be postponed until finally the above mentioned successful meeting was held.

The following officers were elected: Prof. W. F. Durand, honorary chairman; Chever Kellogg, chairman, and C. D. Howe, secretary-treasurer. President Kellogg then conducted the remainder of the meeting, on topics concerning the welfare of our Society.

C. D. Howe,
Branch Secretary-Treasurer.

UNIVERSITY OF MICHIGAN

The following officers were elected for the Student Branch, year 1918-19: Prof. J. E. Emswiler, honorary chairman; D. M. Ferris, chairman; J. T. Huette, vice-chairman, and A. D. Althouse, secretary-treasurer.

J. E. Emswiler,
Branch Honorary Chairman.

UNIVERSITY OF MINNESOTA

The following officers were elected for the Student Branch, year 1918-19: Prof. J. J. Flather, honorary chairman; George W. Bierman, chairman; H. B. Abrahamson, vice-chairman; Ross M. Foltz, secretary; Milton S. Wunderlich, corresponding secretary, and Arthur Baker, treasurer.

J. J. Flather,
Branch Honorary Chairman.

UNIVERSITY OF MISSOURI

The following officers were elected for the Student Branch, year 1918-19: Prof. H. Wade Hibbard, honorary chairman; Will Copher, chairman, and K. K. King, secretary.

H. Wade Hibbard,
Branch Honorory Chairman.

UNIVERSITY OF NEBRASKA

The following officers were elected for the Student Branch, year 1918-19: Prof. L. F. Seaton, honorary chairman; V. E. Kauffman, chairman; W. L. Miller, vice-chairman, and H. M. Glebe, treasurer.

L. F. Seaton,
Branch Honorary Chairman.

NEW YORK UNIVERSITY

The following officers were elected for the Student Branch, year 1918-19: E. McCarthy, chairman; W. W. Damm, vice-chairman; A. A. Landi, secretary, and T. Tottis, treasurer.

A. A. Landi,
Branch Secretary.

OHIO STATE UNIVERSITY

The following officers were elected for the Student Branch, year 1918-19: Prof. Wm. T. Magruder, honorary chairman; Franklin H. Cover, chairman; Howard Orth, secretary, and Victor L. Dannell, treasurer.

Wm. T. Magruder,
Branch Honorary Chairman.

PENNSYLVANIA STATE COLLEGE

Three meetings have been held by the Student Branch since the college year opened, the first two being business meetings at which plans were discussed for carrying on the activities for the year, and the following officers were elected: Prof. J. O. Keller, honorary

chairman; H. W. Parthemer, chairman; I. A. Karam, vice-chairman; C. W. Moore, secretary; R. H. Schmidt, corresponding secretary, and R. Y. Sigworth, treasurer. At the third meeting Professor Fessenden gave a very excellent talk on Motor Transport Service.

R. H. Schmidt,
Branch Corresponding Secretary.

POLYTECHNIC INSTITUTE OF BROOKLYN

November 1, 1918. The first meeting of the Student Branch was very well attended owing to the fact that a great many of the S. A. T. C. students were excused from evening study to attend the meeting. Professor E. W. Church delivered a talk on Submarine Construction in which he told of the various types of submarines and the distinguishing features of each type.

Professor W. D. Ennis, formerly Major in the U. S. Ordnance Department, gave a talk on The Gun as a Gas Engine. He also explained the structure of powder and compared the energy produced by a gun to that produced by a gas engine.

The following officers were elected for the Student Branch: Nathan N. Wolpert, chairman; J. P. Minotty, vice-chairman; Ben Offen, treasurer; M. J. D'Aiello, secretary.

Nathan N. Wolpert,
Branch Chairman.

RENSSELAER POLYTECHNIC INSTITUTE

The following officers were elected for the Student Branch, year 1918-19: Prof. Arthur M. Greene, Jr., honorary chairman; R. I. Todd, chairman; J. M. Dewey, vice-president; C. G. Bragaw, secretary, and J. L. Smith, treasurer.

A. M. Greene, Jr.,
Branch Honorary Chairman.

STATE UNIVERSITY OF IOWA

The following officers were elected for the Student Branch, year 1918-19: Prof. S. M. Woodward, honorary chairman; J. F. McLaughlin, chairman; W. J. Hohl, vice-chairman, and I. C. Jones, secretary-treasurer.

S. M. Woodward,
Branch Honorary Chairman.

THROOP COLLEGE OF TECHNOLOGY

November 20, 1918. A business meeting was held at which the following officers were elected: Prof. W. H. Adams, honorary chairman; Donald D. Smith, chairman; R. T. Knapp, vice-chairman; Roscoe R. Rockafield, secretary, and L. Erb, treasurer.

Roscoe R. Rockafield,
Branch Secretary.

WASHINGTON UNIVERSITY

The following officers were elected for the Student Branch, year 1918-19: Prof. E. L. Ohle, honorary chairman; Sidney Weiss, chairman; Herbert A. Strain, vice-chairman; Wm. J. Anderson, Jr., secretary, and Donald B. Baker, treasurer.

Wm. J. Anderson, Jr.,
Branch Secretary.

UNIVERSITY OF WASHINGTON

The following officers were elected for the Student Branch, year 1918-19: Prof. E. O. Eastwood, honorary chairman; Fairman B. Lee, chairman; C. P. Rummel, vice-chairman; E. E. Bissett, secretary, and Lester R. McLeod, treasurer.

E. O. Eastwood,
Branch Honorary Chairman.

WORCESTER POLYTECHNIC INSTITUTE

The following officers were elected for the Student Branch, year 1918-19: Prof. W. W. Bird, honorary chairman; Raymond B. Heath, chairman; Robert A. Peterson, vice-chairman; Stanley N. McCaslin, secretary; Thos. H. Ewing, treasurer, and Prof. H. P. Fairfield, corresponding secretary.

H. P. Fairfield,
Branch Corresponding Secretary.

YALE UNIVERSITY

The following officers were elected for the Student Branch, year 1918-19: Prof. L. P. Breckenridge, honorary chairman; J. V. Jenks, chairman, and W. L. Austin, Jr., secretary-treasurer.

L. P. Breckenridge,
Branch Honorary Chairman.

CONTROL OF BOILER OPERATION

(Concluded from page 141)

to determine where the loss due to a definite increase in CO will overbalance the gain from an increase in CO_2 making the CO probable.

Assuming, for example, that under the furnace and fuel conditions existing when Tests A and B were made 14 per cent was the safe limit for CO_2 for complete combustion, how much CO will it take to overbalance the benefit of raising the CO_2 to 16 per cent, assuming $T - t = 450$ deg.?

Applying Formula [4], it is found that there is a gain of $\left[\left(0.24 + \frac{58.46}{14}\right) - \left(0.24 + \frac{58.46}{16}\right)\right] \times 450 = 234$ B.t.u., and Formula [7] shows that this gain would be overbalanced by $10{,}150 \times \frac{P_c}{16 + P_c} = 234$, from which $P_c = 0.38$ per cent. Therefore, if the increase of CO_2 from 14 to 16 per cent cannot be accomplished without at the same time increasing the percentage of CO by 0.38 per cent, there is no gain in heat to the boiler.

But since there is no definite relation between the percentage of CO_2 and CO, it follows that within proper limits, depending on the construction of furnace, method of stoking, kind of fuel, air control, etc., maximum CO_2 can be attained without appreciable amounts of CO if the fireman exercises proper care and judgment. What these limits are must be ascertained by experiment for each plant, and if the construction of furnace and method of stoking vary appreciably it may be necessary to determine the maximum economic percentage of CO_2 for each boiler. But such determination is of small avail unless the firemen are properly instructed how to get maximum CO_2 with a negligible percentage of CO and have continuously brought to their attention the percentage of CO_2 they are getting.

THE PATENT SITUATION IN THE U. S.

(Concluded from page 139)

Addendum

To the Editor:

Since the action of the National Research Council and of the Engineering Council approving and adopting the report of the Patent Committee of the National Research Council, at which time the report bore the unqualified approval of the Hon. James T. Newton, Commissioner of Patents, Mr. Newton has written me as follows:

January 21, 1919.

Mr. E. J. Prindle,
The Trinity Building,
111 Broadway,
New York, N. Y.

Dear Mr. Prindle:

Regarding the report of the Patent Committee, after careful consideration I have concluded it best to withdraw my approval of that part of the report concerning the separation of the Patent Office from the Interior Department.

I hope we will all exert ourselves for the passage of these statutes in proportion to the importance of the subject.

With best wishes, I am,
Sincerely,
(Signed) J. T. Newton,
Commissioner.

As Mr. Newton gives no reasons for this action, and as he does not state that he disapproves of this feature of the report, I infer that his action is taken because he considers that he cannot, with good grace, advocate a separation from the Interior Department while he is an official of that department.

Edwin J. Prindle.

January 23, 1919.

A Society pin was found some time ago in the railroad depot in Bridgeport, Conn., and forwarded to the New York headquarters of the Society, where it is being held awaiting the owner.

NECROLOGY

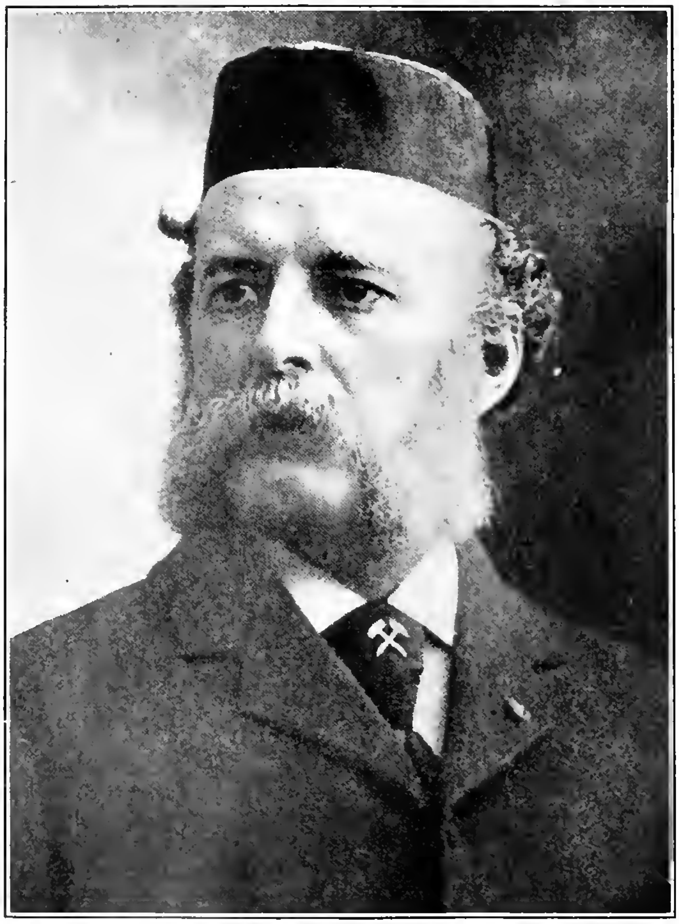
ROSSITER WORTHINGTON RAYMOND

Dr. Rossiter Worthington Raymond, mining engineer, metallurgist, lawyer and author, and for 25 years previous to 1912 the Secretary of the American Institute of Mining Engineers, died suddenly from heart trouble on December 31, at his home in Brooklyn, N. Y. He was born in Cincinnati, Ohio, April 27, 1840. He received his early education in the public schools of Syracuse, N. Y., and later attended the Brooklyn Polytechnic Institute, from which he graduated at the head of his class in 1858. He spent the ensuing three years in study at the Royal Mining Academy, Freiberg, Saxony, and at the Heidelberg and Munich Universities.

Returning to the United States in 1861, he entered the Federal Army and served as aide-de-camp, with the rank of captain, on the staff of Maj.-Gen. J. C. Fremont, by whom, during his campaign in the valley of Virginia, he was officially commended for gallant and meritorious conduct.

From 1864 to 1868 he engaged in practice as a consulting mining engineer and metallurgist in New York City, and in the latter year was appointed United States Commissioner of Mining Statistics, which position he held until 1876, issuing each year "Reports on the Mineral Resources of the United States West of the Rocky Mountains." In 1870 he was appointed lecturer on economic geology at Lafayette College, which chair he occupied until 1882. In 1873, Dr. Raymond was appointed United States Commissioner to the Vienna International Exposition, and as such delivered at Vienna addresses in the German language at the International Meeting of Geologists; and an address in English at the meeting of the Iron and Steel Institute at Liège, Belgium.

From 1875 to 1895 he was associated, as consulting engineer, with the firm of Cooper & Hewitt, owners of the New Jersey Steel & Iron Co., the Trenton Iron Co., the Durham and the Ringwood Iron Works, as well as numerous mines of iron ore and coal. As president of the Alliance Coal Co. and director of the Lehigh & Wilkes-Barre Coal Co., as well as a personal friend of Franklin B. Gowan, he became acquainted with the inner history of the memorable campaign against the "Molly Maguires," and has since been known as a fearless opponent of all tyranny practiced in the name of labor. His articles on "Labor and Law," "Labor and Liberty," etc., published in the *Engineering and Mining Journal* at the time of the Homestead riots, attracted wide attention, and for these, as well as similarly frank discussions of the operations of the Western Federation of Miners in Montana, Idaho and Colorado, he received special denunciations and threats from the labor unions thus criticised.



DR. ROSSITER W. RAYMOND

While connected with Cooper & Hewitt, he assisted Abram S. Hewitt in the management of Cooper Union and for many years directed the Saturday Evening Free Popular Lectures on Science, etc., which constituted the beginning of the present vast lecture system in New York City.

From 1885 to 1889, he was one of the three New York State Commissioners of Electric Subways for the City of Brooklyn, and served as member and secretary of the board. At the close of his official term as commissioner, he became consulting engineer to the New York & New Jersey Telephone Co.

In 1898, Dr. Raymond was admitted to the bar of the Supreme Court of New York State, and of the Federal District and Circuit Courts, his practice being confined to cases involving either mining or patent law, in the former of which he was a leading authority. In 1903, he was lecturer on mining law at Columbia University, New York.

He was an original member of the American Institute of Mining Engineers and served as its vice-president in 1871, 1876 and 1877; and as president from 1872 to 1875. While secretary of the Institute he edited the annual volumes of Transactions in a manner so painstaking and thorough, and with so high a degree of scholarship, that they were universally recognized as models of what such publications should be. To these he contributed many essays, especially pertaining to the United States mining laws, as well as other articles of importance. He was editor of the *American Journal of Mining* from 1867 to 1868, of the same periodical under the title *Engineering and Mining Journal* from 1868 to 1890, and continued thereafter a special contributor to that journal. In 1884 he prepared for the United States Geological Survey an historical sketch of mining law which was subsequently translated into German and published in full by the *Zeitschrift für Bergrecht*, the only periodical in the world devoted exclusively to the subject of mining jurisprudence.

In 1911, during the visit to Japan of a party of members and guests of the American Institute of Mining Engineers, Dr. Raymond received from the Mikado the distinction of Chevalier of the Order of the Rising Sun—fourth class, the highest ever given to foreigners not of royal blood—"for eminent services to the mining industry of Japan." These services consisted in advice and assistance rendered in America to Japanese engineers, students and officials throughout a period of more than twenty-five years.

In 1912, he resigned his position as secretary of the American Institute of Mining Engineers, of which he has been since that time secretary emeritus.

Dr. Raymond was an honorary member of the American Association for the Advancement of Science, the American Philosophical Society, the Society of Civil Engineers of France, the Iron and Steel Institute and the Institution of Mining and Metallurgy of Great Britain, the Canadian Mining Institute, the Mining Society of Nova Scotia, the Australasian Institute of Mining Engineers, and the Military Orders of the Loyal Legion of the United States; he as a member of the National Geographic Society, and a life member of the American Geographical Society. He received the degree of Ph.D. from Lafayette College in 1868, and that of LL.D. from Lehigh University in 1906 and from the University of Pittsburgh in 1915.

Besides the literary work already mentioned, Dr. Raymond prepared many other technical works and papers and was the author of a considerable number of books on general subjects, some in lighter vein and several of them for children. His writings to a remarkable degree were characterized by grace of expression, combined with clearness and unity, and his work bore ample evidence of the precision and accuracy of his scientific mind.

He married in Brooklyn, N. Y., March 3, 1863, Sarah Mellen Dwight of that city. He is survived by Mrs. Raymond and a daughter, Mrs. H. P. Bellinger of Syracuse, N. Y.

GAIL H. BROWNE

Gail H. Browne was born on March 12, 1871, in Salem, New York. He was educated in the public and high schools of Chicago, attending also the Chicago Medical College. He also spent two years in the Dental and Medical College of Northwestern University.

He spent the first five years after leaving college as surveyor and draftsman with the Chicago and North Western Railway and then with the International Harvester Co., and Swift & Co., at Chicago. In 1897 he became U. S. inspector of pier work and dredging in the Grand Rapids district. After one year in this district he became engineer in charge of the civil engineering department, McCormick division of the International Harvester Co. In 1905 he was employed by Ford, Bacon and Davis, engineers, New York. Since that time he has been actively engaged by this firm on important design and construction work, principally at Chicago, Memphis, New Orleans, Allentown, Pa. and in the New York office.

Mr. Browne died at his home in Glen Ridge, N. J., on December 7, 1918. He was a member of the Louisiana Engineering Society. He became a member of our Society in 1916.

ALFRED BETTS

Alfred Betts was born on October 1, 1835, in Wilmington, Del., and was educated at the Friends' School there. He served his apprenticeship with the firm of Pusey, Jones & Betts, Wilmington, afterwards becoming a member of the firm. He was a partner in the firm of E. & A. Betts, manufacturers of machine tools, and later became president of the Betts Machine Co., until his retirement in 1889. He was a member of the Board of Water Commissioners of Wilmington for six years.

Mr. Betts died on Dec. 1, 1918. He became a member of the Society in 1881.

PATRICK JOSEPH BEAKEY

Patrick J. Beakey was born in Glann, Ennistymon, County Clare, Ireland, on July 16, 1881, and was educated there in the Christian Brothers' School.

He came to the United States in 1900 and worked as a machinist for the P. & F. Corbin Co., New Britain, Conn., and for the Pratt & Whitney Co., Hartford, Conn. He was employed in 1903 by the Underwood Typewriter Co., also in Hartford, to build special machinery. In 1908 he joined the tool-making force of the Royal Typewriter Co. and was in a short time promoted to the foremanship of the type department. In this position he assisted in the development and production of typemaking machinery and tools, and designed and produced several styles of typewriter type. At the time of his death, Mr. Beakey was holding this position.

Patrick J. Beakey

Mr. Beakey died on October 24, 1918, of Spanish influenza. He became an associate member of the Society in 1915.

CHARLES MUNROE BURGESS

Charles M. Burgess was born in 1843 in Michigan. He served his apprenticeship with his father, a manufacturer of machinery in Windsor Locks, Conn. For about seven years he worked in the U. S. Armory at Springfield, Mass., and with the Collins Co., Collinsville, Conn., obtaining valuable shop experience. In 1866 he became associated with the Aetna Cutlery Works, New Britain, Conn., and about a year later entered the employ of Russell & Erwin as tool maker and was promoted shortly to foreman of the machine shops and in 1879 to the position of superintendent. In 1898 he retired from active business life.

Mr. Burgess was a member of Company C, 25th Regiment, Connecticut Volunteer Infantry, during the Civil War. He died on September 27, 1918. He became a life member of the Society in 1897.

Charles Munroe Burgess

MURRAY COPES CONLEY

Murray C. Conley was born on December 30, 1889, in Lamar, Mo., and was educated in the public schools of Wichita, Kan. He was graduated from the University of Kansas in 1909 and the following year took a post-graduate course in efficiency engineering.

His first position was with the Dewey Port Cement Co., Dewey, Okla., where he installed the cost sys'em, assisted in laying out and had charge of the construction of a pulverized-coal mill of 100 tons capacity. In September 1913 he became connected with the McEwen Manufacturing Co., Tulsa, Okla., where he assisted in the installation of the Taylor system of scientific management, later having charge of the design and testing on an experimental series of reversing gas engines. His next position was with the Carter Oil Co., Tulsa, where he was employed in laying out walls for tank forms. In Ocober, 1915, he became associated with the Pitcher Lead Co., Joplin, Mo., where he supervised the reconstruction of one of their small lead smelters and the construction of a new lead smelter at Galena, Kan. Later he had charge of the construction of a large zinc-ore smelter at Henryetta, Okla. In June, 1916, he took a position with the Henry L. Doherty Co., New York City, here he was employed in developing the process of pumping crude oils from the Kansas wells. Later he was assigned to one of the subsidiary companies, the Lorain County Electric Co. and was construction engineer on a large electric power plant at Lorain, Ohio, which position he held at the time of his death, December 21, 1918.

Mr. Conley became an associate member of the Society in 1917.

GEORGE DINKEL

George Dinkel, a member of the Society since 1890, was killed in an automobile accident near Havana, Cuba, on January 21.

Mr. Dinkel was born on November 28, 1866. He was graduated from Stevens Institute of Technology, Hoboken, N. J., in 1888, when he became associated with the American Sugar Refining Company as assistant manager at the Jersey City plant. At the time of his death he was chief engineer of the company, having been in its employ for 31 years.

He attained distinction in his profession, and was well known in the sugar industry. He had been granted a number of patents for important inventions, especially in the line of machinery for the refining of sugar.

Mr. Dinkel was also a member of the Engineers' Club of New York, and a member of the Board of Trustees of Stevens Institute of Technology.

FRANK CAZENOVE JONES

Frank C. Jones was born in Washington, D. C., on June 14, 1857. He was graduated from the University of Virginia and then attended Stevens Institute of Technology where he received his M. E. degree. His first two years upon graduation were spent with the Baldwin Locomotive Works. In 1879 he became connected with the Delaware Bridge Co., and was next employed as mechanical expert and superintendent of factories for the New York Belting & Packing Co. Somewhat later he became manager of the International Okonite Co. For a number of years he was also president of the W. A. Underhill Brick Co., New York. Mr. Jones organized the Manhattan Rubber Manufacturing Co. in 1893 and was president of this company for ten years at which time ill health compelled his retirement from active work. At the time of his death, September 19, 1918, he was a director of the Lubricating Oil Co., and chairman of the Okonite Co., New York. Mr. Jones became a member of the Society in 1891.

LIEUT.-COLONEL FRANK J. DUFFY

Frank J. Duffy, Lieutenant-Colonel, 103rd Engineers, U. S. Army, was killed in France on August 18, 1918. Colonel Duffy and motorcycle driver were travelling from one part of the American line to another in a motorcycle. A German shell struck alongside of the machine and both were killed.

Colonel Duffy was born on August 27, 1884, in Scranton, Pa., and was educated there. He served his apprenticeship with the Scranton Railway Co., and was then connected for a short period with a firm of electrical contractors in Scranton on telephone, signal work and motor installation in factories. In 1904 he entered the engineering department of the Bell Telephone Co., Scranton, and a year later took a position with the Delaware & Lackawanna Railroad Co., where he had charge of the electrical installation of the Keyser Valley car shops. From 1906 to 1909 he was in charge of the electrical department, Buffalo division, of the company, later being responsible for all the electrical work of the mining department, in Scranton, Pa.

Frank J. Duffy

When the United States entered the war Colonel Duffy was a leader in organizing the second company of engineers. He was named as Major and placed in charge of a battalion. While the 103rd regiment was in camp in Georgia Major Duffy was advanced to the rank of lieutenant-colonel.

Colonel Duffy was widely known in electrical circles throughout the country and was considered one of the foremost authorities in that industry. He was a member of the American Institute of Electrical Engineers, and of the Scranton Engineers' Club of which he was president. He became a member of our Society in 1917.

CLAUDE P. HAYNES

Claude P. Haynes was born in Ellsworth, Litchfield Co., Conn., on September 3, 1888. He attended the Rochester Mechanics' Institute for three years and later entered Syracuse University, taking the regular mechanical engineering course.

He served his apprenticeship as machinist with the General Electric Co., West Lynn, Mass., and was next with the American Optical Co., Southbridge, Mass., as draftsman. He held positions with the General Electric Co., Erie, Pa., where he designed the tools for a 175-hp. 8-cylinder gasoline motor; with the A. G. Gilman Printing Co., as chief engineer, designing two large rotary presses, folding and paper-handling machinery; with the Aetna Chemical Co., Pittsburgh, Pa., the Trantu Manufacturing Co., in the same city, as engineer salesman on power and power-transmission machinery; with the Aluminum Castings Co., Buffalo, N. Y., as chief engineer of their Niagara plant, and with the Curtiss Aeroplane & Motor Corporation as production engineer.

At the time of his death, Oct. 4, 1918, Mr. Haynes was holding the position of engineer in the research division of the Chemical Warfare Seervice in Washington, D. C.

Mr. Haynes became a junior member of the Society in 1916.

HENRY LOCKETT HUTSON

Henry Lockett Hutson was born at Americus, Ga., on December 30, 1876. He was the son of Charles Woodward Hutson and his wife, Mary Jane Lockett. His father was a college professor, occupying chairs in various southern colleges, including the University of Mississippi at Oxford, and the A. & M. College of Texas at Bryan.

Mr. Hutson received his preliminary education in the public and private schools in the towns where his family resided, and his college training at the A. & M. College of Texas, where he was graduated in the mechanical engineering course in 1896, one of the first three in his class. He exhibited unusual talent for mechanical work in his early childhood, and was a great student of engineering subjects up to the time of his death.

In 1898 he volunteered as a private in the First Regiment of the U. S. Volunteer Infantry, commanded by Colonel Riche. In 1898, after being mustered out, he entered the employ of Henry R. Worthington at the Brooklyn shops as a student apprentice and received the usual thorough training in practical hydraulic engineering given by the Worthington Company. In 1901 he entered the employ of A. M. Lockett & Co., Ltd., of New Orleans, as mechanical engineer. By reason of his ability and great loyalty to the interests of the company he was later promoted to the position of chief engineer.

In addition to engineering skill he possessed unusual talent in business management, and in addition to his work as chief engineer he was the sales manager and secretary of the Lockett Company. He supervised the designing and construction of perhaps a greater number of low-lift centrifugal pumping plants of large capacity than any other one engineer in this country, and by reason of this broad experience he was regarded as an authority on this class of work by other engineers in the Southwest.

Henry L. Huston

Mr. Hutson became a member of the Society in 1906 and at the time of his death was Chairman of the New Orleans Section. He was also an active member of the Louisiana Engineering Society. He died on January 10, 1919.

OCTAVIUS AUGUSTUS LAW

Octavius A. Law was born on October 27, 1872, in Philadelphia, Pa., and received his education in the public schools of that city. He served his apprenticeship with William B. Smith, a general contractor of Philadelphia, later becoming his estimator, draftsman and foreman of erection of numerous public buildings. In 1899 he became connected with the Midvale Steel Co., Philadelphia, as assistant to the chief engineer and had entire charge of all furnace and building construction. He was with this company at the time of his death, October 26, 1918.

Mr. Law became an associate of the Society in 1915.

LEO JULIUS LEFFLER

Leo J. Leffler was born on June 30, 1885, in New York City. He was educated in the public schools of Brooklyn, attending Manual Training High School and later Cornell University from which he was graduated in 1907 with the degree of M. E.

Upon graduation he entered the corporation of Chas. Leffler & Co., Brooklyn, manufacturers of machinery and dies for the manufacture of tin and sheet-metal ware. He assisted his father, Mr. Charles Leffler in the active management of the company. He was secretary of the firm and was holding this position at the time of his death.

Mr. Leffler died on December 20, 1918, in Albuquerque, N. M. He became an associate-member of the Society in 1915.

FRANK SHEPPARD LEISENRING

Frank S. Leisenring was born on January 18, 1887, in Northumberland, Pa. His family moved to Harrisburg, Pa., where he attended the public schools and later the Bordentown Military Academy, where he finished his preparation for Stevens Institute of Technology at the Stevens School, graduating from the latter in 1904. He then entered Stevens and was graduated with the class of 1908.

Upon graduation he entered the employ of the J. F. Shanley Co., contractors, Newark, N. J., and finally became their superintendent. He later went into the railroad supply business for himself under the name of the Mechanical Specialties Co., New York, holding the position of president. For five months after we entered the war he was engaged in inspecting wire for the Government at New Haven, Conn. The last year he devoted to engineering activities in the manufacture of airplanes for the United States Government.

In the latter part of 1917 Mr. Leisenring joined the 22d Regiment, New York State Guard, Company F. He later left Company F and organized a company of engineers, known as Company M, 22d Regiment, New York State Guard, and was connected with this company as Second Lieutenant.

Mr. Leisenring died on October 23, 1918, of pneumonia. He became an associate-member of the Society in 1917.

STEPHEN MINOT PITMAN

Stephen M. Pitman, vice-president of the Narragansett Mutual Fire Inurance Co., died at his home in Providence, R. I., on December 17, 1918.

Mr. Pitman was born in Boston, Mass., on July 19, 1850, and was educated in the public schools of that city. For a short period he attended Brown University, later going to Tufts College, where he received the degree of Ph. B. in 1869. Following his graduation from Tufts Mr. Pitman entered the Harvard School of Mining, receiving the degree of Mining Engineer in 1874, and afterwards went to Germany, where he pursued special studies in chemistry at the Universities of Heidelberg and Berlin. From 1877 to 1882 he was professor of chemistry at Tufts, at the close of that time becoming treasurer and general manager of the Butte Silver & Mining Copper Co., Butte, Mont. In 1886 he returned East as chemist and superintendent of the Valley Falls Co., Valley Falls, R. I. In 1888 he became general manager of the Copp Dyeing Co. He later became secretary of the Philadelphia Manufacturers' Mutual Fire Insurance Co., and was for a time connected with the Holmes Fibre Graphite Co., also of Philadelphia.

In 1894 he was elected secretary-treasurer of the Narragansett Mutual Fire Insurance Co., Providence, R. I., and remained in that capacity until he became vice-president, the office he was holding at the time of his death. He was also a director of the American Investment Co.

Mr. Pitman became an associate of the Society in 1892.

GEOFFREY LAWRENCE REID

Geoffrey L. Reid was born in Lawrence, Mass., on March 29, 1894. He was educated in the public schools of Lawrence and upon graduation from high school entered Massachusetts Institute of Technology, from which he was graduated in 1916 as a mechanical engineer.

His first position was with the General Electric Co., Lynn, Mass., in connection with cost work and estimating on Curtis steam turbines. He was next employed in the inspection department of the Associated Factory Mutual Co's., Boston, leaving that firm to enter the statistical department of the Stone & Webster Engineering Corporation, Boston. In December, 1917, he enlisted in the U. S. Naval Aviation Corps and was assigned as an inspector of aeroplane motors and stationed at the Curtiss Aeroplane & Motor Corporation, Buffalo, N. Y. In April, 1918, he received his honorable discharge from the Army owing to ill health.

Mr. Reid died on December 23, 1918. He became a junior member of the Society in 1916.

EDWIN H. ROUSSEAU

Edwin H. Rousseau was born in New Orleans, La., in September, 1884. He was graduated from the Louisiana State University in 1905 with the degrees of B. S. and M. E. He also attended Tulane University.

His first position was with the Central Electric & Improvement Co., Inc., New Orleans, where he was located for about four years. In 1910 he became manager of the order department and draftsman for the John H. Murphy Iron Works, also in New Orleans. Three years later Mr. Rousseau became connected with Dibert, Bancroft & Ross Co., Ltd., as a designer on multiple-effect evaporators, vacuum pans and barometric condensers, resigning in 1916 to take a position with the Dyer Co., Cleveland, Ohio, having charge of the cane-sugar department, handling all engineering incidental to building cane-sugar factories, etc. In the early part of 1917 Mr. Rousseau became assistant engineer in the engineering department of the E. B. Badger & Sons Co., Boston, Mass., where he had charge of the engineering work connected with the building of complete industrial and chemical plants.

Since October, 1917, Mr. Rousseau has been with the Birmingham Machine & Foundry Co., Birmingham, Ala., as chief engineer, which position he was holding at the time of his death, December 3, 1918.

Mr. Rousseau became a member of the Society in 1915. He was also a member of the Chemists' Club of New York and of the Civic Association of Birmingham.

ANGUS SINCLAIR

Angus Sinclair, D. E., founder and for the last 32 years editor-in-chief of *Railway and Locomotive Engineering*, died January 1, 1919,

Angus Sinclair

at his home in Milburn, N. J. He was born at Forfar, Scotland, and began his railroad career as a telegraph operator, gaining his engineering knowledge at the shops of the Scottish Northeastern Railway at Arbroath. After some service as a marine engineer he came to America and again took up railroading, first with the Erie and later as a locomotive engineer on the Burlington, Cedar Rapids and Northern. He attended the chemistry classes of the Iowa State University and was later appointed chemist on the railway, combined with the duties of roundhouse foreman. It was during this period that he first gave serious attention to the problem of fuel economy and smoke prevention. His methods, which met with considerable opposition at first, are now universally approved.

In 1883 he joined the editorial staff of the *American Machinist* and later became proprietor and editor of *Railway and Locomotive Engineering*. In a short time this paper became a leading authority in its field and has maintained its high character and standing ever since. Dr. Sinclair was the author of many popular books on engineering subjects. In 1908 he received the honorary degree of Doctor of Engineering from Purdue University. About this time he was also appointed special technical instructor in the mechanical department of the Erie Railroad. He traveled extensively in Europe as well as in America and was everywhere received as among the foremost authorities on all matters connected with the mechanical department of railways. He was closely identified with the work of many of the leading engineering societies in America and in Europe. He was elected a member of the American Railway Master Mechanics' Association in 1873. He served as secretary of the association from 1887 to 1896, was elected treasurer in 1900 and served continuously until the time of his death. He became a member of the Master Car Builders' Association in 1873. He was the first president of the New Jersey Automobile and Motor Club. He was a delegate to the International Railway Congress, held at Washington, D. C., St. Louis, Mo., and Berne, Switzerland.

Among the societies which he aided in establishing was the Traveling Engineers' Association, founded in his office in 1892. He was a Knight Templar in the Masonic fraternity, a governor in the St. Andrew's Society, ex-president of the Burns Society, besides being a member of the American Railway Guild, Lawyers' Club, New York Railway Club and numerous railway, Scottish and other societies.

Dr. Sinclair became a member of our Society in 1883.

CLARENCE B. D. UNVERFERTH

Clarence B. D. Unverferth was born on October 10, 1884, in Dayton, Ohio. He was educated in the parochial schools and in St. Mary's

College in Dayton, later taking a special course in hydraulic and steam engineering.

From 1902 to 1907 he was connected with the Platt Iron Works, Dayton, as draftsman on pumps, heaters, condensers and filter-press machinery. His next position was with the Dayton Hydraulic Machinery Co., as chief draftsman and designer on centrifugal pumps. He was with this company for three years, resigning to become designer and draftsman on paper-mill machinery and water wheels for the Dayton Globe Iron Works. In 1911 he became connected with the Ohmer Fare Register Co., Dayton, as tool designer, and the following year was with the Recording and Computing Machines Co., Dayton, as designer of tools and screw-machine cams. In 1913 he entered the office of the County Engineer of Montgomery County, Ohio, as chief draftsman and surveyor in charge of all drafting and field work. At the time of his death he was connected with the Aircraft Production Board at Dayton.

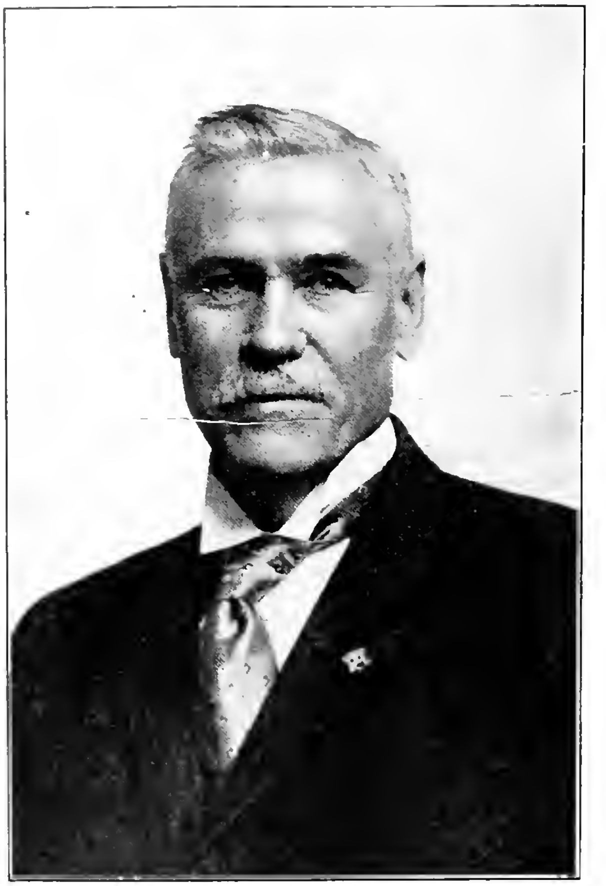
Mr. Unverferth died of pneumonia on November 10, 1918. He became an associate-member of our Society in 1918.

ROLLA C. CARPENTER

Prof. Rolla C. Carpenter, who has been a prominent member of the faculty of Sibley College, Cornell University, since 1890, died at his home at Ithaca, N. Y., on January 19.

The following account of Professor Carpenter's life is taken from that prepared only a few months ago for the *Sibley Journal of Engineering* at the time when he was about to retire from active service at the University, to devote his attention to engineering and consulting work, particularly along the lines of coke manufacture and the recovery of by-products incident to that industry. For many years Professor Carpenter was one of the most actively participating members of The American Society of Mechanical Engineers, a frequent attendant at meetings and one whom a very large number who came to the meetings always wanted to see and talk with.

Professor Carpenter was born near Orion, Michigan, June 26, 1852. His father, Charles K. Carpenter, owned an extensive farm at this place and was also vice-president of a railroad running between Detroit and Bay City, which now forms part of the Michigan Central system.



Rolla C. Carpenter

He graduated from Michigan Agricultural College in 1873 and received the degree of Civil Engineer from the University of Michigan in 1875. He was then engaged as an instructor in the Michigan Agricultural College, at the same time doing graduate work, and received the degree of Master of Science in 1876. In 1878 he was elected professor of mathematics and civil engineering at the Michigan Agricultural College, which position he held until 1890. During part of this period he spent his vacations, which then came in the winter months, studying at other institutions. Part of this time was spent at the Massachusetts Institute of Technology, where he studied under Professors Peabody and Lanza, and part was spent at Cornell, where he received the degree of Master of Mechanical Engineering in 1888. He was greatly assisted in the preparation of his thesis for the M.M.E. degree by his connection with the Lansing Iron and Engine Company of Lansing, Michigan, as consulting engineer. This connection placed at his disposal the facilities of a large and up-to-date manufacturing plant which offered opportunities not then enjoyed by any of the technical schools. This thesis, which is now on file in the University library and which was reported upon by Dr. Thurston in a paper read before The American Society of Mechanical Engineers, was on the subject of Internal Friction in Non-Condensing Engines and, as shown by Dr. Thurston's discussion, played an important part in the entire revision of the ideas which then prevailed concerning steam-engine friction.

In 1890 Professor Carpenter was elected Associate Professor of Engineering at Cornell University and the laboratory work was organized as a separate department under his direction. In 1895 he was elected professor of experimental engineering, which position he held up to the time of his death.

Professor Carpenter's experience in the several leading educational institutions as well as his intimate contact with various industrial enterprises peculiarly fitted him for the work of building up a course of instruction in experimental engineering which has done much for the upbuilding of the reputation of Sibley College and which is regarded by many alumni as furnishing a most valuable part of their education.

This system has been copied with some modifications in many other colleges and technical schools and has no doubt had a pronounced influence upon the methods of teaching other sciences.

Professor Carpenter published his "Notes on Mechanical Laboratory Practice" in 1891. This was the basis of his later text book on "Experimental Engineering" which has been the leading manual in this country on the subject. The first edition of his book on heating and ventilation was published in 1895 entitled "Heating and Ventilating Buildings." This book has gone through six revisions and has had an extensive circulation. It contains much original material from the author's own experience and is much quoted by later writers on heating and ventilating. Professor Carpenter is also joint author with Professor Diederichs of a textbook on "Gas Engines." In addition to these books, he has made many contributions to engineering literature through various societies and publications, among which may be mentioned The American Society of Mechanical Engineers, the American Society of Civil Engineers, and the American Society of Heating and Ventilating Engineers.

Professor Carpenter held membership in eight of the leading engineering societies of America. He was vice-president of The American Society of Mechanical Engineers from 1908 to 1911 and served on various committees of this Society, perhaps the most important of which is the Boiler Code Committee. He was President of the American Society of Heating and Ventilating Engineers in 1898, was vice-president of the American Society of Automobile Engineers in 1910-12, and has taken an active interest in the student branch of The American Society of Mechanical Engineers at Cornell.

Professor Carpenter engaged in a diversified field of investigation and research, including problems relating to power plants, gas engines, cement manufacture, coke manufacture, railway management, heating and ventilating, etc. He was one of the leading patent experts in the country and was employed by many of the leading law firms in various parts of the United States. He invented a number of pieces of laboratory apparatus, such as the Carpenter coal calorimeter, which was for many years a standard for testing the heating value of coal, the throttling and separating steam calorimeters now extensively used, a friction testing machine which may be found in most of the large laboratories and an inertia governor for the steam engine.

Professor Carpenter was honored by appointment to various positions of distinction. He was judge of machinery and transportation at the Chicago Exposition in 1893, at the Buffalo Exposition in 1901, and at the Jamestown Exposition in 1907. He was a member of the commission appointed by the Academy of Science in 1915 at the request of the President of the United States to investigate the slides at the Panama Canal and to make such recommendations as in the judgment of the commission would improve the conditions and lessen the possibilities of slides in the future. He received the degree of Doctor of Laws in 1907 from the Michigan Agricultural College.

Professor Carpenter's kindly manner and genial disposition made it easy for even the most timid to approach him and he was never too busy to be considerate of anyone who sought his council and advice. His large and varied experience, coupled with good judgment and his extensive knowledge of the engineering profession and of human nature, made his counsel and advice exceedingly valuable to his colleagues as well as to students and the world at large.

In a pamphlet on International Control of Minerals recently issued by the U. S. Geological Survey, the strategic position of the United States is graphically shown by a table compiled by Dr. C. K. Leith. The United States controls about one-third of the world's mineral production of 1,700,000,000 tons. The few minerals for which this country is dependent on foreign countries are offset by so many in which we have a dominance of supply and our financial position is so strong that it appears certain that in this respect our entrance into a league of nations would not be based on self-interest. The interests of conservation clearly require an international control of minerals. But this will depend on whether the nations are willing to make the necessary economic sacrifices in the interest of world harmony.

PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by February 15 in order to appear in the March issue.

CHANGES OF POSITION

Alexander M. Grier has become associated with the Combahee Company, White Hall, S. C., in the capacity of general manager. He was formerly sanitary engineer with the E. I. duPont de Nemours and Company, Wilmington, Del.

Arthur B. Coates has resigned his position with the Ford Motor Company, Detroit, Mich., in the power and construction department, and has accepted the position of assistant mechanical engineer with the U. S. Bureau of Mines, Pittsburgh, Pa.

Paul Been has become affiliated with the Morgan Engineering Company, Alliance, Ohio, in the capacity of engineer. He was until recently connected with the Manierre Engineering and Machine Company, Milwaukee, Wis.

Leon E. Jeanneret, formerly connected with the Babcock and Wilcox Company, Bayonne, N. J., has become associated with the King Bridge Company, Cleveland, Ohio.

B. R. Sausen, formerly manager of the Chicago office of the Schutte and Koerting Company, has become identified with the Star Brass Works of the same city, engaged in sales promotion and research work of Spray cooling equipment.

Frederick A. Scheffler, formerly connected with the New York offices of the Babcock and Wilcox Company, has become associated with the Fuller Engineering Company, of Allentown, Pa., as manager of the department devoted to the application and introduction of pulverized coal equipment for steam power plants in the United States. Mr. Scheffler's headquarters are in New York City.

Ernest K. Hill, until recently connected with the Wright-Martin Aircraft Corporation, New Brunswick, N. J., in the capacity of assembly inspector has assumed the position of mechanical draftsman with the E. J. Longyear Company, Marquette, Mich.

W. Jocelyn Dale has resigned as superintendent of power for the Matahambre Copper Mines at Sta Lucia, Pinar del Rio, Cuba, to take the position of electrical engineer with the Elia Sugar Company, and engineer with the Cuba Cane Sugar Corporation, of Havana, Cuba.

Ray Mayhew has severed his connections with the Minneapolis Steel and Machinery Company, Minneapolis, Minn., with whom he has been affiliated for ten years, and has accepted a position as motor engineer with the American Hoist and Derrick Company, St. Paul, Minn.

Roy A. Watkins is no longer connected with the Bureau of Steam Engineering at Washington, D. C., having assumed the duties of vice-president and general manager of the Bath Machine Works, Inc., Bath, N. Y.

ANNOUNCEMENTS

N. L. Snow, formerly vice-president and sales manager of the Terry Steam Turbine Company, Hartford, Conn., has been elected vice-president and general manager of that company. Mr. Snow has been connected with the company for the past ten years.

William Paterson has accepted a position with the Illinois Maintenance Company, Chicago, Ill.

Louis W. Adams has assumed the position of manager of the open hearth department of the Ashland Iron and Mining Company, Ashland, Ky.

Henry Ford has resigned the presidency of the Ford Motor Company, Detroit, Mich., to devote his time to his new weekly newspaper, the *Dearborn Independent*, and his tractor plant at Dearborn, Mich.

Frank D. Baker, formerly in mechanical and mill design in Colorado and, since its organization in 1899, with the American Smelting and Refining Company, as chief engineer of the Colorado department, has retired. He will do limited mechanical consultant work in Denver, in association with his sons.

Walter N. Polakov, consulting engineer, announces the founding of Walter N. Polakov and Company, Inc., New York, consultants in power-production methods, industrial investigations, labor problems, scientific-record systems and production accounting.

Alfred Musso will have charge of the Coast Coaling and Engineering Company's newly-organized department for the development of labor-saving machinery. He will give special attention to questions pertaining to the handling of bulky materials, the coaling of ships and general stevedoring.

Herbert B. Reynolds, formerly a fuel engineer in the U. S. Bureau of Mines, has returned to the motive power department of the Interborough Rapid Transit Company, of New York, as mechanical research engineer.

Morris L. Cooke, Boyd Fisher, Keppele Hall, Horace K. Hathaway, Clyde L. King and John H. Williams, announce the opening of an office in Philadelphia, Pa., as consulting engineers in management.

M. L. Kaufman is a member of the recently established firm of Kaufman and Levine, consulting and industrial engineers, of New York. Mr. Kaufman was employed, for the last three and a half years, by J. H. Wallace and Company, pulp and paper engineers; recently, he was engineer on a section of the work at Nitro, W. Va., connected with the Cotton Purification Area, U. S. Explosives Plant "C."

Lieut-Commander Frederick L. Pryor was presented, on December 21, with a gold watch by the released students at the demobilization of the Naval Section of the Students' Army Training Corps at Stevens Institute of Technology, Hoboken, N. J.

James W. Smith resigned, on January 1, as general superintendent of Gray and Davis, Inc., Cambridge, Mass.

Cleland Coldwell Ross, formerly superintendent with the Coldwell Lawn Mower Company, of Newburgh, N. Y., has recently returned to that company as works manager after serving as a lieutenant in the Ordnance Department of the Army.

Charles T. Myers, formerly production engineer of the Savage Arms Corporation, Utica, N. Y., has been appointed works engineer of the Utica plant, in complete charge of the operation and maintenance of the mechanical and electrical departments of the plant.

Robert E. Newcomb, superintendent of the Deane Works of the Worthington Pump and Machinery Corporation, Holyoke, Mass., was elected president of the New England Foundrymen's Association, at a meeting held in Boston, January 8.

George E. Randles, general manager of the Foote-Burt Company, Cleveland, Ohio, has resigned as director of the maintenance division of the Motor Transport Corps and has returned to his regular duties in Cleveland, from Washington, where he has been located for more than a year.

APPOINTMENTS

Melvin B. Newcomb, formerly chief draftsman of the hydraulic department of the Wellman Seaver Morgan Company, Cleveland, Ohio, has been appointed chief engineer of the rubber machinery department at the Akron, Ohio, works of the same company.

LIBRARY NOTES AND BOOK REVIEWS

George Westinghouse

George Westinghouse. His Life and Achievements. By Francis E. Leupp. Little, Brown and Co., Boston, 1918. Cloth, 6 x 9 in., 304 pp., 5 pl., 6 portraits. $3.

George Westinghouse was a prominent figure in the industrial life not only of America, but of the world for so many years, that it was greatly to be desired that a suitable biography should be written for the satisfaction of his friends and admirers and for the instruction of the younger men in the industrial field.

He worked in so many lines, and with such splendid results, that a complete biography would cover the engineering and technical work which he did, as well as the administrative and business side of his career.

Mr. Leupp is an accomplished literary man, but not an engineer; and he undoubtedly felt that he could not with advantage discuss the technical side of Mr. Westinghouse's career. He disarms criticism by confessing frankly that the mission of his volume is simply human. It is a pleasure to say that within its limitations this biography of Mr. Westinghouse is quite complete and satisfactory. Indeed, it is a credit to Mr. Leupp's industry and investigation that he should have been able, with practically nothing in the shape of diaries or personal correspondence, and relying for the personal touch almost entirely on the memory of associates, to give such a true picture of the great and wonderful man about whom he was writing.

There are, of course, omissions which will occur to anyone who was at all intimate with Mr. Westinghouse and his interests, such, for example, as the absence of the name of Benjamin G. Lamme from the list of able assistants in the electrical field. By many he is regarded as the most striking figure, in the way of electrical genius, of these assistants.

Mr. Leupp stresses the well-known fact among his intimates of Mr. Westinghouse's great confidence in his own judgment;

but it is not quite so clear as he might have made it that there was great justification for this confidence from the numerous cases in which Mr. Westinghouse had backed his own judgment against that of his advisors, and had proved to be right. The reviewer makes this remark because he once had occasion to discuss this very point with a critic of Mr. Westinghouse; and after explaining in detail a number of important and remarkable cases where his judgment had been proved correct, the critic agreed that it was not a cause for surprise that he should have trusted his own judgment more than that of any other person.

The financial difficulties through which the Electric Company passed led many careless observers to say that Mr. Westinghouse was no financier. Mr. Leupp tells the story of the difficulties, both in 1893 and 1907, and shews, to those who know, his appreciation of the fact that Mr. Westinghouse really was a great financier. It so happens that the reviewer, who was then an officer of the Electric Company, came into possession of information entirely independent of Mr. Westinghouse, through financial friends in Pittsburgh, which showed that the rehabilitation of the Electric Company in 1908 was due entirely to Mr. Westinghouse. The Committee of Bankers had advised a scheme which fell absolutely flat; and it was not until the so-called Merchandise-Creditors Plan was proposed that any success was attained. This plan was, in conception and detail, the work of Mr. Westinghouse. Doubtless this is a case of definition. If to be a financier means to sit in a marble palace, handling other people's money and making loans with ample security, refusing absolutely to take any chances whatever, then doubtless Mr. Westinghouse would not have laid any claim to being a financier. If, on the contrary, the courageous meeting of unusual difficulties with all the usually recognized financial authorities against you and success in the solution of the difficulties, is to be a financier, then he certainly was a great one.

It is a pleasure to note in Mr. Leupp's book that Mrs. Westinghouse receives considerable notice; and he shows her great executive ability as a hostess in the sympathetic story he tells. If he had known her intimately, he might have given additional touches showing her great sympathy and attention to all her guests, even the humblest; a trait which does not always accompany the executive capacity.

Mr. Leupp was evidently thoroughly in sympathy with, and a great admirer of, the wonderful man about whom he wrote, a condition which the writer believes absolutely necessary to a satisfactory biography; and the book can be confidently recommended to all who admire the story of a great life, full of wonderful deeds, and a benefit to humanity. As already stated, it is by no means a complete biography, because only the outstanding facts about his great works are given; and the engineering and technical side is almost entirely absent. It is to be hoped that before long the biography will be written by some competent engineer who is also an accomplished literary man, so that the complete story of the wonderful life of George Westinghouse may be preserved.

W. M. MCFARLAND.

THE A-B-C OF AVIATION. A complete, practical Treatise outlining clearly the Elements of Aeronautical Engineering with special reference to simplified Explanations of the Theory of Flight, Aerodynamics and Basic Principles underlying the Action of Balloons and Airplanes of all Types. A non-technical Manual for all Students of Aircraft. This book includes instructions for lining up and inspecting typical Airplanes before flight and also gives easily understood rules for flying. By Victor W. Page. The Norman W. Henley Publishing Co., New York, 1918. Cloth, 6 x 9 in., 274 pp., 128 illus., 7 pl. $2.50.

A companion volume to the author's Aviation Engines, giving a simple account of the operation and repair of airplanes. Intended for use by prospective aviators and mechanics, not as a treatise for engineers and designers.

AEROBATICS. By H. Barber. Robert M. McBride and Co., New York, 1918. Cloth, 11 x 18 in., 61 pp., 29 pl. $3.

An explanation of the general rules governing flying. The instruction is arranged in progressive form and is intended to convert the novice into an expert pilot in the shortest possible time, with the greatest possible degree of safety to himself and his machine.

AMERICAN ENGINEERS BEHIND THE BATTLE LINES IN FRANCE. By Robert K. Tomlin, Jr. First edition. N. Y., published by *Engineering News-Record*. (McGraw-Hill Book Co., Inc., sole selling agents.) New York, 1918. ¼ cloth, 9 x 12 in., 91 pp., illus. $2.

These nineteen articles, reprinted from the McGraw-Hill periodicals of the year, describe various phases of the engineering work executed by the American Army. Gathered together, they form an interesting account of the problems and the methods used to solve them.

AMERICAN PROBLEMS OF RECONSTRUCTION. A National Symposium on the Economic and Financial Aspects. Edited by Elisha M. Friedman, with a Foreword by Franklin K. Lane. E. P. Dutton and Co., New York, 1918. Cloth, 5 x 8 in., 471 pp. $5.

The editor here presents the opinions of some twenty-eight prominent Americans in the hope of stimulating thought on the subject. The specific points treated are the temporary effects of the war, the best methods of facilitating our readjustment to peace conditions, the permanent effects of the war, the changes that these will effect in our national life, and the national economic policy that should be adopted.

ANNUAL CHEMICAL DIRECTORY OF THE UNITED STATES. Second edition, 1918. Consulting Editor, B. F. Lovelace; Managing Editor, Charles C. Thomas. Williams and Wilkins Co., Baltimore. (copyright 1918). Cloth, 6 x 9 in., 534 pp. $5.

This directory is intended as a comprehensive review of all matters relating to industrial, technical and scientific chemical development in the United States. It contains lists, classified by subject and location, of manufacturers and dealers in chemicals and allied products and in equipment; a geographical directory of industrial, institutional, federal, state, municipal and commercial laboratories; a list of technical and scientific societies of the world, and bibliographies of technical and scientific journals, and of the important new books of 1917-1918. A "News and Notes" section completes the work. This second issue is approximately twice as large as the first.

THE ATOMIC WEIGHTS OF BORON AND FLUORINE. By Edgar F. Smith and Walter K. Van Haagen. Carnegie Institution, Washington, D. C. Paper, 7 x 10 in., 65 pp., 4 illus., 4 tab. $1.

The authors decribe in detail their work upon the atomic weight of boron and give a recalculation of that of fluorine, based upon their new value for boron. This latter value is considerably lower than that hitherto accepted.

ELECTRIC MOTORS AND CONTROL SYSTEMS. A Treatise on Electric Traction Motors and Their Control. By A. T. Dover. Sir Isaac Pitman and Sons, Ltd., London, 1918. Cloth, 6 x 9 in., 372 pp., 315 illus., 9 tab. $6.

In this volume, which is an amplification of a portion of his work on Electric Traction, the author treats of the application of electric motors to railways. The endeavor has been to meet the needs of engineers and advanced students of engineering, rather than those of specialists in electric railway equipment.

ELECTRICAL EQUIPMENT OF THE MOTOR CAR. By David Penn Moreton and Darwin S. Hatch. U. P. C. Book Co., Inc., New York, 1918. Flexible cloth, 5 x 7 in., 506 pp., 428 illus. $2.50.

This work is intended to give the lay reader sufficient knowledge of the electrical equipment of an automobile to enable him to operate it intelligently and to make ordinary adjustments and repairs. It is compiled from a series of articles that appeared in *Motor Age*, with additions and emendations.

ELECTRICITY AND MAGNETISM FOR ENGINEERS. Part I. Electric and Magnetic Circuits. By Harold Pender. First edition. McGraw-Hill Book Co., Inc., New York, 1918. Cloth, 6 x 9 in., 380 pp., 98 illus. $3.

This volume covers substantially the same ground as that of the author's Principles of Electrical Engineering. The method of treatment, however, is distinctly different. The various laws and relations are more fully discussed and a greater number of practical applications are given. Particular emphasis is laid upon exact quantitative statements of the fundamental laws.

THE ENGINEERING INDEX

Published Monthly by The American Society of Mechanical Engineers

The Engineering Index was Founded in 1884 by the Association of Engineering Societies; Published from 1895 to 1918, inclusive, by The Engineering Magazine Company; and Acquired January 1919 by The American Society of Mechanical Engineers

THE following pages form a descriptive Index to articles on engineering and related subjects in current periodicals. In its preparation the Society's engineering staff regularly examines all of the technical journals and society publications received by the Engineering Societies Library, which form one of the greatest and most complete collections of scientific periodicals in the world, comprising upward of 1100 distinct publications in some ten languages. Cross-references are freely introduced in the Index, and in all cases where the titles of articles are not sufficiently descriptive, explanatory sentences are appended. The main abbreviations used in the items are given at the bottom of this page.

PHOTOSTATIC COPIES OF ARTICLES LISTED

THE Society is prepared to supply photostatic copies (white printing on brown background) of any of the articles listed. Copies of the periodicals themselves, or clippings of articles, cannot be supplied.

Price of each print (up to 11 x 14 in. in size), 25 cents plus postage. A separate print is required for each page of the larger-size periodicals, but where possible two pages will be photographed together on the same print. Bill will be mailed with the prints.

Those holding coupon books for clippings formerly issued by The Engineering Magazine Company may use the coupons in payment for photostatic prints. In ordering, state plainly

(1) Page number of Index on which item appears
(2) Title of article
(3) Name of periodical.

Orders should be sent to

Harrison W. Craver, *Director*,
Engineering Societies Library,
29 West 39th Street, New York City.

DIVISIONS OF THE ENGINEERING INDEX

Mechanical Engineering

AIR MACHINERY

Turbo-Blowers

Coppus Turbo Blower. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 74-75, 2 figs. Mechanical features of machine constructed by Coppus Eng. & Equipment Co.

Combined Motor and Turbine Driven Blast-Furnace Blower. Iron & Coal Trades Rev., vol. 47, no. 2645, Nov. 8, 1918, p. 523, 1 fig. Operation of unit consisting of synchronous motor driving blower, this motor being operated in addition as a power-factor adjuster on a 3000-volt 50-cycle supply.

Ventilators

The Largest Round Ventilator in the World. Metal Worker, vol. 91, no. 1, Jan. 3, 1919, pp. 28-29, 3 figs. Details of special construction to withstand wind pressure and secure permanence and service.

CORROSION

Aircraft Parts

Corrosion Prevention on Aircraft Metal Parts, H. A. Gardner. Aviation, vol. 5, no. 9, Dec. 1, 1918, pp. 565. Quotes standard procedure of Navy Department for protection or iron, steel and aluminum aircraft parts.

Pipe

Investigation of Pipe Corrosion in Chicago Buildings, with Special Reference to Durability of Pipe Materials, Thomas J. Claffy. Mun. & County Eng., vol. 55, no. 6, Dec. 1918, pp. 208-210. Data secured from inspection of 63 buildings. Rating of cast iron, wrought iron and steel.

FORGING

Density of Steel

Does Forging Increase Specific Density of Steel? H. E. Doerr. Bul. Am. Inst. Min. Engrs., no. 145, Jan. 1919, pp. 79-81, 2 figs. Table of specific densities of ten ingots of basic open-hearth steel both before and after forging shows little or no change in density with steel initially free from cavities.

Drop Forging

Drop Forging in Automobile and Aircraft Work. Part VI. Automobile Engr., vol. 8, no. 120, Nov. 1918, pp. 328-331, 13 figs. Details of typical plant, with description of modern tools and methods.

Gun Forgings

Making Gun Forgings Under War Demands, E. C. Kreutzberg. Iron Trade Rev., vol. 63, no 22, Nov. 28, 1918, pp. 1240-1242, 6 figs. General character of work done by Tacony Ordnance Corps., Philadelphia.

Operation

Recommendations for Economical Operation of Iron Works (Dispositions générales qui peuvent être recommandées dans les installations de forges), O. Duperron. Génie Civil, vol. 73, nos. 20 and 21, Nov. 16 and 23, 1918, pp. 387-389 and 404-407, 3 figs. Concerning regenerative devices, use of powdered fuel, continuousness of operation, use of compressed air. Plans of ideal modern smithy.

FOUNDRIES

Brass Melting

Melting Brass in a Rocking Electric Furnace, H. W. Gillett and A. E. Rhoads. Department of Interior, Bur. of Mines, Bul. 171, Min. Technology 23, 131 pp., 6 figs. Sets forth in detail possibilities and limitations of electric brass melting and compares various types of furnaces. Also Water & Gas Rev., vol. 29, no. 6, Dec. 1918, pp. 9-11.

Chaplets

Obtaining Best Results from Use of Chaplets, Ernest Schwartz. Foundry, vol. 47, no. 317, Jan. 1919, pp. 14-15, 14 figs. Removal or prevention of rust and precautions against excessive moisture essential to prevent blowholes; choosing types and sizes for various purposes.

Note.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
New York (N. Y.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

Core Room

Core-Room of T. H. Symington Co., Rochester, Donald S. Barrows. Can. Foundryman, vol. 9, no. 12, Dec. 1918, pp. 296-299, 9 figs. Arrangement intended to provide good ventilation and lighting.

Efficiency in the Core Room, J. B. Conway. Am. Mach., vol. 50, no. 1, Jan. 2, 1919, pp. 11-14, 6 figs. Conclusions reached as result of investigation into conditions of efficiency and production in southern factory and remedies applied.

Cupola

Operation of a Cupola, William Lanten. Metal Trades, vol. 9, no. 11, Nov. 1918, pp. 461-463, 2 figs. Account of experiments with column charging.

Foundries

Continuous Two-Story Foundry Proves Economical, J. F. Ervin. Foundry, vol. 47, no. 317, Jan. 1919, pp. 40-42, 2 figs. States that extensive handling operations in modern foundry are most readily performed in building of multi-story design. From paper before Am. Foundrymen's Assn.

Unique Features of an Illinois Foundry, Charles Lundberg. Iron Age, vol. 102, no. 26, Dec. 26, 1918, pp. 1563-1569, 13 figs. Electric steel, gray iron and semi-steel departments; continuous operations with large production in small space; use of molding machines. Description of plant of Avery Co., Peoria, Ill.

Molding

How Gear Cases for Tractors Are Molded. Foundry, vol. 47, no. 317, Jan. 1919, pp. 2-5, 8 figs. Molding machines of large capacity and special core-room equipment are employed; special rigging for economies.

Patterns and Their Relation to Molding Problems, Joseph A. Shelly. Machy., vol. 25, no. 4, Dec. 1918, pp. 310-314, 12 figs. First of series of articles dealing with construction and application of patterns, including use of woodworking tools, art of joinery, and various methods of building patterns and core boxes.

Salvage Work

Reclaiming Wealth in the Foundry Yard, F. B. Hicks. Can. Foundryman, vol. 9, no. 12, Dec. 1918, pp. 302-303. Salvage work conducted by a superintendent of Sawyer-Massey works.

War Demands

Shell Need Found Foundries Ready. Iron Trade Rev., vol. 63, no. 22, Nov. 28, 1918, pp. 1229-1236, 15 figs. Methods developed in American foundries to meet increased demand of production.

See also *ELECTRICAL ENGINEERING, Furnaces (Industrial Furnaces, Steel Furnaces).*

FUELS AND FIRING

Blast-Furnace Gas

The Use of Blast-Furnace Gas for Heating Boilers and Metallurgical Apparatus (L'emploi du gaz pour le chauffage des chaudières et des appareils métallurgiques), H. Thiry. Génie Civil, vol. 73, no. 21, Nov. 23, 1918, pp. 401-404, 8 figs. Precautions necessary to insure successful operation of Cowper system. Abstract of discussion before South Wales Inst. Engrs. and Cleveland Inst. Engrs.

Briquetting

The Economy of Briquetting Small Coal, J. A. Yeadon. Trans. Instn. Min. Engrs., vol. 56, part 1, Nov. 1918, pp. 31-34 and (discussion) pp. 34-36. Considerations on conservation of coal and utilization of waste materials; advantages of briquetting; method of manufacture; rectangular and ovoid forms of briquets.

Chimney Design

Saving the Waste in the Chimney, Robert Sibley and Chas. H. Delany. Jl. Elec., vol. 41, nos. 10 and 11, Nov. 15 and Dec. 1, 1918, pp. 463-464 and 511, 4 figs. Nov. 15: Fundamental laws of chimney design as applied to economic operation of oil-fired power plant. Dec. 1: Draft formula for modern power plant.

Combustion Characteristics of Coal

Combustion Characteristics of Coals. Blast Furnace, vol. 6, no. 12, Dec. 1918, pp. 495-497, 5 figs. Factors entering into success of equipment selected for burning different kinds of coal; performance of various types of stokers; data on grades of coal.

Generation of Heat from Bituminous Coal and Its Absorption by the Boiler, Henry Misostow. Power, vol. 48, no. 25, Dec. 17, 1918, pp. 898-899, 3 figs. From paper before National Assoc. of Stationary Engrs., Cincinnati, Sept. 1918.

Considerations and Practical Conclusions in Regard to the Combustion and Gasification of Carbon (Considerations diverses et conséquences pratiques au sujet de la combustion et de la gazéification du carbone), J. Seigle. Bulletin et Comptes rendus mensuels de la Société de l'Industrie Minérale, series 5, vol. 14, 3d issue 1918, pp. 79-112, 7 figs. Chemical and thermodynamic equations. Air is considered as $O_2 + 4N_2$. Examination of changes and combinations in coke gas producers.

Combustion Characteristics of Coal, Joseph G. Worker. Ry. Rev., vol. 63, no. 23, Dec. 7, 1918, pp. 824-827. Behavior of different grades of stationary boiler plant fuel with reference to type of mechanical stoking apparatus best suited for it. Fuels treated range from small sizes of anthracite through several grades and qualities of bituminous and lignites.

Combustion Characteristics of Coals and Selection of Suitable Stoker Equipment, Joseph G. Worker. Railroad Herald, vol. 23, no. 1, Dec. 1918, pp. 9-14, 7 figs. Results of tests on overfeed type of stoker with smaller sizes of nos. 1, 2 and 3 buckwheat coal and tables giving performance of underfeed stoker as applied to various sizes of boilers and burning different grades of coal.

Fuel Conservation

The Fuel Situation in New England, B. B. Pollock. Official Proc. N. Y. R. R. Club, vol. 29, no. 1, Dec. 1918, pp. 5455-5456. Measures taken to meet coal shortage by Federal Administrator, Boston & Maine R. R.

Some Important Points in Fuel Conservation, Robert Collett. Ry. Age, vol. 65, no. 25, Dec. 20, 1918, pp. 1121-1123. Why we must still save fuel; plan of organization; lessons learned from personal experience. From paper before New England Railroad Club.

Hand-Fired Plants

Fuel Economy in Hand-Fired Power Plants —V, Power Plant Eng., vol. 22, no. 24, Dec. 15, 1918, pp. 987-989. Feed water heating and purification. Abstract of circular 7, Univ. Ill. Eng. Experiment Station.

Indiana Coals

Burning Indiana Coal on the Chain Grate, T. A. Marsh. Power, vol. 49, no. 1, Jan. 7, 1919, pp. 17-19, 7 figs. Characteristics of Indiana screenings from four seams supplying most of steaming coal; need of large grate area, large furnace volume and strong draft to give capacity, and long, high-pitched arches.

Iowa Coals

Burning the Low-Grade Coal of Iowa, T. A. Marsh. Power, vol. 48, no. 27, Dec. 31, 1918, pp. 940-941, 4 figs. Burning Iowa coal on chain grate. Being low in heat value, high in ash and of clinkering, non-coking variety, this coal requires, for successful burning, practically continuous ash disposal and non-agitation of fire. Also Elec. World, vol. 72, no. 25, Dec. 21, 1918, pp. 1166-1168, 4 figs. General considerations to observe in selecting stokers and in designing furnaces; specific changes which can be made in order to adapt existing stokers to low-grade fuels.

Lignites

The Firing of Pulverized Lignite, M. C. Hatch. Jl. Elec., vol. 41, no. 12, Dec. 15, 1918, pp. 539-541. Advantages in pulverizing; methods of handling; furnace design for pulverized fuel; calculation of total cost.

Notes on Lignite, Its Characteristics and Utilization, S. M. Darling. Power House, vol. 11, no. 11, Nov. 1918, pp. 328-331. Abstract of U. S. Bureau of Mines paper.

Powdered Coal

Pulverized Coal and Its Preparation, J. M. Wadsworth. Jl. Elec., vol. 41, no. 11, Dec. 1, 1918, pp. 511-512, 2 figs. Arrangement of machinery in small coal pulverizing plant. Compiled for Western needs by technical staff of Fuel Administration. First of series.

Stokers

Power Plant Management VI Mechanical Stokers, Robert June. Refrig. World, vol. 53, no. 12, Dec. 1918, pp. 23-25, 3 figs. Efficiency of stokers; smoke alleviation; characteristics of individual chain-grate stokers.

Storage

Effect of Storage on Coal (II), Coal Trade Jl., year 50, no. 51, Dec. 1918, pp. 1481-1482. Analytical data accumulated during weathering tests made by Eng. Experiment Station of Univ. of Ill. Tests covered period of six years. Coals used were from Illinois field. (Continuation of serial.)

Wood

Waste Wood as a Fuel Possibility, O. F. Stafford. Jl. Elec., vol. 41, no. 12, Dec. 15, 1918, pp. 541-543. Suggests conversion of wood waste into ethyl alcohol, direct fuel and powdered charcoal which might be used directly in specially designed Diesel engine.

FURNACES

Annealing Furnaces

Continuous Type Annealing Furance, Philip d'H. Dressler. Iron Trade Rev., vol. 63, no. 25, Dec. 19, 1918, pp. 1416-1417, 5 figs. Deals specially with a form of continuous car-type annealing furnace. Discussion of H. E. Diller's paper before Am. Foundrymen's Assn.

Heat Treating

Equipment Data on Heat Treat Furnaces. Am. Drop Forger, vol. 4, no. 11, Nov. 1918, pp. 437-439, 6 figs. Discusses refractory material, fuel-oil burners and other furnace equipment.

Insulation

Value of Heat Insulation in Furnaces, A. W. Knight. Am. Drop Forger, vol. 4, no. 11, Nov. 1918, pp. 451-453. Discusses particularly use of insulation as applied to annealing ovens.

Pressures

Graphical Examination of Pressures of Hot Gases and Vapors in Furnaces and Chimneys (Etude de quelques cas généraux de pression des gaz chauds et fumées dans les fours et cheminées par représentation graphique), J. Seigle. Bulletin et comptes rendus mensuels de la Société de l'Industrie Minérale, series 5, vol. 14, 3d issue 1918, pp. 133-151, 17 figs. Variation of pressure at different points of enclosure containing hot gases when (1) enclosure is open at top, (2) open at bottom, and when (3) it connects with another enclosure by conduit at top.

HANDLING OF MATERIALS

Dumper

Dumper at Sewalls Point Handles Two Cars at Once. Eng. News-Rec., vol. 81, no. 24, Dec. 12, 1918, pp. 1086-1088, 5 figs. New facilities of Virginian Ry. at coal pier near Norfolk also include cars of 120 tons capacity, and long incline.

Double Car Dumper for Handling Coal, A. F. Case. Iron Age, vol. 102, no. 24, Dec. 12, 1918, pp. 1435-1438, 7 figs. Description of new Sewalls Point plant of Virginian Ry. Co.

HEAT TREATING

Malleable Iron

Tests in Annealing Malleable Iron, H. E. Diller. Iron Trade Rev., vol. 63, no. 25, Dec. 19, 1918, pp. 1414-1416, 4 figs. Experiments conducted to determine time necessary for annealing; study of results and indication of possibility of annealing in 48 hr.; photomicrographs, description of continuous car-type heating furnace. Paper at annual meeting of Am. Foundrymen's Assn.

Steel

Art of Heat Treating, D. N. A. Blacet. Ry. Jl., vol. 25, no. 1, Jan. 1919, pp. 18-20. Economical aspect of adding metallurgist to personnel of plants manufacturing steel parts; general considerations regarding selection of specifications. From Jl. Am. Steel Treaters' Soc.

Surface Combustion

Application of the Surface Combustion Process to Heat Treating and Similar Work, John D. Bartlett, Jr. Proc. Steel Treating Soc., vol. 1, no. 11, pp. 18-32, 12 figs. Generation and application of heat; proportioning of gas and air mixture; description of several installations for heat treating; automatic heat-treating furnaces for large-size shells.

HEATING AND VENTILATION

Circulation Heating

Heating Shop Floors by Circulation. Metal Worker, vol. 90, no. 24, Dec. 13, 1918, pp. 662-663, 6 figs. Scheme to draw cold air from the floor.

Factory Heating

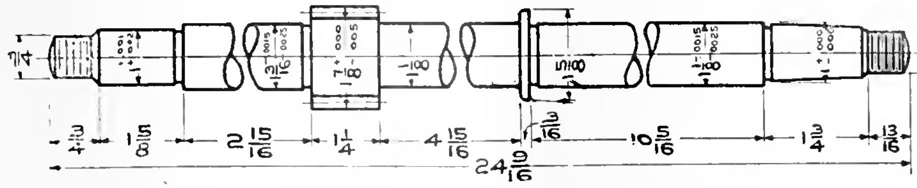
Fuel Wastes in Factory Heating, Charles L. Hubbard. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 23-25. Sources of losses; suggestions for economies; means for temperature control suited to different systems of heating.

Hospitals

Heating and Power Plant Economies for Hospitals, J. D. Kimball. Modern Hospital, vol. 11, no. 6, Dec. 1918, pp. 437-439. Fundamentals and recommendations of National Economy Program. Paper for convention of Am. Hospital Assn.

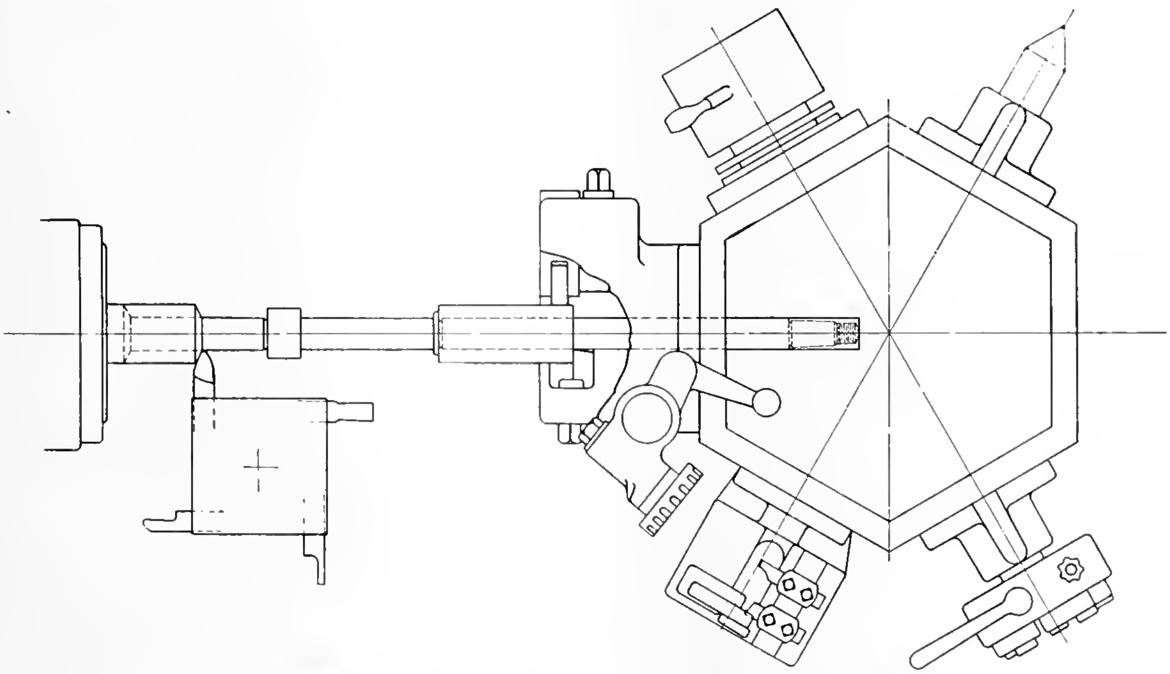
Moisture Removal

The Removal of Moisture from Special Rooms and Buildings, Charles L. Hubbard. Domestic Eng., vol. 85, no. 8, Nov. 23, 1918, pp. 283-285 and 313-315, 6 figs. Notes on in-



Follow This Thru

YOU will spend your time profitably by analyzing each operation in producing this shaft on the No. 2-A Universal Hollow Hexagon Turret Lathe.



1st Operation:—Turn the 1⅛ in. diameter with the turning tool. At the same time, with a cutter in the square turret, form the 1⅝ in. shoulder and turn the 1⅛ in. diameter behind the shoulder. With another square turret cutter, turn the 1⅞ in. and 1 3-16 in. diameter. The two turrets finishing their work simultaneously.

2nd Operation:—Turn the ¾ in. diameter.
3rd Operation:—Center Shaft.
4th Operation:—Turn the 1 in. tapered diameter with taper attachment and nick with square turrent cutter.
5th Operation:—Thread ¾ in. diameter.
6th Operation:—Cut off.

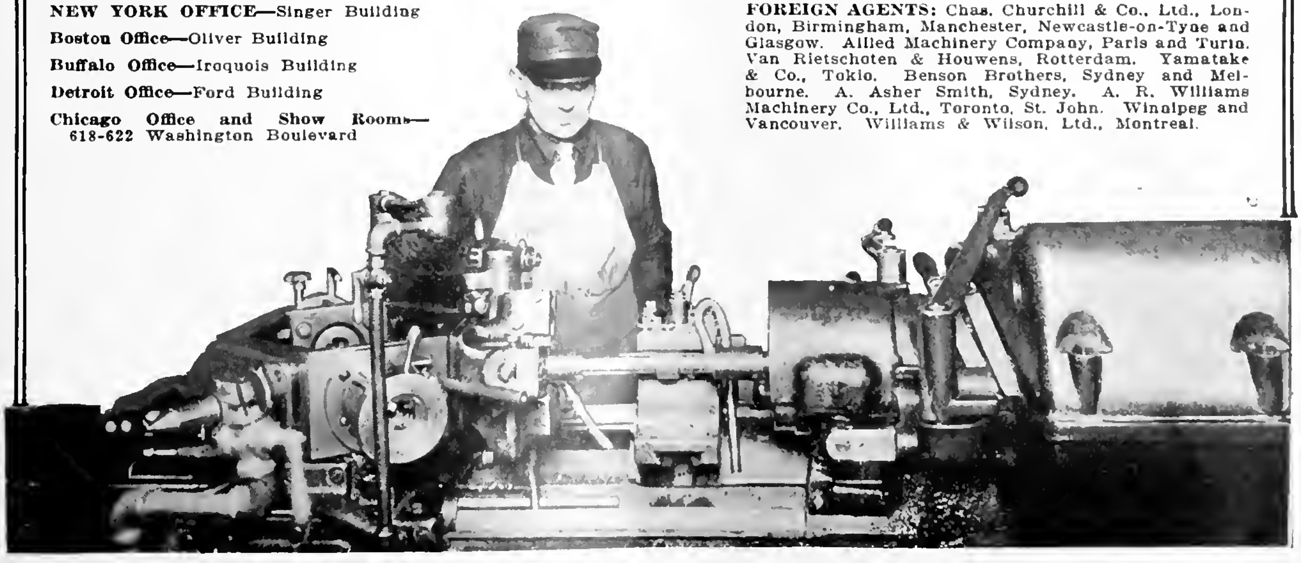
Warner & Swasey turret lathes will mean sure profits to you. Send blueprints for an analysis like the shaft job here.

THE WARNER & SWASEY COMPANY

CLEVELAND, OHIO, U. S. A.

NEW YORK OFFICE—Singer Building
Boston Office—Oliver Building
Buffalo Office—Iroquois Building
Detroit Office—Ford Building
Chicago Office and Show Rooms—618-622 Washington Boulevard

FOREIGN AGENTS: Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. Allied Machinery Company, Paris and Turin. Van Rietschoten & Houwens, Rotterdam. Yamatake & Co., Tokio. Benson Brothers, Sydney and Melbourne. A. Asher Smith, Sydney. A. R. Williams Machinery Co., Ltd., Toronto, St. John. Winnipeg and Vancouver. Williams & Wilson, Ltd., Montreal.



stallation of ventilating systems in laundries, dye houses, paper mills, foundries, flax mills, etc.

Office-Building Ventilation

Air Supply for a Large General Office Building, Samuel R. Lewis. Heat & Vent. Mag., vol. 15, no. 12, Dec. 1918, pp. 21-36, 16 figs. Past and present practice illustrated in remarkable installation for Swift & Co., Chicago.

Radiators

Figuring Direct Radiator Heating Service, W. B. Gray. Metal Worker, vol. 90, no. 24, Dec. 13, 1918, pp. 653-655 and 658, 2 figs. Describes method said to insure correctness and to be of practical application by heating contractors.

Rector System of Gas Heating

New Heating System, Geo. S. Barrows. Gas Indus., vol. 18, no. 12, Dec. 1918, pp. 363-369, 7 figs. Extensive description of Rector system of gas heating.

Steam Heating

Care of Heating and Ventilating Equipment, Harold L. Alt. Power, vol. 48, no. 26, Dec. 24, 1918, pp. 910-912, 3 figs. Describes gravity one-pipe steam system. (Sixth article.)

HOISTING AND CONVEYING

Cableways

Aerial Cableways Successful in Northwest Shipyards. Eng. News-Rec., vol. 82, no. 1, Jan. 2, 1919, pp. 37-40, 5 figs. Similar to loggers cableways; ability to get men expert in handling them is one secret of success; well-planned installations are fast and flexible.

Cranes

Stothert-Pitt 35-Ton Locomotive Crane (Grue-locomotive de 35 tonnes système Stothert et Pitt.) Génie Civil, vol. 73, no. 11, Sept. 14, 1918, pp. 201-203, 5 figs. General arrangement and plans showing dimensions.

HYDRAULIC MACHINERY

Conduits, Loss of Pressure Head

On the High Velocities of Water in Conduits (Sur les grandes vitesses de l'eau dans les conduites), C. Mamichel. Revue Générale de l'Electricité, vol. 4, no. 21, Nov. 23, 1918, pp. 788-790, 1 fig. Experimental results said to have demonstrated loss of pressure head for velocities up to 260 ft. per sec. to be the same as for velocities of 30 ft. per sec.

Penstock Pipe

Saving the Waste in Penstock Pipe Design II), B. F. Jakobsen. Jl. Elec., vol. 41, no. 11, Dec. 1, 1918, pp. 504-505, 2 figs. Presentation and discussion of various formulæ to determine manner in which available money should be distributed among different items in order to get maximum economy. (Continued from Nov. 1 issue.)

Water Hammer

Maxima Excess Pressures Produced by Water Hammer (Sovrapressioni massime nei fenomeni del colpo d'ariete), Maurice Gariel. Abstract of article published in Revue Générale de l'Electricité, Sept. 21. (See Eng. Index, Jan., Mech. Eng., Hydraulic Machy., Water Hammer.)

Notes on the Size and Location in Forced Conduits of Water Hammer Relief Devices. (Remarques au sujet des conditions à remplir par certains dispositifs destinés a attenuer les coups de bélier dans les conduites forcées). Comte de Sparre. Revue Générale de l'Electricité, vol. 4, nos. 19 and 20, Nov. 9 and 16, 1918, pp. 685-690 and 731-740, 1 fig. Nov. 9: Mathematical analysis of phenomena taking place, by reason of elasticity of water and conduit, in surge tank which opens a compensating orifice when water hammer reaches a certain value, the orifice having such dimensions that water hammer will never exceed a permissible maximum. Nov. 16: Application of principles established in preceding installment to calculation of permissible minimum dimensions of surge tanks which will insure a constant value of water hammer during compression.

INTERNAL-COMBUSTION ENGINES

Buckeye Barrett Engine

Buckeye Barrett Crude Oil Engine. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 72-73, 2 figs. Low-compression type burning heavier grades of fuel and designed for service where an engine must run for weeks under full load without a stop.

Design

The Working Process of Internal Combustion Engines, P. H. Sherbondy. Aerial Age, vol. 8, no. 11, Nov. 25, 1918, pp. 564-568, 7 figs. Historical review of inventions which have tended to improve engine efficiency.

Internal Combustion Engine Development, R. E. Neale. Eng. Rev., vol. 32, no. 5, Nov. 15, 1918, pp. 130-132. Indicates lines open to further development particularly in direction of lightening low-speed engines by adoption of higher piston speeds. (To be continued.)

Diesel-Engine Fuel Pumps

The Design and Construction of Diesel Engine Fuel Pumps, G. L. Kirk. Engineering, vol. 106, no. 2759, Nov. 15, 1918, pp. 549-551, 10 figs. Four systems of oil distribution; system of regulation; determination of clearances; constructional details; control lever.

Ignition

Operation of Internal-Combustion-Engine Magnetos (Sul funzionamento dei magneti di accensione dei motori a scoppio), Emilio Biffi. L'Elettrotecnica, vol. 5, no. 29, Oct. 15, 1918, pp. 407-411, 6 figs. Various aspects of spark; study of its oscillatory character; conclusions in regard to magneto operation. (Concluded.)

Ignition Timing and Valve Setting, Vermont Wells. Am. Blacksmith, vol. 17, no. 12, Sept. 1918, pp. 291-293, 4 figs. Rules for timing ignition in different makes of cars.

British Magneto Manufacture. Gas & Oil Power, vol. 14, no. 158, Nov. 7, 1918, pp. 20-22, 3 figs. General dimensions and brief outline of magneto manufactured by British Lighting and Ignition Co.

Dixie Standard Aircraft Magnetos. Automotive Indus., vol. 39, no. 23, Dec. 5, 1918, pp. 954-957, 6 figs. Type which may be adapted to various engines; methods used in manufacture of magneto magnets.

Semi-Diesel Engines

Semi-Diesel Oil Engines, F. D. Weber. Jl. Elec., vol. 41, no. 12, Dec. 15, 1918, pp. 549-550, 4 figs. Types being used to equip auxiliary wooden schooners of 500 to 3000 tons capacity and straight motor schooners up to 1000 tons capacity.

The Semi-Diesel Oil Engine, James Richardson. Gas & Oil Power, vol. 14, no. 158, Nov. 7, 1918, pp. 23-25, 9 figs. Development and operation. From paper before Diesel Engine Users' Assn. Also Macy. Market, no. 944, Dec. 6, 1918, pp. 17-18, 9 figs. Definition; compression pressure; flexibility; range of working.

Valves, Poppet, Air Flow Through

Air Flow Through Poppet Valves. Automotive Indus., vol. 39, no. 25, Dec. 19, 1918, pp. 1047-1051, 5 figs. Experimental investigation from which writer concludes that coefficient of efflux is practically constant for all pressure drops and nearly the same for valves of different sizes, at equal lifts expressed in per cent. of their respective diameters; considerations on number of inlet valves to use.

Air Flow Through Poppet Valves. Automotive Eng., vol. 3, no. 10, Dec. 1918, pp. 461-463, 1 fig. Data on valve sizes; investigation of merits of multiple valves. (To be continued.)

Winton Marine Engine

The Latest Winton Marine Oil Engine. Automotive Eng., vol. 3, no. 10, Dec. 1918, pp. 447-450, 5 figs. Review of mechanical details of 500 and 250-hp. units of Diesel-type reversible motor.

See also ELECTRICAL ENGINEERING, *Electrophysics (Spark Plug Insulators).*

LUBRICATION

Bearing Design

Oiling System and Bearing Designs, A. E. Windram. Tran. Inst. Marine Engrs., vol. 30, no. 238, Oct. 1918, pp. 209-216, 13 figs. Method of making main bearing, crankpin and crosshead brasses oiltight by means of drilling crank webs into oil rings or grooves turned round center of journal, and corresponding oil ring or groove in center of brasses connected with pipes from brasses to brasses, which are made oiltight by sealing rings on ends of brasses.

Oils

Properties of Oils and Their Relation to Lubrication (Propiedades de los aceites; su relacion con la lubricación). Boletin de la Sociedad de Fomento Fabril, year 35, no. 8, Aug. 1918, pp. 537-542. Significance of tests for acidity, carbon-residue, oxidation, volatility, surface tension, emulsion, heat and density.

See also MARINE ENGINEERING, *Ships (Lubrication).*

MACHINE ELEMENTS AND DESIGN

Crankshafts

Hair-Line Defects in Crankshafts, P. J. Piccirilli. Automotive Industries, vol. 39, nos. 25 and 26, Dec. 19 and 26, 1918, pp. 1041-1044, 1104-1105 and 1122, 15 figs. Metallographic study and physical tests of chrome-nickel steel crankshafts to determine nature and effect of so-called hair-line defects on their physical strength.

Springs

A new theory of Plate Springs, David Landau and Percy H. Parr. Jl. Franklin Inst., vol. 186, no. 6, Dec. 1918, pp. 699-721, 8 figs. Mathematical generalization of propositions advanced in first paper, vol. 185, Apr. 1918, p. 481. Special attention given to effect of tapering ends and constructing springs so that leaves continue in contact everywhere on application of load. (To be concluded.)

The Springs of the Car (IV), F. M. Paul. Am. Blacksmith, vol. 17, no. 12, Sept. 1918, pp. 298-299, 8 figs. Considers effect of thickness in regard to deflection and load.

MACHINE SHOP

Chisel

The Cold Chisel, J. A. Lucas. Power, vol. 48, no. 24, Dec. 10, 1918, pp. 838-841, 27 figs. Description of various types of cold chisels and their uses.

Cylinder Manufacture

Cylinder Boring and Reaming, Franklin D. Jones. Machy., vol. 25, no. 5, January 1919, pp. 383-394, 20 figs. First of series of articles dealing with boring, reaming and grinding of cylinders, and tools, fixtures and machines used.

Manufacture of Cylinders for the Hall-Scott Aeroplane Engine, Richard Vosbrink. Metal Trades, vol. 9, no. 12, Dec. 1918, pp. 475-479, 11 figs. Operations followed at California plant to produce accurate results.

Design

Novel Plant of American Tool Company, C. L. Smith. Iron Age, vol. 103, no. 1, Jan. 2, 1918, pp. 29-33, 10 figs. Latest ideas in heating and ventilating, lighting features, transportation facilities, sanitation, handling turnings; unusual drive for planers; machine foundations.

Designing a Shop for Present Day Needs, C. E. Edmund. Am. Drop Forger, vol. 4, no. 11, Nov. 1918, pp. 431-433. Considerations on location, construction and operation of forge plant.

Gages

Notes on the Computing of Gauge Tolerances, M. H. Potter. Can. Machy., vol. 20, no. 24, Dec. 12, 1918, pp. 670-672, 6 figs. Classifies and studies the more frequent troubles experienced with gages and gives rules and formulæ for computing allowable tolerances for various gages. A square hole gage and a depth gage are referred to but the rules proposed apply in general to all gages.

Apparatus for Checking Screw Threads. Automotive Indus., vol. 38, no. 24, Dec. 12, 1918, pp. 1008-1010, 4 figs. Methods of operating machines used for inspection of plug and ring thread gages and similar threaded parts requiring great accuracy.

Flush-pin, Sliding Bar and Hole Gages, Erik Oberg. Machy., vol. 25, no. 5, Jan. 1919, pp. 404-412, 34 figs. Principles involved and procedure followed by Pratt & Whitney Co. in developing gaging systems for interchangeable manufacture. Fourth article.

Contour or Profile Gages, Erik Oberg. Machy., vol. 25, no. 4, Dec. 1918, pp. 301-308, 31 figs. Principles involved and procedure followed in developing gaging systems for interchangeable manufacture. Based upon experience of Pratt & Whitney Co. in furnishing gaging equipment for small arms and heavy ordnance work. Third article.

Gear Cutting

The Manufacture of Spiral Bevels. Automobile Engr., vol. 8, no. 121, Dec. 1918, pp. 336-339, 6 figs. Description of Gleason machine for that purpose.

Problem of the Theoretically Correct Involute Hob, Nikola Trbojevich. Machy., vol. 25, no. 5, Jan. 1919, pp. 429-433, 3 figs. Mathematical theory developed.

Grinding

Grinding of Hardened Work, C. H. Norton. Proc. Steel Treating Research Soc., vol. 1, no. 11, pp. 15-17. Norton Grinding Co.'s experience; suggestions in regard to grinding.

Grinding Operations on "Caterpillar" Tractor Parts, Frank A. Stanley. Am. Mach., vol. 50, no. 1, Jan. 2, 1919, pp. 1-4, 7 figs. Grinding operations include finishing of great variety of gears, bushings, shafts, piston pins, case covers, etc.; details of wheels, limits of accuracy, etc.

Grinding Round Work Without Centers. Am. Mach., vol. 50, no. 1, Jan. 2, 1919, pp. 4-5, 4 figs. Describes new grinding machine built by Detroit Tool Co.

Pistons and Rings

The Manufacture of Pistons and Rings, A. Thomas. Automobile Engr., vol. 8, no. 121, Dec. 1918, p. 358, 3 figs. Notes on operation of Potter-Johnston automatic machine.

Repair Work

Automotive Repair Work in the Machine Shop, Donald A. Hampson. Can. Machy., vol. 20, no. 24, Dec. 12, 1918, pp. 665-668, 7 figs. Practical observations on methods of increasing pedal leverage, making a working clutch, inserting cotters in unseen holes, fitting rings in cylinder, increasing size of cast-iron parts, reaming undersize in cast iron and other similar operations.

The Repair Shop, Automobile Engr., vol. 8, nos. 120 and 121, Nov. 1918 and Dec. 1918, pp. 312-315 and 341-345, 25 figs. Nov. 1918: Notes on heavy vehicle design from viewpoint of repair and maintenance. Radiator; engine; clutch; engine suspension; gear box; universal joints and brakes. Dec. 1918: Deals with rear axle; road wheels and bearings; chassis lubrication, spring and pins; frame; steering and front axle; controls.

MACHINERY, METAL-WORKING

Boring Mill

Blomquist-Eck Horizontal Boring Mill. Machy., vol. 25, no. 5, Jan. 1919, pp. 465-466, 2 figs. General description with illustrations.

Lathes

Large Lathes for Machining Turbine Spindles, A. M. M. Machy., vol. 25, no. 5, Jan. 1919, pp. 439-442, 4 figs. Illustrated description of some large lathes.

Planer

Newton Upright Generating Planer. Machy., vol. 25, no. 5, Jan. 1919, pp. 473-474, 4 figs. Description of machine built by Newton Machine Tool Works, Inc., Philadelphia, Pa.

Reamers

Types of Reamers and Their Use, E. C. Peck. Machy., vol. 25, no. 4, Dec. 1918, pp. 335-337, 6 figs. Description of various types of reamers.

Relieving Machine

Universal Relieving Machine for Hobs and Cutters. Machy., vol. 25, no. 5, Jan. 1919, pp. 467-468, 2 figs. Description of machine built by T. C. M. Mfg. Co., Harrison, N. J.

Steel, High-Speed

The Evolution of a High-Speed Steel Tool, T. L. Thorne. Proc. Steel Treating Research Soc., vol. 1, no. 11, pp. 33-43. Analyses of several high-speed steel specimens; influence of silicon, manganese, sulphur, phosphorus, chromium, vanadium and tungsten on characteristic properties of steel; practice followed in its manufacture; forms of furnaces used; heat-treating and tools.

A New Air-Hardening High-Speed Steel. Am. Drop Forger, vol. 4, no. 11, Nov. 1918, pp. 435-436, 2 figs. Experiences of users of a steel made without tungsten by Cuyahoga Crucible Foundry Co.

Stellite

Stellite and High-Speed Steel Compared. Iron Age, vol. 102, no. 26, Dec. 26, 1918, pp. 1584-1585, 2 figs. Hardness at different temperatures; stellite softer in raw state; relative cutting tests on three materials.

See also RAILROAD ENGINEERING, Shops (Tools, Brass-Working); MUNITIONS AND MILITARY ENGINEERING, Tools for Shell Manufacture.

MATERIALS OF CONSTRUCTION AND TESTING OF MATERIALS

Notched Bars

Some Experiments on Notched Bars, H. T. Philpot. Jl. Soc. Automotive Engrs., vol. 3, no. 6, Dec. 1918, pp. 347-357, 3 figs. Tests to obtain dimensions and shapes for round notched bar for use in acceptance tests on heat treated steels in place of standard square type A test piece. Paper before Instn. Automobile Engrs. of Great Britain.

Hardness

The Ludwik Hardness Test, W. Cawthorne Unwin. Jl. Instn. Mech. Engrs., no. 6, Nov. 1918, pp. 485-492. Traces relationship between indentation hardness tests of ductile metals.

The Value of the Indentation Method in the Determination of Hardness, R. G. C. Batson. Jl. Instn. Mech. Engrs., no. 6, Nov. 1918, pp. 463-483, 6 figs. Deals with determination of hardness by means of indentation produced by a static load and by impact of a ball or cone.

Malleable Iron

Malleable Iron in Engineering Construction, H. A. Schwartz. Foundry, vol. 47, no. 317, Jan. 1919, pp. 19-24, 16 figs. Engineering properties and characteristics of malleable iron which recommend it for wide range of uses. From paper before Am. Foundrymen's Assn.

Optical Stress Determination

Stress Optical Experiments, A. R. Low. Flight, vol. 10, nos. 48-49, Nov. 28 and Dec. 5, 1918, pp. 1355-1356 and 1379-1381, 12 figs. Determination of stress by optical methods. Nov. 28: Elementary theory; changes in uniform field as stress increases; null method of measurement; appearances in non-uniform field; neutral, isochromatic and isoclinic lines. Dec. 5: Simplifications in case of bar under flexure; error of obliquity; observation of errors of parallax; general accuracy of optical observations of stress. Paper before Royal Aeronautical Soc. (To be continued.)

Rubber

Ageing of Vulcanized Plantation Rubber, Henry P. Stevens. Jl. Soc. Chem. Indus., vol. 37, no. 21, Nov. 15, 1918, pp. 305T-306T, 4 figs. Tests on ordinary pale rolled sheet and unrolled sheet.

Testing Machines

Testing Machines in Industrial Laboratories, H. S. Primrose and J. S. Glen Primrose. Can. Machy., vol. 20, nos. 23 and 25, Dec. 5 and 19, 1918, pp. 644-647 and 696-699, 17 figs. Necessity of establishing specifications properly controlled by analysis and test in purchasing engineering materials and features of various testing machines. From Engineering.

Testing of Materials

The Experimental Study of the Mechanical Properties of Materials, W. Cawthorne Unwin. Jl. Instn. Mech. Engrs., no. 6, Nov. 1918, pp. 405-439, 13 figs. Early researches; chain-cable testing machines; calibration of testing machines; large testing machines; Emery testing machine at Bureau of Standards; tests of reception-tension tests, Wöhler test, hardness tests, notched-bar tests.

Wood

Some Tests of Douglas Fir after Long Use, Arthur C. Alvarez. Univ. of Cal. Publications in Eng., vol. 2, no. 2, Nov. 18, 1918, pp. 57-118, 17 figs. Results of 1200 tests on strength, elastic properties and moisture content; includes 27 tables of measured and computed mechanical coefficients.

MEASUREMENTS AND MEASURING APPARATUS

Calibration

On the Choice of a Uniform Temperature for the Calibration of Measuring Instruments (Sur le choix d'un degré uniforme de température pour l'étalonnage des instruments de mesure), Ch. Cochet. Revue Générale de l'Electricité, vol. 4, no. 20, Nov. 16, 1918, pp. 740-742. Report of Commission de Normalisation des Ingénieurs des Arts et Métiers de Boulogne-sur-Seine, recommending adoption of 0 deg. cent. as standard.

Calorimeters

Calorimetric Methods and Devices, Walter P. White. Jl. Am. Chem. Soc., vol. 40, no. 12, Dec. 1918, pp. 1887-1889, 3 figs. Application of rules for calorimetric precision derived by writer to jacket covers and stirrers; vacuum-jacketed vessels; adiabatic method; aneroid or dry calorimeters; double or differential calorimeters; measured-shield calorimeters.

Coke Testing

Coke Factors Affecting Furnace Operation, G. D. Cochrane. Blast Furnace, vol. 6, no. 12, Dec. 1918, pp. 502-504 and 512, 1 fig. Coke-testing machine employed in experiment for determining coke hardness. Mechanical condition of coke an important factor in furnace operation.

Picnometer

A Picnometer Operated as a Volumeter, H. G. Schurecht. Jl. Am. Ceramic Soc., vol. 1, no. 8, Aug. 1918, pp. 556-558, 1 fig. Same as ordinary picnometer but of sufficiently large size and opening to permit introduction of a briquet into the bottle. Volume of briquet determined from standard formula in terms of weight and specific gravity of liquid.

Salinometers

An Instrument for Recording Sea-Water Salinity, A. L. Thuras. Jl. Wash. Acad. Sci., vol. 8, no. 21, Dec. 19, 1918, pp. 676-687, 3 figs. Surface salinity of ocean determined by measuring ratio of resistances of sea water in two similar electrolytic cells. Accuracy, limited by that with which salinity of standard sea water carried in sealed cell is known. Table given showing conductivity of sea water throughout range of concentration found in open ocean.

Scales

Oscillations in Scales, Eugene Motchman. Scale Jl., vol. 5, no. 3, Dec. 10, 1918, pp. 7-9, 4 figs. Use of modern 150-ton beam applied to railroad track scales without loose weight. (Continuation of serial.)

MECHANICAL PROCESSES

Boilers

Boiler Making in an English Shop, A. L. Haas. Boiler Maker, vol. 18, no. 12, Dec. 1918, pp. 333-337, 11 figs. Hopwood, Cornish, Lancashire and Britannia types; shop conditions; position drilling; combustion chamber crown; seven-hour test.

Manufacturing Marine Steam Boilers, E. A. Suverkrop. Am. Mach., vol. 49, no. 26, Dec. 26, 1918, pp. 1155-1163, 21 figs. Description of building operations of single-ended, three-furnace Scotch marine boilers at shop of Sun Shipbuilding Co., Chester, Pa., where production has reached as high as nine per month.

Cans

A Modern Can-Making Plant in a Baking Powder Factory, J. V. Hunter. Am. Mach., vol. 49, no. 26, Dec. 26, 1918, pp. 1173-1176, 11 figs. Description of process of making tin cans.

Chains

The Manufacture of Diamond Transmission Chain, J. V. Hunter. Am. Mach., vol. 49, no. 23, Dec. 12, 1918, pp. 1077-1080, 14 figs. Assembling work. Fourth article.

Clocks

Applications of Magnetic Gears in Electric Clockmaking (Engrenages magnétiques. Application à l'horlogerie électrique), Pierre Seve. Comptes rendus des séances de l'Académie des Sciences, vol. 167, no. 19, Nov. 4, 1918, pp. 681-683. Mutual action of two disks having magnets attached at regular intervals in their peripheries; disposition to provide magnetic escapement.

Engines, Oil

Quantity Production of Engines at the Skandia Pacific Plant, Geo. N. Somerville. Metal Trades, vol. 9, no. 11, Nov. 1918, pp. 429-434, 10 figs. Operations in various sizes of oil engines.

Lubricator

Manufacturing a Mechanical Lubricator, M. E. Hoag. Am. Mach., vol. 49, no. 26, Dec. 26, 1918, and vol. 50, no. 1, Jan. 2, 1919, pp. 1183-1185 and 23-26, 18 figs.

Plates

See Rolling Mills below.

Quarrying

Rock Quarrying for Cement Manufacture, Oliver Bowles. Department of Interior, Bur. of Mines, bul. 160, min. technology 22, 160 pp., 31 figs. Chief types of cement; growth of cement industry in U. S.; character of raw materials used; quarrying method and equipment with special reference to drilling and blasting; rock mining and prospecting.

Radiators

Building Radiators for Automobiles and Other Purposes, Ellsworth Sheldon. Am. Mach., vol. 49, no. 26, Dec. 26, 1918, pp. 1165-1169, 18 figs. Description of certain processes involved in manufacture of cellular type of radiator.

Rolling Mills

Design of Rolls for Making Ship and Boiler Plates, S. W. Staniford. Machy., vol. 25, no. 5, Jan. 1919, pp. 396-400, 1 fig. Rolling-mill practice; drafts of slabbing and plate-mill rolls; universal mill; surface speed of rolls, rolling tin plate.

The Liberty Mill of the Carnegie Steel Company, Charles A. Menk and F. L. Hunt. Elec. Jl., vol. 15, no. 12, Dec. 1, 1918, pp. 483-489, 18 figs. Layout of buildings and equipment of completely electrically-driven plate mill.

Valley Company Now Rolls Plates. Iron Trade Rev., vol. 63, no. 25, Dec. 19, 1918, pp. 1403-1406, 3 figs. Operation and details of electrically-driven steel plant with annual capacity of 350,000 tons.

Selecting Proper Size Mill Rolls, F. Johnson. Iron Trade Rev., vol. 63, no. 26, Dec. 26, 1918, pp. 1466-1468, 7 figs. Outline of relative advantages obtained by using rolls of small or large diameter for effecting a given reduction; effect of cold-working on physical properties of various metals. From paper before Birmingham Metallurgical Soc., England.

A New Departure in Rolling Mills. Iron Age, vol. 103, no. 1, Jan. 2, 1919, pp. 41-44, 6 figs. Neither lifting tables nor reversing drive employed; design developed by Mackintosh, Hemphill & Co.

Lukens Plate Mill is Largest in the World. Iron Age, vol. 103, no. 1, Jan. 2, 1919, pp. 56-59, 5 figs. Description of the mill.

Brier Hill Steel Co.'s New Plate Mill. Iron Age, vol. 102, no. 25, Dec. 19, 1918, pp. 1521-1524, 6 figs. World's largest mill building; houses and 84- and 132-in. units; power entirely electric; boiler plant dispensed with.

Blooming Mill Now Rolling Plates. Iron Trade Rev., vol. 63, no. 23, Dec. 5, 1918, pp.

Stoker Service

MURPHY FURNACES — RILEY STOKERS
R. SANFORD RILEY, PRESIDENT
SANFORD RILEY STOKER CO. WORCESTER, MASS. — MURPHY IRON WORKS DETROIT, MICH.

FRANK B. BIGELOW, GENERAL MANAGER
MURPHY IRON WORKS
DETROIT, MICH.

F. H. DANIELS, GENERAL MANAGER
SANFORD RILEY STOKER CO
WORCESTER, MASS

WM. PESTELL, WESTERN SALES MANAGER
1435 MARQUETTE BLDG., CHICAGO, ILL.

W. L. BIGELOW, EASTERN SALES MANAGER
1226 WOOLWORTH BLDG., NEW YORK CITY
THE RILEY UNDERFEED STOKER SANFORD RILEY STOKER CO WORCESTER, MASS.

W. K. HENNING, DISTRICT MANAGER
1435 MARQUETTE BLDG., CHICAGO, ILL.
THE RILEY UNDERFEED STOKER SANFORD RILEY STOKER CO WORCESTER, MASS.

J. F. MALLORY, DISTRICT MANAGER
1226 WOOLWORTH BLDG., NEW YORK CITY
THE MURPHY AUTOMATIC FURNACE MURPHY IRON WORKS DETROIT, MICH

W. C. ARMSTRONG, DISTRICT MANAGER
FOOT OF WALKER ST., DETROIT, MICH.
THE MURPHY AUTOMATIC FURNACE MURPHY IRON WORKS DETROIT, MICH.

R. M. BASSETT, DISTRICT MANAGER
202 STEPHEN GIRARD BLDG., PHILADELPHIA, PA
THE RILEY UNDERFEED STOKER SANFORD RILEY STOKER CO. WORCESTER, MASS.

A. G. SHELLEY, DISTRICT MANAGER
337 GUARDIAN BLDG., CLEVELAND, O.
THE RILEY UNDERFEED STOKER SANFORD RILEY STOKER CO. WORCESTER, MASS.

W. E. PORTER, DISTRICT MANAGER
1302 FARMERS BANK BLDG., PITTSBURGH, PA
THE MURPHY AUTOMATIC FURNACE MURPHY IRON WORKS DETROIT, MICH

G. C. ILLINGWORTH, DISTRICT MANAGER
1232 UNION TRUST BLDG., CINCINNATI, O.
THE RILEY UNDERFEED STOKER SANFORD RILEY STOKER CO WORCESTER, MASS.

GEO. H. BERGE, DISTRICT MANAGER
1005 MORGAN BLDG., BUFFALO, N.Y.
THE MURPHY AUTOMATIC FURNACE MURPHY IRON WORKS DETROIT, MICH.

When you need legal advice you consult a lawyer.

When you need advice on combustion problems why nct consult a combustion engineer?

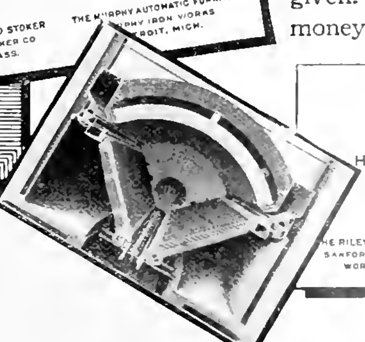
Selection of furnace equipment is a science in itself. Too many have found this to be true at the expense of much time, money and materials.

Replacements are costly. They typify questionable engineering. When you realize that a large percentage of our business is for replacements, then you grasp the significance of having an expert in the first place prescribe the equipment most suitable for your plant.

The *combination* of the sales work of the Sanford Riley Stoker Company and the Murphy Iron Works enables us to unite the efforts and experience of leading combustion experts.

Located at many central points, these engineers stand ready to give constructive service regarding the operation of present equipment as well as making recommendations on new equipment.

Get in touch with our representatives in your territory. They are your councillors. Their services are cheerfully and freely given. Let them save you time, money, men and fuel.



HARRY E OSGOOD, DISTRICT MANAGER
201 DEVONSHIRE STREET, BOSTON, MASS.

TRADE MARK Rx REGISTERED

1285-1288, 4 figs. Account of rebuilding of mill, originally designed for breaking down ingots, to aid rapid transformation from shell steel to peace-time commercial product.

Sawmills

Small Sawmills: Their Equipment, Construction, and Operation, Daniel F. Seerey. U. S. Department of Agriculture, bul. 718, Dec. 17, 1918, 68 pp. Suggestions to portable sawmill operators regarding methods of organization, milling, and lodging which have been proved by experience to give the best results. Written particularly for operators in National Forest timber.

Shell and Ivory Articles

Making Shell Buckles and Brooches, Robert Mawson. Am. Mach., vol. 50, no. 1, Jan. 2, 1919, pp. 20-22. 13 figs. Making of buckles and brooches from shells and ivory performed as far as possible on machines, but some operations are done by hand.

Shovels

Shovels Made Out of Old Locomotive Tires, W. S. Standiford. Can. Machy., vol. 20, no. 25, Dec. 1918, pp. 693-695, 3 figs. Description of manufacturing process.

Tanks, Pressure

Tables for the Design of Pressure Tanks, John A. Cole. Boiler Maker, vol. 18, no. 12, Dec. 1918, pp. 349-351. Specifications for cylindrical pressure tanks; single-riveted lap girth seams, for use when girth and longitudinal seams are the same size; safe working pressures for cylindrical tanks of various diameters; safe working pressures on convex and dished heads.

Tractor

Manufacturing of Farm Tractor, M. E. Hoag. Am. Mach., vol. 49, no. 25, Dec. 19, 1918, pp. 1135-1137. Description of shop arrangement of Moline Plow Co.

MECHANICS

Balancing

Dynamic and Static Balancing, Edward K. Hammond. Machy., vol. 25, nos. 4 and 5, Dec. 1918 and Jan. 1919, pp. 285-292 and 422-426, 26 figs. Two articles explaining conditions which must be fulfilled in balancing machine members, and methods of conducting work.

Stress Theory

The Specification of Stress, Part V, R. F. Gwyther. Memoirs & Proc. Manchester Literary & Phil. Soc., vol. 62, part 1, Aug. 7, 1918, pp. 1-11. Formal solution of elastic stress equations; theory of displacements of materials bodies as consequence of stress; results of hypothesis that nine elements of stress may be functions of nine first differential coefficients of components of some vector; fundamental equations estimating forces causing rate of change of momentum and expression of corresponding rate of change of momentum.

Vibration

Vibration: Mechanical, Musical and Electrical, Edwin H. Barton. Sci. Am. Supp., vol. 87, no. 2244, Jan. 4, 1919, p. 5. Analogies and experimental verification of laws governing vibratory motion. Discourse delivered at Royal Instn. From Engineering.

MOTOR-CAR ENGINEERING

Acceleration Determined by Mechanical Differentiometer

Automobile Performance Analyzed by Mechanical Differentiation, Armin Elmendorf. Automotive Indus., vol. 40, no. 1, Jan. 2, 1919, pp. 11-16, 17 figs. Determination of acceleration from time and distance observations by means of mechanical differentiometer.

Carburetors

Carburetor Adjustments of Twenty Leading Automobiles, George H. Murphy. Am. Blacksmith, vol. 17, no. 12, Sept. 1918, pp. 301-303, 9 figs. Instructions for making adjustments. (To be concluded.)

Design

Post-War Chassis. Automobile Engr., vol. 8, nos. 120 and 121, Nov. and Dec. 1918, pp. 304-305 and 339-340. Nov. 1918: Possible effects of aircraft engine experience and other factors bearing upon design. Pistons; valve position and actuation; valves. Dec. 1918. Valve springs; valve rockers; connecting rods; crankshafts; lubrication.

Analysis of Gas and Gasoline High-Speed Engine Design, Harry R. Ricardo. Int. Mar. Eng., vol. 23, no. 12, Dec. 1918, pp. 673-677. Groups of mechanical losses depend upon form of pipe work; volumetric efficiency and piston design. Second article.

Differentials

The Allen Self-Locking Differential. Automotive Indus., vol. 39, no 26, Dec. 26, 1918, p. 1099, 2 figs. Device embodying reversible ratchet principle. Drive on curves is through inner wheel.

Engines

Used Airplane Engines for Automobile Installation, Frank F. Tenney. Automotive Eng., vol. 3, no. 10, Dec. 1918, pp. 457 and 463. Why engines which have outlived their usefulness in air service may still be of service for other uses.

Exports

Export Opportunities for Automotive Products, 11. Automotive Eng., vol. 3, no. 10, Dec. 1918, pp. 454-456. Export of American combustion engine from 1914 to 1917; motor boats and marine machinery in Siam; demand for motor boats in Denmark; high fuel limits in South America; market tractors in Cuba, tractors in farming sections of Wales. (Continuation of serial.)

Cultivating Japanese Automotive Field (III), Tom O. Jones. Automotive Indus., vol. 39, no. 23, Dec. 5, 1918, pp. 970-971. Types of automobiles desired; equipment and finish; automobile building in Japan. (To be continued.)

France

The Automobile after the War, Georges Cote. Automotive Indus., vol. 39, no. 25, Dec. 19, 1918, pp. 1057-1058 and 1075. Views and suggestions to automobile manufacturers of France as to means and methods of meeting reconstruction problems and foreign competition.

Fuels

Benzol Superior to Gasoline as Auto Fuel. Gas Age, vol. 42, no. 12, Dec. 16, 1918, pp. 548-550, 2 figs. Result of comparative tests made by Automobile Club of America; 90 per cent benzol said to give higher brake hp. at less fuel consumption by the motor.

Liberty Fuel

Liberty Fuel, A Chemical Marvel, E. W. Roberts. Gas Eng., vol. 21, no. 1, Jan. 1919, pp. 1-4, 8 figs. Description of fuel with report of U. S. Government tests.

Properties of Liberty Fuel and Results of Economy Tests. Power, vol. 49, no. 1, Jan. 7, 1919, pp. 9, 2 figs. Particulars as to nature and characteristics of new fuel.

Headlights

Headlamp Glare. Jl. Soc. Automotive Engrs., vol. 3, no. 6, Dec. 1918, pp. 364-366. Account of work done and bases followed by committee of Illum. Eng. Soc. in preparation of headlight specifications.

Manufacturing Problems

Why So Many Motor Models? George F. Crouch. Motor Boat, vol. 15, no. 23, Dec. 10, 1918, pp. 18-20, 3 figs. Observes that concentration by manufacturer on fewer sizes would mean better motors, better service and lower cost.

Radiators

Principles of Tractor Radiator Design, E. Goldberger. Automotive Indus., vol. 38, no. 24, Dec. 12, 1918, pp. 1000-1003, 3 figs. Equations showing dependence of radiator capacity on temperatures, rates of flow and inherent characteristics; advantages of thermosiphon circulation in tractor work.

Steam Vehicles

A New British Coke-Fired Steam Commercial Vehicle. Automotive Indus., vol. 39, no. 22, Nov. 28, 1918, pp. 919-922, 6 figs. Three-ton chassis having automatic control of steam-generating functions and manual control of devices arranged as on a gasoline vehicle.

Suspension

Houdaille Brings Out Adjustable Car Suspension, F. W. Bradley. Automotive Indus., vol. 38, no. 24, Dec. 12, 1918, pp. 1004-1005, 2 figs. Device which permits moving points of attachment of springs to car frame.

Tractors

S. W. H. Tractor a New Cleveland Product. Automotive Indus., vol. 39, no. 26, Dec. 26, 1918, pp. 1085-1088, 5 figs. Three-plow machine with pressed-steel semi-frame bolted to front end of transmission housing; engine and transmission independent.

The Auto Tiller, a Two-Horse Team Replacement Unit. Automotive Eng., vol. 3, no. 10, Dec. 1918, pp. 473-477, 5 figs. Field of utility and mechanical details of motor tractor for farm work operated by one man from a fixed position.

Trucks

Regulation of Speed, Weight, Width and Height of Motor Trucks Discussed, George M. Graham. Eng. News-Rec., vol. 81, no. 25, Dec. 19, 1918, pp. 1109-1112. Regulation, while necessary, should not restrict expansion of motor truck; table of proposed dimensions, speeds, weights, and fees presented.

Double Reduction Gear Drive for Heavy Duty Trucks. Am. Blacksmith, vol. 18, no. 2, Nov. 1918, pp. 32-33. Operation of drive in new 3- and 5-ton White models.

Wheel

An Elastic Wheel (La roue élastique I. D.). Génie Civil, vol. 73, no. 20, Nov. 16, 1918, pp. 393-394, 2 figs. Design which by means of helical springs attached to rim permits tangential effort on wheel to be distributed over a number of contact points of spring.

See also MECHANICAL ENGINEERING, Mechanical Processes (Radiators); Internal-Combustion Engines (Buckeye Barrett Engine); Machine Shop (Repair Work).

PIPE

See MECHANICAL ENGINEERING, Corrosion (Pipe).

POWER GENERATION

Exhaust Steam

Utilization of Exhaust Steam in Collieries for the Generation of Electrical Energy (Considérations sur l'utilisation des vapeurs d'échappement dans les houillères en vue de la production d'énergie électrique), A. Barjou. Industrie Electrique, year 27, nos. 621, 623, 627, 631 and 634, May 10, June 10, Aug. 10, Oct. 10 and Nov. 25, 1918, pp. 166-171, 212-217, 287,293, 373-379 and 425-430. 26 figs. May 10: theoretical aspect of problem. June 10: systems of regulating exhaust steam. Aug. 10: utilization of exhaust steam in low-pressure turbines. Oct. 10: Westinghouse Leblanc system of condensation. Nov. 25: Brequet-Delaporte condenser.

Tides

Tides as a Source of Mechanical Power (Etude sur l'utilization des marées pour la production de la force motrice), F. Maynard. Revue Générale de l'Electricité, vol. 4, nos. 19, 20 and 21, Nov. 9, 16 and 23, 1918, pp. 697-715, 749-762 and 793-802, 14 figs. Brief description of 87 patents granted in France concerning devices for utilization of tidal energy and analyses of their practical values. (To be continued.)

POWER PLANTS

Boiler Water

Control of Concentrated Boiler Water is Essential, Hartley Lell. Smith. Elec. Ry. Jl., vol. 52, no. 25, Dec. 21, 1918, pp. 1087-1091, 1 fig. Methods used for control of concentration in boilers; how ratio of concentration from feedwater to boiler water is determined; calculation of boiler concentration control charts.

Coal Economy

Coal Economy in a Small Steam Generating Station. Elec. Rec., vol. 24, no. 6, Dec. 1918, pp. 27-28, 3 figs. Results secured in 290-kw. plant given as example of coal saving.

Flue-Gas Analysis

Controlling Efficiency of Combustion, E. A. Uehling. Power, vol. 48, no. 26, Dec. 24, 1918, pp. 921-923. Use of flue-gas analysis for controlling combustion.

Furnace Indicating Instruments

Meters and Gages in Boiler Operation, E. A. Uehling. Power, vol. 48, no. 24, Dec. 10, 1918, pp. 842-844. Use of meters and gages in diagnosing condition of furnace.

Hand Firing

Power Plant Management: Hand Firing, Robert June. Power House, vol. 11, no. 11, Nov. 1918, pp. 315-317, 3 figs. Standard practice; proper combustion conditions; thickness of fire; minimization of smoke.

Individual Plants

Steam-Generating Equipment of Mark Plant, Gordon Fox and F. E. Grenley. Power Plant Eng., vol. 22, no. 24, Dec. 15, 1918, pp. 981-984, 3 figs. Description of certain features of new plant of Steel & Tube Co. of America.

Power Plants in 1918

Review of the Year in the Power Field. Power, vol. 49, no. 1, Jan. 7, 1919, pp. 2-8. What has been new and of especial interest during 1918.

Scale in Boilers

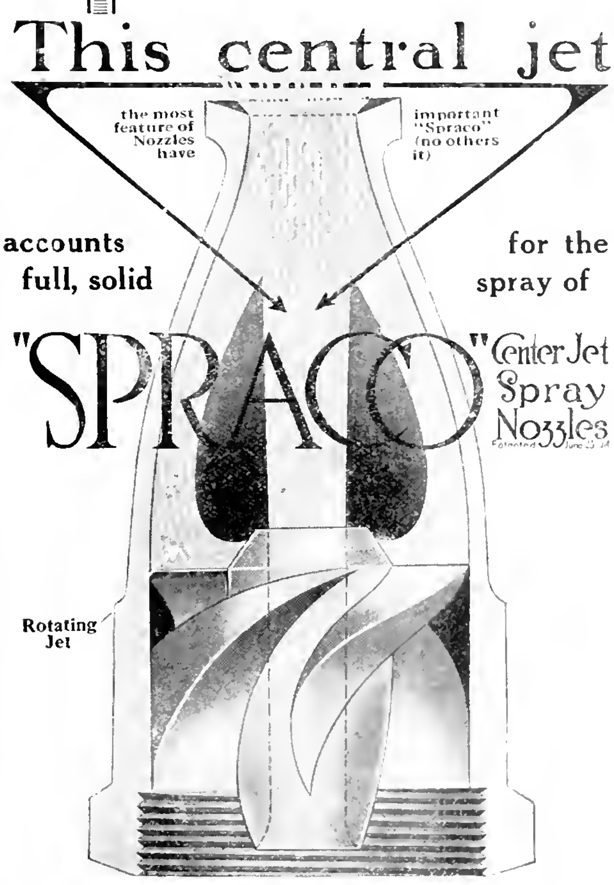
Scale in Water-Tube Boilers. Monthly Jl. Utah Soc. Engrs., vol. 4, no. 9, Sept 1918, pp. 175-176. Results of cleaning a 400-hp. Babcock & Wilcox boiler after operating it for six months, with table indicating the amount of scale taken from each of its 14 sections.

Transmission Losses

Wasting Power in the Using, L. W. Alwyn-Schmidt. Power Plant Eng., vol. 22, no. 24, Dec. 15, 1918, pp. 984-987. Transmission losses, waste of power at machine and methods suggested for overcoming them.

SPRACO

Spraco Cooling System



The war is won, but the necessity for conservation is as great as ever. The whole world needs coal—we must save every pound possible. Spraco Equipment, which helped to put many plants on a basis of wartime efficiency, is ready for the work of reconstruction.

The Spraco Cooling System (with Spraco Center Jet Nozzle) saves fuel and cuts operating costs. Under ordinary conditions it will cool condensing water sufficiently to insure an average vacuum of 27 inches or better, throughout the year. And compared to a cooling tower the Spraco System costs much less to install, about one-half as much to operate and practically nothing to maintain.

Our engineers are at your service—ready to submit drawings, specifications and estimates covering an installation in your plant. A word from you will bring full details.

SPRAY ENGINEERING CO.

93 Federal St., - Boston, Mass.

Engineers Manufacturers

SEE OUR DATA IN 1918 A.S.M.E. CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT

Turbo-Generator Plants

Operating Methods That Increase Economy. C. F. Hirshfeld and C. L. Karr. Elec. World, vol. 72, no. 24, Dec. 14, 1918, pp. 1120-1121, 2 figs. Apply to turbo-generator plants; distribution of loads on boilers and turbines and economical operation of auxiliaries discussed.

Economic Operation of Steam Turbo-Electric Stations. T. C. Hirshfeld and C. L. Karr. Elec. Rev., vol. 73, nos. 23 and 24, Dec. 7 and 14, 1918, pp. 886-890 and 923-928, 5 figs. Bureau of Mines Technical Paper discussing fuel-economy factors, load, distribution between units, boiler room and auxiliaries operation.

Waste Heat

Waste Heat for Steam Generation. Thomas B. Mackenzie. Engineering, vol. 106, no. 2759, Nov. 15, 1918, pp. 567-569, 2 figs. Utilization of waste heat from open-hearth furnaces for generation of steam. Paper before Iron & Steel Inst., Sept. 1918.

PRODUCER GAS

Kiln, Gas-Fired

Heat Balance on a Producer-Gas Fired Chamber Kiln. R. K. Hursh. Jl. Am. Ceramic Soc., vol. 1, no. 8, Aug. 1918, pp. 567-577, 1 fig. Data based on tests of a kiln of 16 chambers, each holding 50,000 standard-sized brick, and on three 6-ft. water-sealed gas producers of the pressure type.

Open-Hearth Furnaces

Waste Heat from Open Hearth Furnaces. Thomas B. Mackenzie. Blast Furnace, vol. 6, no. 12, Dec. 1918, pp. 488-492, 3 figs. Analysis of producer gas supplied to furnace; theoretical principles governing operation of waste-heat boilers; suggestions concerning layout of plant and boiler setting. Paper before British Iron & Steel Inst. (Concluded.)

Wood

The Production of Power-Gas from Wood. Leslie B. Williams. Min. Mag., vol. 19, no. 5, Nov. 1918, pp. 246-250. Discusses composition of power gas from wood and methods of obtaining largest amounts of most effective components.

PUMPS

Motor-Driven Pumps

High Efficiencies Shown by Motor-Driven Water Works Pumps at St. Paul, Minn. Mun. & County Eng., vol. 55, no. 6, Dec. 1918, pp. 202-204, 2 figs. Results obtained from tests of two 12-in. centrifugal pumps.

REFRACTORIES

Classification

Refractories. Clay-Worker, vol. 70, no. 6, Dec. 1918, pp. 504-505. Reasons for classification into acid, basic and neutral; construction, effectiveness and uses of each of these classes; properties of some refractory clays.

Firebrick

How Slag Temperatures Affect Firebrick. Raymond M. Howe. Iron Trade Rev., vol. 63, no. 23, Dec. 5, 1918, pp. 1288-1289. Penetration of slag into brick was determined after allowing bricks, which were previously heated to required temperature, to retain in cavity 35 grams of slag for 2 hrs.; tables given for various temperatures. Paper before Refractories Mfrs. Assn. Also Blast Furnace, vol. 6, no. 12, Dec. 1918, pp. 484-485.

Silica

Silica Refractories. Donald W. Ross. Jl. Am. Ceramic Soc., vol. 1, no. 7, July 1918, pp. 477-499, 6 figs. and (discussion) pp. 499-501. Experimental data on raw materials, manufacture and burning of silica brick, and properties of burned ware.

REFRIGERATION

Ammonia

What Becomes of the Ammonia in Refrigerating Systems? George L. Reuschline. Am. Soc. Refrig. Engrs. Jl., vol. 5, no. 3, Nov. 1918, pp. 161-167. Production of ammonia from normal sources; amount used in ice and refrigerating plants; actual needs and unavoidable losses; actual ammonia loss per ton of ice made; avoidable losses and how to stop them; purging; piston-rod leakage; bonus system.

Ammonia, Compression System

The Ammonia Compression Refrigerating System XXV. W. S Doan. Refrig. World, vol. 53, no. 12, Dec. 1918, pp. 33-34, 1 fig. Testing of lubricating oil; petroleum oils; necessary quantity to feed bearings. (To be continued.)

Ammonia Piping

Discussion of the Topic—Size of and Proper Vapor Velocity in Ammonia Suction and Discharge Mains. Am. Soc. Refrig. Engrs. Jl., vol. 5, no. 2, Sept. 1918, pp. 120-124, 1 fig. Discussion at Milwaukee meeting.

CO_2 Machine

The Carbonic Anhydride Refrigerating Machine. Peter Neff. Am. Soc. Refrig. Engrs. Jl., vol. 5, no. 3, Nov. 1918, pp. 153-156. Items of design requiring research before a CO_2 machine can be developed as successfully as one of the ammonia type.

Forecooling

Discussion of the Topic Advantages of Forecooling Liquid Ammonia Between Receiver and Expansion Valve with Coldest Water Available. Am. Soc. Refrig. Engrs. Jl., vol. 5, no. 2, Sept. 1918, pp. 125-130. Discussion at annual meeting, New York.

Household Refrigerating Machine

The Household Refrigerating Machine. John E. Starr. Am. Soc. Refrig. Engrs. Jl., vol. 5, no. 3, Nov. 1918, pp. 157-160. Attributes difficulty of designing commercial type of small compression machine to leakage at stuffing box, small quantity of liquid circulated per minute and gradual projection of lubricant from high-pressure to low-pressure side.

Ice Manufacture

Ice Plant Investments. George. E. Wells. Am. Soc. Refrig. Engrs. Jl., vol. 5, no. 3, Nov. 1918, pp. 145-152. Detailed ice-manufacturing costs in 1915 of 20 southwestern ice plants using Corliss steam engines.

Power and Labor Requirements of Detroit Type Ice Plant. Donald Cole. Am. Soc. Refrig. Engrs. Jl., vol. 5, no. 2, Sept. 1918, pp. 110-115 and (discussion) pp. 115-119. Operation of electrically driven raw-water plant, low-pressure, drop-pipe system having in conjunction an ice storage house holding full output of thirty to one hundred days.

Motor Driven Raw Water Ice Plant. George E. Chamberlin. Am. Soc. Refrig. Engrs. Jl., vol. 5, no. 2, Sept. 1918, pp. 87-109, 11 figs. Description of electrically driven high-pressure plant making 120 tons of ice per day.

Low-Temperature Compression System

The Low-Temperature Compression System in Practice. H. Sloan. Power, vol. 48, no. 25, Dec. 17, 1918, pp. 896-987, 2 figs. From paper before Am. Soc. of Refrig. Engrs., Milwaukee.

RESEARCH

British

National Laboratory for Industrial Research. Richard T. Glazebrook. Contract Rec., vol. 32, no. 47, Nov. 20, 1918, pp. 924-926. Need of special laboratories for research work; research for trade associations; study of industrial problems in central laboratory. From lecture delivered at Royal Instn.

Science and the Future. A. A. Campbell Swinton. Machy. Market, no. 944, Dec. 6, 1918, pp. 19-20. From address to Roy. Soc. Arts.

National Research Council, U. S.

The Engineering Work of the National Research Council. Henry M. Howe. Bul. Am. Inst. Min. Engrs., no. 144, Dec. 1918, pp. 1715-1719. Purpose, status in October, 1918, and character of researches on pyrometry and electric welding.

STANDARDS AND STANDARDIZATION

Engine-Testing Forms

Standard Engine Testing Forms. Jl. Soc. Automobile Engrs., vol. 3, no. 6, Dec. 1918, pp. 378-381, 3 figs. Four sheets: one giving rules and direction for use of forms and three providing means for giving information regarding engine conditions of test and plotting curves of results.

Gasoline

Government Standard Gasoline and Oil Specifications. Jl. Soc. Automotive Engrs., vol. 3, no. 6, Dec. 1918, pp. 405-406. Specifications for aviation gasoline, motor gasoline, and fuel, gas and bunker oils, adopted by Committee on Standardization of Petroleum Specifications.

Oils, Illuminating

Specifications for Illuminating Oils. Oil & Gas Jl., vol. 17, no. 31, Jan. 3, 1919, pp. 50-52. Methods of test and specifications adopted by Committee on Standardization of Petroleum Specifications. Rules were drafted with view to allow making of products from any satisfactory crude petroleum.

STEAM ENGINEERING

Boilers

Modern Boilers (Les chaudières modernes). L. Conge. Revue Générale de l'Electricité, vol. 4, no. 19, Nov. 9, 1918, pp. 715-718, 11 figs. Several French and American types are considered as usable in large central turbo-electric stations.

Feeding and Circulating the Water in Steam Boilers. John Watson. Trans. Inst. Marine Engrs., vol. 30, no. 239, Nov. 1918, pp. 225-246 and (discussion) pp. 246-264, 7 figs. Historical account of schemes evolved and experimental work undertaken; analysis of present practices in the various types of boilers; effect of mixing hot boiler water with incoming feed in proportions up to 200 per cent. boiler water.

Mechanical Department Circular No. 11, U. S. Ry. Administration. Frank McManamy. Ry. Jl., vol. 25, no. 1, Jan. 1919, pp. 21-22, 1 fig. Rules and instructions for inspection and testing of stationary boilers.

How to Design and Lay Out a Boiler—II. William C. Strott. Boiler Maker, vol. 18, no. 12, Dec. 1918, pp. 353-354, 5 figs. Calculation of proper tube expansion; purpose of beading; use of scant tube lengths; figuring "line-up." (To be continued.)

Condensers

Keeping Up Condenser Performance. Hartley LeH. Smith. Power, vol. 48, no. 25, Dec. 17, 1918, pp. 868-870, 4 figs. How to determine economy which should be obtained and how to correct causes of low vacuum.

Steam Pressure, High

High Steam Pressure and Superheat. Eskil Berg. Power, vol. 48, no. 24, Dec. 10, 1918, pp. 832-835, 3 figs. From a paper before joint meeting of Western Soc. of Engrs., Chicago Section of Am. Soc. of Mech. Engrs. and Am. Inst. of Elec. Engrs.

Turbines

Steam Turbines for Natural Steam. Power Plant Eng., vol. 22, no. 24, Dec. 15, 1918, pp. 990-993, 7 figs. Power plant at Larderello, Italy, operating large turbine units with natural steam taken from crevices and fissures in ground.

Turbine Engines for Cargo Vessels. Marine Rev., vol. 49, no. 1, Jan. 1919, pp. 31-34, 6 figs. Mechanical features of the geared drives.

Steam Turbine Progress and Possibilities. Blast Furnace, vol. 6, no. 12, Dec. 1918, pp. 481-483, 5 figs. Higher boiler pressures; intermediate steam reheating in large multiple-cylinder machines; feedwater heating; use of economizer.

The Historical Development of Steam Turbine (I). Power House, vol. 11, no. 11, Nov. 1918, pp. 311-314, 10 figs. Growth in capacity and in size of individual units during last 30 years. (To be continued.)

Valves, Balanced Slide

Balanced Slide Valve for Andrews-Cameron Steam Engine (Tiroir équilibré pour machine à vapeur système Andrews et Cameron). Génie Civil, vol. 73, no. 17, Oct. 26, 1918, pp. 333-334, 8 figs. Description of two types, one with two and other with three ports.

See also MECHANICAL ENGINEERING, Motor-Car Engineering (Steam Vehicles).

THERMODYNAMICS

Heat Transmission

Heat Transfer Tests of Building Materials. L. M. Arkley. Jl. Eng. Inst. Can., vol. 1, no. 8, Dec. 1918, pp. 386-393, 6 figs. Account of tests (1) to determine selection of proper materials to be used in buildings, (2) to determine effect on transfer of heat through a 12-in. hollow tile wall of laying it up, first with hollow spaces horizontal, and second with hollow spaces vertical and directly over each other, (3) to investigate heat-insulating qualities of a number of materials suitable for refrigerating rooms including built-up walls, cork walls, and ordinary building papers.

New Heat Transmission Tables. William R. Jones. Heat. & Vent. Mag., vol. 15, no. 12, Dec., 1918, pp. 36-40. Third series of tables.

WELDING

Aluminum

How to Use a "Chill" on Aluminum Welding. David Baxter. Jl. Acetylene Welding, vol. 20, no. 6, Dec. 1918, pp. 280-282, 3 figs. Method of backing up hole in aluminum crankcase with piece of heavy galvanized iron and welding across to fill hole with aluminum, the iron acting as a sort of chill.

Arc-Welding Tool

Improved Arc Welding Tool. Aerial Age, vol. 8, no. 12, Dec. 2, 1918, pp. 619-634, 2 figs. Designed to make operation of changing electrodes definite, to permit any amount of pull when electrode freezes to work and capable of operating for voluntary release.

Electric Welding

Comparisons of Processes of Electric Butt Welding. J. B. Clapper. Boiler Maker, vol. 18, no. 12, Dec. 1918, pp. 345-346. Operations

in butt welding; transformer control; strength of butt weld; application of point and spot welding; use of resistance process.

Modern Welding by Use of Electricity. Elec. Rev., vol. 73, no. 25, Dec. 21, 1918, pp. 959-962, 3 figs. Principles of electric arc and spot welding; advantages; methods of application; recent developments; extent of field.

Some Recent Developments in Machines for Electric Spot Welding as a Substitute for Riveting, J. M. Weed. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 928-934, 9 figs. Writer claims his experiments have demonstrated that the thickness of parts to be welded is governed by capacity of apparatus available for doing the work.

Electric Welding—A New Industry, H. A. Hornor. Contract Rec., vol. 32, no. 47, Nov. 20, 1918, pp. 931-934. Status of industry; uses of alternating current; methods of welding and of testing a joint; developments. Paper before Am. Inst. Elec. Engrs.

Comparative Characteristics of Arc Welders, J. F. Lincoln. Elec. World, vol. 72, no. 24, Dec. 14, 1918, pp. 1119-1120. Discussion to bring out comparative advantages and costs of a. c. and d. c. welders.

Features of Arc Welding Development, O. A. Kenyon. Elec. Rev., vol. 73, no. 25, Dec. 21, 1918, pp. 963-965, 2 figs. Control of welding heat; selection of kind and size of electrodes; kinds of joints and their characteristics; systematic planning of welding method to be used.

The Constant-Energy Arc-Welding Set, P. O. Noble. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 938-940, 6 figs. Type of equipment designed to facilitate maintenance of a short arc and to make it difficult to continue a long one.

Electric Welding at the Erie Works, General Electric Company, H. Lemp and J. R. Brown. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 915-918, 12 figs. Applications of process to welding saws, butt-welding high-speed steel to shank of machine steel in manufacture of machine tools, and various other mechanical purposes.

A Review of Electric Arc Welding, John A. Seede. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 881-886, 10 figs. Evaluation of present practice, with special consideration of carbon electrode welding, metallic electrode welding, electrodes, fluxes, holders, a. c. arc welding, automatic welding and apparatus employed.

Inspection of Welds

Inspection of Electric Welds, O. H. Escholz. Power, vol. 48, no. 25, Dec. 17, 1918, pp. 872-873, 3 figs. Describes various tests and their efficiencies.

Inspecting Metallic Electrode Arc Welds, O. S. Escholz. Am. Drop Forger, vol. 4, no. 11, Nov. 1918, pp. 448-450, 4 figs. Comments on significance and value of visual inspection, adhesion of deposit, penetration and electrical tests.

Joints

Lloyd's Experiments on Electrically Welded Joints, H. Jasper Cox. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 864-870, 16 figs. Results concerning modulus of elasticity, approximate elastic limit, ultimate strength, ultimate elongation, alternating stresses, chemical and microscopic analysis, and strength of welds.

Non-Ferrous Metals

The Butt Welding of Some Non-Ferrous Metals, E. F. Collins and W. Jacob. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 958-961, 5 figs. Describes process said to be outcome of search for satisfactory method of connecting end rings to rotor bars of induction motor.

Oxidation

The Welding of Iron and Steel, W. H. Cathcart. Iron Age, vol. 102, no. 26, Dec. 26, 1918, pp. 1578-1583, 10 figs. Principles governing smithy and forge; effect of oxidation; use of a flux; annealing essential; conditions to be fulfilled. From article in Apr., 1918, issue of Jl. of West of Scotland Iron and Steel Inst., Glasgow.

Oxy-Acetylene Welding

Oxy-Acetylene Pipe Welding and Cutting. Gas Age, vol. 42, no. 12, Dec. 16, 1918, pp. 515-516, 5 figs. Practical suggestions on manipulation of blowpipe. (Continuation of serial.)

Handling Acetylene Welding Outfits, E. Wanamaker. Ry. Rev., vol. 63, no. 25, Dec. 21, 1918, pp. 869-871. Discussion of acetylene and oxygen gases and instructions for handling outfits in shops. Paper before Ry. Fire Prevention Assn., Chicago.

Research

Research in Spot Welding of Heavy Plates, W. L. Merrill. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 919-922, 7 figs. Record of experiments with specially built welding machine of 36 tons pressure capacity and 100,000 amperes current capacity, showing probability that new field of application for spot welding will be developed.

Structure of Iron

Microstructure of Iron Deposited by Electric Arc Welding, George F. Comstock. Bul. Am. Inst. Min. Engrs., no. 145, Jan. 1919, pp. 43-50, 10 figs. From microscopic examination of a weld writer concludes that pale crystals typical of steel fusion welds are not cementite or martensite or any similar carbide product, but probably nitride of iron. Discussion of S. W. Miller's paper. (Bul. A. I. M. E., Feb.-May, 1918.)

A Study of the Joining of Metals, J. A. Capp. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 947-956, 36 figs. Microscopic study of welds made (1) with high current applied for long periods, (2) smaller current applied for shorter time, and (3) current just large enough to procure welding temperature when applied for minimum time; made to determine best practice in making butt welds by Thompson electric welding machine.

The Metallurgy of the Arc Weld, W. E. Ruder. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 941-946, 15 figs. Notes based on microscopical examination of crystal structure, gas holes, slag inclusions, impurities, and composition.

Tank Manufacture

Electric Arc Welding in Tank Construction, R. E. Wagner. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 899-911, 35 figs. Qualifications of successful operator; value of intelligent study of work in hand and its preparation for welding; application of arc welding to tank construction; tabular data for determining cost of process.

Welded Seams

Welded Seams Correct Faults in Converters. Boiler Maker vol. 18, no. 12, Dec. 1918, pp. 347-348, 6 figs. Experiments on welded-type heaters; difficulties in welding materials of varying thicknesses; automatic cutting machine. From Jl. Acetylene Welding.

Welding

Principles and Practices of Fusion Welding, S. W. Miller. Am. Soc. Refrig. Engrs. Jl., vol. 5, no. 3, Nov. 1918, pp. 168-215, 83 figs. Differences between various systems; principles of successful welding; composition of weld; testing welds; welding practices and materials; metallurgy and heat treatment of welds; variety of welds.

See also ELECTRICAL ENGINEERING, *Transformers, Converters, Frequency Changers (Welding, Transformers for)*; MARINE ENGINEERING, *Yards (Welding)*; RAILROAD ENGINEERING, *Shops (Welding)*.

VARIA

Metric System

Reflexions on the Arguments For and Against the Metric System (Reflexions sur les pour et les contre du système métrique), Ch. Ed. Guillaume. Industrie Electrique, year 27, no. 624, June 25, 1918, pp. 225-227. Question of fundamental units; decimalization; possible adoption by Anglo-Saxon nations; arguments based on present situation. Remarks on Atkinson's communication to Instn. Elec. Engrs.

Opportunities for Engineers

Broader Opportunities for the Engineer, Charles T. Main. Jl. Am. Soc. Mech. Engrs., vol. 41, no. 1, Jan. 1919, pp. 6-11. Fields of activity opened to engineering societies and individual engineers in consequence of technical and social opportunities which have been created with the advent of world peace. Presidential address delivered at annual meeting of the Society.

Packing, Machinery

The Problem of Packing. Cassier's Eng. Monthly, vol. 54, no. 5, Nov. 1918, pp. 257-262, 6 figs. Suggestions in regard to packing machinery for home market and export.

Society Engineering

Aims and Organization of the Society, L. C. Marburg. Jl. Am. Soc. Mech. Engrs., vol. 41, no. 1, Jan. 1919, pp. 12-15. Relations of the mechanical engineer to his work, to the community and other engineers. Report of Committee on Aims and Organization of the Society.

Technical Writing

Obtaining Ideas for Technical Articles, Albert M. Wolf. Wis. Engr., vol. 23, no. 2, Nov. 1918, pp. 40-41. Value of observation and diligent application of mental faculties to gathering technical data.

Electrical Engineering

ELECTROPHYSICS

A. C. Circuits

The Calculation of Alternating Current Circuits, Gordon Kribs. Power House, vol. 11, no. 11, Nov. 1918, pp. 318-321, 2 figs. Tables of constants offered as readily usable in computing size of wire in a. c. 25- and 60-cycle circuits.

Harmonic Analysis

Harmonic Analysis of Alternating Currents by the Resonance Galvanometer (Sur l'analyse harmonique des courants alternatifs par le galvanomètre de résonance), André Blondel. Comptes rendus des séances de l'Académie des Sciences, vol. 167, no. 20, Nov. 11, 1918, pp. 711-717, 1 fig. Characteristics of method proposed as modification of Pupin's and Armagnat's. Considers (1) non-inductive resistances in circuits of galvanometer, and (2) a circuit having one or several capacities in series.

Spark-Plug Insulators

Resistance of Hot Spark Plug Insulators, R. H. Cunningham. Automotive Indus., vol. 39, no. 22, Nov. 28, 1918, pp. 907-911, 8 figs. Experimental tests to determine loss of resistance at working temperatures; how such loss affects action of plug.

Vapor Arcs

Low-Voltage Arcs in Metallic Vapours, J. C. McLennan. Proc. Phys. Soc., Lond., vol. 31, no. 176, Dec. 15, 1918, pp. 30-48, 6 figs. Repetition of experiments by Millikan and Hebb whose results writer believes to be in conflict with quantum theory. Results showed that quantum relation holds good with moderately heated incandescent cathodes and a moderate supply of metallic vapor. It was possible to obtain questioned phenomena, however, by increasing temperature of incandescent cathode.

ELECTROCHEMISTRY

Copper Plating

Automatic Copper Plating, Joseph W. Richards. Bul. Am. Inst. Min. Engrs., no. 145, Jan. 1919, pp. 27-31, 4 figs. Patented process. Basic principle involved lies in application of plating copper while iron sheet is cold and then melting metal under conditions favorable to formation of plating.

FURNACES

Electric Furnace Improvements During 1918, A. V. Farr. Blast Furnace, vol. 7, no. 1, Jan. 1919, pp. 20-24, 9 figs. Efforts to increase output; linings, tilting apparatus and cooling; power supply; comparative data.

Electrodes

Electrodes for Electric Furnaces: Their Manufacture, Properties, and Utilization (II), Jean Escard. Gen. Elec. Rev., vol. 21, no. 11, Nov. 1918, pp. 781-792, 37 figs. Form, dimensions, grouping, and composition of electrodes, and their arrangement in the various types of furnaces; life, wear, and protection of electrodes; electrode holders, cooling systems, and methods of attaching connections. Translated from Le Génie Civil.

Industrial Furnaces

Electric Heated Industrial Furnaces, George J. Kirkgasser. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 26-32, 14 figs. Type of furnaces and accessory apparatus used in melting irons, brasses and bronzes in foundries; for heat-treating metal parts; in the manufacture of special alloys; for annealing, hardening and tempering tools; and for determining decalescent and recalescent points in tool steels.

Nitrogen-Fixation Furnaces

Nitrogen Fixation Furnaces, E. Kilburn Scott. Gen. Elec. Rev., vol. 21, no. 11, Nov. 1918, pp. 793-804, 16 figs. Salient points of difference between electric furnaces for fixation of nitrogen and those for metallurgical purposes. Discussion of various features in operation, such as phase balance, starting, losses, electrodes, stabilizing arc, power factor, air supply, preheater, absorption, cooling the gas, and theory of reaction. Abstract of paper before Electrochemical Soc.

Steel Furnaces

The Status of the Electric Steel Industry, Edwin F. Cone. Iron Age, vol. 103, no. 1, Jan. 2, 1919, pp. 60-62. United States still leads in output with 287 furnaces; progress since 1910; furnaces in world's industry probably over 815.

Electric Furnaces for the Production of Steel and Ferro-Alloys, J. O. Seede. Gen. Elec. Rev., vol. 21, no. 11, Nov. 1918, pp. 767-780,

28 figs. Fundamentals of high-grade steel manufacture; author prefers electric furnace to all other types; classification and sketches of important furnaces.

Adds Electric Unit to Melting Equipment. Iron Trade Rev., vol. 63, no. 24, Dec. 12, 1918, pp. 1353-1354, 10 figs. Installation in which power is supplied through bank of two single-phase, 500-kva. transformers connected to a 2300-volt, 3-phase, 60-cycle supply line. Furnace hearth acts as neutral electrode, bottom connection being made to central point on transformer. Arcs are formed independently of one another.

Electric Furnaces in Metallurgy. Elecn., vol. 81, no. 2113, Nov. 15, 1918, pp. 588-590, 7 figs. Description of Héroult furnace.

The Electric Furnace in the Grey Iron Foundry. Can. Foundryman, vol. 9, no. 12, Dec. 1918, pp. 291-292 and 295, 4 figs. Work being done by Bowmanville Foundry Co. Mechanical features and electrical control of furnace.

Electric Furnace Data for Ferro-Tungsten. Robert M. Kenney. Blast Furnace, vol. 6, no. 12, Dec. 1918, pp. 486-487. Data and description of ferro-tungsten production; smelting of ferberite concentrate; possibilities of making in one single operation ferro-tungsten containing less than one per cent carbon. Paper before Am. Inst. Min. Engrs.

GENERATING STATIONS

Canada

Electric Power Generation in Ontario on Systems of Hydro-Electric Power Commission, Arthur H. Hull. Can. Engr., vol. 35, no. 25, Dec. 19, 1918, pp. 532-533. Details of generation and electrical distribution: Rideau and Niagara systems: Queenstown development. (Concluded.)

Centralization of Power

Wholesale Power, F. P. Royce. Stone & Webster Jl., vol. 23, no. 5, Nov. 1918, pp. 357-360. Conditions favorable to centralization of electric power. Memorandum of statement made at meeting of New England Section of Nat. Elec. Light Assn.

Hydroelectric Stations

Electric Power Generation in Ontario on Systems of Hydro-Electric Power Commission, Arthur H. Hull. Can. Engr., vol. 35, no. 24, Dec. 12, 1918, pp. 520-523. Paper before Toronto Section Am. Inst. Elec. Engrs. Also Elec. News, vol. 27, no. 23, Dec. 1, 1918, pp. 25-29, 1 fig. General plan and particulars of canal development work and power generation.

The Present Status of Hetch Hetchy, Rudolph W. van Norden. Jl. Elec., vol. 41, no. 10, Nov. 15, 1918, pp. 438-443, 8 figs. Survey, scope and present progress of water and power project undertaken by city of San Francisco.

Data Existing in Regard to the Construction of Hydroelectric Power Plants (Sur les données actuelles en matière de construction d'usines hydroélectriques), Denis Eydoux. Annales des Ponts et Chaussées, year 88, vol. 4, no. 18, Jul-Aug. 1918, pp. 7-96, 34 figs. Résumé of theoretical considerations, general equations and present practice, with special reference to groups of French plants in Dauphiné and the arrangement existing between water-courses of the Société Pyrénéene (Toulouse and Tarn) with those of the Société Meridionale (Aude and Hérault). (To be continued.)

Steam-Electric Stations

A Good Instance of Utilization of Italian Products in Argentine (Uno forte impronta dei produttori italiani nell' Argentina). L'Industria, vol. 32, no. 21, Nov. 15, 1918, pp. 638-644, 13 figs. Details and plans of steam-turbine central station distributing 30 million kw-hr. at 7000 volts to five substations. Substation also described.

GENERATORS AND MOTORS

Dynamical Theory

The Dynamical Theory of Electric Engines. Elecn., vol. 81, no. 2114, Nov. 22, 1918, pp. 616-617, 4 figs. Abstracted from 10th Kelvin lecture delivered by L. B. Atkinson before Inst. of Elec. Engrs.

Alternators

High-Frequency Alternators (Les alternateurs à haute fréquence), O. Billeux. Revue Générale de l'Electricité, vol. 4, no. 21, Nov. 23, 1918, pp. 803-805, 5 figs. Principles of these machines, particularly of the Alexanderson type (frequency, 30,000 per sec.), built for experimental purposes.

Generators

Construction and Use of Generators Driven by Waterwheels. Elec. Rec., vol. 24, no. 6, Dec. 1918, pp. 60-66, 24 figs. Important features in both vertical and horizontal types.

Induction Motors

Reconnecting Induction Motors—For Change in the Number of Poles, A. M. Dudley. Power, vol. 49, no. 1, Jan. 7, 1919, pp. 9-14, 15 figs. (Third article.)

Rotors

Turbo-Alternator Rotors: Features of Mechanical Design (II), S. F. Barclay. Power House, vol. 11, no. 11, Nov. 1918, pp. 323-327, 17 figs. Suggested specifications for guidance in purchasing equipment.

Synchronous Motors

Magnetization Curves for Synchronous Motors (Fältkurvor-diagram och magnetiseringskurvor for flerfasiga synkronmaskiner), John Wennerberg. Teknisk Tidskrift, Elektroteknik, vol. 48, no. 11, Nov. 6, 1918, pp. 138-146.

LIGHTING AND LAMP MANUFACTURE

Fixtures

Linking Science and Art in Lighting, M. Luckiesh. Elec. Rev., vol. 73, no. 23, Dec. 7, 1918, pp. 884-885. Suggestions for fixture dealer in demonstrating lighting effects. Third article. (First and second appeared in Elec. Rev. Oct. 5 and Nov. 2.)

Lamps, Manufacture

Methods of Manufacturing Incandescent Lamps, H. M. Robins. Wis Engr., vol. 23, no. 3, Dec. 1918, pp. 67-76, 6 figs. Description of required operations with reference to advantageous working conditions of manufacturing establishments.

Light Generation and Distribution

Light, Electricity and the Shop, C. E. Clewell. Am. Mach., vol. 49, no. 24, Dec. 12, 1918, pp. 1061-1065, 10 figs. From coal pile to machine tool and lamp, losses are considered.

MEASUREMENTS AND TESTS

Loader

The Loader, Ross B. Mateer. Jl. Elec., vol. 41, no. 12, Dec. 15, 1918, p. 553, 4 figs. Suggests composite symbol to indicate load center, density and character of load served.

Meters

Three-Wire D-5 Meters. Jl. Elec., vol. 41, no. 10, Nov. 15, 1918, pp. 474-475. Wiring diagram and features of watthour meter consisting of two- and three-wire elements placed side by side in common base and registering on common recording train so that sum of revolutions of both elements will be added and indicated on dial.

Power-Factor Indicators

Removing Obstacles to Power-Factor Charge, Will Brown. Elec. World, vol. 72, no. 26, Dec. 28, 1918, pp. 1220-1222, 1 fig. Necessity of standard method of measuring power factor and instrument that would be universally applicable: examination into methods now employed in widely separated plants.

Calibration of Power Factor Indicators, Walter Wescott Hoke. Elec. World, vol. 72, no. 23, Dec. 7, 1918, pp. 1076-1078, 4 figs. Method of calibrating polyphase power-factor indicators of which resistances of potential circuits are not equal: also applies to indicators in which current coil is in one phase of a two-phase line.

Rubber-Goods Testing

Safeguarding Electrical Employees. Elec. World, vol. 72, no. 26, Dec. 28, 1918, pp. 1223-1226, 5 figs. How companies which take active interest in well-being of their employees have made use of protective devices to guard against personal injuries: care and testing.

Transmission Factor for Glass

The Measurement of Transmission-Factor, M. Luckiesh and L. L. Mellor. Jl. Franklin Inst., vol. 186, no. 5, Nov. 1918, pp. 529-545, 8 figs. Investigation of various arrangements of apparatus designed to determine transmission factors for several diffusive glasses for illumination (1) by a narrow beam of light directed perpendicularly to surface of specimen, and (2) uniformly diffused light reaching specimen from all directions; examination of effect on value of transmission factor of position of specimen with respect to light and character of side, smooth or rough, upon which light strikes it.

POWER APPLICATIONS

Alloy Production

New Materials Developed in Germany for Electrical Industry (Les nouveaux matériaux dans l'industrie electrique en Allemagne), S. Frid. Industrie Electrique, year 27, no. 624, June 25, 1918, pp. 227-256. Application of alloys such as electron (10 Al + 90 Mn), magnalium, duralumin and other compositions; regulation governing material to be used in various types of electric lines; instruments and apparatus; machines and transformers.

Dairy Farms

Use of Electricity on Dairy Farms to Increase Production. Elec. Rev., vol. 73, no. 26, Dec. 28, 1918, pp. 995-997, 3 figs. Proper lighting and use of electric fans in Georgia farm stables result in greater quantity and better quality of product.

Electrochemical Processes

Electricity Releases Chemistry's Power, James M. Matthews. Gen. Elec. Rev., vol. 21, no. 11, Nov. 1918, pp. 727-750, 46 figs. Some of the uses of electricity in the chemical industry are illustrated with descriptions of uses of electric furnaces and electrically-driven motors and installations of electrolytic works.

Electrolytic and Electrothermic Processes and Products. Gen. Elec. Rev., vol. 21, no. 11, Nov. 1918, pp. 756-766, 12 figs. Brief outline of manufacture of sodium, calcium, magnesium and aluminum; more detailed description of electric-furnace methods of manufacturing calcium carbide, carborundum, silicon, graphite, alundum, fused silica and carbon bisulphide; methods of fixation of atmospheric nitrogen and oxidation of nitrogen; sketches of Birkland-Eyde, Schonherr, and Pauling furnaces.

Gold Dredges

Use of Electricty on Gold Dredges. Elec. Rev., vol. 73, no. 23, Dec. 7, 1918, pp. 881-883, 3 figs. Description of typical dredge; value of central-station service for work; points to observe in selecting apparatus required; description of electrical equipment used.

Harbors

Extensive Use of Electricity for San Francisco Harbor. Elec. Rev., vol. 72, no. 26, Dec. 26, 1918, pp. 1001-1005, 4 figs. Pier, dock and street lighting; electric clock system; harbor lights and fog signals; fire-alarm and telephone system; electric repair and maintenance service; features of wiring.

Shipbuilding

The Application of Electricity in Ships and Shipbuilding, J. F. Nielson. Elecn., vol. 81, no. 2114, Nov. 22, 1918, pp. 621. Abstract of paper before Scottish Local Section of Inst. of Elec. Engrs., Nov. 1918.

Steel Mills

Operating Electrically-Driven Steel Mills, J. T. Sturtevant. Iron Trade Rev., vol. 63, no. 23, Dec. 5, 1918, pp. 1292-1293, 4 figs. Layout, equipment, power consumption, tonnages and capacities of 11 installations at Lehigh plant of Bethlehem Steel Co.

TELEGRAPHY AND TELEPHONY

Antenna

The Vertical Grounded Antenna as a Generalized Bessel's Antenna, A. Press. Proc. Inst. Radio Engrs., vol. 6, no. 6, Dec. 1918, pp. 317-322, 1 fig. General expression for current at any point of antenna formulated by taking account of variable distribution of inductance and capacity; particular solution for current and voltage distribution in case of antenna having zero current at top and maximum current at bottom.

Capacity of a Horizontal Antenna (Capacité d'une antenne horizontale), J-B Pompey. Revue Générale de l'Electricité, vol. 4, no. 21, Nov. 23, 1918, pp. 790-792, 1 fig. Modification of original derivation of Pedersen's formula.

Duplex Polar Transmission

Improving Polar Duplex Transmission. Telegraph & Telephone Age, no. 24, Dec. 16, 1918, pp. 564-565, 5 figs. Diagrams of five different schemes tried in long lines operated polar duplex.

Photographs, Wireless Transmission of

The Design and Construction of Apparatus for the Wireless Transmission of Photographs, Marcus J. Martin. Wireless World, vol. 6, no. 69, Dec. 1918, pp. 509-513, 7 figs. Describes system outlined in handbook on the Wireless Transmission of Photographs as at present developed. Writer's intention is to provide practical groundwork for improvements. (To be continued.)

Radio Telephony

Some Aspects of Radio Telephony in Japan, Eitaro Yokoyama. Wireless World, vol. 6, no. 69, Dec. 1918, pp. 484-487, 5 figs. Influence of gas clearance, dimensions and shape of electrodes upon discharge. From Proc. Inst. Radio Engrs. (Continuation of serial.)

Radio Transmitter

On the Electrical Operation and Mechanical Design of an Impulse Excitation Multi-Spark-Group Radio Transmitter, Bowden Washington. Proc. Inst. Radio Engrs., vol. 6, no. 6, Dec. 1918, pp. 295-315, 31 figs. Discussion of

impulse excitation; description of three forms of gaps suitable for extreme quenching; oscillograms showing operation of such gaps; operation of actual 0.5-kw. and 2-kw. sets.

Spark Discharges

The Revolving Mirror and Spark Discharges, Lindlay Pyle. Wireless World, vol. 6, no. 69, Dec. 1918, pp. 489-490, 1 fig. Shows diagrammatically and describes briefly method of observing and photographing oscillatory nature of "wireless" spark. From Electrical Experimenter.

Spark Gap

A Ventilated Spark Discharge Gap. Wireless Age, vol. 6, no. 3, Dec. 1918, pp. 44-45, 3 figs. Internal construction and action of apparatus said to be silent in operation and to maintain a predetermined operating characteristic.

On the Possibility of Tone Production by Rotary and Stationary Spark Gaps, Hidetsugu Yagi. Proc. Inst. Radio Engrs., vol. 6, no. 6, Dec. 1918, pp. 323-343, 17 figs. Results produced by needle and spherical gaps with a. c. transformer, spark-gap method and with high-tension d. c. spark-gap method; brief treatment of transient conditions existing before establishment of stable tone régime.

Telephone, Sound-Detecting Devices

Telephone Service Standards. Telephony, vol. 76, no. 1, Jan. 4, 1919, pp. 22-23. Investigation of service and transmission standards and experimental work on sound-detecting devices by telephone section of Bureau of Standards, from 1917-1918 report Secretary of Commerce.

Telephone Troubles

How to Locate Telephone Troubles, J. Bernard Hecht. Telephony, vol. 76, no. 1, Jan. 4, 1919, pp. 26-27. Care and maintenance of primary batteries. Instructions to managers, wire chiefs and troublemen of local battery telephone exchanges. Sixth article.

Vacuum-Tube Electrodes

A Method of Constructing Gas-Free Electrodes. Wireless World, vol. 6, no. 69, Dec. 1918, pp. 488-489. Process of manufacturing vacuum tube in which anode consists of coating of metal sprayed on inside of bulb by incandescing refractory metallic conductor, such as tungsten, in partial vacuum. From Wireless Age.

Time Signaling

Wireless Time-Signaling Device, Wireless Age, vol. 6, no. 3, Dec. 1918, pp. 13-14, 3 figs. Apparatus for synchronizing time clocks from one main radio station, permitting at predetermined intervals a correction of errors encountered in clock mechanisms.

TRANSFORMERS, CONVERTERS, FREQUENCY CHANGERS

Radio Frequency Changers

Radio Frequency Changers, E. E. Bucher. Wireless Age, vol. 6, nos. 3 and 4, Dec. 1918 and Jan. 1919, pp. 20-22 and 20-22, 13 figs. Reported progress in their application to wireless telegraphic and telephonic communication. Control of antenna currents.

Rectifiers

Incandescent-Cathode Arc Device for the Rectification of Alternating Currents. Wireless Age, vol. 6, no. 3, Dec. 1918, pp. 14 and 43-44, 3 figs. Construction and electrical connections of tube; arc started by means of a high-voltage discharge from a pointed cathode.

An Enclosed Rectifier. Wireless Age, vol. 6, no. 3, Dec. 1918, pp. 12-13, 3 figs. Incandescent cathode type. Argon at considerable pressure is injected into enclosed medium.

Rotary Converters

The Effect of Power-Factor on Output of Rotary Converters with Reactance Control, R. G. Jakeman. Elecn., vol. 81, no. 2114, Nov. 22, 1918, pp. 614-616, 4 figs. Dealing with effect of power-factor on size of converter.

Transformer Dimensions

Dimensions of Transformers, A. R. Low. Elecn., vol. 81, no. 2113, Nov. 15, 1918, pp. 597-599. Object of article is to classify principal problems of transformer discussion and compare certain assumptions, methods and results.

Transformer Oil

Transformer Oil. W. S. Flight. Elecn., vol. 81, no. 2115, Nov. 29, 1918, pp. 636-638, 4 figs. Author discusses types and characteristics of oils; formation of sludge; minor tests.

Welding, Transformers for

Transformers for Electric Welding, W. S. Moody. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 935-937. Requirements of those used for spot welding and for arc welding; construction found best to fulfill service specifications of each type.

See also ELECTRICAL ENGINEERING, *Transmission, Distribution, Control (Transformer Losses).*

TRANSMISSION, DISTRIBUTION, CONTROL

Central-Station Service

Twenty-Seven Thousand Dollar Saving in Manhattan Building Plant. Power, vol. 48, no. 26, Dec. 24, 1918, pp. 918-919. By using Edison off-peak service during summer months, substituting motor-driven elevator pumps for inefficient steam pumps, installing a feed-water heater and a stoker.

Frequency Control

Better Frequency Control, Henry E. Warren. Gen. Elec. Rev., vol. 21, no. 11, Nov. 1918, pp. 816-819, 3 figs. Method which records revolutions, thus indicating mean frequency and enabling operator to adjust governor-regulating mechanism to maintain average frequency at its normal value practically exact.

Growth of Electric Systems

The Growth of Electric Systems, Julian C. Smith. Can. Engr., vol. 35, no. 25, Dec. 1918, pp. 539-540. Evolution since 1882; direct and alternating transmission systems; why the "hydro" is 25 cycles; thrust bearings and vertical units. From one of the J. E. Aldred lectures on engineering practice, Johns Hopkins University.

Interconnection

Interconnection of Power Systems. Proc. Am. Inst. Elec. Engrs., vol. 37, no. 12, Dec. 1918, pp. 1297-1333, 12 figs. Technical features of interconnection of electric power systems of California; electric power in northern and central California; function of Pacific Gas and Electric Co. in interconnected operation of power companies of central and northern California. Symposium at meeting of San Francisco Section Am. Inst. Elec. Engrs.

Power Factor

Location for Power-Factor Corrective Apparatus, Will Brown. Elec. World, vol. 72, no. 24, Dec. 14, 1918, pp. 1125-1128, 3 figs. Experience with static condensers; dissimilarities in synchronous machines; using idle alternators as condensers; best motor rating for correction; effect of condenser location on result.

Improvement of Power-Factor by the Operation of Synchronous Motors (Note sur l'emploi des moteurs synchrones pour améliorer le facteur de puissance), Paul Rieunier. Revue Générale de l'Electricité, vol. 4, no. 21, Nov. 23, 1918, pp. 771-788, 15 figs. Mathematical and graphic study of equation, $S\ R = \sin \Phi_1 - \cos \Phi_1 \tan \Phi_2$, where S is current supplied in quadrature by synchronous motor, R current absorbed by network with factor power $\cos \Phi_1$ and Φ_1, Φ_2 are the respective phase angles before and after motor is connected. Practical applications are deduced.

St. Lawrence River Transmission Line

111,000-Volt Transmission Line Over the St. Lawrence River, S. Svenningson. Elec. News, vol. 27, no. 23, Dec. 1, 1918, pp. 31-34. Crossing consists of central span 4801 ft. long supported by two 350-ft. towers. Author gives special attention to cables, insulators, ice protection and sag calculations. Paper before Toronto meeting of Am. Inst. Elec. Engrs.

Substations

Effect of a Tie-Line Between Two Substations, H. B. Dwight. Elec. Rev., vol. 73, no. 25, Dec. 21, 1918, pp. 966-968, 1 fig. Methods of calculating effect of tie-lines upon current and voltage; several formulæ given.

The Modern Outdoor Substation, M. M. Samuels. Elec. World, vol. 72, no. 23, Dec. 7, 1918, pp. 1068-1073, 20 figs. Apparatus developed until it is as reliable as indoor equipment; station design not greatly improved; notes on transformers, oil circuit breakers, lightning arresters, air-break switches and bus supports.

A Two-Unit Automatic Substation, Walter C. Slade. Elec. Ry. Jl., vol. 52, no. 24, Dec. 14, 1918, pp. 1038-1044, 13 figs. Description of Rhode Island Co.'s substation at Oakland illustrating latest practice. Economics of automatic substation application.

Synchronous Condensers

Synchronous Condenser in Fuel Conservation, L. N. Robinson. Jl. Elec., vol. 41, no. 10, Nov. 15, 1918, pp. 456-458, 2 figs. Possibilities due to quadrature phase relation of energy and wattless components of current in virtue of which a synchronous condenser can deliver, under given line regulations, wattless current corresponding to 10,000-kv-a, and simultaneously absorb as motor or deliver as generator 10,000 kw. with total current corresponding to only 14,100 kv-a.

Transformer Losses

Influence of Distributing System on Transformer Losses in Large Networks (Pertes dans les transformateurs des grands réseaux suivant le système de distribution employé). Revue Générale de l'Electricité, vol. 4, no. 19, Nov. 9, 1918, pp. 721-724, 5 figs. Study and comparison of losses in two systems: (1) uniform distribution at 20,000 to 30,000 volts and (2) distribution at 30,000 to 50,000 volts in main network with reduction to 6,000 to 20,000 volts in secondary lines. From Electrotechnische Zeitschrift.

See also ELECTRICAL ENGINEERING, *Generating Stations (Steam-Electric Stations).*

VARIA

Battery Charging, A. C.

High-Tension Battery Fed with Alternating Current (Sur une batterie à haute tension alimentée à courant alternatif). Industrie Electrique, year 27, no. 633, Nov. 10, 1918, pp. 416-417, 1 fig. Principle and diagram of apparatus which by an arrangement of Grætz valves and condensers connected to secondary winding of transformer permits conversion of alternating current into direct current at voltages up to 10,000. From Bulletin de l'Association Suisse des Electriciens, Apr. 1918.

Contract Clauses

Power Factor Clauses in Contracts, Will Brown. Elec. World, vol. 72, no. 25, Dec. 21, 1918, pp. 1164-1165. Commercial problems involved; opinions from widely scattered central stations regarding necessity of considerating power factor; typical clauses of two types of contract which base charges on average power factor.

Electrolysis Protection

Drainage if Necessary vs. Negative Feeder Electrolysis Protection, D. W. Roper. Elec. Ry. Jl., vol. 52, no. 23, Dec. 7, 1918, pp. 1003-1007, 12 figs. Comparison of plans used in St. Louis and Chicago for eliminating damage to underground structures from power company viewpoint. (Abstract of paper before Am. Inst. Elec. Engrs., St. Louis.)

Fires in Oil Switches

R. Frère Process of Extinguishing Fires in High-Tension Oil Switches (L'extinction des feux d'huile dans les cellules d'interrupteurs à haute tension par les procédés R. Frère), Ch. Benjamin. Génie Civil, vol. 73, no. 19, Nov. 9, 1918, pp. 361-363, 10 figs. Fundamental principle of process consists in reducing oxygen in atmosphere by a large quantity of inert gas such as nitrogen.

International Electrotechnic Commission

International Electrotechnic Commission (La Comision Electrotécnica Internacional), German Niebuhr. Boletin de la Asociación Argentina de Electro-Técnicos, vol. 4, no. 8, Aug. 1918, pp. 783-788. Its origin, development and work. (To be continued.)

Lightning Arresters

Substitution of Copper for Platinum in Lightning Rods on Account of Present Shortage of Platinum (L'emploi du platine et du cuivre sur les paratonnerres et la crise du platine), E. Lignorelles. Génie Civil, vol. 73, no. 18, Nov. 2, 1918, pp. 351-353. States that aluminum, copper and iron are satisfactory for lightning rods; gives suggestions as to proper installation.

Storing Direct-Current Aluminum Arresters for the Winter, F. T. Forster. Gen. Elec. Rev., vol. 21, no. 11, Nov. 1918, pp. 820-821. Ill effects of leaving plates standing in electrolyte when arrester is out of service; method of preparing arresters for storage.

Civil Engineering

BRIDGES

Arch Bridge

The Rock Island Builds Two Rainbow Arch Bridges. Ry. Age, vol. 65, no. 23, Dec. 6, 1918, pp. 1003-1005, 4 figs. Limited-weight concrete structure with shallow floor.

Erection

Erection Experiences at the Sciotoville Bridge, Clyde B. Pyle. Eng. News-Rec., vol. 81, no. 26, Dec. 26, 1918, pp. 1182-1186, 6 figs. Machines used found efficient; adjustment of bridge easy; deflections agreed with computed values; last of three articles on field work.

Pontoon Bridge

The Sardah (India) Pontoon Bridge. Ry. Engr., vol. 39, no. 467, Dec. 1918, pp. 221-222,

6 figs. Principles of construction, method of use and structural details of 420 ft. 7-pontoon bridge. From report of Technical Section of Railway Branch, Public Works Department, Government of India.

Railway Bridges

General Specification for Steel Railway Bridges. Jl. Eng. Inst. Can., vol. 1, no. 8, Dec. 1918, pp. 367-385, 3 figs. Final draft as approved by meeting of committee of the Institute.

Reinforced Concrete Flat Slab Railway Bridges, A. B. Cohen. Ry. Gaz., vol. 29, no. 20, Nov. 15, 1918, pp. 528-530, 2 figs. Advantages of this type and details of Lackawanna terminal at Buffalo, N. Y. Paper before joint session of Am. Concrete Inst. and Am. Soc. for Testing Materials.

Stress Measurements on Niagara Gorge Railway Bridge, Charles Evans Fowler. Eng. News-Rec., vol. 81, no. 26, Dec. 26, 1918, pp. 1172-1175, 6 figs. Permissible loading studied by strain gage; dead-load condition of arch determined by forcing crown apart and measuring release of stress.

BUILDING AND CONSTRUCTION

Barracks

Temporary Barracks at Rosedale Heights. Contract Rec., vol. 32, no. 52, Dec. 25, 1918, pp. 1019-1022, 6 figs. Disposition and finish of 24 buildings rapidly completed for Toronto demobilization depot.

Gypsum Houses

Houses of Gypsum Have Many Advantages. Contract Rec., vol. 32, no. 51, Dec. 18, 1918, pp. 1006-1007, 1 fig. Mode of constructing walls of gypsum blocks cast from gypsum mortar.

Hospitals

Details of Hospital Construction, N. V. Perry. Modern Hospital, vol. 11, no. 6, Dec. 1918, pp. 469-471, 5 figs. Remarks on general requirements, adaptable equipments for ward lighting, suitable arrangement of heating system, and special features demanded in floor construction. Paper before convention of Am. Hospital Assn.

Mills

The Reconstructed Plant of the Quaker Oats Company at Peterboro, Ont. Contract Rec., vol. 32, no. 47, Nov. 20, 1918, pp. 918-921, 6 figs. Work done in clearing site in plant destroyed by fire; layout of new buildings.

Ornamentation

Structural Ornamentation. Vol. 70, no. 6, Dec. 1918, pp. 506-507. Study in face brick, fancy brick, architectural terra cotta and decorative tile as factors in the clayworking industry.

Roofing

English Slate and Tile Roofing Methods. Metal Worker, vol. 90, no. 26, Dec. 27, 1918, pp. 703-705, 9 figs. Plain and ornamental slating; single- and double-nailing methods; hints on making repairs.

School

Test of Chicago and Cook County School for Boys, Meyer J. Sturm. Heat. & Vent. Mag., vol. 15, no. 12, Dec. 1918, pp. 41-44, 5 figs. Description of building and its equipment.

Slabs and Culverts

Practice in the Design of Concrete Floor Slabs and Flat Top Culverts, Geo. H. Tinker. Bul. Am. Ry. Eng. Assn., vol. 20, no. 210, Oct. 1918, pp. 3-19. Summary of replies from bridge engineers connected with various railroads to questionnaire in regard to their practice concerning longitudinal, transverse and vertical distribution of axle loads and impact allowance in designing culverts and slabs; a short analysis of the salient points also presented.

Timber Framing, Steel in

How to Use Steel in Timber Framing, Ernest Irving Freese. Building Age, vol. 41, no. 1, Jan. 1919, pp. 13-15, 9 figs. Practical methods of supporting long-span floors and bearing partitions upon structural steel girders.

CEMENT AND CONCRETE

Cold-Weather Concrete

Some Temperature Records of Cold Weather Concrete, L. J. Towne. Stone & Webster Jl., vol. 23, no. 6, Dec. 1918, pp. 414-417, 3 figs. Tests made to secure data on amount of protection necessary to prevent concrete from freezing before setting can take place. On account of heat generated as result of chemical actions incident to setting concrete does not follow daily variations in air temperatures.

Compression Tests

Some Compression Tests of Portland Cement Mortars and Concrete Containing Various Percentages of Silt, Arthur C. Alvarez and James R. Shields. Univ. of Cal. Publications in Eng., vol. 2, no. 3, Nov. 19, 1918, pp. 119-130, 1 fig. Concludes that at age of 28 days the compressive strength of 1:2:4 concrete stored in water increases with increase in percentage of silt for amounts up to 14 per cent by weight of sand, and that of mortars varying in proportion between 1:1 and 1:4 is reduced on an average by about 4.5 per cent with 10 per cent silt.

Oil

Oil and Concrete. Ry. Engr., vol. 39, nos. 462 and 466, July and Nov., 1918, pp. 135-137 and 207-210. Results of laboratory tests on different specimens and under varied conditions; L. Waller Page's experiments on waterproofing concrete; W. Lawrence Gadd's conclusions from his investigation of Page's results; accounts of other experimenters. (To be continued.)

Poles

Hollow Concrete Poles Made by New Method. Ry Age, vol. 65, no. 25, Dec. 20, 1918, pp. 1127-1128, 3 figs. Important savings in weight over solid construction are effected by centrifugal process.

Study of the Construction of Latticed Girder Poles for Electrical Lines (Contributo allo studio delle palificazioni per condutture elettriche), Ettore lo Cigno. L'Elettrotecnica, vol. 5, no. 29, Oct. 15, 1918, pp. 402-407, 7 figs. Analytical investigation of stresses in latticed girder poles of square base with formulæ and graphs for examination of relative significance of mechanical coefficients.

Setting Process

The Setting Process in Lime Mortars and Portland Cements, Cecil H. Desch. Contract Rec., vol. 32, no. 47, Nov. 20, 1918, pp. 922-923. Review of researches undertaken and hypotheses advanced.

Waterproofed Floors

Waterproofed Floors for Railway Crossings Over Streets, H. T. Welty. Eng. News-Rec., vol. 81, no. 24, Dec. 12, 1918, pp. 1081-1086, 9 figs. Grade-crossing work makes severe demands; troughing unsatisfactory; concrete slab floor; methods of sealing concrete to girders.

See also CIVIL ENGINEERING, Building Construction (Slabs and Culverts); Earthwork, Rock Excavation, etc. (Dams).

EARTHWORK, ROCK EXCAVATION, ETC.

Dams

Progress on Concrete Dam at Paris, Ont. Contract Rec., vol. 32, no. 49, Dec. 4, 1918, pp. 955-956, 2 figs. Method of bracing framework.

Construction Features of a Multiple Arch Dam, L. R. Jorgensen. Jl. Elec., vol. 41, no. 11, Dec. 1, 1918, pp. 506-508, 3 figs. Considers details of construction methods with reference to an actual case.

A Veritable Niagara Created in the South—Mammoth Hydro-Electric Development in East Tennessee, Stuart Towe. Mfrs. Rec., vol. 75, no. 1, Jan. 2, 1919, pp. 143-145, 3 figs. Brief description of dam 225 ft. high, 725 ft. long at top and 350 ft. at base, 175 ft. thick at base and 12 ft. at top. For a 90,000-hp. hydroelectric development.

New Concrete Dam and Bridge Over Lynn River at Port Dover. Contract Rec., vol. 32, no. 52, Dec. 25, 1918, pp. 1031-1033, 6 figs. Excavation work; specifications for aggregate.

The Lake Eleanor Dam, Rudolph W. Van Norden. Jl. Elec., vol. 41, no. 12, Dec. 15, 1918, pp. 551-553, 4 figs. Plans, essential features and details of construction. Dam contains 11,000 cu. yd. of concrete.

HARBORS

Floating Docks

Construction and Trials of 30,000-Ton Black Sea Floating Dock. Engineering, vol. 106, no. 2759, Nov. 15, 1918, pp. 551-552, 3 figs. Drawings with principal dimensions and description.

San Francisco Harbor

Harbor Improvements at San Francisco, Charles W. Geiger. Int. Mar. Eng., vol. 24, no. 1, Jan. 1919, pp. 31-35, 7 figs. Extensive enlargement of piers; large bulkhead warehouses; railroad connection with piers; developments in Islais Creek section.

See also ELECTRICAL ENGINEERING, Power Applications (Harbors).

MATERIALS OF CONSTRUCTION

Road Materials

Standard Forms for Tests, Reports, and Method of Sampling for Road Materials. Better Roads & Streets, vol. 8, no. 8, Aug. 1918, pp. 300-306, 2 figs. From Bul. 555 issued by office of Public Roads and Rural Eng.

Stucco

Review of Stucco Tests by Bureau of Standards, J. C. Pearson. Cement & Eng. News, vol. 30, no. 12, Dec. 1918, pp. 36-37. From paper at annual meeting of Am. Concrete Inst.

MECHANICS

Arches

Calculation of Built-In Arches Under the Action of Continuous External Loads (Calcul des arcs encastrés sollicités par des charges extérieures continues), P. Ernest Flamard. Génie Civil, vol. 73, no. 11, Sept. 14, 1918, pp. 207-209, 4 figs. Mathematical study of problem with reference to work of deformation.

Beams

Beam Deflections Under Distributed or Concentrated Loading, J. B. Kommers. Eng. News-Rec., vol. 82, no. 1, Jan. 2, 1919, pp. 44-46, 10 figs. New algebraic method proposed for cases usually solved by graphical calculation gives accurate results.

Bending Moments in Grillage Beams, R. Fleming. Eng. & Contracting, vol. 50, no. 26, Dec. 25, 1918, pp. 585-586, 1 fig. Outcome of recent review of calculations for proportioning grillage beams in foundations.

Lines of Influence for a Vierendeel Beam (Lignes d'influence pour une poutre Vierendeel), G. Magnel. Génie Civil, vol. 73, no. 18, Nov. 2, 1918, pp. 344-347, 5 figs. Mathematical investigation of bending moments and other mechanical factors in reinforced concrete beam.

ROADS AND PAVEMENTS

Boulevards

Boulevards of San Francisco, California, Charles W. Geiger. Good Roads, vol. 17, no. 1, Jan. 4, 1919, pp. 1-3, 5 figs. Notes on history and construction of scenic drives in and near city.

Concrete Pavements

Concrete Pavement Subjected to Severe Test, George C. Swan. Concrete Highway Mag., vol. 2, no. 11, Nov. 1918, pp. 246-247, 3 figs. Damage at crossing where locomotive was thrown off track and dragged itself 40 ft. over concrete surface.

Construction

Construction Methods Employed in Building Lincoln Highway Cut-Off Across the Desert at Gold Hill, Utah, R. E. Dillree. Mun. & County Eng., vol. 55, no. 6, Dec. 1918, pp. 195-197, 12 figs. Building roadway with grade above level of desert under conditions which necessitated using hay to keep heavy equipment from bogging down.

Disintegration of Roads

The Road: Its Paramount Importance as Viewed by a Briton, J. H. A. MacDonald. Mun. & County Eng., vol. 55, no. 6, Dec. 1918, pp. 218-221. Concludes necessity of building good roads from analysis of London traffic statistics and considers problem of road disintegration and that of paying for roads.

Hard-Surface Pavements

The Prevention of Longitudinal Cracks in Hard Surfaced Pavements, Wm. C. Perkins. Contract Rec., vol. 32, no. 49, Dec. 4, 1918, pp. 972-973. Suggests use of tile in artificial foundation.

Macadam Roads

The Maintenance of Macadam Roadways, R. C. Heath. Contract Rec., vol. 32, no. 52, Dec. 25, 1918, pp. 1033-1034. Preventing wear and raveling; carpet treatment; economic importance of road maintenance. Paper before Ky. Highway Engrs. Assn.

Snow Removal

Organization, Methods and Equipment Employed in Removing Snow from Main Roads in Pennsylvania, George H. Biles. Mun. & County Eng., vol. 55, no. 6, Dec. 1918, pp. 216-218. Address before Highway Traffic Assn. of N. Y. State.

Snow Removal on Trunk Line Highways, Charles J. Bennett. Mun. & County Eng., vol. 55, no. 6, Dec. 1918, pp. 214-215, 3 figs. Address before Highway Traffic Assn. of N. Y. State.

State Highways

State Highway Work in 1919. Good Roads, vol. 17, no. 1, Jan. 4, 1919, pp. 4-6. Report of available funds and plans for work in 31 states.

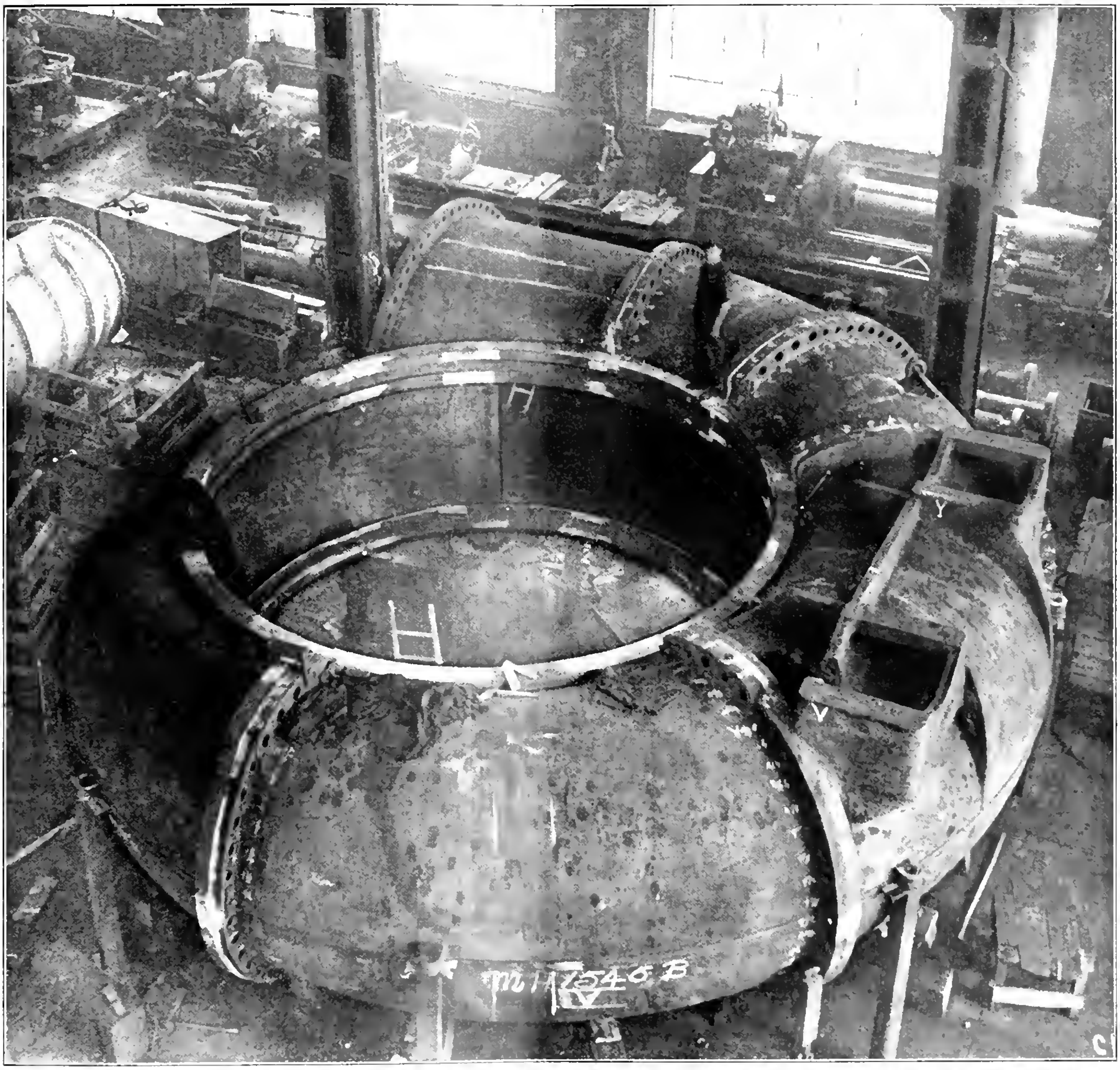
War, Roads During

Construction and Maintenance of Roads During War. Better Roads & Streets, vol. 8, no.

I. P. Morris Hydraulic Turbines

The Wm. Cramp & Sons Ship & Engine Building Co.

Richmond and Norris Sts., Philadelphia



THE MOST POWERFUL TURBINE EVER BUILT

Cast iron volute casing of **37,500 H. P.** Turbine for The Niagara Falls Power Company The turbine is designed to develop the above power under a head of 214 feet, at a speed of 150 R. P. M. We have two of these units now under construction in our shops.

S. Aug. 1918, pp. 299 and 324. Policy issued by Council of Nat. Defence.

See also CIVIL ENGINEERING, *Materials of Construction (Road Materials).*

SANITARY ENGINEERING

Sewage Disposal

Sewage Disposal from an Operator's Standpoint, William K. F. Durrant. Can. Engr., vol. 35, no. 24, Dec. 12, 1918, pp. 512-513. Comments on each of features of plant consisting of detritus pit and screen chamber, pump house, plain sedimentation tanks, bacteria beds, disinfecting chambers and humuspond. Abstracted from Western Min. News.

The Private Sewerage Question, D. H. Wyatt. Clay-Worker, vol. 70, no. 6, Dec. 1918, pp. 500-501. Analysis of results produced by leaky building drains and sewers. Vitrified pipe advocated as well constituted to withstand chemical action.

The Aqua Privy. Indian Eng., vol. 64, no. 14, Oct. 5, 1918, pp. 192-193, 3 figs. Special feature is that nightsoil goes straight into small septic tank under seat, where it undergoes septic treatment.

Concrete Septic Tanks and Subsoil Disposal Fields for Country Homes, John H. Perry. Domestic Eng., vol. 85, no. 10, Dec. 7, 1918, pp. 363-365 and 391, 5 figs. Design and construction of such systems.

Sanitary Conveniences and Comforts for Country Homes. Clay-Worker, vol. 70, no. 6, Dec. 1918, pp. 501-503, 3 figs. Illustrates a manner in which ordinary sewer pipe and drain tile may be used.

Sewage-Pumping Station

Design and Operation of Automatic Sewage Pumping Station at West Haven, Conn., Clyde Potts. Mun. & County Eng., vol. 55, no. 6, Dec. 1918, pp. 199-200, 2 figs. Draining sewage to common point for treatment.

WATER SUPPLY

Freezing

How to Prevent Freezing of Riser Pipes to Elevated Water Supply Tanks. Mun. & County Eng., vol. 55, no. 6, Dec. 1918, pp. 213-214. Four means: (1) providing method for artificially heating water; (2) conserving heat in water by providing sufficient insulation; (3) maintaining temperature of water above freezing point by pumping and withdrawal of water; (4) adding chemicals to lower freezing point. From Water Tower.

Purification

Four Years' Operating Results of Minneapolis Water Purification Plant. Contract Rec., vol. 32, no. 47, Nov. 20, 1918, pp. 926-927. Filtration data of plant having capacity of 96,000,000 gal.

Algal Growths and Chlorine Treatment of London Waters, A. C. Houston. Contract Rec., vol. 32, no. 47, Nov. 20, 1918, pp. 929-930. Report of Director of Water Examination.

Water Treatment at Council Grove, Kansas, Louis L. Tribus. Can. Engr., vol. 35, no. 25, Dec. 19, 1918, pp. 536-538, 4 figs. Results obtained under highly varying conditions of turbidity at plant in operation for three years. Paper before Am. Waterworks Assn.

Reservoir Capacity

Determination of the Available Water Supply in the Haut-Cher Basin (Contribution à la détermination du régime hydraulique du Cher), P. Morin. Revue Générale de l'Electricité, vol. 4, no. 21, Nov. 23, 1918, pp. 805-806, 1 fig. Account of observations made to determine capacity of reservoirs which would insure continuous delivery.

Stream Pollution

Control of Stream Pollution, Earle B. Phelps. Can. Engr., vol. 35, no. 24, Dec. 12, 1918, pp. 515-518. Considers use of streams for waste disposal, effect of stream pollution, self-purification of streams, chemical methods of sewage treatment, biological treatment of sewage, and purification of water. From J. E. Aldred Lecture on Eng. Practice.

Relation of Main Drainage to River and Harbor Front Improvements in Various American Cities, Morris Knowles and John M. Rice. Mun. & County Eng., vol. 55, no. 6, Dec. 1918, pp. 204-205. Special reference to methods adopted for eliminating nuisance caused by discharge of raw sewage at Baltimore, New Bedford, Mass., Cleveland, Toronto, Syracuse, N. Y., Washington, Cincinnati, Waterbury, Conn., and Harrisburg, Pa.

WATERWAYS

Canal Traffic

The Potentialities of Our Inland Water Routes, Robert G. Skerrett. Rudder, vol. 34, no. 12, Dec. 1918, pp. 565-570, 11 figs. Economic and commercial aspects of developing possible canal traffic.

Flumes

Lindsay-Strathmore Irrigation Flume, Stephen E. Kieffer. Can. Engr., vol. 35, no. 25, Dec. 19, 1918, pp. 525-527, 5 figs. Self-supporting, high-level flume with 2-in. walls built on inside forms at rate of 130 lin. ft. per 8-hr. day, nearly $1,500,000 expended in improvements to 15,500 acres in Cal.

Groynes

Groynes as Applied to Water Control and Silt Exclusion. Indian Eng., vol. 64, nos. 14, 15 and 16, Oct. 5, 12 and 19, 1918, pp. 194-195, 206-208 and 222-223, 16 figs. Experiments with silt bags from the results of which writer concludes that when a canal is added to a Bell Bund system, flow behind groyne is introduced, but head still exists in pockets so that arrangement retains power of checking and diverting silt.

Navigable Rivers

The Study of Currents in Navigable Rivers (L'étude des courants dans les revières navigables), P. Dupont. Génie Civil, vol. 73, no. 17, Oct. 26, 1918, pp. 327-329. Recommends study of currents by engineers in order not to differ so often with mariners in regard to construction of improvements.

Calculations in Regard to Improvement of Rivers (Calculs concernant les améliorations de rivières), Alf. Bijls. Génie Civil, vol. 73, no. 19, Nov. 19, 1918, pp. 371-373, 1 fig. Concludes from examination and comparison of formulæ generally used, that in calculations it is advisable to deduce the coefficient of velocity from observations on long sections of 10 to 20 km. and to gage water at all possible levels.

Sediment in Rivers

Sediment in River Waters, J. S. Ryan. Tran. Inst. Marine Engrs., vol. 30, no. 238, Oct. 1918, pp. 217-218, 2 figs. Experience with propeller and shaft due to working amid water mingled with sand.

St. John River

St. John River Affords Big Opportunities, Frank S. Small. Can. Engr., vol. 35, no. 23, Dec. 5, 1918, pp. 489-495, 3 figs. Topographical features; reclamation of waste land by drainage; utilization of water powers; site proposed for tideless harbor.

St. Lawrence River

Canada's Heritage in the St. Lawrence River, Arthur V. White. Can. Engr., vol. 35, no. 24, Dec. 12, 1918, pp. 507-510, 2 figs. Indicates power sites on river and refers to canalization of river as a unit. Address before Elec. Club of Toronto.

Canada's Heritage in the St. Lawrence River, Arthur V. White. Elec. World, vol. 72, no. 26, Dec. 28, 1918, pp. 1216-1217, 1 fig. Estimated low-water power aggregates 2,000,000 hp., of which greater part is wholly within territorial area of Dominion and capable of development. From address before Elec. Club of Toronto, Nov. 12, 1918.

Mining Engineering

COAL AND COKE

California

Tesla Coal Mine, J. W. Beckman. Jl. Elec., vol. 41, no. 12, Dec. 15, 1918, p. 559. Indicates possibilities of a lignite mine in California.

Colliery Output

South Staffordshire and Warwickshire Institute of Mining Engineers. Presidential address, William Charlton. Trans. Instn. Min. Engrs., vol. 56, part 1, Nov. 1918, pp. 13-26. Considers question of output in collieries under two aspects: 1, immediate and pressing need for United Kingdom to produce utmost possible quantity of coal; 2, standpoint of output per unit of person employed, and its bearing on prosperity of coal industry, and those other industries whose ultimate economic position is affected by use and cost of fuel.

What One Coal Mine Has Done. Stone & Webster Jl., vol. 23, no. 5, Nov. 1918, pp. 354-356. Mine in question hoisted 32,514 tons in one week.

GEOLOGY

Lake Michigan District

Explanation of the Abandoned Beaches About the South End of Lake Michigan, G. Frederick Wright. Bul. Geol. Soc. Assn., vol. 29, no. 2, June 1918, pp. 235-244, 3 figs. Peat deposits; series of moraines; supposed changes of level; glacial and clay deposits underneath Chicago; provisional estimates of glacial time afforded in this area. Presented in abstract before the Soc.

MAJOR INDUSTRIAL MATERIALS

Tungsten

Chief Materials Needed in the Electrical Industry: Tungsten (De quelques matières premières nécessaires à l'industrie électrique: le tungstène), D. Pector. Revue Générale de l'Electricité, vol. 4, no. 4, July 27, 1918, pp. 121-125. Metallurgy, uses and ore deposits. Bibliography of documents.

Zinc Concentration

Concentration of Lead-Zinc-Silver Ore at the Zinc Corporation's Mine, George C. Klug. Min. Mag., vol. 19, no. 5, Nov. 1918, pp. 243-245, 1 fig. Methods employed at Broken Hill. Gravity concentration by jigging and tabling for production of high-grade lead concentrate; treatment of zincy tailing by flotation methods (De Bavay, and Delprat); Seale-Shellshear method of cascading as modified by Lyster and Hebbard for selectively separating galena from mill pulp.

Zinc Tailings

Treatment of Accumulated Tailing as Practised by the Zinc Corporation, George C. Klug. Min. Mag., vol. 19, no. 6, Dec. 1918, pp. 298-300, 1 fig. Plant recovering zinc, silver and lead by mineral-separation process of removal in collective float and subsequent separation of a lead concentrate from collective float by tabling methods.

MINES AND MINING

Field Tests

Field Tests for the Common Metals in Minerals, George R. Fansett. Univ. of Ariz. Bul., bul. 93, Min. Technology Series no. 21, Nov. 1918, 20 pp. Compiled for Ariz. State Bur. of Mines and intended as text for lectures on Prospector's Mineralogy.

Fire Protection

Smothering Mine Fires (Note sur l'embouage des feux de mine), M. Cabane. Bulletin et compter rendus mensulels de la Société de l'Industrie Minérale, series 5, vol. 14, 3d issue 1918, pp. 67-77, 6 figs. Principal features of system developed at Commentry Collieries; arrangement at Decazeville mines designed to deliver dust under pressure; materials used to form dust.

Safety

Miners' Safety and Health Almanac for 1919, R. C. Williams. Department of Interior, Bur. of Mines, Miners' Circular 24; 48 pp., 7 figs. Responsibility of miners concerning their own safety and that of others; pure drinking water for mining camps; prevention of accidents and promotion of sanitation; miners' anemia; disposal of human excreta in rural districts; sewage disposal in mines; mine-rescue cars of Bureau of Mines. Other articles dealing with health conditions and tending to impart information to miners are included in bulletin.

Sampling.

Sampling, F. W. Bunyan. Min. & Sci. Press, vol. 117, no. 25, Dec. 21, 1918, pp. 827-832, 2 figs. Emphasizes importance of sampling in analytical work and illustrates with examples value of systematic procedure in performing it.

Stoping Methods

Mining Methods of United Verde Extension Mining Co., Charles A. Mitke. Bul. Am. Inst. Min. Engrs., no. 145, Jan. 1919, pp. 9-22, 3 figs. Considerations which influenced selection and planning of adaptable stoping method. Ore deposit considered as replacement of volcanic schist. Mineralization believed to have taken place after intrusions of diorite and quartz porphyry had folded and faulted schist.

Ventilation

Cooling and Drying the Air in Deep Mines, Sydney F. Walker. Iron & Coal Trades Rev., vol. 47, no. 2645, Nov. 8, 1918, p. 518. Writer believes coal may be mined successfully at depths from 5000 to 6000 ft. by treating each individual mine, each pair of shafts and the workings connecting them, in same manner as modern cold stores are treated. Gives recommendations and refers to actual installations.

Welfare Work

Welfare Work in the Mining Work in the Mining Industry, H. Lipson Hancock. Chem. Eng. & Min. Rev., vol. 10, no. 121, Oct. 5, 1918, pp. 6-13, 18 figs. Betterment work being done by South Australian company.

MINOR INDUSTRIAL MATERIALS

Arsenic

Arsenic and Its Occurrences in South Queensland (1), H. I. Jensen. Queensland Government Min. Jl., vol. 19, no. 221, Oct. 15, 1918, pp. 455-458. Notes on arsenic as a

source of trouble in metal extraction and on its origin and extraction.

OIL AND GAS

Gas Pressure

Record of Gas-Pressure from a Borehole, Charles J. Fairbrother. Trans. Instn. Min. Engrs., vol. 56, part 1, Nov. 1918, pp. 6-8, 2 figs. and (discussion) pp. 8-10. Photographs showing gas blowing out of borehole while clear of rods, and borehole with rods in and water being blown in all directions by force of gas.

Gas Storage

Natural-Gas Storage, L. S. Panyity. Bul. Am. Min. Engrs., no. 145, Jan. 1919, pp. 25-25, 2 figs. Scheme to regulate pressure by connecting exhausted well to high-pressure gas line.

Petroleum Hydrology

Petroleum Hydrology Applied to Mid-Continent Field, Roy O. Neal. Bul. Am. Inst. Min. Engrs., no. 145, Jan. 1919, pp. 1-8. Method of distinguishing between waters that encroach upon oil-bearing beds from sources in stratum and waters that reach oil sands from planes above.

PRECIOUS MINERALS

Gold

Two Instances of Mobility of Gold in Solid State, Edward Keller. Bul. Am. Inst. Min. Engrs., no. 145, Jan. 1919, pp. 33-42, 1 fig. Assay results of gold movement on surface of auriferous copper when latter is subjected to oxidation.

RARE MINERALS

New Minerals

Review of New Mineral Species (Revue des espèces minérales nouvelles), P. Gaubert. Bulletin de la Société Française de Minéralogie, vol. 41, no. 4-5-6, Apr.-June 1918, pp. 93-96 and 117-130. General notes on appearance, occurrence and constitution of 29 minerals discovered in recent years. Reference made in each case to publication where first account of substance appeared.

See also INDUSTRIAL TECHNOLOGY, Yttrium.

Metallurgy

BLAST FURNACES

Development in 1918

1918 Blast Furnace Development Reviewed, F. H. Wilcox. Blast Furnace, vol. 7, no. 1, Jan. 1919, pp. 30-31. Analysis indicates tendency has been toward large hearths, steep and low boshes, high inwall batters and moderate thickness of lining.

Gases

Remarks on the Composition of Blast-Furnace Gases and Volumetric Methods of Measuring the Gas Produced and the Air Blown In (Remarques relatives à la composition des gaz de haut fourneau et méthodes volumetriques pour le calcul du gaz produit et du vent soufflé), J. Seigle. Bulletin et Comptes rendus mensuels de la Société de l'Industrie Minérale, series 5, vol. 14, 3d issue 1918, pp. 113-131, 1 fig. Methods of measuring gases by weight (Gruner and Ledebur); volumetric methods based on combination of carbon or on combination of oxygen; examples of applications; comparison of theoretical results and practical analyses.

Manganese

How to Save Manganese and Coke. Iron Trade Rev., vol. 63, no. 24, Dec. 12, 1918, pp. 1347-1348. Table of operating data of 12 blast furnaces producing ferromanganese and spiegeleisen and 40 per cent of output of manganese alloys in U. S. Conclusion reached that large savings can be effected by using low-ash cokes.

Research

Study of Blast Furnaces, Based on the Researches Undertaken by Francis Mulet (Etude sur les hauts fourneux dapres les travaux de Francis Mulet), E. Damour. Bulletin et Comptes rendus mensuels de la Société de l'Industrie Minérale, series 5, vol. 14, 3d issue 1918, pp. 5-47, 1 fig. Economical operation of furnaces; analysis of charge and of gaseous products; heat required by chemical reactions; influence of temperature of blast on coke economy; utilization of gases; variation in coke consumption with output.

See also MECHANICAL ENGINEERING, Fuels and Firing (Blast Furnace Gas).

COPPER

Brass, Cartridge

A Comparison of Grain-Size Measurements and Brinell Hardness of Cartridge Brass, W. H. Bassett and C. H. Davis. Bul. Am. Inst. Min. Engrs., no. 145, Jan. 1919, pp. 57-78, 16 figs. It was found that grain sizes of brasses annealed at low temperatures are greatly affected by previous grain size and reduction by rolling, consequently hardness of cartridge brass may be better determined by Brinell-hardness measurement than from grain size.

Bronzes

The Constitution of the Tin Bronzes, Samuel L. Hoyt. Bul. Am. Inst. Min. Engrs., no. 144, Dec. 1918, pp. 1721-1727, 15 figs. Explains upper heat effect over $\alpha + \beta$ range.

Chloridizing Roasting

Chloridizing-Roasting of Burnt Pyrites on the Ramen-Beskow System, Peter Klason. Min. Mag., vol. 19, no. 6, Dec. 1918, pp. 301-313, 4 figs. Suggests improvement of Longmaid-Henderson process for extracting copper from pyrites that have been burnt by alkali manufacturers.

Copper-Aluminum Alloys

Constitution and Hardness of Copper-Aluminum Alloys Having High Percentage of Copper (Constitution et dureté des alliages cuivre-aluminium riches en cuivre). La Metallurgie, year 50, no. 45, Nov. 6, 1918, pp. 1631-1633, 1 fig. Effect of temperature of hardening on hardness of alloys containing 9 to 16 per cent aluminum. (Continuation of serial.)

Leaching

The Utah Copper Enterprise (VIII). The Leaching Plant, T. A. Rickard. Min. & Sci. Press, vol. 117, no. 24, Dec. 14, 1918, pp. 787-791, 5 figs. Oxidized cap stripped from main mass of sulphide ore, averaging 0.65 per cent Cu in form of carbonates and 0.1 to 0.2 per cent additional in form of chalcopyrite and chalcolite, is dissolved with H_2SO_4 derived from decomposition of sulphide mineral. Plant has capacity of 2000 tons of ore per day. (To be continued.)

FLOTATION

Ruth Flotation Machine

Ruth Flotation Machine, Arthur J. Hoskin. Queensland Government Min. Jl., vol. 19, no. 222, Nov. 15, 1918, pp. 500-501, 3 figs. Machine for concentrating minerals by oil flotation; designed on principle that best attachment of minerals to bubbles takes place when there is least amount of relative motion.

STEEL AND IRON

Basic Steel

Formula for Strength of Basic Steel, Andrew McWilliam. Iron Age, vol. 102, no. 25, Dec. 19, 1918, pp. 1508-1511, 3 figs. Calculations made from composition; influencing principal elements; application to basic steel. Paper before Iron & Steel Inst., London, Sept. 1918.

Cast Iron

The Mixing and Melting of Cast Iron, J. F. Mullan. Can. Foundryman, vol. 9, no. 12, Dec. 1918, p. 304. Review of opinions expressed by several experts leads writer to assert that success of foundry depends more on proper management of furnace than on any other branch of the trade.

Electric Steel

Making Electric Steel for Roller Bearings, Edward K. Hammond. Machy., vol. 25, no. 4, Dec. 1918, pp. 318-326, 20 figs. Methods of operating Héroult electric furnaces, forging ingots, rolling billets and cold-drawing steel into solid bars and seamless tubing.

Ferro-Alloys

The Ferro-Alloys, J. W. Richards. Gen. Elec. Rev., vol. 21, no. 11, Nov. 1918, pp. 751-755. Composition of these alloys, method of manufacture, and properties imparted to steel by addition of each of the molten metals. Also Metal Trades, vol. 9, no. 12, Dec. 1918, pp. 488-489, 2 figs. Properties of ferromolybdenum, ferro-vanadium, ferrotitanium and ferroboron. Paper read at Nat. Exposition of Chem. Indus.

The Manufacture of Ferro-Alloys, Robert M. Keeney. Automotive Eng., vol. 3, no. 10, Dec. 1918, pp. 461-468. Ores and furnaces used and methods followed to produce ferrochrome, ferromanganese, ferromolybdenum, ferrotungsten, ferrovanadium and ferrouranium; uses of these metals.

The Manufacture of Ferro-Alloys in the Electric Furnace, E. S. Bardell. Min. Jl., vol. 123, no. 4316, Dec. 7, 1918, p. 708. Comparative efficiency of large and small furnaces used in manufacture of ferromanganese. Discussion of Am. Inst. Min. Engrs. paper by Robert M. Keeney.

Record of an Old Ferro-Silicon Furnace, I. Peterman. Blast Furnace, vol. 6, no. 12, Dec. 1918, pp. 492-493. Historical account of plant built in 1792, now a part of Warner Iron Co.

Forged Steel

Influence of Forging and Rolling on the Properties of Steel (Le corroyage de l'acier. Son influence sur les propriétés du metal), Georges Charpy. Revue de Métallurgie, year 15, no. 5, Sept.-Oct. 1918, pp. 427-448, 9 figs. Experiments conducted by engineering staff of large works; records of deformations by forging of straight lines drawn originally on surface of bar and examination of section of hollow threaded cylinder filled with liquid metal of same composition and rolled after solidifying under pressure of 1200 tons from 530 mm. in diameter to 265 mm.

Metallurgy in 1918

Phases of Iron and Steel Metallurgy in 1918, John Howe Hall. Iron Age, vol. 103, no. 1, Jan. 2, 1919, pp. 27-28. Remedies for ingot defects; strides in steel-casting industry; manganese problem; alloy-steel helmets.

Open-Hearth Furnaces

Principles of Open-Hearth Furnace Design, Chas. H. F. Bagley. Blast Furnace, vol. 6, no. 12, Dec. 1918, pp. 505-507, 3 figs. Calculations relating to pressure in furnace, port ends, ratio of air to gas passages. Flue and valve diagrams. Paper before British Iron & Steel Inst. (Concluded.)

Plate and Structural Mills at Fairfield, Ala. Iron Age, vol. 103, no. 1, Jan. 2, 1919, pp. 47-49, 3 figs. New plant of Tennessee Coal, Iron & Railroad Co., to serve Mobile shipyard; producing steel by triplexing at Ensley open-hearth works.

Oxygen in Steel

Determination of Oxygen in Steel. Iron Age, vol. 102, no. 26, Dec. 26, 1918, pp. 1573, 2 figs. Objections to Ledebur method apparently overcome; details of modifications; interesting comparative analyses.

The Heterogeneity of Steel (L'hétérogénéité de l'acier), H. le Chatelier and B. Bogitch. Génie Civil, vol. 73, no. 18, Nov. 2, 1918, pp. 350-351, 6 figs. Concludes, from experiments with Stead's reagent, that microscopic heterogeneity of steel is due to oxygen in solid solution in metal.

Russian Iron Works

Pre-War Russian Iron and Steel Plants. Iron Age, vol. 102, no. 25, Dec. 19, 1918, pp. 1501-1507, 11 figs. Output and equipment of leading works; prospects after war.

Structure of Steel

Inspecting the Structure of Metals, J. J. McIntyre. Am. Drop Forger, vol. 4, no. 11, Nov. 1918, pp. 443-444, 2 figs. Shows manner of taking structural photographs of metals or similar opaque objects with ordinary camera.

Development of Grain Boundaries in Heat-Treated Alloy Steels, R. S. Archer. Bul. Am. Inst. Min. Engrs., no. 145, Jan. 1919, pp. 51-55, 12 figs. Specimen is etched in 4 per cent solution of picric acid in ethyl alcohol from 5 to 25 min., then carbonaceous smudge is rubbed off on moist broadcloth or kersey.

See also MECHANICAL ENGINEERING, Heat Treating (Malleable Iron); Machinery, Metal-Working (Steel, High-Speed); ELECTRICAL ENGINEERING, Furnaces (Steel Furnaces).

Aeronautics

AEROSTATICS

Ascending and Landing

Military Aerostatics, H. K. Black. Aerial Age, vol. 8, no. 16, Dec. 30, 1918, p. 811. Precaution in ascending and in landing. (Continuation of serial.)

Balloons

Manufacture of War Balloons in U. S., Allen Sinsheimer. Automotive Indus., vol. 39, no. 22, Nov. 28, 1918, pp. 925-927, 6 figs. Adaptation of French Caquot type.

Free Ballooning

Military Aerostatics, H. K. Black. Aerial Age, vol. 8, no. 14, Dec. 16, 1918, p. 705, 1 fig. Training in free ballooning. (Continuation of serial.)

Kites

Meteorological Kites (Cerfs-volants météorologiques), L.-P. Frantzen. Aérophile, year 26, nos. 19 and 20, Oct. 1-15, 1918, pp. 298-299, 3 figs. Particulars of German design of "Diamant" type.

AIRCRAFT PRODUCTION

Navy Plant

Our Navy Winged Destroyers. Austin C. Lescarboura. Sci. Am., vol. 119, no. 24, Dec. 14, 1918, pp. 480-481 and 486-487, 8 figs. Work done by Navy in establishing Government-owned aircraft plant for supplying giant seaplanes.

Rigging

From a Rigger's Note-Book. Flight, vol. 10, no. 47, Nov. 21, 1918, pp. 1313-1315, 8 figs. General procedure of rigging. Case of a B. E. 2c is taken up in detail.

U. S. Air Service

Report of the Director of Military Aeronautics. Aerial Age, vol. 8, no. 14, Dec. 16, 1918, pp. 720-722. Story of development of personnel, training and organizing phases of present Air Service.

APPLICATIONS

Aeroplane Business

The Future of the Airplane Business. C. F. Kettering. Jl. Soc. Automotive Engrs., vol. 3, no. 6, Dec. 1918, pp. 358-362 and pp. 362-363 (discussion). 2 figs. Present difficulties in civilian use of airplanes as built at present; types of military airplanes. Presidential address before Detroit Section of Society.

American View

Future of the Aircraft Industry. Harry Bowers Mingle. Aviation, vol. 5, no. 9, Dec. 1, 1918, pp. 560-562, 3 figs. Enumerates possible uses of airplane in scientific, civil and sporting fields.

British Civil Transport

Civil Aerial Transport. Flight, vol. 10, no. 48, Nov. 28, 1918, pp. 1350-1351. Outline of report of Civil Aerial Transport Committee regarding steps to be taken to develop aviation for civil and commercial purposes and utilizing trained personnel for that purpose. From London Times.

Control of Aircraft

The Two Futures for Flight. H. Massac Buist. Flight, vol. 10, nos. 48 and 49, Nov. 28 and Dec. 5, 1918, pp. 1352-1354 and 1370-1373. Argues against establishment of bureaucracy in connection with development of aviation alike for military, public and private purposes, and for absolutely free scope for development and application by individuals or companies.

Dutch View of Future

Flying Machines and Air Communication and Navigation in the Near Future (Vliegmachines, bestuurbare luchtschepen en het luchtverkeer in de naaste toekomst). Ph. Kapteyn. De Ingenieur, year 33, no. 43, Oct. 26, 1918, pp. 827-845, 41 figs.

Italian View of Commercial Aviation

Commercial Aviation. Gianni Caproni. Aeronautics, vol 15, no. 264, Nov. 6, 1918, pp. 428-430, 3 figs. From Rivista dei Transporti Aerei.

AUXILIARY SERVICE

Trucks

Building Trucks for the Aviation Service. M. E. Hoag. Am. Mach., vol. 49, no. 23, Dec. 12, 1918, pp. 1089-1092, 13 figs. Description of construction and assembly of some special parts. (Second article.)

ENGINES

Austro-Daimler

The 200 H. P. Austro-Daimler Aero Engine. Flight, vol. 10, no. 46, Nov. 14, 1918, pp. 1288-1293, 7 figs. Ignition; carburetor and induction system; petrol tanks; air pump; water pump; water cooling system; calibration and endurance test report; metallurgical test report; general data; general analysis by weights. Issued by Technical Department, Aircraft Production, Ministry of Munitions. Also Automobile Engr., vol. 8, nos. 120 and 121, Nov. and Dec., 1918, pp. 316-319, 350-357, 28 figs.

Design

The Design of Airplane Engines, III. John Wallace. Automotive Engr., vol. 3, no. 10, Dec. 1918, pp. 458-460. Mean effective pressure; power; construction of a theoretical diagram; modifying diagram to include practical conditions of ignition; comparison of results. (Continuation of serial.)

Hispano-Suiza

The Hispano-Suiza Aircraft Engine. Donald McLeod Lay. Jl. Soc. Automotive Engrs., vol. 3, no. 6, Dec. 1918, pp. 367-372, 9 figs. Historical review of design and development; mechanical features; circulating water and gasoline systems; production problems.

Four Hispano-Suiza Models. Automotive Indus., vol. 39, no. 22, Nov. 28, 1918, pp. 914-915 and 946, 2 figs. Details of models A, I, E, and H, built in U. S.

The Hispano-Suiza Airplane Engine. Aviation, vol. 5, no. 9, Dec. 1, 1918, pp. 549-553, 4 figs. History of development and detailed description of latest type.

Liberty

Details of the Liberty Engine. J. Edward Schipper. Automotive Indus., vol. 38, no. 24, Dec. 12, 1918, pp. 991-995, 12 figs. Mechanical description illustrated with sectional drawings.

Electrical System of the Liberty Engine. J. Edward Schipper. Automotive Indus., vol. 39, no. 26, Dec. 26, 1918, pp. 1089-1092, 14 figs. Special type of interrupter comprising three breakers in parallel. Storage battery designed to permit of upside-down flying.

The Liberty Motor. Douglas Wardrop. Aerial Age, vol. 8, nos. 14 and 15, Dec. 16 and 23, 1918, pp. 706-717, 762-765, 39 figs. Dec. 16: Extensive description of machine and outline of its development. Dec. 23: Oiling system; electric ignition; voltage regulator; duplex Zenith carburetor.

Starter

The Liberty Starter. Aerial Age, vol. 8, no. 16, Dec. 30, 1918, p. 816, 3 figs. Elevation and sections of 4-cylinder radial 2-cycle air motor. As starter it has a 9 to 1 gear reduction on final drive to motor.

HISTORY

Official U. S. History

Official History of Aircraft Production. Automotive Indus., vol. 39, no. 23, Dec. 5, 1918, pp. 968-969 and 987-990. Objects, problems, production, and results of air program.

MATERIALS OF CONSTRUCTION

Spruce

Development of the Aircraft Spruce Industry. Lawrence K. Hodges. Automotive Indus., vol. 39, nos. 25 and 26, Dec. 19 and 26, 1918, pp. 1037-1040 and 1100-1101, 8 figs. Organization of Spruce Production Division. Figures of monthly cut; problem of by-products disposal.

See also MECHANICAL ENGINEERING, Corrosion (Aircraft Parts).

METEOROLOGY

Aerographic Records

Uniformity in Aerographic Records. Alexander McAdie. Sci. Am. Supp., vol. 87, no. 2244, Jan. 4, 1919, pp. 15-16. Discusses desirability of universal scientific units. Special reference is made to meteorological work.

MODELS

Ford-Motored Aeroplane

Elementary Aeronautics and Model Notes. John F. McMahon. Aerial Age, vol. 8, no. 14, Dec 16, 1918, p. 727, 16 figs. Construction of a Ford-motored airplane.

Model Construction

Model Aeroplane Building as a Step to Aeronautic Engineering. Aerial Age, vol. 8, nos. 11, 12, 15 and 16, Nov. 25, Dec. 2, 23 and 30, 1918, pp. 581, 627, 781 and 826, 16 figs. Table of resistance and weight of spruce struts. Table of plates of different aspect ratios at angles from 5 to 60 deg. showing K_y, K_x and ratio of lift to drift at the different angles. Bracing fuselage. Construction of seat, gas tank and rudder bar.

PLANES

Berg

The Austrian Berg Single-Seater. Flight, vol. 10, no. 46, Nov. 14, 1918, pp. 1285-1287, 9 figs. Wing section; attachment of struts to fuselage and longerons; details of internal bracing; ailerons. (Concluded.)

Bombers

The Gotha Bomber, with Notes on Giant Aeroplanes. Flight, vol. 10, nos. 46, 47, 48 and 49, Nov. 14, 21, 28 and Dec. 5, 1918, pp. 1280-1282, 1318-1322, 1340-1347 and 1375-1378, 84 figs. Nov. 14: Principal dimensions; construction; struts; ailerons; propeller accommodation; empennage; fuselage. Nov. 21: Undercarriage; engine mounting; engines; controls; petrol system; armament; bombs; wireless; instruments; fabric and dope. Nov. 28: Particulars of four-engined giant. Dec. 5: Principal items of interest in five-engined giant brought down by allied forces. Issued by Technical Department, Aircraft Production, Ministry of Munitions. Also Engineer, vol. 126, no. 3281, Nov. 15, 1918, pp. 419-421, 8 figs.; Aeronautics, vol. 15, no. 266, Nov. 20, 1918, pp. 473-486, 79 figs.

De Haviland 4

The De Haviland 4, with Liberty "12" Engine. Aerial Age, vol. 8, no. 17, Jan. 6, 1918, pp. 860-861, 5 figs. General dimensions and weights.

Design

The Probable Trend of Aeroplane Design. R. F. Mann. Sci. Am. Supp., vol. 87, no. 2244, Jan. 4, 1919, p. 11, 1 fig. Review of present stage in development and changes likely to be introduced by reason of applications of airplanes to various purposes. From Flight.

The Trend of German Aeroplane Design. Flight, vol. 10, no. 49, Dec. 5, 1918, pp. 1383-1385. Comparison with British machine of principal features of captured German aeroplanes. Also in Aeronautics, vol. 15, no. 268, Dec. 4, 1918, pp. 518-520.

Gallaudet

The Gallaudet D-4 Light Bomber Seaplane. Aerial Age, vol. 8, no. 16, Dec. 30, 1918, pp. 817 and 831, 3 figs. General specifications. Machine is a biplane and is fitted with one 400-hp. Liberty "Twelve" engine.

Hannoveraner

The German Airplane Hannoveraner, C. L. II. (Avion allemand Hannoveraner C. L. III). Aérophile, year 26, nos. 19 and 20, Oct. 1-15, 1918, pp. 289-296, 10 figs. Comprehensive de-description of light biplane fitted with 200-hp. Opel motor.

Junker

The Junker Armored Biplane. Flight, vol. 10, no. 48, Nov. 28, 1918, pp. 1356-1357, 2 figs. Main characteristics of all-metal aeroplane.

L-W-F

The L-W-F Model G-2 Fighting Airplane. Glenn D. Mitchell. Aviation, vol. 5, no. 9, Dec. 1, 1918, pp. 554-558, 7 figs. General features and dimensions of an all-American design.

Martin

The Martin K-III Single Seater. Aerial Age, vol. 8, no. 15, Dec. 23, 1918, pp. 759-761, 7 figs. Particulars of biplane specially designed as altitude fighter and equipped with oxygen tanks and provision for electrically heating pilot's clothing.

N. C. 1, U. S. Navy

Our Giant Aircraft. Sci. Am., vol. 120, no. 1, Jan. 4, 1919, pp. 7 and 18. General design of N. C. 1 equipped with three 12-cylinder Liberty engines driving three four-bladed tractor screws; wing spread, 126 ft.

Rumpler

Rumpler Two-Seater Biplane. Automotive Indus., vol. 39, no. 23, Dec. 5, 1918, pp. 962-965, 14 figs. Technical description of model German reconnaissance machine. Issued by British Aircraft Department.

PROPELLERS

Metal

The Metal Airscrew. Vladimir Olhovsky. Aerial Age, vol. 8, no. 12, Dec. 2, 1918, pp. 622-623, 2 figs. Results of experiments on wooden and metal propellers; factors entering in design of hollow metal propeller.

Patterns

Propeller Patterns. Joseph A. Shelly. Machy., vol. 25, no. 5, Jan. 1919, pp. 434-438, 8 figs. Describes method of laying out propeller patterns, assembling different sections and working blades to required form. (Second article.)

Research

Experimental Research on Air Propellers, II. William F. Durand. Automotive Eng., vol. 3, no. 10, Dec. 1918, pp. 478-480, 2 figs. Results of work done by Nat. Advisory Committee for Aeronautics. Torque dynamometer; revolution counter; air-speed meter; tests and calibrations of apparatus; uniformity of velocity over cross-section of air stream; relation between depression within experiment room and air stream velocity. (To be concluded.)

Marine Engineering

AUXILIARY EQUIPMENT

Barge

Standard Concrete Barge for Use on the New York State Barge Canal. Engineering, vol. 106, no. 2759, Nov. 15, 1918, pp. 554-556, 6 figs. Drawings showing details of construction.


Starrett
A Few of the Many Styles and Sizes of
Starrett Tools
MANUFACTURERS, toolmakers, machinists, inspectors and mechanics in all trades recognize the Starrett Tools as Standards for accuracy, an assurance that comes through the knowledge that tools bearing the "Starrett" name are guaranteed.
There are tools to meet every practical requirement described in our catalog No. 21—write for your copy. It also shows Starrett Hack Saws that cut quicker and last longer.
THE L. S. STARRETT COMPANY
The World's Greatest Toolmakers
Manufacturers of Hacksaws Unexcelled
ATHOL, MASS., U. S. A.
NEW YORK LONDON CHICAGO
42-839
STARRETT TOOLS
The STARRETT BOOK

Bark, Auxiliary

Auxiliary Bark—The France, George Douglas. Rudder, vol. 34, no. 12, Dec. 1918, pp. 590-592, 5 figs. Sail plan, deck arrangement and design features of five-masted bark, 418.8 ft. long, fitted with two Schneider heavy-oil engines.

Fishing Cruiser

An Outdoor Motored Cruiser—Complete Plans and Building Instructions, William Atkin. Motor Boat, vol. 15, no. 23, 6 figs. Model is adaptation of flat-bottomed work boats used by clammers of Lower New York Bay.

Life Boats

Two Lifeboats in Place of One. Rudder, vol. 34, no. 12, Dec. 1918, pp. 588-590, 7 figs. Design providing partial collapse of one so it can be stowed under the other.

Producer-Gas Power Lighter

Design and Construction of Producer Gas Power Lighter, Frederick S. Nock. Int. Mar. Eng., vol. 24, no. 1, Jan. 1919, pp. 36-37, 3 figs. Special central control for engine and hoisting apparatus; double rudder installation; compact engine-room planning.

Towboat

Plans and Specifications of New Wood Tow Boats. Int. Mar. Eng., vol. 23, no. 12, Dec. 1918, pp. 673-674, 2 figs. Built for hard service; compound engine of 750 hp.; Scotch boiler with three Morison furnaces.

SALVAGE

Salving of the SS. "——— ," Frank A. T. Wheeler. Tran. Inst. Marine Engrs., vol. 30, no. 238, Oct. 1918, pp. 218-220, 3 figs. Steps taken to prevent falling over of vessel struck by torpedo on her port side in No. 5 hole, holes being blown in her 'tween deck and starboard side; watertight bulkhead at after end of engine room leaked badly and eventually flooded engine room.

SHIPS

Boilers

Sediment in Marine Boilers, Its Bearing on Furnace Collapse, W. R. Austin. Trans. Inst. Marine Engrs., vol. 30, no. 238, Oct. 1918, pp. 189-196, 1 fig. and (discussion), pp. 196-209. Occasions where risk arises and suggestions to eliminate it; Backing strains from unequal expansion and their prevention by keeping uniform temperature in furnaces; dangers arising from circulation of sediment caused by rolling of ship; possibilities of creating critical situation while cleaning a fire at sea; means of avoiding accident while lying under banked fires.

Concrete Ship

What the Year Has Taught About the Concrete Ship. Eng. News-Rec., vol. 82, no. 1, Jan. 1, 1919, pp. 14-15. Much learned regarding design and construction; future depends on ability to build in cost competition with steel; structurally, ship is success.

Concrete Ships and Barges (Los buques i barcos menores de concreto). Boletin de la Sociedad de Fomento Fabril, year 35, no. 9, Sept. 1918, pp. 614-619. History of development of process from 1849 to present time.

Shear in Concrete Ships Critical Point in Design, A. C. Janni. Eng. News-Rec., vol. 81, no. 24, Dec. 12, 1918, pp. 1089-1091, 1 fig. According to accepted theory, usual thin shell monolithic with frame gives rise to dangerous conditions.

Design

V-Bottom or Round Bilge—Which? George F. Crouch. Motor Boat, vol. 15, no. 23, Dec. 10, 1918, pp. 30-34, 3 figs. Advantages of each shape; diagrams showing relations between length and speed, and giving approximate form to use for different speeds.

Best Fore-and-Aft Position of Parallel Middle Body in Single-Screw Cargo Ship, William McEntee. Int. Mar. Eng., vol. 24, no. 1, Jan. 1919, pp. 18-23, 8 figs. Effect of variation of position of parallel middle body on shaft horsepower, propulsion coefficient and propeller revolutions. Paper before Soc. of Naval Architects and Marine Eng., Philadelphia, Nov. 1918.

Electric Transmission

Electric Propulsion of Vessels (La propulsion électrique des navires), A. Foillard. Génie Civil, vol. 73, no. 17, Oct. 26, 1918, pp. 321-327, 13 figs. Machinery used and characteristic curves of motors in the vessels Wulsty Castle and Mjölner.

Lubrication

Uniform and Constant Forced-Feed Lubrication of the Steamchests, Cylinders and Other Parts of Steam Engines. Ry. Engr., vol. 39, no. 466, Nov. 1918, pp. 203-209, 8 figs. Describes "Intensifore" Gorton type developed from exhaustive experiments with various mechanical and hydrostatic lubricators by engineering staff of Great Central Ry.

Power Plant

Marine Power Units, J. G. Callan. Wis. Engr., vol. 23, no. 2, Nov. 1918, pp. 42-47. General characteristics of steam turbines and Diesel engines. Reasonableness of adoption of geared unit.

Standards

Adopt British Ship Steel Standards. Iron Trade Rev., vol. 63, no. 22, Nov. 28, 1918, pp. 1245-1246. Decisions of American steel manufacturers at conference in Philadelphia.

Standardization of Ship Steel. Steel & Metal Digest, vol. 8, no. 12, Dec. 1918, pp. 690-691. Recommendation of mills to Emergency Fleet Corporation.

Structural Steel Standardization Cargo Vessels, Henry R. Sutphen. Int. Mar. Eng., vol. 23, no. 12, Dec. 1918, pp. 695-698, 1 fig. How quantity production was met; use of structural steel expedient; layout of yard.

Submarines

The Surrender of the Submarines. Min. Jl., vol. 123, no. 4345, Nov. 30, 1918, pp. 688-691, 5 figs. General features of construction of the different types, their propulsive machinery and other engineering details.

See also MECHANICAL ENGINEERING, *Internal Combustion Engines* (*Winton Marine Engine*).

YARDS

Concrete Vessels

Build Boats in Dry Docks at New Yards in Detroit. Eng. News-Rec., vol. 82, no. 1, Jan. 2, 1919, pp. 21-24, 9 figs. Concrete barges under construction on concrete floors inside dikes which will be flooded for launching; lighters carry construction machinery alongside dry docks.

Reinforced Concrete Shipbuilding in Dorsetshire. Engineer, vol. 126, no. 3281, Nov. 15, 1918, pp. 408-410, 10 figs. Drawings with description of some concrete ships.

Building a Government 3500-Ton Concrete Ship. Eng. News-Rec., vol. 81, no. 24, Dec. 12, 1918, pp. 1058-1065, 16 figs. Fougner yard has concrete ways; reinforcement tacked to outside forms and finish put on with cement gun; air hammers on forms compact concrete.

Control of Construction

Control of the Construction of a 5000-Ton Deadweight Fabricated Steel Ship, "Fabricator." Int. Mar. Eng., vol. 23, no. 12, and vol. 24, no. 1, Dec. 1918 and Jan. 1919, pp. 691-694 and pp. 29-30, 6 figs. Dec. 1918: Special schedule for ordering and installation of machinery and equipment; correlation between order and purchasing departments. (Fourth article.) Jan. 1919: Forms for following up movement and arrival of steel parts; railway shipments of plates and sheets traced. (Fifth article.)

Costs and Estimates

Shipbuilding Costs and Estimates, James M. Robertson. Int. Mar. Eng., vol. 23, no. 12, Dec. 1918, pp. 671-672. Careful reading of specifications necessary; system a requisite; list of items; how to deal with individual items. (Second article.)

Cranes

Pre-Assembly System and Efficient Erection Cranes Speed Up Shipbuilding at Ecorse. Eng. News-Rec., vol. 81, no. 24, Dec. 12, 1918, pp. 1076-1081, 8 figs. Pre-assembling extending rapidly in Lake Yards; reduces erection labor on hulls.

Design

Berth Construction and Side-Launching Practice in Great Lakes Shipyards. Eng. News-Rec., vol. 82, no. 1, Jan. 2, 1919, pp. 7-13, 25 figs. Berth structure simple; timber and concrete foundations for support of ships; concrete launching-way stringers at one yard; keel blocks and cradles variously arranged; trip shores to release ships.

Ship-Design and Quantity-Production Methods of Newark Bay Yard. Eng. News-Rec., vol. 81, no. 25, Dec. 19, 1918, pp. 1122-1125, 4 figs. Project for factory-style shipbuilding based on enlisting new labor supply and using commercial steel; methods dictated by delay in ship orders; bridge shops fabricate straight parts.

Equipment

Fabricating Shop and Berth Equipment at Sun Shipyard. Eng. News-Rec., vol. 82, no. 1, Jan. 1, 1919, pp. 57-61, 9 figs. Assembly bay of shop delivers finished material to shipbuilding cranes; multiple punches and roller tables; reinforced-concrete berths served by bridge cranes.

Fabricated Ship

Fabricated-Ship Construction in One Year's Experience. Eng. News-Rec., vol. 82, no. 1, Jan. 2, 1919, pp. 16-17. New system now tested by large-scale working has proved adaptable and free from inherent difficulties or elements of excess cost.

Ford Eagles

Building the Ford Submarine-Chaser "Eagle." Int. Mar. Eng., vol. 24, no. 1, Jan. 1919, pp. 23-27, 7 figs. Simplicity of hull construction; safety devices on unusual launching platform; routing aids production.

Ford Methods in Ship Manufacture, Fred E. Rogers. Ind. Management, vol. 57, no. 1, Jan. 1919, pp. 1-6, 12 figs. Description of boat with features of plan of manufacture. (First article.)

Building the Ford Submarine Chaser "Eagle." Int. Mar. Eng., vol. 23, no. 12, Dec. 1918, pp. 702-705, 4 figs. Straight-line design; two parts of system; hurried development of process.

Hog Island

Hog Island, the Greatest Shipyard in the World, W. H. Blood, Jr. Int. Mar. Eng., vol. 23, no. 12, Dec. 1918, pp. 678-690, 20 figs. Review of conditions that preceded planning of yard; adopting type and design of boat; troubles encountered and overcome. Before Soc. of Naval Architects and Marine Engrs., Philadelphia, Nov. 1918.

Illumination

A Method of Ship Way Illumination, F. D. Weber. Jl. Elec., vol. 41, no. 11, Dec. 1, 1918, p. 503. Outlines method followed by western company.

Laying Out

Laying Down and Taking Off, Charles Desmond. Rudder, vol. 34, no. 12, Dec. 1918, pp. 584-587, 5 figs. How to lay out shape of transom stern inclined aft with rounded after face and intended to be made of pieces of material bent to shape. (Continuation of serial.)

New Yards

Large Addition to Plant of the Tidewater Shipbuilders, Ltd., Cap de la Madeleine, P. Q. Contract Rec., vol. 32, no. 51, Dec. 18, 1918, pp. 1001-1004, 6 figs. Extensions necessitated to build four 5100-ton steel cargo boats.

Shipbuilding at the Pensacola Yards, John M. Sweeney. Int. Mar. Eng., vol. 24, no. 1, Jan. 1919, pp. 12-16, 8 figs. Well-constructed plant for 9000-ton fabricated steel ship; use of permanent scaffolding; powerful plate-bending machine.

Routing of Materials

Routing of Fabricated Ship Material at Bristol. Eng. News-Rec., vol. 82, no. 1, Jan. 2, 1919, pp. 25-30, 9 figs. Hull construction operated on basis of shop-to-storage-to-ship system requires accurate timing of material supply, shop work, and assembly; routing handled by production department.

Welding

The Steel Ship and Oxy-Acetylene Welding, J. F. Springer. Can. Machy., vol. 20, no. 25, Dec. 19, 1918, pp. 701-703. Observations on behavior of metal under welding flame and precautions to be taken. Writer believes tensile strength of material at and near weld is much less than that of the plates. Of the restorative measures available, he considers reheating method the most convenient and effective.

Welding Designs for Shipyard Use, E. G. Rigby. Marine Rev., vol. 49, no. 1, Jan. 1919, pp. 22-29, 22 figs. Practical examples of electric welding in deck, tank and bulkhead structures; how it is applied to armor plate.

Electric Welding in Ship Construction, H. Jasper Cox. Int. Mar. Eng., vol. 24, no. 1, Jan. 1919, pp. 42-46, 7 figs. Methods of welding and apparatus described; inspection and testing welds; speed and cost of welding; Lloyd's experiments. Paper before Soc. of Naval Architects and Mar. Eng., Philadelphia, Nov. 1918.

The Steel Ship and Oxy-Acetylene Welding, J. F. Springer. Int. Mar. Eng., vol. 23, no. 12, Dec. 1918, pp. 699-701. Autogenous welding decreases strength of steel; behavior under heat; restorative measures.

The First Electrically Welded Boat, John Liston. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 844-848, 10 figs. Process followed in welding 42-ft. boat of 11-ft. beam said to have been plying Lake Erie for two years when the 275-ton, English-built, rivetless welded barge was launched in June 1918.

Electric Welding for Shipbuilding. Elecn., vol. 81, no. 2114, Nov. 22, 1918, pp. 619-620. From address by W. S. Abell, Chief Ship Surveyor of Lloyd's Register, before North-East Coast Inst. of Engrs. and Shipbuilders, Tyneside, Nov. 1918.

U. S. Warship Kept on the Job by Oxy-Acetylene Torch. Jl. Acetylene Welding, vol. 20, no. 6, Dec. 1918, pp. 290 and 292. Repair of boiler with oxy-acetylene outfit.

Electric Welding for Shipbuilding, W. S. Abell. Nautical Gaz., vol. 94, no. 24, Dec. 14,

1918, pp. 346-347. Past progress; strength of joints; possibility of industry. Paper before British Northeast Coast Instn. Engrs. & Shipbuilders.

The Adequacy of Welding in Constructing Hulls of Ships, H. M. Hobart. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 840-845. Investigations of Welding Research Sub-Committee of Emergency Fleet Corporation in regard to relative merits of different systems and equipments.

Spot Welding and Some of Its Applications to Ship Construction, H. A. Winne. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 923-927, 6 figs. Advantages of spot welding over riveting with respect to strength, time, and labor; limitations of spot welder; application of spot welding to construction of ladders and gratings and to plugging of misplaced holes.

Electric Welding in Navy Yards, H. G. Knox. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 849-859, 20 figs. Work conducted in each type of shop in a navy yard; recommendations of welding equipment desirable in each shop; data on speed and cost of welding ship structures; comparative cost data of welding based on records from steam railroads.

The Electric Arc Used in Steamship Overhauling. Can. Machy., vol. 20, no. 24, Dec. 12, 1918, pp. 675-676, 2 figs. Examples of uses of Westinghouse arc welder in repairing marine boiler and furnace while under steam.

Arc Welding in Shipyard, W. L. Roberts. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 860-864, 13 figs. Simplification of anglesmith's work by use of arc welding in production of staples; probability of abandoning staples in favor of directly arc-welding parts; application of electric arc to construction of water, oil, and air tanks, stacks, condensers, and other similar appliances.

Wooden Vessels

Building Wooden Vessels on the Pacific. Int. Mar. Eng., vol. 24, no. 1, Jan. 1919, pp. 8-11, 8 figs. Record of accomplishment; Hough and Ferris types give way to 5000-ton vessels; wood vessels coming into their own again.

VARIA

Emergency Fleet Corporation

Organization of the U. S. Shipping Board Emergency Fleet Corporation, Charles Piez. Jl. Am. Soc. Mech. Engrs., vol. 41, no. 1, Jan. 1919, pp. 32-35, 2 figs. Relationship and functions of Board and construction and operation divisions of Fleet Corporation.

Naval Engineering in War

The Achievements of Naval Engineering in the War, William L. Cathcart. Jl. Am. Soc. Mech. Engrs., vol. 41, no. 1, Jan. 1919, pp. 18-25, 18 figs. Organizations and principal activities of Bureau of Steam Engineering; electric drive for battleships; repair of German merchant ships by oxy-acetylene welding. Presented at annual meeting of Society.

U. S. Shipbuilding in 1918

Shipbuilding in the United States in 1918. Int. Mar. Eng., vol. 24, no. 1, Jan. 1919, pp. 5-7. Three million tons of merchant ship completed in first eleven months; rate of production rapidly increasing.

Organization and Management

ACCOUNTING

Expense Distribution

Efficiency and Democracy, H. L. Gantt. Jl. Am. Soc. Mech. Engrs., vol. 41, no. 1, Jan. 1919, p. 43. Suggestions in regard to accounting systems. Stress is laid on erroneous process of charging work with expense of idle machines.

EDUCATION

Apprentices

The Training of Engineering Apprentices, T. H. Fenner. Can. Machy., vol. 20, no. 23, Dec. 5, 1918, pp. 641-643, 4 figs. Analyzes necessary standard of education and suggests course of training.

Canada

Labor, Apprenticeship and Technical Education. Can. Engr., vol. 35, no. 24, Dec. 12, 1918, p. 511. Report of committee to Ottawa Conference of Assn. of Can. Building and Construction Industries.

Crippled Workers

How to Deal with Crippled Workers, T. Norman Dean. Am. Mach., vol. 49, no. 25, Dec. 19, 1918, pp. 1115-1116. Suggestions from deductions from scientific experience to relieve 2,122,000 industrial cripples in United States.

Physical Reconstruction of Crippled Men, Constance Drexel. Blast Furnace, vol. 6, no. 12, Dec. 1918, pp. 508-509. Plan of U. S. Government for rehabilitation and vocational training; schools established giving courses in oxy-acetylene welding, etc.

Re-Educated Soldiers in the Machine Trade, Katherine Freeman. Can. Machy., vol. 20, no. 25, Dec. 1918, pp. 691-692, 2 figs. Instances in which vocational reëducation, together with artificial limbs, have made injured soldiers earn more than in pre-war days.

Industrial Surveys for Physical Readjustment, A. B. Segur. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 63-65, 2 figs. Method of investigating possibilities of employing disabled persons in industry, developed by Red Cross Institute for the Blind; results shown for few operations in a meat-packing house.

Engineers

The Engineer in Foreign Service, L. S. Rowe. Jl. Am. Soc. Mech. Engrs., vol. 41, no. 1, Jan. 1919, pp. 31-32. Plea to broaden training of engineer in order that he may acquire a greater breadth of view which will permit his adaptability to international service.

English Language

Educational in English Language Promotes Efficiency, Sarah Elkus. Nat. Efficiency Quarterly, vol. 1, no. 3, Nov. 1918, pp. 140-149. Coöperation of Board of Education in promoting English classes in factories; English as a safety-first method.

S. A. T. C.

Students' Army Training Corps, Alexander S. Langsdorf. Proc. St. Louis Ry Club, vol. 23, no. 7, Nov. 22, 1918, pp. 115-127 and (discussion) pp. 127-129. Educational plan as developed by War Department after series of experiments. Special reference made to features and arrangements of Government contracts with Washington University.

Intensive Training, C. R. Dooley. Jl. Am. Soc. Mech. Engrs., vol. 41, no. 1, Jan. 1919, pp. 37-38. Program set up by Committee on Education and Special Training. It consisted of (1) military training, (2) sorting and training according to ability, (3) trade fundamentals and combinations, and (4) development of originality and initiative.

Shipyards

Industrial Training in War Time, E. E. MacNary. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 871-875, 4 figs. Procedure followed and accomplishments performed by Emergency Fleet Corporation. Article deals with teaching of eighteen different trades.

Training 350,000 Men for the Shipyards, J. Will Parry. Eng. News-Rec., vol. 82, no. 1, Jan. 1, 1919, pp. 53-56, 1 fig. How Fleet Corporation met problem.

Training Workers in Shipyards, R. V. Rickford. Int. Mar. Eng., vol. 24, no. 1, Jan. 1919, pp. 38-42, 12 figs. Short cut over old apprentice system; work progresses from simple to difficult operations; rivet records show results.

Trade Journals

Technical Journal Best Aid to Education, S. Balmfirth. Can. Foundryman, vol. 9, no. 12, Dec. 1918, pp. 307-309. After analyzing advantages and disadvantages of various sources of technical education writer concludes that technical journals, by reason of their ready availability and simplicity of style, are best help for self-instruction. Also in Can. Machy., vol. 20, no. 23, Dec. 5, 1918, pp. 655 and 657.

Training Factory

Lens Grinding in a Training Factory, Erik Oberg. Machy., vol. 25, no. 4, Dec. 1918, pp. 330-332, 3 figs. Means for meeting war emergencies devised by U. S. Government.

Vocational Schools

Need for vocational Schools in Mining Communities, J. C. Wright. Bul. Am. Inst. Min. Engrs., no. 145, Jan. 1919, pp. 91-94. Kinds of vocational schools which may be organized under the terms of the Federal Vocational Education Act.

Welders

The Training of Electric Welders, H. A. Horner. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 876-881, 9 figs. Development of ingenuity and manipulating skill necessitated by welding operators said to be principal aim of course given by instructors of Emergency Fleet Corporation.

Women

Service for Women in the Gisholt Shop, J. V. Hunter. Am. Mach., vol. 50, no. 1, Jan. 2, 1919, pp. 6-10, 17 figs. Methods used in training women workers in a Wisconsin shop.

Preliminary Training for Women Workers, Fred H. Colvin. Am. Mach., vol. 49, no. 24, Dec. 12, 1918, pp. 1067-1070, 9 figs. Account of methods employed in school of Packard Motor Car Co.

Motor Company's Shop Training for Women, F. L. Prentiss. Iron Age, vol. 102, no. 24, Dec. 12, 1918, pp. 1453-1455, 1 fig. Intensive work at Lincoln plant done in threshold school; women employees are protected by enforcement of rigid rules.

Work Schools

New Developments in Industrial Organization, Modern Methods of Port Sunlight (Ill.), W. G. Cass. Cassier's Eng. Monthly, vol. 54, no. 5, Nov. 1918, pp. 248-256. Work schools at Port Sunlight works.

FACTORY MANAGEMENT

Employment Managers

Aids to Employment Managers and Interviewers on Shipyard Occupations with Description of Such Occupations. Special Bul. U. S. Shipping Board Emergency Fleet Corporation, 1918, 147 pp. List of fundamental trades and occupations with most commonly accepted names used as standard. Specifications describe occupation from shipyard standpoint.

Duties of the Employment Manager, Charles W. Moon. Machy., vol. 25, no. 5, Jan. 1919, pp. 443-447, 9 figs. Fundamental principles involved and methods used successfully by R. K. Le Blond Machine Tool Co.

Employment Managers Graduate at the University of California, A. T. Parsons. Metal Trades, vol. 9, no. 11, Nov. 1918, pp. 450-452. Historical account of development of industrial activity involved in occupation of employment managers.

Handbook on Employment Management in the Shipyard. Organizing the Employment Department—I. U. S. Shipping Board Emergency Fleet Corporation 1918, 17 pp. Methods and processes of handling employment problems, which have been found successful in some of largest shipyards and corporations in U. S.

The Employment Manager a New Factor in the Industrial Relationship, Edward D. Jones. Wis. Engr., vol. 23, no. 2, Nov. 1918, pp. 48-53. Considerations on necessity for and meaning of formanizing labor as developed in new profession. Also in Metal Trades, vol. 9, no. 12, Dec. 1918, pp. 500-501.

Employment Methods

Installing Employment Methods, William Alfred Sawyer. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 7-11, 16 figs. Record of first year's work of employment and health department of American Pulley Co.

Interviewing and Selecting, Mark M. Jones. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 66-67. From address before Am. Assn. of Public Employment Officers.

Environment

Influence of Environment on Production, Lewis J. Brew. Am. Drop Forger, vol. 4, no. 11, Nov. 1918, pp. 428-429. Suggestions in layout and details of forge plant.

Equipment

Equipment for Diversified Production, A. B. Shuart. Am. Drop Forger, vol. 4, no. 11, Nov. 1918, pp. 429-430. Features of forge-plant design contributing to eliminate manual labor to large extent.

Ford Shipbuilding Methods

Ford Methods in Ship Manufacture—I, Fred E. Rogers. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 1-6, 12 figs. Basic features that made possible the production of Eagle submarine chasers. (To be continued.)

Foundry

Organizing a Foundry to Obtain Top Production, Paul R. Ramp. Foundry, vol. 47, no. 317, Jan. 1919, pp. 8-13, 5 figs. Systematic method of following up work of foremen in each department essential. From paper before Am. Foundrymen's Assn., Milwaukee.

Inter-Departmental Communications

Shooting the Shop Orders to Their Targets, Robert L. Clegg. Iron Age, vol. 103, no. 1, Jan. 2, 1919, pp. 53-55, 4 figs. Simple scheme of Geometric Tool Co. to rush instructions to departments the instant they are required.

Localization of Industry

The Localization of Industry, Malcolm Keir. Sci. Monthly, vol. 8, no. 1, Jan. 1919, pp. 32-48. Localization traceable as response to resources either in raw materials and power, or in unskilled labor; chance and monopoly as contributing factors; requirements of factories utilizing waste products; dependence of localized industries on skilled labor; influence of localization in formation of labor unions; deterrent features of localization.

Material Handling

Saving Tool Materials in Winchester Shop, W. E. Freeland. Iron Age, vol. 102, no. 26, Dec. 26, 1918, pp. 1574-1575, 2 figs. Work of central material planning division. Files are kept on steel basis. Tenth article dealing with methods at Winchester plant.

Organization

What Should Organization Achieve? Harry Tipper. Automotive Indus., vol. 40, no. 1, Jan. 2, 1919, pp. 17-18. Its effect on (1) providing incentive to work, (2) settling individual grievances and general disagreements, (3) improving the working force, (4) decreasing labor turnover, and (5) reducing friction between departments.

Production Control

Graphic Production Control—V The Control of Equipment and Labor, C. E. Knoeppel, Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 56-62, 22 figs. Features of control said to improve efficiency of workmen, do away with idleness of equipment and improve faulty shop practice. (To be concluded.)

Public-Utility Plants

Practical Measures for Securing Greatest Economy in Public Utility Plant Operation, Charles Brossman. Mun. & County Eng., vol. 55, no. 6, Dec. 1918, pp. 206-208. Proper use of recording and indicating instruments; bonus system; examples of plant neglect.

Purchasing

Principles of Purchasing and Storing, Dwight T. Farnham. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 33-38, 6 figs. Instructions concerning storing of materials and supplies, their withdrawal from stock, preparing purchasing requisitions, obtaining bids and quotations, placing purchase orders, following up delayed purchase materials, and reporting receipt of materials. From U. S. Employment Service Bulletin.

Rates and Rate Setting

Time Studies for Rate Setting on Gisholt Boring Mills (III), Dwight V. Merrick. Cassier's Eng. Monthly, vol. 54, no. 5, Nov. 1918, pp. 271-275, 4 figs. Time required in actual manipulation of machine for cuts.

Establishing Basic Rates Saves Time Study Work, Carle M. Bigelow. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 17-22, 5 figs. Using as examples the determination of basic rate for a machine and finding basic rate for manual labor, writer points out how their use gradually increases usefulness of time-study men by simplifying vexatious problems of determining allowed times and repeated studies due to variation of product for single operation.

Shop Efficiency

The Cultivation of Shop Efficiency, H. J. MacMillan. Am. Drop Forger, vol. 4, no. 11, Nov. 1918, pp. 446-447, 9 figs. Contrasts present with past conditions in industrial relationship between employees. In illustration quotes work accomplished by Mueller Mfg. Co.

Tool System

A Simple Tool System, B. L. Van Schaick. Indus. Management, vol. 57, no. 1, Jan. 1919, p. 32, 1 fig. Plan based on actual inventory and formation of central crib where all grinding, dressing and repairing is done.

FINANCE AND COST

Cost Accounting

Cost Accounting to Aid Production IV. The Principles of Burden Distribution, G. Charter Harrison. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 49-55, 2 figs. Details of method of obtaining machine rates, bringing in use of punched cards and sorting and tabulating machines. (To be continued.)

Cost Finding

True Cost Finding What It Can Do for the Railroads, Morris Llewellyn Cooke. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 40-42. States that since main purpose in collecting cost data is to measure efficiency, its scientific application in railroad operation will provide gage for efficiency of each performance; and that initiative in scheming out an adequate cost finding system should be taken by U. S. Railroad Administration.

Cost Systems at Factories

Costing at National Factories, W. Webster Jenkinson. Iron & Coal Trades Rev., vol. 47, no. 2645, Nov. 8, 1918, pp. 513-516. Forms of progress records and cost returns; desirability of introducing cost system in a business. (Concluded.)

Cost Systems, Construction

How to Figure Construction Costs, Stanley D. Moore. Cement & Eng. News, vol. 30, no. 12, Dec. 1918, pp. 30-32. Notes on calculation of sewer system costs. Address at annual meeting of Iowa Eng. Soc.

INSPECTION

Fuel Supervision

Supervision and Fuel Economy, Robert Collett. Official Proc. N. Y. R. R. Club, vol. 29, no. 1, Dec. 1918, pp. 5452-5455. Recommends supervision by friendly counsel and encouragement.

LABOR

Bonuses

Day Labor, Force Account Work and Bonuses, Charles M. Upham. Good Roads, vol. 16, no. 25, Dec. 21, 1918, pp. 239-241. Discusses advantages and disadvantages. Paper presented at meeting of Am. Assn. State Highway Officials, Chicago.

Piece Work and Bonus System (Le travail aux pièces et la prime), M. Crémieux. Génie Civil, vol. 73, no. 17, Oct. 26, 1918, pp. 329-333, 8 figs. Established fundamental equations for comparison of these two systems of remunerating workers.

Compensation

Workmen's Compensation, Health Insurance and Hospitals, Thomas Howell. Modern Hospital, vol 11, no. 5, Nov. 1918, pp. 414-416. Discussion of future relations of charitable hospitals to industry, indicating probable vast changes.

Cripples

An Experimental Employment Bureau for Cripples, Eleanor Adler, Modern Hospital, vol. 11, no. 5, Nov. 1918, pp. 402-405. Brief historical account of efforts to find employment for disabled with reference to establishment of bureau under control of Federation of Assns. for Cripples and the Hudson Guild.

Opportunities for Crippled Soldiers in the Metal Industries, Elsie Plant. Metal Trades, vol. 9, no. 11, Nov. 1918, pp. 448-449, 3 figs. Some of the things disabled men can do, as found by Red Cross Inst. for Crippled and Disabled Men.

Demobilization

When Labor Comes to Market, Walton H. Hamilton. Survey, vol. 41, no. 14, Jan. 4, 1919, pp. 425-428. Explanation and comment on demobilization chart of U. S. Labor Policies Board showing importance of rate at which demobilization is to be effected, analysis of problem and contingencies upon which solution depends.

Status of the Unproductive Worker, Harry Tipper. Automotive Indus., vol. 39, no. 25, Dec. 1918, pp. 1045-1046. Right of salaried workers to representation in organization with skilled and unskilled employees.

Employment Department

Employment Department, Hog Island Shipyard. Am. Mach., vol. 49, no. 23, Dec. 12, 1918, pp. 1071-1075, 11 figs. Shows forms used and describes process of employing men.

A Definition of "Penny-Wise, Pound Foolish," Applied to the Picking and Developing of Men for Big Jobs, Christian Girl. Monthly Jl. Utah Soc. Engrs., vol. 4, no. 9, Sept. 1918, pp. 169-175. Analysis of characteristics in personnel which contribute to stability of organization. Experience of writer in picking out men. From System.

Selecting Employees. Gas Industry, vol. 18, no. 12, Dec. 1918, pp. 359-362. Forms used by company covering appearance, mentality, and ability of applicants, who are examined on each by different person.

Housing

Instances of Industrial Housing. Stone & Webster Jl., vol. 23, no. 6, Dec. 1918, pp. 408-413, 11 figs. General appearance and finish of industrial housing at Mills of Carnegie Steel Co., and Buckeye Coal Co. Developments include building of houses, grading of streets, installation of water and sewer lines, etc.

The New E. F. C. Hotel at Hog Island, W. H. Blood. Stone & Webster Jl., vol. 23, no. 5, Nov. 1918, pp. 344-346, 4 figs. Views; rules; conveniences available. Hotel accommodates 2176 men.

Industrial Courts

New Basis for Industrial Relations, Harry P. Kendall. Am. Contractor, vol. 39, no. 52, Dec. 28, 1918, p. 17. Discusses establishment of set of federal industrial courts as in Australia, and formation of boards set up by workmen and their employees with equal representation on each side to determine standards of wages, hours and conditions of employment. Address before Nat. Councillors of Chamber of Commerce of U. S.

Labor Representation

How Labor Representation Operates. Iron Trade Rev., vol. 63, no. 24, Dec. 12, 1918, pp. 1349-1351. Presents plan adopted by Youngstown Sheet & Tube Co., in which the company commits itself to whatever may be declared to be just and equitable.

Political Plan of Organization Satisfactory for Relatively Small Establishments, Harry Tipper. Automotive Indus., vol. 39, no. 26, Dec. 26, 1918, pp. 1083-1084 and 1088. Combined work of employees' representatives and supervisors' committee.

Real Labor Representation, Harry Tipper. Automotive Indus., vol. 39, no. 24, Dec. 12, 1918, pp. 1006-1007 and 1010, 1 fig. Analysis of Midvale Steel & Ordnance Co.'s plan. Organization constituted of legislative and judicial committees elected by employees in the various plants.

Labor Situation

What About Labor? Business Digest & Investment Weekly, vol. 22, no. 12, Dec. 17, 1918, pp. 421-423 and 429. Reasons why, despite resumption of normal business activity, there is hesitancy due to possibilities in labor situation.

Mine Labor

Employment of Mine Labor, Herbert M. Wilson. Bul. Am. Inst. Min. Engrs., no. 145, Jan. 1919, pp. 83-85. Important aspects of securing and retaining workmen; purpose of Federal Board for Vocational Education.

Piece-Rate Card System

Layout and Piece-Rate Card System, John J. Borkenhagen. Machy., vol. 25, no. 4, Dec. 1918, pp. 327-329, 13 figs. Forms that assist in efficiency shop management.

Relations Between Employees

A Unique Method of Handling Employees. Jl. Elec., vol. 41, no. 10, Nov. 15, 1918, pp. 443-444. Promoting activities which will foster social relationship between them.

The Human Touch in Supervision, E. C. Clarke. Elec. Ry. Jl., vol. 52, no. 24, Dec. 14, 1918, 1048-1050, 3 figs. Object of management should be to instill spirit of coöperation among employees; how it may be done.

Wages

The Relation of Wages to Public Health, B. S. Warren and Edgar Sydenstricker. Am. Jl. Public Health, vol. 8, no. 12, Dec. 1918, pp. 883-887. Points out the necessity of providing families with suitable money value commensurate with local necessities and capable of eliminating undesirable factors which may bring about unhealthy conditions. Based on statistics for period 1907-1912.

Standardization and Administration of Wages, H. P. Kendall and E. D. Howard. Jl. Am. Soc. Mech. Engrs., vol. 41, no. 1, Jan. 1919, pp. 35-37. Consequences of system of contractual relations between employers and employees; work of the War Labor Policies Board; post-war labor problems; advisability of establishing system of organized labor participation in management.

Welfare

Welfare or Manpower Engineering? Frances A. Kellor. Nat. Efficiency Quarterly, vol. 1, no. 3, Nov. 1918, pp. 123-139. Contends that welfare work does not touch basic structure of plant management and that industrial relationship must be built in terms of engineering—impersonal, accurate, just and coördinated.

Women

Wartime Experience With Women Metal Workers. Foundry, vol. 47, no. 317, Jan. 1919, pp. 6-7. Their efficiency has been demonstrated in core shops, foundries and metal-working plants generally and in some respects they have been found superior to men.

Women Workers and Labor Turnover, Ida May Wilson. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 67-68. Temperamental and psychological factors determining complacency and permanency of women employees.

Women in Industry. Travelers Standard, vol. 6, no. 12, Dec. 1918, pp. 237-256, 9 figs. Present and future need for women; their limitations; selecting and training them; supervision and discipline; special aspects of safety problem; hours of labor; sanitation and general welfare; reference to American and European practices.

Woman's Place in Scientific Industry. Cassier's Eng. Monthly, vol. 54, no. 5, Nov. 1918, pp. 263-264. Woman's labor after demobilization.

The Women in Our Industries. Jl. Elec., vol. 41, no. 11, Dec. 1, 1918, pp. 499-500. Record of situation in U. S. with special reference to conditions in the West.

Developing Latent Labor Forces, John E. Otterson. Nat. Efficiency Quarterly, vol. 1, no. 3, Nov. 1918, pp. 168-178. Women as laborers.

Let the Women Do the Work, D. C. Fessenden. Metal Trades, vol. 9, no. 11, Nov. 1918,

pp. 435-438, 4 figs. Experience of several western companies.

LEGAL

Boiler Making

Legal Decisions Affecting Boiler Makers, John Simpson. Boiler Maker, vol. 18, no. 12, Dec. 1918, pp. 339-340. Employer responsible for condition of tools; employers' liability in America and England; employee's risk when precaution is disregarded; decision covering steam-pipe fitting; liability under federal boiler inspection act.

Change of Appliances

Change of Appliances, Chesla C. Sherlock. Power, vol. 48, no. 25, Dec. 17, 1918, p. 887. Some legal decisions.

Engineering License Laws

Engineering License Laws. Can. Engr., vol. 35, no. 25, Dec. 19, 1918, pp. 530 and 535. Report of committee appointed by Am. Assn. Engrs. to gather information concerning state engineering license laws, either proposed or in operation, and to draw up a standard license law.

Labor Legislation

Coordination of Legislative and Operative Functions in Labor Essential to Success, Harry Tipper. Automotive Indus., vol. 39, no. 23, Dec. 5, 1918, pp. 958-959 and 986. Organization fundamentals and changes; experiments in organization and their advantages. (Second series.)

Power Plants

Some Recent Legal Decisions. Power, vol. 48, no. 27, Dec. 31, 1918, pp. 970,971. Brief reports of some cases involving power plants.

LIGHTING

Chicago Factories

Productive Intensities, Wm. A. Durgin. Trans. Illum. Eng. Soc., vol. 13, no. 8, Nov. 20, 1918, pp. 417-424, and (discussion), pp. 424-428, 6 figs. Illumination survey of Chicago factories having connected load of 100 kw. or more.

Electrical Manufacturing Plants

Improved Lighting of Electrical Manufacturing Plants, F. H. Bernhard. Elec. Rev., vol. 73, no. 24, Dec. 14, 1918, pp. 917-922, 7 figs. Last of series of twelve articles on electric lighting in industries.

Inspection

Light, Electricity and the Shop, C. E. Clewell. Am. Mach., vol. 49, no. 25, Dec. 19, 1918, pp. 1117-1122, 11 figs. Description of educational plan for state factory inspectors in New Jersey and Pennsylvania and some results accomplished in these states.

Machine Tools

The Lighting of Machine Tools, Cassier's Eng. Monthly, vol. 54, no. 5, Nov. 1918, pp. 276-279, 4 figs. Schemes for lighting punching machine, bench vises, turret lathe and drilling machine.

War Effects

Lighting Units for Commercial, Office and Home Illumination. Elec. Rec., vol. 24, no. 6, Dec. 1918, pp. 45-53, 37 figs. Discussion of present practice with illustrations of the various types; emphasis laid on effect of war.

Wartime Lighting Economies. Trans. Illum. Eng. Soc., vol. 13, no. 8, Nov. 20, 1918, pp. 387-400 and (discussion) pp. 400-410. Rules limiting use of artificial light to minimum necessary numbers of hours per day, and promoting efficient use of artificial light during those hours. Prepared by Committee on War Service of Illum. Eng. Soc.

See also MARINE ENGINEERING, Yards (Illumination).

PUBLIC REGULATION

Federal Control of Labor

Effect of Federal Control on Railway Labor, W. S. Carter. Ry. Age, vol. 65, no. 24, Dec. 13, 1918, pp. 1061-1064. Outline of efforts to create improved relations between employer and employee.

Water-Power Development

A Plan for Power Development, C. Edward Magnusson. Jl. Elec., vol. 41, no. 10, Nov. 15, 1918, pp. 549-460, 1 fig. Scheme permitting Government aid without doing away with private enterprise and its application to State of Washington.

RECONSTRUCTION

Automobile Industry

Some Probable Effects of the War on the Automobile Industry, A. A. Remington. Automobile Engr., vol. 8, no. 120, Nov. 1918, pp. 306-311, 2 figs. Presidential address before Instn. Automobile Engrs.

British Export Trade

Quantity or Quality, W. Slater. Cassier's Eng. Monthly, vol. 54, no. 5, Nov. 1918, pp. 284-286. Remarks on British export trade.

Canada

Reconstruction in Canada and the Social and Economic Forces Which Will Condition It, J. A. Stevenson. Survey, vol. 41, no. 14, Jan. 4, 1919, pp. 441-446. Problem of repatriation of troops as being worked out by committee of cabinet.

Canada Readjusting from War to Peace, Carroll E. Williams. Mfrs. Rec., vol. 75, no. 1, Jan. 2, 1919, pp. 159-160. Plans of industrial and agricultural work for returning soldiers.

Dumping

The Truth About German Steel Dumping, E. T. Good. Cassier's Eng. Monthly, vol. 54, no. 5, Nov. 1918, pp. 286-288. Warning against introduction into England of German products; former German policy.

Exports

World Markets for American Manufacturers, Lynn W. Meekins. Sci. Am., vol. 120, no. 1, Jan. 4, 1919, p. 12. Factors limiting market in France; how Germany obtained East Indian business; possibilities in Dutch East Indies.

Cultivating Japanese Automotive Field (V), Tom O. Jones. Automotive Indus., vol. 39, no. 25, Dec. 19, 1918, pp. 1059-1061. Opportunities for American tire makers; suggestions to American manufacturers.

Cultivating the Chinese Automotive Field, Tom O. Jones. Automotive Indus., vol. 39, no. 26, Dec. 26, 1918, pp. 1106-1107 and 1122, 5 figs. Condition of Chinese roads as a factor in automotive development; types of cars for China.

Latin-American Exports

Entering the Export Markets of Latin America. IV The Value of Insurance, Percy F. Martin. Cassier's Eng. Monthly, vol. 54, no. 5, Nov. 1918, pp. 280-283. Advisability of insuring shipments against loss or damage.

Post-War Trade

Obstacles to Post-War Trade, Richard Cooper. Soc. of Engrs. Jl. & Trans., vol. 9, no. 11, Nov. 1918, pp. 169-179 and (discussion) pp. 179-187. Sets forth problems of reorganization of industry to peace work. Possible profit from a system of high wages indicated from author's experience in engineering and chemical industry.

Readjustment Problems

Readjustment Problems Confronting America, Harry A. Wheeler. Gas Age, vol. 42, no. 12, Dec. 16, 1918, pp. 511-514. Presidential address before Chamber of Commerce of United States, Atlantic City. Also in Am. Fertilizer, vol. 49, no. 12, Dec. 7, 1918, pp. 38-39.

Reconstruction Problems, M. F. Chase. Bul. Am. Inst. Min. Engrs., no. 145, Jan. 1919, pp. IX-XI. Parallel between European and American reconstruction problems; cancellation of contracts for war materials.

Petroleum and Reconstruction Problems, Chester Naramore. Bul. Am. Inst. Min. Engrs., no. 145, Jan. 1919, pp. XIV-XVIII. Erroneousness of conception that petroleum demands will decrease after signing of peace. Present leading position of U. S. in industry and means to perpetuate it.

Reconstruction of American Business, Edwin L. Seabrook. Boiler Maker, vol. 18, no. 12, Dec. 1918, pp. 338 and 352. Advisability of Government control during transitional period; adjustment of wages and prices; special legislation.

Organizing the Nation for Peace, L. W. Alwyn-Schmidt. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 45-48. Survey of general plans of England, France and Germany for redistributing labor, repatriating army, invalid labor, reëstablishing artisans and industrial housing. Also points out difficulties to be faced by United States in meeting world-wide competition.

See also MECHANICAL ENGINEERING, Motor Car Engineering (Exports).

SAFETY ENGINEERING

California State Commission

Accident Prevention, John R. Brownell. Proc. Pacific Ry. Club, vol. 2, no. 8, Nov. 1918, pp. 12-13. Work being done by commission which administers State Compensation Fund created by California legislature in Workmen's Compensation Insurance and Safety Act.

Causes of Industrial Accidents

Factors Concerned in the Causation of Industrial Accidents. Automotive Indus., vol. 39, no. 22, Nov. 28, 1918, pp. 916-918. Comparison of report of Health of Munition Workers Committee of British Ministry of Munitions with U. S. Labor Bureau statistics.

Reduction of Accident Hazard, R. L. Gould. Cassier's Eng. Monthly, vol. 54, no. 5, Nov. 1918, pp. 265-270, 1 fig. Discussion of questions confronting safety engineer in his endeavor to minimize risk of accident to limb and life in industrial plants and suggestions for promoting work.

Cranes

Safety First for Crane and Operator. Jl. Elec., vol. 41, no. 11, Dec. 1, 1918, pp. 524-525, 2 figs. Special protection panel for cranes having three polyphase motors. Panel provides two inverse time-element overload relays for each motor.

Diseases

Diseases and Infections, Chesla C. Sherlock. Am. Mach., vol. 50, no. 1, Jan. 2, 1919, pp. 18-30. Some legal interpretations of liability.

Dust Inhalation

Effects of Dust Inhalation, J. S. Haldane. Queensland Government Min. Jl., vol. 19, no. 222, Nov. 15, 1918, pp. 515-517. Analysis of dust and result of experiments on its reported destructive effects. Paper submitted to Chem. Metallurgical & Min. Soc. of South Africa and to Instn. Min. Engrs.

Eye Protection

Eye Protection in Iron Welding Operations, W. S. Andrews. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 961-966, 7 figs. Charts illustrating spectra of commercially available glasses and their combinations, for use in selecting best protection against radiations of welding arc.

Inflammable Materials

The Dangers of Explosion With Inflammable Liquids and Vapors, W. Payman. Sci. Am. Supp., vol. 87, no. 2244, Jan. 4, 1919, p. 7. Criteria for judging liability of a given liquid to produce dangerous conditions; precautions necessary in handling inflammable liquids. From Jl. Soc. Chem. Indus.

The Dangers of Explosion with Inflammable Liquids and Vapors, W. Payman. Jl. Soc. Chem. Indus., vol. 37, no. 21, Nov. 15, 1918, pp. 406R-408R. Limits of inflammability of commoner organic solvents as recorded by different observers.

Lighting Defects

The Relation Between Light Curtailment and Accidents, R. E. Simpson. Trans. Illum. Eng. Soc., vol. 13, no. 8, Nov. 20, 1918, pp. 429-435 and (discussion) pp. 435-438. Considerations based on statistical figures and present systems of factory illumination.

Metal Industries

Causes and Prevention of Accidents in the Metal Industries, L. W. Chaney and Hugh S. Hanna. Metal Trades, vol. 9, no. 12, Dec. 1918, pp. 498-499, 3 figs. From Bul. 234 of U. S. Department of Labor.

Quarries

Accident Prevention in Quarry Operation, William H. Baker. Cement & Eng. News, vol. 30, no. 12, Dec. 1918, pp. 27-28. Work of Committee on Safety and Welfare of Atlas Portland Cement Co. From address before Nat. Safety Council.

Shop Safety Organization

Shop Safety Organization. The Bulletin, N. Y. State Indus. Commission, vol. 4, no. 3, Dec. 1918, pp. 48-52 and 57. Plan worked out by Bureau of Statistics and Information of State Industrial Commission and discussed at session of Industrial Safety Congress.

Steel Industry

Hazards Reduced in Steel Industry. Iron Trade Rev., vol. 63, no. 24, Dec. 12, 1918, pp. 1341-1345, 5 figs. Review of safety work of iron and steel industry in the last few years. From Bul. 234 of U. S. Bureau of Labor Statistics.

See also MINING ENGINEERING, Mines and Mining (Fire Protection; Safety).

SALVAGE

Waste Reduction

Conservation of Materials in Our Plants, Francis G. Hall. Am. Drop Forger, vol. 4, no. 11, Nov. 1918, pp. 440-441. Reducing waste by careful handling. (Second of Series.)

Salvaging Miscellaneous Wastes, W. Rockwood Conover. Indus. Management, vol. 57, no. 1, Jan. 1919, pp. 12-16, 3 figs. Methods for salvaging rubber, leather, fiber, rope, string, muslin rags, cloth trimmings, burlap sacks, old belting, asbestos sheeting, mica, insulation papers, wire, waste paper, boxes,

barrels, cans, containers, emery cloth, cotton waste, brooms, brushes, oil and fuel gas.

See also MECHANICAL ENGINEERING, Foundries (Salvage Work).

TRANSPORTATION

Inland Waterways

Handling Freight on Inland Waterways, H. McL. Harding. Int. Mar. Eng., vol. 23, no. 12, Dec. 1918, pp. 667-670, 6 figs. Advantages of effective inland terminals; operating costs small; importance of mechanical methods.

Motor-Truck Transport

Cost and Charges of Motor Truck Service. Ry. Rev., vol. 63, no. 23, Dec. 7, 1918, pp. 805-810, 9 figs. Some motor truck cost figures.

Rural Motor Express, S. W. Fenn. Jl. Soc. Automotive Engrs., vol. 3, no. 6, Dec. 1918, pp. 383-384 and (discussion) pp. 384-388. Work accomplished in Iowa; moving crops by motor trucks in Idaho; organization of rural lines in Tennessee, Alabama and Georgia.

VARIA

City Manager

Progress, Prospects and Pitfalls of the New Profession of City Manager, O. E. Carr. Can. Engr., vol. 35, no. 24, Dec. 12, 1918, pp. 513-514 and 519. Abstracted from paper before Fifth Annual City Mgrs. Convention.

Industrial Technology

Alcohol

Industrial Alcohol. Times Eng. Supp., no. 529, Nov. 1918, p. 228. Possible sources of supply.

Ammonium Nitrate

Coke Makers Now Make Nitrate of Ammonia, Mark Meredith. Chem. Engr., vol. 26, no. 12, Nov. 1918, pp. 451-452. English research proves it is commercially possible to turn ammonia by-product of coke ovens into nitrate of ammonia.

Clays

The Nature of the Air Content of Pugged Clays, H. Spurrier. Jl. Am. Ceramic Soc., vol. 1, no. 8, Aug. 1918, pp. 584-585, 1 fig. Apparatus to secure gas occluded in clay and result of analysis of gases collected from pugged-clay samples.

Burning Clay Wares (XXXII), Ellis Lovejoy. Clay-Worker., vol. 70, no. 6, Dec. 1918, pp. 496-498, 12 figs. Principle and arrangement of single outside stack kilns.

Chemical Industry

The Synthetic Organic Chemical Industry, Francis H. Carr. Jl. Soc. Chem. Indus., vol. 37, no. 22, Nov. 30, 1918, pp. 425R-428R. Importance of chemistry to the life of a nation and achievements of British chemists during years of war. From chairman's address to Nottingham Section.

Recent Progress and Future Development of Chemical Industries in France (Les progrès récentes et l'avenir des industries chimiques en France), Paul Razous. Génie Civil, vol. 73, nos. 19, 20 and 21, Nov. 9, 19 and 23, 1918, pp. 368-371, 390-393 and 407-410. Nov. 19: Potassium and sodium bichromates; mineral colors and varnishes; electrochemical industries; oils, pastes; fermentation; sugars; Nov. 23: Tanning industry; resins distillation of tars; carbonization of wood; artificial coloring.

The Criteria in the Declaration of Chemical Independence in the United States, I. Newton Kugelmass. Science, vol. 48, no. 1251, Dec. 20, 1918, pp. 608-612. Address at meeting of Alabama Section, Am. Chem. Soc.

Coal Products

Utilization of Lignite. Water & Gas Rev., vol. 29, no. 6, Dec. 1918, pp. 13-14. Characteristics of gas, ammonia, oils and tar obtained as by-products from lignite.

Distillation Tar from Mond Gas Plant, A. Gatley Lyons. Chem. Eng. & Min. Rev., vol. 10, no. 121, Oct. 5, 1918, pp. 19-20, 1 fig. Description of installation at Sulphide Corporation Works, New South Wales. Paper before Aust. Inst. Min. Engrs.

The Manufacture of Retort Coal-Gas in the Central States Using Low-Sulphur Coal from Illinois, Indiana and Western Kentucky, W. A. Dunkley and W. W. Odell. State of Ill., Div. Geol. Survey, bul. 21, 24 pp., 3 figs. Present use of central district coals; problems in their use in coal-gas manufacture; results reported; economical advantage of using them.

Dust Precipitation

Removing Foundry Dust by Electric Precipitation, H. D. Egbert. Foundry, vol. 47, no. 317, Jan. 1919, pp. 43-45, 6 figs. Two sets of electrodes used in Cottrell process, dust being charged with static electricity and attracted to collecting electrodes.

Cleaning Blast Furnace Gases by Electrical Precipitation, N. H. Gellert. Mfrs. Rec., vol. 74, no. 24, Dec. 12, 1918, p. 58. Tests on furnace operating on spiegeleisen and having a rated capacity of 200 tons of pig iron per day.

Enamels

Antimony Oxide as an Opacifier in Cast-Iron Enamels, J. B. Shaw. Jl. Am. Ceramic Soc., vol. 1, no. 7, July 1918, pp. 502-511 and (discussion) pp. 511-513. Results of experimental efforts to outline satisfactory working formulæ having antimony oxide as chief opacifying agent.

Preparation and Application of Enamels for Cast Iron, Homer F. Staley. Jl. Am. Ceramic Soc., vol. 1, no. 8, Aug. 1918, pp. 534-555, 3 figs. Details and arrangement of machinery in storing, weighing and mixing raw materials, melting enamel, drying, grinding and screening; operations followed in enameling process; enameling-room equipment.

How High-Grade Enameling Is Done, E. C. Kreutzberg. Iron Trade Rev., vol. 63, no. 23, Dec. 5, 1918, pp. 1290-1291, 4 figs. Practice followed in a New York plant.

Filtration

Filtration in the Laboratory, Robt. T. Smith. Color Trade Jl., vol. 4, no. 1, Jan. 1919, pp. 21-24. Modern methods: natural suction and under hydraulic head. Suggestions in regard to selection of papers and adaptation of accessory apparatus.

Glass

The Effect of Certain Impurities in Causing Milkiness in Optical Glass, C. N. Fenner and J. B. Ferguson. Jl. Am. Ceramic Soc., vol. 1, no. 7, July 1918, pp. 468-476. Reasons for opalescence with which certain pots of glass were affected at Bausch and Lomb plant and how it was overcome.

Gypsum

Some Factors Influencing the Time of Set of Calcined Gypsum, F. F. Householder. Jl. Am. Ceramic Soc., vol. 1, no. 8, Aug. 1918, pp. 578-583, 5 figs. Tests to determine effect of varying consistency of mixtures, time and rate of stirring and temperature of water used in mixing.

Mantle Lamps

Influence of B.t.u. on Gas Mantle Efficiency, R. S. McBride, W. A. Dunkley, E. C. Crittenden and A. H. Taylor. Gas Age, vol. 42, no. 12, Dec. 16, 1918, pp. 519-521, 3 figs. Extract from technological paper 110 of U. S. Bureau of Standards upon tests made in 1916 and giving data upon operation of mantle lamps.

Photography

Dyes in Photography, A. Seyewetz. Sci. Am. Supp., vol. 87, no. 2244, Jan. 4, 1919, p. 6. Their use in orthochromatic work and for non-halation plates. Abstract of paper in Chemie et Industrie, published in the British Jl. of Photography.

Pickling

The Chemistry of Pickling Baths. Automotive Indus., vol. 39, no. 23, Dec. 5, 1918, pp. 960-961. Action of acid on metal below scale; effect of variations in strength of bath and in temperature; modifying action of bath by organic and inorganic materials.

Niter Cake Substitute for Pickling Steel, E. E. Corbeit. Blast Furnace, vol. 6, no. 12, Dec. 1918, pp. 497-501. Investigation conducted by U. S. Bureau of Mines chiefly for purpose of conserving sulphuric acid.

Picric Acid

The Manufacture of Picric Acid, Alexander Murray. Color Trade Jl., vol. 4, no. 1, Jan. 1919, pp. 5-8, 2 figs. General features of nitrating pots; nitrating operation; description of large installation; crystallization of picric acid.

Silica Products

Study of Silica Products, A. Bigot. Iron & Coal Trades Rev., vol. 47, no. 2645, Nov. 8, 1918, pp. 521-522. Recommendations in regard to grinding rocks and burning products. Abstract of paper before Refractories Section of Ceramic Soc. of Swansea.

Sugar Industry

On the Manufacture of Polariscopes in the United States, C. A. Browne. Louisiana Planter, vol. 62, no. 1, Jan. 4, 1919, pp. 12-14. Reasons for and against proposed change in manufacture of saccharimeters and getting away from German sugar scale and starting anew upon international scale proposed by Sidersky and Pellet. Opinions from 14 leading American chemists quoted.

Ultra-Violet Light

Ultra Violet Light (XIX), Carleton Ellis and A. A. Wells. Chem. Engr., vol. 26, no. 12, Nov. 1918, pp. 463-464 and 473. Its application in chemical arts.

Vegetable Drying

The Desiccation of Vegetable Substances at Different Temperatures (Sur la dessiccation des substances végétables effectuée à différentes temperatures), G. Andre. Bulletin de la Société Chimique de France, vol. 23, no. 10, Oct. 1918, pp. 430-437. Results of experiments at temperatures above 100 deg. cent. in which the substances were subjected to dry air deprived of CO_2.

Yttrium

The Preparation and Properties of Yttrium Mixed Metal, J. F. G. Hicks. Jl. Am. Chem. Soc., vol. 40, no. 11, Nov. 1918, pp. 1619-1626, 1 fig. Preparation in powder form by decomposing anhydrous chlorides with sodium in vacuo and by electrolysis of these chlorides in fused condition; study of solution of yttrium earth metals in fused cryolite and of loss of yttrium chloride by volatilization.

Water Gas

Water-Gas Manufacture with Central District Bituminous Coals as Generator Fuel, W. W. Odell and W. A. Dunkley. State of Ill., Div. Geol. Survey, bul. 22, 24 pp., 3 figs. Data gathered by writers during inspection of 20 water-gas plants in Illinois and surrounding states, in which bituminous coal from central mining district of Illinois, Indiana and western Kentucky is being used as generator fuel.

Wood Waste

Some Uses of Wood Waste, Armin Elmendorf. Wis. Engr., vol. 23, no. 2, Nov. 1908, pp. 33-39, 2 figs. Methods for converting waste material into products valuable for use in industries.

See also ELECTRICAL ENGINEERING, Power Applications (Electrochemical Processes).

Railroad Engineering

ELECTRIC RAILWAYS

Argentina

Electric Traction on the Central Argentine Railway. Ry. Gaz., vol. 29, no. 20, Nov. 15, 1918, pp. 518-524, 8 figs. Rolling stock. (Continuation of serial.)

Regenerative Braking

Braking System Permitting Recovery of Energy in Vehicles Operated by Single-Phase Commutator Motors (Système de freinage avec récupération d'énergie pour véhicles actionnés par moteurs monophasés à collecteur), Behn-Eschenburg. Génie Civil, vol. 75, no. 18, Nov. 2, 1918, pp. 347-350, 5 figs. Theoretical aspect of question as suggested from new developments permitting recovery of braking energy at all speeds and with any charge.

Rolling Stock

The New Rolling Material of the Dutch Electric Railways Co. (Het nieuwe rollend materieel der E. S. M.), H. F. Adams. De Ingenieur, year 33, no. 46, Nov. 16, 1918, pp. 893-904, 13 figs. Description of new electric cars.

ELECTRIFICATION

California

Railway Electrification Recommended. Jl. Elec., vol. 41, no. 10, Nov. 15, 1918, pp. 465-466. Report of investigations made preliminary to recommending electrification of mountain divisions of Cal. railroads to Director General of Railroads.

Montreal Tunnel

Electrification of the Montreal Tunnel Zone, William G. Gordon. Proc. Am. Inst. Elec. Engrs., vol. 37, no. 12, Dec. 1918, pp. 1285-1296, 7 figs. Method of constructing tunnel 3.1 miles long; details of equipment of substation and dimensions of locomotives and motor cars; features of catenary system due to local conditions and prevailing extremely low temperatures. Also Elec. News, vol. 27, no. 23, Dec. 1, 1918, pp. 29-30.

LABOR

Women

Women in the Service of the Railways, Pauline Goldmark. Ry. Age, vol. 65, no. 23, Dec. 6, 1918, pp. 1016-1018. Address before Labor

Reconstruction Conference, Academy of Political Science, New York, Dec. 6, 1918.

LOCOMOTIVES

Boilers

Report of Inspection of Locomotive Boilers. Ry. Rev., vol. 63, no. 26, Dec. 28, 1918, pp. 907-909, 1 fig. Department of Locomotive Inspection shows favorable results notwithstanding handicap of war.

Design

Modern Locomotive Engine Design and Construction (XLIII). Ry. Engr., vol. 39, no. 467, Dec. 1918, pp. 222-227, 4 figs. Different types of superheaters for any desired working pressure; design calculations and formulæ.

Feedwater Heating

Locomotive Feed Water Heating, H. S. Vincent. Ry. Mech. Engr., vol. 92, no. 12, Dec. 1918, pp. 645-649, 8 figs. Discussion of exhaust steam and waste-gas methods of preheating for locomotive boilers.

Fireboxes

Radiant Heat and Firebox Design, J. T. Anthony. Ry. Mech. Engr., vol. 92, no. 12, Dec. 1918, pp. 658-660, 3 figs. Combustion chambers increase furnace efficiency and radiation; long tubes are of little value. From paper before Central Railway Club, May, 1918.

Individual Types

4-6-0 Passenger Engine and Double Bogie Tender: London and South-Western Railway. Ry. Engr., vol. 39, no. 467, Dec. 1918, pp. 228-229 and insert, 3 figs. Working drawings of engine and tender built at Eastleigh. Supplement to illustrations and particulars given in Oct. issue, pp. 184-186.

2-10-2 Type Locomotive for the Rock Island Lines. Ry. Age, vol. 65, no. 23, Dec. 6, 1918, pp. 992-994, 5 figs. Description with drawings and principal data.

A. T. & S. F. 4-8-2 Type Locomotives. Ry. Mech. Engr., vol. 92, no. 12, Dec. 1918, pp. 649-652, 2 figs. Drawings, description and principal data.

Standard Locomotives

Standard 4-8-2 and Light 2-10-2 Locomotives. Ry. Age, vol. 65, no. 24, Dec. 13, 1918, pp. 1067-1073, 12 figs. Drawings, descriptions and principal data.

Stokers

Mechanical Stoking of Locomotives, W. S. Bartholomew. Southern & Southwestern Ry. Club, vol. 14, no. 11, Sept. 1918, pp. 40-70 and (discussion) pp. 71-76, 62 figs. General arrangement of various types of stokers and their application to large freight and passenger locomotives; development of duplex stoker; result obtained in different types of locomotives.

Superheaters

Locomotive Superheater Maintenance. Ry. Mech. Eng., vol. 92, no. 11, Nov. 1918, pp. 621-623, 5 figs. From Bulletin No. 4, Locomotive Superheater Company.

Superheater Locomotive Performance. Ry. Mech. Eng., vol. 92, no. 12, Dec. 1918, pp. 652-655, 1 fig. From committee report presented at 1918 convention of Traveling Engrs'. Assn.

Three-Cylinder Locomotives

Three-Cylinder Locomotives, H. Holcroft. Ry. News, vol. 110, no. 2862, Nov. 9, 1918, pp. 331-332. Outline of British practice and study of problems involved in operating three valves by means of two gears. Paper before Instn. Locomotive Engrs.

Tires

Falling Weight Test on Railway Tyres, J. H. G. Monypenny. Engineering, vol. 106, no. 2759, Nov. 15, 1918, pp. 545-547, 8 figs. General discussion of this method of testing; suggestions in regard to changes in method.

NEW CONSTRUCTION

Hetch-Hetchy Project

San Francisco's Venture in Railroad Construction, A. J. Cleary. Ry. Age, vol. 65, no. 24, Dec. 13, 1918, pp. 1047-1050, 8 figs. Account of completion of 68-mile line as facility for Hetch Hetchy project.

OPERATION AND MANAGEMENT

British

British Railways Under War Conditions. Engineer, vol. 126, no. 3281, Nov. 15, 1918, pp. 410-412. Early events after outbreak of hostilities. (Ninth article.)

British Railway Engineering and Operation—Some Immediate Problems to Be Faced, John A. F. Aspinall. Ry. News, vol. 110, no. 2862, Nov. 9, 1918, pp. 326-330. Presidential address before Instn. Civil Engrs.

Foreman

Mission of Railway General Foreman, Robert Quayle. Ry. Jl., vol. 25, no. 1, Jan. 1919, pp. 28-29. Possible ways in which foremen can approach their men and develop in them loyalty to organization.

Fuel Conservation

Cooperation in Fuel Conservation, D. R. MacBrain. Official Proc. N. Y. R. R. Club, vol. 29, no. 1, Dec. 1918, pp. 5447-5452. Necessity to secure interest in fuel conservation of every one in a railroad operating organization; influence of general condition of locomotive on fuel economy; time and experience required by an engineer to become master of locomotive engineering; education of firemen.

The Responsibility of General Officers for Fuel Economy, R. J. Pearson. Official Proc. N. Y. R. R. Club, vol. 29, no. 1, Dec. 1918, pp. 5445-5447. Importance of establishing system of supervision which will enable officers to ascertain consumption of fuel.

Address of Mr. Eugene McAuliffe. Official Proc. N. Y. R. R. Club, vol. 29, no. 1, Dec. 1918, pp. 5437-5445. Railway fuel, and railway fuel conservation. Working details of Fuel Conservation Section.

Reclamation

Reclamation on Chicago, Milwaukee & St. Paul. Ry. Rev., vol. 63, no. 26, Dec. 28, 1918, pp. 903-905. Adapted from report of special committee (H. S. Sackett, chairman) investigating status of reclamation with view to formation of future policy.

Tonnage Rating

Train Resistance and Tonnage Rating. Ry. Jl., vol. 25, no. 1, Jan. 1919, pp. 29-31. Reports received by Committee of Master Mechanics' Convention from 25 roads, dealing with experience, tests conducted, regulations adopted and methods of supervision.

PERMANENT WAY AND BUILDINGS

Ballasting

Modern Track Needs Good Ballast, R. C. Cram. Elec. Ry. Jl., vol. 52, no. 25, Dec. 21, 1918, pp. 1080-1085, 14 figs. Why well-ballasted track is economical to maintain; types of construction; properties and materials necessary for ideal ballast; ballast and ballasting from standpoint of best engineering practice.

Concrete-Base Track

Concrete Base Track Gives Good Results on Northern Pacific Railway. Eng. News-Rec., vol. 81, no. 24, Dec. 12, 1918, pp. 1071-1074, 13 figs. New type of construction four years in actual service; concrete slabs built on gravel roadbed have wood supports for rails; no ballast used; maintenance work not continuous but intermittent.

Grade Crossings

The Proper Engineering Treatment of Necessary Railroad Grade Crossings, Rodman Wiley. Good Roads, vol. 16, no. 26, Dec. 21, 1918, pp. 241-243. Claims no engineering advice has dictated present policy of establishing crossings in railroads. Paper before Am. Assn. of State Highway Officials, Chicago.

Stresses in Track

Stresses in Permanent Way. Ry. Engr., vol. 39, nos. 464, 465 and 466, Sept., Oct. and Nov. 1918, pp. 179-181, 191-194 and 211-213, 13 figs. Report of joint committee of Am. Soc. Civil Engrs. and Am. Ry. Eng. Assn., appointed to investigate stresses in railway track.

Ties

A New Concrete Railroad Tie. Mun. & County Eng., vol. 55, no. 6, Dec. 1918, pp. 212-213, 3 figs. Details of tie satisfactorily used for several years on municipal railroad of San Francisco, Cal.

Service Tests of Cross-Tie, P. R. Hicks. Bul. Am. Ry. Eng. Assn., vol. 20, no. 210, Oct. 1918, pp. 21-71. Tables comprising 350 service test records on 28 different species of ties, including 30 completed records submitted by 22 railroads.

Resilient Chairs and Reinforced Concrete Ties for Railway Track. Contract Rec., vol. 32, no. 47, Nov. 20, 1918, pp. 921-922, 2 figs. Details of sleeper said to have given satisfactory service on East Indian Ry.

Track Improvement

Making the Old Track Last a Little Longer, P. Ney Wilson. Elec. Ry. Jl., vol. 52, no. 24, Dec. 14, 1918, pp. 1053-1054, 5 figs. What Connecticut Co. did to extend life of stretch of track in New Haven, with particular reference to arc welding.

See also CIVIL ENGINEERING, *Bridges (Railway Bridges).*

RAILS

Transverse Fissures

Transverse Fissures Cause Rail Failures, Ry. Age, vol. 65, no. 23, Dec. 6, 1918, pp. 1007-1009. Suggests that rails are being stressed beyond service limit. (From report by W. P. Borland, chief of Bureau of Safety of Interstate Commerce Commission of an investigation made by James E. Howard, engineer-physicist of Commission.) Also Ry. Rev., vol. 63, no. 24, Dec. 14, 1918, pp. 843-847, 11 figs.

Reheating as Cure for Rail Fissure, G. F. Comstock. Iron Trade Rev., vol. 63, no. 26, Dec. 26, 1918, pp. 1457-1462, 17 figs. Metallographic investigations of transverse fissures, using a special etching reagent; results apparently support theory that transverse failures are due to defect in steel and that reheating of blooms will diffuse bands of phosphorus. From paper to be presented at Feb. meeting of Am. Inst. Min. Engrs.

ROLLING STOCK

Cleaning

Rotary Brushes for Cleaning Cars, C. H. Shaffer. Ry. Jl., vol. 25, no. 1, Jan. 1919, pp. 26-27, 2 figs. Brush operated at about 900 r.p.m. through special flexible shaft used in conjunction with air drill.

Refrigerator Car, Standard

Government Standard Refrigerator Car. Ry. Rev., vol. 63, no. 25, Dec. 21, 1918, pp. 865-868, 5 figs. Data and further description of Government's new design. Detail drawings. Also Ry. Mech. Eng., vol. 92, no. 12, Dec. 1918, pp. 663-668, 6 figs, and Ry. Age, vol. 65, no. 25, Dec. 20, 1918, pp. 1115-1117.

Welded Freight Car

Electrically Welded Gondola Car. Ry. Rev., vol. 63, no. 24, Dec. 14, 1918, pp. 833-835, 5 figs. Car constructed for C., B. & Q. R. R. pioneer attempt at fabricating steel freight-car structure by process of electric welding. Also Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 913-915, 8 figs.

SAFETY AND SIGNALING SYSTEMS

Accident Prevention

The Conservation of Man-Power, H. A. Adams. Proc. Pacific Ry. Club, vol. 2, no. 8, Nov. 1918, pp. 7-11. Brief record of work done by Government, Congress and private agencies to prevent accidents in railroad operation, including present endeavors of U. S. Railroad Administration.

SHOPS

A. E. F. Repair Shops

Railroad Repair Shops in France Equipped and Operated by American Forces, Robert K. Tomlin, Jr. Eng. News-Rec., vol. 81, no. 26, Dec. 26, 1918, pp. 1178-1182, 6 figs. Features of shops; individual electric drive for all machine tools.

Roundhouse Design

Locomotive Round-House at San Bernardo, Chile (La maestranza de San Bernardo, Chile), C. V. Cruchaga. Boletin de la Sociedad de Fomento Fabril, year 35, no. 9, Sept. 1918, pp. 609-614. Details of American design built of concrete and is said to be largest of its kind in the world.

Roundhouse Methods

Mileage of Engines—Its Relation to Cost of Shop and Running Repairs, George H. Logan. Ry. Jl., vol. 25, no. 1, Jan. 1919, pp. 24-26. Remarks on shop practice based on experiences in roundhouses.

Accuracy in Locomotive Repairs, M. H. Williams. Ry. Mech. Eng., vol. 92, no. 12, Dec. 1918, pp. 673-677, 8 figs. Methods of making and of fitting new and repair parts for locomotives with gages and micrometers.

Tools, Brass-Working

Brass-Working Tools in a Railroad Shop, Frank A. Stanley. Am. Mach., vol. 49, no. 23, Dec. 12, 1918, pp. 1081-1084, 8 figs. Describes tools for making blow-off valves and their fittings.

Welding

Arc Welding in Railroad Shops, B. C. Tracy. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 887-898, 20 figs. Based on its success in locomotive repair work, writer believes arc welding must be given serious consideration by railroads, not only from an economic viewpoint, but also to increase transportation facilities.

TERMINALS

South Boston

New Haven Improvements at South Boston Terminal. Ry. Age, vol. 65, no. 26, Dec. 27, 1918, pp. 1149-1152, 7 figs. Involve construction of two additional tracks and depressing old line. All done under heavy traffic.

Munitions and Military Engineering

Ambulance Trains

Ambulance Train of the American Army (Train-ambulance de l'armée américaine). Génie Civil, vol. 73, no. 18, Nov. 2, 1918, pp. 341-343, 15 figs. Disposition and arrangement of coaches (built in England) for transportation of wounded soldiers.

Automobile Transport

Organization of the French Army Automobile Service, W. F. Bradley. Automotive Indus., vol. 39, no. 26, Dec. 26, 1918, pp. 1093-1095. How repairs were handled. Equipment included 90,000 trucks and 150,000 men.

Military Transport Chassis. Part IX. Automobile Engr., vol. 8, no. 121, Dec. 1918, pp. 346-349, 4 figs. Their performance under war conditions. Details of Pierce-Arrow 5-ton model R. S truck.

Camp Holabird—Largest Truck Overhaul Depot. Automotive Indus., vol. 39, no. 25, Dec. 19, 1918, pp. 1053-1055, 8 figs. Data on plant with capacity for assembling 30 trucks a day and crating 22 an hour for shipment.

Construction Work

How Construction Met the Issue, R. C. Marshall. Am. Contractor, vol. 39, no. 51, Dec. 21, 1918, pp. 22-25. Accomplishments of construction Division of War Department. Functions, organizations and procedure; "cost-plus and sliding scale fee contract." Address at meeting of Gen. Contractors' Assn.

Gun Erosion

Experts Discuss Big Gun Erosion, Hudson Maxim. Iron Trade Rev., vol. 63, no. 26, Dec. 26, 1918, pp. 1463-1464. Analysis of causes producing erosion and study of possibilities to overcome them, together with recommendations in regard to material and method of lining. Discussion of Henry M. Howe's paper before Am. Inst. Min. Engrs.

Hand Grenades

Making the American Hand Grenade, Edward K. Hammond. Machy., vol. 25, no. 5, Jan. 1919, pp. 448-453, 15 figs. First of two articles on methods of machining and loading bodies and assembling bouchons.

H. E. Shells

Manufacture of High Explosive Shells and Detonators, from the Metallurgist's View Point, C. B. Swander. Proc. Steel Treating Research Soc., vol. 1, no. 11, pp. 9-14, 5 figs. Outline of forging operations on an 8-in. American carbon-steel high-explosive shell; machining; nosing operation; heat treating; copper banding; placing detonator; British, French and Russian detonators.

Howitzers

How the 155-Mm. Howitzer Is Made, J. V. Hunter. Am. Mach., vol. 49, no. 25, Dec. 19, 1918, pp. 1123-1129, 28 figs. Third article.

Illuminating Shells

Rockets and Illuminating Shells as Used in the Present War, A. Bergman. Illum. Engr., vol. 11, no. 8, Aug. 1918, pp. 189-191. Composition and data on candlepower developed. From paper before Illum. Eng. Soc.

Military Roads

Some Phases of Military Road Work, Gordon F. Daggett. Wis. Engr., vol. 23, no. 3, Dec. 1918, pp. 79-88. Trend of construction during last two years. Difficulties encountered, organizations required and materials available in work undertaken at the front. Requirements of wearing surface for military purposes.

Railway Artillery

Railway Artillery, James B. Dillard. Jl. Am. Soc. Mech. Engrs., vol. 41, no. 1, Jan. 1919, pp. 44-49, 5 figs. Development of models; types of cannon used; problems of design; barbette mortar carriages; foreign types; American types; auxiliary cars; tactical uses; value and economy of seacoast defence.

Long-Range Heavy Navy Guns with Railway Mount, D. C. Buell. Jl. Am. Soc. Mech. Engrs., vol. 41, no. 1, Jan. 1919, pp. 25-27, 5 figs. Work done in completing mobile battery of naval 14 in. 50-caliber guns originally built for use in battle cruisers.

The War Department Railway Artillery. Ry. Age, vol. 65, no. 25, Dec. 20, 1918, pp. 1113-1114, 5 figs. Brief description of 8-in., 12-in. and 14-in. railway mounts.

Semi-Steel Shells

How Semisteel Shell Are Machined. Iron Trade Rev., vol. 63, no. 22, Nov. 28, 1918, pp. 1236-1237, 17 figs. From circular of Ordnance Department recommending standard practice for manufacture of this class of projectile.

Tanks

The Mark VIII Land Cruiser, J. Edward Schipper. Automotive Indus., vol. 40, no. 1, Jan. 2, 1919, pp. 6-9, 11 figs. Technical description of large-sized battle tank developed during latter period of war; equipped with an adaptation of Liberty aircraft engine and weighs 40 tons. Also Motor Age, vol. 35, no. 1, Jan. 2, 1919, pp. 18-21, 9 figs. Mechanical features of huge model that carries 11 men.

Tools for Shell Manufacture

Special Tools and Appliances for Shell Manufacture, George A. Neubauer and Erik Oberg. Machy., vol. 25, no. 5, Jan. 1919, pp. 416-421, 7 figs. Describes number of devices used by Buffalo Pitts Co. in making 4.7 high-explosive shells. (First article.)

Tools for Boring a Closed-Bottom Shell, M. H. Potter. Machy., vol. 25, no. 5, Jan. 1919, pp. 427-428, 6 figs. Types of blades used in boring heads and methods of grinding and setting blades.

See also MECHANICAL ENGINEERING, *Foundries (War Demands); Forging (Gun Forgings).*

General Science

CHEMISTRY

Analysis

Quantitative Analysis of Metals by Electrolytic Deposit Without Using External Source of Electrical Energy (Sur un procédé de dosage des métaux par dépôt électrolytique sans emploi d'une énergie électrique étrangère), Maurice François. Comptes rendus des séances de l'Académie des Sciences, vol. 167, no. 20, Nov. 11, 1918, pp. 725-727. From a conductor resting on borders of platinum crucible containing sulphuric acid or similar reagent and salt to be analyzed a zinc or aluminum hook is suspended. Electrolytic action deposits metal in salt at bottom of crucible.

Method of Chromic Oxide Determination, W. C. Kiddell and Esther Kitredge. Chem. Engr., vol. 26, no. 12, Nov. 1918, pp. 457-458. Government chemists claim new method permits rapid handling of ore samples submitted for analysis. (To be concluded.)

The Quantitative Analysis of Small Quantities of Gases, H. M. Ryder. Jl. Am. Chem. Soc., vol. 40, no. 11, Nov. 1918, pp. 1656-1662, 3 figs. Description of apparatus for analyzing water vapor, CO_2, CO, O, H, N and methane; its manipulation; results of tests made to determine its accuracy.

Catalytic Exothermic Gas Reactions

Starting and Stability Phenomena of Ammonia Oxidation and Similar Reactions, F. G. Liljenroth. Gen. Elec. Rev., vol. 21, no. 11, Nov. 1918, pp. 807-815, 7 figs. Explains fundamental characteristics of catalytic exothermic gas reactions.

Methane

Methane, William Matisoff and Gustav Egloff. Jl. Phys. Chem., vol. 22, no. 8, Nov. 1918, pp. 529-575. Formulation of results of research up to date and their classification along physical (constants, specific properties, gas properties, industrial applications) and chemical (combustion, explosion, solubility, occlusion, industrial reactions) characteristics; notes on possibilities of research on methane both theoretical and practical.

Occluded Gases in Glass

Gases and Vapors from Glass, R. G. Sherwood. Phys. Rev., vol. 12, no. 6, Dec. 1918, pp. 448-458, 8 figs. Author finds that under the influence of heat there are two distinct kinds of gaseous evolution products, namely, one associated with absorption—readily removable at 200 deg. cent., and other resulting from formation of new chemical equilibria. Also Jl. Am. Chem. Soc., vol. 40, no. 11, Nov. 1918, pp. 1645-1653, 9 figs.

Rare Earths

Observances on the Rare Earths (VIII). The Separation of Yttrium from Erbium; the Ratio Er_2O_3: 2 Er Cl_3, Edward Wichers, B. S. Hopkins and C. W. Balke. Jl. Am. Chem. Soc., vol. 40, no. 11, Nov. 1918, pp. 1615-1619. Comparison between cobalticyanide and nitrite precipitation methods; preparation of erbium material by nitrate fusion method; determination of ratio of erbium oxide to erbium chloride in seven analyses.

Structure of Matter

The Atomic Structure of Carborundum Determined by X Rays, C. L. Burdick and E. A. Owen. Jl. Am. Chem. Soc., vol. 40, no. 12, Dec. 1918, pp. 1749-1759, 4 figs. Measurements of angles of reflection of palladium X-rays from principal planes of crystal of carborundum and interpretation of measurements of intensities of reflection of different orders. Writers conclude elementary tetrahedron of carborundum differs from that of diamond only in a slight shortening of vertical axis and slight difference in displacement of carbon atoms from centers of tetrahedron.

MATHEMATICS

Elliptic Functions

On the Coefficients in the Expansions of Certain Modular Functions, G. H. Hardy and S. Ramanujan. Proc. Roy. Soc., vol. 95, no. A667, Nov. 7, 1918, pp. 144-155, 2 figs. Three theorems relating to properties of elliptic functions in powers of variable $Q = e^{n}$, where $n = \pi i \tau$.

Equations

On the Characteristics of Partial Derivative Equations of Second Order (Sur les caractéristiques des équations aux dérivées particlles du second ordre), E. Gau. Comptes rendus des séances de l'Académie des Sciences, vol. 167, no. 19, Nov. 4, 1918, pp. 675-678. Invariant for characteristics of system by two quadratures.

Systems of Coördinates, G. H. Light. G. H. Light. Univ. of Colo. Jl. Eng., vol. 15, no. 1, Oct. 1918, pp. 23-27, 4 figs. Intrinsic equation of catenary and cycloid in system defined by length of arc and radius of curvature.

Heaviside Development Theory

Generalization of Heaviside Development Theorem (Généralisation du théorème du développement de Heaviside), Abraham Press. Revue Générale de l'Electricité, vol. 4, no. 19, Nov. 9, 1918, pp. 691-693. States that Carson (Phys. Rev., Sept. 1917, pp. 217-225) does not quite generalize theorem in question because the applied forces he considers have the exponential form; writer accordingly takes up case of any forced vibration by discussing general differential equation with constant coefficients.

Rectification of Arc

Notes on a Geometrical Construction for Rectifying Any Arc of a Circle, F. A. Lindemann. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 216, Dec. 1918, pp. 472-474, 1 fig. Process involving successive bisections and based on rapidly converging trigonometric series.

Single-Sided Surfaces

A Surface Having Only a Single Side, Carl Hering. Jl. Franklin Inst., vol. 186, no. 5, Nov. 1918, pp. 627-630, 4 figs. Further variations and minor corrections in study of surface generated by line moving along circle, always remaining in planes passing through axis of circle and simultaneously revolving around circle as axis at half angular rate of its movement along circle. Addendum to article in Aug. issue.

PHYSICS

Calorimeters

Calorimetric Lag, Walter P. White. Jl. Am. Chem. Soc., vol. 40, no. 12, Dec. 1918, pp. 1858-1872. Mathematical treatment of elimination of three lag effects of bodies external to calorimeters: (1) change in heat capacity of calorimeter, (2) thermal leakage, (3) loss dependent on jacket temperature.

The Conditions of Calorimetric Precision, Walter P. White. Jl. Am. Chem. Soc., vol. 40, no. 12, Dec. 1918, pp. 1872-1886. Expressing leakage effect as a function of time, thermal head for experimental period and leakage modulus of calorimeter, the effects of diminishing each of these on the values of other two are analyzed and rules for calorimetric precision are derived.

Crystals

Experimental Study on the Growth of Crystals (Etude expérimentale sur le développement des cristaux), René Marcelin. Annales de Physique, vol. 10, Sept.-Oct. 1918, pp. 185-188. Report of observations on paratoluidine. It appeared that these crystals grew not in depth but in surface by successive alluvions.

Formation and Optical Study of Sodium Chromate Crystals Having Four Water Molecules (Mode d'obtention et étude optique des cristaux de chromate de soude à 4 molécules d'eau), Lucien Delbaye. Bulletin de la Société Française de Minéralogie, vol. 41, nos. 4-5-6, Apr.-June 1918, pp. 80-93, 4 figs. Experimental research: Variation of three principal indices in terms of wave length; variation of apparent and true angles in turns of wave length; variation of position of bisectors in crystal in terms of wave length.

Crystalloluminescence

Crystalloluminescence (II), Harry B. Weiser. Jl. Phys. Chem., vol. 22, no. 8, Nov. 1918,

pp. 576-595, 1 fig. Survey of theories advanced by various investigators concerning nature of triboluminescence (property of many crystalline substances which emit phosphorescent light when rubbed or crushed); theory that it is the result of chemical action and is identical with crystalloluminescence so far as chemical reaction is concerned, differing only between themselves in physical process employed to bring about reaction; experiments with arsenic trioxide and with potassium sulphite.

Curie and Haüy Laws

Note on Curie and Haüy Laws (Sur les lois de Curie et de Haüy), C. Viola. Bulletin de la Société Française de Minéralogie, vol. 41, nos. 4-5-6, Apr.-June 1918, pp. 108-116. Demonstrates inter-connection of the two laws, Haüy's being developed analytically from Curie's differential fundamentals.

Curie Point in Iron

Curie's Point in Pure Iron and Ferrosilicon Alloys (Le point de Curie dans le fer pur et les ferro-siliciums), A. Sanfourche. Comptes rendus des séances de l'Académie des Sciences, vol. 167, no. 19, Nov. 4, 1918, pp. 683-685. Experimental measurements of termal manifestation at Curie's point. Alloys experimented on contained from 0.5 to 2.5 per cent silicon.

Density of Gases, Determination

An Accurate Method for Measuring the Density of Gases, O. Maas and J. Russell. Jl. Am. Chem. Soc., vol. 40, no. 12, Dec. 1918, pp. 1847-1852, 1 fig. Applicable to gases which can be condensed by liquid air or some other freezing agent. Known volume at known pressure and temperature is liquefied in bulb attached to containing vessel; bulb is then sealed off and gas weighed at room temperature.

Double-Suspension Mirror

The Double Suspension Mirror, L. Southerns. Lond., Edinburgh and Dublin Phil. Mag., vol. 36, no. 216, Dec. 1918, pp. 477-486, 8 figs. Theory of a method of observing deflections in a delicate balance; method a modification of "double suspension mirror."

Drops

Sounds Produced by Drops Falling on Water, A. Mallock. Proc. Roy. Soc., vol. 95, no. A667, Nov. 7, 1918, pp. 138-143, 6 figs. Theoretical determination of shape of cavity a falling sphere must make when it penetrates a fluid; experimental confirmation by instantaneous shadow photographs of falling shot.

Electromagnetic Vectors

The Electromagnetic Vectors, H. Bateman. Phys. Rev., vol. 12, no. 6, Dec. 1918, pp. 459-481. Geometrical study of an electromagnetic field in relation to a moving observer and location of vectors with aid of two cones which at each point limit directions of forces acting on electric and magnetic charges moving with velocities less than that of light; expression of electromagnetic laws in terms of forces on unit electric and magnetic charges in motion and deductions relating to lines of force, derived from Hargreaves' theorems for space-time integrals; discussion of energy in electromagnetic field; development of theory in regard to amount of concealed energy in field of moving electron.

Explosion, Effects of

On the Rupture of Mirrors and Window-Panes by Explosions (Sur la rupture des glaces et des vitres par les explosions), P. Gaubert. Bulletin de la Société Française de Minéralogie, vol. 41, nos. 4-5-6, Apr.-June 1918, pp. 65-67. Explanation for shapes commonly presented by pieces into which a large plate breaks as result of explosion.

Fluorescence

The Physical Characteristics of X-Ray Fluorescent Intensifying Screens, Millard B. Hodgson. Phys. Rev., vol. 12, no. 6, Dec. 1918, pp. 431-435, 2 figs. Fluorescence of various materials discussed from point of view of photographic efficiency; qualitative determination of spectral distribution of fluorescence from calcium tungstate; photographic efficiency of characteristic radiation from silver, tungsten, platinum and lead.

Fluorescence (La fluorescence), Jean Perrin. Annales de Physique, vol. 10, Sept.-Oct. 1918, pp. 133-159. Destruction of fluorescent bodies by emission of fluorescence; influence of temperature on intensity of emission; molecular and atomic fluorescence; limiting power; fluorescence of concentrated solution; fragility of fluorescent molecules.

Gravitation

On a Peculiarity of the Normal Component of the Attraction Due to Certain Surface Distributions, Ganesh Prasad. Lond., Edinburgh and Dublin Phil. Mag., vol. 36, no. 216, Dec. 1918, pp. 475-476. Cases in which component N of Newtonian attraction at point P along normal through P meeting surface at O tends to no limit as P approaches O along normal.

Impact

The Photographic Study of Impact at Minimal Velocities, C. V. Roman. Phys. Rev., vol. 12, no. 6, Dec. 1918, pp. 442-447, 6 figs. Graphs showing relation between coefficient of restitution and velocity of impact for polished spheres of equal radius of brass, aluminum, hard bronze, white marble, and lead.

Inflammability of Gaseous Mixtures

The Inflammation of Mixtures of Methane and Air in a Closed Vessel, Richard Vernon Wheeler. Jl. Chem. Soc., vols. 113 and 114, no. 673, Nov. 1919, pp. 840-859, 7 figs. Results of experiments in spherical vessels. Giving data on maximum pressures developed, rates of development of pressure, and speeds of propagation of flame.

Ionization

Ionization of Mercury, Sodium and Potassium Vapors and the Production of Low Voltage Arcs in These Vapors, T. C. Hebb. Phys. Rev., vol. 12, no. 6, Dec. 1918, pp. 482-490, 2 figs. Concludes from experiments that: Potassium vapor can be ionized at 1.6 volts; sodium vapor at 2.5 volts; D lines of sodium can be excited at less than 1.0 volt; sodium and potassium arcs in mercury vapor can operate below their resonance potentials and as low as 1.4 for sodium and 0.5 volts for potassium; mercury spectrum can be produced at 0.5 volt in atmosphere of mercury and potassium.

Latent Heat of Fusion

Latent Heat of Fusion as the Energy of Molecular Rotations, Kōtarō Honda. Phys. Rev., vol. 12, no. 6, Dec. 1918, pp. 425-430. Tables and calculations, based on Landolt and Börnstein's values, which lead writer to assert that latent heat of fusion consists of energy of rotation of molecules gained during fusion.

Light Emission

On the Light Emitted from a Random Distribution of Luminous Sources, Lord Rayleigh. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 216, Dec. 1918, pp. 429-449, 3 figs. Mathematical treatment of probable expectation of intensity in any direction. By "expectation" is meant the mean of a large number of independent trials, or combinations, in each of which the phases are redistributed at random. Sonorous vibrations are considered but the results are shown to be applicable to electric vibrations.

Light Polarization

The Light Scattered by Gases: Its Polarization and Intensity, R. J. Strutt. Proc. Roy. Soc., vol. 95, no. A667, Nov. 7, 1918, pp. 155-176, 5 figs. Measurements of intensity of vibrations parallel to existing beam of light scattered at right angles by gases and vapors; particular study of behavior of helium; evaluation of intensity of scattering by different gases in terms of refractivity; photographs of polarizations of ether, vapor and nitrous oxide.

Liquid Films

The Stratification of Liquid Films (La stratification des lames liquides), Jean Perrin. Annales de Physique, vol. 10, Sept.-Oct. 1918, pp. 160-184. Result of Johonnott's microscopical examination of soap bubbles; superficial tension of soap solutions; law of multiple thicknesses; chemical separation by simple extension of free surfaces.

Pitched Baseball

A Pitched Baseball, Willard W. Griffin. Sci. Am. Supp., vol. 87, no. 2244, Jan. 4, 1919, pp. 12-14, 3 figs. Mechanical analysis of a "floater" and other curved ball paths.

Radioactivity

The Problem of Radioactive Lead, Theodore W. Richards. Science, vol. 49, no. 1253, Jan. 3, 1919, pp. 1-11. Account of experimental researches; hypothesis concerning disintegration of uranium; hypothetical calculation of atomic weight of uranium-lead; solubility of two kinds of lead nitrate; comparison of properties of different kinds of lead. Presidential address before Am. Assn. for Advancement of Science.

Sound, Standard of

A Possible Standard of Sound, Chas. T. Knipp. Phys. Rev., vol. 12, no. 6, Dec. 1918, pp. 491-492, 1 fig. Adjustment of mercury vapor trap of pyrex glass to furnish sound of desired pitch. From paper presented at meeting of Am. Phys. Soc.

Specific Heat

Specific Heat Determination at Higher Temperatures, Walter P. White. Am. Jl. Sci., vol. 47, no. 277, Jan. 1919, pp. 44-59, 4 figs. Experimental technique at temperatures up to 1400 deg. cent. by method of mixtures; modifications in furnaces and in methods of transferring to calorimeter; variability of heat losses attending dropping of hot bodies into water; use of aneroid calorimeters.

Silicate Specific Heats, Walter P. White. Am. Jl. Sci., vol. 47, no. 277, Jan. 1919, pp. 1-43, 4 figs. Experimental determination for temperatures from 100 to 1400 deg. cent. by dropping from furnaces into calorimeters; checks and precautions employed; two methods for determining true or atomic heats from interval heats. Paper extends scope of writer's previous communications.

The Specific Heat of Platinum at High Temperatures, Walter P. White. Phys. Rev., vol. 12, no. 6, Dec. 1918, pp. 436-441. Redetermination of specific heat from 100 to 1300 deg. cent. with precision of 0.3 per mile. Results agree with those of Gaede, Plato, Corbino, Magnus and Fabaro.

Spectra

The Origin of Spectra, J. C. McLennan. Proc. Phys. Soc. Lond., vol. 31, no. 176, Dec. 15, 1918, pp. 1-29, 14 figs. Outline of investigations undertaken since Frank and Hertz' measurements of mercury-vapor ionization potential and further experimental researches including also vapors of zinc, cadmium and magnesium. Ultraviolet region investigated with a fluorite spectrograph and extreme ultra violet region with a vacuum grating spectrograph. General discussion of results obtained by writer and other investigators.

On the Ultraviolet Spectra of Magnesium and Selenium, J. C. McLennan. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 216, Dec. 1918, pp. 450-460, 2 figs. Records of investigations with Hilger quartz spectrograph and another specially constructed fluorite spectrograph showed 12 new lines in selenium spark spectrum between $\lambda = 2200$ A°. V. and $\lambda = 1850$ A°. U., five lines in selenium are between same limits, and reversal at $\lambda = 2200$ A°. U. in absorption spectrum of selenium metal in carbon arc.

On Fundamental Frequencies in the Spectra of Various Elements, J. C. McLennan. Lond., Edinburgh & Dublin Phil. Mag., vol. 36, no. 216, Dec. 1918, pp. 461-471, 7 figs. Extensive experimental research with photographic records. It is concluded that when zinc and cadmium vapors respectively are bombarded by electrons whose kinetic energy is gradually increased, monochromatic radiation is suddenly emitted by vapor when impact voltage reaches certain value, beyond which no additional relation is produced; also that when a Bunsen flame is fed with vapor of heated zinc, it is possible to obtain monochromatic radiation of wave-length $\lambda = 3075.99$ A°. U.

Welsbach Mantle

A Physical Study of the Welsbach Mantle, Herbert E. Ives, E. F. Kingsbury and E. Karrer. Jl. Franklin Inst., vol. 186, no. 5, Nov. 1918, pp. 585-625, 21 figs. Extension of Ruben's work on thoria-ceria mixtures to large family of such combinations; from investigation of conditions under which visible absorption bands of ceria and other materials appear and disappear, an explanation is offered of different behavior of mantle in flame and cathode-discharge heating; attempt to fix possible attainable efficiencies of gas-light production by present methods (Concluded from p. 438, Oct. 1918.)

See also ELECTRICAL ENGINEERING, *Electrophysics (Vapor Arcs).*

HEAT TREATMENT OF LOW-CARBON STEEL

Characteristic Structures Found in Steel, Their Formation by Heat Treatment and the Effect Each Has on the Quality of the Steel

By W. M. Wilkie,[1] Toronto, Ont.

Steel is made up of iron combined with certain percentages of carbon, manganese, silicon, phosphorus, sulphur and other elements, each one of which by its presence in varying quantities imparts some special quality to the steel. It is, however, the writer's intention to confine himself to a study of the more usual combinations of iron and carbon that exist in low-carbon steels, for the whole subject of heat treatment is really a study of the different forms or phases in which the various combinations of iron and carbon exist, and the conditions under which they are formed. That is, knowing the particular quality a certain form or phase imparts to steel, and the treatment required to produce it, we are in a position to prescribe the treatment necessary for producing steel of any desired quality.

From microscopic examinations of polished and etched sections of steel, it has been found that there are a number of characteristic structures under which steel exists, each being the result of some special treatment. To determine these characteristic forms and the reason for their formation, a study should be made of the different kinds of treatment that steel receives in ordinary commercial practice and the results of these various treatments. The subject may be divided as follows:

1 Unworked steel, i.e., cast steel $\left\{\begin{array}{l}\text{cooled slowly}\\ \text{cooled rapidly}\\ \text{reheated}\end{array}\right.$

2 Hot-worked steel $\left\{\begin{array}{l}\text{cooled slowly}\\ \text{cooled rapidly}\\ \text{reheated}\end{array}\right.$

Cast Steel Cooled Slowly

In molten steel the carbon exists as chemical compounds of iron and carbon of varying composition, called carbides. The most common of these has the composition FeC_3 and is called cementite. These carbides are found dissolved in the molten iron in the same way as salt is dissolved in water; also as the steel solidifies, the carbides continue in solution and form what is known as a "solid solution."

The solid solution of iron and the carbide FeC_3 is called austenite, and is the usual form or phase that iron is found in just after freezing.

Austenite, owing to its instability at lower temperatures, is rarely ever found in steel unless special precautions are taken, such as by cooling very rapidly from temperatures above 1000 deg. cent. (1768 deg. fahr.) It has a crystalline structure, which becomes coarser the slower the steel is cooled, due to the fact that as no mechanical work has been done on the steel, adjacent crystals tend to assume the same orientation and merge into a larger crystalline grain. Such slowly cooled, coarse-grained steel is brittle, has minimum tenacity and toughness, and can only be used where it is possible to make up strength by using large masses of metal.

Along with the growth in the size of the grains, the rate of cooling is uniform until a temperature somewhere between 900 deg. cent. and 700 deg. cent. (1652 and 1292 deg. fahr.) is reached. At this point the rate of cooling is gradually retarded, until finally the temperature becomes either stationary or even slightly higher. After a short interval the temperature will again fall at a gradually increasing rate until it becomes uniform, at which it continues to cool to atmospheric temperatures.

The explanation of this peculiar phenomenon is that a change occurs in the structure of the steel during this change of temperature, caused by the austenite, now having reached a temperature at which it is no longer stable, proceeding to change into the more stable phases of lower temperatures. This change is accompanied by a liberation of heat, which explains the change in the rate of cooling. A similar but reverse action takes place when steel is being heated.

The range of temperature within which this change occurs is called the critical range, while the upper and lower limits of this range are known as the upper and lower critical points. The lower point is about 690 deg. cent. (1274 deg. fahr.) for all percentages of carbon content, whereas the upper point ranges from 900 deg. for pure iron to 690 deg. for steels containing 0.85 per cent carbon. These points also vary slightly with the amounts of other elements besides carbon present, also depending on whether the steel is being heated or cooled. The critical range and its limits are important points to remember in heat treatment, and it is necessary to become thoroughly familiar with the reactions that occur in this range.

The slow-cooling steel under consideration has now reached the upper critical point where the martensite is no longer stable and begins to change into some more stable form such as pearlite, ferrite or cementite.

Pearlite is a definite mechanical (not chemical) mixture of the carbide FeC_3 with pure iron or "ferrite," with a carbon content of 0.85 per cent. Steels having such a carbon percentage will, after annealing, be all pearlite and are known as "eutectoid" steels. If the carbon content is *less* than 0.85 per cent, all the carbon is combined with iron to form the carbide FeC_3 or cementite, which by the addition of a further amount of iron immediately is converted into pearlite, while any excess iron is left free. Such steel is called hypoeutectoid steel, and consists of pearlite and ferrite when in the annealed condition.

If the carbon content is *over* 0.85 per cent, there will be an excess of cementite over the amount required to make pearlite from the free iron present, and so we have the two phases, cementite and pearlite, when the steel is annealed. Such steel is known as hypereutectoid steel.

Pearlite is a constituent of all slowly cooled steels, the greater the proportion of carbon—and hence of pearlite—the stronger and tougher and less ductile will be the steel, until the eutectoid composition is reached, when the steel has maximum strength, as all additions of carbon above this composition only result in the formation of cementite, which has no strengthening power.

Pearlite also by its ability to take up free ferrite and change into austenite is the hardening constituent of steel, so that eutectoid steel is the composition that has maximum hardening powers, though eutectoid steels are not necessarily the hardest, as hypereutectoid steels may be harder as the result of the hardness caused by the presence of cementite.

Ferrite is the name of pure iron and it is the constituent of all low-carbon slowly cooled steels. It is very soft, ductile, relatively weak, and has no hardening power.

Cementite is a substance about which little is known. It is a definite chemical compound, FeC_3, and it may be assumed that it is very hard and brittle, and therefore lacks tenacity and ductility. It has no hardening power beyond the extreme hardness it itself confers on the steels.

The properties of these three constituents of steel as given by Howe are set forth in Table 1.

When the slow-cooling steel has reached the upper critical point, it will be coarse grained because of the very slow cooling. At this point each grain of austenite tends to transform into the pearlite composition by throwing off the excess ferrite or cementite it contains, and if the cooling is carried on with sufficient slowness, it will be found that by the time the lower critical range is reached each original grain of austenite has changed into the pearlite or eutectoid composition, while the excess iron in the hypo-eutectoid steels, or the excess cementite in the hypereutectoid steels, has been liberated as follows:

---

[1] Imperial Munitions Board, Toronto.

Paper presented at a meeting of the Ontario Section of The American Society of Mechanical Engineers, Toronto, April 18, 1918.

TABLE 1 PROPERTIES OF CONSTITUENTS OF STEEL

Constituent	Tensile strength, lb. per sq. in.	Elongation, per cent	Hardness	Hardening power
Ferrite..........	50,000	40	Soft	None
Pearlite.........	125,000	10	Hard	Maximum
Cementite.......	5,000 ?	0	Very hard	None

1 As a film or envelope around the original grains
2 Between the cleavage planes of the crystalline grains
3 As a combination of both.

The first form results with fairly rapid cooling, whereas the second form is the result of very slow cooling.

As the steel cools past the lower critical range the changes are all completed, and any further cooling has no effect on the internal structure, provided it is not rapid enough to set up strains.

Having followed the changes in a slow-cooled cast steel, it is found that the final condition is a coarse-grained, softened steel, which owing to its coarse-grained structure lacks strength, toughness and ductility, but is relatively soft, and has for its constituents the phases pearlite, combined with either ferrite or cementite, depending on the carbon content.

Cast Steel Cooled Rapidly

In cooling steel very rapidly, by quenching it in oil or water, we find marked differences from the slowly cooled steel. First, the grain structure is finer, the growth of the grains being prevented. Second, the steel is very hard and brittle, because the reaction in which austenite transforms into pearlite, with a residue of ferrite or cementite, can only take place completely when the cooling is very slow. If the steel is cooled rapidly, the reaction only partially takes place, and as a result there are a number of new phases formed which are really part-way transformations between the austenite phase and the phases of soft steel.

The most important of these forms is martensite. This is really an allotropic form of austenite, whose most characteristic features are its needle-like structure, with the crystals crossing each other at 60 deg., and its extreme hardness. It is formed by quenching steel in water, if the pieces are fairly large, or in oil in case of small objects, from above or near the upper critical point. This rapid cooling causes rapid contraction, which sets up great pressures and results in the crystals assuming the structure indicated above.

Martensite is the form or phase giving maximum hardness to steel, so that the more rapid the cooling and, consequently, the greater the amount of martensite, the harder and more brittle will be the steel. Extremely brittle steel is, however, of very little use commercially.

If the steel instead of being quenched in water is either allowed to cool slowly to the middle critical range and then quenched, or is quenched in oil in case of small sections, another form, called troostite, is formed. This is a further stage in the transformation from austenite into pearlite, i.e., the grains have gone a step further toward reaching the eutectoid composition. Troostite occurs in dark-colored, irregular areas or nodules, and is nearly always accompanied by martensite and sorbite. It is slightly softer and has more ductility and toughness than martensite.

If the steel instead of being quenched in oil or water is cooled rapidly in air, or a large piece of steel is quenched in oil, a new constituent called sorbite is formed, which is another stage in the transformation of austenite into pearlite. It is considerably softer than martensite, and in fact is not a constituent of hardened steel. Its properties more nearly approach that of pearlite, i. e., it is stronger, harder and less ductile than pearlite, but softer and more ductile than troostite. Its composition also approaches more closely to the pearlite composition than the solid solution of iron and ferrite found in austenite; in fact, sorbite is the last stage in the transformation from austenite to pearlite.

Accordingly, unworked steel cooled slowly contains the phases of soft steel, but owing to the coarse-grained crystalline structure it is brittle and lacks strength and ductility. Similarly with rapidly cooled unworked steel the rapid cooling tends to retard the growth of large grains, but unless great precautions are taken to cool the steel very rapidly, it will still have a fairly coarse granular structure, which, combined with the brittleness caused by rapid cooling, leaves a material having little commercial value.

Cast Steel Reheated

To overcome these difficulties it is necessary to give the steel some special heat treatment—in this case, annealing. Theoretically, in annealing the steel should be heated to the upper critical point, and then cooled slowly, but the rate of cooling has to be varied, depending on the particular steel required.

The theory of this treatment is that as the steel is heated above the lower critical point, the phases of softened steel, i. e., pearlite, ferrite, and cementite, tend to change into austenite. This reaction continues through the critical range accompanied by the absorption of heat which causes a retarding in the rate of heating, similar but opposite to the action in cooling, and when the upper critical point is reached it is found that the steel has been all converted into martensite, provided sufficient time has been given in heating to permit this reaction to occur completely. The result of this transformation is to break the coarse-grained crystals into a finer-grained or even an amorphous structure.

Such is the treatment required theoretically, but in cast steel there are certain conditions that prevent the reaction from occurring as expected, so that it becomes necessary to soak the steel for a long time at temperatures considerably above the upper critical point before obtaining an annealing action. These conditions will be discussed in detail under annealing.

In the case of cast steels which have been quenched (unlikely in actual practice), we have the usual hardening of steel. Any reheating will result in changes similar to tempering. Hardening and tempering will be discussed in later paragraphs.

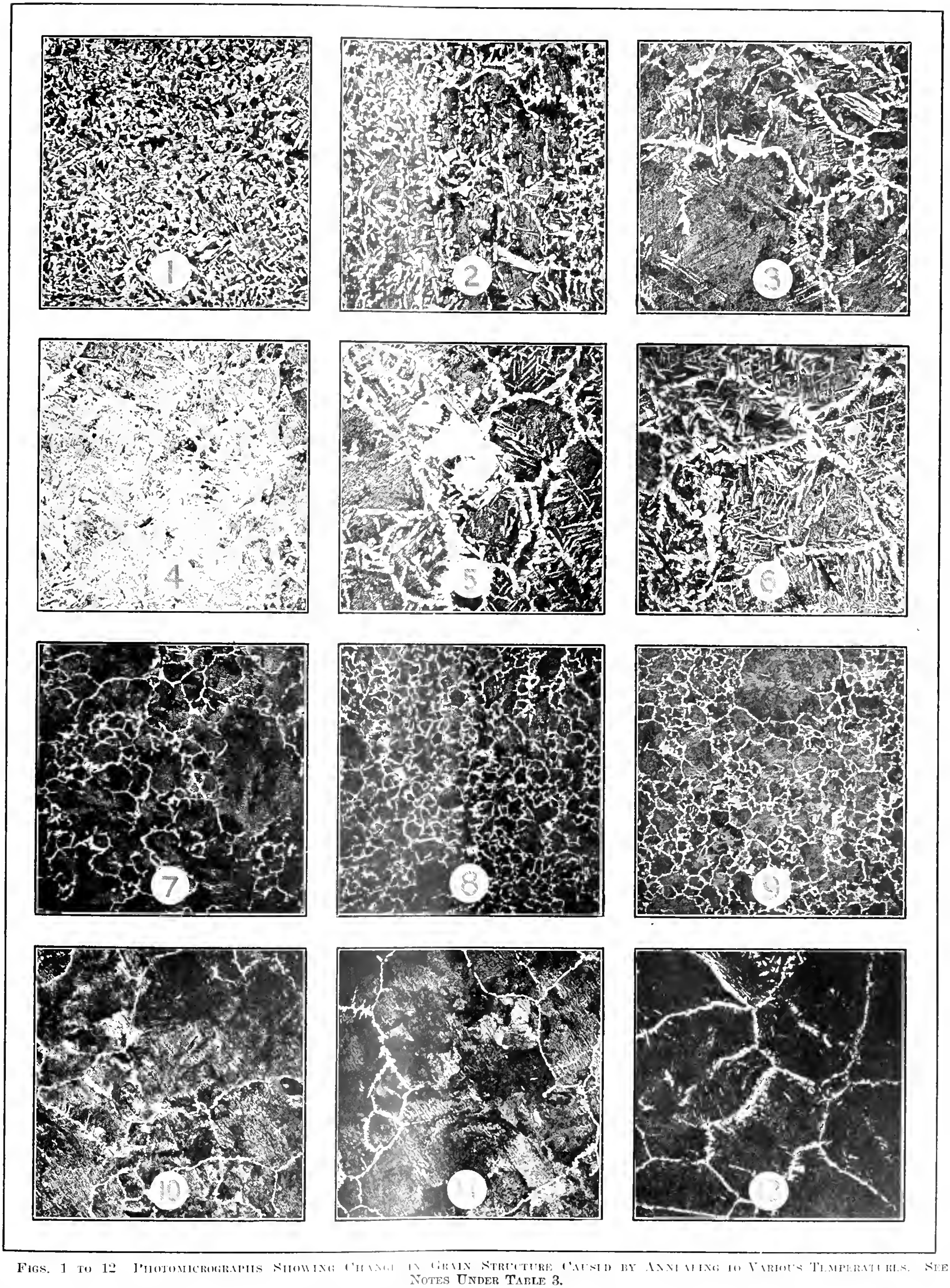
Hot-Worked Steel Cooled Slowly

In cast steel it was found that the size of grain structure was dependent on the rate of cooling, but with steel subjected to mechanical treatment such as rolling or forging, we find that the crystalline growth is much slower, if not altogether discontinued, during the time the steel is being so treated. The extent of this retardation of the crystalline growth is controlled by:

1 *The nature of the work being done.* Light hammering, with only a slight reduction in size, may leave the steel almost like cast steel, while pressure under a hydraulic press, combined with a large reduction in area will leave it with a fine-grained or even amorphous structure. The latter is an ideal condition.
2 *The temperature at which work was stopped.* As soon as we discontinue working the steel the growth of size of crystalline grain again commences and continues to the upper critical range.
3 *Rate of cooling from time of completion of work to the upper critical point.*

If steel is cooled slowly from the temperature at which work was stopped (especially if this temperature was high) to the upper critical point, the result is a coarse-grained structure of the phases of softened steels. Due to the relatively large grains of pearlite the tensile results, including the elongation, will be found to be low. This is a condition frequently met in the forging of shells where the finishing temperatures are around 1800 deg. fahr. or even higher. In high-carbon heats the forging manufacturers attempt to soften the steel by long-continued cooling, and if this rate of cooling is sufficiently slow we reach the above conditions and find heats failing on yield with an ultimate strength of about 43 tons, where the normal results should be 50 tons and over. To overcome this condition it is necessary to carefully anneal the steel to remove the coarse-grained structure.

Where the mechanical treatment is continued to the upper critical point the structure is fine-grained and is in its ideal condition, but the cost of working steel down to this temperature usually forbids it, so that any crystalline structure that is formed between the finishing temperature and the upper critical point must



Figs. 1 to 12 Photomicrographs Showing Change in Grain Structure Caused by Annealing to Various Temperatures. See Notes Under Table 3.

be removed by reheating (annealing) the steel to the upper critical point and then cooling either slowly or rapidly, depending on the product required.

Annealing of Steel. The purpose of annealing steel is—

1 To increase the softness and ductility of steel in cases where it is too hard for machining;
2 To remove strains and refine grain structure and reduce brittleness or other defects caused by:
   a High finishing temperature while hot-working, leaving a coarse-grained structure
   b Coarse granular structure due to slow cooling as in castings
   c Strains caused by cold-working of steel below critical temperature;
3 To soften steels too hard and brittle as the result of too rapid cooling.

In annealing the operation consists in (1) slowly raising the steel to its upper critical temperature; (2) holding it or soaking it at this temperature for a certain time depending on size of piece being treated and condition of previous treatment; and (3) cooling from annealing to atmospheric temperature.

Theoretically, as the steel is heated to the lower critical point the usual transformation from the phases of softened steel to austenite is commenced, and continues through the critical range, so that when the upper critical point is reached the steel should be all austenite. As a result of this transformation all preëxisting structures, no matter how coarse, are obliterated and the mass assumes an amorphous structure, providing sufficient time has been taken in heating to permit these changes to occur.

Further, if the temperature is carried above the upper critical point the tendency is for this amorphous structure to again become crystalline. Hence, in annealing steel its temperature should theoretically be raised to the upper critical point only, but practically there are conditions that modify this. For example, in cast steels we find that temperatures considerably higher (as much as 100 deg. cent. above the theoretical temperatures), combined with long soaking, are required to break up the coarse-grained structure. The reason for this is rather obscure. One theory that has been advanced claims that each grain in cast steel is surrounded by a film of sulphides, phosphides and silicides of iron which prevents the crystals from breaking up under ordinary treatment, but with long soaking at high temperatures these impurities tend to migrate to the center of the grains and leave the surface of the crystals free to break up.

TABLE 2 ANNEALING TEMPERATURES FOR STEEL

Range of Carbon Content	Range of Annealing Temperatures	
	Deg. Cent.	Deg. Fahr.
Less than 0.12 per cent.	875 to 925	1607 to 1697
0.12 to 0.25 per cent.	840 to 870	1544 to 1598
0.30 to 0.49 per cent.	815 to 840	1499 to 1544
0.50 to 1.00 per cent.	790 to 815	1454 to 1499

Mechanical work on steel seems to have the same effect, i. e., it breaks up this intercrystalline film, and as a result we find that the more a piece of steel has been worked the closer the annealing temperatures can be kept to the upper critical point, while the nearer the steel is to the unworked or cast condition the higher the temperatures must be. The ranges of temperatures given in Table 2 have been recommended by the Committee on Heat Treatment of the American Society for Testing Materials.

The time of soaking depends largely upon the size of the object being annealed, but sufficient time should be given to permit the object to be heated throughout to the annealing temperature and allow the internal changes to occur. Pieces 12 in. thick require about one hour.

HOT-WORKED STEEL COOLED RAPIDLY

The rate of cooling after annealing is controlled by the product required. If a maximum softness and ductility is desired, i. e., for easy machining, we cool as slowly as possible, by either burying the article in a bed of insulating material or allowing it to cool in the furnace. If, however, we wish to retain a certain amount of hardness and strength we must cool faster, as in air or, if a very low-carbon steel, in water, but to do so we must sacrifice a certain amount of ductility and softness. As a general rule, the lower the carbon the more rapid may be the cooling. For example:

a Steels with carbon contents below 0.15 per cent can be quenched in water and remain ductile and at same time have maximum hardness and strength.

b Steels with carbon contents below 0.20 per cent can be quenched in oil with results similar to 0.15 per cent carbon quenched in water.

c Steels with carbon above 0.30 per cent cannot be cooled so rapidly without destroying the ductility of the steel and so must be either cooled in the furnace, or in the air when extreme softness is not required.

The size of objects must also be considered along with the product desired. Other things being equal, the larger the object the more quickly must it be cooled, so long as the cooling is not too rapid to set up strains.

As an example of the effect of rate of cooling on the strength of steel, we have a system of strengthening steels on high-explosive shells known as the Sandberg air-cooling method. By this method air at pressures ranging from 6 oz. to 15 oz., usually around 10 oz., is either passed around the shell forging or forced to impinge on the revolving shell in such a way that a shell that would normally cool in about thirty minutes or more in the open air, is cooled in six to eight minutes. As a result the ultimate strength is raised from 4000 to 10,000 lb., with an increase in the elastic ratio but with very little variation in the ductility of the steel. This process is really an intermediate treatment between annealing and the regular hardening of steel, due to the formation of sorbite, which, as explained before, is a transformation phase between martensite and pearlite. Another way to get this sorbitic steel is to first quench steel from the upper critical range, thus retaining its fine-grained structure but leaving the steel very hard and without ductility. The steel is now reheated close to but below the lower critical range, say, from 500 to 650 deg. cent. (932 to 1202 deg. fahr.), when it loses its hardness and becomes ductile. The reason for this is that the steel has been changed from martensite to sorbite. This is really a hardening and tempering treatment, but is referred to here because it is sometimes called a double annealing treatment.

Photomicrographs of Annealed Steel. The photomicrographs reproduced in Figs. 1 to 12 illustrate graphically the distinct change in grain structure caused by annealing to various temperatures. Figs. 1 to 6 apply to one grade of steel, *A*, and Figs. 7 to 12 to another grade, *B*. The properties of these steels, after ordinary forging, but before annealing, are given in Table 3.

TABLE 3 ANALYSES AND PROPERTIES OF ANNEALED STEELS *A* AND *B*

Steels	Carbon, per cent	Manganese, per cent	Phosphorus, per cent	Sulphur, per cent	Stretch at 19 tons	Ultimate breaking load, tons	Elongation, per cent
A	0.40	0.61	0.062	0.057	0.0	40.3	26.0
B	0.55	0.80	0.058	0.057	0.0	47.9	18.5

HEAT TREATMENT

Figs. 1 and 7: Samples heated to 1500 deg. fahr., held for 2 hr., withdrawn, and cooled in air.

Figs. 2 and 8: After the above heat, samples were heated to 1600 deg. fahr., held for 1½ hr., withdrawn, and cooled in air.

Figs. 3 and 9: After the above heats, samples were heated to 1700 deg. fahr., held for ½ hr., withdrawn, and cooled in air.

Figs. 4 and 10: After all the above heats, samples were heated to 1900 deg. fahr., held for ½ hr., withdrawn, and cooled in air.

Figs. 5 and 11: After all the above heats, the samples were heated to 2100 deg., held for 20 min., withdrawn, and cooled in air.

Figs. 6 and 12: After all the above heats, samples were heated to 2275 deg. fahr., held for 20 min., withdrawn, and cooled in air.

In samples *A* the grain structure increases progressively from the start. In samples *B* the grain is finest at 1600 deg. fahr., Fig. 8, and increases thereafter. At 1900 deg. fahr., Fig. 10, signs of overheating appear, while samples *A* show damage only in Fig. 6, at 2275 deg. fahr.

Hardening of Steel. The most common constituents of hardened steel are martensite and troostite, and as we know the conditions under which they are formed, it is only necessary to treat the steel so as to produce either or both, depending on the hardness required.

To obtain martensite the steel must be raised to the upper critical range so as to transform the pearlite and ferrite, or pearlite and cementite, into austenite. We must not let the temperature rise above the upper critical point, as by so doing we coarsen the structure, and our aim should be to keep this as fine as possible. So we should quench the steel just as it issues from the upper critical range in the quenching medium selected, due to the fact that long exposures to temperatures above the critical point will increase the grain size. However, in deciding on the temperatures to be used we must consider the previous work and treatment given the steel. For example, a piece of cast steel will require considerably higher temperatures for reasons similar to those given under annealing, while steel that has had considerable work done on it (especially when work is continued down to the upper critical range) need only be heated to the upper critical range before quenching. The hardening temperatures in Table 4 are given by E. F. Houghton & Co.

TABLE 4 RELATION OF HARDENING TEMPERATURE TO CARBON CONTENT

Carbon Content	Hardening Temperature to Use	
	Deg. Cent.	Deg. Fahr.
Up to 0.20 per cent	871 to 899	1600 to 1650
0.20 to 0.35 per cent	843 to 871	1550 to 1600
0.35 to 0.50 per cent	815 to 843	1500 to 1550
0.50 to 0.70 per cent	787 to 815	1450 to 1500
0.70 to 0.90 per cent	760 to 787	1400 to 1450
0.90 per cent or over	732 to 760	1350 to 1400

It is difficult in quenching steel to control the percentage of martensite and troostite that will result, or, in other words, to get uniform results from hardening alone, as the various factors that control these percentages as size of piece, rate of cooling, etc., vary so much. So the practice is to endeavor to get the maximum amount of martensite by as rapid a cooling from above critical point as is permissible without unduly setting up cooling strains which might rupture the metal. This leaves the metal too hard and brittle for ordinary requirements, but by tempering we can arrive at any degree of hardness or toughness required.

Steel is most commonly quenched in oil or water. In either case care must be taken, especially with high-carbon steels, to prevent cracking as the result of strains set up by too rapid cooling. If oil or water is used the object should be withdrawn from the bath before its temperature has fallen below 100 deg. cent. (212 deg. fahr.), and the drawing or tempering treatment should follow immediately.

Hot-Worked Steel Reheated (Tempering)

Steel that has been hardened is generally harder and more brittle than is necessary, and in order to bring it to the condition that meets our requirements a treatment called tempering is used. This increases the toughness of the steel, i. e., decrease the brittleness at the expense of a slight decrease in hardness.

There are several theories to explain this reaction, but generally it is only necessary to remember that in hardening we quench steel from the austenite phase, and, due to this rapid cooling, the normal change from austenite to the eutectoid composition does not have time to take place, and as a consequence the steel exists in a partially transformed and unstable condition at ordinary atmospheric temperatures. But owing to the strains and rigidity set up by this rapid cooling the steel is unable to change into its more stable phase until these strains are removed by the application of heat. The higher the heat, the greater the transformation into the softer phases. As the transformation takes place, a certain amount of heat of reaction, which under slow cooling would have been released in the critical range, is now released and helps to cause a further reaction, the result of which is that if a piece of steel is heated to a certain temperature and held there, the tempering color, instead of remaining unchanged at this temperature, will advance in the tempering-color scale as it would with increasing temperature. This means that the tempering colors do not absolutely correspond to the temperatures of steels, but the variations are so slight that we can use them in actual practice.

Temperatures to Use. As soon as the temperature of the steel reaches 100 deg. cent. (212 deg. fahr.) the transformation begins, increasing in intensity as the temperature is raised, until finally when the lower critical range is reached, the steel has been all changed into the ordinary constituents of unhardened steels.

If a piece of polished steel is heated in an ordinary furnace, a thin film of oxides will form on its surface. The colors of this film change with temperature, and so, in tempering, they are generally used as an indication of the temperature of the steel. The steel should have at least one polished face so that this film of oxides may be seen.

An alternative method to the determination of temper by color is to temper by heating in an oil or salt bath. Oil baths can be used up to temperatures of 500 deg. fahr.; above this, fused-salt baths are required. The article to be tempered is put into the bath, brought up to and held at the required temperature for a certain length of time, and then cooled, either rapidly or slowly. This takes longer than the color method, but with low temperatures the results are more satisfactory, because the temperature of the bath can be controlled with a pyrometer. The tempering temperatures given in Table 5 are taken from a handbook issued by the Midvale Steel Co.

TABLE 5 TEMPERING TEMPERATURES FOR STEELS

Temperature for 1 hour		Color	Temperature for 8 min.		Uses
Deg. F.	Deg. C.		Deg. F.	Deg. C.	
370	188	Faint yellow	460	238	Scrapers, brass-turning tools, reamers, taps, milling cutters, saw teeth
390	199	Light straw	510	265	Twist drills, lathe tools, planer tools, finishing tools
410	210	Dark straw	560	293	Stone tools, hammer faces, chisels for hard work, boring cutters
430	221	Brown	610	321	Trephining tools, stamps
450	232	Purple	640	337	Cold chisels for ordinary work, carpenters' tools, picks, cold punches, shear blades, slicing tools, slotter tools
490	254	Dark blue	660	349	Hot chisels, tools for hot work, springs
510	265	Light blue	710	376	Springs, screw drivers

It will be noted that two sets of temperatures are shown, one being specified for a time interval of eight minutes and the other for one hour. For the finest work the longer time is preferable, while for ordinary rough work eight minutes is sufficient, after the steel has reached the specified temperature.

The rate of cooling after tempering seems to be immaterial, and the piece can be cooled at any rate, providing that in large pieces it is sufficiently slow to prevent strains.

How are we to know if we have given a piece of steel the very best possible treatment? The best method is by microscopic examination of polished and etched sections, but this requires a certain expense for laboratory equipment and upkeep, which may prevent an ordinary commercial plant from attempting such a refinement. However, I would certainly recommend any firm that has any large amount of heat treatment to do, to install such an equipment, which can be purchased for from $250 to $500. Its intelligent use will save its cost in a very short time.

The other method is by examination of fractures of small test bars. Steel heated to its correct temperatures will show the finest possible grain, whereas underheated steel has not had its grain structure refined sufficiently, and so will not be at its best. On

the other hand, overheated steel will have a coarser structure, depending on the extent of overheating.

To determine the proper quenching temperature of any particular grade of steel it is only necessary to heat pieces to various temperatures not more than 20 deg. cent. (36 deg. fahr.) apart, quench in water, break them, and examine the fractures. The temperature producing the finest grain should be used for annealing and hardening.

Similarly, to determine tempering temperatures, several pieces should be hardened, then tempered to various degrees, and cooled in air. Samples, say six, reheated to temperatures varying by 100 deg. from 300 deg. cent. to 800 deg. cent. will show a considerable range of properties, and the drawing temperature of the piece giving the desired results can be used.

Precautions to be Used in Heat-Treating. The following precautions should be observed in the heat treatment of steel:

1 Do not put a cold piece of steel into a highly heated furnace. Either reheat it or put it into a cold furnace and allow it to heat up with the furnace. This precaution is especially applicable in cold weather. Also remember that the changes occurring in the critical range are not instantaneous. The steel must be given time to change. It does not pay to rush the heating. Raise the temperature slowly.

2 Allow the piece to soak at the quenching temperature until it is uniformly heated throughout, the length of time depending on the size of the piece and the rate of heating.

3 Do not allow the piece to be directly on the hearth of the furnace, but have it supported at a sufficient height to allow a free circulation of gases on all sides. Long pieces should have sufficient support to prevent sagging.

4 Never allow a piece, especially if it has points or sharp corners, to come in contact with flame.

5 In quenching, immerse the piece with the axis vertical. This will prevent excessive warping or cracks due to unequal contraction in cooling.

6 Care should be taken that no sharp grooves, corners or seams are left on pieces to be quenched, which may develop into cracks.

7 In drawing the temper of a large piece in a furnace never put a piece into a furnace hotter than the drawing temperature nor allow the furnace to exceed the required temperature, otherwise the steel will be softer than required.

8 In drawing large pieces, soak a sufficient time at the desired drawing temperature, to allow the heat to affect the center of the piece.

9 In annealing and quenching never depend on the eye to judge the temperature; use a pyrometer.

RESULTS OBTAINED—SANDBERG AIR-COOLING TREATMENT

[In an appendix to his manuscript the author gave details of the results obtained in heat-treating cast-steel billets for large shells to meet the specified requirements of 19 tons yield, 35 to 49 tons ultimate breaking load, and 14 per cent elongation in a 2-in. test piece. For example, a cast-steel blank containing 0.60 per cent carbon and 0.87 manganese was soaked for four hours at 1575 deg. fahr., allowed to cool in the furnace to 1350 deg. fahr., removed from the furnace and cooled quickly to black in air; then reheated to 1275 deg., soaked for $2\frac{1}{2}$ hours and allowed to cool in the furnace. On test this sample showed over 19 tons yield, 46.2 tons ultimate breaking strength, against 51.2 tons theoretical, and 19.5 per cent elongation, which indicates very good annealing.

In a second appendix the author gives details of O. F. A. Sandberg's patented method of blowing air upon hot annealed steel for the purpose of increasing its toughness, elastic limit and ultimate strength over that of normal forged steel, the use of which method was allowed free to manufacturers of forgings for the duration of the war. The method is also to be applied to steel rails to improve their wearing qualities. It involves the distribution of air at $\frac{1}{2}$ to 20 lb. pressure over the pieces being treated to rapidly abstract the heat from the steel. The lower the carbon content, the more rapid should be the cooling.

The beneficial influence of this air blast upon four samples of steel is evidenced by the results given in Table 6.—EDITOR.]

TABLE 6 RESULTS IN TEMPERING BY AIR BLAST

Percentage Analysis		Before Treatment			After Treatment			
Carbon	Manganese	Stretch at 19 tons, in.	Ult. strength, tons	Elongation, per cent	Stretch at 19 tons, in.	Ult. strength, tons	Elongation, per cent	Theoretical ultimate strength, tons
Electric Steel								
0.36	0.57	0.1	37.9	23.0	0.0	40.4	21	36
0.35	0.73	0.2	37.9	27.5	0.0	39.1	26.5	39
Basic Steel								
0.47	0.64	0.1	37.7	27.4	0.0	41.8	25	41
0.52	0.53	0.1	34.5	23.0	0.0	46.6	20.5	42

U. S. Shipping Board Rules for the Inspection of Marine Machinery

Standardization work worthy of more than passing mention is that recently accomplished by the United States Shipping Board Emergency Fleet Corporation, the results of which are embodied in a pocket-sized volume it has issued under the title Rules and Instructions for the Inspection of Marine Machinery, Series I. These rules deal respectively with reciprocating steam engines; Diesel engines; steam turbines and reduction gears; water-tube and Scotch marine boilers; direct-acting pumps; condensing apparatus, feedwater heaters, evaporators and distillers; refrigerating machinery; propellers; auxiliary deck equipment such as capstans, winches, towing engines, etc.; and electrical equipment, including d. c. generators and searchlights.

Shortly after embarking on its huge ship-production program the Emergency Fleet Corporation found itself confronted with the imperative need for rational, precise and concordant inspection instructions covering the machinery to be installed in its vessels, not only to facilitate their rapid equipment—which the exigencies of the times demanded, but to insure that reliable machinery making for safety at sea, conforming with existing maritime regulations and whose standard parts were of interchangeable construction, would be produced.

The task of formulating such rules was accordingly placed late last fall in the hands of John A. Stevens, Standardization Engineer of the Fleet Corporation, a Vice-President of The American Society of Mechanical Engineers and Chairman of its Boiler Code Committee. Mr. Stevens at once summoned to Philadelphia some sixty of the country's prominent engineers—selected for their expert knowledge of the practical allowances, clearances, tolerances and materials that were to be provided for in the proposed instructions, and these in conjunction with the departmental engineers and chiefs of the Fleet Corporation, under his effective direction, succeeded after a few short weeks of unremitting endeavor in accomplishing the desired result. Twenty-eight of those coöperating in this important work are members of The American Society of Mechanical Engineers.

It is stated in the introductory remarks that the rules and instructions as published are not retroactive in nature and are not to be applied to machinery which has been constructed, inspected and stored; and that the whole intent of the work is to provide reasonable, sensible and commercial inspection on machinery now building or which may be built in the future.

The total number of merchant vessels under construction throughout the world (excluding the Central Powers) on December 31, 1918, according to Lloyd's Register Shipbuilding Returns, was 2189 ships of 6,921,989 gross tons, or double the largest corresponding tonnage under construction before the war.

Electric Furnaces as Applied to Steel Making

By HENRY LAWRENCE HESS,[1] BALTIMORE, MD.

THE war has wrought many remarkable changes, and when details are fully published, I believe it will be found that the electric furnace and the electric-steel industry have given a decidedly satisfactory account of themselves.

The war has undoubtedly aided the phenomenal growth of the electric furnace, but this growth has to a large extent been the result of the demand of the steel user for a quality product. The ultimate consumer in a large measure is the court of last appeal. It is the ultimate consumer who realizes that the best materials are none too good, and, taking into account the comparative cost of the steel, the cost of labor put upon it, and the tools used in fabricating, decides that it is economy to use the best steel, and that electric steel meets his requirements uniformly and satisfactorily, thus producing a demand resulting in its rapid growth.

In 1910 there were in operation in the world 114 electric furnaces. Most of these were small experimental units. In 1913 there were 140 in use. In the United States there were in operation in 1913 only 19 furnaces. In 1914, just before the war broke out, there were 213. Since then, of course, we have no reliable information as to the number of furnaces operating in Europe, but in January, 1918, there were in the United States alone, 233, 126 of which were of the Héroult type. An *Iron Age* estimate of the total furnaces in the world at the beginning of 1918, is 733. This is an expansion of over five times in four and a half years, which is truly a remarkable showing. Since January additional furnaces have been installed, bringing the total up to 265 units for the United States.

The probable tonnage of electric-furnace steel for the world is about 4,000,000 tons per year, with the United States and Canada contributing a little less than one-half of this, or about 1,800,000 tons.

Two Methods of Producing Electric Steel

In speaking of electric-furnace steel for forgings or rolling, we must bear in mind that there are two distinct types of this steel, or rather two distinct methods of producing electric steel. One is the duplex method, where molten steel, partly refined in the open hearth, is taken from this latter furnace and charged in the electric furnace for finish refining. The other is the cold-melt method where the raw materials are charged cold into the electric furnace and the entire process of melting and refining is done in that furnace. Naturally there are advocates for both methods. One manufacturer using the duplex method has referred to the cold-melt method as the complex way of making electric steel. All cold-melt makers will naturally disagree with this alleged complexity of manufacture.

The refining period is the critical period in the electric-furnace cycle and this is naturally present in both the duplex and the cold-melt methods. Any multiplication of operations adds to the possibility of added difficulties. Pre-melting in the open hearth, entails two types of equipment and specialists for both. Given competent supervision of the electric furnaces and experience in their operation, the cold-melt method appears to be the far more simple of the two. There is no comparison between the ease of control and the adaptability of the electric furnace to metallurgical manipulation and those features of the open hearth. Suffice it to say that the electric furnace is the most advanced medium for the manufacture of steel that can be placed in the hands of the metallurgist or steel manufacturer. The cold-melt method is particularly adapted to small units. Where the furnace capacity runs above 10 tons, difficulties are encountered in satisfactory melting, although furnaces of this character have been built.

Many concerns using the duplex method have done so since the electric furnace has come as a natural addition to their plants which originally contained open-hearth furnaces. A very important factor in favor of duplex electric steel is its lower cost of production. Electric power is not cheap, and melting by electricity means high conversion cost. Melting in the open hearth and refining in the electric furnace gives good steel, when handled correctly, at lower cost. There is always the possibility, however, and sometimes the tendency, to decrease the electric refining period, and the costs, and to put on the market an electrically washed steel in price competition with true electric steel. A discussion as to the metallurgical superiority of well-made steel of either class is a lengthy although interesting one, and much can be said on either side, although it is fairly agreed that the advantage of ultimate quality rests with the cold-melt method.

The Héroult Type of Furnace, Old and New

The plant that I am interested in operates two 6-ton and four 7-ton Héroult furnaces. These furnaces were chosen because there is a far greater number of them in operation in this country than of any other type, and it is, therefore, easier to obtain men familiar with the operation of the Héroult furnace. Even so, it has been decidedly difficult during the last few years to educate men in the operation of electric furnaces fast enough to keep pace with increased installations.

The 6-ton furnaces and the 7-ton units are very similar as to electrical equipment and operation. The most pronounced mechanical difference is in the method of tilting when pouring. The older 6-ton furnaces have a rounded bottom to which are attached heavy cast-steel semi-circular racks that roll forward on a horizontal rack attached to the foundation, the tilting being done by an electric motor through a series of gears, pinions and tilting arms. Tilting in this way throws the spout and the stream of metal forward as the angle of tilt increases, making necessary the following of this stream by the ladle. To eliminate this feature, the new furnaces are pivoted on trunnions, the center line of which is directly under the pouring spout. As this furnace thus tilts around the spout, the stream remains constant and it is not necessary to move the ladle during the entire pouring of the heat. The weight being carried well forward in this design, necessitates the provision of counterbalance weights to make possible the use of a small tilting motor and eliminating the likelihood of a sudden dropping back of the furnace due to shearing of a key in the tilting mechanism or other cause.

The power comes to us as 25-cycle, 3-phase, 13,200-volt current. In our stations we transform this down to 100 to 110 volts for use in the furnaces. The 6-ton furnaces are rated at 1200 kva. and the 7-ton at 1500. The power consumption runs from 650 to 900 kw. per ton, depending upon the type of steel being melted and the degree of refining necessary.

In using the electric furnace for casting purposes, acid linings are sometimes employed; but when used for the production of ingots which are later to be turned into tool or alloy steels it is almost universal practice to line electric furnaces to somewhat above the slag line, with a basic lining. Magnesite brick is used for the walls and partially for the bottom; magnesite, magdolite, dolomite, syndolag, etc., being used for bottom making and patching, according to the individual preference of the manufacturers.

The Cold-Melt Method of Producing Electric Steel

The raw materials in the cold-melt process are charged into the furnace, the electrodes being raised to permit the loading of a full charge. The doors are then closed, the hand control drawn into operation, and the electrodes, which in the 6-ton and 7-ton size Héroult furnaces are usually made of carbon and are 17 in. in diameter, are gradually fed down until contact is made with the charge. Naturally as contact is first made with the scrap and as the interstices between this material vary and change as the melting takes place, there are rapid fluctuations of power input. These power fluctuations are individual to each phase, and it is because of this very rapid change of load and the practical im-

[1] Vice President, the Hess Steel Corporation, Jun. Am.Soc.M.E.

possibility of taking care of this mechanically, that the hand operation is often used, which operation is not as rapid as the mechanical.

As the charge begins to melt, and when the power load has settled down somewhat, the switch is thrown on to the mechanical control. This control operates through a series of switches connected to a control apparatus, which throws the power into the direct-current motors which are directly attached through a series of gears to drums which raise or lower the electrodes, decreasing or increasing the power input.

Control of temperatures and knowledge as to the temperature to be used during melting and refining is of prime importance.

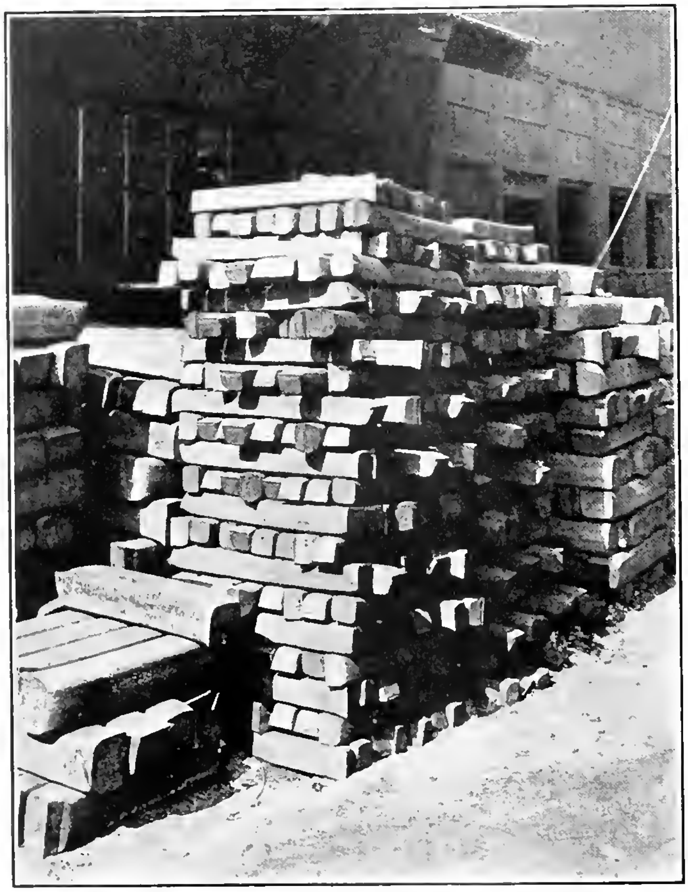


Fig. 1 Electric Steel Billets, Each Having Identification Marks

The pouring temperature must be right, for if the metal is too cold a heavy scull will be left in the ladle; if too hot, the possibility of ingot surface troubles is present, coupled with a greater likelihood of segregation.

The initial melting is done under as high power input as is possible, bearing in mind the necessity of obtaining from the furnace walls and roof the longest life economically possible when compared with the output.

Later, after the metal is melted, metallurgical reasons necessitate close control, and the temperature has quite a little to do with the removing of impurities from the steel. During the melting down, the raw materials charged have given up impurities of various sorts which are held in suspension in the molten metal. These impurities may be oxides, silicides, silicates, etc., which do not alloy with the steel but remain distinctly separate from the metal. If the molten steel were as transparent as water in a glass, we could see these foreign inclusions floating in the bath very much like small particles of dust. They are too small to rise to the surface of the bath in a short time, although their specific weight is lower than that of the steel. If, however, they could agglomerate and run together as mercury does and form large globules, then they would rise much more quickly to the surface on account of the greater buoyancy of their larger volume and would leave behind a cleaner steel. The melting temperature of most of these admixtures, however, is much higher than that of the steel, which means that they are still solid when the steel has reached a temperature sufficiently high for tapping.

In order to make the foreign inclusions coalesce and so form larger globules which will more readily free themselves, it is necessary, if possible, to liquefy them, which means a superheating of the metal. Such superheating also enables the deoxidizing agents, such as silicon, manganese, etc., to act more effectively and to make the deoxidation of the bath more complete than would be the case if the metal were more or less sluggish, or viscous. It is very necessary, however, that care be taken in this superheating, as the electric arc is the hottest-known source of heat and there is a grave possibility of burning the steel, as well as the aforementioned shortening of life of linings and roof.

Refining and slag building require that high temperatures be used, and as a rule the power is shut off entirely a few minutes before pouring in order that the bath may have a chance of settling and relieving itself of any particles of slag which may have been stirred into it.

As the melting continues, the operation becomes smoother until finally with a completely molten bath, the input of power is practically constant and is regulated according to the temperature required by the melter, to suit the stages of the refining operation. The total power input, as mentioned above, varies from 650 to 900 kw. per ton.

The charge depends upon the type of material to be made. For certain tool steels and highest-quality products it has been found best to use wash metal and ingot iron as a base. This material necessitates very little refining. For ordinary materials, because of the ease of refining in the electric furnace, it is possible to use a greater variety of raw stock. Heavy melting scrap bought on analysis limitations is used as a rule. With this charge of scrap a certain amount of limestone is added, which, upon fluxing with the molten metal, forms the basis for the slag. Through its reactions and affinities the impurities contained in the bath are eliminated to a large extent, especially phosphorus, which it is desired to reduce from the metallic charge. The character of the slag is altered to suit the reaction desired. After the action of the first slag is completed, it is removed and a second added.

During the various stages of the melting-down and refining periods, the metallic additions are made to bring the steel to the final analysis. These additions comprise, for instance, ferromanganese and ferro-silicon, which are used as deoxidizers, as well as for alloying, ferro-chrome, nickel, vanadium, tungsten, etc., etc. In addition to these ferro-titanium is sometimes used, and where deoxidization is not complete, it is sometimes customary to use a small amount of aluminum; this latter, however, is not considered best practice.

Building Up Correct Slags

The building up of correct slags is quite an art and is one of the most important factors in the making of a successful electric-furnace steel. Practice varies in this to some extent. Certain concerns prefer limestone; others use slacked lime. Preference lies with some for a more liquid slag than others think best, which means a variation in the use of sand and fluorspar. A ground coke is used in the formation of the white slag, the reason being that it attacks the calcium oxide (CaO) and forms metallic calcium which in turn splits sulphides of iron and manganese (FeS and MnS) forming calcium sulphide and metallic iron or manganese (CaS and Fe or Mn). The surplus of calcium combines with the surplus carbon and forms calcium carbide—a sure sign that active desulphurizing conditions are present in the furnace. The older opinion that calcium carbide is the active agent in desulphurizing, does not hold good in actual operation, and formerly calcium carbide was added for desulphurization, neglecting the fact that calcium carbide in itself is not active in desulphurization, depending, as it does, upon its first splitting for its action.

Naturally of prime importance is the selection of the raw materials and alloys entering into the metal and the correct calculation of the weights of these, etc., but too much consideration cannot be laid upon the necessity of careful manipulation and an ex-

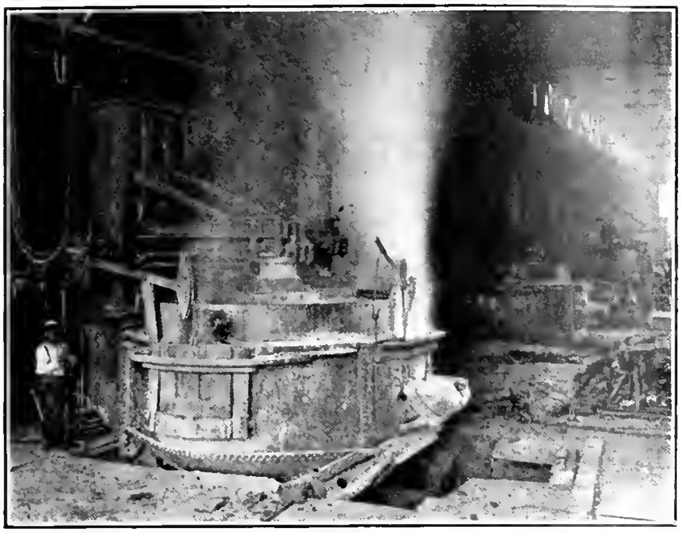


Fig. 2 Electric Furnace in Operation

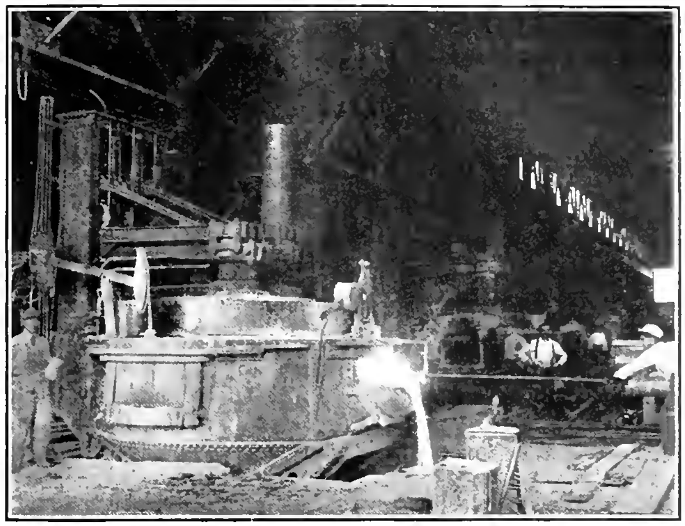


Fig. 3 Skimming Slag from Electric Furnace

perienced judgment in controlling the materials charged in the furnace during their melting and refining periods. The charge must be melted as rapidly as possible. Some concerns in melting down place great importance upon the necessity of not burning out the carbon below a point of approximately 0.20 content. The manganese will then, if everything has been operated carefully, be approximately around 0.30. Other concerns permit the carbon to be practically entirely reduced, a content of 0.04 or 0.05 being quite usual. It is somewhat more difficult to control the carbon and prevent this being entirely removed, but if such reduction of carbon and manganese is prevented, there is evidence that the bath has not been in an overoxidized condition, which may have been the case when the carbon has been completely removed. It should be borne in mind that when an undue amount of overoxidation has been once introduced into the molten metal, that it is practically impossible to thoroughly deoxidize the steel again with any degree of certainty. Even with the greatest care in the deoxidizing, there will always remain metallic oxides of one form or another, practically impossible to remove, and which exert a deleterious influence upon the metal produced. Fast melting with a careful supervision of the power input, proves advantageous in connection with the above practice of holding the carbon and manganese.

Heating in the Héroult Furnace

In some types of electric furnaces, the metal is subjected to heating not only from the top but from the hearth as well. In the Héroult all the heating is done from above by means of the electrodes near and above the center of the bath. This means that the heat is applied more or less locally and that there is very little tendency for circulation of the metal. In other words, the molten metal lies practically dead on the hearth. This is particularly true of that portion of the metal lying near the bottom, and for this reason, the heavier alloys have a tendency to settle, causing lack of homogeneity of the product and segregation of certain elements. This fact must be taken into account in the operation of the furnace and the metal must be put in circulation by means of systematic and vigorous stirring.

Pouring from the Furnace

In tapping the metal from the furnace, great care must be taken to see that there is as little opportunity as possible for the slag again to become mixed with the metal, and that opportunity also be given for any slag that has become mechanically mixed with the steel to rise from the metal. This is done by holding the steel in the ladle after it has been poured for as long as may be, without bringing the metal down to a temperature below that which is safe for pouring.

In ingot work practically all of the steel made is poured from "bottom-pour" ladles. Some pour directly from such ladles into the mold, others use intermediary measures such as boxes which break the head and give a more uniform and less violent stream, which tends to improve the ingot surfaces and prevent surface defects in the rolled billets and bars. Both of these methods are termed "top pouring."

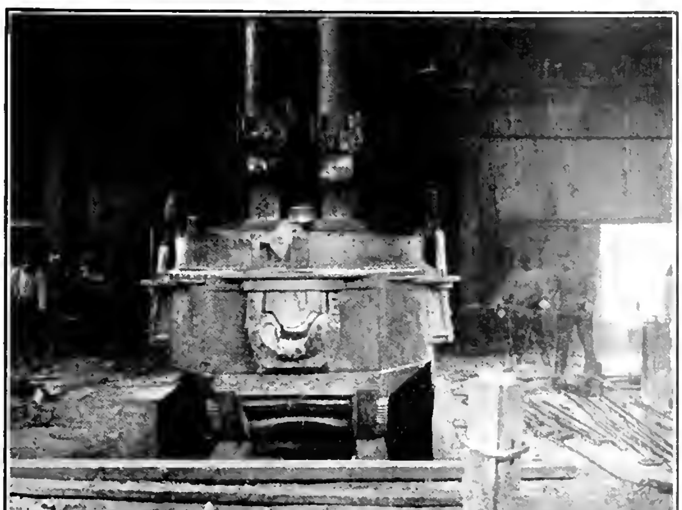


Fig. 4 Charging

Fig. 5 Stripping, Showing Refractory Top Brick

Another method is to pour down a central runner which divides at the bottom into feeders very much like the fingers of a hand, which in turn lead the metal to the bottom inlet of the ingot molds, so that as the steel is poured down the central runner, the metal rises uniformly in a set-up of molds, which usually take an entire heat.

In cooling there is a contraction of the molten metal in the molds. This contraction develops, upon solidification, along the axis of the ingot, a central cavity, largest at the top of the ingot. By carefully designing ingot molds, this tendency can be checked to some extent, and where the saving in croppage warrants such expense, as is the case with alloy and tool steels, a heat-retaining form is set upon the top of the mold, which by preventing radiation of the heat, keeps the enclosed metal hot, which metal then feeds the cavity or pipe as it develops in the ingot proper. These refractory forms are sometimes rammed up of molding sand at the plant, or are of a specially prepared fireclay material particularly adapted to this work. This latter type of hot-top brick is considered decidedly good practice, as with the use of such brick, there is practically no added possibility of introducing dirt into the steel, as is very often the case when the molded sand hot tops are used, since the faces of these sometimes spall off when subjected to the intense heat of the stream of molten metal passing by them.

Rolling

After cooling, the ingots are removed from the molds, commonly called stripping, inspected and sent forward for further working, which may consist of forging or rolling. This paper will deal with rolling only.

Some grades of steel require special precautions, such as slow pit cooling to prevent surface cracking; or annealing to relieve internal strains and prevent checking, and for the improvement of the ingot structure. This annealing is preferably done before the ingots cool down materially.

In tonnage plants, operating on steels for rails, plates, structural shapes, etc., the ingots are charged hot as quickly as possible after pouring, into soaking pits for heating, and are then rolled or forged, as much of the initial pouring heat being retained as is feasible.

Each ingot naturally bears its identification number, which number is carried along to the final product, so that it is possible to check the bar or rod back to the heat where it was made in order that the causes of any defects may be traced.

In most alloy mills the ingots after being delivered to the rolling mill are charged into a heating furnace where they are brought up to the temperature necessary for rolling. This temperature varies according to the analysis of the material to be rolled and must be uniform throughout the ingot. If the ingot is unevenly heated, trouble will be encountered in the rolling. If very cold, the rolls may break due to their inability to stand up against the enormous strain put upon them in attempting to reduce the cold metal. If heated unequally, one side being hot and the other cold, it will be difficult to control the material in rolling, as the hot side will naturally elongate more easily than the colder and the bloom will warp and cause trouble in passing through the guides, and sometimes make it impracticable to follow through the series of passes to final reduction.

Often an ingot will look as though it were heated to the correct temperature, but the period allowed for heating may have been too short, and the core, or the center of the steel, be still cold. This will also give considerable trouble as there will be a differential flow between the outer hot layers of the material and the colder core.

It is impossible to go into great detail here as to the various processes and methods of rolling, the power required, etc., but the equipment used by the company with which I am connected may serve as an indication.

This concern has adopted as its standard for alloy and tool steels, 9-in. by 9-in. ingots weighing approximately 850 lb. This ingot is heated up in a continuous heating furnace, equipped with an electric pusher, which furnace feeds a 20-in. mill having two three-high roughing stands and one two-high finishing stand. It is driven by a 600-hp. Westinghouse motor with Westinghouse slip-type regulators, driving through a series of herringbone gears, which reduce the speed of rotation to a mill speed of 62 r.p.m.

The bar capacity of the mill is from the 9-in. ingot down through a series of Gothics, squares and diamonds, to rounds and squares 2 in. in diameter. The standard billets produced for re-rolling are 4 in. These smaller billets after being rolled, are carefully inspected for surface checking, etc., pickled, chipped, reheated in another heating furnace and rolled down into the size desired on a five-stand 9-in. mill capable of giving all sizes from $1\frac{7}{8}$ in. to $\frac{3}{8}$ in. round or square. The hp. required on this smaller mill is 400. The same type of slip regulator is used for speed regulation, but, as on the smaller work, it is necessary to have some variation in speed control of the mill, and as this is not easily possible with alternating current, a heavy two-speed gear change is provided, which enables the mill to roll at 120 or 240 r.p.m.

After the bars are finish rolled, they are cut to length, inspected, straightened and shipped as finished bars, or are annealed for the refining of their grain and the softening of their structure, or heat-treated to obtain special physical characteristics.

These latter phases of the steel industry are by far the most interesting of the entire business, and most remarkable results can be obtained due to modern laboratory control and micrographical examination.

German Substitute Materials

Prior to the war by far the greater portion of raw stuffs required by Germany were imported from abroad (in round figures valued at about 10,000,000,000 marks). The blockade practically shut out foreign imports. It is thus natural that the question of substitute materials became the absorbing one in Germany. Official, industrial, and scientific Germany applied its utmost energy in attempting to solve it.

The principal efforts were made in the fiber and thread industry. The most interesting inventions in the field of textile substitutes are those procured from burning nettles, and it is believed that a valuable substitute for cotton has been found. A new chemical process for the extraction of the glutinous matter of the plant fiber has been developed and great progress has been made in extending the cultivation of burning nettles, which have been planted in great quantities.

Peat fiber belongs to the most interesting discoveries in the field of substitute textile raw stuffs. This can not, however, be practically used without mixture with other kinds of fiber. A mixture of 50 per cent peat fiber and 50 per cent wool gives what is said to be a strong and durable material that looks well and is satisfactory for men's clothing. The valuable qualities of peat fiber, however, are limited by the difficulties in procuring the peat. Only the younger moss turf can be employed in spinning. The black peat (used for burning) cannot be employed. The production from about 500,000 tons of peat amounts to about 10,000 tons of fiber; in other words, a very small amount, when the labor as well as the actual yield are both taken into account.

Great efforts have been expended, also, in attempting to find substitutes for leather and rubber.

The textile company "Barken" has succeeded in finding a substitute for "uppers," which promises to prove valuable even in peace times. Artificial rubber was produced prior to the war, but was shortly given up owing to the fact that cultivated rubber fell in price from 30 to 4 marks per kilo. When the scarcity of rubber again arose with the war, the production of synthetic rubber was again considered. Substitutes, however, had to be discovered owing to the lack of acetone and aluminum. When it was found possible to produce acetone from coal and carbide and to produce aluminum on a large scale (principally by "Grisheimer-Electron"), the production of artificial rubber could be undertaken. But the synthetic rubber is evidently merely fitted to meet a war need, for it cannot compete with the genuine article. Added to this its cost is much higher than London quotations for genuine rubber. (*Commerce Reports*, Jan. 18, 1919.)

LIBERTY ENGINE TESTS

Authentic Data on Performance Tests of the Standard High-Compression Army-Type 12-Cylinder Liberty Engine

Since the signing of the armistice a considerable amount of information has been published as to the design of the Liberty engine and its accessories. It is believed, however, that this is the first time that complete information as to the performance of the Liberty engine of the standard high-compression Army type has been published in a general engineering periodical. This information is of special interest as it shows the great power developed by this type of engine.

THE Liberty engine represents a typically American design from several points of view. The fundamental problem in developing this motor was to produce a unit which could be manufactured in quantity with such labor as was available in this country. Of course, there were at least as many skilled workmen in America as in Europe, but every skilled man was immensely necessary in a position where only skilled labor could be employed, such as tool making, ordnance production, etc., and the vast demands for aircraft motors could not be satisfied with skilled labor without disorganizing other equally important fields of production of war material.

If aircraft engines were to be built in sufficient quantities (and the original idea was to supply motors not only to America but also to the Allied forces) such motors had to be designed in such a manner as to be produced, as far as possible, by automatic machinery. This problem is actually far more difficult than would appear at first sight, because an aircraft motor has to combine unusual endurance qualifications together with light weight.

Figs. 1 to 4 show the general design of the Liberty engine. Its peculiar characteristics were such a development of parts that practically all parts could be produced on machinery of the type previously employed for mass production of automobiles.

The crankshaft is of the conventional type with seven bearings, but without counterweights. The pistons are of the die-cast aluminum-alloy type with very thick heads and tapered, increasing in thickness toward the top; a floating-type piston pin is employed. The assembly was based on the use of the individual cylinder design with steel cylinders made by a process developed by the Ford Company.

Data of several tests covering various phases of performance of Liberty engines of the standard high-compression Army type have been published in recent issues of the Bulletin[1] of the Experimental Department, Airplane Engineering Division, Bureau of Aircraft Production, War Department, from which the following abstract has been prepared by special permission.

A heat-balance test on a standard high-compression Army-type 12-cylinder Liberty engine was carried out at McCook Field, Dayton, Ohio. In this test the engine was run at a constant speed of 1600 r.p.m. with wide-open throttle, developing under these conditions an average horsepower of 372.5, the tests being continued for one hour under constant conditions. These conditions involved a water-outlet temperature of 170 deg. fahr., a water-inlet temperature of 150 deg. fahr., a carburetor setting choke 36, jet 160, compensator 165 and an average speed of 1600 r.p.m.

Pennsylvania gasoline of 68 deg. Baumé gravity was used, with an average consumption of 0.492 lb. per hp-hr. The average amount of jacket water pumped per minute was 90 gal., or, roughly, 720 lb.

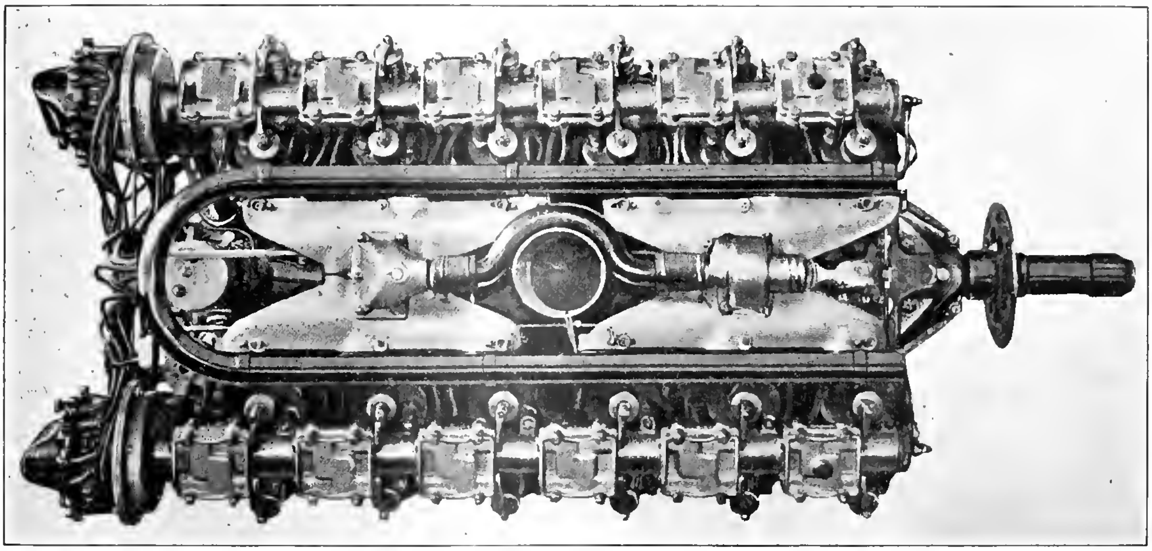


Fig. 1 Top View of Liberty Engine

Based on 19,000 B.t.u. per lb. of gasoline at 100 per cent efficiency, 183 lb. of gasoline per hour will give theoretically 1365 hp., which was distributed as shown in Table 1.

TABLE 1 HEAT BALANCE OF STANDARD LIBERTY "12" ENGINE

	Hp.	Per cent of B.hp.	Per cent of total
Average brake horsepower	372	100	27.3
Average heat absorbed by jacket water	339	91	24.8
Average frictional horsepower	48	13	3.5
Remaining heat units carried off by exhaust	606	163	44.4
Total—Theoretical horsepower	1365		100.0

This table indicates that 27.3 per cent of the theoretical horsepower was converted into power by the engine, which shows a high efficiency of the water plant, especially considering the high heat losses at the exhaust. (Bulletin, June 1918, p. 77.)

A still more important test is reported in the Bulletin for July 1918. In this instance twelve engines of the standard model-A production were given identical tests in the McCook Field dynamometer laboratory, after which they were torn down and carefully inspected.

The engines were given a complete run with the standard production setting of the Zenith carburetors of 31 choke, 140 jet and 150 compensator, as well as a test with setting of 36 choke,

[1] Bulletin of the Experimental Department, Airplane Engineering Division, U. S. A., McCook Field, Dayton, Ohio, June, July and August, 1918.

165 jet and 170 compensator to determine the influence of the carburetor adjustment on the average results.

In this connection it may be stated that it has been found that the latter setting is much better than the former to such an extent that at 1800 r.p.m. with wide-open throttle the average difference in power varies in the favor of the former setting from 30 to 34 hp., the gasoline consumption being also in favor of the first setting.

Tables 2 and 3 give, respectively, the average power data and the average gasoline and oil consumption obtained from six of the twelve engines (made by the Packard Motor Car Company, of Detroit, Mich.). These data show that the engines developed power curves, of which Fig. 5 is here reproduced as representative of the set. It is also of interest as bearing out the data of Tables 2 and 3. (Bulletin, July 1918, pp. 86-104.)

A series of highly interesting tests was carried out at the laboratories of McCook Field with a special single-cylinder Liberty engine built for test purposes only. Tests carried out with this engine covered such elements of engine design and construction as pistons, piston rings, valve construction and timing, cam design, ignition timing, cylinder lubrication, spark-plug tests, etc. In such tests a single-cylinder engine is as good and sometimes better than one of the multi-cylinder type, not only because it is cheaper and easier to handle but because it affords better

TABLE 2 AVERAGE POWER DATA OBTAINED FROM SIX PACKARD LIBERTY "12" MODEL "A" PRODUCTION ENGINES

Engine No.		Brake Horsepower													
		1200 R.p.m.		1300 R.p.m.		1400 R.p.m.		1500 R.p.m.		1600 R.p.m.		1700 R.p.m.		1800 R.p.m.	
Packard	S. C.	Choke 31	Choke 36	Choke 31	Choke 36	Choke 31	Choke 36	Choke 31	Choke 36	Choke 31	Choke 36	Choke 31	Choke 36	Choke 31	Choke 36
708	18179	270	271	279	301	314	325	344	353	360	378	376	397	376	413
715	18180	281	279	306	307	331	332	355	358	373	381	383	399	385	410
716	18182	274	273	301	301	329	325	351	352	370	377	381	395	383	410
719	18183	275	278	301	306	324	334	347	354	363	384	374	403	377	420
720	18184	268	275	290	301	320	328	343	351	357	378	366	396	366	412
732	18181	279	271	305	297	329	324	347	355	368	373	380	392	375	407
Averages...		274	275	300	302	325	328	348	356	365	379	377	397	378	412

TABLE 3 AVERAGE GASOLINE AND OIL CONSUMPTION OBTAINED FROM SIX PACKARD LIBERTY "12" MODEL "A" PRODUCTION ENGINES

Engine No.		Gasoline Economy at 1600 R.p.m.						Oil Economy at 1600 R.p.m.					
		36—165—170 Average Hp., 378			31—140—150 Average Hp., 367			36—165—170 Average Hp., 378			31—140—150 Average Hp., 367		
Packard	S. C.	Lb. hr.	Gal. hr.	Lb. hp-hr.	Lb. hr.	Gal. hr.	Lb. hp-hr.	Lb. hr.	Gal. hr.	Lb. hp-hr.	Lb. hr.	Gal. hr.	Lb. hp-hr.
708	18179	200 0	32 0	0 530	194 5	31.1	0 535	14 1	1 95	0 0370	19 4	2.67	0 0532
715	18180	199 0	31 8	0 526	195 0	31.2	0 520	11 5	1 59	0 0304	13 0	1 79	0 0350
716	18182	199 0	31 8	0 527	198 5	31.8	0 541	13.5	1 88	0 0360	15 8	2.17	0.0430
719	18183	192 5	30 8	0 502	190.0	30 4	0.519	10.7	1 48	0 0280	12 6	1.74	0 0350
720	18184	192 5	30 8	0 510	193 0	30.9	0.539	11.3	1.56	0 0290	10 3	1.42	0 0288
732	18181	193 0	30 9	0 533	195 5	31.3	0.525	11 8	1 63	0 0320	9.6	1 31	0 0256
Averages......		196 0	31 3	0 521	194 4	31.1	0 530	12 2	1 68	0 0321	13 6	1 85	0 0351

on an average from about 275 hp. at 1200 r.p.m. to 412 hp. at 1800 r.p.m., which is a very good output considering the weight of the engine.

Spark plugs gave considerable trouble throughout the test. It was noted that this trouble would diminish greatly as the test proceeded, showing that a certain number of plugs will fail after a very short time in service, frequently as little as 5 min. This generally was noted by the porcelain chipping off at the outside of the plug, thereby allowing the plug to jump from the center electrode to the outside shell. There is evidently a strain set up in the manufacture of some of these plugs, so that they are unable to withstand the heat or vibration of the engine for an appreciable time.

A suggestion is made in the report that consideration be given to some method of subjecting the plugs to an operating test at the manufacturer's plant which will in some way simulate actual operating conditions, thus enabling the manufacturer to eliminate those plugs which now give service only for a few minutes. At the same time it should be borne in mind that dynamometer testing conditions are somewhat more severe on spark plugs than are actual flying conditions.

Curves for fuel and oil economy are given as well as average facilities for detecting slight variations in the character of operation.

For these tests a special engine was constructed, in reality a standard Liberty engine of one cylinder instead of twelve: the cylinder itself, valves, valve springs, piston, piston pin and rings, etc., being exactly the same as those used in the 12-cylinder engine, while the crankcase, crankshaft and camshaft were different. Care was taken to arrange the installation in such a manner that the design of the engine would not differ from that of the 12-cylinder engine to such an extent that it might affect the results. For all tests a special carburetor was used—diagrammatically shown in the original article. The ignition for this engine was identical with that of the Liberty-12, a special timing mechanism being used.

Data of tests are summarized in a table, each test covering one or more variables as the case may be. It might be stated, in this connection, that the tests made with the single-cylinder engine to obtain data for the improvement of the design of the 12-cylinder unit are of particular interest as a good lesson on methods in engine designing. While not every plant can afford such a thorough investigation of its products, it is certainly an excellent way to secure extremely valuable results wherever it can be done.

The tests have brought out several factors of considerable importance. The first variable which was tested was that of the employment of a horizontal intake pipe that was not water-jacketed. Five series of tests were run; the first without any intake pipe at all; then with different lengths of pipe, such as 6-in., 10-in., 14-in., and 18-in. It was found that the results were materially affected by the carburetor choke size and were non-uniform for different speeds. Thus, with $1\frac{1}{8}$ in. choke, the highest horsepower with the 14-in. intake was obtained at 1600 r.p.m., equaling that with the 10-in. manifold pipe at 2000 r.p.m. With the same choke and an 18-in. intake pipe the highest output was secured at 1600 r.p.m. (29.6 b.hp.), but at 2000 r.p.m. this fell to 26.8 b.hp., which would indicate that with the increased suction there was a throttling action at the choke or increased turbulence in the intake pipe. This agrees well with the third set tests with $1\frac{5}{8}$ in. choke, where the brake horsepower increased fairly uniformly with the engine speed in all cases and did not appear to be materially affected by the difference in length of intake from 14 to 18 in., though with the short intake, 10 in., it was slightly lower (41.0 b.hp. as against 42.0 and 42.8, respectively).

At first the improvement realized with the 18-in. intake pipe, which size proved superior to any of the others, was ascribed solely to the "battering-ram" characteristics acquired by the column of mixture in the intake header. The particles, having some inertia, tend to build up a pressure against the carbureter side of the inlet valve while the valve is closed, which pressure is available on the next suction stroke to assist in forcing in the new charge. That there is considerable pressure generated in this manner is proven by the fact that the gasoline vapor is blown back out of the carbureter choke when the engine is running. Later experiments proved, however, that the battering-ram feature plays a minor part in the success of the long intake header. Tests made later with a water-jacketed manifold to the same length proved that it was the reduction of temperature in the long intake pipe which accounted for most of the improvement in the tests which were run without any water jacket around the intake header. It was found that the mixture when not heated in the intake pipe reaches a minimum temperature of about 40 deg. fahr. below the carbureter intake air temperature.

Fig. 7 shows the 18-in. horizontal intake manifold fitted with a water jacket so that all the cooling water passing through the cylinder jacket also passes through the water jacket around the intake header after leaving the cylinder. The curves in Fig. 9 show the effect on the horsepower output of the use of this water-jacketed intake, and also the resulting increase in temperature of the gases in the intake manifold. The engine outlet water temperature was controlled and power readings were taken over a range of various temperatures of the cooling water from 90 deg. to 200 deg. fahr. at a constant engine speed. The drop in power with the increase in water temperature, which, of course, increased the temperature of the gases in the inlet manifold, was plotted together with the actual changes in the inlet gas temperatures.

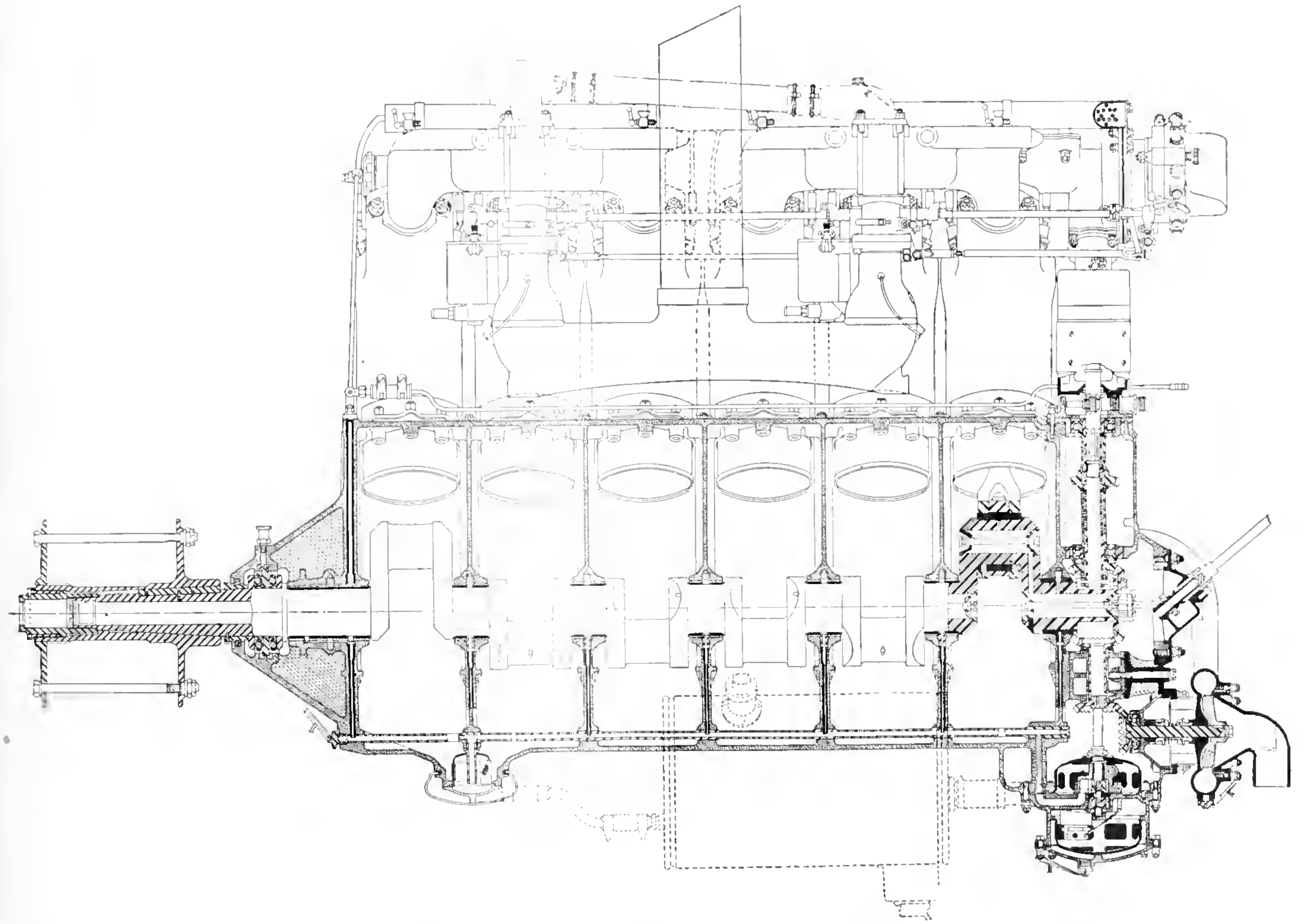


Fig. 2 Longitudinal Section of Liberty Engine

The curves in Fig. 8 prove conclusively that the power output is largely increased with the cold manifold, and show that this is one of the simplest means of obtaining supercharge. The amount of supercharge may be easily as high as 10 per cent, figuring an increase of volume of 0.2 per cent for each 1 deg. fahr., based on 100 per cent volume at 32 deg. fahr. In other words, with the temperature in the inlet pipe at 32 deg. fahr., 10 per cent more mixture can be had at atmospheric pressure than if the temperature in the intake pipe were 82 deg. fahr.

It is believed that certain difficulties will arise if the intake temperatures are lowered too much. It is reasonable to suppose

that the distribution of a uniform mixture to the various cylinders will become more and more difficult as the temperatures are lowered, due to the heavy particles of fuel carried along in a liquid state having considerable inertia. No doubt there would be a tendency for these particles to accumulate in larger percentages in those cylinders which from the nature of the manifold are reached by an easier or straighter path from the carbureter.

It would seem that the so-called "hot-spot" manifold would furnish a solution of this difficulty. This type is so designed that only a portion of it is heated, that being the section in which the liquid particles carried along by the gas are most likely to come in contact with the inner walls of the manifold.

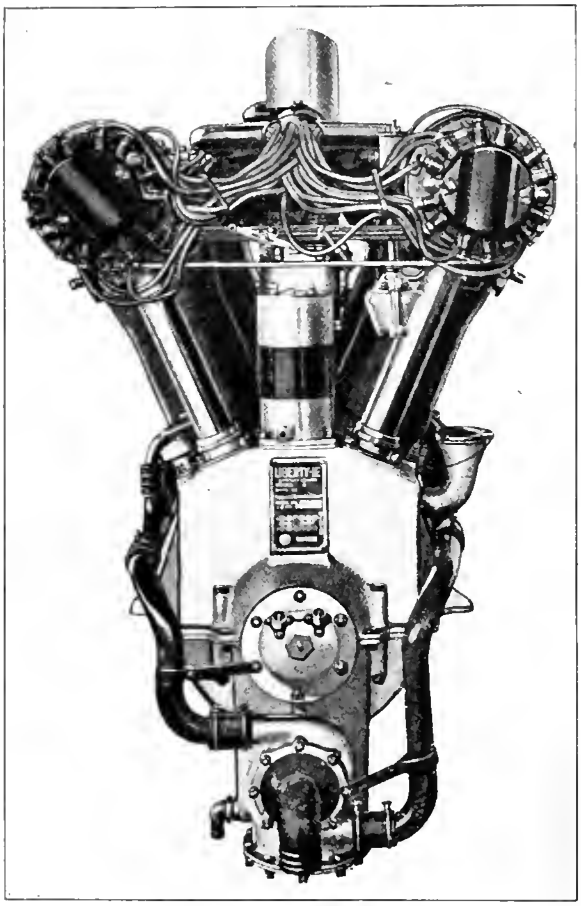


FIG. 3 DISTRIBUTOR END OF LIBERTY ENGINE

It is noteworthy that both the Mercedes and the Benz engines have long manifolds which are covered with an insulating wrapping. Recent tests of a 260-hp. Mercedes so equipped have shown perfect distribution of the intake gases, proving that by proper design of the intake manifold distribution difficulties with cold mixtures can be practically eliminated.

The question of fuel economy also comes up in this connection, although this evidently is largely a matter of distribution. There are indications, however, that a slight sacrifice of economy may accompany a large increase of power, due to cold intake gases.

Obviously there is little or no likelihood of using a straight 18-in. horizontal intake pipe on a V-type engine such as the Liberty-12. In order, therefore, to simulate as much as possible the construction form which would exist in such an engine, a crooked vertical intake pipe was made up as shown in Fig. 6.

The results of numerous tests with the crooked intake pipe prove that its action is on the average quite similar to that of the straight pipe. Comparisons of tests 8 with 16, 20 with 13, 12 with 15, and 24 with 36 (see Table 1, August Bulletin) show that in one case one pipe is somewhat superior and in another case the other pipe is slightly better. It is apparent, therefore, that the cooling action of the one pipe is about the same as the other, and whatever difference there may be in the battering-ram action between the two pipes does not materially affect the result.

There was very little spark-plug trouble throughout the single-cylinder engine tests, which would seem to indicate that the raising of the brake mean effective pressure in the 12-cylinder Liberty engine will not necessarily bring about an increase in spark-plug defects.

With the best combination of features on the single-cylinder engine it was found that at 1800 r.p.m. it developed 39 hp. Multiplying this by 12 would give 468 hp. for a similarly fitted 12-cylinder engine. Theoretically, the power output of the 12-cylinder engine should be about 25 hp. more than this, due to the fact that the friction losses of the 12-cylinder engine would not be 12 times as great as in the single-cylinder engine.

From results of these tests it would appear that a 12-cylinder engine can be advantageously fitted with pistons of a 6 : 1 compression ratio. Such a compression ratio in combination with the other features appeared also desirable, as it was believed that it would give a greater ceiling for the plane and greater speed at high altitudes. These tests further indicated that it might become desirable to use a reduction gear between the engine and propeller, thus enabling the engine to develop its greatest power at the highest practicable running speed while still utilizing more efficient propeller design. This has been ultimately adapted with the so-called Liberty epicyclic reduction gear.

The next tests were designed to determine the results of operating two production motors in the air for long periods without overhauling. In this instance two standard-production Liberty engines were given flight tests under service conditions as nearly as possible. One of the test engines (801) originally ran 60 hr. and the other (719) was operated 75 hr. Both were then torn down for examination, when it was found that they were in such excellent condition that it was decided to reassemble them without any replacements of parts and give them a much longer test. The first engine was run an additional period of 100 hr. and the other 85 hr., making a total of 160 hr. for each.

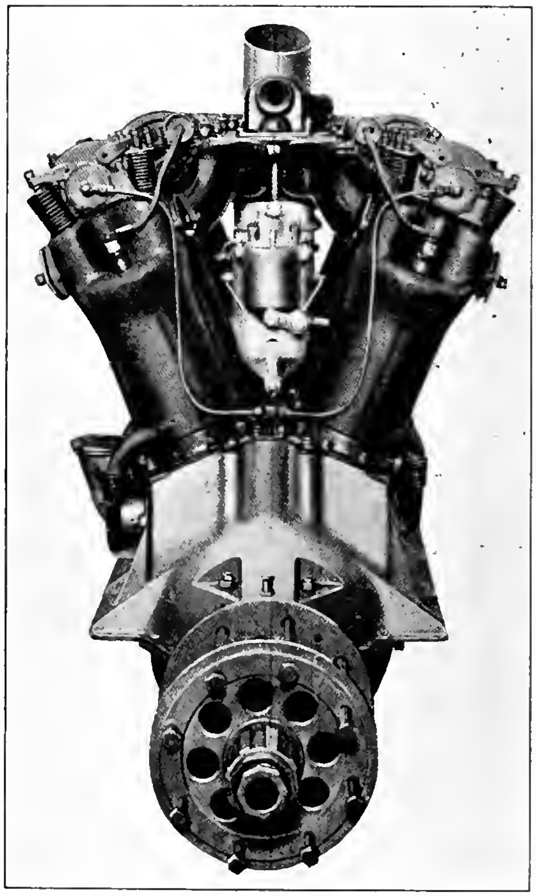


FIG. 4 PROPELLER END OF LIBERTY ENGINE

When these engines were torn down after the 160-hr. runs they were still in fairly good running condition, neither having shown

any signs of imminent failure. On the other hand, it was apparent that neither engine would have run very much longer.

In all these tests the engines were mounted in Curtiss R-4 planes, which are somewhat slower and heavier than the DeHaviland-4, but similar enough to the DeHaviland to warrant the belief that both the horsepower developed and the fuel consumed

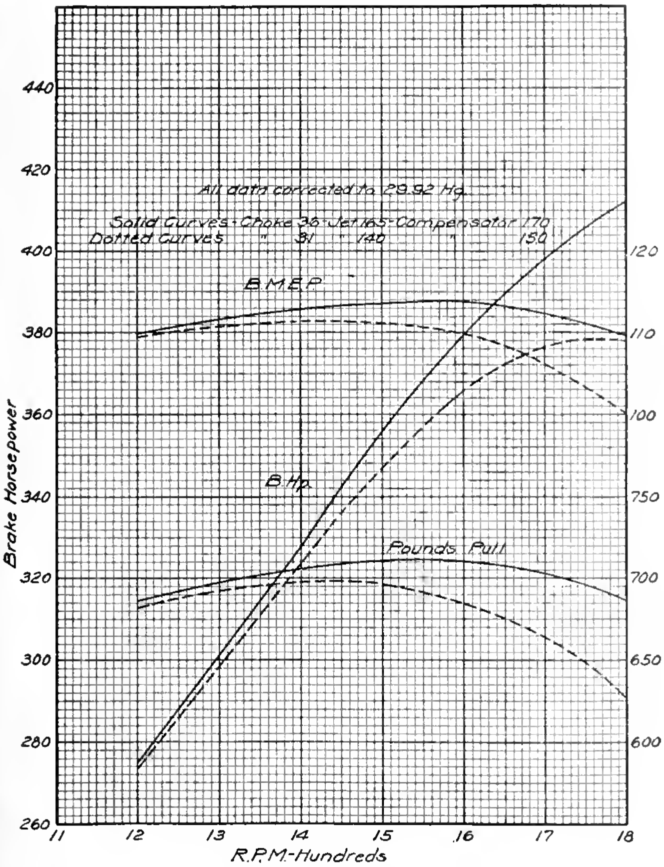


FIG. 5 CURVES OF FUEL AND OIL ECONOMY AND OF AVERAGE POWER OF LIBERTY ENGINE

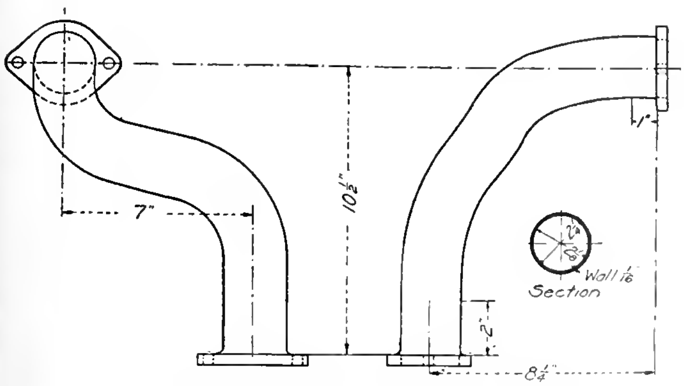


FIG. 6 CROOKED INTAKE PIPE USED FOR TESTS

would be nearly the same in both cases. The planes did not carry full loads such as would be carried, for instance, in bombing expeditions at the front, but the results of the tests were considered to be sufficiently representative to allow computing quite closely the probable flight duration of the Liberty engine in different planes and under various service loads.

Castor oil was used exclusively in one engine and Wolf's Head No. 8 mineral oil in the other. Judging from the condition of the two engines at the end of the runs, castor oil gave slightly better results than the mineral oil, although spark-plug troubles were more frequent in the engine using it.

While both engines unquestionably required overhauling after the 160 hr. of operations in the air, most of the parts were still in fine condition, the crankshaft and connecting-rod bearings being practically the only parts badly worn.

The spark plugs gave the worst trouble, only minor replacements being needed otherwise. It is of interest to note, as regards the condition of the cylinders, that on final inspection after the 160-hr. runs the bores were still in excellent condition and showed a maximum out of round on one engine of but 0.0015 in. and on the other of but 0.002 in. Very little carbon was found on the head.

The general impression is that such troubles as were experienced during these tests were due almost entirely to workmanship,

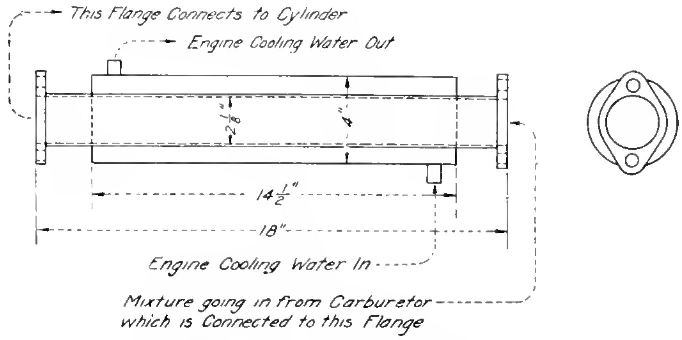


FIG. 7 DIAGRAM OF 18-IN. WATER-JACKETED INTAKE

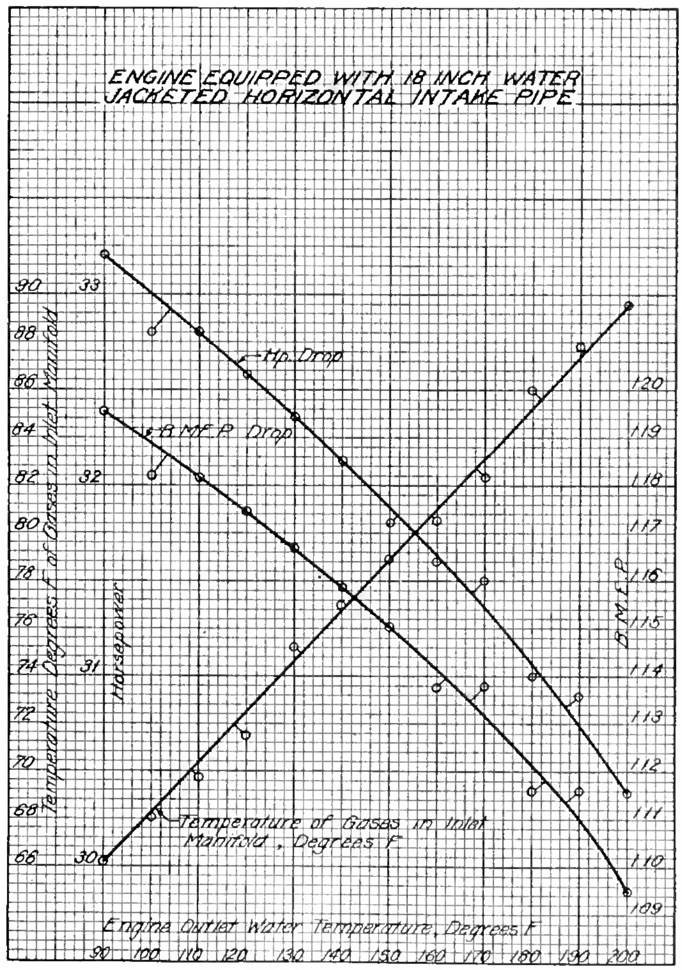


FIG. 8 CURVES SHOWING DROP IN HORSEPOWER WITH INCREASE OF TEMPERATURE OF INTAKE GAS

materials and the personal element that enters into the manufacture and assembly, but not to faults in design.

These tests have brought out conclusively that 125 to 150 hr. is not too much to expect of the Liberty engine without fatigue, which is a very good performance compared with other engines now in operation.

(Concluded on page 295)

BABBITT AND OTHER BEARING METALS

Compositions Recommended by the Committee of the Manufacturers' War Service Association

At the request of the Assistant Chief in Charge of Tin, War Industries Board, the War Service Association of Manufacturers of Solder and Bearing Metals appointed a special committee to study the report of the United States Bureau of Standards to the Conservation Division of the War Industries Board, the suggestions for the conservation of tin which the War Industries Board proposed in a circular letter to users of babbitt and other bearing metals, and other similar documents.

Pending the termination of the researches which are now being undertaken by the Sub-Committee on Bearing Metals of The American Society of Mechanical Engineers, as reported in the January issue of Mechanical Engineering, p. 71, it will be of interest in the meantime to present a brief abstract of the recommendations offered by this special committee of the Association of Manufacturers of Solder and Bearing Metals as a result of their examination of the aforesaid documents and a general survey of the available literature and of the experience of manufacturers and users of bearing metals.

The committee favors the adoption of all the alloys listed by the American Society for Testing Materials in Their Tentative Specifications for White Metal Bearing Alloys, Serial Designation B-23-18-T (See Table 1), subject to the following modifications and additions:

a To increase the allowable maximum for lead in alloys Nos. 1, 2 and 3, providing the Bureau of Standards after complete investigation of the matter of lead content feels that it is safe to do so.

b To increase the arsenic maximum of alloys Nos. 11 and 12 (see Nos. 14 and 15 in Table 2) to 1 per cent.

c Include the following alloys and designate them numerically Nos. 6, 7 and 8 and increase the numerical sequence of alloys Nos. 6 to 12 of the A. S. T. M. accordingly:

	Alloy No. 6	Alloy No. 7	Alloy No. 8
Tin, per cent.	61½	45	30½
Antimony, per cent	10½	7½	8½
Copper, per cent	3	1½	1
Lead, per cent	25	46	60

d Include under the numerical designation Nos. 16 and 17 the lead alloys recommended by the Bureau of Standards in their suggestions for the conservation of tin. (See Table 2.)

Table 1 therefore is modified as represented in Table 2, which shows the composition of the alloys as finally recommended.

The committee believes that the 17 alloys in Table 2 will cover in a very comprehensive manner the number needed to meet every service requirement.

TABLE 1 COMPOSITIONS OF A. S. T. M. TENTATIVE STANDARD ALLOYS

Alloy Grade No.	Tin, per cent	Antimony, per cent	Lead, per cent	Copper, per cent	Iron, max., per cent	Arsenic, max., per cent
1	91	4½	0.35*a*	4½	0.08	0.10
2	89	7½	0.35*a*	3½	0.08	0.10
3	83⅓	8⅓	0.35*a*	8⅓	0.08	0.10
4	75	12	10	3	0.08	0.15
5	65	15	18	2	0.08	0.15
6	20	15	63½	1½	0.08	0.15
7	10	15	75	0.50*a*		0.20
8	5	15	80	0.50*a*		0.20
9	5	10	85	0.50*a*		0.20
10	2	15	83	0.50*a*		0.20
11		15	85	0.50*a*		0.25
12		10	90	0.50*a*		0.25

a Maximum.

TABLE 2 COMPOSITIONS RECOMMENDED BY COMMITTEE OF WAR SERVICE ASSOCIATION OF MANUFACTURERS OF SOLDER AND BEARING METALS

Alloy, Grade No.	Tin, per cent	Antimony, per cent	Lead, per cent	Copper, per cent	Iron, max., per cent	Arsenic, max., per cent
1	91	4½	*b*	4½	0.08	0.10
2	89	7½	*b*	3½	0.08	0.10
3	83⅓	8⅓	*b*	8⅓	0.08	0.10
4	75	12	10	3	0.08	0.15
5	65	15	18	2	0.08	0.15
6	61½	10½	25	3	0.08	0.15
7	45	7½	46	1½	0.08	0.15
8	30½	8½	60	1	0.08	0.15
9	20	15	63½	1½	0.08	0.15
10	10	15	75	0.50*a*		0.20
11	5	15	80	0.50*a*		0.20
12	5	10	85	0.50*a*		0.20
13	2	15	83	0.50*a*		0.20
14		15	85	0.50*a*		1.00
15		10	90	0.50*a*		1.00
16			98*c*			...
17			98*d*			...

a Maximum. *b* See recommendation (*a*) of committee. *c* Approximate: balance alkali metals. *d* Approximate: balance alkaline earth metals.

With reference to the conservation of tin, the committee proposes the following suggestions:

a For resistance to extreme pressures and impacts, when the design of the bearing is such that a heavy liner is used—Alloy No. 3.

b For supporting smaller loads, or resisting smaller impacts, and when thinner liners are used—Alloy No. 2.

c For the thinnest liners, particularly those attached to bronze or steel backs by the soldering process, and under conditions where the shocks are not so severe as to require the use of harder alloys, either Alloys Nos. 6, 7 or 8, depending on which exhibits the best physical properties (these to be determined by the Bureau of Standards).

d For all classes of service other than *a*, *b*, *c*, *e* or *f*—Alloy No. 10, which is the most satisfactory lead-base babbitt containing tin and antimony.

e For service under low pressures, and without impact, operated at fairly low speeds—Alloy No. 14.

f Alloys Nos. 16 and 17 for the special classes of service for which they may be found suited after sufficient service experience.

Further details are now available regarding the record flight of a U. S. Navy seaplane with 50 passengers at Rockaway on November 27. The machine was an N. C. 1 of the flying boat type, the wings having a span of 126 ft., fitted with three low-compression Liberty engines, each of 385 hp. The normal speed of the machine is 80 miles per hour, but with 50 passengers this was reduced to 72 miles per hour. According to the report of the Aero Club of America, the machine left the water within 1000 ft. at a speed of 45 knots, and rose to a height of 35 ft. It is stated that the machine can climb 2000 ft. in ten minutes.

To overcome a threatened power shortage and to provide power for the rapidly increasing industrial activities in the San Francisco Bay region, the California-Oregon Power Company, the Northern California Power Company, and the Pacific Gas and Electric Company have consolidated, and electric power is now being transmitted continuously over a distance of 300 miles. The surplus power developed in the northern section of the state is thus made available in the industrial district. According to the State Railroad Commission, it is expected the 60,000,000 kw-hr. of energy will be brought to the Bay district annually, with a saving of 20,000 barrels of oil which is now used for the generation of power.

The Loomis Cooling System for Aircraft

A System Embodying a Nose Radiator, an Adjustable Booster and a New Form of Expansion Tank with Positive Ejection

Two features new to airplane cooling systems and which are adaptable to any airplane carrying a water-cooled engine have been developed at McCook Field, Dayton, Ohio, and incorporated in the USD-9A day bombing machine. Particulars of these features, comprising what is known as the Loomis cooling system, appeared in a War Department publication of recent date, which is herewith abstracted by special permission.

THE Loomis cooling system for aircraft was developed at McCook Field, Dayton, Ohio, and first applied to the USD-9A plane. Particulars of this system have been given in a recent issue of the Bulletin[1] of the Experimental Department, Airplane Engineering Division, Bureau of Aircraft Production, War Department, from which the following information has been abstracted by special permission.

The two new features in the Loomis system are an expansion tank that surrounds the core and is an integral part of the nose radiator, thus taking the place of the shell ordinarily used; and an injector in the water connection between the main and booster radiators, which draws water through a nozzle outlet from the bottom of the expansion tank and injects it into the return pipe, thus keeping constant the volume of water in the circulating system.

It is claimed that through these features the loss of water due to steaming or air pockets is minimized and excessive depression in the pump intake is prevented, making possible a much faster water circulation and, therefore, increased cooling efficiency without danger of cavitation in the pump or the drawing in of air around the hose connections on the suction side.

Water from the cylinder jackets enters the upper well of the nose-radiator core in the usual manner, and nearly all of it works down through the core to the bottom of the well, and then through the venturi outlet to the return pipe leading to the booster radiator and the pump. Owing to the action of the venturi, the head of water in the nose-radiator core and the type of pump impeller used, pressure is built up on the intake side of the pump.

A small quantity of water from the upper header of the radiator core normally overflows through holes in the top of the upper well into the expansion tank (Fig. 1) above, and then flows downward in this chamber by gravity. The lowest part of the expansion tank, underneath the lower header of the radiator core, has an outlet nozzle which opens into the throat of, and is concentric with, the venturi outlet from the lower tank. The top of the expansion tank is open to the atmosphere through the vent pipe terminating in the radiator filler neck, so that constant atmospheric pressure is maintained on the water in the expansion chamber, in order that it may be drawn into the return pipe through the action of the venturi at the nozzle.

The auxiliary radiator is located in the water return line between the nose unit and the pump, so that all water from the main radiator passes successively through the venturi and the booster or auxiliary radiator, from top to bottom, before reaching the pump. Fig. 2 shows the connection between the main radiator, injector and booster.

Running entirely around the outside of the nose-radiator core and its upper and lower headers is a separate compartment, $\frac{7}{8}$ in. wide, and of the same depth as the core, which acts as an expansion chamber for the cooling system. The only communications between this tank and the upper well of the radiator core are three $\frac{5}{16}$-in. vent holes. As shown in Fig. 3, the bottom of the well of the core communicates only indirectly with the bottom of the expansion tank through the venturi and nozzle. The injector consists of a $1\frac{1}{16}$-in. diameter venturi outlet from the lower tank or well of the radiator core, with the $\frac{1}{2}$-in. diameter nozzle of the outlet pipe from the bottom of the expansion tank projecting into the throat. The general construction of the outlet is shown in Fig. 3.

Mounted in a vertical rack to the rear of the engine and transversely to the fuselage is the adjustable booster radiator, which is connected in series with the nose unit. The auxiliary radiator may be lowered to project $9\frac{1}{8}$ in. below the bottom cowl of the fuselage, or drawn up into the body until only the edge of the lower tank is exposed.

When the auxiliary unit is lowered to its extreme position, practically its entire surface is exposed to the air stream under the fuselage.

In its upper position this radiator has very little cooling effect, as it is then almost entirely enclosed in the fuselage and only a small amount of air can circulate through it. Most of the air going through the nose radiator is discharged through the louvers in the engine cowls forward of the booster.

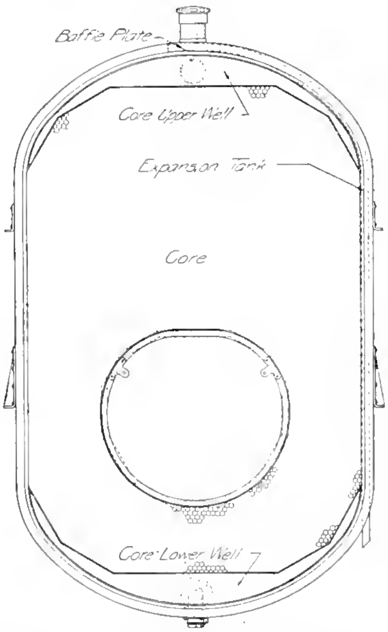


Fig. 1 Diagram Showing the Expansion Tank Around Radiator Core as Used on the USD-9A Plane

The auxiliary cooling unit is raised or lowered by a handwheel on the right side of the pilot's cockpit, which is connected by short lengths of chain and intervening wires with a pinion meshing with a rack attached to the upper part of the auxiliary radiator. The pilot can set the booster unit to project any desired distance below the under side of the fuselage, within the limits provided, in order to obtain the exact amount of cooling capacity needed under different conditions.

While both the nose-radiator shutters and the adjustable-booster unit are provided for the same purpose, that is, to increase or decrease the cooling capacity of the system as a whole, it is the practice to open the shutters first and to lower the auxiliary radiator later, to provide still greater cooling capacity, and vice versa, thereby keeping the parasite resistance down to a minimum.

A series of test flights was made at McCook Field with two DeHaviland-4 planes to determine the relative efficiency of the new cooling system designed for the USD-9A in comparison with other comparable types. Owing to the similarity in size between the DeHaviland-4 and the USD-9A, and to the fact that both planes carry standard Liberty-12 engines, it was considered that the tests would give a good indication of the performance to be expected of the new system in the USD-9A.

The other radiators tested on the same planes for comparison were the Wolverhampton, used in the British DeHaviland-4, and

[1] Bulletin of the Experimental Department, Airplane Engineering Division, U. S. A., McCook Field, Dayton, Ohio, vol. 2, no. 2, November 1918, pp. 61-68. 7 figs.

rated as adequate for a 350-hp. engine, a special American Monogram radiator made by the A-Z Co., and two sample Mayo radiators with ribbon-type cores. These last two were especially designed for the American DeHaviland-4 with Liberty engine. The units tested were near enough alike in general features to offer a fair basis of comparison for the USD-9A system.

By means of preliminary tests a type of pump impeller was selected which was found to be well suited to the new system which produces a certain amount of pressure on the intake side of the pump due to the action of the injector. For use with the Wolverhampton radiator, it was necessary in order to prevent excessive suction to cut down the standard straight-blade impeller with the DeHaviland-4 to 3¼ in. diameter. The regular pump impeller was used without alteration with the other radiators tested. The original report gives the curves of pressure on pump inlet both developed by the straight-bladed pump impeller cut down to 3¼ in. diameter for the English radiator and by the USD-9A radiator with curved-blade impeller used with the Loomis system.

Various precautions described in the original report were taken to insure the correctness and comparability of results obtained with various radiators.

One of the interesting features developed in the tests is that the greatest difference between air temperature and water outlet temperature was found at altitudes between 3000 and 5000 ft., which tends to prove the assertion that a radiator which is adequate up to 3000 ft. under rapid-climb conditions will probably provide sufficient cooling capacity for all purposes.

The following conclusions are made in the report, which also gives the main data secured in tabular form.

Taken on the whole, the USD-9A radiator tests yielded quite good figures for efficiency, which can be depended upon as reliable. The efficiency values obtained in the various trials of this system were:

With no engine top cowl, bottom cowl with extra louvers—91 per cent.

With extra louvers in top and bottom engine cowls, average of two tests—88.8 per cent.

With standard top cowl and no louvers in bottom cowl, average of three tests—87.8 per cent.

These figures indicate that although something is gained by extra louvers in the cowling, still the engine and its front bearer in the USD-9A obstruct the flow of air through the nose radiator to such an extent that the only great gain to be obtained would be by using wide lateral openings in front of these two units to exhaust the air passing through the nose radiator.

Steaming falsifies the apparent efficiency of a radiator, as it reduces the amount of cooling required to be done by the cooling system. A steam calorimeter in the overflow tube would be necessary for accurate corrections.

The only comparisons possible with the other radiators tested must be based on the figures obtained during those trials where no steaming of the other units took place. The comparative results obtained in such tests, with corresponding figures for the USD-9A system, are given in Table 1.

The addition of engine top cowling must produce less effect on the new cooling system than on the other two radiators mentioned in Table 1, for the reason that part of the total cooling surface of the new system, represented by the booster radiator, is independent of all cowling above or below the engine, provided, of course, the lower cowling does not obstruct the auxiliary unit when in its lowest position. The addition of shutters on the nose radiator also produces less effect on the USD-9A cooling system than on the others, and for the same reason.

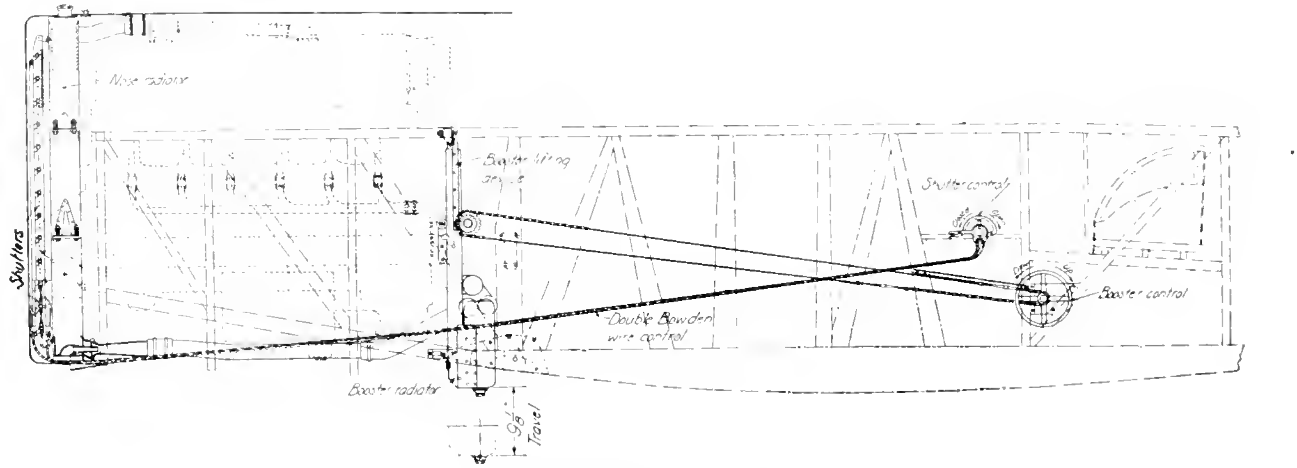


FIG. 2 USD-9A COOLING SYSTEM

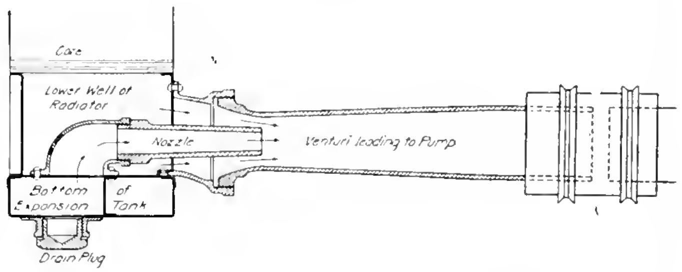


FIG. 3 INJECTOR DEVICE AT BOTTOM OF NOSE RADIATOR

With this radiation system any reasonable increase in cooling capacity can be obtained by adding to the height of the auxiliary radiator. It is quite probable, however, that the present amount of auxiliary radiation is sufficient in view of the fact that very little steaming was encountered even under the severe conditions of the tests. Under ordinary conditions the high-compression Liberty engine is not intended to be run at full throttle near the ground, as was done in these tests.

TABLE 1 COMPARATIVE EFFICIENCY OF RADIATORS

Radiator	Efficiency, per cent	Cooling surface, sq. ft.	Weight full, lb.
Monogram	76 75	202	176 5
Wolverhampton	82 5	246	142
USD-9A	91	219	204 5

The United States Navy Department has successfully carried out the experiment of launching an airplane from a dirigible balloon. The airplane was attached by a 100-ft. cable to the dirigible; both rose to about 3,000 ft. and then the airplane was released; after diving about 1,000 ft. it obtained sufficient speed to continue its usual flight.

STRESSES IN WIRE ROPE

Development of a New Formula for the Determination of Bending Stresses

By SHORTRIDGE HARDESTY,[1] KANSAS CITY, MO.

At the December 1918 Annual Meeting of the Society a valuable paper on the Determination of Stresses in Wire Rope as Applied to Modern Engineering Problems was presented by James F. Howe, Wire Rope Engineer of the American Steel and Wire Company, Worcester, Mass. This paper has drawn out the accompanying contribution by Mr. Hardesty. A very full review of Mr. Howe's paper was given in The Journal for December 1918, p. 1016.

THE writer has been deeply interested for some time in the subject of wire-rope stresses, upon which Mr. Howe has written, and submits the following notes on a few points to which he has given considerable study.

Mr. Howe brings out the point that while the modulus of elasticity in tension of the material in the wires is 27,500,000, the corresponding value for an entire rope of standard 6 x 19 construction is about 12,000,000; or, in other words, that the rope stretches about 2.3 times as much as would one made of straight wires. Different investigators in the past have found values of this function ranging from 12,000,000 to 17,000,000. For any given rope its value depends somewhat upon the age and condition of the rope. For a new, well-lubricated rope, 12,000,000 is correct; while in an older rope, in which the hemp center has been compressed and has become hardened, a larger value will be found. If, however, the rope is subjected to bending over small sheaves, the hemp center will be continually worked and stretched, and the rise in the value of the modulus of elasticity will be much smaller.

It is not difficult to explain why the rope stretches more than would a bundle of straight wires. A 6 x 19 rope is composed essentially of 114 spiral springs. Under tension these springs stretch out, the diameters of the helices reducing slightly. This stretching-out action does not occur freely, as the tightly twisted wires and strands interfere with each other. In a new, well-lubricated rope, the helical strands can pinch down considerably on the elastic core, the amount of stretching out is large, and the modulus is small; while after the core compresses and becomes hardened, the strands cannot pinch down so much, the amount of stretching out reduces, and the modulus becomes greater.

Mr. Howe discusses the question of the stiffness of an ordinary wire rope as compared with that of a rope composed of straight wires, calling attention to the fact that the ordinary rope is much more flexible. He concludes that, on account of the lower modulus of elasticity in tension of the ordinary rope, the bending stresses produced in the individual wires are correspondingly smaller than those in the straight wires, and thus accounts for the greater flexibility. From this reasoning we would expect the ratio of the stiffnesses of the two ropes to be 2.3 to 1. Actually, however, this ratio is much larger than 2.3 to 1. The writer suggests the following explanation of the greater flexibility of the ordinary rope:

If a rope composed of straight wires, having the same number and arrangement of wires and strands as the standard 6 x 19 rope, be bent around a sheave, certain wires will lie on the outside of the curve throughout, and must evidently elongate and be subjected to tensile stresses in addition to bending stresses, while other wires will lie on the inside of the curve throughout, and will receive compressive stresses as well as bending stresses. On account of the axial stresses being thus produced in the wires, the stiffness of the rope will be much greater than that of the 114 wires themselves—about 200 times as great if all of the stretching or shortening of the wires has to occur in the bent portion of the rope, and probably 50 to 100 times as great if the stretching or shortening of the wires can extend out into the straight portions of the rope, as will usually be the case.

Consider now a piece of ordinary 6 x 19 wire rope, say 1 in. in diameter. The strand which lies at the top of the rope at one point is at the bottom about 3 in. away; and the wire lying at the top of a strand at one point is at the bottom about $1\frac{1}{4}$ in. away. If such a rope, well lubricated, be bent around a sheave, evidently it is unnecessary that any large axial stresses be set up in the wires. Instead, the strands will slip along the core and the wires will slip along each other in the strands. Evidently, then, the wires will be subjected to bending stresses, and in addition only to sufficient axial stresses to make the strands slip along the core, and the wires along each other. These axial stresses will be negligible in a well-lubricated rope.

From the foregoing it is clear that the ordinary rope is much more flexible than the rope composed of straight wires, for the reason that in bending the latter there are set up large axial stresses, as well as bending stresses, in the individual wires, while in bending the former there are set up bending stresses only in the wires. Evidently, therefore, we cannot argue from the greater flexibility of the ordinary rope that the bending stresses in the wires are smaller than those in the rope composed of straight wires.

Mr. Howe, having deduced 12,000,000 as the value of the modulus of elasticity in tension for the entire rope, then assumes that this value can be used in computing the bending stresses in the separate wires, and thus obtains values about half those which have generally been accepted. The writer can see no direct reason why the modulus of elasticity in tension should necessarily apply to the calculation of bending stresses in the separate wires, and feels that the author should give his reasons for making this assumption. The point certainly requires explanation.

The writer has put considerable study on the question of bending stresses in wire ropes, and offers the following formula. It is simple and logical in derivation, so far as he can see, and it agrees with the only tests bearing directly on the question of which he has any knowledge.

Suppose a straight wire of diameter d to be bent 180 deg. around a sheave of diameter D. The length of the bent portion of the wire is $\pi D/2$ and the total angle through which it is bent is π, so that the angle of bending per unit length is $\pi/(\pi D/2)$ or $2/D$. Letting f be the extreme fiber stress in the wire and E the modulus of elasticity of the material, the angle of bending per unit length is also $(f/E)/(d/2)$, or $2f/Ed$. We then have

$$\frac{2f}{Ed} = \frac{2}{D}$$

whence

$$f = E\,\frac{d}{D}$$

This latter expression is the formula given by Reuleaux, Rankine, Unwin, and other writers, and is evidently applicable to straight wires only.

Now consider a helical wire, such as the center wire of one of the strands of a wire rope. Let the angle between the wire and the axis of the helix be a, and other notation as before. Now suppose the helical wire bent 180 deg. around the sheave. The total angle through which the wire is bent is evidently π, as before, and the length of the bent portion is $(\pi D/2)\sec a$; so that the average angle of bending per unit length is evidently $\pi/(\pi D/2)\sec a$, or $(2/D)\cos a$. We then have

$$\frac{2f}{Ed} = \frac{2}{D}\cos a, \text{ whence} \qquad f = E\,\frac{d}{D}\cos a$$

Next consider a compound helical wire, such as one of the outer wires in a strand of a rope. Let the angle of lay of the strand be a, and the angle of lay of the wire in the strand be b. As before, suppose the wire bent 180 deg. around the sheave. The length of the bent portion of the wire is $(\pi D/2)\cos a\cos b$, whence we find

$$f = E\,\frac{d}{D}\cos a\cos b$$

[1] Of the firm of Waddell & Son, Inc., Consulting Engineers.

It appears difficult to the writer to consider the bending stresses to be any smaller than those given by the foregoing formulæ. The total length of the wire and the total angle through which it is bent are known, definite quantities in each case, from which we can deduce directly the average angle of bending per unit length; and from this latter quantity the extreme fiber stress in the wire can be computed directly and without any doubt whatsoever.

While the last-mentioned formula thus appears to be correct, it is, of course, very desirable to check it experimentally. The results of some experiments given in a paper by Mr. R. W. Chapman in the *Engineering Review* of October 1908, entitled The Stress in Wire Ropes Due to Bending, offer an opportunity

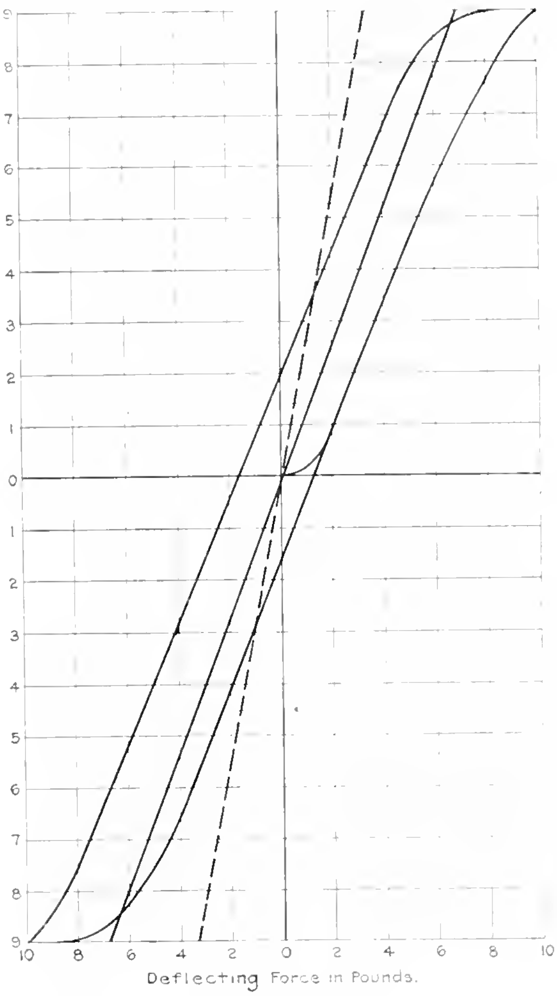


FIG. 1 DEFLECTION OF 6 x 12 WIRE ROPE WITH LOAD 24 IN. FROM SUPPORT

for such a check. Mr. Chapman took a short length of wire rope, clamped one end securely, applied transverse forces to the other end, and then measured the resulting deflections. Figs. 1 to 4 record graphically the results of four of his experiments.

In making such an experiment, evidently we must allow for the effect of the internal frictional forces between the various strands and wires. Mr. Chapman eliminated the effect of these forces in the following manner: He first applied a gradually increasing force in one direction, then reduced it gradually to zero, then applied a gradually increasing force in the other direction, and then gradually reduced it to zero. When the first small forces were applied the deflections were very small, as the wires and strands had not yet begun to slip on each other, and the rope had nearly the stiffness of a solid bar. The flat portion of the deflection curve just to the right of the origin in each figure corresponds to this stage. As the forces were increased the internal friction was overcome, the wires and strands began to slip freely on each other, and the deflection curve turned up sharply and continued practically a straight line as long as the forces were increased. The reduction of the forces then began. The resulting deflection curve was at first very flat, the rope acting as a solid bar while the direction of the internal frictional forces was reversing; then the curve turned down sharply as slippage in the opposite direction began. The forces were then gradually reduced to zero and then applied in the opposite direction, the deflection curve continuing downward as a straight line meanwhile. The forces were then reduced gradually to zero, the deflection curve being at first very flat, then turning up sharply and continuing as practically a straight line. The forces were again reversed in direction, the curve continuing upward and joining the curve first drawn, thus forming a complete loop.

In the loop just described the nearly horizontal portions at the top and bottom, as stated before, represent the deflection curve when no slippage of wires and strands occurs; while the long, steeply inclined sides represent the curve when the wires and strands are slipping freely, with the effect of internal friction eliminated.

Our next step is to compute the theoretic deflection curves for each of the four examples in accordance with the formulæ for bending stresses deduced by Mr. Howe and the writer, and to plot them on the four figures.

The rope used in the tests plotted in Figs. 1 and 2 consisted of 6 strands of 12 wires each, with a hemp core for the rope and hemp cores for the strands. The rope was of ordinary lay, the angle of lay being $18\frac{1}{2}$ deg., and the diameter of the wires 0.082 in. The moment of the inertia of the 72 wires is $72 \times 0.082^4 \times 0.0491 = 0.000159$. The value of EI, according to Mr. Howe's formula, is $12{,}000{,}000 \times 0.000159 = 1910$; while according to the writer's formula, since $\cos 18\frac{1}{2}$ deg. $= 0.95$, it is $27{,}500{,}000 \times 0.000159 \times 0.95 \times 0.95 = 3950$.

For Fig. 1, the distance from the support to the end of the rope was 26 in., and the distance from the support to the load was 24 in. The deflection y of the end for a load P is therefore

$$y = \frac{24P \times 12 \times 18}{EI} = \frac{5180P}{EI}$$

For Mr. Howe's formula, $y = 5180P/1910 = 2.71P$, and for the writer's formula, $y = 5180P/3950 = 1.31P$.

For Fig. 2, the distances from the support to the end of the

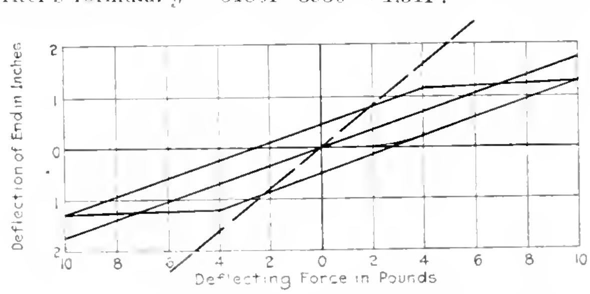


FIG. 2 DEFLECTION OF 6 x 12 WIRE ROPE WITH LOAD 12 IN. FROM SUPPORT

rope and to the load point are 14 in. and 12 in., respectively, so that the deflection of the end is

$$y = \frac{12P \times 6 \times 10}{EI} = \frac{720P}{EI}$$

For Mr. Howe's formula, $y = 720P/1910 = 0.376P$, and for the writer's formula, $y = 720P/3950 = 0.182P$.

The rope used in the tests recorded in Figs. 3 and 4 was a Lang lay rope consisting of 6 strands of 7 wires each, the diameter of the wires being 0.111 in. The lay was not stated, but may be assumed as $18\frac{1}{2}$ deg. The moment of inertia of the 42 wires is $42 \times 0.111^4 \times 0.0491 = 0.000313$. The value of EI, according to Mr. Howe's formula, is $12{,}000{,}000 \times 0.000313 = 3760$; and according to the writer's formula it is $27{,}500{,}000 \times 0.000313 \times 0.95 \times 0.95 = 7780$.

For Fig. 3, the distances from the support and the load point are 23 in. and 21 in., respectively, so that the deflection of the end is

$$y = \frac{21P \times 10.5 \times 16}{EI} = \frac{3530P}{EI}$$

For Mr. Howe's formula, $y = 3530P/3760 = 0.94P$; and for the writer's formula, $y = 3530P/7780 = 0.455P$.

For Fig. 4, the distances from the support and load point are 16 in. and 14 in., respectively, so that the deflection ot the end is

$$y = \frac{14P \times 7 \times 11.33}{EI} = \frac{1110P}{EI}$$

For Mr. Howe's formula, $y = 1110P/3760 = 0.295P$; and for the writer's formula, $y = 1110P/7780 = 0.143P$.

The deflection curves computed by the writer's formula have been plotted on each of the four figures as straight full lines, and those figured by Mr. Howe's formula as straight dotted lines. It will be noted that in each figure the full line is approximately parallel to the deflection curve when the wires and strands are slipping freely, with the effect of internal friction eliminated; while the dotted line does not agree at all with these deflection curves. These tests therefore indicate the substantial correctness of the formula proposed by the writer and the incorrectness of the one proposed by Mr. Howe.

The foregoing experimental data, while meager, are all that the writer has been able to find bearing on this subject. It is to be hoped that it can be supplemented in the near future by an extensive series of tests. Mr. Howe, as an engineer of a wire-rope company, may be in a position to carry out such experiments. The question of bending stresses in wire ropes has long been discussed from the theoretic standpoint, and also in its purely practical features; and it seems high time that the two aspects be combined in a scientifically conducted series of tests.

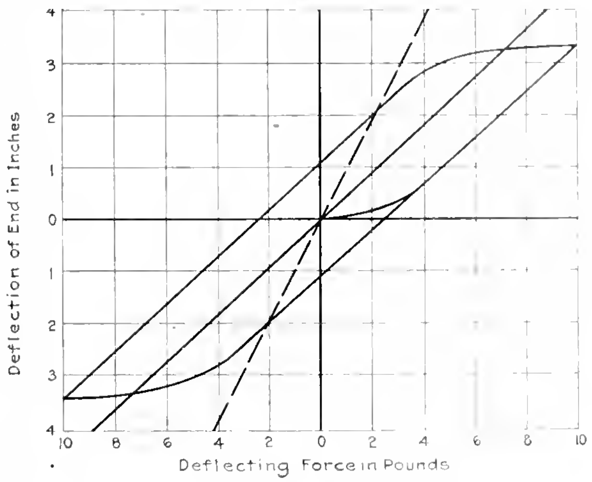


FIG. 3 DEFLECTION OF 6 x 7 WIRE ROPE WITH LOAD 21 IN. FROM SUPPORT

Practical working rules for design can be easily developed from the formula deduced by the writer, namely,

$$f = E\frac{d}{D}\cos a \cos b$$

E can be taken as 27,500,000. For a 6 x 19 rope d equals about $c/15$, where c is the diameter of the rope. Cos a can be taken as 0.95; cos b is 1.00 for the center wire of each strand, 0.97 for the second row of wires in each strand, and 0.95 for the outer row. We then have the following expressions:

Center wire of strand:

$$f = 27{,}500{,}000 \times \frac{c}{15D} \times 0.95 = 1{,}740{,}000\frac{c}{D}$$

Second row of wires:

$$f = 1{,}740{,}000\frac{c}{D} \times 0.97 = 1{,}690{,}000\frac{c}{D}$$

Outer row of wires:

$$f = 1{,}740{,}000\frac{c}{D} \times 0.95 = 1{,}650{,}000\frac{c}{D}$$

As an average value, we can use

$$f = 1{,}700{,}000\frac{c}{D}$$

Since the area of the rope is approximately $0.4c^2$, the product of the unit bending stress by the area is

$$680{,}000\frac{c^3}{D}$$

It has been mentioned that when a rope is bent around a sheave, axial stresses are produced only great enough to make the strands and wires slip, and that for a well-lubricated rope they will be negligible. This is borne out by Mr. Chapman's tests, the widths of the loops being small. If the lubrication be poor, the axial stresses will be larger; and if the rope be rusted so that slippage cannot take place, the axial stresses will be dangerously high. These facts point to the imperative need for thorough lubrication

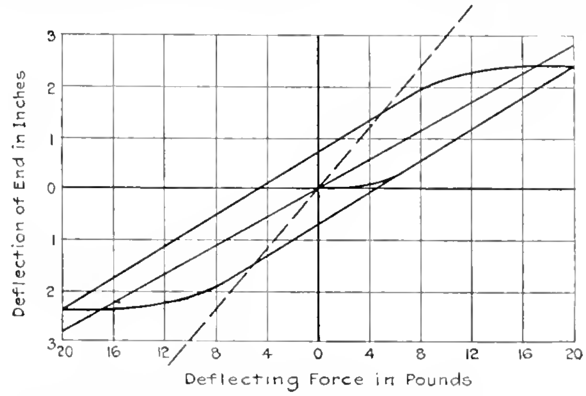


FIG. 4 DEFLECTION OF 6 x 7 WIRE ROPE WITH LOAD 14 IN. FROM SUPPORT

and protection of wire ropes. The lubricant chosen must be one which will penetrate to the inside of the rope and thoroughly saturate the hemp core. A heavy dressing which merely forms a coating on the outside of the rope may be worse than useless, for it may give a false sense of security, while the inside of the rope is devoid of lubricant and possibly even rusting. If an extensive series of bending tests is made, an attempt should be made to secure quantitative values of the stresses in poorly lubricated ropes.

Mr. Howe mentions the destructive effect of reversed bending in ropes. This point cannot be too strongly emphasized. The writer is inclined to believe that reversed bending over sheaves of diameter 60 times that of the rope is nearly as bad as bending in one direction over a sheave of diameter 30 times that of rope.

Mr. Howe also mentions the possibility of using 6 x 37 and 6 x 61 constructions for large ropes. He suggests 6 x 37 ropes for 1½-in. to 2-in. diameters, and 6 x 61 ropes for diameters over 2 in. The writer would hardly agree with these limits for lift-bridge work, as a great deal of trouble is experienced in keeping the ropes properly lubricated, and this fact would discourage the use of smaller wires than is necessary. He would suggest, for this service, that 6 x 19 ropes be used up to 2¼ in. diameter, and 6 x 37 ropes for larger diameters.

MR. HOWE'S COMMENT ON THE PROPOSED FORMULA

The foregoing discussion of his paper was submitted to Mr. Howe, who comments thereon as follows:

The formula as proposed by Mr. Hardesty, namely,

$$f = E\frac{d}{D}\cos a \cos b$$

will give as applied to ordinary 6 x 19 wire rope, assuming that $\cos a = 0.95$ and $\cos b = 0.95$, a value for $\cos a \cos b$ of 0.9025. If this is multiplied by E, it will mean, assuming E to be 27,500,000 as proposed by the writer in his paper, that the modulus of elasticity of the entire rope would be equal to the product of 0.9025 and 27,500,000 or 24,818,750 lb.: or in other words, the modulus of elasticity of the wire rope would be only about 10 per cent less than the modulus of the straight wires. Experimental proof has shown that the modulus is much less than this, as will be noted by reference to curves shown in Figs. 6 and 7 of the paper, the latter of which appeared as Fig. 4 on p. 1018 of THE JOURNAL, December 1918.

Reference has been made by Mr. Hardesty to the paper delivered by W. R. Chapman, published in the *Engineering Record* in 1908, in which Mr. Chapman gave particulars of experiments made to show the value of the bending stress in wire ropes. In that paper Mr. Chapman gives for a 3¼-in.-circumference rope (1.034 in. diameter) a bending stress of 18,945 lb. over a 3-ft. sheave. This corresponds to a modulus of elasticity of approximately 24,300,000 lb., which agrees with Mr. Hardesty's formula. However, Mr. Hardesty is basing his conclusions entirely upon the Chapman experiments, so that the agreement of his formula with the Chapman experiments is by no means conclusive evidence of the correctness of the assumptions which have been made.

The entire experimental proof of Mr. Chapman rests upon a series of experiments made by clamping a piece of wire rope in a solid jaw, suspending this rope vertically and then applying various loads at the end of this rope and recording the deflections. For ordinary testing where the material being tested is a solid, this method would probably give fairly correct results; but in testing wire rope in this manner, very serious complication has been allowed to creep in which completely nullifies the results obtained. This will be readily understood when the structure of wire rope is examined. When the clamp is placed upon the wire rope, it is bound solid and no action can take place. Furthermore, the lower end of the wire rope must be held solid in a seizing of wire. This prevents any play of the strands either at the end of the rope or at the point where they are clamped. The distance in between is so short that it seriously affects the results obtained, because it gives a much greater stiffness to the rope than is possessed by the rope under actual working conditions. Any person who has handled wire rope knows that the effect of binding both ends of a short piece of rope is to render it very stiff. If the piece of rope is lengthened, this stiffness is overcome. However, experiments of this kind, while they are interesting, do not give true results as to the working of a full-length specimen of rope, and this is what the engineer wants to know. Behavior of a short specimen under bending does not concern him. It is what the specimen will do when it is put to work in commercial lengths on a large outfit.

Taking the case already cited, namely, the 1.03-in.-diameter rope working over a 3-ft. sheave, the bending stress on a sheave 1 ft. 6 in. in diameter would be, according to Mr. Chapman, 18.94 tons. A rope of this diameter would have an ultimate strength of 30 tons for crucible steel, or 38 tons for plow steel. It is not an unusual case for a derrick to be equipped with rope working under these conditions, carrying a load of 6 to 7 tons. Were the bending stresses as high as these Chapman experiments would indicate, the life of the rope would be exceedingly short, because the material would be worked at or near the elastic limit at all times, even without any additional load. Other similar cases might be cited wherein these conditions are duplicated. This of itself is conclusive proof that the bending stress cannot be as great as would be computed either by the Chapman formula or by Mr. Hardesty's formula as he proposes it.

Were the stress as high as calculated by Messrs. Chapman and Hardesty, wire rope would give practically no service at all under the conditions noted, whereas we know of numerous cases where ropes have lasted from six to eighteen months under conditions similar to those just noted. The practical results of rope operation offer added proof, therefore, that the bending stress is a much smaller factor than indicated by Mr. Hardesty's calculations.

In a note dealing with the possibilities of the commercial airships, issued recently by the British Air Ministry, it is predicted that future airships will have a capacity of 10,000,000 cu. ft., a propelling apparatus of 6000 hp., and a maximum speed of 85 miles per hour. These ships would be 1000 ft. in length, 150 ft. in overall height, possess a range of 20,000 miles, and could stay aloft for three weeks without requiring refilling. The crew would consist of three officers and 26 men, and the freight capacity would be 200 tons. The cost of a 10,000,000-cu. ft. airship is estimated at between $1,000,000 and $1,500,000. From *Aviation*, February 1, 1919.

RECOLLECTIONS OF ERICSSON

As the ninth of this month marks the thirtieth anniversary of the death of the noted engineer, Captain John Ericsson, it has been thought fitting to recall his many and great achievements, as recounted by his friend, George H. Robinson, in Recollections of Ericsson, a published address which was delivered before the Commercial Club at Providence, R. I., on March 24, 1894. This little book has recently been donated by George L. Shepley to the Society to be placed in the Library, and the following paragraphs are reprinted as showing the variety and scope of Captain Ericsson's work.

In John's earliest boyhood his delight was to be in the mines studying the machinery and making drawings. At the age of nine he constructed a sawmill, using a watch spring for a saw, transformed by the aid of a file borrowed from a neighboring blacksmith, and

John Ericsson, the Thirtieth Anniversary of Whose Death Occurs on March 9

From a Painting Presented to the Society by the Late Prof. F. R. Hutton

from a broken tin spoon he cast his crank. He built a water wheel and attached his sawmill to it, and had the delight of seeing the machinery in actual operation sawing sticks. The next summer he designed a pump for drawing water from the mines. The motive power was derived from a windmill. He had never seen a windmill, but he built it from descriptions given by his father. It failed to work because it had not been adjusted to the changes of the wind. His father, describing a visit to a neighboring mine, spoke of a ball and socket joint. The idea was seized at once by John, and he joined the connecting rod for his crank to the pump lever with a ball and socket joint. From early infancy John Ericsson was connected with great engineering works, the Göta Canal being a marvel of canal building even for the present day.

At seventeen the military spirit took possession of him, and after much opposition from his engineering advisors he was assigned to the 23d Regiment Rifle Corps, with the rank of ensign. Soon after he joined the service orders were given to survey the District of Jemtland, where he was stationed. The work was secured by competition, and Ericsson easily won a prize. Ericsson was so rapid of execution that he performed more than double duty, and he was carried on the payrolls as two persons in order to avoid criticism and charges of favoritism. At the age of twenty-two he constructed the flame engine.

Showing the drawings of his flame engine to King Charles, he was advised to go to England, where he could find a more fitting field for his ambition.

Now followed invention after invention in rapid succession. An engine using steam combined with the gases arising from the combustion of coal; next a start toward his future caloric engine—an engine with two cylinders; in one of these was a loosely fitting piston, and directly under this he placed his fire, the loosely fitting piston actuating his working cylinders. Then he constructed a pumping engine, consisting of a series of cisterns rising one above the other; by ex-

hausting the air from these cisterns in succession the water was raised to the desired height.

In 1828 he constructed an air compressor, which was placed in successful operation in the mines near Truro, in Cornwall. It had an air cylinder of twenty inches diameter and five feet stroke.

In 1828 he patented artificial draught, a year before Stephenson made his reputation by the application of the same principle to his locomotive "Rocket." The year 1828 was marked by another revolutionary invention by Ericsson, the steam fire engine. He built several, but a generation passed before his invention was used, and then his fire engine came into service almost without change.

Now comes the era of locomotive building. The officials of the Liverpool & Manchester Road published an advertisement offering a prize of £500 for the best locomotive conforming to certain stipulations. Five months were allowed for completing the engine. Of the twenty-two weeks, fifteen had passed before Captain Ericsson learned of the competition. He had seven weeks only to make his plans and build his machinery. He had never built a locomotive. John Stephenson was engineer of the Liverpool & Manchester Road, and had been five years at the head of an establishment manufacturing such locomotives as were in use in the colleries; and he had the further advantage of controlling the road that ordered the trials, and the sympathy and support of its officials. His locomotive "Rocket" was virtually completed before Ericsson's "Novelty" was begun. Stephenson tested the "Rocket" in actual practice and remedied its defects, that would have been fatal if left to the day of trial. Ericsson could make no test before trial, and on that day he had to adjust the wheels of the "Novelty" to fit the track. Stephenson had been obliged to conceal the speed he hoped to attain, and ten miles had been spoken of as the limit of possible speed.

For the trials five engines entered; three were of little moment. The contest was between the "Rocket" and the "Novelty." Stephenson depended on chimney draught. Ericsson provided his engine with artificial means for supporting the combustion in the boiler furnace. A blowing machine was applied, moved directly by the engine so that the supply of air was greatest when the engine worked at maximum speed. The result was the "Novelty" shot by the "Rocket" like a projectile. The "Novelty" did a mile in fifty-six seconds. The second day the "Novelty" blew out several tubes and Ericsson withdrew her from the contest. The following year Ericsson built two locomotives—the "King William" and the "Queen Adelaide." To these was applied for the first time the link motion for reversing steam engines.

In 1830 he patented an apparatus for making salt from brine. In 1831 a rotary engine; two were built on a large scale, one being placed in a steamship. The next year he applied a centrifugal fan blower, driven by a separate small engine, to the steamer "Corsair." The independent blower system is now universally adopted, but not one in ten thousand who uses it knows to whom he is indebted.

In 1833 he took out his first patent for caloric engines. The use of high temperature in the air engine suggested another step with steam. He followed with his "Superheating Condenser Steam Engine." The deep-sea sounding machine, known as Ericsson's Sea Lead, was his next important invention.

In 1836 he patented an automatic file-cutting machine. The next greatest gift to this century—the invention that revolutionized commerce, that made possible the utilization of that other great invention, the cable—was the screw propeller. This was the first direct-acting screw-propeller engine ever built.

In 1854 Ericsson sent to Napoleon III a plan of a monitor, differing only from what is known as the original "Monitor," in that the turret was a rounded dome. These plans were not adopted, but the Emperor was greatly interested, acknowledging them personally and sending Ericsson a gold medal testifying his appreciation.

In 1862, when the days of our Civil War were darkest, the Southern Confederacy was fitting out the "Merrimac"; with her they hoped to capture every port on the seaboard, destroy our commerce and compel the surrender of Washington. Ericsson, the best-equipped American of the day, was entirely ignored. He had become a citizen in 1848. His friend, DeLamater, was familiar with the plans sent to Napoleon. These plans had been the result of thirty years' study, and were conceived in his boyhood. "You assume correctly," he wrote to his friend Fox, in 1875, "that the plan of the 'Monitor' was based on the observations of the behavior of timber in our great Swedish lakes. I found that while the raftsman in his elevated cabin experienced very little motion, the seas making over his nearly submerged craft, those seas at the same time worked the sailing vessels on their beam ends." He saw then the impregnable warship and only waited the call.

On August 3, President Lincoln approved an act appointing a board to determine upon building ironclad steam vessels. An advertisement inviting proposals was published. One of the first sets of plans recommended for adoption by the Committee was presented by C. S. Bushnell, and he was awarded a contract to build the vessel known as the "Galena." He consulted Mr. DeLamater, many of the naval men having doubted her ability to carry the stipulated amount of iron. Mr. DeLamater advised him to go to Captain Ericsson, whose opinion would settle the matter definitely and with accuracy. He called on Ericsson, laid the matter before him and was requested to call the next day for his verdict. It was entirely favorable. Captain Ericsson then produced his model and plan of a monitor sent to Napoleon. He found a most willing champion in Bushnell, and gave him both plan and model to present at Washington.

The next day the board condemned the plan. Bushnell labored with them and won over Admirals Smith and Paulding, who promised to report favorably if Captain Davis would join them. Captain Davis told Bushnell "to take the little thing home and worship it, as it would not be idolatry, because it was in the image of nothing in the heaven above or on the earth beneath, or in the waters under the earth."

Bushnell felt that the only way to succeed was to have Captain Ericsson present in Washington. He came to New York, saw Mr. DeLamater, and together they went to Beach Street. The exact facts were not given to Captain Ericsson, but he was told that some explanations were needed that he alone could make. He went to Washington that night. He was told as soon as he appeared before the board that his plans had been rejected. His indignation impelled him to withdraw at once, but he wisely asked why the plan was rejected. He was told the vessel lacked stability. He explained with elaborate demonstration and so convincingly that Commodore Paulding said frankly and generously: "Sir, I have learned more about the stability of a vessel from what you have said than I ever knew before." He was told the next day by Secretary Welles that a contract would be awarded, and asked to proceed at once with the work. The contract was signed October 25, 1861. The keel of the "Monitor" was laid on the same day. Steam was applied to the engines at DeLamater Iron Works December 30th. She was launched January 30th, and practically completed February 15, 1862. She made her first trial trip February 19th. Ericsson's work during that three months was herculean. Not only the necessary labors, but the worries from continued doubts sent from Washington required almost superhuman power.

The "Monitor" left New York harbor March 6, 1862, commanded by Commodore Worden. She arrived at Hampton Roads on the morning of the 9th, and before the sun set that day the famous battle of the "Monitor" and the "Merrimac" was done. What was due to the man whose brain had conceived and whose will had directed this mighty work that had delivered a nation? The "Monitor" conquered the "Merrimac" before payment had been made, before she had been accepted by the Government.

The war vessel was changed in one day. The monitor type became the war vessel of the world.

Ten years later we had the "Cuban scare," and the "Dictator" was hurried into active service. She left for the rendezvous in charge of her consort, who lost her off Savannah during a bad storm. The consort put into that port, and it was telegraphed from there that the "Dictator" was lost and all on board. Captain Ericsson was overwhelmed at the news, but, seeking a cause, he finally concluded that her steering gear had become disarranged. The next morning Captain Ericsson sent word: "He had been thinking all night, and had concluded that her steering gear could not get disarranged. The "Dictator" would report at Key West within twenty-four hours." She arrived at Key West a few hours later.

In 1869 the Spanish government wished to protect Cuba from filibusters and insurgents. Captain Raphael de Aragon came to Messrs. DeLamater & Co. commissioned to spend a considerable sum, but without any plan. Naturally, Ericsson was consulted. He had just been studying the defense of Sweden and suggested a scheme at once; to build thirty gunboats, each armed with a 100-pound gun mounted on her bow. He named two conditions only—to make his plans without submitting, and that DeLamater should execute the contract. These thirty boats were completed in thirty weeks, and some years later the designer and builder each received from the Spanish government the Commander's Cross of the Order of Isabel la Catolica, in recognition of their services.

Ericsson now was at work on harbor defense, and developed, after years of trials, the "Destroyer," which carried a submarine gun and discharged a projectile thirty feet long, loaded with three hundred and fifty pounds of explosive. For General Grant a test was made, and she performed what her designer claimed for her. She hit a target ten feet square, ten feet below the surface of the water, and traversed the distance—300 feet—in less than three seconds' time.

I am aware of what injustice I am doing Captain Ericsson's work; I cannot even speak of his conclusive researches regarding solar heat, of the solar engine he built and ran in Beach Street, developing ten horsepower from the direct rays of the sun; of the caloric ship "Ericsson," of his numberless achievements. The history of his honors and decorations almost universally conferred would alone considered make an interesting talk. He was recognized by every Government in Europe and by most of the leading societies in the world. He received in 1862 for his "Caloric Engine of 1858" the gold and silver Rumford medals. The prize was founded in 1796 by Count Rumford, a native of Concord, N. H., and was in the gift of the American Academy of Arts and Sciences. They awarded it in 1839 to Robert Hare 43 years after its foundation, but 23 more passed before another was found worthy of the award.

On March 9, 1889, on the anniversary of the battle of the "Monitor" and the "Merrimac," came to this man rest.

On August 23, 1890, the remains of Captain Ericsson were placed on board the "Baltimore" and sent to Sweden. His native government asked it. His adopted government granted it with every honor possible, sending him home on her finest warship.

ENGINEERING CONDITIONS IN FRANCE

Return of American Engineer-Delegates Who Have Been Conferring with French Engineers on Reconstruction Problems. Meetings Held in Boston and New York

As announced in The Journal for December 1918, an invitation was extended to the American Society of Civil Engineers by the Société des Ingénieurs Civils and the Committee of the French Engineers' Congress, for a delegation of American engineers to go abroad to discuss some of the problems involved in the rehabilitation of France. The delegation was organized by the Civil Engineers with the coöperation of the other American national societies, and Past-President Charles T. Main attended as delegate from The American Society of Mechanical Engineers.

During the visit the French Congrès Général du Génie Civil passed a resolution asking the formation of a permanent Franco-American Committee and the French members of such a committee were duly appointed by the Congress, consisting of a general secretary and the presidents of the five committees with whom the members of the American delegation had been coöperating, as follows: Ports and Navigable Waterways; Water Power; Roads; Agricultural Development and Technical Education. To meet the desire of the French engineers the American delegates consented to act temporarily as members of the international committee, and pending action in the matter by the councils of the several American societies.

It is a pleasure to note that a return trip by a delegation of French engineers is expected to occur this month.

The American engineers report a successful and interesting trip and upon their return two meetings were held, one in Boston at which Past-President Main was welcomed and one in New York where addresses were made by several members of the delegation. Reports of these meetings follow, together with the text of a brief address made by Mr. Main at Martigues on the occasion of entertainment by the Chamber of Commerce of Marseilles.

Dinner in Boston for Past-President Main

The January meeting of the Boston Section, which was held at the Engineers' Club, January 31, was devoted to welcoming Past-President Charles T. Main on his return from France in connection with the rehabilitation of that country. Mr. Main was first welcomed at a dinner of about fifty members, after which he addressed an audience of members which filled the auditorium of the Engineers' Club.

The questions which the party of engineers, of which Mr. Main was a member, were asked to consider included commercial ports, water power, roads, technical education, mines, mining and agriculture. Mr. Main covered many phases of the work accomplished by the American engineers, and the following are a few of the points mentioned:

The French engineers are very capable. Their knowledge of theory is perhaps better than ours. Their plans are made very thoroughly; but due to the almost universal lack of standardization, with every man doing his work in his own personal way, the facility with which operations are completed seems relatively slow.

In Paris a munitions works capable of turning out 20,000 shells a day was begun in May 1918 and completed in four months. This plant was of sufficiently substantial construction and was admirably arranged for speed and economy of producing shells. In another place a plant was constructed which at the time of the signing of the armistice was delivering 25 tanks a day.

The coal shortage of France is leading to consideration of hydroelectric development, especially of the waters from the Alps and Pyrenees. This power is being largely used for electrochemical industries and the electrification of railroads is being very seriously considered. The hydraulic turbines which are used are of efficient design and contain wheels similar to those in a steam turbine.

A Franco-American Engineering Committee was formed. The American representatives were asked to serve as members of this Committee, which they agreed to do temporarily until they could report to their different engineering organizations.

A visit of the French engineers to the United States was arranged for March next, when they will study the electrification of railways and visit the larger manufacturers of railway and power-plant apparatus.

The actual damage to France caused by the war has been estimated at about \$14,000,000,000. This is for physical damage only, and does not include consequential damage. This approximate estimate of losses is divided as follows:

For buildings	20,000,000,000 francs
For furniture	5,000,000,000 francs
For grounds, cattle and forests	10,000,000,000 francs
For industry	20,000,000,000 francs
For public works	10,000,000,000 francs

It has been estimated that at least 250,000 buildings were totally destroyed, 250,000 partially destroyed, and at least 250,000 acres of land so devastated as to require restoration.

The French laws are such that an alien cannot hold more than one-third of the capital stock of a French company, which leaves the control in French hands.

Contrasting French technical schools with American schools, the French seemed to require less mechanical equipment; and the actual working out by the student of problems similar to those encountered in the daily practice of engineering, the actual handling of equipment such as electrical machinery and the doing of work on machine tools in the school shops, was much less common than in America.

The ability of the Americans in forcing construction work made an impression on the French, who intimated that some Americans might be desirable as superintendents and foremen in their plants.

The suggestion of the French to improve transportation by the construction of more canals was not favored by the American engineers, because under the average conditions in America railroads have proved more advantageous.

Engineering Problems Connected with Reconstruction

Address By Past-President Main at Martigues, France

We consider it a very great honor and privilege to be allowed to come to France to discuss with you the problems of reconstruction and redevelopment. We have, in our own country, many problems of reconversion from war to peace activities. We were unprepared for war, which was a possibility, and we are unprepared for peace, which is a certainty.

There are now before Congress two bills contemplating the creation of a commission for the discussion of such problems as labor, capital and credit, public utilities, demobilization of industrial and military resources, foreign trade, continuance of existing industries, agriculture, adequate production and effective distribution of coal, gasoline and other fuels, shipping, shipyards, ownership of yards and ships, housing conditions, technical education, the supply, distribution and availability of raw materials and foodstuffs, conservation of natural resources, transportation by rail and water, reorganization of Government bureaus on an economical and efficient peace basis, and consolidation and amendment of acts of Congress.

These are only a repetition of your own problems. In each of the belligerent countries there are the same problems to face, except that you have the additional one of the reconstruction of the devastated territory. We shall be very glad if we can be of any assistance to you in any of these problems.

Nearly all of the problems suggested are directly and indirectly engineering problems, and the assistance of engineers will be

needed now more than ever before, and the engineers should look upon them with a broader vision and should take a more active and helpful attitude toward public affairs and industrial relations which they have considered heretofore beyond the scope of their work.

You have asked us to consider with you the problems of Harbors, Water Powers, Roads and Pavements, Agriculture and Technical Education.

We have visited some of your ports and are very much impressed with the great possibilities of their further development. It would be presumptuous of us to attempt in the short time we have given the subject to say which is the best method of development.

The question of roads and pavements is a more definite one, and our committee has made its report with definite recommendations.

The problems connected with agriculture are so involved in the laws of France that we may not be able to give the advice you desire, but our committee has made a report which may be helpful.

Your technical schools are good, but we think it would be of great benefit to this country if we could have an exchange of professors and some of your professors and students could spend a year in some of our technical schools.

We have seen some of your water-power developments and have had presented to us in detail several projects for the development of hydroelectric power. The possibilities appear to be satisfactory for the development and use of some or all of these, especially when considering the high price and the possible shortage of coal.

The problems of water-power development are the same in all countries, with varying local conditions, and are largely problems in economics. It cannot be expected that private individuals or corporations will invest in enterprises of this sort that do not promise a fair return on the investment. If the cost of construction for a given project is so great that a fair return cannot be earned, it will remain undeveloped, unless the Government assists in financing it. Such assistance would be warranted if in addition to the power generated there were public benefits to be derived, such as prevention or diminution of floods, irrigation, or conservation of fuel, which would preserve for future generations the heritage which properly belongs to them.

Nearly all of the developments in our country use all the flow of the stream for some months in the year, and for the remaining months there is a deficit of water power which is supplied by steam power. The economic limit of development is also one of economics and can be solved within reasonable limits. As the requirements of business grow more exacting, it becomes absolutely necessary to have constant power assured.

In our own country considerable attention is being given to the construction of storage reservoirs, but no great progress has been made in the actual construction of such reservoirs for power purposes only. We have had very little encouragement for water-power development owing to the laws and the attitude of the law makers. A water-power bill is now under discussion in Congress, and it is hoped that a bill will be passed which will be liberal enough to stimulate developments. We were surprised to see in the vicinity of Grenoble two high-head powers, which were originally developed in 1868-1869, thus antedating any of the high-head developments in America.

Transportation problems are getting to be very serious with us. At least one-quarter of the transportation is for the coal used by the railroads. The development of electric transmission of power has made it possible to change many of our previous methods of doing business, and we are now discussing the feasibility of constructing steam plants near the mouth of the mines and at tide-water of larger capacity than have previously been built. We are also considering the further and more efficient development of water power, and the running of great connecting trunk lines for the transmission of electric current and the electrification of the railroads. If these projects could be carried out a large portion of the railroad equipment would be released for other purposes and less coal would be burned.

It appears to us that these are the general lines along which you are proceeding and should proceed with your future developments. The principal projects should be considered together, and the successive developments made as they will best fit into the general plan. Competition may be ruinous, but concerted effort will prove to be successful.

We have been privileged to visit some of the devastated areas and to get a definite idea of the damage done to your country. We cannot express the depth of our sympathy. We can be of some assistance to you in transmitting our impressions first hand to the citizens of our own country.

Our delegation is deeply indebted to you and to every one for the gracious courtesy which has been so uniformly accorded us. We shall carry back to America a memory which will last as long as we live. On behalf of our delegation, I desire to thank you all for these courtesies.

Engineering Delegates Tell of Their Observations Abroad

On February 10 the delegates to the French Engineering Congress presented to a meeting of the four engineering societies, held at New York, an informal report of their trip and of their impressions of engineering conditions in France.

Dr. George F. Swain described the work of the Congress and spoke interestingly of certain aspects of the present situation in France. Speaking of Waterways and Transportation he said in part:

"France has done more than any other country in Europe to develop a system of internal waterways, canals and navigable rivers. All of these are owned and maintained by the government, which has assumed the debt and pays the interest on the debt and maintains the river and canal work. The man who wants to operate a boat on a canal simply buys the boat and operates it; and when one pays for canal transportation he simply pays the boatman his charge, whatever it is.

"The railroads are dominated by the government, but of the seven railroads of France, six are owned by private corporations while the seventh is a state railroad. Even for private corporations the state assumes the risk of all funds for construction. The companies pay all expenses of maintenance and operation. They pay due taxes to the government and they are allowed to earn a dividend for their stock holders which amounted, three years ago, to something over 4 per cent.

"The French have a great idea of developing waterways and the only point in which the members of the delegation were not quite in accord with the French engineers was with regard to their plans for spending large sums of money in building canals and making rivers navigable. Apparently no study was being made of the economics of these questions; no statistics of transportation, no study as to whether they could get any return from the expenditure."

With regard to technical education, one of the subjects investigated, Dr. Swain said:

"I think the French appreciate that with them as with us, the events of the last few years ought to lead to changes in educational methods. It is a great thing to have one nation learn from another and the best time to learn is when a man is young. We emphasized at every opportunity the desirability of having Americans go to France to study and Frenchmen come to America to study.

"Their engineering schools are in the hearts of the cities where they cannot grow, where they have no room for laboratories or any expansion. One of the ministers said they were going to appropriate large sums for technical education, and I think they will. I hope they will open their schools to foreign students without undue petty requirements or restriction and I think there will be, in the future, an interchange of our young men with their young men. I think there is a good prospect of that proceeding."

Mr. George W. Tillson, a civil engineering delegate, gave an account of French plans and methods of road construction. In the course of his remarks he said:

"I, personally, was considerably surprised to find that the

question of roads was one for discussion, because I knew that the French for many years had the reputation of having probably the best system of roads in the world. I was surprised that they should ask this new country of ours for anything in the way of information on that subject, but, when we came to confer with them, it was very simple."

It had been pointed out to the American delegates, however, that the development of motor traffic necessitated new methods of construction and the two methods which seemed to appeal to the French engineers were the construction of asphaltic macadam by the penetration method and by the mixing method.

"We told them," Mr. Tillson said, "of the miles of concrete roads that have been built in this country during the past ten years and the good results that have been obtained and that they could expect better results in France because they did not have the great ranges in temperature which we have here and which cause cracks in the concrete. They were, however, inclined to disapprove of this method because some years ago a concrete road had been unsuccessful, and so without further experiment they had dropped this manner of road building. We urged further experimental work and while our ideas did not appeal very strongly to them, the Congress, nevertheless, agreed to recommend the use of concrete where the materials were so convenient that it would be cheap."

The question of finances as related to road building was of special interest according to Mr. Tillson. American methods would not do, for while they liked the idea of a special assessment, such as we have in this country, and seemed to think that it would be proper that the abutters on the road should pay a certain amount of the cost, under present conditions in France they thought it would be hardly possible to bring it about.

The Mining Engineers were represented by Mr. E. G. Spilsbury, who described a trip to the devastated coal regions of Lens. Before the war this section had 60 mines and 18 were models of mining appliances.

The buildings were all stone or concrete, surrounded with steel structures, washeries and grading machinery with massive steel and concrete storage bins and loading equipment. Of all this nothing remains except tangled masses of broken steel. Not content with letting these structures take their chance of being wrecked by shell fire, the Huns systematically cut the steel supporting legs of the railroad ways and with cables to heavy motor trucks pulled them over. Every hoisting pump and machine was either dynamited or broken up with sledges and every boiler showed signs of having been exploded from the inside, besides the shell perforations in some of the steel domes. The electrical generators and motors had been taken out and presumably shipped to Germany.

The mines were flooded by cutting ditches to some of the shafts and laying pipes to the more distant ones through which they turned the waters of the Somme canal.

It is estimated that it will take 30,000,000 hp. for a year and a half for dewatering. They have a small surface coal deposit about 12 miles from Lens where they are now building a power station from which to run pumps. A thing which was very apparent to the delegates was that the French are not seeking the help of foreign engineers to aid in this work. They have plenty of talent of their own and they are going to use it and use it more or less exclusively.

Hydroelectric developments were discussed by Mr. Lewis B. Stillwell. There is at present, according to Mr. Stillwell, 4,500,000 to 6,000,000 undeveloped horsepower in France, and while our assistance in its development will be welcomed, we can teach the French practically nothing in the technicality of the hydraulic art and the construction of factories. The only matter they may have to learn from us in respect to the work, is that our experience has been on a somewhat larger scale, and with higher pressures. We can, however, assist them in standardizing their plants and systems. Even now, such important factors as frequency and voltage are not standardized, and interconnection, which is so desirable, cannot be accomplished until a standard is universally adopted.

They will also have to carry out the idea of standardization in great detail, if they wish to get the cost of production down to a reasonable basis. At present, the idea of individuality is carried to an extreme that is astonishing to us. The smaller manufacturer who makes a lamp socket, for example, or the retailer who sells the lamp socket will call on the manufacturer to make his a little different from the other kind, on the theory that having obtained his original customers he can hold them as they cannot get that particular type anywhere else.

Other speakers of the evening were Mr. George W. Fuller, who discussed French agriculture and finance; Mr. A. M. Hunt, who outlined the French plans for developing their ports and the proposed east and west railroad to Basle, Switzerland; and Mr. Nelson C. Lewis, who described a trip through the "Smiling Valley of the Marne."

Past-President Charles T. Main, who represented the A.S.M.E. on the delegation, was unable to be present, due to an engagement at Boston.

FUEL PROBLEMS OF THE PACIFIC COAST

The Possibilities of Fuel-Oil Conservation Through Its Economical Use and the Development of Hydraulic Power

In harmony with the spirit of the times, fuel conservation vs. the great demand for power occasioned by our many war industries, was the subject for discussion at a joint meeting of the local sections of the A.S.C.E., A.S.M.E., A.I.M.E., A.I.E.E., and A.C.S. at San Francisco shortly before the signing of the armistice. Although the problems of peace now occupy our minds, we must be governed by realities, and much of the discussion given at that time is pertinent to the reconstruction period through which we are now passing.

In addition to the papers which are abstracted below and which bear directly on the subject indicated in the title, others were presented by Major George F. Sever, U. S. A., Capt. Robert W. Brewer and Prof. Edmund O'Neill, respectively. Major Sever told of the careful study he was making of the electric power situation on the Coast for the Government; Captain Brewer gave particulars regarding the various methods and devices employed in conserving fuel in England; and Professor O'Neill pointed out the numerous ways in which the chemist had been of service in solving problems connected with the economical burning of fuel.

Fuel Conservation

A. E. Schwabacker[1]

In presenting his subject Mr. Schwabacker outlined the plans of the U. S. Fuel Administration for carrying on its important work. He said that America's war needs called for 100,000,000 more tons of coal in 1918 than in 1917, and 200,000,000 tons more than in 1914. This tremendous increased demand had to be met by most intensive work in three directions: increased production, efficient conservation, and a distribution which would insure against lost motion.

While every European country had decreased its coal produc-

[1] U. S. Fuel Administrator for California.

tion since the war began, the United States had increased its output by 50,000,000 tons during the first year of the war; 735,000,000 tons of coal were necessary for our railroads, ships, war industries and people; 100,000,000 tons had to come from the anthracite fields and the remainder of the amount from the bituminous.

In 1917 there were produced about 330,000,000 bbl. of oil, and in 1918 an additional amount of approximately 23,000,000 bbl. was required.

Two limiting factors in the production of coal were labor and transportation. With a decreased labor supply, and increased demand, full production had to be obtained by greater efficiency of mine workers and conservation by industrial and domestic consumers. The Production Bureau of the United States Fuel Administration appointed a special committee at each mine. Three members were chosen by mine operators, and three by the workers. This committee urged miners to work eight hours a day six days a week, to report the number of tons produced, and to discourage shortages of hours or absence from duty.

Before the war the demand for domestic coal during the summer was so light that miners would often seek other occupations. The Fuel Administration encouraged the early buying and storage of coal by patriotic appeals to consumers through a "Buy Early" campaign. This was a tremendous success and kept the demand upon many mines during the summer months up to maximum.

The Fuel Administration created a labor bureau, wherein the matters pertaining to labor in the coal-mining industry remained under the jurisdiction of the United States Fuel Administrator. Strikes in the industry were reduced to a minimum, thanks to the efficient work of this bureau.

A zoning system which eliminated cross-hauling of coal and avoided waste of transportation was estimated to save over 20,000,000 car-miles a year in the movement of coal. A consequent saving of fuel that would otherwise be used in this transportation was also made.

Before the organization of the Fuel Administration shipments of bunker coal to seaports contained as high as 10 per cent of foreign substance. Strict regulations introduced later, however, prohibited the delivery of any coal to Atlantic or Gulf ports for bunkering purposes that was not up to the Fuel Administration's specifications.

Fuel oil also had to be conserved to the utmost for the use of ships. Mr. Rossetter, Director of Operations of the United States Shipping Board, had advised that the emergency fleet could be operated by American seamen in competition with foreign vessels manned by cheap Asiatic labor, providing fuel oil was burned instead of coal.

The speaker said that the experience of H. R. Collins, of the Fuller Engineering Co., with many grades of coal, indicated that every solid carbonaceous fuel from lignite to the graphitic anthracites of Rhode Island, would yield its maximum measure of heat if burned in pulverized form. The cement industry alone, in California, consumed 1,700,000 bbl. of fuel oil per annum. If California low-grade lignites and sub-bituminous coals were pulverized and utilized as fuel to serve this industry, approximately 350,000 tons of coal in the pulverized state would release for ship's use 1,700,000 bbl. of fuel oil.

The Fuel Administration had endeavored to stimulate development of hydroelectric power to serve as a substitute for fuel oil and coal. Central generating stations were recognized to have far greater possibilities for fuel conservation than smaller isolated plants, and the elimination of less efficient plants was being urged.

Interconnection of power companies had been accomplished in many localities through the efforts of the Fuel Administration. Substantial savings of fuel oil and coal had been made possible, particularly in those communities where water-power plants had been interconnected with those operated by steam. By the closing or consolidation of many so-called "less essential" industries, supplies of fuel, raw materials and man power had been made available for war industries.

Lightless nights were estimated to have saved 500,000 tons of coal. Skip-stop systems on street railroads promised to save 3 per cent of fuel consumption and the daylight-saving plan had saved approximately $1\frac{1}{2}$ million tons of coal per annum.

Production of Energy

A. M. Markwart[1]

Mr. Markwart drew attention to the vital importance of developing the water-power resources of the country. Our coal measures, he said, were sufficient for several generations, but production had already reached the point which, with the supply of oil, would answer the most essential needs only if these supplies were guarded by the most careful restrictions as to their use. Naturally, in increasing the supply of energy, we should give some consideration to that form which would best serve our present and future needs.

The production of coal took an enormous amount of man power each year, the value of which was lost after the coal was consumed, and the natural resource was diminished accordingly. This was equally true of oil, whereas the human effort expended on the creation of a hydroelectric plant was much less and it was spent but once; its result was conserved throughout the plant life, and a corresponding amount of wealth was created.

In developing the greatest natural resource of the country—"white coal"—a beginning had barely been made. Here was a practically inexhaustible supply of energy. The undeveloped water power of the nation had been variously estimated at from 55 million commercially to 225 million horsepower theoretically. Accepting the lower estimate it was said that 40 million of this was to be found in 13 western states and mostly under Federal control. Of this there was perhaps 5 million in the state of California, but not over half a million of which had been developed. The total developed water horsepower of the United States was stated to be about $6\frac{1}{2}$ million, and the steam-engine horsepower, including railroad locomotives, 28 million. It was evident that there were great water-power opportunities, many of which were favorably situated for immediate development, to satisfy the needs of a wide and constantly increasing consumption.

The laws under which water power might be utilized, however, were so stringent that there had been a stagnation in water-power development. While in normal times policies were deterrent, in war times they were practically prohibitive, and the obstacles to be encountered were so numerous that corporations could not undertake any kind of expansion whatsoever. To develop a hydroelectric project in California it was necessary to obtain permits from the Forest Service (if public lands were involved), the State Water Commission, the Railroad Commission, the Commissioner of Corporations, and the Fuel Administration; and then, when all of these permits had been obtained, it was necessary to secure a certificate from the Capital Issues Committee that the issuance of the securities in connection with the project was not incompatible with the interests of the United States. And after all this had been done, the War Industries Board, the Railroad Administration and the Selective Service Boards would thus determine respectively whether or not the necessary materials of construction might be obtained, transportation arranged, and men secured to accomplish the physical work. These restrictions were doubtless necessary to safeguard the interests of the public and to maintain the conduct of the war, but they did not facilitate the development of this enormous wealth of potential energy.

It would therefore seem that sane, accelerant effort should be directed toward the utilization of hydroelectric power rather than exclusively toward the exhaustion of coal and oil, with the consequent waste of man power and absorption of transportation facilities. Water power was now locked up by prohibitive restrictions. We should have done with this kind of conservation and should proceed with the development and utilization of this tremendous resource in order to save for posterity some of those non-renewable natural resources upon which this generation was drawing so heavily.

[1] Civil Engineer.

Gas as a Conservation Measure

J. A. Britton[1]

The essential and fundamental elements of conservation are being taught the American people of today, who are rapidly learning their lesson and who patriotically desire to conserve that which the Government requests them to conserve. In reference to the economies of heat, light and power under the conditions of distribution as they exist in the north central part of California, the alternatives for artificial gas are electricity, wood, coal, oil and the residual products of crude oil.

Electricity, while fulfilling every expectation as a means of light and power, has never measured up to the standard of other means for producing heat. Heat generated by means of electric resistance can never be a successful competitor of gas where the materials from which gas is derived are readily obtainable. It is also conceded that the transporting cost of coal and oil from which gas is made, to the point of manufacture, is materially less per heat unit than the cost of conducting electric energy to the point of its conversion into heat. The use of electricity for heating therefore becomes at once an economic waste of material and man power. The same truth would apply to lighting except for the diversified uses of electric energy, its adaptability and the personal care that is necessary in the use of gas and oil.

The lack of a good quality of bituminous coal in California renders its use as a competitor of oil or gas at once out of consideration. When one considers the enormous amount of labor required in the mining, transportation and distribution of coal, and the lack of efficiency in its application to the production of heat, and the necessity for the removal of the residuals of combustion such as clinker and ash it is evident that it may be dismissed from this discussion. The chief consideration can safely be given to the relative merits of oil used directly and of oil transformed into artificial gas by the modern process which is essentially Californian in character.

In the modern process of gas manufacture from crude oil it is safe to estimate that not more than 7 gal. of oil is used, for all purposes, in the production of 1000 cu. ft. of gas having a thermal value of 550 B.t.u. per cu. ft., 70 per cent of which is applied to effective work in modern domestic appliances and more when used in large industrial installations. The distribution of gas requires no transportation or man power nor are these involved in the disposal of residual or by-products. It is available to the smallest consumer as well as the largest and has been a most important factor in war work.

The gas company in delivering gas to the consumer eliminates the coal bin, and provides hauling of material to any waste from the kitchen or factory. A much higher percentage of the total heating value is utilized than in any other form of fuel. The use of gas means conservation of man power. for all equipment is ready and manufacturers and industrials need not stop other important work to supply the needs of gas companies.

Oil-transmission lines deliver the material to the plants and men and transportation facilities are released for other work. Engineers, firemen, laborers, horses and wagons and the minor materials necessary in the operation of small steam plants can be dispensed with if gas is the fuel. Insurance rates are lower, for the fire hazard is reduced to a minimum.

Future Requirements of Oil

D. M. Folsom[2]

No one can measure with any degree of accuracy the quantity of oil under ground and no oil company can ever hope to secure in storage above ground more than a few months' supply of crude oil or any petroleum product. A change in the demand for refined products is immediately reflected in the entire industry. While it was rash to predict the future, the speaker said, he would attempt to point out in a broad way the future requirements of oil on the Pacific and particularly to emphasize the dependency of Pacific industry and commerce upon oil.

If the United States is to meet successfully the industrial and political problems which will arise after the war it must be done through increased domestic development and through the expansion of our foreign commerce. Furthermore, every boat that operates successfully on the Pacific under the American flag must be an oil burner, and eventually these boats will be equipped with internal-combustion Diesel engines. There are two reasons for this. In the first place the coaling stations of the world are under the control of either the English or Japanese nations, but more important than this is the fact that only through the use of oil can America meet the cost of competition under the handicap of the high wages which this country pays its seamen.

Oil is a natural fuel for ships: compared with coal it is cheaper, easier to handle, and more efficient in use. It gives a longer steaming radius to vessels. The amount of oil required to supply our new boats will tax our resources to the utmost. At present we are not producing in this country enough oil to meet our own domestic requirements and the present estimates of the Shipping Board call for an additional eighty million barrels, or 25 per cent of the present production, for the support of the new merchant fleet.

This can only mean one thing—a smaller quantity of oil for use on land. It is inconceivable to us as Americans that our fleet will not be a success, but we will be unable to compete successfully in the commerce of the world unless we provide oil for this fleet by conservation and substituting other fuel or power on land for the fuel oil we are now consuming.

On the Pacific Coast this presents an acute problem worthy of the best talent in the engineering profession. Oil is our best fuel, and California oil supplies two-thirds of the power, light and heat over the western third of the United States.

If we are to expand our own trade and develop products to supply cargoes for our ships, we must have fuel for factories, mines and farms. With the necessity for decreased use of oil, where is the Pacific Coast to get this power? I believe there is no single solution, but instead a joint solution to this problem. Oil must be used more efficiently both on land and on ships through the development and increased use of the internal combustion engines, and on land hydroelectric power must be developed and used on a greater scale than ever before.

Intelligent conservation means efficiency in the use of our fuel—not curtailment that cripples industry. Intelligent conservation also requires development of natural resources now utilized. Regardless of the cost in money or the labor involved, the streams of the Pacific slope must be made productive of power.

This program brings an opportunity to engineers—in fact it brings more than an opportunity—it is an obligation to each society of engineers and each individual to get out of the technical groove and to use imagination, to use initiative, and to think in terms of the future.

Electric Consolidations and Their Relations to Fuel Conservation

H. G. Butler[1]

Since the beginning of the war the Government has gradually eliminated all the more conspicuous forms of waste, and it will be necessary to continue this policy after the war if we are to compete successfully with the industries of Europe, all of which have been speeded up for war production in such a way that the speed can be maintained after peace comes. In France, to cite only one instance, 180,500 hp. has been installed since 1914 on three rivers of the Alps. The magnitude of this development can be appreciated when it is understood that it would carry about 50 per cent of the peak load of all the power plants in the state of California north of Merced.

Production all hinges on power; power reduced to its simplest

[1] Vice-President and General Manager, Pacific Gas and Electric Co.

[2] U. S. Fuel Administration, Oil Division.

[1] Power Administrator.

terms means one of two things, fuel or water. The first step in the program of this country, beyond all question, should be to harness the streams.

There has lately been a move all over the world to interconnect independent power plants in the same locality, and interconnection has been held forth as a panacea for many of the ills to which the electrical industry is heir. The fact that interconnections are being made throughout the United States and other countries indicates that the mutual savings of the interconnected companies are great. They would be much greater, however, if the diverse interests of each company were harmonized and the entire situation in any given territory were handled as a unit. For a supply of 500,000 kw. for war industries in the East it has been estimated that isolated plants, in comparison with central stations, require for installation twice the investment and for operation four times the coal, four times as many coal cars with their complement of locomotives, track and terminal facilities, and four times the man power. Again it has been estimated that if the whole of England were linked up with central stations located at economical points near the coal supplies 50,000,000 tons of coal per annum would be saved.

It is impracticable to attempt to show the actual savings which could be made in fuel by either interconnection or consolidation, because there are many unknown factors in each case and which vary from day to day. Broadly speaking, consolidation would conserve fuel in five ways:

1 It would improve the yearly load factor and the daily load factor because of the greater diversity of load, thus increasing the efficiency of the steam plants; instances of which are the consolidation or interconnection of two companies, one having a large lighting load in the winter and the other a large irrigation load in the summer, or of two companies, one having an industrial load and the other a street-railroad load.

2 In the case of companies having both water- and steam-power plants, the combined operation of water-power plants of different physical characteristics, as for instance a plant with natural stream flow but without storage and a plant with a large forebay, would permit the carrying of peak loads by water power which, without combination, would necessarily be handled to a large extent by steam by the company having the natural stream flow developments.

3 It would permit the load to be blocked out to the more efficient steam plants, so that the less efficient plants would operate only on the peaks or would shut down if the combination had excess generating capacity.

4 In making extensions the combined companies would install larger and more efficient units than the several constituent companies, if each company should make its own extension. In the larger plant higher-class boiler-room supervision would result in fuel economies.

5 Under consolidation existing plants would be enlarged and new plants would be built in locations better adapted to handle the consolidated load, thereby saving fuel through reduced line losses.

As a by-product of consolidation, the loads which could be safely allotted to a certain generating equipment are materially increased and it would be feasible to apply to regular service a large portion of that generating capacity of the companies which would be otherwise held in reserve, because the interconnected transmission lines would make the reserve capacity of any one division available for the whole consolidated system.

In several of these instances it is possible that the mutual benefit to the interconnected companies would lead them to operate their plants to effect these economies; but in many cases commercial, legal and other reasons would interpose objections to the use of the plants in this manner, which could be overcome only by consolidation.

The economies effected in the use of fuel are only one phase of the whole question of consolidation. Consolidation results in saving man power, in conserving capital and in reducing operating expenses; but perhaps after all the greatest gain would be found in the fact that under consolidation the problems which arise in the territory of the consolidated companies would be approached and solved with a mind single to giving the best service for the least cost. Consolidation does not necessarily mean government or state ownership. Until the means of transmission shall have been improved the problems of the electrical utilities in each locality must be solved locally, and in no section of the country is the industry of such magnitude that it cannot be organized and managed by private capital. So many of the motives which urge men to put forth the best that is in them are lost under government ownership that it should be resorted to only after everything else has been tried and has failed. Some way surely can be found to secure both the benefits of consolidation and of private enterprise. Possibly the ultimate solution of the matter will be found in some partnership arrangement whereby the state or nation will do more than regulate but less than own and operate the electric utilities.

Sources of Energy Supply

P. M. Downing[1]

The development of the art of transmitting electric energy long distances has made possible the development of many water powers remote from suitable manufactures or railroad centers, and has been of particular importance in California where there is an abundance of potential water power and a dearth of fuel.

Water-power development in this state has been about equally divided between the northern and southern portions. In 1900 the aggregate installed capacity of all of the plants in the northern part was approximately 15,000 kw. In 18 years this has increased to over 375,000 kw., or at the rate of over 20,000 kw. per year. In addition to this there are also installed steam-generating plants having an aggregate capacity of approximately 187,500 kw., and yet with all of this development California is today facing one of the most serious power shortages in its history. In 1917 the five large power companies in the northern part of the state generated 1,507,000,000 kw-hr. Approximately 16 per cent of this was produced on steam, requiring 1,195,000 bbl. of oil. The peak load during the year was 265,000 kw. The load, both energy and peak demand, is increasing at the rate of 10 per cent per year. To meet this increase there will have to be provided each year additional facilities having an energy-producing capacity of not less than 150,000,000 kw-hr. and a peak capacity of not less than 26,500 kw.

The winter of 1917-18 was one of abnormally low precipitation. Without the usual late storms during the past spring, the stream flows during recent months have established new minimums. The steam plants which heretofore have always been considered as reserves to be used only in emergencies, have been called upon to operate up to their maximum capacity throughout the entire 24 hours of the day. During the past few months approximately 40 per cent of the energy supplied in the northern part of the state has been produced on steam, 40 per cent from stored water, and 20 per cent from natural stream flows.

A forecast of the future is not so bright. The only additional energy that will be available other than that due to a more nearly normal season, is 60,000,000 kw-hr. from the systems of the California Oregon Power Co. and the Northern California Power Co., and an additional 75,000,000 to 100,000,000 kw-hr. from the increased steam plants of the Pacific Gas & Electric Co. On the basis of an annual increase in load amounting to 150,000,000 kw.-hr., this additional energy, even with normal water conditions, will hardly be sufficient to carry the load through the year 1919.

Unless other facilities are obtainable by 1920 there will be a more serious shortage beginning with that year, which will be cumulative until other facilities are provided. No new hydro developments are under way at the present time, and in view of the scarcity of labor and material no new installation of any size can be made in less than two years. Without additional hydroelectric power to relieve the situation, there will be required for steam generation by 1920 between 3,000,000 and 3,500,000 bbl. of fuel oil—an increase of between 500,000 and 700,000 bbl. per year.

[1] Chief Engineer Electrical Department, Pacific Gas & Electric Co.

District Steam Heating as Related to Fuel Conservation

H. S. Markey[1]

District steam heating affords a means for the conservation of fuel. The records of district steam heating over an area of approximately 56 city blocks in the business, hotel and apartment-house districts of San Francisco, and operated in conjunction with a main steam-electric generating station, show, for example, a considerable saving.

The steam is supplied from two well-equipped and efficiently-operated central stations and is delivered through underground pipes. Such a system should be economical in the use of fuel oil, especially if turbo-generators are interposed between the boilers and the consumers, because electric energy so generated reduces the load on the main steam-electric generating stations.

The fuel burned in the stations during the twelve months ending with August 31, 1918, amounted to 129,893 bbl. Maximum and minimum months were January (16,043 bbl.) and August (7102 bbl.).

During the same twelve months the stations produced 6,411,990 kw-hr. Maximum and minimum months were January (947,030 kw-hr.) and August (319,590 kw-hr.). In addition to the electric energy some power is developed in a pair of large steam-driven elevator pumps, but as this power would have to be estimated, no account is taken of it in the records. A comparatively small number of consumers who are not within reach of the exhaust mains are served from a high-pressure main with steam direct from the boilers.

Because of the electricity generated the district steam system is credited with fuel, the exact amount of which can be determined only from thermodynamic considerations. An allowance which is practically correct can be made as follows: The use of steam turbines in the line increases the fuel consumption by 8 per cent or 10,340 bbl. per year. The main station generates from 80 to 240 kw-hr. per barrel, depending on the load, the average for the twelve months being 195.2. The electricity generated at the steam stations, therefore, reduced the year's consumption of fuel at the main station by 32,900 barrels. The difference, 22,510 barrels, was actually saved. This amounts to one barrel for each 285 kw-hr. generated at the steam stations. The high efficiency of the steam-heat stations is due, of course, to the fact that the heat contained in the exhaust from the turbines is not rejected to a condenser or the atmosphere.

The steam-heat stations are therefore to be credited with 22,510 bbl. for the 12-month period, 3325 bbl. for January and 1120 bbl. for August, leaving 107,383, 12,718 and 5982 bbl. chargeable to steam heat for the year, for January and for August, respectively.

The steam delivered to consumers is all metered with the exception of about 5 per cent, which is used in open-jet apparatus and which must be estimated for each consumer using such apparatus. This estimated quantity is added to the registration of the consumer's meter each month. Including the open-jet steam there was delivered to the consumers during the 12-month period 306,978,000 lb. of steam, and during January and August 41,609,000 lb. and 14,914,000 lb. respectively.

The steam is supplied to the consumers at an average pressure of 5 lb., and by the steam tables each pound carries 1156 heat units above 32 deg. fahr. The condensate leaves the premises at a temperature of from 100 deg. to 180 deg. fahr. above 32 deg. To get an even figure assume 156 deg. as an average. Then each pound of steam passing through the premises leaves behind it 1000 heat units. This is the difference between heat put in and heat rejected and is therefore the useful heat delivered to the consumer.

The useful heat delivered to the consumer per barrel of fuel, works out as follows:

For the 12-month period	2,860,000 units
For January	3,270,000 units
For August	2,500,000 units

[1] Engineer, City Electric Co., San Francisco.

Assuming 6,000,000 units as the heat value of a barrel of oil, the overall efficiency is:

For 12 months	48 per cent
For January	55 per cent
For August	42 per cent

The variation in the demand for steam is such that for three or four months the larger of the steam-heat stations is not operated and for about two months during the winter both are needed. This condition affects the efficiency unfavorably.

Fuel would be still further conserved if there were twice as many consumers connected to this system so that its efficiency would be maintained the year round. During the winter peaks additional steam could be supplied direct from boilers held in reserve for that purpose. The amount of fuel burned under these boilers for a month or two would be small compared to the saving effected at the main steam-electric generating stations in a year.

Railroad Electrification as a Fuel-Conservation Measure

W. J. Davis, Jr.[1]

In making a study of the possibilities of conserving our available supply of fuel through the electrification of the railroad systems of the United States, there are two points from which the subject may be viewed:

1 The possible saving that may be effected by the replacement of the steam-locomotive equipment now in use with electric locomotives supplied with power from modern steam-electric generating plants of large capacity, suitably located with regard to cheap fuel and water and distributing over large areas through high-voltage transmission systems.

2 Saving to be expected by comparing the possible performances of modern compound steam locomotives using high superheat with a system of electrification and power supply as above described.

Basing calculations on pre-war conditions, it is found from the Reports of the Interstate Commerce Commission that the total gross ton-mileage movements of the railroads in the United States for the year 1914 were approximately as follows:

	Ton-Miles	Per Cent of Total
1 Bituminous coal	166,400,000,000	15.93
2 Anthracite coal	38,200,000,000	3.66
3 Railway-company coal	57,600,000,000	5.51
4 Miscellaneous freight	372,040,000,000	35.65
5 Locomotives	148,200,000,000	14.20
6 Locomotive tenders	74,630,000,000	7.15
7 Passenger cars	186,890,000,000	17.90
Total	1,043,960,000,000	100.00

In estimating the gross freight-ton mileage it has been assumed that the net ton-mile movement of the freight alone will be approximately equal to that of the cars. This assumption applies of course only to the first four items.

Assuming that the complete electrification of the railroads is feasible and desirable, it is at once apparent that a considerable saving may be made in the total ton-mileage shown above. In the third item of the table, railway-company coal, the ton-mile movement may be reduced to about one-third by the greater economy of electric power generation and a still further reduction will follow due to the location of many of the central power plants near the mines and to the use of such hydroelectric power as may be available. It would appear fair to assume, therefore, that the ton-mileage now required for the movement of railway company coal may be reduced to about 25 per cent of item 3, or 14,400,000,000 ton-miles. The saving in this item would be approximately 43,200,000,000 ton-miles or 4.15 per cent of the total.

[1] Engineer, General Electric Co., San Francisco.

The sixth item, ton-mile movement of locomotive tenders, may be eliminated completely, making a possible reduction of 74,630,000,000 ton-miles or 7.15 per cent of the total by the use of electric locomotives. We therefore find that the total ton-mile movement of all of the railroads in the year 1914 would have been approximately 926,130,000,000 if all of the roads were electrified, a saving of 11 per cent.

In estimating the fuel consumption of the electric power plants required for the above movement, we can take as a basis for our calculations the results of some tests made on the Chicago, Milwaukee & Puget Sound Railroad, between Three Forks and Colorado Junction. The net energy consumption in a round trip over this section of heavy grades and curvature, using regenerative braking, was 23.75 watt-hours per ton-mile at the locomotive, including power required for all of the auxiliary apparatus. The energy consumption of the same train on level track of the same curvature as determined from the known train weights, profile and locomotive efficiency, was found to be 20.4 watt-hours per ton-mile. These results are of particular interest as they show that with electric locomotives and regenerative braking it is possible to eliminate a large proportion of mountain grades in so far as they affect the power required for moving the trains.

It will be seen from the above that highly efficient compound non-condensing steam locomotives of modern type operating in railway service as it exists today would be expected to use more than 2.5 times as much fuel as is required by an equivalent electric system. If we assume the total fuel requirements of the two systems to be in the ratio of the estimated economies shown above with allowance for reduced ton-mileage of items 3 and 6 in the ton-mileage table, the saving in fuel on this basis for 1914 would be 79,400,000 tons.

In our final consideration of the possibilities of fuel conservation by electrification of the railroads, we must not overlook the fact that in large steam-power plants it is feasible and often economical to burn low-grade coals, whereas the steam locomotives require the higher grades of selected lump coal. This will release a large part of our highest-grade fuel which may be applied to our growing merchant-marine demands and to household uses.

Assuming a transmission efficiency of 72 per cent from the power-station bus bars to the collectors of the locomotive, the energy consumption at the power house, using the larger test result as a basis for calculations, is found to be 33 watt-hours per ton-mile.

Assuming then a total ton-mile movement of 926,130,000,000, the energy consumption required by complete electrification would be 30,500,000,000 kw-hr., to which should be added 20 per cent for shifting and yard movements and additional requirements of suburban passenger service, making 36,600,000,000 kw-hr. as the total energy consumption for the completely electrified system. On the basis of an operating economy of 1.84 lb. of coal per kw-hr., the annual fuel requirements for electrification would be 33,700,000 tons of coal. As the actual amount of coal consumed by the railroads in 1914 for locomotive use alone, including an allowance for fuel oil on the basis of 4 bbl. of oil per ton of coal, has been found to be approximately 120,000,000 tons, the total saving to be expected in case of complete electrification would be 86,300,000 tons. This is about one-sixth of the total coal production of the United States.

The point may be raised that the above calculations are hardly fair to the steam locomotive as we are comparing a highly efficient modern electric-generating system with a variety of steam locomotives, many of them of old and inefficient types, and that modern compound steam locomotives using high steam pressures and high superheats might accomplish almost as great a saving as would be obtained by electric haulage. That this can not be true is due to a number of factors inherent to the two systems. The effect of these factors may be seen from the following tabulated calculations in which the economy of a large turbo-generator station operating under steam conditions demonstrated to be

(Concluded on page 292)

DAVID MOFFAT MYERS ON FUEL CONSERVATION

At the Refrigeration Session of the Annual Meeting in December, David Moffat Myers, Advisory Engineer of the U. S. Fuel Administration, discussed in a brief address the engineer's part in carrying out the object of the United States Fuel Administration, which was to obtain the fuel required for conducting the war. He said when he went to Washington a year earlier he found that the only kind of conservation practiced was saving by curtailment. When, however, the four national engineering societies had appointed a committee, of which Professor Breckenridge was chairman, that coöperated with the Bureau of Mines and some officers of the Fuel Administration, a plan of action was adopted which solved the problem of fuel shortage with least inconvenience to all concerned. The guiding motive was "maximum production with minimum waste." Instead of saving coal by shutting down factories, they were kept going at higher efficiency, so that a saving of 10 to 25 per cent was made in their coal consumption, a saving which, during the first six months of this program, starting May 1, 1918, was equivalent to 7,000,000 tons of coal per annum from the power plants alone, plus 5,000,000 tons saved in other directions.

During 1918 a force of 1500 volunteer engineers, including a large representation of The American Society of Mechanical Engineers, gave their efforts to the work of inspecting and advising power-plant operators in the economical generation of steam and power. The demand for coal increased so rapidly during the war that by the end of 1918 the United States would have produced and distributed 100,000,000 tons of coal more than during the year 1916.

Mr. Myers then described how the Fuel Administration proceeded to enlist the coöperation of industrial plants. It was recognized that during the war there was little opportunity for improving the existing equipment of plants, but it was entirely feasible by education to impress upon the operators the necessity for fuel conservation and the means available for effecting it. In addition to personal visits by the representatives of the Fuel Administration, lectures were arranged to reach a large audience. At such lectures a number of lantern slides were made use of, which served to bring out in a simple manner the several fundamental rules to be observed in the economical operation of steam and power plants. Reports received at Washington served to prove that the entire campaign was very successful in both small and large power plants. These slides were also exhibited at this meeting and explained by Mr. Myers.

The speaker further related how in the beginning of the work failure had been predicted because of the attempt of the fuel engineers to go into a man's plant with the intention of telling him what to do. It was decried as paternalism. But the results showed that with the possible exception of one, all of the states endorsed the procedure of the administrative engineers; and directly after the signing of the armistice, when there was talk of the dissolution of the Fuel Administration, requests poured in from all parts of the country to continue the good work. In reply to these requests a conference was held early in December 1918, attended by Van. H. Manning, Director of the United States Bureau of Mines, Dr. Otis Smith, Director of the United States Geological Survey, and Dr. H. A. Garfield, United States Fuel Administrator, at which it was decided to merge some departments of the Fuel Administration into the other two Government departments named. For example, the work of the Conservation Bureau as well as the engineering program would be taken over by the Bureau of Mines. In conclusion Mr. Myers asked the engineers present to continue to loyally support the conservation movement until the new organization was ready to relieve them of this work.

At this session, which was held jointly with the American Society of Refrigerating Engineers and presided over by Dr. D. S. Jacobus, two papers were also presented: namely, The Development of a Standard Refrigerator Car, by Dr. Mary E. Pennington, of the Food Research Laboratory, U. S. Department of Agriculture; and Refrigerating Plant Efficiency, by Victor J. Azbe.

Chairman Jacobus in opening the discussion inquired of Mr. Myers whether in his opinion the excellent results achieved in war time were likely to continue after peace had been declared, when one of the actuating motives, namely, patriotism, would not be as strong as during the war. He further would like to know whether, in Mr. Myers' opinion, the power given the Fuel Administration to cut off the fuel supply in case there was undue waste, which was not corrected, had any important influence. Mr. Myers responded that in no case had it become necessary to actually cut off the supply because the idea of conservation had met with widespread favor, and he believed that the good results would be likely to continue if means were provided for properly carrying on the movement after the war.

plant with the object of improving it to earn a fee. From the speaker's sad experience he feared that hereafter the operating engineer, especially in a small plant, would have the same difficulty as formerly in convincing the management that he should be supplied with the equipment and instruments required for economical operation.

Joseph Harrington, Fuel Administrative Engineer for Illinois, at the suggestion of Harold Almert, described a chemical method of removing soot from boiler tubes which, he declared, was very effective. It consisted simply in throwing coarse salt upon the incandescent bed of clean fuel once every day. This would fill the furnace with dense white fumes, chlorine gas, which would attack and loosen the soot, whether it was a boiler or a domestic furnace,

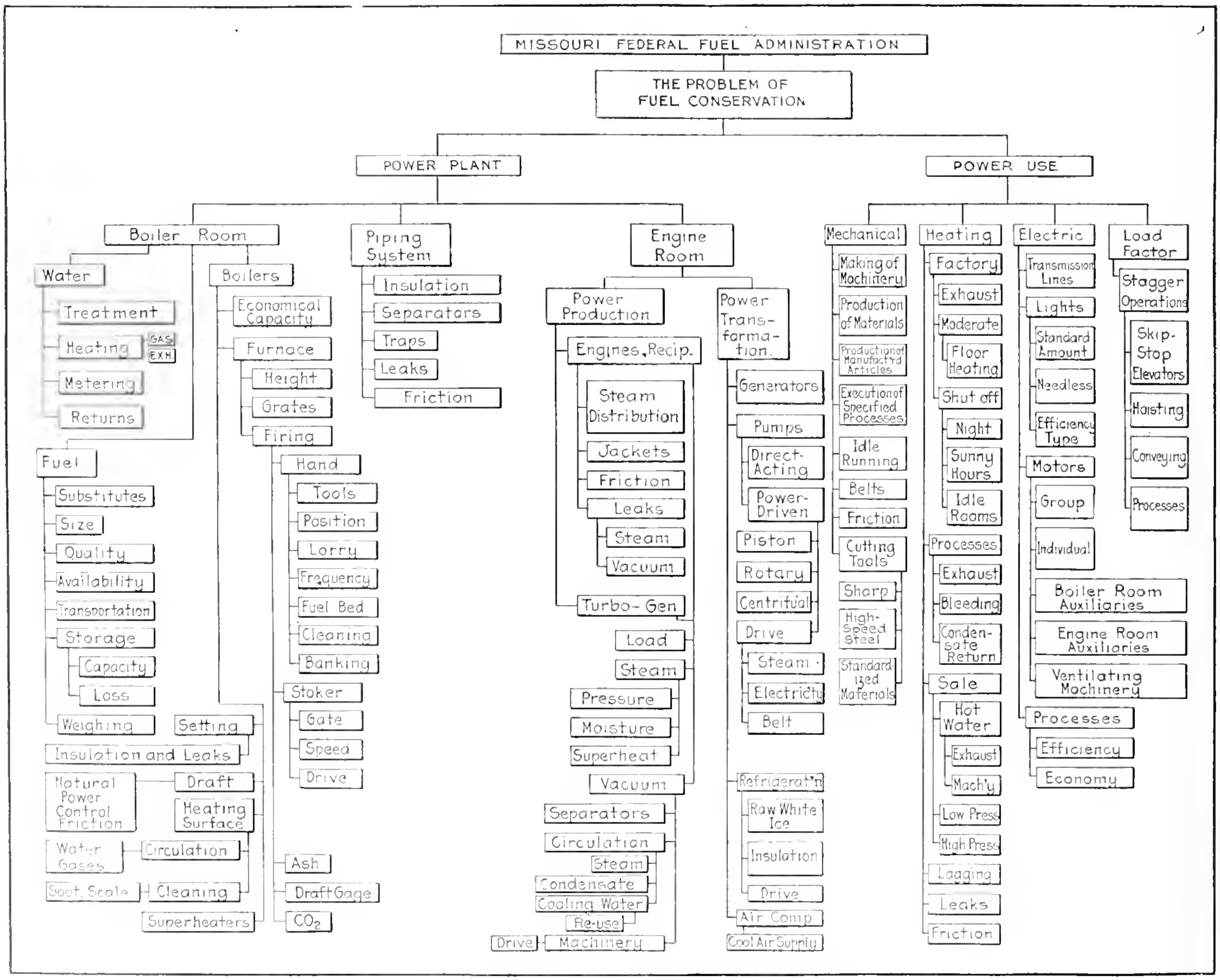


Fig. 1 Problem Chart Used by Fuel Administration in Missouri

Edward N. Trump thought it a good plan to have every plant in the country fill out the questionnaires and have the statistics thus obtained tabulated; the Bureau of Mines could then step in where required and encourage the saving of fuel.

Edgar G. Scott felt that a great deal of the success of the fuel-conservation plan was due to the fact that it reached the owners and managers of plants who ordinarily paid little attention to their cost of power because it represented only a small percentage of the cost of doing business. No doubt the presidents of companies realized that the best engineering skill was behind the questionnaires, and that the force of the national engineering societies supported the cause. Hence their attitude was more friendly than in the case of a single engineer coming into their

and whether hard or soft coal was burned. The soot greatly interfered with the rapid transmission of heat, and it was therefore important to remove this obstacle to fuel economy. A pound or two applied once or twice a week would keep a domestic furnace in good condition. In the case of a 300-hp. Stirling boiler, equipped with Green chain grate, burning Illinois coal, five ordinary coal scoops of salt were being introduced, one at a time. It took about half an hour for each scoopful to disappear. It might take half a day to thus clean a dirty boiler, but if this treatment was applied every day or two, the boiler would always be clean. After two years no sign of corrosion or deterioration of the brickwork would be detected.

Mr. Myers estimated from the results of an accurate test made

two years ago on a 5000-hp. boiler installation in a steel mill that even with the periodical manual removal of soot once every three days, the soot increased the coal consumption on the average by 6 per cent.

THE FUEL ADMINISTRATION IN MISSOURI

THE very thorough manner in which the work of the Fuel Administration, outlined above by Mr. David Moffat Myers, has been conducted in the various states and districts throughout the country, is well illustrated by the following account of the Fuel Administration movement as carried out in Missouri and particularly in one district of that state. The information was supplied through the courtesy of Prof. H. Wade Hibbard,[1] Mem. Am.Soc.M.E., District Engineer in the Fuel Administration of Missouri. Accompanying it were the problem chart shown in Fig. 1 (p. 270) and the district organization chart shown in Fig. 2. These were presented by Professor Hibbard at an early fall meeting of the state and district officers of the Coal Conservation Section of the Fuel Administration.

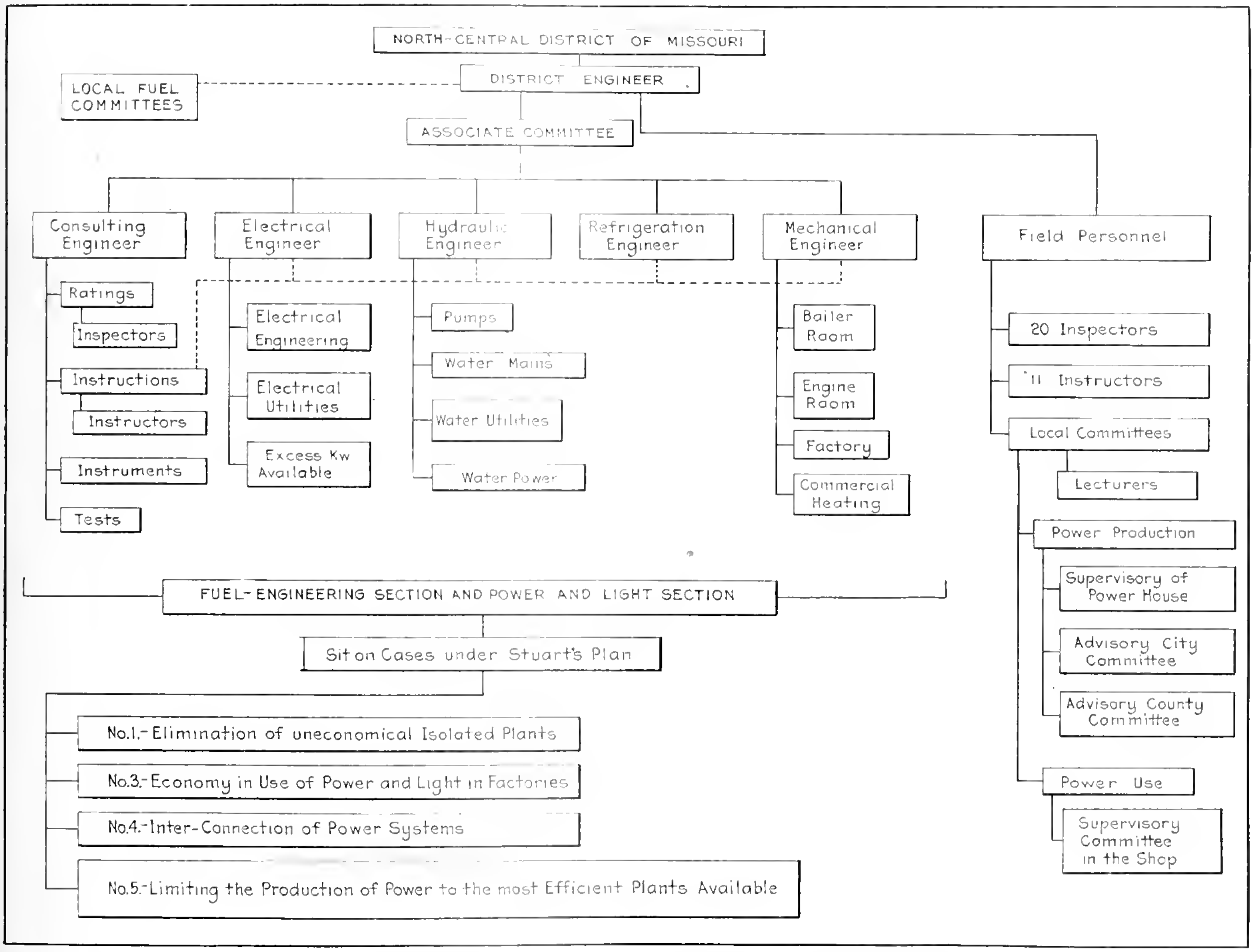


FIG. 2 ORGANIZATION CHART USED BY FUEL ADMINISTRATION IN MISSOURI

ORGANIZATION AND CONDITIONS IN THE STATE

The work of fuel conservation in power plants and factories was being successfully carried out over a very large area of the United States in the second year of the war. The Coal Conservation Section of the United States Fuel Administration, although centrally administered, permitted autonomy as regards organization within the different states. The centralization or distribution of power plants in a state, its topographical divisions, the availability and concentration of Engineers suited for the work—all had their influence in determining the form of a state's organization.

In Missouri the State Administrative Engineer is Mr. J. A. Whitlow, Mem.Am.Soc.M.E., an engineer in the Public Service Commission which patriotically permitted him to devote his entire time to this work. His office was already located in Jefferson City, the capital, and at the geographical center of the state. Under him there are eleven District Engineers, each also already located within his district, and serving without pay.

The state is almost square, measuring 314 miles by 353 miles. It has two large manufacturing cities, St. Louis and Kansas City, respectively, in its extreme east and west, with many small cities scattered over its rich agricultural northern half, separated by the great barrier of the Missouri River from a more sparsely settled southern half, broken up by the Ozark mountain region. In the southwest there is a populous mining district and along the Mississippi and Missouri Rivers are numerous cities of moderate size. These features indicated a suitable division of the state, and also produced variations of organization among the Districts.

PROBLEM CHART

The purpose of this chart (Fig. 1) is to show in classified graphical form the items in power plant and factory affecting the use of coal, with their interrelationships. The chart serves as a guide to office and field work, and eventually would have

[1] Prof. Mech. Engrg., University of Missouri, Columbia, Mo.

been placed in the hands of every inspector and instructor, and posted in each power house and factory.

In its Power Plant Section this chart bears some resemblance to that used by a power-plant designer, but it will be noticed that a great number of items are omitted which such a designer would use. His need is for a statement of the inter-relations of every piece of machinery, equipment and apparatus which by any possibility could enter into his design, while this chart considers that subject purely from the viewpoint of coal saving.

A similar comment should be made regarding the Power Use Section. Naturally the details of every industry could not be included in such a published chart, but only the more general features common to a large number of industries in the state. The Committee on Power Use, mentioned in the Organization Chart in Fig. 2 as in each factory, would work out the additional items for its own chart along the lines suggested here. This local work would be under the help and guidance of the visiting instructor and the engineers of the Fuel Administration.

Organization Chart

The chart in Fig. 2 gives the organization as developed in the district of which Professor Hibbard had charge. The office was at Columbia, thus permitting the use of the volunteer work of a number of men connected with the School of Engineering and the power plant of the University. The local fuel committees had been previously appointed by the state fuel administration, headed by Lieutenant-Governor Crossley, and were at the county seats which are the chief centers of population and industry in the eighteen counties of the district. These committees had charge of fuel requirements, production and distribution, and were naturally closely interested in this work of fuel conservation.

Quite different from the practice followed in some neighboring states, this district made use of inspectors and instructors living in different parts of the district. In the summer of 1918 the District Engineer visited every important power plant, and from their chief engineers selected the best for his purpose. Several men were traveling engineers of pumping stations for oil pipe lines or connected with railways. Some were general managers of power plants with engineering education. Where desirable, employers were interviewed and gave hearty and patriotic consent that their subordinates should devote part time to this work. In a district where the power plants are scattered over an area of 140 by 133 miles, it seemed impossible to carry on this work of inspection and instruction thoroughly and efficiently by men located in one city, even though the men were available, as they were not. As the work was entirely without salary the men could not be expected to be away from home for considerable periods.

Large-scale maps were used showing each man's territory, cities and their data, with railroads and time tables and some automobile routes; charts with power plants under each man, with dates of assignments and visits; 10 by 12 card indexes of each town and its factories, with all names, facts, characteristics and other desirable data; maps for routing of lecturers and films; "tickler" indexes for keeping track of the work; and other time-saving devices familiar to the organizing and management engineer.

Under Field Personnel and Local Committees in Fig. 2 will be noticed the Advisory City Committee. These committees are made up of owners and chief engineers of all the plants in the city, with the leading chief engineer as chairman, unless an inspector or instructor resides there. Local enthusiasm is thus intensified, and the smaller chief engineers get the benefit of advice from their more expert associates.

"Send a Miner Substitute to Pershing" was the slogan adopted and spread among all the power plants of the district. They all knew that the general was born at Laclede in the district. In the Civil War a drafted man could send a substitute in his place. In the present war men beyond draft age, or rejected or deferred because indispensable, were as intensely patriotic as those who went. They enthusiastically took up the slogan in fuel conservation. Any man who was the means of saving one coal-miner's annual output thereby released that man to carry a rifle in France or drive a ship rivet or make a shell. So if owners and engineers and firemen and shopmen could send their "miner substitutes" to establish freedom and liberty in the world, they were exceedingly glad to do so. Coöperation with the Fuel Administration became an easy task; they were not only waiting but aching "to be shown" how they could help.

Those whose hearts have been in this conservation work of the United States Fuel Administration hope that this most widespread university or engineering-extension scheme will in some form be continued by the Government, that the new efficiency, the management engineering in power plants, may carry on its far-reaching education and save human effort in a fundamental industry supporting all the industries.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Departments of Mechanical Engineering by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in this journal, or brief articles of current interest to mechanical engineers.

Proposed Modified Form of Screw Thread as an International Standard

To the Editor:

Numerous commentaries have been written upon the advantages of standardization of engineering productions for use in this country. Now the theme has grown, until today the topic is International Standardization and the question becomes one involving consideration of manufacture in all countries; also of what changes may be made without disrupting business.

Those versed in screw-thread matters have from time to time expressed themselves regarding the shortcomings of the Sellers or U. S. Standard form of thread, particularly in the finer pitches. Among those that have so expressed themselves are Messrs. L. D. Burlingame, Ellwood Burdsall, E. H. Ehrman, F. O. Wells and E. T. Bysshe. The consensus of opinion has been that the crests and roots of screw threads should be flatted to a greater extent than in the U. S. standard thread.

Suggestions have been made for a thread form flatted more than the U. S. Standard thread which might serve as a basis for an international standardized screw thread. Figs. 1 and 2 show respectively the suggestions of Mr. Burdsall and of Messrs. Bysshe and Ehrman.

The diagrams suggested are basic and do not include such details as crest or root clearance, depth of engagement, etc. They lend themselves well, however, to the application of liberal clearance and tolerance without reducing the depth of engagement below that in some of the existing standard profiles.

Assuming a standard pitch, it appears that the following conditions must be met:

A standard thread profile must be

1 No greater in depth than the shallowest existing thread
2 Equal or greater in depth of engagement than the least depth obtainable in any of the existing threads
3 With crest or root clearance sufficient to provide for tool wear in manufacture, and for service

4 Equal to or better than existing profiles in withstanding mistreatment
5 Such as to permit a latitude in the shape of the tool crest
6 No more difficult of production in respect to tools, gages, or product than in any of the present systems
7 With pitch diameter no less than any existing thread profile
8 With elements of thread profile the same; or if there are differences they must be within the commercial tolerance allowed, if internationalism is to be considered
9 With strength of screw equal to or greater than in prevailing systems.

Having in view these axioms, we must consider the principal systems now in use. There are the U. S. Standard and Whitworth systems, both of which have admitted disadvantages, of which the following are the most prominent:

a U. S. S. Root: This is admitted to be too narrow, especially in the finer pitches, and the truncation triangle too small (1) to secure a stable crest in the tool, or (2) to obtain adequate root clearance in the product.

b Whitworth Crest: The depth of engagement is needlessly reduced by at least 0.9 of the height of the rounded crest.

c Whitworth Crest: The apparent advantage of the rounded crest to withstand marring in handling is offset by the difficulty (1) to accurately produce it in the tool and gage, and in the product; (2) to vary it sufficiently to provide adequate clearance, or even necessary tolerance without reducing the depth of thread bearing in a greater ratio.

d Whitworth Angle: An angle of 55 deg. is more difficult to reproduce than the U. S. S. 60-deg. angle.

e U. S. S. Crest: While this crest may not hold its theoretical shape in the tool as well as does the Whitworth crest, the cause may not be due entirely to profile; in all probability it is due partly to its relative narrowness. On the other hand its production, both in the tool product and the gage, is attained and maintained with much greater facility than is the shape of the Whitworth crest.

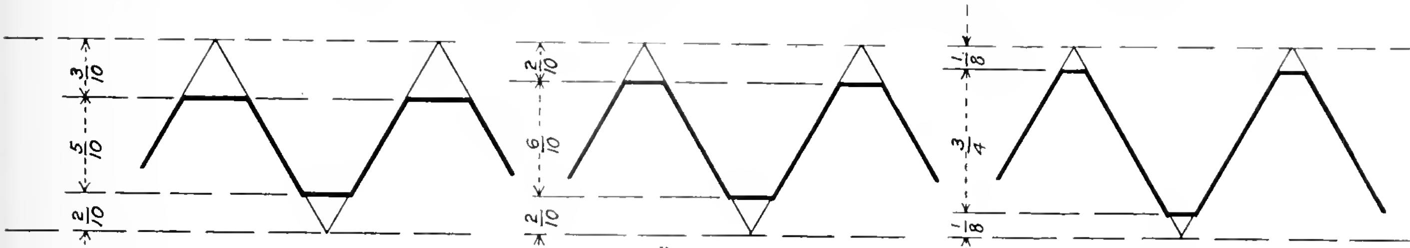


FIG. 1. Suggested by E. Burdsall.

FIG. 2. Suggested by Ernest T. Bysshe and Edwin H Ehrman.

FIG. 3. U.S. Standard. Present.

The modified form of thread suggested by Mr. Burdsall has an increased area of 17, 19 and 24 per cent, respectively, for $\frac{1}{4}$-in., $\frac{3}{8}$-in. and $\frac{1}{2}$-in. bolts, and under test has shown an increased strength at root varying between 11 and 12 per cent. None of these bolts failed by stripping.

The form of screw thread used on the well-known Liberty engine furnishes an excellent example of the possibilities and advantages that are to be gained through a greater truncation than that which obtains in the U. S. Standard thread.

At a meeting of the Gage Committee of the British Engineering Standards Association in September, 1917, a modified form of thread was proposed having the thread truncated slightly at the crest and slightly deepened at the root, the angle of thread and the effective diameter to remain the same. Arrangements were made with a few manufacturers to make sample screws of this modified form of different metals and forward a report.

Owing to the fact that the British manufacturers were then in the stress of high production, a thorough trial was not possible, and the Committee, as a result of the reports received, made the following recommendations:

It was considered undesirable to recommend to the Designs Department the adoption of this flattened form of thread as a compulsory measure, but that tolerance of large amount might be given at crest and root. (See C. L. 4102, British Engineering Standards Association.)

All authorities have agreed that the condition governing the fit of a screw is that the engagement must be as much as possible on the side of the thread, and that the crest and root must clear.

Experience has shown that the sharp "V" thread is impossible to produce because the point of the tool wears so rapidly, producing a screw which will only interchange with difficulty.

The U. S. Standard and Whitworth threads are modifications of the sharp "V" and overcame the low-production manufacturing difficulties of the day now past.

In this communication it has been shown that engineers in widely separated localities have developed independently the same idea, and the feasibility of the features mentioned has been demonstrated by the Liberty engine. Therefore, is it not possible that the proposed modified screw thread contains the fundamental characteristics for modern large-production manufacture and for international agreement?

Great progress in individual standardization of screw threads has been made by the manufacturing countries of the world, but the master mind always considers the future and introduces these questions:

1 Has the best form of screw thread been adopted?
2 When definitely promulgating standards, should other manufacturing countries be considered?
3 After the recent stress of high production, can we complacently look on and consider the science of perfectly manufacturing screws to be thoroughly understood, and further progress impossible?

It seems illogical to suppose that the modern engineer will answer affirmatively to the first and third questions.

The National Screw Thread Commission is about to publish a tentative report, with recommendations on Screw Thread Form, Pitches, Classification and Gaging. This report considers only the form of thread in use in the United States, but since it is but a tentative report, the merits of a modified form of thread may be considered, and the door to international standardization not be closed.

Robt. Lacy,
Lieut. Engrs., U. S. A.

Washington, D. C.

Marine Practice in Valves and Fittings

To the Editor.

Professor Christie's paper in Mechanical Engineering for February, on the state of shipbuilding standards, is particularly opportune, coming at a time when the experiences of manufacturers and shipbuilders alike have pointed out the great hindrance to production occasioned by insufficiently or improperly standardized equipment.

Standards. About three years ago the writer questioned an experienced naval constructor as to why the A. S. M. E. standards in flanges and fittings had never been adopted by the Navy, and was informed that the requirements necessitated the use of stronger materials in order to cut down the weights. This would indicate a tendency to ultra-conservatism among shipbuilders rather than dependence on facts and logic.

The weight of piping in a ship probably never reaches five per

cent of the total weight, and any increase in weight due to the adoption of standard dimensions and materials would be measurable in hundredths of a per cent. A striking example of the need for standards is found in the case of brass and copper tubing. Almost without exception in the trade, brass and copper tubing is made in standard O. D. sizes, yet shipbuilding orders are for the most part specified by I. D. sizes; and the writer has found the use of 12 or 13 different gages on *each size* of tubing between $1\frac{1}{2}$ in. I. D. and 5 in. I. D. Such a condition is not merely uneconomical; it is ridiculous. Many times orders from the same yard differ by one or two thousandths of an inch for the same I. D. sizes, and in many cases the gage is expressed in ten-thousandths. Very likely this last is chiefly due to some conscientious but recent technical graduate. No doubt there is good reason to save money on this expensive material by keeping down thickness, but certainly three to four gages in each size would entirely cover the requirements, especially since the stresses involved in piping under temperature variations are so nearly indeterminate. Most of the failures in piping have been due, not to bursting stress, but to abuse in erection, water hammer, and insufficient provision for expansion.

The objections to copper piping are the expense, both for material and fabrication; low tensile strength; and unsuitability for superheat. Steel piping meets these requirements much better, the sole objection to it being possibility of quicker corrosion. The corrosion from the steam side is of no more importance than in land practice, however, and the exterior corrosion, as Professor Christie suggests, should be cared for by suitable painting. Properly covered pipe should be safe from external corrosion, provided the covering is kept unbroken (particularly around joints) and well painted. The covering presents a considerable resistance to the flow of salt water along the outside of the pipe, and if the pipe has a fairly high temperature there is little or no danger of any liquid ever reaching the pipe itself, as at the slow rate of absorption the liquid is evaporated before it can reach the metal.

Expansion. More reliable provision for expansion can be made in a material of high elastic limit like steel than in copper, as indicated by experience with corrugated copper expansion joints of multiple bellows type.

These joints have not been treated as *springs*. They are deformed by the movement beyond the elastic limit, and dependence is placed on the ductility of the material to withstand such heroic treatment. This statement can be readily proved by compressing a copper joint to its full rated capacity; it will not return to the original face-to-face dimensions.

The consequence of this has been that the weakest convolution takes most of the bending, resulting in a fracture. This condition has been partly avoided and the life of the joint increased by adding spacing rings inside and outside the corrugations, limiting the movement of any individual corrugation, and more or less equalizing the deformations. If this type of joint were made of steel and treated as a spring, with no deformation exceeding the elastic limit, no trouble should be experienced. The success of this joint has been successfully proven by an English company manufacturing corrugated-steel barrels, which has brought out a perfectly satisfactory steel joint without spaces. An Australian (Beiliez) company has also developed a process for making corrugated pipe either in straight lengths or bends, which has from 15 to 20 times the flexibility of uncorrugated bends. We therefore have available suitable means for taking care of expansion without resorting to packed expansion joints of the slip type.

Piping. The enormous and successful use in land practice of the lap or Van Stone joint, and also of the welded header-and-line joint casts a doubt upon the wisdom of excluding them from marine work.

No tests have been published showing any well-grounded reason why these devices cannot be successfully used for marine work. One of the particularly advantageous features of the lap joint for marine work is the loose flange and consequent ease of alignment of bolt holes.

The tendency in land practice is to increase the use of welded work, and the writer has expressed the opinion that for extreme pressures and temperatures welding should be universal.

Valves and Fittings. The writer believes in strict specifications for the material for high-pressure steam valves. Cast steel should be used for all high-pressure steam work; the use of semi-steel is unsafe, as the mixtures are unreliable. It would be better to encourage the development of a cheaper steel casting than this hybrid material of uncertain characteristics.

The writer's practice on high-pressure work is to use flanged joints on everything of 3 in. and over; on low-pressure work (except for drainage piping under very light pressure) flanged joints on 4 in. and over. No trouble has been experienced with the smaller screwed work.

The use of gate valves should by all means be encouraged; for all line purposes they are as tight as globe valves and of course much reduce friction loss. For throttles and stop valves the globe or angle type will necessarily be retained.

Flanges. The writer does not feel that the revival of six-hole flanges in the small sizes noted by Professor Christie is either necessary or desirable. The stresses involved for all sizes under the A. S. M. E. standards were figured from the same basis; consequently there is no excuse for a change on that ground. But the six-hole flange permits of only two positions of a standard drilled fitting, whereas the four-hole drilling permits of four. This is of very considerable value if field or special drilling is to be avoided.

Another desirable consideration in favor of the purchase of standard accessories such as reducing valves and relief valves, is that the makers of these devices are doing nothing else, and are selling the goods on their merits. The designs are therefore more likely to be satisfactory than where produced by marine designers to whom they are only an occasional undertaking.

The lavish use of brass and copper pipe could probably be much reduced without any decrease in reliability. For instance, brass pipe is now much less used for boiler-feed lines, except for the short section between the feed-regulating valve and the boiler drum.

Another cause which enormously restricted the output of the tube mills was the requirements for condenser tubes. The Government and consequently the shipyards maintained for over two years three inspection tests of such tubes that were incompatible, and in fact that forced the manufacturers to make a tube that was not desirable. The three tests were the hammer, pin and compression tests. The hammer test (crushing the tube flat to three times gage overall) and the pin test (expanding $16\frac{2}{3}$ per cent in diameter) would be satisfactory if a soft tube were furnished. But the compression test (loading with definite weights across the tube and limiting the permanent set) requires a hard tube which in view of the season certain to occur is very undesirable. The reason for its adoption was ostensibly to guard against crushing by packing too tightly with the corset lacing.

As a matter of fact, a hard tube can be crushed by abuse in packing as well as a soft tube, and further, corset lacing was abandoned years ago by up-to-date power-plant operators for fiber ferrules, which are a better material and with which it is difficult to crush any tube. The hard tube is certain to cause trouble if expanded into the tube sheets (as in the destroyers), yet it required two years' effort to get the compression-test limits raised from 0.005 to 0.020. With regard to both condenser tube and all other brass and copper tube the Society would confer a lasting benefit, increase tube capacity, and decrease cost, by standardizing the sizes and specifications.

R. J. S. Pigott.

Bridgeport, Conn.

We are advised by Dr. William Paul Gerhard that in the Annual Report of the Library Board, published in the February 1919 issue of Mechanical Engineering, p. 183, an error has been made in stating that the collection of books on gas engineering was presented by him to the American Gas Institute. Dr. Gerhard states that these books were originally donated by him to the Illuminating Engineering Society, and transferred to the Library by that society, with his approval.

ENGINEERING SURVEY

A Review of Progress and Attainment in Mechanical Engineering and Related Fields, as Gathered from Current Technical Periodicals and Other Sources

AERONAUTICS

The Aeroplane in Curvilinear Flight (*Schaerer. Aero. Club Bulletin*, Nos. 8 and 9). The article describes an investigation into the attitude taken up by an aeroplane in curvilinear flight. It is admittedly only a very approximate method, assumptions being made in order to simplify the mathematics. When an aeroplane turns, it banks, and if the banking is excessive the machine sideslips inward, the opposite being the case if the angle bank β is not large enough. First of all the author examines the relation between β and other quantities, defining the machine and the motion.

If ρ be the radius of curvature of the path and V the velocity, then the angle of bank β is given by $\tan \beta = V^2/\rho g$, assuming the sine law for the resistance of the planes.

A few remarks are made on the gyroscopic effect of the airscrew either in assisting or opposing the banking movement, together with a consideration of the difference in the lifts on the two wings due to the circular motion.

The effect of the angle of the rudder is next examined, and an expression is derived for the radius of curvature of the path. If F_s be the area of the rudder, and a the initial value $(t = 0)$ of the angle through which the rudder is turned, then the component forces acting on the rudder parallel and perpendicular to the longitudinal axis of the machine are respectively—

$$R_s = v^2 F_s \sin^2 a \, \psi \gamma / g$$
$$A_s = v^2 F_s \sin a \cos a \, \psi \gamma / g$$

γ = the density of the air and ψ is a constant coefficient. The latter force produces a moment about the vertical axis through the center of gravity and if the average be l, M can be written in the form

$$M = C \sin 2a$$

C being assumed constant and equal to $\psi \gamma l v^2 F_s / 2g$, and the moment produced by R_s neglected in comparison with M. Further neglecting the opposing moments due to difference of the relative speeds of the outer and inner wings, the equation

$$\frac{d^2 \phi}{dt^2} = \frac{C \sin 2a}{J}$$

is obtained, where ϕ is the angle between the original rectilinear flight path and the axis of the machine at time t, and J the moment of inertia about the vertical axis through the center of gravity.

On the integration this gives the angular velocity

$$w = \frac{C \sin 2a}{J} t$$

and the angular displacement $\phi = \dfrac{C \sin 2at^2}{2J}$ and since $\phi = vt/\rho$,

$$\rho = 2vJ / C \sin 2at$$

In actual flying the banking of the machine due to difference in the speed of inner and outer wings will cause the machine to "take the curve" and the centrifugal force will balance the lateral force so as to do away with sideslipping.

It is admitted that the above formula for ρ is only a rough approximation, assuming as it does the constancy of a and v. At large values of β, M is usually small; for the extreme case $\beta = 90$ deg., it vanishes. J also ceases to be a principal moment of inertia for values of β other than 0 deg. or 90 deg. Still it is claimed that the approximation is good for the values of β up to about 25 deg. Further,

$$\tan \beta = \frac{v^3 F_s l \sin 2a}{4gJ}$$

Finally a few calculated values of β are given for $a = 5$ deg. and 10 deg. and for values of t varying between $t = 1$ and 20 sec., and the personal element introduced into the control of the machine is discussed. (*Technical Supplement to the Review of the Foreign Press*, London, vol. 3, no. 1, Jan. 7, 1919, no. 3838, p. 22)

Douglas Automatic Aeroplane Ignition Interrupter. The Douglas interrupter was primarily developed for military planes but it may find application also in peaceful aeronautics.

In the event of the propeller's breaking there results a seriously unbalanced condition of the plane. In a tractor plane the tendency is to go into a dive and in a pusher plane to go into a tail stall, and either type of machine is apt to pass into a spin as a result of the unbroken propeller blade tending to swing the machine around a neutral point between the center of pressure of the unbroken blade and the center of torque.

In addition to this the unbalance of the power plant itself due to the unequal torque is apt to break a gasoline line and cause fire.

The operator cannot always be relied upon to cut off the power quickly enough, since the time interval per revolution for aeroplane engines at full throttle varies from 1/23 to 1/27 of a second and conditions may get beyond repair long before the aviator realizes what is wrong with the plane.

The interrupter acts automatically and through practically instantaneous action cuts off the power, thereby confining the danger to the initial breakage, which is seldom serious in itself, provided it is not followed by unbalanced power development. Such an interrupter is probably particularly valuable in the case of twin-engined planes, as such an accident happening to one engine would cause the good engine to suddenly swing the machine around and probably into a spin.

It may be added that, from this point of view, the interrupter practically plays the part of the self-locking differential as preventing the skid of an automobile on a slippery pavement, though acting in an entirely different manner mechanically.

The instrument is very simple and may be briefly described as consisting of a suitably pivoted metal bar so mounted as to swing in a plane transverse to the axis of rotation of the propeller.

Under normal operating conditions the free movement of this bar is confined to a very limited arc in its plane of movement by means of tension springs. The amplitude of this movement is determined by the weight of the bar, the intensity and frequency of the transverse vibrations of the engine and the opposing strength of the springs confining it. An intense oscillating shock trans-

verse to the engine such as an unbalanced engine propeller torque reaction resulting from the breaking of a propeller at speed or similar causes will force the bar to swing through its full amplitude, raise a trigger usually held by a compression spring and in this way interrupt the ignition through grounding the magnetos.

On the other hand, there is a compression spring—in itself presenting an unbalanced force—which is designed to prevent the bar from disengaging the ignition latch as a result of cylinder misses coinciding with bad vibration periods of the engine, lateral shocks to which the plane may be subjected at landing, etc. In this way the interrupter automatically differentiates between harmless vibrations and intense oscillating shocks transverse to the axis of the engine which may cause a dangerous state of dynamic unbalance.

It was feared at first that the presence of this instrument would be apt to complicate ignition, particularly so on the Liberty engine where the double distributor system is used. Actually, however, it has been found that no trouble results from its installation.

Two types of interrupters have been developed; one of the Mecca type for magneto ignition, and the other of the breaker type for battery-generator engines, such as the Liberty. (*Aerial Age Weekly*, vol. 8, no. 23, February 17, 1919, pp. 1121 and 1141, 4 figs., *d*)

Italian Aircraft Engine as Redesigned in U. S. A.

THE KING-BUGATTI AVIATION MOTOR, G. Douglas Wardrop, Mem.Am.Soc.M.E. An interesting feature of this motor is that it represents practically a foursome assembly. There are four carburetors, each supplying one block of four cylinders and likewise four magnetos, two on each side of the engine (Fig. 3).

The carburetors are specially designed Miller, feeding through separate water-jacketed manifolds. They are set low so that gravity feed may be used and all four are identical, there being no rights or lefts.

Fig. 1 shows the carburetor assembly, which apparently does not very materially differ from the ordinary Miller carburetor.

The throttle valve is of the barrel type; the axes of all valves being parallel with the center line of the engine, the two carburetors on each side of the engine being operated by one shaft which is connected with the valves at each end through adjustable couplings. The shafts on the two sides of the engine are connected so that all four valves move in unison, the valve openings being synchronized by means of adjustable couplings.

From the float chamber which is controlled in the usual manner the gasoline enters the jet holder in which there are seven jets with drill sizes from No. 76 for idling to Nos. 76, 75, 71, 68, 57 and 53. These jets progressively come into action as the throttle is opened, thus gradually giving an increasing supply of gasoline.

Gasoline is drawn into the jet through the small hole in the bottom of the threaded end, mixing with a certain amount of air sucked in through the four holes drilled in the barrel of the jet just above the threaded portion. This air is taken from the outside through the upper 3/16-in. hole in jet holder and passes down around the outside of the jet to the four holes mentioned above. The major portion of the air enters the carburetor through the lower end of the venturi, which is 3 in. in diameter, passes up around the jet bar holder, combining above this with the rich mixture from the jets to form the proper mixture for combustion.

Assembly of the altitude valve is shown on drawing (Fig. 2). This valve operates by turning the lever which is attached to the altitude-control valve. This valve has two openings in its seat which when in the open position register with two similar openings in the stationary cover, thus making two free passages to the outer air, the size of these passages being governed by the position of the lever.

There are four outlets (Fig. 2), one of which connects to each of the four elbows, opening directly into the top of the float chamber. The float chamber is always in direct connection with the venturi through a 5/64-in. drilled hole opening into the venturi about 1/4-in. above the jet holder and into the float chamber well above the gasoline level. Opening the altitude-control valve decreases the vacuum thus increasing the flow of gasoline through the jets.

Oiling is by pressure feed and spray. There is one pressure and one scavenging pump, both of the rotary-gear type. These are located at the front of the engine, driven directly from the crankshaft through a pin and slotted coupling, Figs. 4 and 5. This coupling is squared to the pump shaft but is not pinned, thus relieving the shaft of any end driving pressure. The gears in both pumps are the same except that the scavenging pump gears have a wider face. The oil is forced into the pressure line running the entire length of the crankcase. An adjustable pressure-regulating valve is located in the crankcase front-gear cover, generally set so that the pressure gage which is connected to the rear end of the main oil line in the crankcase registers about 30 lb.

This valve has holes drilled through the head so that there is always a certain amount of oil discharged on to the gears.

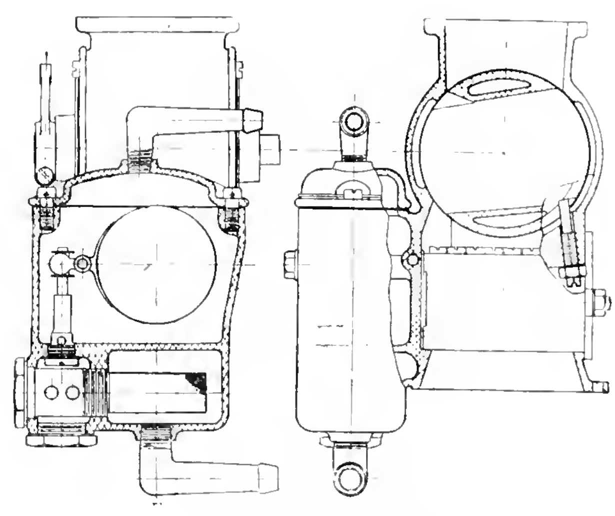


FIG. 1 CARBURETOR ASSEMBLY

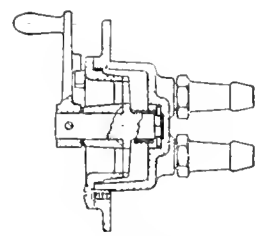


FIG. 2 ALTITUDE-CONTROL-VALVE ASSEMBLY

Cooling water is circulated through the engine by means of a centrifugal pump, see Fig. 6, driven from the rear end of the left-hand crankshaft by a pin and coupling the same as used on the oil pump.

The cooling system from the pump inlet to the outlet elbows on the front cylinders holds $4\frac{1}{4}$ gal. of water.

The pump impeller is $5\frac{1}{8}$ in. in diameter with eight vanes, the web being drilled with eight 3/8-in. holes on a circle of 2 in. diameter to equalize the water pressure.

The pump shaft is packed with a graphite-asbestos rope packing, automatically held together under compression by a coiled spring acting on the gland.

The pump shaft is hollow, the rear end being in direct communication with the water in the pump case. Water entering the shaft is pumped out to the shaft rear-bearing surface through a 1/8-in. hole. Any leakage of water past the asbestos packing is drained outside of the crankcase through a 5/8-in. cored hole in the water-pump body. The front bearing on the pump shaft is lubricating by spray from the crankcase which collects on the shaft-bushing support and drains down into a 1/8-in. hole leading

to the bearing. Any oil leakage from the front end of this bearing returns to the pump, and slight leakage from the rear end of the bearing is drained outside of the crankcase with the water leakage from the rear bearing.

There is one water inlet to the pump $2\frac{1}{4}$ in. in inside diameter while the single outlet is $2\frac{3}{16}$ in. in diameter. Water from the pump is forced up into an aluminum pipe with one branch leading to the rear end of each of the rear cylinder blocks, water entering the cylinders at the top of the water jacket on the exhaust side. A certain amount of the water circulates through the inlet manifold jacket, the remaining filling the cylinder water-jacket space.

Cylinder blocks are cast with integral water jackets, except the sides below the inlet and exhaust ports, which are covered by an aluminum water-jacket plate held in position by screws.

The construction of the water passages in the head of the cylinder is such that the valve stems and exhaust passages are very thoroughly cooled.

All four cylinder blocks are identical, the water passing from the rear to the front cylinder blocks through openings similar to the inlet opening, leaving the front blocks through another similar opening.

The crankshaft is made in two pieces connected at the center by a taper and key drawn up with a nut. Each section of the shaft forms a four-cylinder shaft with the throws all in one plane, the throws of the two sections being assembled at right angles. In assembling the rear end of the front half is immersed in boiling water the tapering end of the rear section which is cold is then slipped into position and the parts drawn together by the nut, using a long-handled wrench. The rear end of each complete shaft has clutch teeth cut on it for attaching the starter. All bearings including the connecting-rod bearings, with the exception of the center main bearings, are undercut. This results in a total shortening of the shaft of approximately 4 31/32 in. This results in a considerable saving in the weight of various parts, while still allowing ample bearing surface. The crankshaft main bearings are bronze bushings babbitt-lined. They are not relieved at the parting line and in the majority of them there are no oil grooves at all.

Contrary to the system used in the Liberty engine, the cylinders are of iron cast in blocks of four. The water jacket is cast integral, with the exception of the sides of the cylinder block below the inlet and exhaust ports, which are covered with the cast aluminum plate attached with screws. The cylinders are bolted directly to the top of the crankcase without the use of a gasket, but a gasket is used between the water-jacket aluminum plates and the cylinder. Provision is made for a liberal circulation of water in the neighborhood of the valve ports, seats and guides. The spark plugs, of which there are two per cylinder, are located at the side of the combustion chamber in close proximity to the

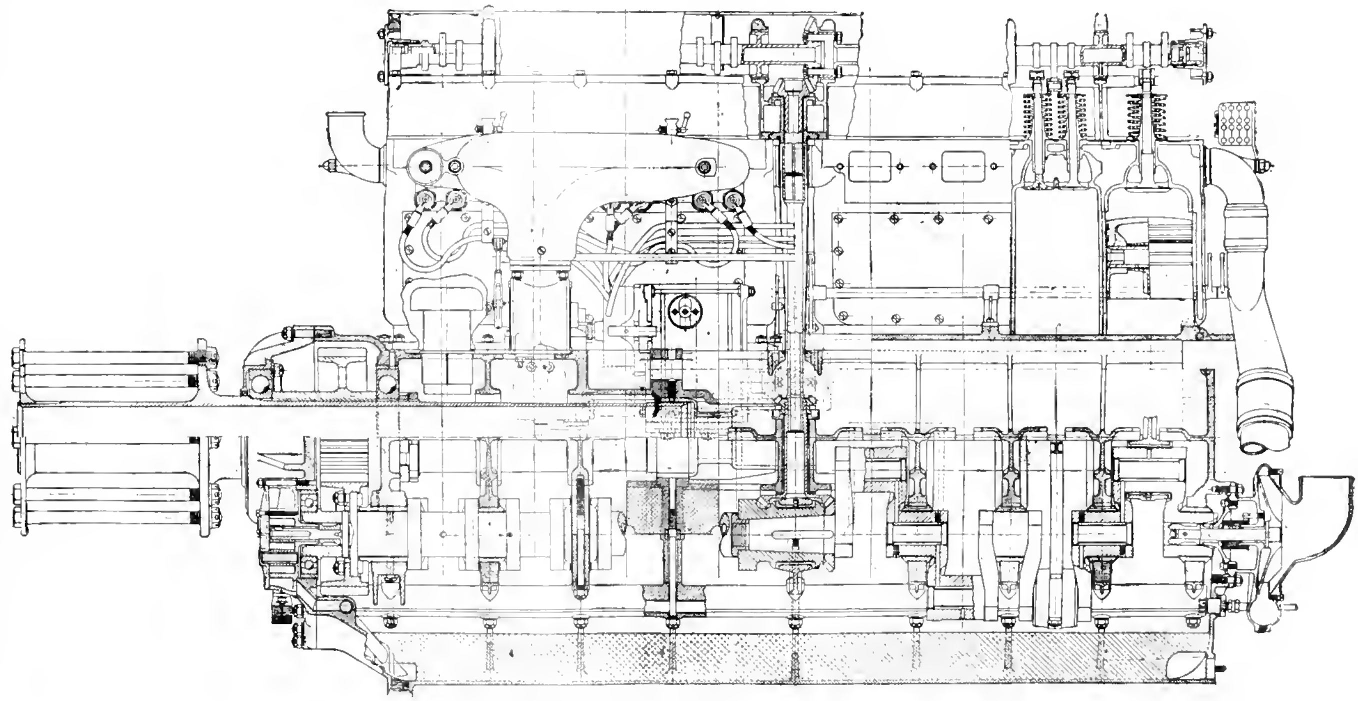


Fig. 3 The 410-h.p. King-Bugatti Engine, Longitudinal Section

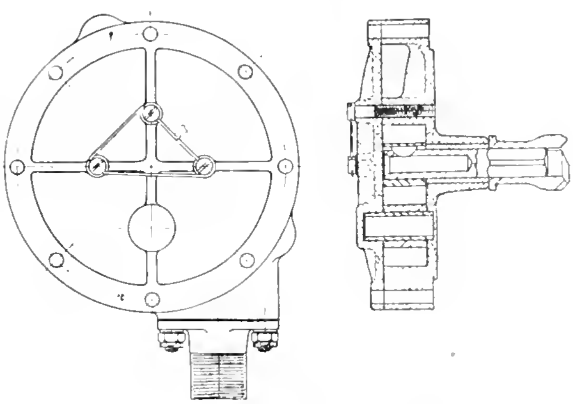


Fig. 4 Oil-Pressure-Pump Assembly

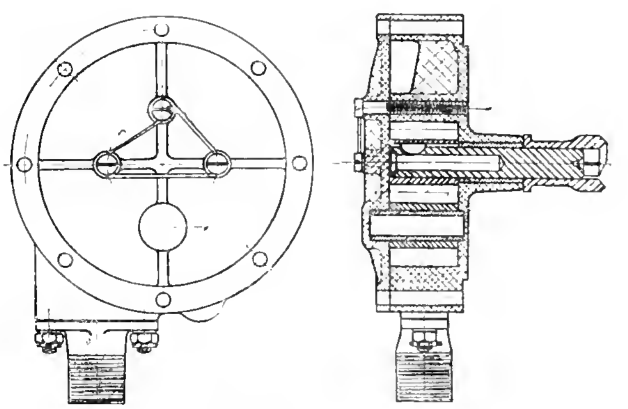


Fig. 5 Oil-Suction-Pump Assembly

inlet valves and are well cooled by the circulating water. (*Aerial Age Weekly*, vol. 8, no. 22 and 23, Feb. 10 and 17, 1919, 51 figs., *d.t*)

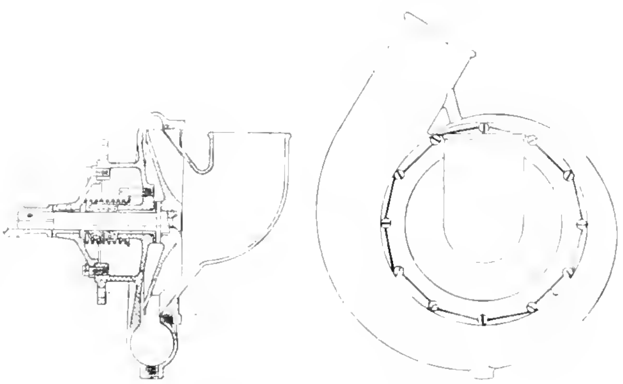


FIG. 6 WATER-PUMP ASSEMBLY

CEMENT AND CONCRETE

INFLUENCE OF VIBRATION UPON CONCRETE (*Deutsche Bauzeitung*, Sept. 28, 1918). In concrete construction it is generally believed that vibration during the period of setting has a bad effect, so that it must be prevented as much as possible. On the other hand, tests made by von Bach in 1905 on the frictional resistance of iron reinforcement in concrete showed that this was increased by vibration during setting and varied inversely with the quantity of water present in the concrete mass.

The German Committee for Reinforced Concrete decided to make further tests to verify von Bach's results, and the figures are set forth in a pamphlet of 88 pages, with 33 tables and numerous photographs of fractured test beams. The vibration or shaking is divided into three classes, which are described in detail. The test beams of a transverse section 20 cm. by 30 cm. were laid across supports 2 m. apart. They were made of concrete composed of 1 part cement to 4 parts of gravelly sand, or 1 part cement, 2 of sand, and 2 of syenite broken fine and reinforced with iron rods of 16 mm. section. Both kinds of concrete were used in three degrees of dampness. Fluid concrete is more sensitive to vibration than concrete with less water. The precise figures for surface friction in the iron are not given. (*Technical Supplement to the Review of the Foreign Press*, London, vol. 2, no. 13, Dec. 24, 1918, no. 3619, p. 364)

GAS PRODUCERS (See Mechanical Processes)

HYDRAULIC MACHINERY

A New Type of Water-Turbine Governor

WATER TURBINE AT THE HYDROELECTRIC PLANT AT KUBEL, SWITZERLAND. Description of a new turbine and governor installed at a Swiss hydroelectric plant by the Escher-Wyss Company.

This turbine was installed in 1915 and is rated at 2500 hp. at a speed of 500 r.p.m. The turbine presents several interesting innovations both on the hydraulic and the electric end. Thus, the alternator bed has to support only the weight of the shaft end and the rotor, but does not have to take care of any load coming from the turbine itself, as the axial thrust is hydraulically balanced by means of a special device. This balancing is produced by the pressure of the water circulating in two annular passages located on each side of the runner. To make this possible, the runner has its two faces carefully ground and so arranged that there is an interval of a few tenths of a millimeter between the runner faces and the corresponding surfaces of the side bracket on one side, and the discharge pipe on the other side. If the runner should shift from its central position the pressure, because of the change in volume of the interval, will rise in one of these annular passages, while it will fall off in the other, and this will tend to bring the runner back into its central position.

The most interesting feature in the installation is the new type of Escher-Wyss governor. Its general construction is shown diagrammatically in Fig. 8, and its essential characteristic lies in the fact that the interruption in the governing movement is as a rule produced just at about the same time when it is necessary.

The double servomotor (2-3) is located in the casing (1), which also serves as an oil reservoir. The movements of the double piston are transmitted by a special articulated lever (4) to the governor shaft (5), which, in its turn, operates the governing organs of the turbine. The distribution of pressure on both sides of the servomotor is effected by means of the valve (7-7*a*) also located in the casing, while the gear pump thus forces by the passage (30) oil under pressure to the centrally located chamber (31) of the governor valve. The same chamber (31) has connected to it the safety valve (8) loaded by means of a spring which regulates the maximum pressure of the oil in the governor. The chambers (32 and 32*a*) respectively located above and below the governor valve provide a means of escape to the oil and are directly connected to the reservoir (1), while the central chambers (33 and 34) are connected by passages (33*a* and 34*a*) to the respective cylinders (3 and 2) of the servomotor, in addition to which these two sides of the servomotor can be placed into communication by means of a valve (9). The edges of the governor valve as well as the distribution valve (7 and 7*a*) have only a very small amount of play when the governing mechanism is in its neutral position and the pump works then at only very low pressure, but this pressure automatically rises when governing becomes necessary so as to overcome the resistance of the servomotor.

The stem of the distribution valve has two collars (12*a*) the purpose of which is to limit its movements, and the distribution valve itself acts through two double levers (11 and 11*a*) between which is located the dashpot (18). This action does not occur directly by means of the centrifugal pendulum (13), but is effected through a device called pre-command, the construction of which has been described on other occasions. This pre-command device is embodied into the upper part of the centrifugal pendulum and, among other things, comprises a differential piston (35). The spring pendulum operates solely the spindle (14), which, turning with the pendulum, makes an integral part therein and influences the distribution of pressure in the differential piston.

A special arrangement is described for very large governors. The operation of the governor during the process of speed regulation is as follows: As soon as the speed of the turbine and that of the spring pendulum (13) rises above the normal value the spindle (14) is raised and the opening in the diaphragm (37) closes so that the whole pressure is applied under the piston (35).

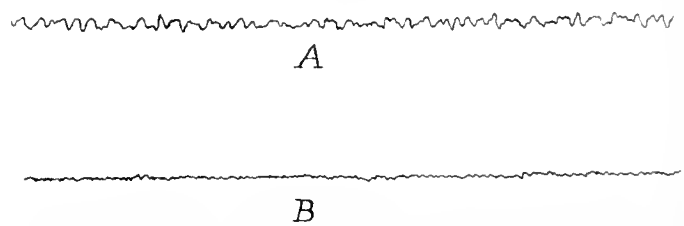


FIG. 7 TACHOGRAMS WITH THE OLDER TYPE OF ESCHER-WYSS GOVERNOR (A) AND THE NEW GOVERNOR (B) OF THE SAME COMPANY

This piston follows the movement of spindle (14) and raises the operating lever (11), which then instantaneously turns around point (19).

The casing of dashpot (18) is then carried away by the larger spring inside of it and the operating piston (7) is also raised by the casing (18). Since the entire travel of the piston is very slight, a short movement of the spindle (14), that is, a very small change in the number of revolutions, is sufficient to displace over its entire path the piston of the distributing valve and thus communicate the greatest possible speed to the servomotor.

When the piston (7) is in its upper position, this on one hand produces communication between cylinder (2) of the servomotor and the oil pump, and on the other hand opens the connection between cylinder (3) and the outlet passages, which results in a

movement from left to right and produces the closing of the double piston of the servomotor. During this process of governing the number of revolutions of the turbine per unit of time will rise until the servomotor has attained a position corresponding to the new load. During this time the piston (7) preserves its highest position and the cylinder of the dashpot cannot, of course, move any further. Nevertheless, under the influence of the continuing increase in speed the spindle (14) continues to rise together with the pre-command piston (35) and lever (11). As a result the piston enclosed in the dashpot (18) is displaced upward and compresses the upper spring still more. But as soon as the speed of the spring pendulum decreases to such an extent that the spindle (14) and hence the pre-command piston (35) begin to fall down, the cylinder dashpot (18) instantly joins its piston because of the oil contained therein. This new position is shown in Fig. 8 at the top and to the right. Because of this the piston of the distributor valve (7) is instantly brought to its middle position and the movement of closing is interrupted, which always happens immediately after the peak of the speed curve is exceeded or at the moment when the position of the servomotor corresponds to the new load. Then, under the influence of the larger spring on the dashpot, the easing of this latter is gradually brought to its middle position and the proper velocity corresponding to the new load is established.

On the other hand, if the speed of the turbine falls below its normal value because of the overload, the same operations take place in an inverse order. In both cases the auxiliary mechanism (16) operates in the usual manner and may be adjusted for either positive or negative effect and for isochronous regulation. The most usual system in the case of turbines driving three-phase generators is to give the auxiliary mechanism a slightly positive action corresponding to only a part of the pendulum motion, while the other part of this motion is likewise used but for varying the speed.

In order to increase the sensitiveness of the apparatus, the pendulum used runs at a very high speed and its inertia masses are reduced to the strictest minimum. Further, the hydraulic pilot piston (35) is located in the immediate vicinity of the pendulum which leads to complete suppression of disturbing oscillations. It is claimed as a further advantage of the new governor that all of its rotating parts are located inside of a casing which prevents projection of oil outside; also, the oil reservoir is completely enclosed and is thereby protected from access of impurities.

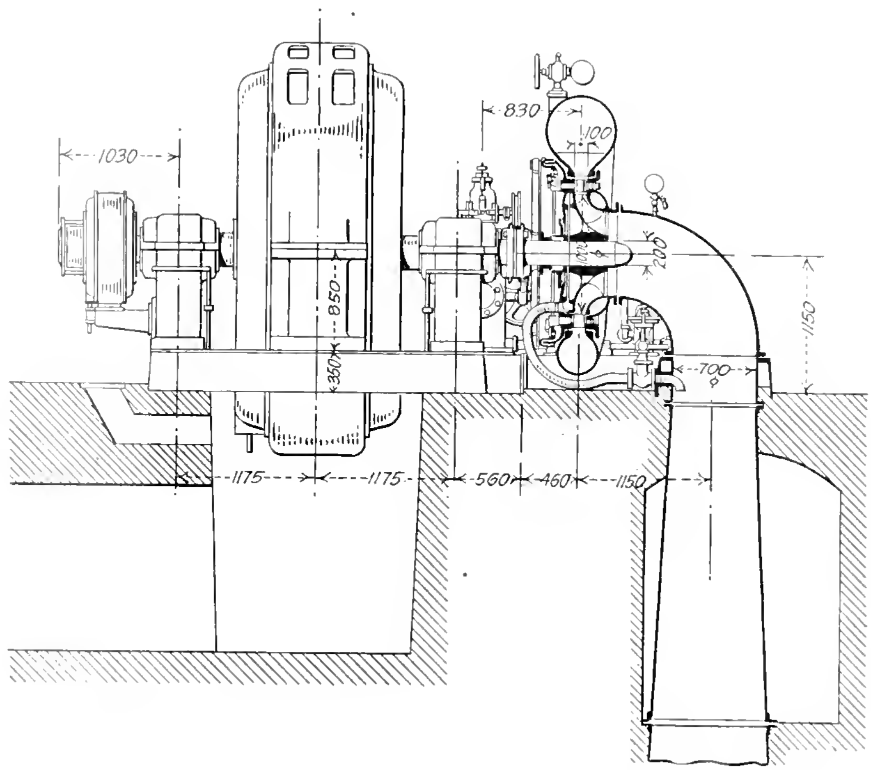


Fig 9 Axial Section of the Swiss Hydraulic Turbine at Kubel

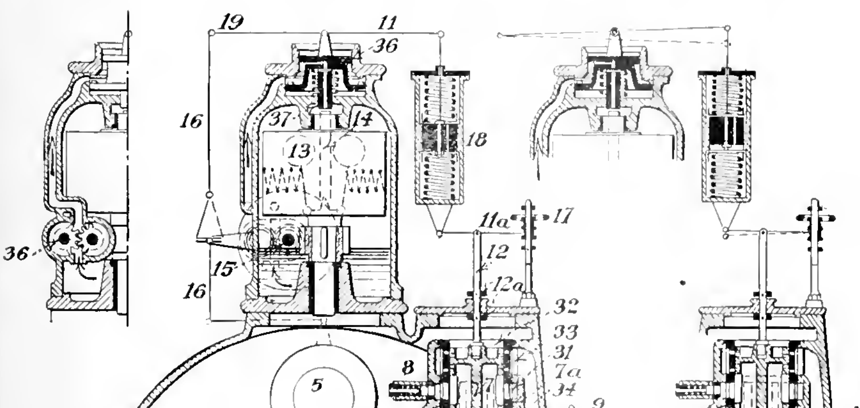


Fig 8 Section and Details of the New Governor on the Kubel Hydraulic Turbine

Acceptance tests were carried out in October 1916 and are claimed to have given excellent results. Of particular interest are tachograms taken; the first (A) on six turbines equipped with the old-style governors, and the second (B) on six other machines equipped with the new governor. A glance at the two curves indicates the great improvement made by the use of the new apparatus (Fig. 7). (La nouvelle turbine de 2500 ch de l'usine hydro-electrique de Kubel près Saint-Gall (Suisse), P. V. *Revue Générale de l'Electricité*, vol. 5, no. 1, Jan. 4, 1919, pp. 19-25, 9 figs., *dA*)

INTERNAL-COMBUSTION ENGINEERING (See also Aeronautics)

The High-Compression Oil Engine, W. G. Gernandt. Comparative discussion of high-compression oil engines of various cycles, covering the four-stroke constant-volume or Otto engine, the Diesel or high-compression engine, the Hvid engine, the McClintock and the Gernandt engines. The writer gives in each case a brief summary of what he considers the advantages and disadvantages of each cycle.

In the Gernandt engine the fuel is injected into the combustion chamber by supercompressing a portion of the products of combustion which have been trapped at the time the pressure in the cylinder has attained its maximum. Mechanically this can be accomplished in various ways, depending on the general design of the engine, and the trapping chamber may be actually sealed by the use of valves between the supercompressing means and the combustion chamber, or be in direct communication with the combustion chamber through very small injector holes.

The injection itself takes place as follows: Taking the case of a four-cycle engine the fuel is deposited during the suction stroke in a small chamber between the combustion chamber and the supercompressing means. This fuel is metered and passed through a mechanically timed valve. During the compression stroke the fuel attains the necessary temperature and the pressure rises in the fuel chamber. When the piston reaches its upper dead center the products of combustion previously trapped are supercompressed mechanically and forced through the fuel chamber and into the combustion chamber. (This sentence is repeated verbatim from the original article. From it, it would appear that combustion takes place previous to supercompression.)

It is claimed that, contrary to what occurs in the Diesel engine, the injection gas is highly heated and refrigeration has been practically eliminated, the amount of fuel necessary for injection being so small that the burning effect has not been impaired. Also there is no burning of the fuel until it is actually injected into the combustion chamber.

It is claimed that actual tests on this method of injection have shown promising results. No data of tests are, however, reported in the original article, except in answer to some questions during discussions. From these it appears that the engine which gave promising results is a 4-in. by 6-in. single-cylinder stationary engine in which the speed ranges from 200 to 860 r.p.m. No data as to horsepower developed are given. The compression is about 450 to 500 lb., depending upon the fuel used. The control of the engine is entirely by the amount of fuel burned. The needle valve regulates the quantity of fuel. Runs have been made at speeds as low as 200 r.p.m.

No data are given as to the amount of power developed at the various speeds. (*Journal of the Society of Automotive Engineers*, vol. 4, no. 2, February 1919, pp. 112-118. 3 figs., *cd*)

MACHINE DESIGN

INVENTION IN SMALL MECHANISM (*Technique Moderne*, October 1918). The small mechanism to which the present article alludes is that of a size most commonly used in watchmaking, etc.

It is not sufficient to have a knowledge of kinematics and forms of mechanisms to be able to design machines. It is necessary, first, to be familiar with the characteristics of small mechanism, then to know how to state a practical problem for solution, so as to be able to unite the experimental data which are concerned and to think out tests on apparatus which are the embryos of the machines to be built.

The choice and the design of cams play the principal share in this second part of the realization of an industrial invention: they are governed by simple rules that are ignored by too many inventors, whereas if these rules are followed the efficiency of the machine can often be increased.

The author treats the subject in considerable detail over eight pages of the journal. The first portion deals with the general problem; this is followed by a section dealing with the classification of types of cams and study of motions caused by cams and rollers. Section 3 discusses the stages of a mechanical invention, and, finally, the author illustrates his idea by describing a complicated machine for making the paper tubes for cigarettes. The object is to show that there are rules and methods of procedure which should be followed in the process of mechanical invention, and that if they are carefully followed far better results will be attained than if mere rule-of-thumb methods and random experiments are made. The author, Mr. Emile Belot, has successfully designed a large number of machines for industrial purposes. (*Technical Supplement to the Review of the Foreign Press*, London, vol. 3, no. 1, Jan. 7, 1919, no. 3750, p. 8)

MACHINE SHOP

BOILING TANKS IN LOCOMOTIVE WORKSHOPS (*Organ für die Fortschritte des Eisenbahnwesens*, Oct. 1, 1918). In the locomotive repair shops at Karlsruhe steam-heated boiling tanks have been installed, in which the parts of locomotives and vehicles are cleaned before they are repaired. The tanks are large enough to receive the bogie frames, and the installation comprises the boiling tank containing the washing fluid; the rinsing tank, in which the boiled articles are treated with cold water; a tank in which the washing fluid is cleaned for use again; and an overhead crane. In one installation the washing fluid is heated by the admission of steam through nozzles, and in the other it is heated by steam coils. The advantages and disadvantages of the two systems are discussed in the article. The working drawings to scale are reproduced in plates, which are bound up with the journal.

The washing fluid consists of 100 grams of 80 per cent caustic soda to 1 liter of water, the whole kept at a temperature of 80 deg. to 90 deg. cent. The use of steam boiling nozzles is not recommended, as the solution is gradually weakened; heating by steam pipes is much better, but the water must be kept stirred. The fluid is pumped out of the boiling tank and lifted to the storage tank at high level by a centrifugal pump, the suction pipes inside the boiling tank having nozzles pointing upward. The stirring of the boiling liquid is now effected by means of a jet of air under pressure. Complete bogie frames can be thoroughly cleaned in 50 to 70 min., and the air jet is only required for the last 15 min. The cost of steam is the most important factor. The boiling tank is 7 m. long by 3.213 m. wide by 1.500 m. deep, and the author gives calculations for the consumption required. Most of the dirt falls to the bottom of the boiling tank, and the proposed filtering apparatus in the high-level tank is not yet perfected. With the large new apparatus it is found that a saving in cost of cleaning of 40 per cent is effected, as against the former system, in which small tanks and steam nozzles were employed, and the cleansing is far more thoroughly done. (*Technical Supplement to the Review of the Foreign Press*, London, vol. 3, no. 2, Jan. 21, 1919, no. 3839, p. 39)

THE EFFECT OF TEMPERING ON WATER-QUENCHED GAGES. The following information has been supplied by Automatic and Electric Furnaces, Ltd., 6, Old Queenstreet, London, S. W.:

Two gages of $\frac{3}{4}$ in. diameter, 12 threads per inch, were heated in a Wild-Barfield furnace, using the pyroscopic detector, and were quenched in cold water. They were subsequently tempered in a salt bath at various increasing temperatures, the effective diameter of each thread and the scleroscope hardness being measured at each stage. The figures are in 10,000ths of an inch, and indicate the change + or — with reference to the original effective diameter of the gages. The results for the two gages have been averaged (Table 1).

TABLE 1

Thread	After quenching	Tempering Temperature, Deg. Cent.					
		220	260	300	340	380	420
1	+25	+19	+17	+15	+13	+11	+11
2	+18	+12	+11	+ 9	+ 6	+ 5	+ 5
3	+12	+ 6	+ 5	+ 3	0	0	0
4	+10	+ 4	+ 4	+ 2	. .	0	— 1
5	+ 9	+ 4	+ 1	+ 2	0	0	0
6	+ 9	+ 4	+ 3	+ 2	0	0	0
7	+10	+ 5	+ 5	+ 3	+ 2	+ 1	+ 2
8	+ 8	+ 4	+ 3	+ 2	0	0	+ 1
9	+ 9	+ 4	+ 3	+ 2	+ 1	+ 1	+ 1
10	+ 9	+ 5	+ 5	+ 3	+ 2	+ 2	+ 2
11	+ 7	+ 4	+ 4	+ 2	+ 1	+ 1	+ 1
12	+ 9	+ 5	+ 5	+ 5	+ 4	+ 4	+ 3
Scleroscope	80	70	70	62	56	53	52

Had these gages been formed with a plain cylindrical end projecting in front of the screw, the first two threads would have been

prevented from increasing more than the rest. The gages would then have been fairly easily corrected by lapping after tempering at 220 deg. cent. Practically no lapping would be required if they were tempered at 340 deg. cent. There seems to be no advantage in going to a higher temperature than this. The same degree of hardness could have been obtained with considerably less distortion by quenching directly in fused salt. It is interesting to note that when the swelling after water quenching does not exceed 0.0012 in., practically the whole of it may be recovered by tempering at a sufficiently high temperature, but when the swelling exceeds this amount the steel assumes a permanently strained condition, and at the most only 0.0014 in. can be recovered by tempering. (*The Engineer*, vol. 126, no. 3286, December 20, 1918, p. 537, *ep*)

MACHINE TOOLS

Precision Lathe for Cutting Screw-Thread Gages

A British Precision Screw-Cutting Lathe. Description of a machine tool made by Alfred Herbert, Ltd., of Coventry, England, designed for the single purpose of cutting the thread on a screw gage. It is capable of cutting a screw up to 3 in. long on a cylinder up to 6 in. long and up to $2\frac{1}{2}$ in. in diameter.

Although the machine is intended solely for cutting screw threads, it is a true lathe and not a screw machine. The work revolves on centers and the cutter is a single-point tool clamped to a slide rest. The cutting movement on the tool is controlled by a lead screw and both the turning and the traveling movements are positively related by toothed gearing controlled by a single belt drive.

The main difficulties in cutting accurate screw threads on an ordinary lathe arise from—(1) Imperfect alignment between the axis of the work and the line of travel of the tool, a condition which may be due to distortion of the bed, warn centers, looseness of the spindle, etc.; (2) irregular or unsteady travel of the saddle; (3) want of means for making small corrections in pitch; (4) errors in adjusting the tool in the slide rest to the correct height and angle, and (5) the faulty clearing of the tool at the end of the cut and advancing it with the precise addition for the new cut.

These and other difficulties can all be overcome on an engine lathe by an experienced man of careful method, provided he be allowed a large proportion of non-cutting time. But even with the best of the engine lathes and the best of men screw cutting demands very close and sustained attention. The new lathe has been designed to facilitate thread cutting on screw gages and similar high-precision work.

A general view of the lathe is given in Fig. 10. The stands of the bed are inverted cast-iron boxes with walls of uniform thickness. The arrangement of the feet is shown in section at *A* in Fig. 12. The foot is a bolt with a ball-head extension which rests in a cup within a socket. One foot is secured against horizontal movement by making the cup a close fit in the socket, while the others have a little play to accommodate the movement caused by the expansion of the bed under a change of temperature. All three feet are held down to the stand securely but not harshly. The makers hold that distortion of lathe beds is mainly due to tying the bed down at four or more points and so producing on one hand a permanent stress by reason of inequality of pressure at these points and varying stresses by reason of the lack of freedom for expansion.

In the headstock both centers are stationary or dead. The work piece is fixed in with a carrier and is driven by a box pin. It should be borne in mind that only the screw cutting is done on this lathe, the piece being previously finished to thread-crest diameter. The driving plate *A*, Fig. 11, revolves on a bearing surrounding the fixed headstock center, and has spur teeth cut on its rim. The driving spindle is driven by a three-step pulley, and has a pinion *B* at one end gearing with the driving plate and a pinion *C* at the other end gearing with the change wheels. When a gear train is set the plates carrying it are rigidly bolted to the frame, so that the wheels work steadily together. The wheels *A* and *B*, Fig. 11, reduce the driving-plate speed to one-fourth of the belt-pulley speed; therefore the pinion *C* makes four revolutions to one revolution of the work piece. The lead screw is cut with eight threads to the inch.

The lead screw is short (it does not reach to the back of the driving belt) and lies well above the lathe bed and between the V-guides of the saddle. This position gives a more direct pull than does the usual under saddle frontal arrangement.

The lead-screw nut is carried on a bracket rising from an extension of the saddle. It is not a split nut, the arrangement

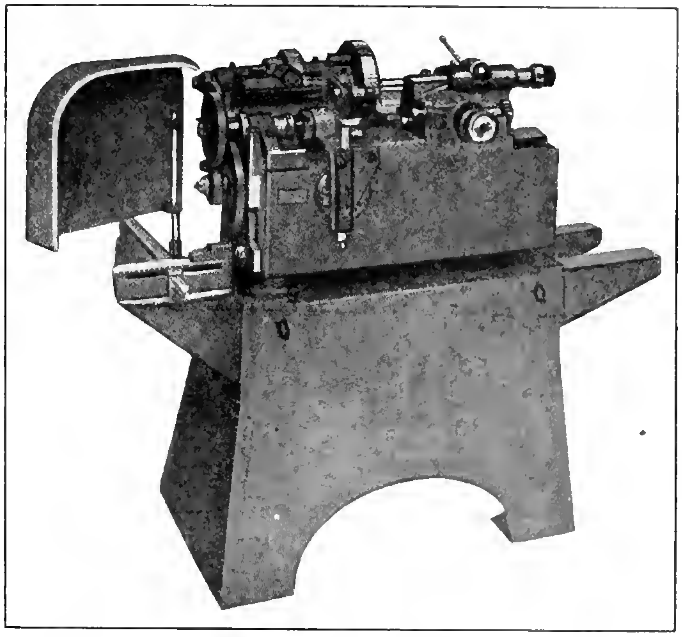


Fig. 10 General View of Precision Screw-Cutting Lathe

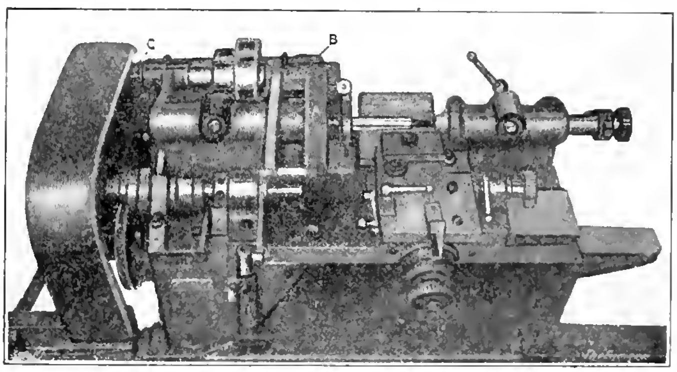


Fig. 11 Plan View of Precision Screw-Cutting Lathe

being that the reverse motion is obtained from the countershaft which is fitted with a two-speed reversing gear.

If the thread is cut correctly to pitch in the soft steel the pitch will be short when the steel is hardened. It is therefore necessary that a screw of, say, sixteen threads to 1.000 in. should be cut as sixteen threads to, say, 1.001 in., but this margin will vary with different steels and perhaps with different diameters. An extremely delicate means of varying the pitch is therefore necessary, and it must act evenly on every thread. This variation is obtained by the gear shown at the front of the lathe in Fig. 13. The vertical sliding rod carries a peg passing through its lower end and projecting into the slot plate attached to the bed of the lathe. The upper end of the sliding rod is attached to a lever arm controlling the lead-screw nut. The casing in which the rod slides is rigidly attached to the saddle and moves with the saddle in its travel. If the slot is set parallel with the lead screw the nut will be held stationary and the pitch of the thread will be cut true to the change-wheel setting. If the slot is set at an angle to the lead screw the sliding rod will move vertically and partially rotate the nut. The slot plate is graduated round its edge so that it may be

easily set to produce a variation of pitch either above or below the change-wheel setting. The graduations indicate 0.0001 per inch of screw to be cut.

The tool as shown at B in Fig. 12 is of special construction. The stock or shank is round in cross-section and is ground parallel to $^3/_4$ in. diameter, less half a thousandth. The total length is about $3^3/_4$ in. The grinding and lapping end to any angle, and to the necessary degree of accuracy, is provided for in a way which it is claimed puts this usually difficult operation within the reach

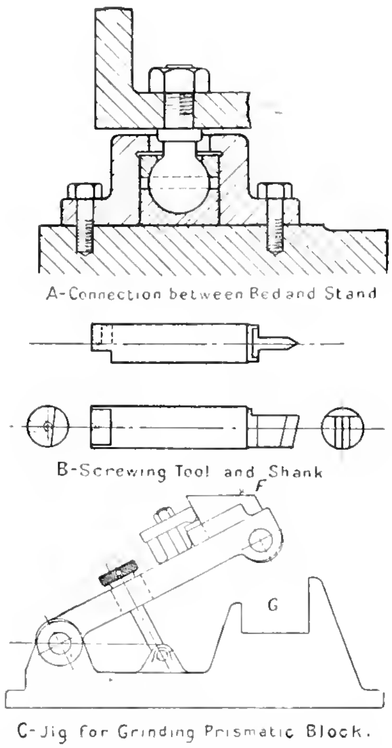


Fig. 12 Details of Precision Lathe

of an unskilled operator on a surface grinding machine. A block for holding the tool by its shank is provided in a jig on a box-like base which may be secured to a grinding-machine table. The holding block rests at an angle on a prismatic block which sets the surface to be dressed parallel with the grinding table. Everything, it is stated, is easily adjusted and secured so that by passing the tool under the grinding wheel the correct angle is obtained. The grinding of the prismatic block is provided for by a jig, as shown at C, Fig. 12, in which a sine bar is embodied so that the surface of the block to be ground may be easily and rapidly set to give the correct angle. The calculations of the precise angles of the prismatic block reduce to finding the thickness of a packing piece to be laid under the free end of the sine bar. The various thicknesses have been tabulated for all required tool angles. In Fig. 12 (C) the surface of the prismatic block to be ground is indicated at F and the space for the packing piece at G.

Where gages are being produced in quantity the roughing and finishing cuts for the thread may be taken on successive settings of the lathe or in two or more lathes operating in series. It is claimed that on this lathe unskilled operators are enabled to produce screw threads of the greatest precision that can be measured. One horsepower is required to drive the lathe and the total weight of the machine is a little over 14 hundredweight. (*The Engineer*, vol. 126, no. 3287, December 27, 1918, pp. 558-560, 9 figs., *d*A)

MEASURING INSTRUMENTS

Centrifugal Tachometers, Conical-Pendulum Type

Centrifugal Tachometers on the Principle of the Conical Pendulum (*Zeitschrift d. s Vereines deutscher Ingenieure*, Nov. 16 and 23, 1918). The article is in two parts and describes five main types of centrifugal tachometers. The general theory of each type is given, and the relation between n, the revolutions per minute, and α, the angular displacement of the arms of the conical pendulum, is worked out. There is for each type a variable β, such that $n = f(\alpha, \beta)$, and a series of characteristic curves of n against α are drawn for a range of values of β.

a Conical pendulum with flat-spiral-spring control. In this instrument the shaft, whose revolutions are to be measured, carries two arms in the form of a cross, each of which can turn about its center, i.e., about an axis at right angles to that of the shaft. Each arm also carries a ball at each end. The couple due to the centrifugal forces on the balls is balanced by that due to the pull in a flat spiral spring whose plane is parallel to the two arms.

The variable parameter β in this case is the angle α_0, which is the value of α when n is zero. The characteristic curves show that positive values of α_0 up to about 30 deg. give the best range of measurable speeds, and the most open space. α_0 is positive when the zero position (spring unstretched) is such that the spring is extended when the arms begin to move outward and away from the axis.

The angular movement of the arms is communicated by means of a pair of links to a sleeve which slides on the revolving shaft. The axial displacements of the sleeve are transmitted by means of a connecting rod and crank to the scale pointer. An excellent

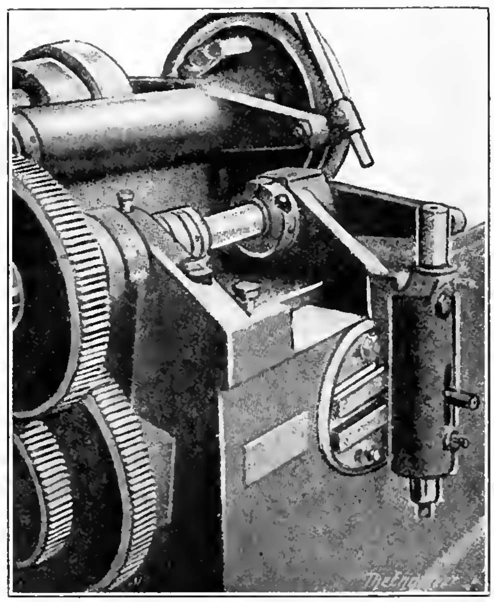


Fig. 13 Lead Screw and Nut of Precision Lathe

uniform scale over a fairly wide range of speeds can be secured in this manner; the best results are obtained if the joint of connecting rod and crank lies above the crank center when the shaft is at rest, assuming the axis of the shaft to be vertical.

b Conical pendulum with gravity load. This is an instrument on the principle of the Watt governor. It can only be used for limited ranges of speed. Characteristic curves are shown in which the variable parameter is the ratio between the distance of the hinges of the arms carrying the balls from the axis of rotation and the length of the arms.

c Conical pendulum with linear-spiral-spring control. This scheme is the basis of successful types of accurate tachograph. The pendulum masses are joined directly by the spring, and their arms are hinged about the ends of a bar which is at right angles to, and turns with, the shaft whose revolutions are to be measured. The angular movements of the pendulum arms are communicated by a link mechanism to a sleeve on the shaft, and the sleeve's movements are directly transmitted to the pen which traces a record on a revolving drum.

The characteristic curves are drawn with the unstretched length of the spring as the variable parameter. They show that the

principle is only applicable to cases where the speeds to be recorded are merely comparatively small variations from a constant mean.

d Centrifugal tachometers with differential gear drive. In these instruments the principle of the foregoing centrifugal tachometers, viz., a conical or rotating pendulum controlled by means of springs, is utilized, but the method of registering the deflection of the arms is essentially different. In outline the method is as follows: The displacement of the rotating pendulum masses produces a relative motion between two concentric shafts, one of which is connected to one side of the differential gear, and the other (a hollow shaft) is driven directly through bevel gearing from the main shaft. This hollow shaft has a speed of rotation equal and opposite to that of a second hollow shaft, also driven from the main shaft by bevel gearing, and connected to the other side of the differential gear. The above-mentioned relative displacement of the concentric shafts can therefore be seen as a displacement of the axis of the two middle wheels of the differential gear with respect to the axis of the shaft, and this latter displacement is registered by the indicator. The arms carrying the rotating pendulum masses have their hinges at opposite ends of the diameter of a rotating disk mounted on the hollow shaft, and the axes of the hinges are also those of a pair of toothed wheels which gear with a pinion on the inner shaft. Any displacement of the arms gives rise to a turning of the toothed wheels, and therefore to a relative movement between the two concentric shafts.

If the centrifugal forces on the rotating masses are balanced by flat spiral springs, then the characteristic curves are similar in character to those of type *a*. There are no improvements in the characteristics as compared with type *b* when the two means of the present kind of tachometer are joined by a linear spiral spring. An instrument can, however, be devised which gives an excellent linear relation between n and α and over a very wide range of speeds. The essential point of such an instrument is to choose suitably the position of the fixed end of a straight spiral spring which is attached at its other end to one ball only. The axis of the spring should be roughly at right angles to the mean position of the arm carrying the ball.

e Centrifugal tachometers with combined spring and gravity loading. The example given of this type is a combination of types *b* and *c*, and its characteristic curves are certainly an improvement upon those of either *b* or *c*, both as regards range and approximate proportionality between n and α. (*Technical Supplement to the Review of the Foreign Press*, London, vol. 3, no. 2, Jan. 21, 1919, no. 4015, p. 58)

MECHANICAL PROCESSES

Making Seamless Tubes. Description of the process of manufacture used at the plant of the Standard Seamless Tube Company at Economy, Pa., particularly interesting because of the fact that the plant has only been recently erected and therefore embodies the latest ideas in equipment and methods of manufacture.

The plant is equipped to make boiler tubes for stationary and marine boilers and for locomotives from 1 to 4 in. outside diameter, both hot-rolled and cold-drawn as well as seamless steel tubing for various mechanical processes.

Both basic open-hearth furnace and electric (Héroult) steel are used. Considerable care is used to remove all surface defects from the blooms, air-operated chipping hammers being provided for this purpose, the work going on day and night, with electric illumination during the latter period. Each workman engaged in chipping is required to wear goggles so as to protect his eyes against possible injury.

From the chipping house the bloom goes into a continuous heating furnace and from there it is delivered by a charging machine to a 23-in. bar mill. This mill consists of eight stands of three-high rolls arranged in parallel and driven by a motor through reduction gears. Two electrically driven tilting tables are placed on the front and rear sides of the roll stands. From the bar-mill rolls the bar is transferred by a runout table to the hot saw, which cuts the bar either into merchant sizes or to the size which the piercing mill is working.

This latter is of the Stiefel type and is electrically driven. In the mill the bar is passed through it over a mandrel, as shown in Fig. 14. After a hole has been pierced through the center of the bar the resultant tube is passed successively through a set of 22-in. electrically driven rolls and over a mandrel until the proper diameter and thickness are obtained.

The tube is then transferred to an expanding mill and thence through reeling mills from which it goes to a sizing mill where it is brought to final size according to specifications. If the size is found to be above specifications, the tube is passed through a continuous heating furnace and then through an electrically operated continuous reducing mill, which is expected to bring it up to the size called for in the order.

Every tube is inspected for wall thickness and interior imperfections, which is done by holding an electric lamp at one end while the inspector looks in from the other.

Fig. 14 Section of Solid Steel Bar During the Piercing Process (Left) and Section of Tubing During the Cold-Drawing Process (Right)

Another section of the plant takes care of the production of cold-drawn tubing. In this process one end of the tubes is heated in a gas-fired electric furnace and the heated end is pointed by means of a Yeakley-type power hammer. The tubes are then pickled in a solution of sulphuric acid and rinsed in water in order to remove as far as possible all scale which adheres to the surface. A lubricant is then applied to the surface of the tube after which it is passed over a shafting and fed into a die. It is then drawn to the size called for in the order. The drawing machines are both of the single-chain and double-chain types.

The drawing makes the tube extremely hard and brittle, so that it becomes necessary to put it through a process of annealing. Tubing intended for mechanical purposes is given only a slight anneal, while boiler tubing is made fairly soft. (*The Iron Trade Review*, vol. 64, no. 4, January 23, 1919, pages 259-264, 11 figs., *d*)

MOTOR-CAR ENGINEERING

Steam Agricultural Tractors, Dahme (*Zeitschrift des Vereines Deutscher Ingenieure*, Nov. 16, 1918). This article, which is well illustrated and is to be concluded in another issue, describes the latest road tractors constructed by the firm of R. Wolf, A.-G., in Magdeburg.

The boiler is tubular and is designed for pressures up to 10 atmos. The superheater is in the smokebox and consists of a large number of vertical spiral wrought-iron tubes of small diameter, which are set in parallel groups and through which the steam passes, flowing in a direction opposite to the passage of the exhaust gases to the smokestack. Steam temperatures up to 350 deg. can by means of this superheater easily be obtained.

The superheater and the boiler tubes are cleaned by means of a number of small steam jets playing into the smokebox in both directions, which effectually remove all matter adhering to the tubes.

The bunker is of sufficient size to take fuel and water for a 20- to 30-km. run, and the engine is supplied with a steam-jet suction pump for procuring the water en route.

The control of the engine is so arranged that it can be driven forward or reversed by the movement of a single lever. The steam supply is automatically controlled for hills, so that it is increased for ascending and decreased for descending. This arrangement can be put out of action whenever a very heavy load is being hauled, by the adjustment of a single screw.

In running this tractor as a stationary engine a great advantage is the fact that it runs as satisfactorily on the reverse as the direct, and, in consequence, crossed belts can be eliminated, and the automatic control is a great assistance in dealing with sudden intermittent heavy loads.

These engines are equally suitable for all kinds of road traction, driving sawmills, threshing machines, and the like. (*Technical Supplement to the Review of the Foreign Press*, London, vol. 3, no. 1, Jan. 7, 1919, no. 3746, p. 7)

POWER PLANTS

Elimination of Oil and Air from Feedwater (*De Ingenieur*, Nov. 9, 1918). In a paper read before the Department of Marine Engineers of the Royal Institution of Dutch Engineers by J. C. Dijxhoorn, the importance of perfectly clean feedwater for steam boilers is dealt with. The presence of cylinder lubricating oil in the condensed water is always a likely source of trouble. Numerous devices are resorted to in order to overcome this, as, for instance, trays with suitable porous material through which the water can move forward and backward while the oil is deposited on the material; coke filters, in which the oil adheres to the surface of the coke; or pressure filters, in which the contaminated water is forced through filter cloths which retain the oil.

None of these appliances have succeeded in completely removing the oil, because it is in an emulsive state and divided into globules of less than 0.001 mm. diameter, which can pass through the finest filtering medium. Various precipitants are mentioned, but success depends in every case on subsequent filtration of the water through large sand filters.

The tiny globules of oil can be made to coalesce by passing an electric current through the water, and the author describes an apparatus he has designed for this purpose, using continuous current at 110 volts while the water flows through the feed pipe. The electrically treated water is then sent through a pressure filter consisting of perforated cylinders covered with cloth and enclosed in a strong vessel provided with inlet and outlet stop valves. Such a filter has very little effect on ordinary feedwater, but, as the electric process described above causes the oil globules to coalesce, the whole of the oil is effectively retained, leaving pure water only to pass through.

A pressure gage on the filter indicates the condition of the filter cloth, which must be changed when the pressure rises much above boiler pressure. It is also important to remove the air from feedwater, and the author describes a special apparatus he has designed which automatically accomplishes this. (*Technical Supplement to the Review of the Foreign Press*, London, vol. 3, no. 1, Jan. 7, 1919, no. 3760, p. 10)

Elimination and Recovery of Oil from Feedwater. (*De Ingenieur*, Nov. 30, 1918). An account is given of an oil-recovery plant used at the Central Station in Flushing. It is similar to the Perrett plant used in England during the last 15 or 20 years. The feedwater is first allowed to flow through a brickwork tank having baffle plates with openings at the bottom, while the oil which rises between the plates is removed through a valve and freed from water and dirt by being passed through a centrifugal separator.

The feedwater is then conducted to a second tank fitted with metallic baffle plates charged with continuous current at a pressure of 8 volts. Emulsified oil again separates as a layer between the plates, and can be recovered as before. The feedwater is finally passed through a coarse filter, which removes the last traces of oil. (*Technical Supplement to the Review of the Foreign Press*, London, vol. 3, no. 2, Jan. 21, 1919, no. 3905, p. 41)

RAILROAD ENGINEERING

Heavier 2-10-2 Type Locomotives Built for the Pennsylvania Lines. Description of the locomotives built for the Pennsylvania Lines West of Pittsburgh by the American Locomotive Company. These locomotives are notable for two reasons: First, the total weight is greater than that of any engines of this type previously built and yet they are able to operate on 23-deg. curves. Next, they are equipped with pilots capable of meeting requirements for road or yard service. Also these locomotives are extremely heavy though they are to be used on a division with low grades. Locomotives with five coupled pairs of driving wheels and a lateral-motion driving box on the front axle cannot traverse curves sharper than 16 deg., and the present locomotives had to be equipped with the Woodward floating axle on the front and rear drivers to enable them to pass 23-deg. curves.

The equalizing system is considered to be a very unusual departure from standard American practice, namely, a four-point suspension. The leading truck is equalized with the front driving wheels; the three center drivers on each side are equalized together and the rear drivers are equalized with the trailing truck. The valve motion, which is of the Walschaerts type, has an extremely long travel which is secured without excessive angularity by the use of a long radius rod and a long link combined with an eccentric crank of large throw. This gives a travel of $8\frac{1}{2}$ in. The experience with consolidation locomotives has shown that the theoretical advantage of long valve travel is borne out in actual practice.

It is interesting to note that tubes of $2\frac{1}{2}$ in. diameter are used in the boiler. It is stated, in this connection, that while the total heating surface is decreased by the use of such large tubes, experiments have demonstrated that as tubes are lengthened beyond a certain point the evaporation does not increase proportionately. The most desirable ratio of length to internal diameter is approximately 100, such a ratio being secured in this instance by the use of $2\frac{1}{2}$-in. tubes. (*Railway Age*, vol. 66, no. 4, January 24, 1919, pp. 249-251, 3 figs., *d*)

New Departure in Firebox Construction. Description of an installation recently tested out on a Chicago, Milwaukee & St. Paul locomotive designed by the Nicholson Firebox Company, of Chicago, Ill.

The installation as shown in Fig. 15 is called a thermic siphon and is so disposed as to displace the arch tubes hitherto depended on to support the firebrick. Each element consists of an approximately square plate of firebox steel folded on itself along a diagonal in such a manner as to resemble a flattened cornucopia. The lower extremity of the siphon is flanged into tubular shape and is inserted into and secured to a throat sheet of the firebox, giving to the tubular portion a slope corresponding to that of the customary arch tube.

The purpose of the use of thermic siphons is double: namely, to utilize to better advantage the radiant heat transfer available, and to accelerate the water circulation within the boiler.

Practically all of the heat absorbed by the heating surfaces of the ordinary firebox is radiated from the fuel bed and from the flames to the heating surface. The siphons break up the flame into several channels, thereby increasing the flame radiating surface, which is equivalent to increasing the firebox heating surface, so that with the same flame temperature a greater quantity of heat may be radiated to the surfaces of a firebox thus equipped.

Referring to Fig. 16, it appears that firebox *B* equipped with the siphons evaporated approximately 5000 lb. per hour more than firebox *A*. While the shape of the flame passages in *B* would tend to increase the heat absorption from the hot gases by direct contact or convection, the amount of heat so absorbed would still be very small compared to the amount of radiant heat absorbed from the flames.

The second purpose of the use of the flame siphons is that of increasing the amount of water circulation. The volume of water

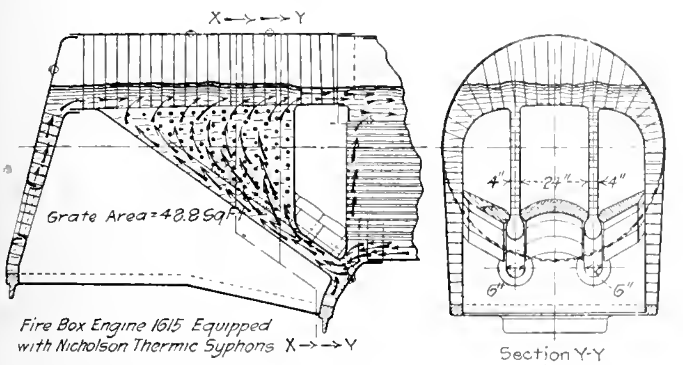


Fig. 15 General Arrangement and Scheme of Operation of the Nicholson Thermic Siphon for Locomotive Boilers

circulated through a pipe, such as an arch tube exposed to the high firebox temperatures, seems to be greatest when the volume of water and steam discharged at the outlet are about equal, and this condition prevails when high firebox temperatures are obtained. The ratio of the average cross-sectional area of the water passage of the siphon to the perimeter, or the heating surface, is practically the same as that of an arch tube, and it is reasonable to suppose that under similar conditions of temperature the proportion of water and steam discharged would be the same. Assuming, however, that under normal conditions of working and firebox temperatures, the steam leaving the outlet of the siphon carried with it only half its volume of water, the circulation through the two siphons is found to be sufficient to cause all of the water in the boiler to pass through them every five minutes, and at the highest rate of working the velocity of circulation practically would be doubled.

With such high velocity of circulation as is here indicated and with such large volume of water siphoned through the inlets in such a short space of time, it is apparent that no cold water could collect in the belly of the boiler, or remain there long.

The siphons are located so as to take advantage of the natural trend of circulation in the boiler and give greatly added velocity to it. The cold water fed in finds its way to the bottom of the boiler and slowly travels back toward the firebox. The siphons draw their water supply from this ordinarily cold zone at such a rapid rate that the cold water fed in is quickly drawn back to the throat and siphoned through the hottest zone of the firebox where it is heated up to the temperatures of the steam and partly evaporated.

The water at steam temperature discharged from the top of the siphons travels forward toward the front flue sheet, thereby tending to draw the cold water up from the bottom of the side and back water legs. Under such conditions of circulation the water is maintained at a nearly uniform temperature throughout the boiler, and this should result in a marked decrease in the prevalent boiler troubles due to the unequal contraction and expansion caused by wide variations in the temperature of the water in different parts of the boiler.

The article describes in some detail and illustrates the method of attaching the siphons. (*Railway Review*, vol. 64, no. 2, Jan. 11, 1919, pp. 47-51, 5 figs., *d*)

Three-Cylinder Locomotive for Constantinople (*Zeitschrift des Vereines Deutscher Ingenieure*, Nov. 9, 1918). A ten-coupled three-cylinder goods locomotive supplied to the Constantinople Military Authorities, by Henschel, of Cassel, is described and illustrated. The advantage of the three-cylinder type over the two- or four-cylinder types, especially for goods locomotives, are clearly pointed out. Tests were made with two three-cylinder locomotives, one with all three cylinders horizontal and the other with the two outer cylinders horizontal and the middle one inclined upward at 1 to 6.143. By having three cylinders, the large diameter (686 mm.) required for a two-cylinder engine was avoided. The starting of the three-cylinder type is better owing

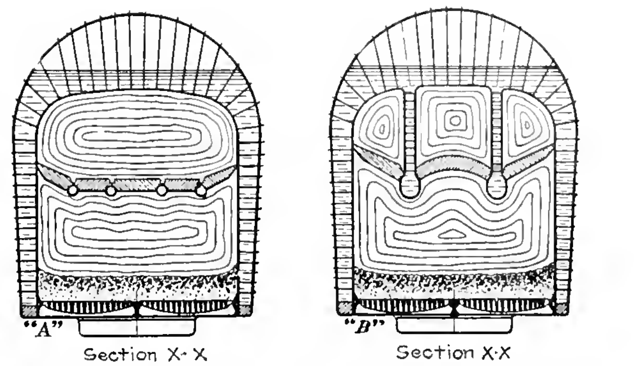


Fig 16 Flame Radiation in Locomotive Fireboxes with and without the Use of Nicholson Thermic Siphon

to the distribution of the turning force on the three-crank axle, and the draft on the fire is more regular owing to the 50 per cent increase in the number of the exhaust blasts. The angle of 120 deg. between the cranks as obtained on the three-cylinder engine is the most efficient turning angle.

The locomotive was designed for a maximum speed of 45 km. per hr. and to pull 500 tons up a gradient of 1 in 20 at a speed of 15 km. per hr. The leading dimensions are as follows:

Cylinders, diameter	560 mm.	Adhesive weight	78,600 kg.
Piston stroke	600 mm.	Tender wheels, diameter	1,018 mm.
Driving wheels, diameter	1,250 mm.	Tender wheel-base	3,300 mm.
Leading wheels	820 mm.	Tender water capacity	12 cu. m.
Total wheel-base	8,500 mm.	Tender coal	7,000 kg.
Total boiler pressure	13 kg. per sq. cm.	Tender weight empty	18,170 kg.
Area of grate	4½ sq. m.	Tender weight loaded	37,170 kg.
Heating surface of firebox	16.13 sq. m.	Total wheel-base for locomotive and tender	15,000 mm.
Heating surface of tubes	225.22 sq. m.	Overall length of locomotive and tender	18,235 mm.
Heating surface of superheater	80.88 sq.m.		
Weight empty	82,560 kg.		
Weight loaded	91,290 kg.		

The engine has 80 mm. sideplay each side on the front wheels and 25 mm. on the second and fifth coupled wheels for turning curves. The center line of the middle inclined cylinder passes 100 mm. vertically above the center line of the crankshaft. The two outside cranks are set at an angle of 120 deg. to each other, and the middle crank at an angle of 130 deg. 31 min. to the right-hand crank and 108 deg. 29 min. to the left-hand crank.

Ten of these locomotives were supplied to the Military Authorities at Constantinople. Several goods and passenger engines of the type have been supplied to the Prussian State Railways. (*Technical Supplement to the Review of the Foreign Press*, London, vol. 3, no. 1, Jan. 7, 1919, no. 3747, pp. 7-8)

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer.

MECHANICAL ENGINEERING
THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Published Monthly by
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
29 West Thirty-ninth Street, New York

M. E. Cooley, *President*
William H. Wiley, *Treasurer* Calvin W. Rice, *Secretary*

PUBLICATION COMMITTEE:
George A. Orrok, *Chairman* J. W. Roe
H. H. Esselstyn George J. Foran
Ralph E. Flanders

PUBLICATION STAFF:
Lester G. French, *Editor and Manager*
Leon Cammen, C. M. Sames, *Associate Editors*
Frederick Lask, *Advertising Manager*

Yearly subscription \$3.00, single copies 35 cents. Postage to Canada, 50 cents additional; to foreign countries \$1.00 additional.

Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

The House passed a bill on February 18 extending the life of the Screw Thread Commission for one year. The matter at this writing is now in the Senate for approval. The commission, it will be remembered, was appointed for six months in October, 1918, by the Secretary of Commerce. While its work has advanced to a point where a tentative report is being prepared, the added time is much needed for the proper completion of so important and intricate a matter.

Two of our best-known engineers and educators, a president and a past-president of this Society, one a dean of colleges of engineering and the other a president of a technical institute, have recently made addresses bearing on the future of the engineer and on what he must expect to do and become, and what viewpoint would seem to be necessary if he is to live up to his full duties and responsibilities. One address was made at Detroit by President Cooley and the other at Ottawa by Past-President Hollis. While in treatment they are different, in their application they point in the same direction, toward the service of the public. Both addresses are reported in this number, the one by Dean Cooley under what he styles " one of the finest titles I ever worked out "—An Unoccupied Rung in the Engineer's Ladder of Fame—and the one by Dr. Hollis under News of the Engineering Societies. Read them.

The headquarters of the A.S.M.E. is favored with frequent visits of members who are either returning from France or are on their way overseas. Recently Major W. B. Gregory, of New Orleans, a member of the Council, returned after 16 months' absence, having been engaged mainly in waterworks construction for supplying the railway lines leading to the western front.

Major Gregory speaks appreciatively of the cordial relations which he experienced among the French people with whom he came in contact; of their appreciation of the service rendered by the Americans; and of their desire to show their gratitude by such means as are at their disposal.

Another visitor was Prof. E. R. Hedrick, of the University of Missouri, who is now on his way abroad to take charge of instruction in mathematics as applied to engineering among the A. E. F. Professor Hedrick will work under the direction of Dean L. E. Reber, Mem.Am.Soc.M.E., of the University of Wisconsin, who is in control of the engineering and trade courses for the soldiers. A brief account of this educational work is given in another column of this issue.

The Spring Meeting

The Spring Meeting, to be held June 16 to 19 at Detroit, with headquarters at the Hotel Statler, will have as its leading professional feature an all-day session devoted to the subject of industrial research—a subject which has received a great impetus in this country in consequence of the war and the necessary and unusual development of certain of our industries. Other features will be a report of the Aims and Organization Committee whose work is attracting widespread attention among the Sections of the Society, and a session conducted by the Detroit Local Committee and the Committees of the various Mid-Western Sections.

One session will be devoted to a survey of industrial relations, taking up certain aspects of labor conditions and covering employees' service. At least two sessions will be devoted to general technical papers. Particulars about excursions and social features cannot at this time be given, but it is needless to say that the wonderful resources of Detroit will be at the disposal of the members and their friends who attend the meeting.

Don't forget the Spring Meeting—June 16 to 19—when so many matters of vital interest to the profession and to the members individually will be discussed at this critical time in our history. Note that the meeting opens on *Monday*, June 16, instead of Tuesday, as has been usual.

Secretary's Letter

THE outstanding note throughout the country in this present period of uncertainty and unrest is that of optimism. During an extended trip among the Sections of the A. S. M. E., which has just been concluded, I have followed a path through the Central States to Chicago, then through the South Atlantic States and west to Oklahoma and up to the northern border. Everywhere this feeling of optimism is evident. I have yet to find one man, engineer or man of business, who does not think the cycle of temporary business depression will be completed during this calendar year; the majority say in six months, and not a few predict a shortage of labor within three months. I have been informed of contracts actually let for large increases in plants of certain industries, to be begun as soon as weather permits.

This condition in business obviously is reflected in the outlook for the work of the societies, local and national. I mention local first because I am unreservedly for developing and supporting the local society first of all. After one has done his full duty locally then he may join that national society which best serves his specialty.

Further, all local societies can depend on the support of our national organizations in charging the members to bear their full share of the work of maintaining professional interest in their communities. The best means for effecting such coöperation is for our Sections, and the sections of all the other national societies, to head up in the local society. As soon as this is accomplished in every locality we will have a truly national spirit and a community of interest.

The usefulness of the local organizations in public affairs is illustrated by action taken recently by the Associated Engineering Societies of St. Louis under the auspices of the Engineers' Club with reference to the proposed municipal bond issue of that city. Most of this bond issue is for engineering projects and consequently the engineer-citizen is vitally interested. At a meeting held to discuss the subject the civic committee of the Engineers'

Club participated, and there was very evident interest on the part of all in attendance.

The one great necessity in the industrial prosperity of the nation is research and more research. Indeed, if we are even to survive, much less excel, in the competition which is to come, we must reduce the unit cost to manufacture, and one of the potent means of doing this is to conduct adequate researches. For example, with the high wages and low efficiency of the present time, and with ships costing from two and a half to three times what other countries are paying, how can we endure unless we develop processes which will insure quantity production?

This work is peculiarly within the province of the engineer, and there is no more important undertaking under way by the different professional societies than that of their research committees. The development of the research attitude of mind throughout the nation should command our instant attention, and the desirability of a research department in every industry may well be emphasized.

This work must be done today. Tomorrow will be too late. The A. S. M. E., through its Research Committee, stands ready not only to act as a clearing house, but to take the initiative and, modestly at first, but nevertheless definitely, to make grants for promising research, when such is for the common good.

The National Research Council is to head up all the research work in the nation, and this Society is working hand in glove with the National Research Council in that field which is peculiarly ours.

An important adjunct in his work, in fact its predecessor, is our Library Service. Our joint libraries, comprising the best collection of technical books and periodicals on this continent, is literally "at your service." It has a large staff of trained searchers. It has been found that 40 per cent of all problems have already been solved by some one. Save time and money. Consult *your* library.

In this connection, I wish to congratulate the American Society of Heating and Ventilating Engineers for its vision and enterprise in undertaking research as a Society. Its plan contemplates the collection of a fund of $20,000 a year for five years to carry on this work.

Hand in hand with research is standardization. Our newly formed American Engineering Standards Committee, representing the several departments of the Government and the leading engineering societies, and paralleling the organization of the British Engineering Standards Association, bids fair soon to play its important rôle. Our Society has appointed as one of its representatives on the American Engineering Standards Committee the Canadian representative of the British Engineering Standardization Association, who is a member of our Society, to assure ourselves of the most complete coöperation.

Looking out into a still broader field we find that through the selection of a Washington representative by the Engineering Council (representing the societies in their relations with the public) we are fast taking on activities closely related to the life of the nation.

Another joint activity of the societies, operating under the auspices of the Engineering Council, is the Engineering Societies Employment Bureau. This service is just now in great demand—150 professional men daily seeking positions. In order that we may function more effectively in this activity, we need branches of this Bureau in each city. Will you assist?

Calvin W. Rice,
Secretary.

Council Meeting, February 22

A regular meeting of the Council was held in Pittsburgh, Pa., on February 22. On the morning of the day of the meeting an inspection trip was made to Dr. John A. Brashear's observatory and shops, which was followed by luncheon at the Duquesne Club. The Council meeting was held at 2:00 p. m. in the rooms of the Engineers' Society of Western Pennsylvania. An account of the business transacted at this meeting will appear in the April issue of Mechanical Engineering.

In the evening a public dinner, preceded by an informal reception, was held at the William Penn Hotel, to which all members of the Society in Pittsburgh and vicinity were invited. Among the speakers were Dr. John A. Brashear, Past-President and Honorary Member, Am.Soc.M.E., President Mortimer E. Cooley and George H. Neilson, President of the Engineers' Society of Western Pennsylvania.

Washington Office Opened by Engineering Council

A National Service Committee has recently been organized by the Engineering Council, having for its general purpose to seek out public services which may be best performed by engineering societies and to offer the proper men for such services; to speak authoritatively for the Council before committees of Congress and Governmental departments; and to supply first-hand information to engineers and their organizations regarding pending legislation.

M. O. Leighton
Chairman National Service Committee, Engineering Council, and Manager of Washington Office

The chairman of the Committee is Marshall O. Leighton, consulting engineer, Washington, D. C., under whose direction a Washington office for the Council has been opened at 502 McLachlen Building, Tenth and G Streets. The personnel of the Committee is representative of engineers throughout the country and comprises, besides the Chairman, the following men: C. B. Burdick, Chicago; George F. Swain, Boston; Philip N. Moore, St. Louis; L. D. Ricketts, Warren, Ariz.; Andrew M. Hunt, San Francisco and New York; Andrew M. Lockett, New Orleans; W. C. L. Eglin, Philadelphia, and Bancroft Gherardi.

Mr. Leighton, the Chairman, was graduated from Massachusetts Institute of Technology and has been a practicing sanitary engineer and consulting expert. He was connected with the Government in the U. S. Geological Survey for about eleven years and has been engaged in various public works, such as river hydraulics, water power, sewerage pollution, etc.

Discharged Engineers of Public Service Commission, New York, Now Reinstated

At the January meeting of the New York Section, as reported in the February issue of Mechanical Engineering, Mr. Charles Whiting Baker, Mem.Am.Soc.M.E., called attention to the action of the Board of Estimate and Apportionment in New York City, in the abrupt dismissal of some 370 engineers of the Public Service Commission of the city. In consequence of this drastic action, the Engineering Council, representing the Civil, Mining, Mechanical and Electrical Engineers, arranged a hearing on the

afternoon of January 14 in the Engineering Societies Building, New York, at which various representatives of city departments and of associations interested were present.

It developed that the Board of Estimate and Apportionment had adopted in December what is called a "line budget" the provisions of which led to the discharge of the engineers, but against whom no charges were made. In view of the facts developed at the hearing and the very evident curtailment of construction and disruption of a highly organized staff which would occur if the order were allowed to stand, the Engineering Council passed the following resolution:

Resolved, that in view of the above facts, the Board of Estimate and Apportionment be urged to reconsider at once its action of December 30 and to make such appropriation as will enable the Public Service Commission to carry on with safety and economy the rapid completion of the subway work, and that the Board of Estimate should leave to the Public Service Commission, on which the law places the responsibility, the detailed apportionment of these funds in accordance with a practical schedule to be prepared by it and submitted to the Board of Estimate for its information.

It is a pleasure to report that announcement was made on January 31 that the discharged employees had been reinstated, an appropriation having been made at the instance of the Board of Estimate and Apportionment sufficient to maintain the organization for the months of February and March.

Educational Work of Our Army Abroad

A great deal of interest is evidenced, both among engineers and educators, in the remarkable educational work of the A. E. F. abroad. This work has been developed under the efficient management of the Army Educational Commission of the Y. M. C. A., which has the direction of the courses of study and the selection of the personnel of the instructing staff.

The administration of the work, in so far as it is necessary for the Army to coöperate with the Commission of the Y. M. C. A. for its effective handling, is in charge of the General Headquarters abroad. General Robert I. Rees, who was recently Chairman of the Committee on Education and Special Training of the War Department, is now overseas in charge of arrangements for the military coöperation.

The work of the Army Educational Commission of the Y. M. C. A. in this country is directed by Dr. James Sullivan of the Department of Education of New York State; and by Samuel C. Fairley, Associate Home Director. Abroad, the work is directed by a Commission consisting of Dr. John Erskin, of Columbia University, *Chairman;* Dr. Frank E. Spaulding, Superintendent of Schools of Cleveland, Ohio; and Kenyon L. Butterfield, President of the Massachusetts Agricultural College.

Instruction is to be given at the various camps and at certain of the schools and colleges. The soldiers are to have the option of either five hours' drill or two hours' drill and three hours' educational work per day. Already 18,000 men are taking courses in the various departments. An idea of the extent of the project are expected to take courses of three months' duration in higher subjects at the various universities and colleges of France and Great Britain.

It is expected that at least half of the educational work will be of the vocational type, which is under the direction of Dean L. E. Reber, Mem.Am.Soc.M.E., of the University of Wisconsin, who has lately been in war work with the Emergency Fleet Corporation in Philadelphia. Assisting him are Dean W. H. Kenerson, Mem.Am.Soc.M.E., of Brown University; Prof. Frank C. Theissen, of the University of Wisconsin; Prof. E. R. Hedrick, Mem. Am.Soc.M.E., of the University of Missouri, and a number of other specialists.

The Y. M. C. A. has been conducting a recruiting campaign to secure educational executives, and as a result of its efforts more than two hundred men have sailed and one hundred and fifty are ready for sailing. A million and a half of textbooks and pamphlets valued at one and a quarter million dollars have been shipped already by the Y. M. C. A. for distribution among the soldiers.

Engineering Council Acts on Public-Works Control

A joint meeting of the Reconstruction, Public Affairs and National Service Committees of the Engineering Council was held on January 28 to consider what action should be taken relative to legislation affecting the supervision of national public works. The importance of the matter is evident from the fact that the value of construction work undertaken for the war, in the way of docks, hospitals, storehouses, railroads, water-supply systems, etc., aggregated $800,000,000 and that *every year* many million dollars' worth of engineering works are constructed, operated and maintained by the numerous bureaus and departments of the Government.

The war work mentioned has been carried on under the direction of the Construction Division, reporting directly to the General Staff of the Army. This division was recruited largely from engineers in civil life, 90 per cent of whom probably went into the work at a personal sacrifice. The law is such that 90 days after peace is declared the Construction Division must go out of existence.

One item of legislation referred to is an amendment of the Military Appropriation Bill providing for the continuance of the Construction Division and its permanent establishment as the Construction Corps, to have charge of the property which it has constructed, including completion, operation, maintenance and demolition.

Another item is the Kenyon Bill, S. 5397, which would create an Emergency Public Works Board "to coöperate with all federal, state and municipal agencies entrusted with the execution of public works, and to stabilize industrial and employment conditions during the period of demobilization." The bill carries a special appropriation of $100,000,000 and provides for further advances by the War Finance Corporation not to exceed an aggregate of $300,000,000 under the terms stipulated in detail and under control of the Secretary of Labor in conjunction with the Emergency Public Works Board. This bill as originally drafted gives the Engineer Corps of the U. S. Army a large measure of control in the civilian works to be constructed under the terms of the act.

It was the sense of the conference of the committees of Engineering Council that the legislation providing for the Construction Corps should be supported, but that the Kenyon Bill should be materially modified before its passage could be supported by engineers.

From Col. Elliott H. Whitlock

Col. Elliott H. Whitlock, former member of the Council of the A. S. M. E., writes from Toul, France, under date of December 27, 1918, as follows:

Soon after the first of October I was relieved from my work at the Engineering Depot at Is-sur-Tille and sent to the Second Army to join my regiment at Toul. I found our Colonel here in the Chief's office as Executive Officer and I was made Supply Officer for the army, with our regiment scattered all about the front, in charge of the depots and parks and also doing a lot of shop work.

We soon got some more machinery up here and put up a couple of good-sized shops where we could handle pretty good-sized jobs, machine, carpenter and blacksmith. I usually spent one day in the office and the next going out around the different places.

We got our engineering materials out in large quantities and placed well up to the front ready for the drive that started on November 10, so we were all ready to go forward; and then the armistice was signed on the eleventh and fighting stopped at eleven o'clock on that morning, and now we are hauling all that stuff back to the depots.

Part of our regiment were transferred to the Third Army, known as the Army of Occupation, and we soon started for Germany. That was a very interesting trip, for we passed over the old front lines of both sides and on up into Luxemburg and then across to Prussia. It was a grand sight to see the American troops by the thousands marching across the Moselle River bridges

into the enemy territory that Sunday morning, and an inspiring one, especially to those of us who had been so closely in touch with things for the past few months.

And now our regiment is all back here with the Second Army again, helping straighten out things and get the materials together, and the machines brought back to the depots so it will be in good shape to move; and what is more, we do not care how soon this is finished and the word comes to get ready to go home, for there is not a one of us but is anxious to shake this country and set foot on good old U. S. A. soil again. And I guess the most of us will agree with the fellow who, after landing in N. Y., said, "The Statue of Liberty will have to turn around if she ever wants to look me in the face again."

Request for Correct Addresses

The names listed below are those of members of the Society whose addresses are either unknown or upon which there is doubt. The Secretary will be pleased to receive information regarding the present addresses of these members.

Address Unknown

Barry, John L.
I. C. Green.
Robert M. Hale.
J. J. de Kinder.
James L. Kirsch.
Samuel F. McIntosh.
George P. Marrow.
Sir Charles H. A. F. L. Ross.

Address Doubtful

Chalmers B. Boles, c/o Wilson & Co., 71st St. and Ashland Ave., Chicago, Ill.
Capt. George S. Brady, 613 G St., N. W., Washington, D. C.
Lieut. Col. H. M. Byllesby, 1607 H St., N. W., Washington, D. C.
William W. Chace, Amesbury Apt., 18103 Canterbury Rd., Cleveland, O.
David P. Clemmer, U. S. S. B., 72 W. Adams St., Chicago, Ill.
Benjamin J. Cline, c/o Holt Mfg. Co., Peoria, Ill.
William H. Doron, c/o The Barrett Co., 17 Battery Pl., New York, N. Y.
Hugh H. Hargrave, 2238 Cecil Ave., Baltimore, Md.
First Lieut. William Knight, 509 W. 174th St., New York, N. Y.
Ragnvald Naess, Philippine Vegetable Oil Co., Inc., 608 Fife Bldg., San Francisco, Cal.
Capt. Burritt A. Parks, 509 Grand Rapids Saving Bldg., Grand Rapids, Mich.
Harold D. Root, 277 N. 20th St., East Orange, N. J.
Herbert S. Selindh, Holly Sugar Corpn., Swink, Colo.
Capt. Alexander C. Sladky, 892 14th St., Milwaukee, Wis.
E. Platt Stratton, 80 Broad St., New York, N. Y.
Capt. John Weber, 4413 15th St., N. W., Washington, D. C.
James J. Zimmerman, 313 South St., Johnstown, Pa.

Prize Essay Contest in Industrial Economics

The National Industrial Conference Board, Magnus W. Alexander, Mem.Am.Soc.M.E., Managing Director, offers a prize of one thousand dollars for the best monograph on any one of the following subjects:

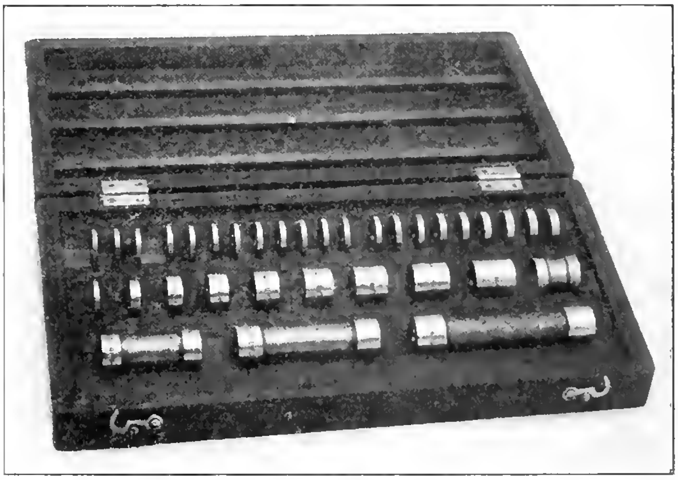
1 A practicable plan for representation of workers in determining conditions of work and for prevention of industrial disputes.
2 The major causes of unemployment and how to minimize them.
3 How can efficiency of workers be so increased as to make high wage rates economically practicable?
4 Should the State interfere in the determination of wage rates?
5 Should rates of wages be definitely based on the cost of living?
6 How can present systems of wage payments be so perfected and supplemented as to be most conducive to individual efficiency and to the contentment of workers?
7 The closed union shop *versus* the open shop: their social and economic value compared.
8 Should trade unions and employers' associations be made legally responsible?

The Committee of Award is composed of Frederick P. Fish, Chairman of the National Industrial Conference Board; Dr. Jacob Gould Schurman; Henry R. Towne, Past-President, Am.Soc.M.E.

Manuscripts, to be considered in the contest, must be mailed on or before July 1, 1919, to the National Industrial Conference Board, 15 Beacon Street, Boston, Mass., marked "For Prize Essay Contest in Industrial Economics."

Manufacture of Precision Gage Blocks at the Bureau of Standards

During the annual meeting of the A.S.M.E. in December, 1918, the demonstration conducted in the Branch Gage Section of the Bureau of Standards, in the Engineering Societies Building, New York, showing the utility of the light-wave interference method for measuring the precision gage blocks being made at the Bureau of Standards, attracted the attention of many members of the Society. The unheard-of accuracy with which these blocks were being produced, and the accuracy and facility with which comparisons of length, tests of flatness and parallelism were made by the interference method, resulted in many comments upon the method both as being novel and of particular interest.



Set of Gage Blocks Made by the Bureau of Standards

It is possible to produce these commercially to the remarkable accuracy of five millionths of an inch for length, flatness and parallelism through the use of the light-wave interference method of measurement

At that time there were exhibited several different sizes of precision gages which had been completed by the Bureau. Those who were fortunate enough to visit the Branch Laboratory will recall that the blocks produced are of a cylindrical shape rather than a prismatic shape, as are the similar Swedish gages. The blocks are made cylindrical rather than prismatic for the reason that greater wearing surface is secured, additional applications for direct measurement are possible, and the cylindrical shape is more economically manufactured.

There is shown in the accompanying illustration one of several sets of the cylindrical blocks which have been completed by the Bureau of Standards. The various blocks of these sets are being produced commercially to within an accuracy of 0.000005 in. for length, flatness and parallelism of the end surfaces. It has been found comparatively easy to hold the flatness and parallelism of the blocks to within about two millionths of an inch; and with special care absolute length may be held within this accuracy. However, for commercial sets the limit of five millionths of an inch mentioned above is deemed satisfactory.

The manufacture of these precision gage blocks is being carried out by the Gage Section, Bureau of Standards, in collaboration with the Engineering Division, Ordnance Department, U. S. A. When it is considered that there has been developed in a period of about six months the art of making gage blocks more accurate than those heretofore obtainable only in Sweden, where the manufacture has been carried on for 10 or 15 years as a secret process, the achievement represented in the development of the process for manufacturing these gages commercially will be realized.

The success in the development of the manufacture of the precision gage blocks on a commercial basis has been due largely to the efforts of Mr. H. L. Van Keuren, Mem.Am.Soc.M.E., Chief of the Gage Section, Bureau of Standards; Lieut.-Col. E. C. Peck, Head of the Gage Section, Engineering Division, Ordnance Department; and the inventor, Major William E. Hoke, Gage Section, Engineering Division, Ordnance Department. In addition, the facilities of the Optical Division and Metallurgical Division of the Bureau of Standards, and the full coöperation extended by Dr. S. W. Stratton, Director of the Bureau of Standards, has made it possible to realize a very rapid progress in overcoming unforeseen obstacles and securing blocks extremely accurate in flatness, parallelism and length.

Machine-Gun Cooling Problem

The Inventions Section of the General Staff is desirous of obtaining a solution of the problem of improving the methods of cooling machine guns during continuous fire, and the prevention of the freezing of the cooling liquid during cold weather when the gun is not in use.

At present the ordinary water-cooling system is used. It is necessary to transport several boxes of water for each gun in the field, as the water in the cooling jacket quickly turns into steam during firing. The following points should be observed in the solution of this problem:

1 It should be easily obtainable
2 It should be easily carried
3 It must not be too expensive
4 It must not injure the metal parts of the gun
5 If possible, it should be capable of being used several times so as to avoid extra weight
6 A minimum of waste during use should be obtained.

It must not be assumed from the above that a cooling system for machine guns must necessarily follow the lines of the present water-filled jacket. Any efficient method of cooling will receive serious consideration.

Correspondence in regard to this matter should be addressed to the Inventions Section, General Staff, Army War College.

The Relation of an Engineering Society to the Training of Workers

Two letters of general interest to engineers have been received by Mr. L. C. Marburg, chairman of the Committee on Aims and Organization, relating to the present and future need for the training of industrial workers. That this is one of the greatest of industrial problems cannot be doubted, and it is contended by each of the writers that it should come within the aims and purposes of the "Society of the Industries." We are informed by Mr. Marburg that, as a matter of fact, his committee expects to take up the subject of better training for industrial workers under heading A5 of the program entitled Education and Special Training. Quotations from the two letters follow:

U. S. DEPARTMENT OF LABOR
Washington, D. C.

I regret that you have not included in the outline of professional aims a paragraph relating to better training for industrial workers. Of what value are the most excellently conceived plans if there are not at hand men or women trained and sufficiently skilled to understand those plans, to appreciate their value and to execute them with efficiency and economy? As all students of development understand, this country has drifted into the habit of expecting to recruit its skilled labor from other lands and has not in any adequate manner made provision for replenishment of its supply of skilled workers. The rising wage scales and habits of other lands have dried up the stream of skilled labor supply. Even before the war broke out practically no skilled labor was coming to America. Now we cannot expect that any will come for several years, and unless American industries set out with deliberate purpose and broad understanding to inculcate training, we may find ourselves some fine morning with work to execute and nobody to do it.

This is an engineer's job if I ever saw one; and only engineers with professional ethics, with a broad point of view, with cultivated understanding, can save the situation.

C. T. Clayton,
Director.

UNITED STATES SHIPPING BOARD
New York City

This seems to be a subject which should receive a great deal of attention from the A.S.M.E. There are, I believe, four distinct branches in which the Society could very profitably interest itself, and for which there is a distinct need for definite consideration on the part of a representative body:

1 Legislation for regulating the conducting of training work in factories, whereby it shall be kept up to certain standards and conducted on certain systematic and thoroughgoing principles, possibly first considering the actual need of men required in the industry in order that clashes may be avoided with organized labor.
2 Preparation of material for the conducting of this work.
3 In connection with No. 1 the determination and promotion of standard methods and utilization of qualified instructors.
4 Organization of instructors and directors of training committees.

In this connection may I point out that the work of the United States Shipping Board in education and special training has been confined mostly to the training of men to increase and cheapen production.[1] This has resolved itself into three definite branches of work:

1 The training of tradesmen, utilizing these men as instructors and giving to them the necessary instruction in order that they may become capable teachers. The one great weakness in any training scheme heretofore has been due to the fact that the ordinary tradesman is anything but a good teacher.
2 The training of foremen, particular stress being laid on the handling of men.
3 The giving of supplementary courses in evening schools and other public institutions, the information given being very closely tied up with the work done by the men in the yards.

The foregoing, of course, involved the utilization of a large number of men who were already trade teachers and the getting out of a large amount of instructional material. A few figures will enable one to gage more definitely the amount of work that has been accomplished in this district alone in connection with the shipbuilding program: Twenty staff instructors have been utilized (for training the skilled shipyard men to become instructors); 390 tradesmen have been trained as instructors; 500 foremen have received foremen training courses; 3000 students have received supplementary training in evening schools, and 15,000 men have been broken in as shipyard tradesmen by the organized training methods of the Fleet Corporation.

R. V. Rickford,
District Representative, Education and Training Section.

The Bureau of Standards Gage Laboratories

THE Gage Section of the Bureau of Standards has become known to a large number of American manufacturers who required limit gages in the production of interchangeable parts for munitions of war. There has been developed at the bureau an adequate organization, and the apparatus, equipment and methods in use are such as to permit the accurate and quick testing of various types of gages, including screw-thread plug and ring gages, profile gages and plain gages, as well as precision standards, measuring tools and apparatus.

In addition to the Gage Section at Washington, branch gage sections have been established in the Engineering Societies Building, 29 West 39th Street, New York City, in the Plymouth Building, 22nd and Prospect Avenue, Cleveland, Ohio, and in the Meigs Building, Bridgeport, Conn.

Up to the present time the gages tested by the Bureau have been either for departments of the Federal Government, or manufacturing concerns who were executing war contracts. In the last few weeks, however, quite a number of gages have been submitted by manufacturing concerns engaged in peace-time production. It is the desire of the Bureau to meet this situation as it is felt that the organization and apparatus developed for war purposes should be maintained for the benefit of manufacturers during peace times. The future possibilities of this work, however, depend entirely upon the coöperation secured from manufacturers. The future possibilities of this work depend entirely, however, upon the coöperation secured from manufacturers.

Work of the Technical Staff

In connection with the work of the technical staff there has been accumulated a vast amount of information and data on the

[1] Some interesting pictures and a somewhat more detailed account of the work are given in *International Marine Engineering*, January 1919.

construction, measurement and use of all kinds of gages, and it is planned to use the technical staff now available for the preparation of pamphlets, publications and other literature in order to make this information accessible to American manufacturers. Furthermore, the technical staff will be engaged in research work: on steel treatment and methods used in the manufacture of gages; in developing, perfecting, designing and constructing simple forms of measuring instruments for shop use; and in arranging formulæ, charts and methods of computation in simplified form for the use of toolmakers and gage makers.

For the work of the technical staff, as outlined above, where the results are of general utility to American manufacturers, no charge will be made for the service rendered.

Schedule of Fees for Gage Testing

A nominal fee will be charged, however, for the routine test of gages when the results of the test will be of benefit to but one or two parties. The amount of this fee will depend largely on whether the gage is one that is easily measured, or is a complicated gage requiring the expenditure of considerable effort in its test. The fee will be based upon the accuracy of the test desired. The following schedule of fees is proposed:

Plain plug gages	$0.50 each
Plain ring gages	0.50 each
Snap gages	0.50 each
Flat or round-end standards or checks	0.50 each
Measurement of any one element, such as lead, angle, or diameter, of threaded plug gages	0.50 each
Measurement of lead or angle of threaded ring gages	0.50 each
Complete measurements of thread gages	1.00 each
Photographs of form of thread of threaded plug or threaded ring gages	0.25 each
Profile gages or fixtures	1.00 and up

(Depending upon the complexity.)

Such gages, instruments or tools as may be submitted for test should be accompanied with drawings or specifications with which they are supposed to conform in order to facilitate the test and to permit the reporting of the important dimensions of the gage submitted. Also, complete information should be included as to the route of the shipment of gages, the nature of the test desired, and the disposal of the gages after test.

Gage Shop

A gage shop was organized at the Bureau of Standards in Washington for the salvage of master gages and for the manufacture of master and inspection gages which were needed by the War Department for exigency purposes; such as to prevent stoppage of production, or for immediate use overseas. This shop, while not large, is equipped to manufacture all types of precision gages including precision end standards, profile gages, plug, snap and ring gages, and threaded plug and ring gages.

It is planned that this shop be used for the manufacture of such standard gages as may be required for certain apparatus, such as complete sets of standards for the use of the Government and American manufacturers, like those designated by the National Screw Thread Commission. These standards will be deposited in Washington, and possibly extra sets will be available at the branch laboratories for use in connection with problems or disputes arising among manufacturers. It is proposed, also, that this shop be utilized for the building of gages for manufacturers when the need is very urgent.

Manufacturers are urged to utilize the facilities of the Gage Section to the fullest extent in connection with their manufacturing work. In order that suitable arrangements can be made to handle promptly the routine work of gage testing, it is requested that the Bureau of Standards be advised now of the desire of manufacturers to submit gages for test and to utilize the other facilities available, and, also, that they notify the Bureau as to the approximate number of gages that they may wish to submit during the coming year.

United Engineering Society

Annual Report of President

During 1918 the activities of the United Engineering Society, the Library, the Engineering Foundation and Engineering Council were deeply affected by the German war and much important war work has been done in our building.

The endowment of Engineering Foundation was increased to $300,000 by an additional gift of $100,000 from Ambrose Swasey.

By bequest of Dr. James Douglas the American Institute of Mining Engineers received an endowment of $100,000, the income of which will be expended in the maintenance of its library (now a part of the joint library).

The Library has continued to grow and improve and now contains over 153,000 books and pamphlets. The Library Service Bureau has gained steadily. Its business for 1918 amounted to nearly $10,000.

Indexing of current engineering literature has been undertaken in conjunction with the Founder Societies and the Index is being printed in their publications. This service has been extended to the Engineering Institute of Canada and the Canadian Mining Institute. The expense is borne by the Societies. In this connection The American Society of Mechanical Engineers has purchased the Engineering Index heretofore published by *Industrial Management*.

In June the Westinghouse and General Electric companies donated to the United Engineering Society their Patent Control Library of about 8000 volumes. Other noteworthy gifts were a collection of 370 pieces relating to patent litigations, from Jesse M. Smith, and Dr. William Paul Gerhard's collection on gas engineering, transferred by the American Gas Association.

For lack of means the combined libraries of the Founder Societies have never been recatalogued as one library. The Library Board has just voted to undertake at once the complete recataloging of the Library. This work is estimated to cost from $20,000 to $25,000, and to require about two years. United Engineering Society can finance the project if the four Founder Societies are willing to contribute $2500 each per year until the work is done.

War conditions continued to interfere with the receipt of foreign publications throughout the year. Details of the Library's work for the year are recorded in the annual report of the Library Board. [See Mechanical Engineering, February, 1919, p. 183.—Ed.]

The membership of Engineering Foundation Board was increased in April from eleven to sixteen and an executive committee of five members was provided.

The following matters have been considered by Engineering Foundation:

There has been continued coöperation with the National Research Council;

Information collected about industrial laboratories in this country;
Continued investigation of the wear of gears;
Investigation of spray camouflage for vessels;
Investigation of secret selective control of wireless communication;
Investigation of weirs for measurement of water.

The foundation offered to make a survey of existing engineering societies and to formulate recommendations regarding coöperation, but the suggestion was not accepted by the Founder Societies.

The annual report of the Foundation shows income for 1918 $10,929.67, expenditure $7,490.76, and accumulated unexpended income $30,253.88. Its income is now $15,000 a year.

On May 2 a dinner was given at the Engineers' Club to Dr. George E. Hale, Chairman, and other representatives of National Research Council, by the officers of the Founder Societies, and a large meeting was held in the Auditorium on May 28 at which an address was made by Dr. Hale.

A joint meeting of United Engineering Society and Engineering Foundation Board was held October 7 to receive Mr. Swasey's additional gift of $100,000. This fund is in the form of securities and is deposited with the Cleveland Trust Company, of Cleveland, Ohio. November 14 a dinner was given to Mr. Swasey at the Engineers' Club, to which were invited the governing bodies of the four Founder Societies, the Engineering Foundation Board, the Library Board, Engineering Council and officers of the Club; seventy-two were present, including twenty-one presidents and past-presidents of the Founder Societies.

An oil portrait of Ambrose Swasey, painted by Weerts, of Paris, was presented by him to United Engineering Society and has been hung in the Library along with the portrait of Dr. James Douglas.

Engineering Council has devoted much of its energy to war work. The Council's work has been done through its general meetings, many committees and its secretary's office.

The committee called "American Engineering Service" was succeeded in November by Engineering Societies' Employment Bureau. It collected personal information about many thousands of engineers and filled many requisitions from various governmental departments, supplying the names of engineers carefully selected in each case. In addition, many engineers and vacant positions in civil life were brought together. The secretaries of the Founder Societies constitute the Board of Directors of this Employment Bureau.

The War Committee of Technical Societies devoted itself largely to reviewing thousands of inventions and suggestions for war work.

It was associated with the Naval Consulting Board. The Committee was discontinued in December.

Other committees appointed by Engineering Council have been the:

Fuel Conservation Committee
Public Affairs Committee
Patents Committee
Water Conservation Committee
License Committee
National Service Committee.

The Engineering Council has established an office in Washington, D. C.

Invitations have been extended to three additional societies to have membership and representation in Engineering Council.

The John Fritz Medal Board of Award, composed of representatives chosen by the Board of Directors of the four Founder Societies, awarded the medal for 1918 to J. Waldo Smith, "For achievement as engineer in providing the City of New York with a supply of water." The medal was presented before a large audience in the Auditorium on April 17.

The Engineering Societies Building has been fully occupied throughout the year. There are several applications for increased space, as well as applications from societies not now represented in the building. During the year the gratuitous use of the auditorium and meeting rooms was granted for various war purposes on twenty-two occasions. The taxes assessed upon portions of the building have been reimbursed by the six taxable societies. A change has been made in the superintendent, also the bookkeeper, resulting in economy and better efficiency.

The Society responded to the requests of the Fuel Administration for heatless Mondays and complied with the requests of the Board of Health of New York as to office hours during the influenza epidemic.

Four men who contributed largely of service or means to United Engineering Society have died since the last annual meeting: Dr. Frederick R. Hutton, Robert M. Dixon, Dr. James Douglas and Dr. Rossiter W. Raymond.

At this date the membership of the four Founder Societies is 36,000, and of associate societies 21,500, so that a total of 57,500 engineers now have headquarters in our building.

Funds for the benefit of Engineering Societies Library were obtained during 1918 from the following sources:

American Society of Civil Engineers	$4,000.00	
American Institute of Mining Engineers	4,000.00	
American Society of Mechanical Engineers	4,000.00	
American Institute of Electrical Engineers	4,000.00	
Income from Endowment Fund	5,000.00	
Total income		$21,000.00

Library expenses were as follows:

Salaries (except Service Bureau)	$15,137.59	
Books and binding	3,905.90	
Supplies and miscellaneous expenses	1,682.27	
Total		20,725.76
Unexpended balance		$ 274.24
Funds for the work of Engineering Council were provided by contributions of $4,000 each from the Societies of Civil, Mining, Mechanical and Electrical Engineers—Total.		$16,000.00

Engineering Council's expenditures were:

Secretary office	$6,368.85	
American Engineering Service and Employment Bureau	4,099.72	
National Service Committee	500.00	
War Committee of Technical Societies	2,257.68	
Traveling	363.54	
Total		13,589.79
Unexpended balance, December 31, 1918		$ 2,410.21

The income of the Society during 1918 was	$77,759.61
The expenditures totaled	72,342.28
Surplus for the year	$ 5,417.33
The surplus at the close of 1917 was	$ 8,116.10
The gain for 1918 has been	5,117.33
Total	$13,533.43
Amount now transferred to the Depreciation and Renewal Fund	8,000.00
Leaving the surplus December 31, 1918	$ 5,533.43

The General Reserve Fund established in 1915 remains at $10,000. The Depreciation and Renewal Fund is $86,163.78, the total of the two funds being $96,163.78.

The credits to the funds have been as follows:

	From General Funds	Interest
1907	$ 5,000.00	......
1908	5,000.00	......
1909	5,000.00	......
1910	5,000.00	......
1911	5,000.00	......
1912	5,000.00	......
1913	10,000.00	......
1914	20,000.00	1,441.39
1915	5,000.00	2,404.28
1916	10,000.00	2,610.45
1917	Nothing	3,581.29
1918	8,000.00	3,126.37
	$83,000.00	$13,163.78
	13,163.78	
	$96,163.78	

Beginning with 1915 the sum of $10,000 per year, plus interest earned, should have been added to the Depreciation and Renewal Fund in accordance with the action of the Trustees, November 19, 1914, or $40,000 for the four years of 1915, 1916, 1917 and 1918, but the income has not been sufficient and only $23,000 of the amount has thus been set aside.

The Funds held by the United Engineering Society December 31, 1918, were as follows:

Engineering Foundation Fund	$303,374.80
Library Endowment Fund	102,559.70
General Reserve Fund	10,000.00
Depreciation and Renewal Fund	86,163.78
Surplus	5,533.43
Total	$507,631.71

The real estate owned by United Engineering Society is valued at $1,947,171.16. The total net assets are $2,454,802.87.

The Finance Committee has very effectively supervised the accounts, the assessments, expenditures and the investments. Acknowledgements are also due the House Committee, composed of the secretaries of the Societies, for careful attention to the details of management of the building, and especially to Mr. Alfred D. Flinn, who has acceptably filled the post of joint secretary of the United Engineering Society, The Foundation and Engineering Council.

The affairs of the Society are believed to be in a satisfactory condition.

Charles F. Rand,
President, United Engineering Society.

FUEL PROBLEMS OF THE PACIFIC COAST

(Continued from page 269)

commercially practicable is compared with that of a high-grade compound locomotive working at maximum practicable steam pressures and superheat:

CENTRAL-STATION STEAM PLANT

Assumed steam pressure, lb. gage	300
Superheat, deg. fahr.	250
Vacuum (30 in. bar.), in.	28.5
Temperature of steam, deg. fahr.	672
Total heat above 32 deg. fahr. B.t.u.	1345.8
Available energy per lb. of steam, ft-lb.	340,500
Heat efficiency, per cent	33.8
Efficiency of turbine including generator losses, per cent	78
Efficiency of boilers, per cent	75
Thermal efficiency of turbo-generator: $33.8 \times 0.78 \times 0.75 =$	19.8
B.t.u. per kw-hr. at generator $= \frac{3412}{0.198} =$	17,230
B.t.u. per kw-hr. at switchboard allowing 2.5 per cent for auxiliaries, etc.	17,660
Assumed load factor, per cent	50
B.t.u. per kw-hr. output of plant at 50 per cent load factor	21,200
Lb. coal of 11,500 B t.u. per kw-hr. output of plant	1.84
Assume average percentage efficiencies of transmission and conversion from power house to drawbars of electric locomotive as follows:	
Step-up transformers 98.5	
Transmission line 95	
Step-down transformers 97.5	
Conversion apparatus 88	
Trolley distribution 90	
Locomotive 88	
Combined efficiency power house to locomotive drawbars 63.4	
B.t.u. per drawbar hp-hr. $= \frac{21,200}{0.634} \times 0.746 =$	25,000
Lb. coal of 11,500 B.t.u. per drawbar hp-hr. =	2.17

COMPOUND LOCOMOTIVE WITH SUPERHEATERS

Assumed steam pressure, lb. gage	225
Operating steam temperature, deg. fahr.	625
Superheat, deg. fahr.	227
Total heat above 32 deg. fahr., B.t.u.	1326.6
Available energy per lb. of steam, ft-lb.	184,500
Heat efficiency, per cent	18.5
Efficiency of engine (steam and mechanical), per cent	75
Efficiency of boilers, per cent	65
Efficiency from fuel to drawbar, per cent: $18.5 \times 0.75 \times 0.65 =$	9.02
B.t.u. per drawbar hp-hr. $= \frac{2550}{0.0902} =$	28,300
Assume load factor, per cent	25
B.t.u. per drawbar hp-hr. at 25 per cent load factor	46,000
Assume standby and other unavoidable abnormal losses, per cent	30
Total B.t.u. per drawbar hp-hr.	65,700
Lb. coal of 11,500 B.t.u. per drawbar hp-hr.	5.7

AMONG THE LOCAL SECTIONS

(The Usual Brief Accounts of the Sections' Meetings and Student Meetings Will Be Found in Section Two of MECHANICAL ENGINEERING.*)*

WE are just about in the middle of the active season for the Local Sections' work, and now is a good time to comment on how things are going and what are the prospects for accomplishing what we set out to do; what are the new tendencies and what will be the outcome at the end of the year.

Most of the Sections have now resumed their programs which were abruptly halted by the influenza epidemic, and some exceedingly interesting meetings are being held. For example, Cleveland carried out successfully on February 4 the first of its quarterly all-day conventions with the following program: 10:00 a. m., Rubber and Its Manufacture by Prof. H. E. Simmons, Akron; 11:00 a. m., Electric Traveling Crane Development (Illustrated) by G. W. Shem, Alliance Machine Co.; 12:30 p. m., luncheon served in C. E. S. rooms. Following this Colonel J. R. McQuigg gave an address on Some Experiences of Engineers in France. Automobiles were provided to take 250 guests and members to the new plant of the National Acme Company, which comprises over seven acres under one roof and an installation of the largest and most modern screw machines.

The party returned in time to arrive at the University Club where dinner was served at six o'clock. Dr. Charles S. Howe, President of Case School of Applied Science, was Toastmaster. Addresses were made by C. A. Otis of the War Industries Board and Major J. R. Campbell of the Ordnance Department on How the Big Guns Were Developed. Motion pictures taken at Aberdeen Proving Grounds were also exhibited. Over three hundred sat down to dinner.

Other meetings of unusual interest have been held at Boston and New York at which addresses were made by the representatives of the various societies who went abroad at the request of the engineers of France to confer on reconstruction problems. Accounts of these meetings are given elsewhere in this number.

Secretary Rice, at the time of writing, is on his second trip among the Sections and his experiences are being reported in another column. When he has completed this trip and also a third trip contemplated for the middle of March, he will have visited every Section as well as a number of places in which Sections are contemplated.

Mr. Ernest Hartford of the A.S.M.E. staff has been released by the War Department, and has now returned to his work in connection with Sections affairs. He has recently visited Cleveland, Akron, Erie, and Buffalo.

At the last meeting of the Meetings Committee a tentative program for the Spring Meeting was laid out and one of the professional sessions was assigned to the Mid-Western Sections for them to procure the papers; and the Chairman was instructed to visit Detroit and find out to what extent the suggestion could be put into effect. If it materializes that the Sections carry out this session, with the Detroit Section responsible for the entertainment of the whole convention, then the Sections will truly have played an important part in the Spring Meeting.

Coöperation with the Aims and Organization Committee should be pushed at this time. This Committee hopes to have a meeting about the end of March, and before long the Section delegates will take up with their respective Local Sections the matter of assigning a definite meeting to the discussion of this Committee's program. In the same connection, Local Committees should have received requests from delegates for the appointment of subcommittees in each Section to support these delegates; to date, about six Sections have made such appointments. This Committee's work is very urgent, as the field is enormous and the Committee has to make a report by the Spring Meeting.

Coöperation between the Increase in Membership Committee and the Local Sections has been initiated by the former Committee asking the Local Committees to what extent they have developed membership increase in their Sections. A number of helpful replies have been received and it is expected that the two major committees will shortly formulate a plan of coördination of activities.

An Unoccupied Rung in the Engineer's Ladder of Fame

DETROIT and the Detroit Section had the honor of being first to have an address from the new President of The American Society of Mechanical Engineers, Dean M. E. Cooley. President Cooley spoke at a special meeting of the Detroit Section held at the Board of Commerce on January 11.

He said that the Secretary at first asked him to make some informal remarks; but that later he had asked him to wire the title of his *address*. He had therefore spent a good part of one forenoon working up the title, and was so pleased with it that he wired it in immediately. But after he had sent the wire he had tried to think what he would say under the title. He told his audience that it was one of the finest titles he had ever worked out, and that some day he would write an address to go with it; but, nevertheless, the thought which he wished to bring to the meeting would work in with the title that he had decided upon, namely, An Unoccupied Rung in the Engineer's Ladder of Fame. Continuing, President Cooley said in part:

"It is unnecessary to point out to a body of engineers what engineers have accomplished in the development of the material part of the world's civilization. The entire world, so far as its material structure is concerned, can very justly be said to be the work of the engineer, or of professional men very closely allied to the engineer and to engineering. Our great buildings, our railways, the subways of New York City, would not be possible without the work of the engineer. But it is not necessary to enumerate such features. It is enough to say that it would be difficult to think of anything that makes it possible to live the life we are living—I am speaking, of course, of the material side—that was not conceived by the engineer.

"Then look at what has happened in our relations with different countries of the world through navigation on water and in the air, the latter developed to the most wonderful extent since the war began, and only in its infancy at the present moment. And look at the great conflict, with the result brought about by the work of the engineer—and the war itself brought about by the work of the engineer in the first place in helping to create commercial supremacy—fought and won by means designed and built by the engineer; and I think if the engineer had the settling of the war, it would be pretty well done; but it is going to be settled by other than engineers, and it won't stay settled, you can be sure of that. I don't want to speak in any pessimistic way at all, and I don't think I am so speaking when I say that it is in my bones that the war has just begun, absolutely just begun—that is a thought for you to carry away with you. Some of you will recall your study of history and the days of Augustus Cæsar, and following to the end of the decline of the Roman Empire, and at the beginning of the dark ages, when the Huns swept down and destroyed the civilization of the world. Who knows what the future has in store? Who can say that we are not going to have another dark age? I am not going to argue that we are at all—I just raise that question as something for you to think about. We are optimistic in this country. We are very optimistic with our opportunities in this country; we have no thought for the morrow except as we may make more than we made today.

"Now, all this leads around to the unoccupied rung I had in my mind.

"I have tried to show you that the engineer stands preeminent in the world today because of his work, upon which depends so much, the civilization in which we live, and because of which we have seen also the destruction in this war of civilization.

"Now, the engineer has done all these things in his professional capacity. We have wonderful experts. The different professions are filled with experts, men who know one thing and know it better than any other man in the world. It is natural that the engineer should become a specialist. It is the bread-and-butter thing for him to do. In doing this he is creating for himself a big reputation among his colleagues in engineering lines.

"But the engineering profession needs something more for itself, and the world needs something more from the engineer. The world needs the engineer with all his technical training to take a part in its general affairs, which up to now he has not taken. The engineer has not performed his duty to the general public. He has not given the general public the benefit of his knowledge which would enable many of the great questions which are puzzling the world today to be settled over night—if there was any desire to have them settled.

"Take your Detroit street-railway situation—you may not have heard of that. (Laughter.) It is as simple a problem as A, B, C; but does Detroit want it settled? What would be done for political capital if it were settled? *Quien sabe?* I am told that the same thing is true of Chicago. The engineer's job, as I see it in such a situation, is to make it known that problems like these can be settled if the people want them settled, and that the engineers know how to settle them.

"So the idea I had in mind in choosing this title that has been announced this evening, viz., this unoccupied rung in the engineer's ladder of fame, has to do with the engineer occupying positions in public relations which he has not up to now occupied.

"What is the best training for taking this position; going back to the college, for instance? I would say that the best training would be secured by first recasting the engineering curricula that we have. Leave out of them, at least, a quarter or half of the professional stuff that is now taught, and substitute for it the good old stuff that we used to have crammed down our throats when some of the older of us were boys or young men. I believe it to be a fact that the engineer who was graduated back in the 70's or 80's was a much more broadly educated man than the engineer who is graduated today. He was a better man to cope with the general problems that arose in the field of engineering, for the man graduated today can do only one thing, as a rule, while in those old days he could do a good many things well. While this may sound like heresy, I believe, nevertheless, that we should make our education more liberal. And if I can do one thing more before I finish my work at the University of Michigan, and one thing while I am president of The American Society of Mechanical Engineers, it will be to hammer on the one thought that we must break down the walls which we are building around the young men who are in college—walls built so high that they cannot look over. Break them down and use your influence to have them broken down. See that your boys, who are going to become engineers, are so trained that they do not have to remain privates or non-commissioned officers in an army of engineers but that they can be field officers, line officers, major-generals, lieutenant-generals of engineering, men who are qualified to be on the hilltop and look far away and have a proper perspective. That is what I mean by the unoccupied rung in the engineer's ladder of fame.

"Where do you find engineers occupying big public positions, political positions, if you like? But we do not like politics. How many engineers are there in Congress, how many in the cabinet? How many on the public-service commissions? Answer these questions and you will find where the unoccupied rung is. Perhaps we cannot do much in the little of life that is left to us, but certainly we can train those who follow us, and those who follow them. We should bring up in this country a different kind of engineer, a man who by his broad education and training will stand head and shoulders above the professional man of today. That is the kind of man I want to see, and you gentlemen can do it. My message to you tonight is to awake you to a sense of your responsibilities, not alone to your own profession but as an engineer and citizen to the public.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A. S. M. E.

THREE communications have been received in time for this number of MECHANICAL ENGINEERING which have been used in making up our notes for the current issue. Next month we hope to have many more. The success of the department depends on the coöperation of engineers who are engaged upon or are interested in research matters. Have you any data or inquiries to send in?

Information is desired relative to research work conducted by laboratories, either commercial or professional, by colleges, by Government institutions, or by individuals, and the Chairman would appreciate advice from any of these sources.

As outlined in the last number, the Research Committee hopes to conduct its department under the following heads:

A RESEARCH RESULTS
B RESEARCH IN PROGRESS
C RESEARCH PROBLEMS
D RESEARCH EQUIPMENT
E RESEARCH, PERSONAL NOTES
F BIBLIOGRAPHIES

The method of reporting work in these notes will be to give a title to research of a general nature followed by a serial number and the year. The special title will then be given. Reference by general title with numbers is all that is necessary. The name of the person is given from whom information may be had, together with the address.

ARTHUR M. GREENE, JR., *Chairman.*

B—RESEARCH IN PROGRESS

Metallurgy 2-19 Data on Influence of Size in Heat Treatment. (Research Committee of American Steel Treaters' Society.)

Metallurgy 3-19 Data on Critical Points. (Research Committee of American Steel Treaters' Society.)

Metallurgy 4-19 Statical Tests on Special Steels in Connection with Different Heat Treatments. (Research Committee of American Steel Treaters' Society.)

Metallurgy 5-19 Standard Heat Treatment of Gears, Shafting, etc., with Regard to Dimensions. (Research Committee of American Steel Treaters' Society.)

The above list represents the problems of a committee of a sister society and any data had by our members would be gladly received by their secretary, E. J. Janitzky, Metallurgical Engineer, Illinois Steel Co., So. Chicago, Ill.

Metallurgy 1-19 Bearing Metals. (Sub-Committee on Bearing Metals of the A.S.M.E., Christopher H. Bierbaum, *Chairman*, Buffalo, N. Y.)

Heat 1-19 Heat Transmission. Transmission of heat through various forms of partitions. (Sub-Committee on Heat Transmission, A.S.M.E. George A. Orrok, *Chairman*, 29 W. 39th St., New York.)

Lubrication 1-19 Lubrication. (Sub-Committee on Lubrication of the A.S.M.E. Albert Kingsbury, *Chairman*, Pittsburgh, Pa.)

Meters 1-19 Flow Meters for Fluids. (Sub-Committee on Flow Meters, A.S.M.E. R. J. S. Pigott, *Chairman*, 29 W. 39th St., New York.)

C—RESEARCH PROBLEMS

Gases 1-19 Critical Velocity for Gases. (Submitted by Strickland Kneass, Jr., Youngstown, Ohio.)

E—RESEARCH, PERSONAL NOTES

A visit to the Bureau of Standards at Washington, D. C., by the Chairman of the Research Committee of the A.S.M.E. was made on Feb. 10, 1919. The Director of the Bureau, Dr. S. W. Stratton, explained some of the work of the Bureau and made clear that the Bureau is prepared to give to manufacturers advice relating to fundamental facts and researches of physics, chemistry or any branch of science on which their special application may rest. This institution is organized to give aid to those requiring it if this aid is confined to the fundamental principles.

F—BIBLIOGRAPHIES

Friction 1-16 Friction and Allied Subjects.

Research in Heat Transmission

At the recent annual meeting of the American Society of Heating and Ventilating Engineers George A. Orrok, Mem.Am. Soc.M.E., made a plea for coördination in research in heat transmission. Mr. Orrok is chairman of the sub-committee of the Research Committee of the A. S. M. E. on the subject of heat transmission, the other members of which are Prof. A. T. Wood, Dr. Harvey N. Davis, Dr. Edgar Buckingham and Arthur D. Pratt. Mr. Orrok said in the course of his remarks before the H. and V. Engineers:

The exigencies of the war have precluded the chance for any but the merest beginnings of the work of this sub-committee, as most of its members have been actively engaged in governmental activities. Mr. Buckingham is still in Italy; Mr. Pratt has had his hands full with work for the Emergency Fleet Corporation; Professor Wood with the S. A. T. C., and Dr. Davis and I with the helium work. However, we have found time to organize and partition the preliminary work among the various activities best fitted to secure results. Professor Wood has enlisted the committee of the American Society of Refrigerating Engineers in what I might call, in default of a better word, the "Insulation Division," and we have asked your committee of the American Society of Heating and Ventilating Engineers to work with them and coöperate along these lines and also in the subject of building materials.

Work on the radiator problem is being considered by your society as well as the A.S.M.E., and we shall be able to organize and coördinate this very shortly, as well as the kindred but very different line, that of aeroplane and automobile radiators. The problem of heat transfer under steam-generating conditions is also being organized and work is being done.

In the condenser and heater field there is yet some unpublished work which will be made public shortly and there are certain physical discoveries to be digested and applied to results already obtained. This work will be undertaken very soon and will be available.

In numerous other lines work has been laid out, and as fast as the men return from the front to their ordinary lines we shall endeavor to have work started and carried on to a satisfactory end.

But the main work of the committee, the formulation of an adequate and universal law of the transmission of heat, is, I think, very far off in the future. Dr. Buckingham, I believe, has stated that in the simple problem of the transfer of heat from steam to water through a copper tube there are 26 quantities entering into the equation, most of which are partially unknown or rather imperfectly known.

In this connection it is well to recall the many experimenters in this field who have worked on the same identical problem with results as diverse as can well be imagined. The fault lay in the apparatus used which had not been arranged with a view to the elimination of the many unknown factors affecting the transmission of heat. Some of these researches are of value today now that we know how to apply the proper correction factors, but most of them represent wasted effort. Another class of investigations are of little or no value because only such heat was transmitted as was present in the apparatus, the result being, of course, limited to this amount. Another class of experiments must be considered as useless since the leakage condition was so bad that no consistent results could be obtained. Let us report all contemplated and undertaken research to the committee, ask advice and avoid duplication.

Research Work and New Equipment at Purdue University

Tractor-Testing Laboratory. Through the agency of the Engineering Experiment Station at Purdue University, Lafayette, Ind., a new farm-tractor-testing plant is being constructed. The plan is to test farm tractors the same way as the locomotive has been tested at the same institution.

The equipment will be placed in a laboratory newly constructed for that purpose, and will include electric dynamometers, specially designed recording transmission dynamometers, and other apparatus. It is hoped by this means to assist in standardizing the information which the buying public, as well as the people who are in the market for the farm tractor, desire to know. A description, with photographs showing the complete plant, will be forthcoming for MECHANICAL ENGINEERING in the weeks to follow.

Research Work. For a year and a half extensive work has been carried on at Purdue University along two distinct lines: One, under the direction of Professor Berry, in connection with the Engineering Experiment Station, takes up the carbonization of liquid fuels. Four phases of this research work are worth mentioning: The first is the volatilizing temperatures of liquid fuels as affected by a "hot spot"; second, the effect of efficiency on internal-combustion motors with the wet or dry mixture; third, the effect on efficiency and power capacity of preheating the air; and fourth, the effect on efficiency of raising the temperature of the mixture. A paper on some one of these phases will probably be prepared by Professor Berry for presentation at the Spring Meeting.

Another line of unusual interest being carried on at the University relates to the utilization of crushed coal in furnaces connected with power plants. In this connection the coal is not dried nor is the crushing carried to such an extent as to be in any way known as powdered fuel. Thirty per cent of the coal is about the size of a grain of wheat. Later on, when the results are completed, the whole story will be presented in a formal paper.

LIBERTY ENGINE TESTS

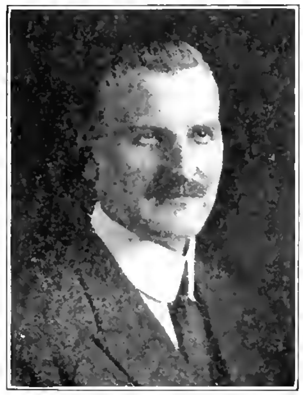
(*Continued from page 253*)

The mechanical adjustments when considered in connection with the motor inspection after test seemed to vary in proportion to the thoroughness of inspection between flights. Replacements which were made during the flight test all point to the same general kind of troubles in each case, and seem to be a true indication of the class of workmanship and inspection involved in the manufacture of these motors. It is quite probable, however, that many of the replacements made were not absolutely necessary for continual running, but they were considered essential for safety. (Bulletin, August 1918, p. 50.)

It may be added that the foregoing constitutes the first truly technical presentation of the achievement involved in the design and construction of the Liberty engine open to general engineering circles, and it is hoped it will help to dissipate the doubts and misunderstandings surrounding this subject. A general survey of these tests shows a careful and thorough effort to investigate all the elements contributing to the operation of the motor and a willingness to test the motor under strenuous conditions closely approaching those which it would meet at the front. Even though 160 hr. of continuous operation may not be sufficient to beat the average record of such an engine as the Rolls-Royce, it represents unquestionably a great achievement in view of the fact that the Liberty motor can be produced in quantity many scores of times greater than the Rolls-Royce could be produced under American conditions. Furthermore, for military use 125 to 160 hr. of useful life is fully adequate.

L. P. Alford
Member at Large

R. W. Angus
Ontario Section



E. S. Carman
Cleveland Section

R. Collamore
Detroit Section

C. H. Bierbaum
Buffalo Section

A. G. Duncan
Boston Section

S. B. Ely
Member at Large

J. T. Faig
Cincinnati Section

H. P. Fairfield
Worcester Section

H. Gassman
Birmingham Section

W. F. M. Goss
Member at Large

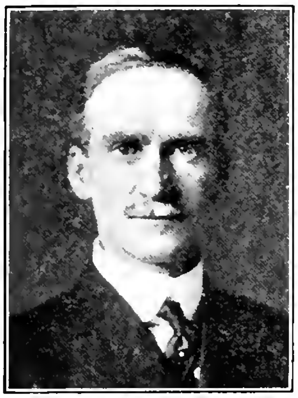
L. Gustafson
St. Louis

J. Hartness
Member at Large

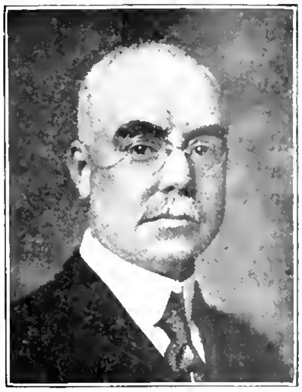
J. L. Henning
New Orleans

COMMITTEE ON AIMS AND ORGANIZATION

The question of national coöperation among engineers and the improvement of their position in the esteem of society, a question of first importance in ordinary times, has assumed even greater moment in the period of reconstruction following the war, and serious attempts are being made by all the national engineering societies to reduce this coöperation to a concrete form. The participation of The American Society of Mechanical Engineers in this movement is being engineered by the Committee on Aims and Organization, appointed



D. S. Kimball
Member at Large



C. E. Lord
Chicago

F. R. Low
Member at Large

L. V. Ludy
Indianapolis

T. C. McBride
Philadelphia

L. C. Marburg
Member at Large

G. K. Parsons
New York

G. I. Rockwood
Member at Large

SECTIONS' DELEGATES AND MEMBERS AT LARGE

E. F. Scott
Atlanta

C. M. Spalding
Erie

L. E. Strothman
Milwaukee

last December to "discuss and formulate the aims of the Society in the light of modern development and present-day thought, and to assist toward finding a method of coöperation with the rest of the engineering profession suitable to carry out the aims." The committee consists of one delegate from each of the local sections and seven members at large. It held a two-day meeting in connection with the Annual Meeting and plans to report to the Society at the forthcoming Spring Meeting, to be held in Detroit, Mich., June 16 to 19, 1919.

C. W. Tubby
Minnesota

A. E. Walden
Baltimore

COMMITTEE ON AIMS AND ORGANIZATION

ON pages 296 and 297 are given photographs of members of the new special Committee on Aims and Organization which held a two-days' session at the Annual Meeting, and which will meet again and prepare a report of progress to be presented at the business meeting of the Spring Meeting. The program of this Committee has already been published in MECHANICAL ENGINEERING, as well as the statement of its chairman of the results of its first sessions. The following supplement to the photographs will be of interest:

LEON P. ALFORD, member at large and member of the Executive Committee, is editor of *Industrial Management* and is an authority in that field. He is a graduate of Worcester Polytechnic Institute and has had many years' experience with machinery-building firms and in engineering editorial work. He is the author of several engineering publications. He has been active in committee work in the Society and was last year chairman of the Committee on Meetings.

CHRISTOPHER H. BIERBAUM, representing the Buffalo Section, has for twenty years made a special study of bearings, and in recent years has made extended researches on graphite and its application to lubrication. He is now doing special research work in the microstructure and microcharacteristics of the bearing alloys. He is chairman of the Sub-Committee on Bearing Metals of the Research Committee.

L. P. BRECKENRIDGE, representing the Connecticut Section, is best known for his work on fuels. He has been a teacher of mechanical engineering since 1882—at Lehigh University eight years, Michigan Agricultural College two years, University of Illinois sixteen years and Yale University five years. He has been very active in the work of the Connecticut Section.

E. S. CARMAN, representing the Cleveland Section, of which he is chairman of the Executive Committee, has been since 1913 secretary and chief engineer of the Osborn Manufacturing Company, Cleveland. He has been active in engineering society affairs for several years past; and especially active as librarian of the Cleveland Engineering Society, in advocating a united engineering organization for all branches of the profession.

RALPH COLLAMORE, representing the Detroit Section, has been continuously connected with the firm of Smith, Hinchman & Grylls since 1903. He has been president of the Detroit Engineering Society, the Michigan Chapter of the American Society of Heating and Ventilating Engineers, etc., and was chairman of the Organization Committee of the Detroit Section. He is a member of the Committee for Revising Building Codes of the City of Detroit, and was recently chairman of the Local Advisory Committee of the U. S. Fuel Administration.

ALBERT GREENE DUNCAN, representing the Boston Section, has been treasurer of the Harmony Mills, Cohoes, N. Y., since 1910. He has been active in society affairs and was at one time president of the National Association of Cotton Manufacturers. During the war he was appointed on the Boston Advisory Committee for the Purchase of Army Supplies.

SUMNER BOYER ELY, member at large, was at one time chief engineer of the American Sheet Steel Company, and secretary of the Board of Engineers of the U. S. Steel Corporation. He is a member and past officer of the Engineers' Society of Western Pennsylvania, and for the past year has been president of the University Extension Society of Pittsburgh.

JOHN T. FAIG, representing the Cincinnati Section, has been active in society affairs. He has been three times president of the Engineers' Club of Cincinnati, and is vice-president of the Society for the Promotion of Engineering Education. He was for twelve years professor of mechanical engineering at the University of Cincinnati, and since 1918 has been president of the Ohio Mechanics' Institute.

HOWARD P. FAIRFIELD, representing the Worcester Section, is secretary of the Sub-Committee of Machine Shop Practice of the Committee on Meetings. Since 1899 he has been on the faculty of the Worcester Polytechnic Institute, and in 1914 was appointed assistant professor of machine construction.

HOWARD M. GASSMAN, representing the Birmingham Section, was at one time chief electrical engineer of the Tennessee Coal, Iron and Railroad Company. Since 1916 he has been engaged in general consulting work along power and industrial lines, with offices in Birmingham.

W. F. M. GOSS, member at large, past-president of the Society, is president of the Railway Car Manufacturers' Association. He came to this position in 1916, after having been for eleven years dean of the College of Engineering at the University of Illinois.

LEWIS GUSTAFSON, representing the St. Louis Section, is chairman of this Section for the current session. He has been superintendent of The David Ranken Jr. School of Mechanical Trades, of St. Louis, since 1907, and prior to that for several years was with the Lewis Institute of Chicago.

JAMES HARTNESS, member at large, and past-president of the Society, is known as an inventor and manufacturer of various machines for metal turning, designed to take the place of the engine lathe. He has been granted over one hundred patents in this field. He is president of the Jones and Lamson Machine Company of Springfield, Vt.

JOHN LOVEJOY HENNING, representing the New Orleans Section, has been for twenty years with the Union Sulphur Company, operating the Frasch process for sulphur mining. He is now vice-president of this company and in charge of all their interests in the South.

DEXTER S. KIMBALL, member at large, is the chairman of the Committee on Meetings and Programs of the Society. He has been professor of machine design and construction at Cornell University since 1904, and during the summer of last year was acting president of the university. He is the author of publications on machine design.

C. E. LORD, representing the Chicago Section, is in charge of all patent and trademark work of all the International Harvester Companies. He is a member of the bar of the states of Ohio, Wisconsin and Illinois, as well as a member of a number of engineering organizations.

FRED R. LOW, member at large, has been editor of *Power* since 1888, in which position he has won distinction not only for the publication itself, but as an authority on power-plant subjects. He has served on a number of committees of the Society. He is the author of textbooks on steam engines.

LLEWELLYN V. LUDY, representing the Indianapolis Section, and member of the Executive Committee, has been professor of experimental engineering at Purdue University since 1912. Previous to that he was professor of steam and gas engineering at the University of Wisconsin.

THOMAS C. MCBRIDE, representing the Philadelphia Section, has been engineer for the Worthington Pump and Machinery Corporation since 1899. He is a specialist in sugar refineries, sugar machinery and paper mills and machinery. He was chairman of the Philadelphia Section when first organized.

LOUIS C. MARBURG, member at large, was elected as chairman of the Committee on December 3, 1918, after having acted as temporary chairman in accordance with resolutions of the executive committee of the general committee. He has been secretary and treasurer of Marburg Brothers, Inc., engineers, since 1910, engaged mainly in the import and export of engineering products. Previous to that he was with the Allis-Chalmers Company, General Electric Company, Sprague Electric Company, Siemens and Halske, and Sulzer Brothers.

GEORGE KINGDON PARSONS, representing the New York Section, is also chairman of the War Industries Readjustment Committee. For several years he has specialized in reorganizing and improving established businesses, as president of the G. K. Parsons Corporation.

EARL F. SCOTT, representing the Atlanta Section, has for the past five years been engaged in business as agent and contracting

mechanical engineer. He is now president of the corporation which bears his name, engaged in selling and installing power-plant equipment.

C. M. Spalding, representing the Erie Section, has been for more than twenty years with the General Electric Company, engaged chiefly in engineering and design of railway motors, railway locomotives, air compressors and other allied apparatus for railway service.

Louis Edward Strothman, representing the Milwaukee Section, entered the employ of the Allis-Chalmers Company in 1902 and has held various positions. In 1915 he became manager of the steam-turbine and pumping-engine departments. He was chairman of the Milwaukee Section in 1915 and was president of the Engineering Society of Milwaukee the following year.

Charles W. Tubby, representing the Minnesota Section, has been in charge of the business of the Worthington Pump and Machinery Corporation since 1912 in the Middle Northwest and all of the Lake Superior mining regions. For six years previous to that he was in private business in St. Paul, representing builders of heavy machinery.

A. E. Walden, representing the Baltimore Section, has held responsible executive positions since 1891, including those of engineer in charge of construction, superintendent and manager of various companies, as well as construction and reconstruction of industrial and manufacturing plants, grain elevators, coal properties, transmission lines, etc.

John T. Whittlesey, representing the San Francisco Section, has since 1912 been retained to advise Messrs. Spreckels in their large public utilities interests in California. He was at one time chief engineer of the Brooklyn Rapid Transit Company, and also chief engineer of the Public Service Corporation of New Jersey.

Robert William Angus, representing the Ontario Section, was chairman of the Executive Committee of that Section last year. He has been professor of mechanical engineering on the faculty of applied science of the University of Toronto since 1906.

Charles H. Repath, representing the Los Angeles Section, was at one time mechanical superintendent of the Anaconda Cupper Mining Company, and later superintendent of the International Smelting and Refining Company. He is now in consulting practice in Los Angeles.

George I. Rockwood, member at large, and member of the Executive Committee, is a consulting engineer at Worcester, Mass. He is president and treasurer of the Rockwood Sprinkler Company. He was formerly on the publication committee of the Society and was chairman of the Worcester Section.

NEWS OF THE ENGINEERING SOCIETIES

Inspiring Address by Dr. Ira N. Hollis before Engineering Institute of Canada—Heating and Ventilating Engineers Start Research Work—Automotive Engineers Meet

The Cleveland Engineering Society issues a live weekly Bulletin called "Cleveland Engineering" which bears out the reputation of the Society for maintaining close contact with both the public and its membership. The issue of this Bulletin of January 7 contains a portrait of Major Frank B. Gilbreth, Mem.Am.Soc.M.E., who gave a talk before the society, illustrated by moving picture films of the Browning machine gun. It also reprints in full from Mechanical Engineering (January, 1919, page 16) the article by Jesse M. Smith, Past-President, Am.Soc.M.E., on a plan for the organization of engineers.

Akron Engineers Form New Club

The engineers of Akron, Ohio, and vicinity met on the evening of February 5 for the purpose of organizing an association of engineers at Akron. Dean F. E. Ayer, head of the department of engineering of the University of Akron, was elected chairman; M. B. Robinson, professor of mechanical engineering at the University and a member of the A.S.M.E., was elected secretary and treasurer, and an executive committee of 14 members representing different lines of technical work was chosen. The following sub-committees have been appointed: Organization, Program, House and Publicity. The initiation fee has been set at $5.00 and the dues at $3.00, and one hundred and eight applications for membership have already been received.

Mr. E. S. Carman, Chairman of the Cleveland Section of the A.S.M.E., was present and outlined the successful work along both civic and engineering lines which has been accomplished by the Cleveland Engineering Society.

The second meeting of the organization was held Wednesday evening, February 19, with a dinner, followed by an address by the county surveyor relative to existing and proposed engineering operations in the county. These operations are vital in a large degree to the city of Akron, its water supply, etc.

American Steel Treaters' Society

There has recently been organized in Chicago the American Steel Treaters' Society, whose object is "to promote the arts and sciences connected with the heat treatment of steel." The principal means for this purpose are to be the holding of meetings for the reading and discussion of papers bearing upon processes, apparatus, instruments, etc., employed in research work and practice connected with the art of heat treating.

This Society is experiencing a rapid growth and a chapter with a large membership has already been formed in Cleveland, Ohio, while movements for chapters in other cities are under way. One of the aims of the Society is to reach into the heat-treating rooms of the various industries, and to further the worker's knowledge of the art by bringing him out to its meetings, where he will come into intimate contact with metallurgists, chemists and scientific men.

The society publishes a monthly journal which already contains a considerable amount of valuable material and undoubtedly will prove of increasing value. The Secretary, Mr. W. H. Eisenman, 154 E. Erie Street, Chicago, Ill., advises that many manufacturers have been quick to see the direct financial benefit to be derived by placing one or more of their staff in the society—one firm has 12. At a recent meeting in Chicago it was found that the interest in the subject was so great that several engineers came from distances of 80 and 100 miles to attend.

The Engineers' Club of St. Louis Alive to Municipal Affairs

In his letter this month Secretary Rice calls attention to the participation by the Engineers' Club of St. Louis in discussions relative to a municipal bond issue of that city, and in connection with this the following letter received from the secretary of the Engineers' Club of St. Louis will be of interest:

To the Editor:

Meetings of the Associated Engineering Societies of St. Louis were held on February 5 and 12 for the discussion of the proposed $23,384,000 St. Louis municipal bond issue.

Topics of this kind are considered by the Engineers' Club of St. Louis and Associated Societies in conformity with a resolution adopting the principle of taking an active interest in economic, industrial and civic affairs.

Both of these meetings were a marked success in interest evi-

denced as well as in attendance. At the meeting of February 12 the attendance was double the average attendance.

As practically all of this proposed bond issue would be spent for municipal improvements directly involving engineering and the engineer, it is only natural that the engineer-citizen and the engineers as a body should give it due consideration.

The several items in the detailed budget of the proposed bond issue were presented to the meeting by engineers in the city employ who are in charge of the several departments of the public works concerned. In this manner the subject was placed intelligently before the members. The presentation of the subject took up the entire meeting of February 5. At the meeting of February 12 the discussion of the subject was continued and led by members of the Civic Committee of the Engineers' Club, which committee also had the matter under investigation for report. A very lively discussion developed at this meeting, and at the hour of adjournment was not nearly concluded; a resolution was therefore adopted requesting the Civic Committee of the Engineers' Club to report its recommendations at an early date relative to the issue to the Joint Council of the Associated Societies for further action.

Engineering subjects of public importance and matters affecting the engineer or the engineering profession are promptly considered by the Associated Engineering Societies of St. Louis in an endeavor to enlighten the public and to put on record an expression of the profession.

Joseph W. Peters,
Secretary.

American Society of Heating and Ventilating Engineers

The twenty-fifth annual meeting of the American Society of Heating and Ventilating Engineers was held at the Engineering Societies Building, New York, January 28-30, 1919, important features being the presentation of a number of valuable technical papers and the election of fifteen members chosen from among the different fields of activity of the society to constitute a Bureau of Research which will conduct experimental studies in coöperation with the Bureau of Mines. Funds are being collected to finance the work and the committee will undertake research work on the transmission of heat and similar engineering problems. The announcement of this commendable enterprise aroused considerable enthusiasm among the members and the opinion was generally expressed that the work will soon develop into a permanent activity for the good of the profession.

Dr. Emery R. Hayhurst presented the results of his experiments to determine the feasibility of maintaining in the ordinary house a proper humidity (40 to 50 per cent), comfortable temperature, and healthful atmosphere during the closed-up season of the year. His observations went to show that it requires up to 20 gal. of water per day (depending upon the temperature of the air to be heated and its rate of escape from the house) to supply sufficient water vapor for the air; he therefore recommended that some continuously operating device, such as an atomizer, be connected with the water supply of the building.

In a forceful discussion Dr. E. Vernon Hill pointed out the comparative values of mechanical and natural ventilation. The problem of ventilation, he remarked, is to determine what air conditions are desirable in a given space with a given type of occupancy, occupation, etc., and then to decide from experience and from tests in similar buildings whether these conditions can be maintained without mechanical ventilation; if they cannot, the mechanical adjuncts necessary to secure them will have to be adopted.

Air washing and humidification in school buildings was treated by Perry West, who emphasized the necessity for maintaining a constant degree of relative humidity in class rooms by quoting the New York State Commission on Ventilation. This body has conclusively proven, he asserted, that the enervating effect of 78 deg. as compared with 68 deg. for the air surrounding pupils reduces by at least 35 per cent their inclination to work. Mr. West explained that it is better to maintain the humidity at a convenient value than to raise the temperature alone to the point of comfort. Thus, for instance, on a zero day with 50 per cent humidity the air would have to be raised to 87 deg. to feel comfortable, and would then have a humidity of 2 per cent; if, however, by suitable humidification the air is maintained with a relative humidity of 50 per cent, the temperature would feel comfortable at 67 deg. and there would then be no enervating or devitalizing effect.

F. J. Hoxie called attention to the importance of properly arranging heating pipes to prevent decay of factory roofs. It appears from the records of his observations of the condition of various roofs that an effective protection of sawtooth roofs against decay is afforded by locating part of the steam pipes at the back of the sawtooth farthest from the windows. He illustrated his talk with several instances of roofs which had rotted in a few years in the part of the sawteeth where the heating pipes were placed directly under the windows and were well preserved where the pipes ran along at the bottom of the sawteeth.

Other papers were: The Transfer of Heat, by Geo. A. Orrok (referred to elsewhere in this number); Air Duct Design, by Leo Kraft; Dust Determination in Air and Gases, by E. R. Knowles; Fuel Conservation by Means of Automatic Temperature Regulation, by F. A. DeBoos; A Test of the Conductivity of Window Shades, by John R. Allen; Limiting the Fuel for Domestic Heating, by Konrad Meier; Engineering Economics of Heating, by M. W. Ehrlich; and By-Product Coke, by William T. Harms.

Society of Automotive Engineers

The annual meeting of the Society of Automotive Engineers was held in New York, February 4 to 6, 1919, at which papers were presented embracing a wide range of subject-matter. Mr. Chas. M. Manly was elected president for the coming year.

Among the papers dealing with war topics was one on Problems of the Naval Aircraft Factory During the War, by Commander F. G. Coburn, in which the splendid work done by the factory was described and the many expedients resorted to for improving the work shown. Airplane and Seaplane Engineering, again from the point of view of the work done by the Navy, was discussed by Commander H. C. Richardson, who showed, among other things, a chart for determining the efficiency of propellers and considered briefly the general matter of design of propellers, sea floats and seaplanes.

Two historical papers were also presented, one on The Story of the U. S. Standard Truck, by J. G. Utz, and another by J. G. Vincent, Mem.Am.Soc.M.E., on the designing of the Liberty engine, including certain data on its construction.

The Relation Between Airplane and Automobile Engines was discussed by several speakers. It was quite natural that such a subject should come up, as the greatest part of the work in designing aeroplane engines for the United States Government was carried on in automobile factories under the supervision of their own engineers.

Howard C. Marmon pointed out the essential factors controlling the design of areoplane and automobile engines and their differences. Thus, the automobile engine, besides being built for work under entirely different conditions both as to operation and maintenance, would not equal the aeroplane engine in power per cubic inch of piston displacement as it had to be carbureted for greater flexibility and not solely for maximum torque output through a comparatively limited range of speed. Neither could it use two or four carburetors like an aeroplane engine. An automobile engine could not use the high-compression pressure of an aeroplane engine as this would be impracticable at the full load, at low engine speeds and in climbing. Further, the lower-grade fuels commonly used in automobile engines gave more trouble under high compressions than the fuels customarily used in aeroplanes. Other points of difference in construction and design were considered; among other things being the fact that if an automobile engine were built with the same easy clearances on the pistons and the ample freedom given all the bearings it would make so much noise as to be entirely unsuitable for ordinary use. On the whole, the conclusion of the speaker was that the aeroplane engine was a more expertly engineered and manufactured development of the internal-combusion engine than the automobile engine. It was, however, developed for a set of objectives differing from those demanded in an automobile and none of its major features could be directly grafted upon the motor car. Further,

TABLE 1 AVAILABLE OIL REMAINING IN GROUND, AS ESTIMATED BY THE U. S. GEOLOGICAL SURVEY (BBL. OF 42 GAL.)

Oil fields	Marketed production in 1917	Marketed production in 1918 (preliminary estimate)	Total marketed production to end of 1918	Available oil left in ground, January 1919	Present average gasoline extraction, per cent
Appalachian	24,932,205	25,300,000	1,221,737,000	550,000,000	28.0
Lima, Indiana	3,670,293	3,100,000	448,404,000	40,000,000	20.0
Illinois	15,776,860	13,300,000	298,159,000	175,000,000	22.0
Mid-Continent	144,043,596	139,600,000	990,573,000	1,725,000,000	24.0
North Texas	10,900,646	15,600,000	78,971,000	400,000,000	33.0
North Louisiana	8,561,963	13,000,000	90,902,000	100,000,000	28 0
Gulf	24,342,879	21,700,000	303,954,000	750,000,000	1 5
Wyoming	8,978,680	12,370,000	39,793,000	400,000,000	40–50
California	93,877,549	101,300,000	1,114,000,000	2,250,000,000	12.0
Alaska, Colorado, Michigan, Montana, etc.	230,930	230,000	10,651,000	350,000,000	....
Total	335,315,601	345,500,000	4,598,144,000	6,740,000,000	....

the speaker believed that motor cars would be improved as a result of aeroplane experience and that this would come about as a result of better manufacturing facilities, higher shop standards and more intelligent inspection rather than from any radical changes in design.

Essentially the same view was supported by the other speakers. Henry M. Crane said that he felt certain that there was no reason to expect any radical change in automobile design due to aircraft-engine development, though in racing cars the effect of aviation-engine progress was bound to be considerable, as the service required was very similar in both cases. In his opinion, the motor-car engine should be designed to develop its best pulling characteristics at considerably lower speed than does the aircraft engine, which will undoubtedly mean very much lower compression ratios and lower mean effective pressures.

O. E. Hunt gave further arguments to support the same contention. He pointed out that an aeroplane is almost entirely devoid of a power-transmission system. The conventional aeroplane engine has the propeller mounted directly on the end of the crankshaft. For certain purposes, reduction gears of a fixed ratio are used to drive from the crankshaft a lay shaft carrying the propeller, but gear changes, such as are applied to cars, are unknown. The only element of the power transmission that has a counterpart in car work is the propeller hub, which performs a similar function and is similar in design to the rear-wheel hub of cars. Aeroplane-propeller hubs must be readily demountable and this requirement has resulted in some new design details that are entirely unnecessary for cars.

The engine requirements for aeroplane service are so different from those for cars that factors which are vital in the former type of machine are of minor importance in the latter, and vice versa.

Like others, Mr. Hunt believed that the influence of aeroplane experience on automobile-engine design would be of an indirect nature—mainly in bringing about better methods of production and a higher regard for metallurgical practice.

An important section of the meeting was devoted to the consideration of the present fuel situation, in the course of which data of great interest were presented by various speakers.

E. W. Dean, of the U. S. Bureau of Mines, told of the status of refinery practice with regard to gasoline production. He said the refiner might be able to augment his production of gasoline from a given amount of crude petroleum by from 35 to 40 per cent, exclusive of the gains possible through wider application of the cracking reaction. Some of the possibilities, however, overlapped each other, and a more probable summation estimate was 25 to 30 per cent. The Bureau believed that, if commercial developments were favorable, the wider use of cracking processes might permit of further increases up to a possible additional 100 per cent. No prediction, however, was ventured as to what part of this figure would actually be attained.

It might be mentioned, also, that the development of engines capable of utilizing the combined gasoline and kerosene fractions of crude petroleum would not be likely to alter the limit of maximum increase, but would materially hasten the day when it would be attained, and would in considerable degree help to keep the price of liquid fuel from ascending to painfully high altitudes.

Mr. Dean's paper may have produced the impression that the Bureau of Mines is not enthusiastic over the advantages to be gained by the development of a kerosene-consuming internal-combustion engine. Such is not the case, but it must be emphasized that this is not the only line along which the automotive industry must work.

Jos. E. Pogue, of the Bureau of Oil Conservation, Oil Division, U. S. Fuel Administration, summed up the present engine-fuel situation by stating that the principal factors are the demand for liquid fuel and the adaptability of the internal-combustion engine on the one hand, and the supply of crude petroleum, the gasoline-producing capacity of this material, and the substitute fuels in sight, on the other. On the whole the speaker claimed the automotive industry is working without due regard to the engine-fuel situation, that the domestic production of crude petroleum is nearing its maximum, and that the natural-gasoline content of this fuel is lessening. Conditions in Mexico are such that no adequate relief may be expected from that source. Substitute fuels need not enter into present consideration and cracking cannot meet the issue at a favorable price. The burden, therefore, falls upon the automotive engine, which must consequently so adapt itself as to gain higher thermal efficiency, and to use less specialized (less volatile) fuel.

As an emergency measure, therefore, the automotive industry should at once take steps to shape its development in the direction of increased fuel economy and less specialized requirements as to fuel, establishing for this purpose centralized machinery to study the problem in full detail; should keep the industry informed of every development in the situation; should coördinate research and design in the competing units of the industry; and should conduct basic lines of research not now adequately encompassed by individual agencies.

The question of petroleum supplies in the United States and Mexico was covered respectively by Davis White, of the U. S. Geological Survey, and R. de Golyer, a consulting geologist of New York City, neither of whom gave very encouraging promises. Table 1, presented by Mr. White, is of particular interest as giving an authoritative estimate of the available oil remaining in the ground in this country.

While it is quite likely that the amount of fuel underground in Mexico is very great, there are both political and technical conditions which make it impossible to consider that country as a source of *speedy* relief for the existing situation.

Mexican petroleum is not refined as extensively as American, and the speaker stated that the greatest possibilities for future extended uses of Mexican petroleum seem to lie either in the further perfection and more widespread development of combustion engines using very heavy oils as fuel or in an improvement of refining methods by which heavy oils can be more easily converted into lighter oil.

Engineering Institute of Canada

THE annual meeting of The Engineering Institute of Canada, which was combined with a general professional meeting, was held in Ottawa, February 11, 12, and 13, and was one of the most successful ever held. The large attendance and the en-

thusiasm prevailing are evidences that there is a greatly increased interest being taken by Canadian engineers in their profession and show clearly that the recent changes in the organization were well justified.

The preliminary session of the Annual Meeting was held in Montreal, as prescribed by the by-laws, and was adjourned to Ottawa, February 11, with headquarters at the Chateau Laurier where all the meetings and luncheons were held. A notable feature of the gathering was the attendance of eminent engineers from the United States, all of whom gave addresses, including Dr. Comfort A. Adams, President of the American Institute of Electrical Engineers; Dr. Ira N. Hollis, Past-President of The American Society of Mechanical Engineers; Alfred D. Flinn, Secretary of the Engineering Council, and F. H. Shepherd, Director of Heavy Traction, Westinghouse Electric and Manufacturing Company. Other speakers outside of the membership of the institute were, The Duke of Devonshire, Hon. F. B. Carvell, Minister of Public Works, and The Hon. Arthur Meaghan, Minister of The Interior.

The first day's session, and part of the morning session of the second day, were devoted entirely to business, including a report of council, reports of library and house committee, finance committee; papers, board of examiners, and education, publications committee, international electrical technical committee, engineering standards committee, roads and pavements committee, and the reports of the branches. In Canada the branch societies of the Engineering Institute comprise the local engineering bodies, the membership including the members of the institute of all grades, who reside within 25 miles of the branch headquarters and branch affiliates. They conduct their own affairs, and elect their own members of council, and the reports show them all to be in an active flourishing condition.

The report of the Honor Roll Committee showed the great part that Canadian engineers have played in the war. The scrutineer's report, read by the secretary, announced the officers, with Lt.-Col. R. W. Leonard, M.E., as president.

A special meeting of the representatives of the various branches appointed to consider the subject of legislation placed a resolution before the meeting, which was adopted, to the end that a special committee be formed to meet at headquarters, before the 15th of April, 1919, to draw sample legislation, and that they submit the proposed legislation to the council before the 1st of May, following which a letter ballot will be issued to all the members and, if favorable, steps taken to secure legislation.

In his presidential address Mr. H. H. Vaughan, Mem.Am.Soc. M.E., told the story of munition production in Canada, which showed the remarkable proportion which it assumed.

The Gzowski medal, which is awarded every year for the premier Canadian paper on an engineering subject, was given to B. F. Haanel, M.E.I.C., for his paper on the Fuels of Canada.

Of the addresses given during the meeting of the Engineering Institute of Canada, we are fortunate in having the text of the remarks by Dr. Ira N. Hollis, Past-President, The American Society of Mechanical Engineers, given at a luncheon on February 12. Dr. Hollis was in his happiest mood and with clear vision and keen analysis spoke of the relations between Canada and the United States, and the part which each had played in the war. Dr. Hollis' address follows.

Address by Dr. Ira N. Hollis

A Broad View of the Aims and Opportunities of the Profession

I want to assure you that for a number of reasons it is a real delight to me to come to Canada, one of them being that I promised two or three times while I was President of The American Society of Mechanical Engineers to come to Ottawa, and every time I had to break my promise for some reason connected with our entering the war. This is, therefore, a redemption of my promise to friends in Ottawa and Toronto.

Another reason why I am glad to be here is that it affords an opportunity of congratulating you on the statement of the aims of your institute which appears on the cover of your journal. We as engineers often fail to understand the significance of our own profession. It is not necessary to shout from the housetops, but who has ever produced a better motto for an institute such as this than the following:

> To facilitate the acquirement and interchange of professional knowledge among its members, to promote their professional interests, to encourage original research, to develop and maintain high standards in the engineering profession, and to enhance the usefulness of the profession to the public.

Numerous committees of The American Society of Mechanical Engineers, the American Society of Civil Engineers, and the Engineering Council have endeavored to state the aims and purposes of our societies, but with all our attempts in the past we have not produced anything as good as this.

I think that in The American Society of Mechanical Engineers the percentage of technical papers has decreased in proportion as the papers intended to be useful to the public have increased. I do not know whether that is the best thing for a technical society, but I do know that it bids fair to make our profession in the United States a profession of better citizenship. We must never forget that the purpose of any technical organization like ours or like this is mainly educational—to teach its members how to do their work better and how to serve the public and build up their relations with it in a better way.

Another reason for my coming here is deeper and broader than anything I could state in regard to our profession; it relates to your part in the war. Although much smaller in population than the United States, you, gentlemen, are our older brothers in arms. Upon your shoulders fell the first shock of the war as you rallied so splendidly to the defense of human liberty. I can state nothing better in this connection than two or three sentences contained in a letter from a relative on the other side who went in at Chateau-Thierry and ended up at Stenay. Every one of his letters contains some stronger statement of this sentiment. He said: "As the time goes on and I learn more about this war, I take my hat off to the British and Canadians who fought here in the beginning. We came in with our army as a large reserve, we fought in some important actions, and we were getting more troops to the front, but we came in at a time when the Germans were putting forth their last great effort after time for ample preparation, whereas the British and Canadians had to prepare while they were fighting. I take off my hat to them." I cannot help feeling, gentlemen, that that is the finest reason of all for my coming up here to salute you.

I look upon our race as the inheritors of the liberties of this world. After all, we have the English ideals of government on this continent, and we have to make all those who come to our shores from other countries English in ideals. South of the line we call ourselves Americans, and we call you Canadians, but we are all Americans in the freedom of the atmosphere in which we live. I come from that federation of states which split off from the mother country more than a century ago through a document written, after all, by Englishmen—one of the noblest statements in our language next to the Magna Charta. We are all Americans, and we have here on this continent the best league of peace that I can imagine. No fortifications on our boundaries, and war is unthinkable north of the Rio Grande. Our league is written in the hearts of two peoples who do not resort to bloodshed to settle their differences. As we meet here the Peace Conference is sitting in Paris and is working toward definite action—for what? It will be the most important decision ever made in the world, and it will be framed into some kind of statute where the cowardly bully who has bathed the soil of France in the blood of our sons and covered the ocean with ships and the bodies of the innocent is up for sentence to be rendered impotent until the centuries shall have turned him into a Christian.

So far as our profession is concerned, I am glad to bring the greetings of The American Society of Mechanical Engineers. We have the same warmth of feeling toward you that we have toward our members in the States, and we congratulate you on the formation of an Institute containing all the societies of engineers in the

youth of those societies. We have a harder task ahead of us in the United States to make one great society of engineers, because each separate society has already crystallized into its own methods and its own policies, thus rendering it difficult to form a union of all.

The Opportunities of the Profession

At the beginning of one of Mr. H. G. Wells' books you will find this sentence: "Civilization is advanced in proportion to a man's control over power outside of himself." Through what James Watt gave to mankind a little over a century ago we have entered our present era, the possibilities of which are not even thought of, inasmuch as we can use the power and energy that God placed on this earth for the development of man into something higher and far better than has gone before. Some day this century will seem but as the dark age to our descendants, and that mainly through the control of power entirely outside of man. I speak of this because that gives you plainly and at once the function and the place of the engineer.

I was speaking in New York not very long ago on the subject, Is Science Safe for Mankind? I dealt with the subject in all seriousness, for if science can be turned into a destructive agency to cover the earth with blood and to destroy all that has been previously produced, it is not safe. How can it be made safe? It can be made safe through our profession by approaching the discoveries and applications of science in that reverent attitude that will forever prevent its being used as a destructive agency. What does it amount to if we produce another railroad, another dock, a finer type of bridge, or a better machine, if it but leads to a conspiracy for the control of the earth? What does efficiency amount to if that, after all, is the end; if it places in the hands of the privileged few the control of the masses who are to be trained to service very much as the ox or the hórse is trained?

The Engineer and Conservation

Another feature of the engineering profession is its opportunity to teach that proper attitude of mind toward the patrimony that nature has handed dowu to us on this continent so that we may prevent its being used or wasted in the destruction of mankind by self-indulgence or war. I can speak, perhaps, for the United States as I saw it before we entered the war. We were the most wasteful people on the face of the earth. We had found in our country immense resources which we prided ourselves on exploiting for the luxury and the greed of a great many people. But this war has brought to our profession a different vision, and we have certain things to think of. The first is found in the word "conservation," which has grown up in the United States, and which I have no doubt you have in Canada. What is the significance of it? It means the saving of everything that will help to perpetuate the influence of the Anglo-Saxon race; it means the saving of anything that will promote our ideals as a race; that our language and our efforts may civilize this whole world, the Germans as well as the others. I cannot help feeling that there are two or three aspects of that to which we have given but little attention. My interest in the matter was aroused in Massachusetts, because during the past eighteen months I have assisted in the conservation of fuel for that state. In Worcester, through an effective committee of manufacturers, where there are 200,000 people, during the past year we saved, not by cutting off any industries, but by actual scientific study of the problem of saving in our power stations and in our factories, 125,000 tons of coal —a million dollars saved for that city alone during the past year. In a state which takes 12,000,000 tons of bituminous coal in the course of a year, we saved at least ten per cent; and we were rash enough to promise Mr. Garfield and the Fuel Administration that we would take two and a half million tons less during this year than we took the previous year. We had just touched the fringe of this subject when the armistice was signed and the bottom dropped out of the whole movement. Are we going to permit this effort throughout the United States to break down? Not at all.

In my state—but it is not my state; I was born in Kentucky— when I went as a professor to Harvard College years ago, my picture was published in the Louisville *Courier-Journal;* and lest I should become vain on that account, my photograph was bracketed on the same page with a man who had been hanged in Louisville the day before. One of my friends saw that picture, an old farmer whom I had known in my youth, and who was living in Jefferson County, Kentucky. He said to me: "I see you have resigned from the Navy and are going to Harvard College as a professor." I said: "Yes." He said: "For God's sake don't do it; you are going amongst those d—— Yankees." The New England people do not like that story very much, but it shows that sometimes misunderstanding can exist among our states, the same as I have sometimes heard of between Canada and the United States. But whatever misunderstandings have occurred between those two countries, they do not approach some of the former bitterness between the North and the South; do not approach some of the misunderstandings between the different states. That man who was talking to me about New England knew nothing about the spirit which existed there, nor of the generous attitude of the people toward everything that has a value to the public. You will find in New England the same broad generosity to be found in Canada, if you look for it.

Returning to the subject of conservation, we have not only learned to save coal, but to save food; we have reduced the amount of transportation for unnecessary commodities and thus have made our railroads more effective. Saving can be effected in every respect, even in our water power. Indeed, there is nothing in which there is not room for further study and coöperation to the end that America—Canada and the United States—may remain as long as possible the chief influence for good on this earth.

Importance of Standardization

Next to conservation, standardization is the most important subject we have to deal with. There is an enormous amount of waste in the production of a great many articles which should be duplicates. There is not one aspect of manufacturing connected with engineering that is not susceptible of improvement by coöperation among manufacturers, to the end that articles for like purposes shall be produced in the same way and shall be standard. I think our economic supremacy among the nations is dependent upon this.

Engineers Must Equip for Administrative Work

Then there is the labor question. During the past six months we have been involved in the United States in the question of the relation between labor and the employer and in the reëmployment of soldiers. I do not know any men who are better qualified to take a hand in that than the engineers. But in this connection I want to destroy what may be called another illusion; a man is not competent to organize and direct industries or to handle labor questions simply because he is an engineer; he may only become competent by interesting himself in them if it is in his natural field. I have heard a great many people say: you ought to put engineers in the Administration. I say, not unless they fit themselves to go into the Administration. I have heard again that the engineer ought to take an active part in politics and in the public life of his country—not at all, unless he fits himself for it; and it is his business to fit himself. In other words, our profession is a great profession only in proportion as we make it so, and not by reason of the fact that we are called engineers.

Service in Peace as Important as Service in War

We talk about this having been an engineers' war, about machinery having won the war. But it is the blood of our sons which has won the war; it is the men who have done it. When I heard the statistics read by your president yesterday, I rejoiced that men in my profession, members of this Institute, could so help the world in this crisis. Of course, we were not in it so long; I sometimes think we were tardy in getting in. We got there, and we might have done a great deal more and suffered a great deal more if you fellows had not pretty nearly cleaned up

the thing before we got in to help. Nevertheless, we ought to keep in mind the fact that machinery alone did not win the war; what brings such a victory as ours is the willingness of men to give their lives for a great cause.

The same thing applies in time of peace; a man may help his country and the community by willingness to dedicate himself to a profession, to give himself to the advancement of the human race; and that willingness is expressed in the one word, "service." If I were to try to visualize the condition necessary to the progress of the world to-day, I would express it in two words, in the nature of a formula for our profession: "to serve." At the beginning of the war we heard very much the phrase "to make the world safe for democracy." After all that is but a method of saying that we are seeking a form of government for the human race that will permit every individual to develop the maximum of his possibilities in the service of mankind. That is what democracy means. Our profession will have great power in the near future of peace, in the league of nations, because no league of nations will last if the proper spirit is not there. Without that attitude of mind, we cannot achieve what should be our great purpose.

About two months ago it was proposed in New York that The American Society of Mechanical Engineers go to London for a meeting in a year or two. What I want to see within the next two years in London or Paris is a great meeting of all the engineers of this continent—civil, mechanical, electrical, mining—met together to rejoice over that peace that I hope is going to come out of the present proceedings in Paris.

NECROLOGY

ABRAM T. BALDWIN

Abram T. Baldwin was born on September 26, 1870, in Yonkers, N. Y., and was educated in the public schools and Cornell University, graduating from the latter with the class of 1893.

Upon graduation Mr. Baldwin first worked in the Wm. A. Sweet Rolling Mills, Syracuse, N. Y., and served his apprenticeship in practically every branch of the industry. In January 1895 he became connected with the Solvay Process Co., also in Syracuse, where he worked through the various departments, being assistant manager of the soda ash department at the time he left Syracuse to enter the coke department of the same company in Detroit. In May 1910 th Precision Instrument Co. was organized, in which Mr. Baldwin was very much interested. It was not until 1911, however, that he gave this company his full attention and at that time he became its treasurer; in 1913 he was made president and general manager of the firm, which position he was holding at the time of his death.

When the United States entered the war, Mr. Baldwin was asked to take up the manufacture of air-speed indicators for the Science and Research Division of the Bureau of Aircraft. His work in this connection was so arduous that it resulted in his physical breakdown and sudden death from heart collapse on January 8 in Boston.

Mr. Baldwin was greatly interested in the combustion of coal and efficiency of boiler operation. He was a member of the Detroit Engineering Society, the National Association of Stationary Engineers, the American Gas Institute and the Detroit Board of Commerce. He became a junior member of the Society in 1899 and in 1902 a life member.

CHARLES C. CHRISTENSEN

Charles C. Christensen was born on September 30, 1851, in Copenhagen, Denmark. He attended the technical college at Navy Yard, Horten, Norway, where he studied marine and mechanical engineering. He served an apprenticeship in shop practice and drafting from 1871 to 1875 in Norway. The next four years he worked with the firm of Jansen & Dahl, Norway, as a designer on iron vessels and on engines.

In 1880 Mr. Christensen came to the United States, where he was employed by the Allis-Chalmers Co. as draftsman. From 1882 to 1888 his position was that of designer of mining machinery and at the end of that period he was placed in charge of the engineering and drafting department. From 1889 until the time of his death, December 13, 1918, he held the position of estimating engineer.

Mr. Christensen was the author of a number of articles relating to mining machinery which have been published in both American and English mining journals and also translated for Spanish and German technical periodicals. He became a member of the Society in 1890.

MICHAEL JOSEPH GOLDEN

Michael J. Golden was born on November 17, 1862, in Stratford, Ont., Canada. He received his early education in the schools of Lawrence, Mass., and later attended the Massachusetts Institute of Technology for two years as a special student. He served an apprenticeship with William McCartney in Lawrence and was for six years assistant to E. Lyford.

For one year he was an instructor in mechanical drawing at a high school in Hyde Park, Mass. In 1884 he became connected with Purdue University, Lafayette, Ind., as an instructor in shop work, later receiving his degree in mechanical engineering from the University. From 1889 until June 1916, when ill health compelled his resignation, he served as professor of practical mechanics at Purdue, and from 1907 was also director of the practical mechanics laboratory. He was considered an authority in shop management and shop experience and his course of shop lectures was widely known. He spent much of his time in research, investigating microscopically the structure of wood, for this purpose designing and building much special apparatus.

Professor Golden was the author of several works on mechanics and of a number of shorter articles which appeared in the technical press. He was a member of the Indiana Academy of Science, the American Society of Naval Engineers and the Manual Training Teachers' Association of America. He became a member of the Society in 1892. His death occurred on December 18, 1918.

LAURENCE RICHARD GULLEY

Laurence R. Gulley was born at Mason, Mich., on August 14, 1888. He attended the University of Illinois, receiving in 1910 his B.S. degree in mechanical engineering (M.S. in 1911; M.E. in 1917). From 1908 to 1911, during his vacations, he was connected with the Burr Co., Champaign, Ill., as draftsman.

Upon graduation he was employed by the same company and from 1911 to 1913 he served as chief engineer. In 1913 he became general manager of the firm and at the time of his death, October 24, 1918, in addition to holding this position, was also secretary of the Burr Co.

A short while previous to his death Mr. Gulley had designed and built the Gulley tractor dynamometer, which has proved of much interest to tractor-manufacturing concerns.

Mr. Gulley was a member of the honorary societies of Tau Beta Pi and Eta Kappa Nu. He became an associate-member of the Society in 1917.

GEORGE SHERWOOD HODGINS

George S. Hodgins, editor of *Railway and Locomotive Engineering*, died at his home in New York City on January 18, 1919. He was born in 1859 in Toronto, Ont., and was a graduate of the Upper Canada College and the school of practical science, University of Toronto.

He served his apprenticeship with the Canadian Locomotive & Engine Co., Kingston, Ont., in machine-shop work, locomotive erecting, etc. In 1882 he was appointed draftsman in the same company and was directly responsible for locomotive design. After some experience in a division master mechanic's office on the Canadian Pacific Railway, he was advanced to various positions on the road and of late was locomotive inspector on the entire system. In 1889 he was recalled to the Canadian Locomotive Works as mechanical engineer, where he had charge of all engineering and designing work. Later he entered the service of the Pressed Steel Car Co., Pittsburgh, Pa., as general inspector of the output of that extensive plant, and was also for some years inspector of the Richmond Locomotive Works.

During these earlier years he had contributed to a number of railroad publications. In 1900 he entered the field of practical journalism as editor of *The Railroad Digest*. In 1902 he joined the staff of *Railway and Locomotive Engineering* as associate editor and in 1908 became managing editor, which position he held until 1911, when he was called by the Canadian Government to make a comprehensive report on the shops, appliances, tools and equipment necessary for the Trans-Continental Railroad. On the completion of that work in 1915 Mr. Hodgins joined the staff of the Railway Periodicals Company as managing editor of the *Railway Master Mechanic* and *The Railway Engineering and Maintenance of Way*. In 1916 he returned to *Railway and Locomotive Engineering* and remained on the staff as editor until his death.

He contributed many articles to popular science magazines and as a writer on engineering and technical subjects his style was marked by an exact and comprehensive lucidity.

Mr. Hodgins became a member of the Society in 1908.

HENRY SMYTH ISHAM

Henry S. Isham was born in New Britain, Conn., on March 16, 1866, and was educated at Mowry and Goff's English and Classical School, and at the Bryan and Stratton Business College in Providence, R. I.

He first served an apprenticeship of three years with the Harris-Corliss Engine Works, Providence, and then entered the service of

the Rhode Island Locomotive Works in the capacity of draftsman. From that position he went as draftsman with the Jeffrey Manufacturing Co., Columbus, Ohio, and in the following year, 1892, he became connected in the same capacity with the Johnson Steel Co., Johnstown, Pa. Mr. Isham's next position was with the Pond Machine Tool Co., Plainfield, N. J., as draftsman. The year of 1895-1896 he was with the Washington, Alexandria and Mount Vernon Railway, and a little later was located in the chief engineer's office of the Central Railroad of New Jersey. For over a year he worked with the Mossberg Manufacturing Co., Attleboro, Mass., leaving that firm to take a position in 1897 with the Metropolitan Street Railway Co., New York City, as track expert in the office of the engineer of maintenance of way. From 1899 to 1901 he was designing draftsman for the São Paulo Railway, Light & Power Co., Ltd., São Paulo, Brazil, S. A.

In 1901 Mr. Isham returned to the United States to enter the employ of the Pennsylvania Steel Co., Harrisburg, Pa., remaining there until 1903. From 1903 to 1908 he was chief draftsman with Ford, Bacon & Davis, New York City, and then became associated with the New York Railways Co., where he had charge chiefly of the track work. His next connection was again with Ford, Bacon & Davis as chief draftsman. About the middle of 1918 he entered the service of the New York Edison Co., New York City, and was with that company at the time of his death, which occurred in an accident on November 28, 1918.

Mr. Isham became a member of the Society in 1902.

PAUL JONES

Paul Jones was born in Wilmington, Del., on May 11, 1881, and was educated in the schools of that city, later attending the Heath School. He studied as a special student in mechanical and mining engineering and in 1902 took a position with the Diamond Steel Co., Wilmington, where he was engaged in general drafting for iron- and steel-works equipment, later becoming engineer of tests and then assistant to the superintendent of shops and steel products.

In 1906 Mr. Jones became connected with the E. I. du Pont de Nemours Co., Wilmington, in the light, power and heat division. His duties were in the general office and in field engineering work in connection with construction, design and maintenance of power plants and power transmission systems and costs. His next position was in 1909 with the H. C. Frick Co., United States Steel Corporation, Pittsburgh, Pa., as assistant engineer for the design of coal and coke plants, railroad trackage and structures, power plants, etc. For the year 1910 to 1911 Mr. Jones's services were loaned to the G. S. Baton Co., as construction engineer, where his duties were along the same lines as they had been with the Frick Co. He returned to the employ of the Frick Co. and was made plant superintendent of the Filbert Works. He completed this plant, developing and maintaining all plant operations.

In 1914 he became associated with the Bosch Magneto Co., Plainfield, N. J., as works engineer. He was engaged in the design, construction and maintenance of buildings and equipment and the direction of power-plant systems. In the Spring of 1918 he was commissioned a first lieutenant in the Aviation Section, Signal Reserve Corps, of the Army and was assigned to duty in the finance department. At the time of his death, December 17, 1918, he was connected with the Air Nitrates Corporation, New York, having been honorably discharged from the service.

Mr. Jones was a member of the American Institute of Mining Engineers. He became an associate-member of our Society in 1917.

GEORGE ALEXANDER JUST

George A. Just was born in 1860 in New York City. He attended Rensselaer Polytechnic Institute, from which he was graduated in 1881 with the degree of C.E. He was first employed by the Phoenix Iron Works, and then was connected with the New Jersey Steel and Iron Co., Trenton, N. J., later acting as engineer for that firm in New York. He was also chief engineer of the Jackson Architectural Iron Works, afterward becoming a member of the firm Lewison & Just, consulting engineers.

Mr. Just was a pioneer in the steel industry and was at one time associated with Cooper, Hewitt & Co., and was one of the first engineers to develop the modern steel-frame building. At the time of his death, December 27, 1918, he was president of the George A. Just Co. He took an active interest in politics and was the engineer member of the commission which framed the Code of Building Laws for Greater New York, and from 1907 to 1915 served as chairman of the Board of Examiners of New York.

He was a member and ex-director of the American Society of Civil Engineers. He became a member of our Society in 1901.

DAVID TOWNSEND

David Towusend, a member of the Society since 1882, and vice-president during the years 1899 to 1901, died at his home in Philadelphia. Pa., on November 27, 1918.

Mr. Townsend was born on February 21, 1856, in Philadelphia. Pa. He was a graduate, class of '76, of the University of Pennsylvania, degree of B.S. In 1878 he was a special student at Stevens Institute of Technology, and assistant to Dr. R. H. Thurston and Prof. Albert H. Leeds. From 1878 to 1893 he was with the Bush Hill Iron Works, Philadelphia, specializing in rolls, rolling mills, steel and iron works construction equipment. He first served his apprenticeship in machine shop, foundry and drawing room, later becoming general manager. In 1893 he became general manager of the Philadelphia Roll & Machine Co., building and operating their works. He was with this firm until 1898, when he went to Germany to the Krupp Works at Magdeburg to study the methods and construction of the Gruson Revolving Coast Defense Turrets. Upon his return he designed, built and operated the Gruson Iron Works, Eddystone, Pa., as general manager. In 1903 this property was sold to the Baldwin Locomotive Works, who have since occupied it for themselves and for the Remington Arms Co.

From 1903 to 1912 Mr. Townsend was engaged in private engineering practice, specializing in iron and steel foundries, roll and rolling-mill designs and general construction for iron and steel products. Mr. Townsend became president of the Production Engineering Co. in Philadelphia in 1912, specializing in oil-burning apparatus of all kinds, holding this position up to the time of his death.

During the year 1916 he was also manager of the Philadelphia plant of the Neidich Process Co. and the Calco Chemical Co., producing aniline dyes.

AUGUST H. BORNHORST

Lieut. August H. Bornhorst was born on August 1, 1888, in St. Marys, Ohio. He received his early education in the schools of St. Marys and then attended Ohio State University, from which he was graduated in 1911 with the degree of M.E.

August H. Bornhorst

He first worked with the Ford Motor Co., Detroit, Mich., as machine designer on a 5000-hp. gas engine In March 1912 he was assigned through a civil-service appointment to the U. S. Engineer's Office, Seattle, Wash., as mechanical draftsman, where he designed cranes for handling concrete work and designed and laid out lock gates, lock-gate machinery and a proposed emergency dam. In March 1916 he became connected with the Puget Sound Navy Yard, Bremerton, Wash., as a marine-boiler and engine draftsman. Later he was connected for a short period with the Seattle Machine Works.

In July 1917 he entered the service as a first lieutenant in the Signal Officers' Reserve Corps and was afterward transferred to the Aircraft Production, Air Service Branch of the Army, in which he was serving at the time of his death, December 7, 1918.

Lieutenant Bornhorst became a junior member of the Society in 1916.

JOHN HORTON DALLY

John H. Dally was born on July 10, 1868, in Lafayette, N. J. He was educated in the public schools of Newark and later attended the Newark Technical School, of which he was a graduate. He served a three-years' apprenticeship with the Watts-Campbell Co., Newark, and from 1891 to 1895 worked in the shops of the same concern. He spent one year with the Richmond Locomotive Works and for the Whitehall Engineering Co. He was also connected for short periods with the Colorado Automatic Refrigerating Co. and with the New York Refrigerating & Construction Co. He was chief engineer of the Waldorf-Astoria Hotel, New York, for about a year and a half, and from 1896 to 1902 was chief engineer of the Carnegie Music Hall, New York.

From 1903 until the time of his death, December 23, 1918, he was chief engineer of the New York Stock Exchange. Since 1897 he had also acted as supervising engineer for the Fine Arts Society.

Mr. Dally became a member of the Society in 1903.

J. SELLERS BANCROFT

J. Sellers Bancroft, general manager and mechanical engineer of the Lanston Monotype Machine Company, of Philadelphia, Pa., died in that city on January 29, 1919.

Mr. Bancroft was born in Providence, R. I., in 1843. He became a member of the Society in 1880, and held the office of manager from 1909 to 1911, and that of vice-president from 1915 to 1917. A more extended notice will appear in the April issue.

PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by March 15 in order to appear in the April issue.

CHANGES OF POSITION

J. PAUL CLAYTON has resigned his position of commercial manager of the Middle West Utilities Company, Chicago, Ill., and has been elected vice-president of the Central Illinois Public Service Company, Mattoon, Ill.

FRANK H. ABBEY, for the past six years Boston manager for the Gifford-Wood Company, has been elected president of the Southworth Machine Company, of Portland, Me. The new duties, assumed on January 1, 1919, include the general management of the company.

LEMUEL C. BIGLOW, who for a number of years acted as New York manager for the Morse Chain Company, of Ithaca, N. Y., and who for the past year has been connected with the Charles A. Schieren Company, as manager of their engineering department, has been appointed eastern representative of the W. A. Jones Foundry and Machine Company, of Chicago, Ill., with headquarters in New York City.

MALCOLM M. HENDERSON has resigned his position as chief mechanical engineer of the Commonwealth Railways of Australia and has joined the Perry Engineering Company of Adelaide and Gawler, South Australia, as manager.

MANNING E. RUPP has severed his connection as superintendent of the ordnance department, Curtis and Company Manufacturing Company, St. Louis, Mo., to become associated with the Gifford-Wood Company, Hudson, N. Y., as general superintendent.

LEWIS S. MANFIELD has resigned his position as mechanical engineer with the Carver and Nate Company, engineering contractors, to accept the position of assistant to the secretary of the Heating and Piping Contractors' National Association, New York.

WILLIAM F. PARISH, for many years manager of the lubricating division of the Texas Company, and lately chief of the oil and lubrication branch, Air Service, War Department, has joined forces with the Sinclair Refining Company, Chicago, Ill. As technical director of the company, Mr. Parish will assist in organizing the section of lubrication engineering, and in connection with the lubricating sales department will aid in establishing broader and more direct representation.

FRED W. FISCHER has severed his connection with the United States Nitrate Plant at Muscle Shoals, Ala., to accept the position of boiler-plant supervisor with the Du Pont Engineering Company.

THEODORE H. HERMANSON, formerly with the Harrison Works of the Worthington Machinery Corporation, has become associated with the Epping-Carpenter Pump Company, of Pittsburgh, Pa., as works manager.

EDMUND S. HIGGINS, until recently affiliated with the Du Pont Engineering Company, Richmond, Va., has accepted a position with the Oakland Motor Company, Pontiac, Mich.

F. L. GILMAN resigned his position as works manager of the National Conduit and Cable Company last November, and has left for abroad to take a position as European general superintendent for the Western Electric Company, in charge of the company's manufacturing plants in England and on the continent.

ALEXANDER A. KOSWICK, formerly with Wright-Martin Aircraft Corporation at their Long Island plant, has accepted a position as an engineer with Ford, Bacon and Davis, in their valuation and report department, with headquarters in New York City.

ANNOUNCEMENTS

CAPTAIN JULIUS M. LONN, who for the past 20 months has been located in the small arms ammunition department at the Frankford Arsenal, Philadelphia, Pa., has been released from military service and has resumed his position in charge of engineering with the Great Western Manufacturing Company, La Porte, Ind.

G. CHARTER HARRISON announces that Eric A. Camman, associated with him since the establishment of the business, has been admitted into partnership. The firm will continue to specialize in the design of plans to meet modern industrial problems, under the firm name of G. Charter Harrison and Company, with offices, as heretofore, in New York City.

GEORGE H. SHARPE, until recently fuel engineer for the conservation department, United States Fuel Administration, has become associated with Frame, Friend and Stineman, Inc., New Haven, Conn., as consulting fuel engineer.

E. LOGAN HILL, secretary of the United States Shipping Board Commission on Port and Harbor Facilities, has resigned and has become associated with Heyl and Patterson, Inc., contracting engineers of Pittsburgh, Pa. Previous to his appointment as an official of the Shipping Board, Mr. Hill was assistant general manager of the Erie Railroad. He will be located at the New York sales office of the company, which is particularly interested in the application of their cranes to wharves, cargo handling and other special purposes.

THEODORE MAYNZ has become associated with the Gulf Pipe Line Company, Houston, Tex.

LIEUT. E. R. GLENN, who has been acting as production officer for the ordnance department at the Bethlehem Steel Company for the past year, has been discharged from the service and has become associated with the Simplex Valve and Meter Company of Philadelphia, Pa.

CLEON E. PHELPS, recently discharged from Government service, has accepted the position of assistant works manager of the Underwood Computing Machine Company, Hartford, Conn.

MAJOR JAMES GUTHRIE, Ordnance Department, U.S.A., has been ordered from Washington to Detroit, becoming engineering manager for the Michigan district, with headquarters at 818-820 Book Building.

E. HOWARD REED, vice-president of Reed and Prince Manufacturing Company, Worcester, Mass., is in the naval service and has been transferred from the torpedo station at Newport, R. I., to duty at Toledo, Ohio.

MAJOR R. W. FULLER, Ordnance Department, Washington, D. C., is leaving for Japan, China and Vladivostok, Russia, where he will represent W. R. Grace and Company of New York City.

PAUL P. BIRD has assumed the presidency of the Boston Sand and Gravel Company, with headquarters in Boston, Mass. He retains his partnership in the engineering firm of Norton, Bird and Whitman, of Chicago and Baltimore, and has opened an office for the firm in Boston.

L. H. THULLEN was elected president of the Grand Rapids Brass Company, Grand Rapids, Mich.

WILLIAM McCORMICK NEALE, formerly connected with the Newman Machine Company, Greensboro, N. C., as secretary, treasurer and mechanical engineer, announces the opening of an office in Greensboro for consulting practice, specializing in plant design, and the design and development of special labor saving machinery and devices.

W. S. QUIGLEY, president of the Quigley Furnace Specialties Company, Inc., sailed for Liverpool on the Baltic, February 15, for the purpose of further developing European connections of his company. Mr. Quigley will spend several weeks in England, France and Italy and visit the plants installing the Quigley system for preparing and burning pulverized coal and lignite.

APPOINTMENTS

CAPTAIN EDWARD E. ASHLEY, JR., for many years consulting mechanical and electrical engineer for Starrett and Van Vleck, architects, of New York, has resigned his commission in the Air Service of the U.S. Army to accept an appointment as sales engineer of the Mercury Manufacturing Company, Chicago, Ill. This company manufactures electrically driven tractors for use in connection with industrial haulage systems.

CHARLES W. STEPHEN has been appointed assistant works manager of Pratt and Cady Company, Hartford, Conn. He retains his present position as mechanical engineer.

MAX E. CUTTLER, formerly supervising engineer and superintendent of the Hamilton and DeLoss Company, Bridgeport, Conn., has been appointed general superintendent of The Hawthorne Company, which was merged with the Hamilton and DeLoss Company on February 1.

AUTHORS

S. H. GRAF has contributed an article on Structure and Strength of Overheated Rivet Steel to the February 6 issue of *Engineering News-Record*.

H. COLE ESTEP addressed the members of the Cleveland Engineering Society at a luncheon on January 31, on reconstruction work upon which engineers will be called. Mr. Estep was a member of a mission of fifteen technical experts invited by the British Government to inspect British industries and the western front.

DR. RICHARD MOLDENKE was the speaker at the New England Foundrymen's Association meeting, February 12. The subject of his address was Foundry Melting Methods.

LIBRARY NOTES AND BOOK REVIEWS

Our Cities Awake

OUR CITIES AWAKE. Notes on Municipal Activities and Administration. By Morris Llewellyn Cooke, M.E., Consulting Engineer, formerly Director of Public Works, City of Philadelphia. With Foreword by Newton D. Baker, Secretary of War. Doubleday, Page & Co., Garden City and New York, 1918. Cloth, 5 x 7½ in., 351 pp., 119 illustrations. $2.50.

Morris Llewellyn Cooke was a pupil and discipline of Frederick W. Taylor. Efficiency means more to him than a time clock and a card index. He was among the first to emphasize the part that the engineer should play, not only in industry, but in public life. When, therefore, he was called by Mayor Rudolph Blankenburg as Director of Public Works of the City of Philadelphia in 1912 he brought to the task the vision of a city in which not only the things that must be done should be done in the most efficient and creditable way, but in which the application of the common means and effort of a people with an awakened civil consciousness to the making of their city rich, artistic and beautiful, and their communal life helpful, inspiring and enjoyable, should be developed to the utmost. The book is a commentary upon his experience in the office, interspersed with observations suggested by that experience and his study of public management, or drawn from the experiences of other cities; with the views of other publicists, and information, statistical and otherwise, from various sources.

The first chapter, Paving the Way, tells how the interest of the people was aroused, and discusses financial methods, budgets, cost-keeping and appropriations. The abuses attending the jockeying of contracts are described, and the public manner adopted for opening bids illustrated. Ten pages are devoted to an exposé and condemnation of the common practice of levying assessments upon city employees by political parties.

Chapter II considers Some Mechanisms of Municipal Management such as Home Rule for Cities, Municipal Government by Commission, The City Manager, The Ballot (favoring the short variety), Functional Management, Committee Control and Leadership.

Chapter III tells of the application of Scientific Management in City Affairs. The science of management has for its object the development of the one best way in every part of its field, with the emphasis on the "one." In private manufacturing establishments the owner can frequently put into practice means and methods not understood or indorsed by the workers.

Under the title Coöperation the One Best Way, Chapter IV seeks to show that in a city, which is a great industrial plant owned by its citizens collectively, the genuine interest of intelligent citizens, is needed to back up any municipal program. There should also be coöperation between cities, as many of their problems admit of a common solution. The moving of trained municipal employees from city to city in the course of their professional progress, and the rise of the commission manager plan of city administration will hasten this coöperative movement. Standard specifications for contracts and materials are suggested; coöperation between householders, street-cleaning forces, municipal road repair forces, regular contractors' groups and the street-railway company helps in solving the snow-removal problem.

In Chapter V, devoted to the city employee, the means taken to discourage his political activity are described. Uniforming, it is said, generally results in raising the grade of certain classes of employees. Equalization of pay, promotion, pensioning, competitions and welfare work are also touched upon. The author says that even under the civil-service law men can be removed from the public service for the same reasons that they can property be removed from the service of a private company, and tells how he dealt with cases of discharge and discipline.

Although an enthusiastic advocate of the civil service or merit system, Mr. Cooke believes that The Man in Ten Thousand, the man who is best fitted for the larger position, will be found through the personal effort of the appointing officer rather than in the list of eligibles furnished by a civil-service commission. Civil service does very well for positions paying less than $3000 per year, but in his opinion will, as applied to the higher position, take the form of coöperating with the appointing officer in finding the right man, and in fearlessly and exhaustively checking that officer's judgment, rather than in insisting on taking the initiative. He suggests that if the secretaries of the four national engineering societies could be authorized by their several councils to associate themselves as a civil service board to act as an advisory committee to federal, state and municipal civil-service commissions, it would be a decided step in the right direction in filling engineering positions.

Those who know Mr. Cooke through his previous utterances will turn with especial interest to his chapter upon Our Utilities and Their Owners. "If we have good reason," he says, "for speaking without venom and by the facts, we have equally strong incentive for speaking fearlessly. I have already mentioned politics, the juggling of contracts, the absence of expert service and the lack of understanding of the problems of government on the part of the people, as among the causes which retard our progress. But more important than any of these, in my opinion, is the baleful influence constantly wielded directly and indirectly in almost every city in the land by the private-utility interests through their support of the lowest type of political machinery and intrigue."

"The basic fact underlying any discussion of municipal utilities is the essential solidarity of the private interests which control them." What, for want of a better name, he calls "courtesy" precludes the financing of competing interests and the invasion of preëmpted or allotted territory. "Anything like a complete victory for either side in this matter means to the one side wholesale destruction, through public ownership, of certain kinds of paper values, and to the other new and heavy public duties. The present-day managers of a property actually worth hardly $25,000,000, but with outstanding securities of over $50,000,000, are in an exceedingly embarrassing position. They want more than sympathy; they want help."

Methods of financing, and the rôle of the holding company, the efficiency of which the author says, "as a device for the injection of water, compares with the high finance which preceded it as a high-pressure fire main does to a garden hose," are described. Bankers realize that a widespread program of municipal ownership and municipal operation is more or less imminent, and the author has been told by those high in the banking world that the intention is to make these plants yield every possible penny in revenue against the day when ownership will change.

"Where private companies furnish good service at fair rates, give them protection, a free field and a square deal. If they fail in these essentials, any self-respecting city will call the bluff by insisting upon public ownership and public operation."

Confidence in state regulation is on the wane. The work that comes before the public-service commissions is largely engineering, and yet there are almost no engineers on the commissions. The cities are at a disadvantage in obtaining expert testimony in regard to costs and values, as most of the experts have been brought up in the employ of the utilities.

The greatest present-day problem in utility matters is not *who* is to own and operate them, but *how* they are to be operated. A titanic battle is on between a democratic army and eleven billions of capital.

Chapter IX shows how the city can be developed as an ally of industrial progress by attention to its food supply, transportation, public parks and baths, commercial, educational and vocational guidance, the stabilizing of employment, and all those things which make for industrial competency and attract and develop a desirable industrial population.

The citizen must amount to Something More than a Voter. Such organizations as chambers of commerce, city clubs, business men's associations, improvement associations, technical societies, etc., have unlimited possibilities for helping the city.

"In the last analysis," says the author in the concluding chapter, "a city is simply an aggregation of homes, and the object of each individual home is to be the source of the maximum of service and human happiness. Fortunately, it is not necessary to await future developments in order to visualize a beautiful city filled with prosperous folk leading happy and inspiring lives —a 'singing city.'"

FRED R. LOW.

AMERICAN HIGHWAY ENGINEERS' HANDBOOK. Editor-in-chief, Arthur H. Blanchard. First edition. John Wiley and Sons, Inc., New York, 1919. Flexible cloth, 7 x 4 in., 1658 pp., illus., tables. $5.

The task undertaken has been the compilation of a reference book which would include reliable and comprehensive information on all branches of highway engineering and related subjects, including organization and administration of highway departments, financing of improvements, highway design, paving, testing, costs, etc. These questions are discussed in twenty-nine sections, each of which has been edited by an authority. Bibliographies for each section and an extensive index have been provided.

AMERICAN METHODS IN FOREIGN TRADE. A Guide to Export Selling Policy. By George C. Vedder. First edition. McGraw-Hill Book Co., Inc., New York, 1919. Cloth, 8 x 6 in., 204 pp. $2.

The author of this volume is a believer in the soundness of the distinctively American methods of developing an export trade which have hitherto been adopted by our most efficient world traders. He attempts in this volume to explain how these firms have achieved success and to outline the proper policy to be adopted by those interested in entering foreign markets.

CHILTON TRACTOR INDEX. Published semi-annually by the Chilton Co., Philadelphia, 1919. Paper, 10 x 7 in., 464 pp. $1.

The Tractor Index is a directory of the manufacturers of tractors, tractor parts and accessories, and power farming machinery in the United States. It also includes an illustrated list of American tractors, in which brief specifications for each tractor are given, a table giving complete specifications for 198 tractors, and a similar table of specifications for power farming machinery. A collection of articles on tractors and farm machinery completes the work.

CHLORINATION OF WATER. By Joseph Race. First edition. John Wiley and Sons, Inc., New York, 1918. Cloth, 8 x 5 in., 158 pp. $1.50.

The author has collected and correlated the scattered information in print on the purification of water by chlorine, and presents a systematic account of the theory, practical application and results. Numerous references to the original publications are given.

THE FUNDAMENTAL EQUATIONS OF DYNAMICS. Its Main Coördinate Systems Vectorially Treated and Illustrated from Rigid Dynamics. By Frederick Slate. Berkeley, University of California Press, 1918. Cloth, 8 x 6 in., 233 pp. $2.

The author of this volume feels that the extensiveness of the field of dynamics has necessitated such compression in the general surveys of its principles that the usual treatment leans too heavily on mathematics. His desire has been to prepare a supplement to such standard works which will direct attention to the physical aspects, and to experimental reasoning, by offering a flexible continuation of an elementary stage with unsettled achievement. The book forms Part II of Principles of Mechanics (Part I, Macmillan Co., 1900).

A HANDBOOK OF PHYSICS MEASUREMENTS. Vol. I, Fundamental Measurements, Properties of Matter, and Optics. Vol. II., Vibratory Motion, Sound, Heat, Electricity and Magnetism. By Ervin S. Ferry, in collaboration with O. W. Silvey, G. W. Sherman, Jr., and D. C. Duncan. First edition. John Wiley and Sons, Inc., New York, 1918. Cloth, 8 x 5 in., 233 pp. illus., tables. $2 a volume.

The aim of this work is to furnish the student of pure or applied science with a self-contained manual of the theory and manipulation of those measurements in physics which bear most directly upon his subsequent work in other departments of study and upon his future professional career. The experiments have been selected with regard to the particular determinations now demanded by science and industry and so grouped as to segregate those of value for students of the various branches of engineering.

MAKING THE SMALL SHOP PROFITABLE. By John H. Van Deventer. First edition. Published by the *American Machinist*. (McGraw-Hill Book Co., New York, sole selling agents.) 1918. One-quarter cloth, 12 x 9 in., 113 pp., illus. $1.75.

This book contains a series of articles on important phases of the activities of small machine shops, proper methods of working, cost-keeping, etc., and also illustrations of many handy devices for facilitating work, particularly in shops with limited equipment. It is a continuation of the author's Success in the Small Shop. The articles first appeared in the *American Machinist*.

STEAM ENGINES. Prepared in the Extension Division of the University of Wisconsin, by E. M. Shealy. (Engineering Education Series.) First edition. McGraw-Hill Book Co., Inc., New York, 1919. Cloth, 9 x 6 in., 290 pp. 173 illus. $2.50.

This is the third of a series of three textbooks on steam engineering, prepared for correspondence students in the University of Wisconsin Extension Division. The aim in this volume is to teach the fundamental principles underlying the operation of the steam engine, in as simple and non-mathematical a manner as possible. Particular attention is given to valve gears.

LOCOMOTIVE HAND-BOOK. Compiled by American Locomotive Company, New York, 1917. Leather, 4 x 6 in., 195 pp., 9 illus., 89 tab. $0.75.

The compilers have arranged the tables, formulæ and other information used by locomotive designers, in a convenient book of pocket size.

OXWELDING AND CUTTING. Manual of Instruction. Compiled by the Oxweld Acetylene Company, Jersey City, N. J. First edition. (copyright 1918). Paper, 5 x 8 in., 124 pp., illus. $0.50.

The manual describes the apparatus, the methods of using it and gives a series of practice problems illustrating correct methods of meeting those that occur in shops where oxy-acetylene is used for cutting and welding.

PRACTICAL AVIATION. An Understandable Presentation of Interesting and Essential Facts in Aeronautical Science. By Charles B. Hayward. Second edition. American Technical Society. Chicago, 1919. Flexible cloth, 6 x 8 in., 784 pp., illus. $3.75.

This volume treats of the theory, design and construction of airplanes and dirigible balloons, and their motors; and describes the types in use. Considerable space is given to the military uses of airplanes and to the methods of flying used by military aviators.

PRACTICAL AVIATION FOR MILITARY AIRMEN. By Major J. Andrew White. Wireless Press, New York. (copyright 1918). Cloth, 6 x 9 in., 197 pp., illus., pl. $1.75.

The author's aim has been to produce a textbook suited for intensive study by students of military aviation who wish to learn the essentials of flying in the shortest possible time. The reading matter has been condensed by eliminating everything but essentials, and providing a large number of drawings, conveniently arranged.

SCRAP METALS. Study of Iron and Steel Old Material, Its Preparation and Markets. By George H. Manlove. The Old Metals, by Charles Vickers. The Penton Publishing Co., Cleveland, 1918. Cloth, 6 x 8 in., 278 pp. $2.

The two monographs which compose this volume treat of the utilization of old metal. The first is restricted to scrap iron and steel, while the second discusses non-ferrous metals. The book is a pioneer attempt to present the scrap industry in print.

TOPOGRAPHIC STADIA SURVEYING. A Manual with Reduction Tables and a new Type of Reduction Diagram. By C. E. Grunsky. D. Van Nostrand Co., New York, 1917. Cloth, 4 x 7 in., 99 pp., 18 illus., 8 tab., folding diag. in cover pocket. $2.

The author describes a method of surveying and a special type of diagram for the reduction of stadia notes, which has been found to be very satisfactory in practice.

THE ENGINEERING INDEX

Published Monthly by The American Society of Mechanical Engineers

The Engineering Index was Founded in 1884 by the Association of Engineering Societies; Published from 1895 to 1919 by The Engineering Magazine Company; and Acquired January 1919 by The American Society of Mechanical Engineers

THE following pages form a descriptive Index to articles on engineering and related subjects in current periodicals. In its preparation the Society's engineering staff regularly examines all of the technical journals and society publications received by the Engineering Societies Library, which form one of the greatest and most complete collections of scientific periodicals in the world, comprising upward of 1100 distinct publications in some ten languages. Cross-references are freely introduced in the Index, and in all cases where the titles of articles are not sufficiently descriptive, explanatory sentences are appended. The main abbreviations used in the items are given at the bottom of this page.

PHOTOSTATIC COPIES OF ARTICLES LISTED

THE Society is prepared to supply photostatic copies (white printing on brown background) of any of the articles listed. Copies of the periodicals themselves, or clippings of articles, cannot be supplied.

Price of each print (up to 11 x 14 in. in size), 25 cents plus postage. A separate print is required for each page of the larger-size periodicals, but where possible two pages will be photographed together on the same print. Bill will be mailed with the prints.

Those holding coupon books for clippings formerly issued by The Engineering Magazine Company may use the coupons in payment for photostatic prints. In ordering, state plainly

(1) Page number of Index on which item appears
(2) Title of article
(3) Name of periodical.

Orders should be sent to

Harrison W. Craver, *Director,*
Engineering Societies Library,
29 West 39th Street, New York City.

DIVISIONS OF THE ENGINEERING INDEX

MECHANICAL ENGINEERING

Air Machinery
Corrosion
Forging
Foundries
Fuels and Firing
Handling of Materials
Heat Treating
Heating and Ventilation
Hoisting and Conveying
Hydraulic Machinery
Internal-Combustion Engines
Lubrication
Machine Elements and Design
Machine Shop
Machinery, Metal-Working
Machinery, Special
Machinery, Woodworking
Materials of Construction and Testing of Materials
Measurements and Measuring Apparatus
Mechanical Processes
Mechanics
Motor-Car Engineering
Pipe
Power Generation
Power Plants
Power Transmission
Producer Gas
Pumps
Refractories
Refrigeration
Research
Standards and Standardization
Steam Engineering
Textiles
Thermodynamics
Welding
Varia

ELECTRICAL ENGINEERING

Electrochemistry
Electrodeposition
Electrophysics
Furnaces
Generating Stations
Generators and Motors
Lighting and Lamp Manufacture
Measurements and Tests
Power Applications
Standards
Telegraphy and Telephony
Transformers, Converters, Frequency Changers
Transmission, Distribution, Control
Wiring
Varia

CIVIL ENGINEERING

Bridges
Building and Construction
Cement and Concrete
Earthwork, Rock Excavation, etc.
Harbors
Materials of Construction
Municipal Engineering
Roads and Pavements
Sanitary Engineering
Water Supply
Waterways

MINING ENGINEERING

Alloys, Ferrous
Base Materials
Coal and Coke
Copper
Explosives
Geology and Mineralogy
Iron
Lead
Major Industrial Materials
Mines and Mining
Minor Industrial Materials
Oil and Gas
Precious Minerals
Rare Minerals
Tin
Transportation
Varia

METALLURGY

Aluminum
Blast Furnaces
Copper
Flotation
Iron and Steel
Non-Ferrous Alloys
Occluded Gases
Waste Recuperation

AERONAUTICS

Aeroplane Parts
Aerostatics
Aircraft Production
Applications
Auxiliary Service
Design
Dynamics
Engines
Gliders
History
Instruments
Materials of Construction
Mechanics
Meteorology
Military Aircraft
Models
Planes
Propellers
Specifications, Aeroplane
Transatlantic Flight

MARINE ENGINEERING

Auxiliary Equipment
Salvage
Ships
Yards
Varia

ORGANIZATION AND MANAGEMENT

Accounting
Education
Export
Factory Management
Finance and Cost
Inspection
Labor
Legal
Lighting
Public Regulation
Reconstruction
Safety Engineering
Salvage
Transportation
Varia

INDUSTRIAL TECHNOLOGY

RAILROAD ENGINEERING

Electric Railroads
Electrification
Equipment
Foreign
Labor
Locomotive
Maintenance
New Construction
Operation and Management
Permanent Way and Buildings
Rails
Rolling Stock
Safety and Signaling Systems
Shops
Special Lines
Street Railways
Terminals

MUNITIONS AND MILITARY ENGINEERING

GENERAL SCIENCE

Chemistry
Mathematics
Physics

Note.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
New York (N. Y.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

Mechanical Engineering

AIR MACHINERY

Air Pumps

Air Ejectors (Les éjecteurs extracteurs d'air), L. Congé. Revue Générale de l'Electricité, vol. 4, no. 17, Oct. 26, 1918, pp. 629-632, 6 figs. Details of Westinghouse-Leblanc air pump, of Breguet ejector and of British Westinghouse apparatus.

See also MECHANICAL ENGINEERING, Heating and Ventilation (Air Cooling)

CORROSION

Wire Ropes

Interior Corrosion of Wire Ropes, Wm. Fleet Robertson. Can. Min. Jl., vol. 40, no. 1, Jan. 8, 1919, pp. 6-7. Report of tests undertaken on rope which broke, it is said, by oxidizing of wires, chiefly internally, caused by action of corrosive water and a humid atmosphere.

FORGING

Drop Hammers

4-ton Drop Hammer at Crewe Works. Engineering, vol. 106, no. 2765, Dec. 27, 1918, pp. 736-737, 7 figs. Description with illustrations of the hammer and some of its work. Its development and the necessary equipment.

European Situation

Some Drop Forge Possibilities Abroad, L. W. Alwyn-Schmidt. Am. Drop Forger, vol. 4, no. 12, Dec. 1918, pp. 471-473. Review of present conditions; situation in foreign countries; methods of procuring business in Europe.

Forge-Shop Capacity

Selecting a Source of Supply for Forgings, W. F. Rockwell. Am. Drop Forger, vol. 5, no. 1, Jan. 1919, pp. 1-3. Convenience of enlarging forge-shop capacity; preference of buyers to order forgings by sets.

Forge Shop

Pan Motor Forge Shop About Completed. Am. Drop Forger, vol. 4, no. 12, Dec. 1918, pp. 490-492. Details of layout and equipment; methods for handling raw and finished material. Shop to be largest in U. S.

A Progressive Forge Shop in Rockford. Am. Drop Forger, vol 4, no. 12, Dec. 1918, pp. 480-481, 6 figs. Equipment and general layout of departments.

Modern Forge Shop at the Essington Plant. Am. Drop Forger, vol. 4, no. 12, Dec. 1918, pp. 474-475, 3 figs. General description of works turning out marine equipment. Layout of shops allows for future expansion.

Forging Industry

A Review of the Drop Forging Industry, A. W. Peterson. Am. Drop Forger, vol. 5, no. 1, Jan. 1919, pp. 36-38, 2 figs. Data showing production development of forging industry over period of 35 years; importance of forging industry during years of war.

Furnaces

Heating and Preheating Forging Furnaces. Blast Furnace, vol. 7, no. 1, Jan. 1919, pp. 57-59, 4 figs. Recent installation designed to withstand distorting action of heat as well as wear. Combustion chambers on preheating furnace are staggered on each side.

Historical Data

Historical Data on Hammers and Forgings, Howard Terhune. Am. Drop Forger, vol. 5, no. 1, Jan. 1919, pp. 39-41. Review of improvements since issue of first patent in 1842; introduction of principle of modern board drop hammer in 1861; present tendencies.

See also ELECTRICAL ENGINEERING, Furnaces.

FOUNDRIES

Brass Foundries

Materials and Chemicals Used in Brass Foundry Practice, Charles Vickers. Brass World, vol. 14, no. 12, Dec. 1918, pp. 343-345. Deals with history, properties, appearance, physiological action and commercial use of substances commonly used in brass founding. First of series of articles.

Casting Methods

Molding and Pouring a Gasoline Engine Bed, F. H. Bell. Can. Machy., vol. 21, no. 5, Jan. 30, 1919, pp. 106-108, 4 figs. Shows method of casting a sheet-steel bottom into a gray-iron casting, making entire bed into a tank.

Core Ovens

The Application of Pyrometers to Core Ovens, G. W. Keller. Foundry, vol. 47, no. 318, Feb. 1919, pp. 72-74, 3 figs. From a paper before Am. Foundrymen's Assn.

Furnace, Electric

The Electric Furnace in the Grey Iron Foundry, F. H. Bell. Can. Machy., vol. 21, no. 1, Jan. 2, 1919, pp. 7-8, 4 figs. Practicability of melting gray iron for foundry purposes by electricity; process followed at Bowmanville Foundry Co.

Irons

Conversion of White Iron into Foundry, C. T. Huang. Iron Age, vol. 103, no. 4, Jan. 23, 1919, pp. 231-232. How Chinese native irons may be made available as a means of relieving the scarcity of other grades in that country.

Molding

Molding Shoes for Caterpillar Tractors. Iron Age, vol. 103, no. 2, Jan. 9, 1919, pp. 119-120, 3 figs. Davenport molding machine with hurriedly devised handling rigging gives satisfactory results; 1000 shoes made per day.

Patterns

The Laying Out of Patterns, Joseph A. Shelly. Machy., vol. 25, no. 6, Feb. 1919, pp. 493-497, 12 figs. Methods of making the drawings or layouts that are required by the patternmaker in planning his work, together with allowances necessary for draft and shrinkage and for machining castings in the shop.

Steel Castings on Pacific Coast

Steel Castings on the Pacific Coast. Iron Age, vol. 103, no. 4, Jan. 23, 1919, pp. 233-235, 2 figs. Growth of industry due to the war; good steel made without pig iron; overcoming manufacturing difficulties.

Tumbling Barrels

Tumbling Barrels in Foundries (Scheurfaesser und Putztrommeln in Giessereibetrieben), Rauch und Staub, vol. 8, no. 12, Sept. 1918, pp. 113-114. General discussion on construction, use and advantages of tumbling barrels for changing castings. States that castings up to 45 in. long and weighing 2000 lbs. can be cleaned in suitable revolving drums. Describes inclined drums 36 ft. long, 28 in. in diameter.

See also MARINE ENGINEERING, Ships (Castings); ELECTRICAL ENGINEERING, Furnaces.

FUELS AND FIRING

Argentine

Fuels in Argentine (Die Brennstoffe Argentinens), Rauch und Staub, vol. 8, no. 12, Sept. 1918, pp. 114-115. General discussion on the fuel situation in Argentina, abstracted from Berichte ueber Handel und Industrie, vol. 23, no. 4, Feb. 1918.

Ash

Fusibility of West Virginia Coal Ash, Walter Selvig. Coal Age, vol. 15, no. 1, Jan. 2, 1919, pp. 12-16, 2 figs. Method of preparing ash for fusion test and determining initial softening temperature and interval of fusion. Includes a tabulation of tests on West Virginia coals.

Bagasse

Bagasse Feeders, Furnace Design and Furnace Control, A. Gartley. La. Planter, vol. 62, no. 21, Jan. 11, 1919, pp. 25-28, 5 figs. Suggestions on design; curves giving pounds of water which can be evaporated per pound of bagasse having different percentages of moisture. Paper before Hawaiian Sugar Planters' Assn.

Briquets

Some Notes on the Manufacture of Fuel Briquettes, E. H. Robertson. Trans. Min. & Geol. Inst. India, vol. 13, pt. 1, Sept. 1918, pp. 49-61, 6 figs. Analysis of manufacturing methods; results obtained by some experimenters; examples of survivance of briquettes.

The Economy of Briquetting Small Coal, J. A. Yeadon. Tran. Min. Inst. Scotland, vol. 40, pt. 7, 1918-1919, pp. 145-148 and (discussion) pp. 148-150. Gain in calorific power by briquetting with pitch as agglomerant; rectangular and "ovoid" forms of briquettes.

Coal Selection

Selecting Coal for Power Plant Use, Robert June. Elec. Rev., vol. 74, no. 3, Jan. 18, 1919, pp. 94-97, 4 figs. Characteristics of various coals; influence of coal upon furnace-chamber design; purchase of coal. (First of series on power-plant management.)

Clay Products, Burning

Fuel Economy in Clay Products Burning—III, A. V. Bleininger and A. F. Greaves Walker. Can. Mfr., vol. 39, no. 1, Jan. 1919, pp. 87-88. Means of controlling burning.

Conservation

Fuel Conservation, Robert Collett. New England R.R. Club, Dec. 10, 1918, pp. 190-208. Waste of fuel by reason of engines delayed on road and by engines kept under steam unnecessarily at terminals; improper handling of engines; excessive firing; engines not in good condition; fuel not up to contract specification.

The Threatened Coal Shortage and the Possible Methods of Economising Fuel—II, John B. C. Kershaw. Cassier's Eng. Monthly, vol. 54, no. 6, Dec. 1918, pp. 308-315, 2 figs. Applicability of remedies proposed in October issue to English conditions; recommendations of U. S. Fuel Administration; coal-dust firing as an aid to fuel conservation.

Fuel Economy Will Continue a Serious Problem, W. A. Shoudy. Elec. World, vol. 73, no 1, Jan. 4, 1919, pp. 14-16, 3 figs. Can be improved by proper application of correctly designed apparatus maintaining high vacuum, eliminating small wastes and not operating too many boilers; other suggestions.

Draft

Saving the Waste in the Chimney—III, Robert Sibley and Chas. H. Delany. Jl. Elec., vol. 42, no. 2, Jan. 15, 1919, pp. 79-80, 1 fig. Determination of actual draft required for different fuels. Chart showing lb. of coal burned per sq. ft. grate surface per hr. against draft between furnace and ash pit in in. of water.

Steam Plant Efficiency. Coal Trade Jl., year 51, no. 2, Jan. 8, 1919, pp. 37-38, 4 figs. Relation between kinds of coal and completeness of combustion for six sets of conditions; gaging air supply for given furnace and fuel. (Concluded.)

Fuel Requirements for Factories

Fuel Requirements for Factories, Charles L. Hubbard. Indus. Management, vol. 57, no. 2, Feb. 1919, pp. 125-126. How to make tests of fuel requirements for extremes of weather, calculate needs for other conditions and outside temperatures, and estimate amount of fuel needed month by month throughout heating season.

Gas

Uses Gas in Twenty-One Manufacturing Processes, F. M. Lester. Gas Age, vol. 43, no. 2, Jan. 15, 1919, pp. 102-104, 6 figs. How gas is used in plant manufacturing gasoline motors and railway supplies and consuming 10,000,000 cu. ft. gas per month.

Gas Fuels

See Producer Gas below; items under INDUSTRIAL TECHNOLOGY; and Coal and Coke (Coke-Oven Gas) and Oil and Gas, under MINING ENGINEERING.

Heat Value, Determination of

Use of the Hydrogen-Volatile-Matter Ratio in Obtaining the Net Heating Value of American Coals, A. C. Fieldner and W. A. Selvig. Department of Interior, Bur. of Mines, tech. paper 197, 13 pp. 4 figs. Curves, constructed from 2000 analyses, showing relation between percentages of hydrogen and volatile matter of different coals.

Calorific Valuation of Coal Without a Calorimeter, Proctor Smith. Cassier's Eng. Monthly, vol. 54, no. 6, Dec. 1918, pp. 333-334. Approximate analysis by Goutal's formula.

Indiana Coals

Getting Better Combustion of Indiana Coals, T. A. Marsh. Elec. World, vol. 73, no. 2, Jan. 11, 1919, pp. 72-74, 7 figs. Practical methods by means of which furnace equipment installed years ago can be made to produce results comparable with good modern practice.

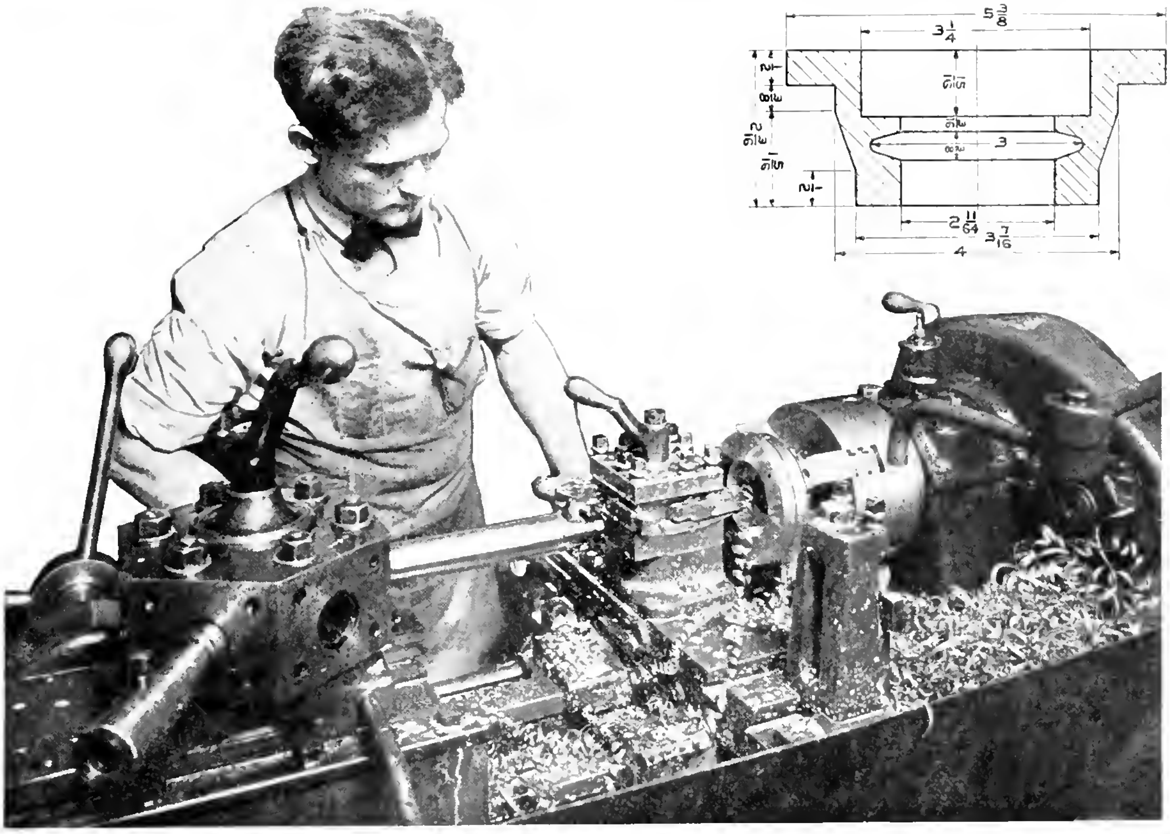
Lignites

Combustion of Lignite and High-Moisture Fuels, T. A. Marsh. Elec. World, vol. 73, no. 6, Feb. 8, 1919, pp. 265-267, 5 figs. Typical analyses of high-moisture fuels in the United States and Canada and summary of experience derived from burning fuels of the kinds described in power plants.

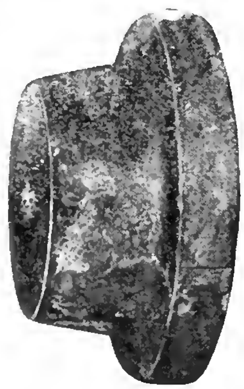
Notes on Lignite, S. M. Darling. Power Plant Eng., vol. 23, no. 3, Feb. 1, 1919, pp. 148-150. Characteristics and utilization. Abstract of Technical Paper 178, Bureau of Mines.

Motor Fuel

The Motor Fuel Problem, W. R. Ormandy. Colliery Guardian, vol. 116, no. 3021, Nov. 22, 1918, pp. 1076-1077. From paper before Instn. of Petroleum Technologists.



Value of the Square Turret



THIS shows the amount of material removed and how well the many operations on these tough power sprocket clutches were finished on the No. 4 Universal Screw Machine. The hexagon turret was used only for boring. The square turret, loaded to capacity with cutters, did the rest with the aid of its eight power cross and longitudinal feeds.

For Work too Complicated for Ordinary Screw Machines

The special features of the No. 4 Universal (in this case the unusual use for the square turret) adapt them to a wide range of work too complicated for ordinary screw machines or turret lathes.

SEND FOR DETAILS

Turret Lathes and Screw Machines
from 5/8 in. x 4 in. to 4½ in. x 44 in., Maximum Swing 21½ in.

THE WARNER & SWASEY COMPANY

CLEVELAND, OHIO, U. S. A.

NEW YORK Office—Singer Building. **Boston Office**—Oliver Building. **Buffalo Office**—Iroquois Building. **Detroit Office**—Ford Building. **Chicago Office and Show Rooms**—618-622 Washington Blvd.
FOREIGN AGENTS: Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. Allied Machinery Company, Paris and Turin. Van Rietschoten & Houwens, Rotterdam. Yamatake & Co., Tokio. Benson Brothers, Sydney and Melbourne. A. Asher Smith, Sydney. A. R. Williams Machinery Co., Ltd., Toronto, St. John, Winnipeg and Vancouver. Williams & Wilson, Ltd., Montreal.

Peat

Peat and the Electrical Industry (La tourbe et l'industrie électrique), Pierre Gieu. Revue Générale de l'Electricité, vol. 4, no. 22, Nov. 30, 1918, pp. 843-851, 3 figs. Artificial drying and gasification of peat; effects of humidity on its calorific value; permissible percentage of humidity. Results of an extended investigation undertaken under the direction of Minister of Mines, Canada.

Peat in 1917, C. C. Osborn. Department of Interior, U. S. Geol. Survey, Mineral Resources of the United States—Part II, Dec. 19, 1918, pp. 257-283, 1 fig. General conditions of peat industry; occurrence, properties and uses of peat; peat industry in principal foreign countries; selected bibliography; map of U. S. showing principal peat deposits.

Powdered Fuel

Progress Realized During the War in the Utilization of Fuels (Progrès réalizés pendant la guerre dans l'utilisation des combustibles), E. Damour. Industrie Electrique, year 28, no. 637, Jan. 10, 1919, pp. 5-7. Gasification and pulverization of fuels. From extensive account in Chemie et Industrie.

Powdered Coal Advance and Development, H. A. Kimber. Blast Furnace, vol. 7, no. 1, Jan. 1919, pp. 67-68. Use of powdered fuel for steam generation; improvements in distribution; control of fuel; summary of furnaces for which pulverized coal was installed during 1918.

A Review on the Use of Powdered Coal, W. O. Renkin. Am. Drop Forger, vol. 5, no. 1, Jan. 1919, pp. 22-25, 3 figs. Early uses and present methods; comparative data on fuels.

Suggestions for Burning Pulverized Coal, W. G. Wilcox. Am. Drop Forger, vol. 4, no. 12, Dec. 1918, pp. 492-494. Control of combustible and air in burning pulverized coal; method of projecting coal in suspended form into furnace; importance of mixing coal dust properly.

Stokers

Fuel Burning Equipment of Modern Power Stations, Joseph G. Worker. Elec. Jl., vol 16, no. 2, Feb. 1919, pp. 55-60, 15 figs. Examples of various installations using underfeed stokers, auxiliary equipment to control their operation.

Mechanical Stokers—II, Robert June. Brick & Clay Rec., vol. 53, no. 14, Dec. 31, 1918, pp. 1147-1149, 3 figs. Concludes from examination of various types that chain-grate stoker is suitable for boilers of good size up to 250 per cent rating and overfeed stoker for medium-sized installations up to 200 per cent rating.

Waste Heat, Utilization of

Utilization of Waste Heat at Municipal Gas Works of Tuebingen (Die Abhitzegewinnung und verwertung im staedt. Gaswerk Tuebingen), Henig. Journal fuer Gasbeleuchtung, vol. 61, no. 45, Nov. 9, 1918, pp. 529-534, 1 fig. History and performance of rational waste-heat system utilized for heating water for distant municipal bath. Tests. Costs.

Steam Raising with Waste Heat from Coal- and Oil-Fired Furnaces, Iron & Coal Trades Rev., vol. 97, no. 2648, Nov. 22, 1918, pp. 580, 4 figs. Description of standard heat-raising unit (Brett system), embodying coal-fired furnace with boiler.

See also MINING ENGINEERING, Coal and Coke (Coal Oxidation and Ignition); MECHANICAL ENGINEERING, Motor-Car Engineering (Fuels), Power Plants (Low-Grade Fuels)

GAGES

Profile Gages

Grinding Accurate Profile Gages by Means of Master Plates, Herbert M. Darling. Am. Mach., vol. 50, no. 3, Jan. 16, 1919, pp. 105-106, 3 figs. Description of operation.

Thread and Wing Gages

Thread Gages; Wing Gages, Erik Oberg. Machy., vol. 25, no. 6, February, 1919, pp. 502-506, 13 figs. Last of a series of articles describing principles involved and procedure followed by the Pratt & Whitney Company in developing gaging systems for interchangeable manufacture.

The Precision Measurement of Thread Gages. Can. Machy., vol. 21, no. 5, Jan. 30, 1919, pp. 113-115, 4 figs. Commercial equipment manufactured by Arthur Knapp Eng. Corporation after models developed by Bur. of Standards.

HANDLING OF MATERIALS

Ash Handling

Bennis Ash Handling Plant. Elecn., vol. 82, no. 2121, Jan. 10, 1919, pp. 84-85, 3 figs. Pneumatic ash plant; steam suction conveyors, ash elevators and ash hoists.

Coal Handling

Coal Handling at Ports, H. Hubert. Elecn., vol. 82, no. 2121, Jan. 10, 1919, pp. 42-45, 6 figs. An account of a number of modern plants for dealing with coal at ports.

Coal-Handling Appliances at the Coventry Electricity Works, George Frederick Zimmer. Engineering, vol. 107, no. 2767, Jan. 10, 1919, pp. 37-42, 27 figs. Drawings, general data and description of the plant.

Coal Tipple and Washery at Lehigh, Mont., E. P. Stewart. Coal Age, vol. 15, no. 1, Jan. 2, 1919, pp. 9-11, 4 figs. Apparatus designed to clean coal thoroughly and prepare locomotive fuel.

Coal Handling Plant at Sewall's Point, Virginia. Power, vol. 49, no. 2, Jan. 14, 1919, pp. 54-56, 5 figs. Description of new facilities of Virginia Railway at coal pier near Norfolk, Va. From Coal Age.

Coke

The Mechanical Handling of Coke, Alwyne Meade. Elecn., vol. 82, no. 2121, Jan. 10, 1919, pp. 57-61, 8 figs. The problems involved; description of conveyors designed to overcome difficulties; aspects of cost.

Explosives

Munition Handling Devices. Elecn., vol. 82, no. 2121, Jan. 10, 1919, pp. 73-75, 5 figs. A few examples in which well-known types of conveying apparatus are modified to serve specific purposes in the manufacture of explosives.

Gravity Roller Runway

The Gravity Roller Runway, George Frederick Zimmer. Elecn., vol. 82, no. 2121, Jan. 10, 1919, pp. 33-41, 28 figs. The component parts of gravity roller runways; accessory plant such as shoots, "humpers," stackers and "gadgets."

Mechanical Handling

The Mechanical Handling of Materials, Percy G. Donald. Elecn., vol. 82, no. 2121, Jan. 10, 1919, pp. 29-32, 8 figs. After discussing objections to mechanical handling, the author deals with such plant as an investment, the speed that is desirable, the importance of a suitable layout, and finally indicates the various types of plant that are available.

Paper Mill

Material Handling in a Paper Mill, Henry J. Edsall. Indus. Management, vol. 57, no. 2, Feb. 1919, pp 97-103, 18 figs. Labor-saving equipment of Dill & Collins Co. (To be continued.)

Pneumatic Handling of Cereals

Pneumatic Handling of Cereals, C. Bentham. Elecn., vol. 82, no. 2121, Jan. 10, 1919, pp. 61-67, 15 figs. Importance of pneumatic systems in unloading ships; types of plant in operation; the exhauster; problems involved in the design of a suitable nozzle.

Portable Pneumatic Grain Unloading Plant. Conveying, Cassier's Eng. Monthly Supp., vol. 1, no. 7, Dec. 1918, pp. lxxxiii-lxxxvi, 4 figs. Equipment includes 6-cylinder Aster petrol engine of 85 hp. with rotary blower, mounted on 4-wheeled, 25-ton railway truck.

HEAT TREATING

Developments in 1918

1918 Developments in Heat Treating, James H. Herron. Am. Drop Forger, vol. 5, no. 1, Jan. 1919, pp. 53-54. Changes in methods used for heat-treating materials; scope of heat-treating activities.

Furnaces

Heating Furnaces and Annealing Furnaces—II. W. Trinks. Blast Furnace, vol. 7, no. 1, Jan. 1919, pp. 69-72 and 80, 7 figs. Design, operation and construction. Furnace capacity; rate of heat transfer; temperature to which metal is to be heated.

Malleable Iron

Reducing the Malleable Iron Annealing Period, A. E. White and R. S. Archur. Foundry, vol. 47, no. 318, Feb. 1919, pp. 61-65, 12 figs. Report of an investigation made at the University of Michigan. From a paper before the American Foundrymen's Assn.

Steel for Motors

Treatments of Steels Used in the Construction of Light-Weight Engines. (Emplois et traitments des aciers utilisés dans la construction des moteurs légers), M. L. Barbillon. Bulletin Technique de la Suisse Romande, year 44, nos. 15 and 17, July 27 and Aug. 24, 1918, pp. 140-142 and 158-160, 4 figs. July 27: Steel employed for shafts, nuts, bolts and cams. Aug. 24: Soft carbon steels; chrome-nickel steels; nickel steels; tungsten steels; special steel having 0.20C + 0.13 Si + 0.36 mn. — 12 Ni.

Lincoln Motor Co.'s Heat Treating Plant, F. L. Prentiss. Iron Age, vol. 103, no. 2, Jan. 9, 1919, pp. 107-111, 7 figs. Department equipped for quantity production in plant designed for changing from airplane to commercial motor work.

See also METALLURGY, Iron and Steel (Heat Treatment)

HEATING AND VENTILATION

Air Cooling

Special Applications of Small Air-Cooling Systems. Heat. & Vent. Mag., vol. 16, no. 1, Jan. 1919, pp. 43-46, 4 figs. Arrangements with forced and gravity circulation of air.

Boiler Rating

Heating Versus Power Boiler Rating, P. J. Dougherty. Power, vol. 49, no. 3, Jan. 21, 1919 pp. 84-85. Showing why rules in general used for determining and comparing rating or capacity of high-pressure boilers are not applicable to low-pressure or so-called heating boilers.

Central-Station Heating

Central Station Heating; Its Economic Features with Reference to Community Service, John C. White. Department of Interior, Bur. of Mines, tech. paper 191, 23 pp., 6 figs. Data on costs and results obtained with central heating stations.

Factory Heating

Modern Factory Heating, Alfred G. King. Domestic Eng., vol. 86, nos. 1 and 2, Jan. 4, 11, 1919, pp. 27-30 and 76-79, 11 figs. Requirements for factory heating; construction details.

Tunnel Ventilation

The Ventilation of Tunnels and Buildings, Francis Fox. Universal Engr., vol. 28, no. 6, Dec. 1918, pp. 40-46. Ventilation systems in operation at several European tunnels; prescribed hygienic practice concerning renovation of air in dwellings.

Ventilation Plant for Simplon Tunnel (Die Ventilationsanlage des Simplon Tunnels), F. Rothpletz. Schweizerische Bauzeitung, vol. 73, no. 1, Jan. 4, 1919, pp. 3-4, 3 figs. Remodeling and enlarging of the ventilation system, located at the north entrance only of the twin-tunnel, operated electrically. Southward air current chosen to avoid rusting of structural steel due to condensation if southern air were sent northward. Total air volume 180 cu. m. per sec. at velocity in tunnel of 3 to 4 m. per sec. Part 1.

Two-Pipe System

Care of Heating and Ventilating Equipment, Harold L. Alt. Power, vol. 49, no. 5, Feb. 4, 1919, pp. 156-159, 14 figs. A discussion of the two-pipe system. Seventh article.

Vapor Heating

Modern Practice in Vapor Heating. Heat. & Vent. Mag., vol. 16, no. 1, Jan. 1919, pp. 48-52, 6 figs. The Broomell system.

See also MARINE ENGINEERING, Ships (Ventilating and Heating)

HOISTING AND CONVEYING

Conveyor Types

Conveyors for Engineering Works. Engineer, vol. 126, no. 3283, Nov. 29, 1918, pp. 462, 3 figs. Deals with types in use in engineering works, such as conveyors for rapid assembly of motors, case elevators, and shell conveyors. (From paper before Manchester Assn. of Engrs., by W. H. Atherton.)

Design

Some Details of Conveyors and Elevators, W. H. Atherton. Elecn., vol. 82, no. 2121, Jan. 10, 1919, pp. 46-49, 20 figs. Design of a number of essential details in conveyors and elevators, dealing with chains, sprocket wheels, buckets, skidders, frames and bearings.

Design of Electrically-Driven Lifting Blocks. Elecn., vol. 81, no. 2115, Nov. 29, 1918, pp. 639-640, 7 figs. Abstract of article in Elektrotechnische Zeitschrift, No. 1, 1918.

Electric Haulage

Notes on Three-Phase Electric Haulage Equipment, L. Fokes. Colliery Guardian, vol. 116, no. 3025, Dec. 20, 1918, pp. 1295-1296, 5 figs. Haulage room; motor; slip rings and brush gear; control equipment; isolating switch; reversing switch; controller; resistances; liquid resistance.

History

History of Conveying—II, George Frederick Zimmer. Conveying, Cassier's Eng. Monthly Supp., vol. 1, no. 7, Dec. 1918, pp. lxxv-lvvvii, 9 figs. Bucket elevators; elevator and conveyor chains. (Continued.)

Trucks

See Transportation, under ORGANIZATION AND MANAGEMENT.

Wire Rope

The Wire Rope and Its Uses for Conveying Purposes. Elecn., vol. 82, no. 2121, Jan. 10, 1919, pp. 77-79. General principles: single and double ropeway systems; single fixed rope system.

HYDRAULIC MACHINERY

Hydraulic Plants

Extension to the Ontario Power Co.'s Plant, Thos. H. Hogg. Can. Engr., vol. 36, no. 3, Jan. 16, 1919, pp. 139-144 and 149-151, 23 figs. Construction of 13 miles of 13.5-ft. diameter wood-stave pipe for 50,000-hp. capacity; steel differential surge tank, 60 ft. in diameter, 94 ft. high; installation of two 20,000-hp. turbines with direct-connected generators.

Turbines

Banki's New Hydraulic Turbine (Neue Wasserturbine von Donat Banki, Professor in Budapest). Schweiz. Bauzeitung, vol. 72, no. 24, Dec. 14, 1918, pp. 235-236, 4 figs. The new turbine fills the gap between the Pelton wheel and the Francis turbine. Very compact.

New 2500-Hp. Turbine in the Kubel Hydroelectric Power House, near Saint Gall, Switzerland (La nouvelle turbine de 2500 ch. de l'usine hydro-electrique de Kubel pres Saint-Gall Suisse). Revue Generale de l'Electricite, vol. 5, no. 1, Jan. 4, 1919, pp. 19-25, 9 figs. Results of trials of compact design of turbine with overhanging rotor to determine output, regulation and efficiency. Description of new regulator.

Turbine Operation

Economical Operation of Hydraulic Turbines, E. A. Gibbs. Can. Engr., vol. 36, no. 2, Jan. 9, 1919, pp. 127-128. Cleanliness, care and upkeep important factors in obtaining maximum efficiency. Also abstracted in Elec. World, vol. 73, no. 1, Jan. 4, 1919, pp. 25-26.

Turbine Tests

Standard Testing Code for Hydraulic Turbines, F. H. Rogers. Elec. Wld., vol. 73, no. 4, Jan. 25, 1919, pp. 164-166. Engineering societies are urged to adopt code of Machinery Builders' Society.

Water Hammer

Charts for Calculating Water Hammer. Jl. Elec., vol. 42, no. 2, Jan. 15, 1919, pp. 74-75, 2 figs. Constructed to give maximum possible rise or fall in pressure due to water hammer as determined from $h = a V/g$, a being velocity of wave (in an additional diagram) and V velocity of flow in pipe.

See also MECHANICAL ENGINEERING, *Power Generation (Tides)*

INTERNAL-COMBUSTION ENGINES

Design

Port Design for Two-Cycle Oil Engines, D. O. Barrett. Gas Engine, vol. 21, no. 2, Feb. 1919, pp. 37-42. Description of some types of two-cycle engines; formulae for inlet, transfer and exhaust ports.

Oil Engines

The High-Compression Oil Engine, W. G. Gernandt. Jl. Soc. Automotive Engrs., vol. 4, no. 2, Feb. 1919, pp. 112-117 and discussion, pp. 117-118.

Internal Combustion Engine Development. Eng. Rev., vol. 32, no. 6, Dec. 16, 1918, pp. 164-166, 8 figs. Piston designs; leading particulars of engines developing 80 hp. per cylinder. (Concluded.)

LUBRICATION

Motor-Cylinder Lubrication

Motor-Cylinder Lubrication, G. S. Bryan. Universal Engr., vol. 28, no. 4, Oct. 1918, pp. 37-45, 1 fig. Study of conditions under which lubrication takes place and of characteristics of motor-cylinder oils that determine their suitability for these conditions.

See also RAILROAD ENGINEERING, *Locomotives (Lubricators)*; MECHANICAL ENGINEERING, *Motor Car Engineering (Lubrication)*

MACHINE ELEMENTS AND DESIGN

Ball Bearings

Why Do Ball Bearings Sometimes Fail? F. J. Jarosch. Am. Mach., vol. 50, no. 5, Jan. 30, 1919, pp. 209-213, 23 figs. An analysis of failures arising from poor selection and mistreatment.

Floating-Frame Reduction Gear

The Design and Progress of the Floating-Frame Reduction Gear, John H. Macalpine. Proc. Engrs., Soc. Western Pa., vol. 34, no. 7, Oct. 1918, pp. 519-535. Discussion. (Continued from Proc. Feb. 1918, p. 71.) Discussor contends rigid-frame gears are running continuously, with equally high tooth pressures, at the same speeds as floating-frame gears.

Machine Design

Developing Designs for Machinery and Tools, F. E. Johnson. Machy., vol. 25, no. 6, Feb. 1919, pp. 517-518, 5 figs. Cost of designing a new machine; evolution of design of a specific machine; overcoming defects in original design.

Screws

Optical Projection for Screw-Thread Inspection, James Hartness. Mech. Eng., vol. 41, no. 2, Feb. 1919, pp. 127-135, 10 figs. Analysis of screw-thread elements essential to strength and dependability; description of method for their accurate inspection.

Determination of Screw Dimensions (Détermination des dimensions à donner aux vis). La Métallurgie, year 51, no. 1, Jan. 1, 1919, pp. 21-23. Formulæ in three cases: (1) when screw is subject to tension and compression, (2) when screw is subjected to tension or compression by motion of nut, (3) when subjected to shear.

MACHINE SHOP

Die Making

The question of Our Die Room Equipment. Am. Drop Forger, vol. 5, no. 1, Jan. 1919, pp. 26-32, 23 figs. Improvements in die-room practices during years of war; suggestions to executives in regard to selecting equipment.

Grinding

Abrasives for Grinding Malleable Castings, W. T. Montague. Foundry, vol. 47, no. 318, Feb. 1919, pp. 74-75. Adapted from a recent publication of the Norton Co.

Machine Shops

Westinghouse Marine Engineering Works, Edward K. Hammond. Machy., vol. 25, no. 6, February, 1919, pp. 538-544, 12 figs. Description of a new plant at South Philadelphia for manufacturing the Westinghouse Marine System.

Milling Cutters

How Milling Cutters Are Made, F. B. Jacobs. Iron Trade Rev., vol. 64, no. 2, Jan. 9, 1919, pp. 150-154, 14 figs. How quantity production is secured by modern standard machinery and careful routing of work.

Some Milling Applications and Adaptations. Engineer, vol. 127, no. 3288, Jan. 3, 1919, pp. 6-9, 22 figs. Description of the development and use of the Francis milling cutter in munitions work.

Repair Shop

Camp Holabird Motor Truck Repair Shops. Jl. Soc. Automotive Engrs., vol. 4, no. 2, Feb. 1919, pp. 86-87. Repair shop procedure. Shop does 80 per cent of repair work required by Army trucks.

Tool Casting

Casting Tools from an Air-Hardening Steel. Foundry, vol. 47, no. 318, Feb. 1919, pp. 66-67, 3 figs. New alloy used successfully in the manufacture of dies and forming tools without forging; tungsten not present in the metal.

Tool Making

The Alfred Herbert Machine Tool Shop. Cassier's Eng. Monthly, vol. 54, no. 6, Dec. 1918, pp. 325-332, 8 figs. Facts about British key industries. (Second article.)

Machine Shop Economies. Universal Engr., vol. 28, no. 6, Dec. 1918, pp. 35-39. Manufacture of jigs and special tools; possible economy in selecting speeds and feeds.

See also MECHANICAL ENGINEERING, *Mechanical Processes (Dies)*

MACHINERY, METAL-WORKING

Boring Machine

Cylinder Boring and Reaming Tools, Franklin D. Jones. Machy., vol. 25, no. 6, Feb. 1919, pp. 507-515, 26 figs. Types and designs of cutter heads used for rough-boring and reaming small engine cylinders.

Boring Mill for Precision Work. Iron Trade Rev., vol. 64, no. 2, Jan. 9, 1919, pp. 156-157, 3 figs. Base and column of horizontal boring machine are heavily ribbed and metal distributed to reduce vibration. Operating mechanism is provided with ball thrust bearings.

Drilling Machine

The Hill Multiple-Spindle Drilling Machine. Am. Mach., vol. 50, no. 5, Jan. 30, 1919, pp. 189-190, 2 figs. Spindle drive design permits of close spacing of the drilling heads with a simple mechanism.

Lathes

The Bullard 8-Inch Mult-Au-Matic. Am. Mach., vol. 50, no. 5, Feb. 6, 1919, pp. 236-241, 6 figs. A detailed description of the machine.

Marking Machine

Making Milling and Gear Cutting Attachment—II, Robert Mawson. Can. Machy., vol. 21, no. 4, Jan. 23, 1919, pp. 78-81, 11 figs. Tools and methods used by Presto Machine Co., with special reference to marking machine for graduating dividing head base.

Milling Machines

Making Milling and Gear Cutting Attachment—III, Robert Mawson. Can. Machy., vol. 21, no. 5, Jan. 30, 1919, pp. 97-100, 15 figs. Tools and methods followed when machining vertical slide column base, dividing head, index bearing and plates of attachment.

Building the Kempsmith Milling Machine, M. E. Hoag. Am. Mach., vol. 50, nos. 3 and 5, Jan. 16 and 30, 1919, pp. 101-104 and 195-198, 23 figs. Description of some of operations followed in construction of milling machines.

MACHINERY, WOODWORKING

Felling Trees, Machine

Machine for Felling Trees (Machine abatteuse-billonneuse électrique pour le sciage et l'abatage des bois). Revue Générale de l'Electricité, vol. 4, no. 21, Nov. 23, 1918, pp. 165D-166D, 2 figs. An abstract is given of French patent no. 469,995, describing electrically-driven circular saw for felling trees.

MATERIALS OF CONSTRUCTION AND TESTING OF MATERIALS

Cast Iron

Wearing and Anti-Frictional Qualities of Cast Iron, J. E. Hurst. Iron & Coal Trades Rev., vol. 97, no. 2647, Nov. 15, 1918, pp. 546. Abstract of "Preliminary Note" to a Carnegie Scholarship Memoir.

Porcelain

Some Types of Porcelain, F. H. Riddle and W. W. McDanel. Jl. Am. Ceramic Soc., vol. 1, no. 9, Sept. 1918, pp. 606-627, 13 figs. Determination of burning range of porcelain bodies having covering fired at cone 10 and above. Composition of bodies used varied from 45 to 85 per cent clay content and from 10 to 30 per cent flux.

See also METALLURGY, *Iron and Steel (Tests)*; CIVIL ENGINEERING, *Cement and Concrete*.

MEASUREMENTS AND MEASURING APPARATUS

Boiler Feedwater

Measuring Boiler Feedwater, D. L. Fagnan. Nat Engr., vol. 23, no. 1, Jan. 1919, pp. 18-22, 5 figs. Discussion of various methods; principles of operation and construction of representative types. Paper before Nat. Assn. Stationary Engrs.

Calorimeters

The Calorimetry of Coal. Engineering, vol. 107, no. 2767, Jan. 10, 1919, pp. 33-36, 10 figs. A description of the calorimeter and its use.

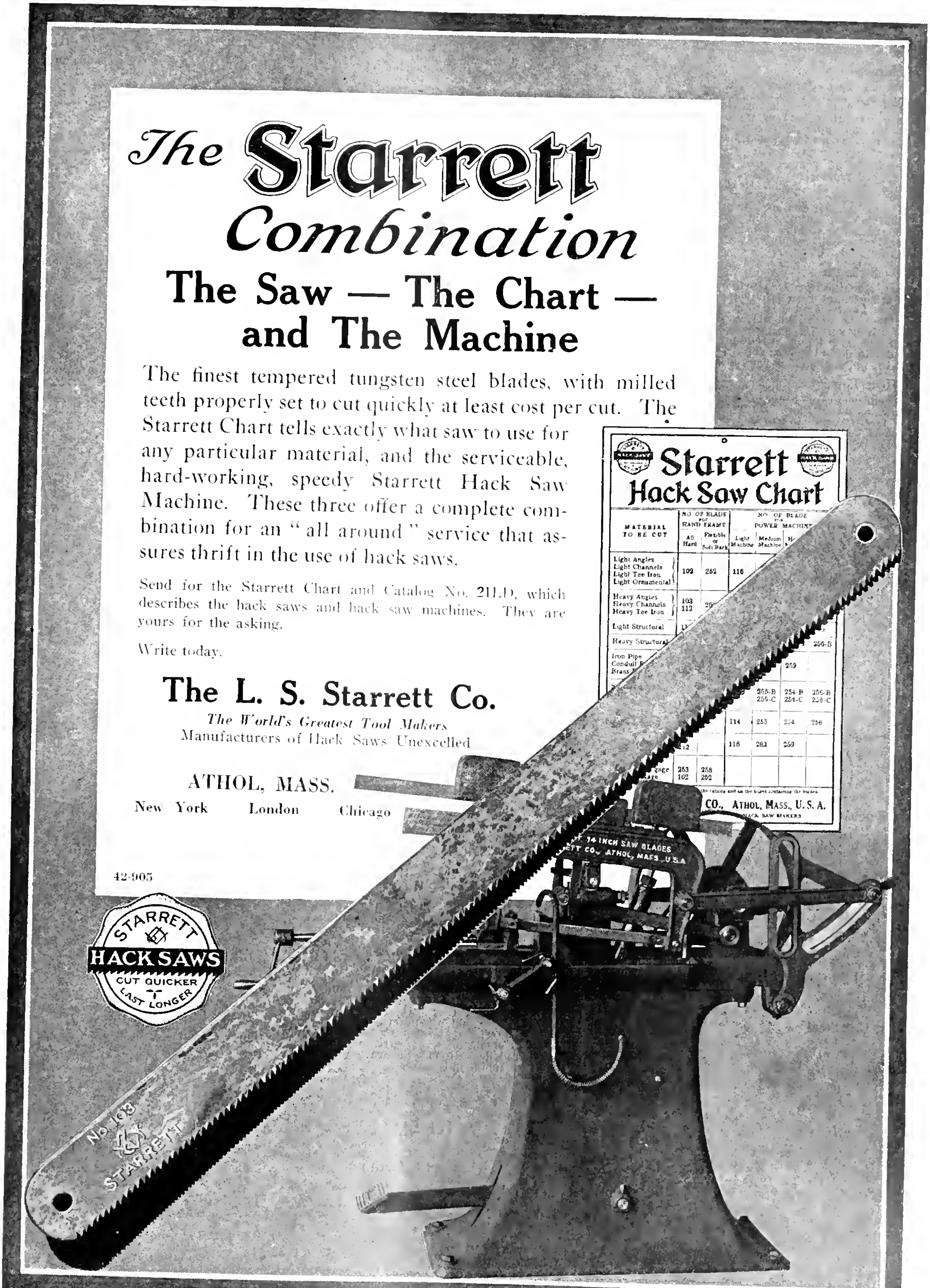
Compressibility of Solids

The Determination of the Compressibility of Solids at High Pressures, Leason H. Adams, Erskine D. Williamson and John Johnston. Jl. Am. Chem. Soc., vol. 41, no. 1, Jan. 1919, pp. 12-42, 12 figs. Essence of method is to compare change of volume under hydrostatic pressure of a cylinder of a material and that of a similar soft-steel cylinder the compressibility of which is assumed as $0.60/10^6$ cm.^{2} per megadyne at all pressures. Results are presented for 16 materials (metals, alloys and salts) at pressures up to 12,000 megabars.

Hardness

Hardness of Soft Iron and Copper Compared, F. C. Kelley. Iron & Steel Can., vol. 1, no. 11, Dec. 1918, pp. 433-434. Tests by Brinell methods on samples of American ingot iron and ordinary commercial cold-rolled copper which were given similar treatments in an electrically heated vacuum furnace.

Instruments for Hardness Tests, C. E. Clewell. Am. Mach., vol. 50, no. 3, Jan. 16, 1919, pp. 93-96, 5 figs. Importance of hardness tests; early forms of Brinell hardness determination and recent modifications; use of scleroscope as check on pyrometer; methods suggested for holding materials under test.


The Starrett Combination
The Saw — The Chart — and The Machine
The finest tempered tungsten steel blades, with milled teeth properly set to cut quickly at least cost per cut. The Starrett Chart tells exactly what saw to use for any particular material, and the serviceable, hard-working, speedy Starrett Hack Saw Machine. These three offer a complete combination for an "all around" service that assures thrift in the use of hack saws.
Send for the Starrett Chart and Catalog No. 21LD, which describes the hack saws and hack saw machines. They are yours for the asking.
Write today.
The L. S. Starrett Co.
The World's Greatest Tool Makers
Manufacturers of Hack Saws Unexcelled
ATHOL, MASS.
New York London Chicago
42-905
Starrett Hack Saw Chart
STARRETT HACK SAWS CUT QUICKER LAST LONGER
No. 103 STARRETT

Testing Materials for Hardness, Howard Ensaw. Am. Mach., vol. 50, no. 6, Feb. 6, 1919, pp. 257-258. Describing some methods of testing materials for hardness.

Pyrometers

How to Test Pyrometer Efficiency. Iron Trade Rev., vol. 64, no. 2, Jan. 9, 1919, pp. 158-159, 5 figs. Method provides for maintenance of calibrated platinum-platinum-rhodium thermocouple and comparison of this standard with the instruments that are to be tested.

Standards of Temperature and Means for Checking Pyrometers. Proc. Steel Treating Research Soc., vol. 2, no. 1, 1919, pp. 30-37, 7 figs. Method for carrying out necessary tests and suggestions of various equipments suitable for determining inaccuracies in pyrometer readings, which, it is said, are always traceable to thermocouple, measuring instruments or lead wires.

Shearing Strength

New Machine for Measuring the Shearing Strength of Cast Iron (Nouvelle machine pour mesurer la résistance de la fonte par la méthode du cisaillement). Ch. Fremont. Génie Civil, vol. 73, no. 26, Dec. 28, 1918, p. 516, 9 figs. Also Comptes rendus des séances de l'Academie des Sciences, vol. 167, no. 24, Dec. 9, 1918, pp. 949-952, 9 figs.

Stack Heat Losses

Measurement of Stack Heat Losses, J. H. Blakey. Power Plant Eng., vol. 23, no. 3, Feb. 1, 1919, pp. 151-152, 2 figs. Electrical device embodying simplicity and accuracy for determining stack heat losses.

See also ELECTRICAL ENGINEERING, *Measurements and Tests (Thermocouples and Pyrometers)*

MECHANICAL PROCESSES

Barrels, Steel

Manufacture of Steel Barrels, Edward K. Hammond. Machy., vol. 25, no. 6, February, 1919, pp. 526-533, 19 figs. Blanking the barrel heads, bending the sheets for the bodies, welding flanging, brazing, bilging, pickling and testing.

Boiler Manufacture

How to Design and Lay Out a Boiler—III. William C. Strott. Boiler Maker, vol. 19, no. 1, Jan. 1919, pp. 10-12, 4 figs. Thickness of butt straps; rivet failures due to tearing of plate, stretching of holes or tendency to shear. (To be continued.)

Boiler Smoke Tubes

The Repair of Steel Boiler Smoke-Tubes. Ry. Gaz., vol. 29, no. 26, Dec. 27, 1918, pp. 729-731, 4 figs. Specifications to which tubes are purchased; operations in repairing of tubes removed from boiler.

Brass Extrusion

The Extrusion of Brass, Alfred Hutt. The Central (Jl. City & Guilds Eng. Col.), vol. 15, no. 44, Dec. 1918, pp. 68-77, 5 figs. Description of a brass extrusion press. By extrusion is meant process whereby a plastic substance is given a definite shape by being forced through an orifice or die under pressure. Alloy used is Muntz metal consisting of 60 per cent copper and 40 per cent zinc.

Cement Mills

Operating Details of an Electrically Operated Cement Mill. Elec. Rev., vol. 74, no. 6, Feb. 8, 1919, pp. 210-212, 4 figs. Progress of material through mill; process of cement manufacture; apparatus and size of motor utilized.

Chains, Cast-Steel

The Manufacture and Testing of Cast Steel Chain Cables. Jl. Am. Soc. Naval Engrs., vol. 30, no. 4, Nov. 1918, pp. 858-862. Memorandum issued by Lloyd's Register of Shipping. From Engineer.

Coke Manufacture

Plant of the Seaboard By-Product Coke Company, D. Mac Arthur. Gas Age, vol. 43, no. 2, Jan. 15, 1919, pp. 69-73, 9 figs. Coke-loading equipment; electrical control switchboard; light-oil extraction and refining. (Concluded.)

Cotton Compression

Economics of High Density Cotton Compression, Richard Hoadley Tingley. Textile World Jl., vol. 55, no. 2, Jan. 11, 1919, pp. 133, 191 and 381, 4 figs. Description of present compression methods; brief history of high-density movement.

Dies

Making Dies for Cutting Rubber, Leather, Paper, Cloth, etc., S. A. Hand. Am. Mach., vol. 50, no. 2, Jan. 9, 1919, pp. 52-54, 11 figs.

Kilns

The Use of Car Tunnel Kilns for Brick and Other Products of Crude Clays, Ellis Lovejoy. Jl. Am. Ceramic Soc., vol. 1, no. 9, Sept. 1918, pp. 628-634, and (discussion) pp. 634-636. Features and respective values of (1) direct heating in car-tunnel kilns, (2) indirect heating in tunnel, and (3) compartment-operation types of car-tunnel kilns.

Lubricator, Mechanical

Manufacturing a Mechanical Lubricator, M. E. Hoag. Am. Mach., vol. 50, no. 2, Jan. 9, 1919, pp. 71-74, 13 figs. (Third article.)

Machine Knives

Making Machines Knives, W. F. Sutherland. Can. Machy., vol. 21, no. 4, Jan. 23, 1919, pp. 73-77, 8 figs. Operations connected with welding and grinding of knives for wood-working tools and paper cutters.

Magnetos

The Magneto Industry. Engineer, vol. 127, no. 3289, Jan. 10, 1919, pp. 26-29, 12 figs. Description of the Thomson-Bennett Works, Birmingham.

Plate Mills

New Plate Mills with Modern Lay-Out. Blast Furnace, vol. 7, no. 1, Jan. 1919, pp. 43-47, 8 figs. Designed to give sufficient capacity of heating, finishing and shipping.

Lukens New Plate Mill Largest in the World. Boiler Maker, vol. 19, no. 1, Jan. 1919, pp. 6-10, 6 figs. Mill is of 4-high type with rolls 204 in. wide, and will roll 5000 tons of plate per week.

Pliers

The Liberty Plier; Drop-Forged Victory. Am. Drop Forger, vol. 5, no. 1, Jan. 1919, pp. 32-35. Distribution of work and sanitary dispositions at Krauter plant where 23,000,000 forgings have been completed during last 18 months.

Sugar Manufacture

Sugar Factory Engineering, C. B. Thompson and J. O. Frazier. Nat. Engr., vol. 23, no. 1, Jan. 1919, pp. 23-26, 2 figs. Problems peculiar to industry and equipment details of factory; preparation and burning of bagasse; arrangement of multiple effect.

Tin Plate

Tin Plate Manufacturing and Detinning. Engineering, vol. 106, no. 2764, Dec. 20, 1918, pp. 701-702. An historical article.

See also ELECTRICAL ENGINEERING, *Power Applications (Steel-Mill Drives)*

MECHANICS

Shafts, Whirling Speed of

The Whirling Speed of Shafts Supported in Three Bearings, Arthur Morley. Engineering, vol. 106, no. 2760, Nov. 22, 1918, pp. 573-574, 3 figs. Introduction notation; calculation from equation of energy; method of successive approximation; application of various forms of support; Dunkerley's empirical rule; Bauman's method. (To be continued.)

New Critical Shaft Speeds as Effects of the Gyroscopic Disc-Action, A. Stodola. Engineering, vol. 106, no. 2763, Dec. 13, 1918, pp. 665-666, 4 figs. Mathematical development.

Springs

A New Theory of Plate Springs, David Landau and Percy H. Parr. Jl. Franklin Inst., vol. 187, no. 1, Jan. 1919, pp. 65-97, 14 figs. Study of trapezoidal, circular, parabolic and square leaf points. It is concluded that tapering points of leaves of leaf springs in plane of width only has no practical effect on strengths, reactions, stresses, or flexibilities of springs. Calculations of stresses, bending moments and deflections. Separation of loads in the top compound plate.

A Theory of Plate Springs, David Landau and Percy H. Parr. Jl. Soc. Automotive Engrs., vol. 4, no. 2, Feb. 1919, pp. 67-72, 9 figs. Based on assumption that any leaf of a spring can be considered as a beam, encastré at one end, loaded at the other, and having a flexible support somewhere between the point of encastrement and that of application of the load. (To be continued.) From Jl. Franklin Inst.

Wires, Tension in

Rapid Determination of the Tension in Stretched Electric Wires (Récherche rapide de la tension à laquelle travaille le metal dans les canalisations électriques sous l'action de l'effort de traction), Jean Hely. Revue Générale de l'Electricité, vol. 5, no. 1, Jan. 4, 1919, pp. 26-27, 1 fig. Chart constructed on physical law of vibration of chords. Tension determined from number of transversal vibration of a known length.

MOTOR-CAR ENGINEERING

Air Cleaners

Carbureter Air Cleaners, W. G. Clark. Jl. Soc. Automotive Engrs., vol. 4, no. 1, Jan. 1919, pp. 18-22 and (discussion) pp. 22-23, 14 figs. Classification and description of four types: cleaners having cloths or screens or both, inertia cleaners, those in which water or some other liquid is used to wash air, and centrifugal or gravity cleaners.

Design

1919 Engineering Trends, H. Ludlow Clayden. Automotive Industries, vol. 40, no. 3, Jan. 16, 1919, pp. 88-89, 94-97 and 157, 11 figs. Graphs showing increase of crankshaft revolutions per mile, increase in stroke-bore ratio, tendencies in drive of accessories, comparative percentages of disk and cone clutches, use of vacuum gasoline feed, use of spiral bevel drive and changes in lubricating systems.

Trucks Show Few Mechanical Changes. Automotive Industries, vol. 40, no. 3, Jan. 16, 1919, pp. 110-111, 4 figs. Claims that war activities have retarded mechanical development in commercial vehicle design and that curtailment of supplies of raw material has reduced production originally planned.

Automotive Industry Achievements in 1918. Am. Drop Forger, vol. 5, no. 1, Jan. 1919, pp. 44-48, 2 figs. Development in tractor, truck, trailer and aeroplane manufacture; relation of drop-forging industry to automotive-engine evolution.

Fuels

Benzol as a Motor Fuel, S. E. Whitehead. Gas Jl., vol. 144, no. 2901, Dec. 17, 1918, pp. 615-616. Remarks that a Motor Union Committee in 1907 reported they had successfully used benzol, either alone or in combination with petrol, as motor fuel. It then takes up more in detail properties of benzol and its intrinsic adaptability as motor fuel.

The Motor Fuel Problem, W. R. Ormandy. Petroleum Rev., vol. 39, nos. 853, 854 and 855, Nov. 23 and 30, Dec. 7, 1918, pp. 335-336, 355-356 and 363. Demand and supply of motor fuels in British Empire. Solid gaseous and liquid fuels are considered separately.

Headlights

The Requirements of Automobile Headlights. Illum. Engr., vol. 11, no. 9, Sept. 1918, pp. 209-211. Report of a committee on the Illum. Eng. Soc.

Horns

Electrical and Mechanical Warning Signals for Automobiles, Fred I. Hofman. Automotive Industries, vol. 40, no. 2, Jan. 9, 1919, pp. 47-50, 21 figs. Principles involved in operation of diaphragm signals; relative advantages of electric motor horn, electric vibrator horn and hand-operated horn; variety in mechanism of hand horns.

Kerosene Engines

Bellem-Brégéras Method of Using Refined Petroleum and Heavy Oils in Low-Compression Oil Engines (Emploi du pétrole lampant et des huiles lourdes dans les moteurs à explosion à basse compression. Procédés Bellem et Brégéras. Génie Civil, vol. 73, no. 22, Nov. 30, 1918, pp. 433-435, 3 figs. Description of machine which obtained 50,000-franc prize offered by the Chambre Syndicate des Industries du Pétrole for best automobile petroleum engine. Account of tests also given.

Locking Devices

Automobile Locking Devices. Jl. Soc. Automotive Engrs., vol. 4, no. 2, Feb. 1919, pp. 97-98, 1 fig. Results of study of automobile locking devices by committee of Soc. Automobile Engrs.

Lubrication

Lubrication and Fuel Tests on Buda Tractor Type Engine, P. J. Dasey. Jl. Soc. Automotive Engrs., vol. 4, no. 1, Jan. 1919, pp. 50-53, 5 figs. Horsepower developed at different speeds by four fuels; power developed per lb. of fuel, fuel consumption in lb. per b-hp. hr.

Production

Future Production Plans Will Require Special Machinery, J. Edward Schipper. Automotive Industries, vol. 40, no. 3, Jan. 16, 1919, pp. 145-149, 13 figs. Description of certain machines which permit production on large scale and forecast of developments on jigs, tools, gases, etc., necessary to fit into efficient production scheme.

Spark Plugs

Effect of Temperature on Spark Plug Insulations. Automotive Industries, vol. 40, no. 1, Jan. 2, 1919, p. 25, 1 fig. Experiments carried out in England show that minimum permissible insulation resistance varies with frequency of sparks and compression pressure.

Statistics

Truck Production for 1918 Is 250,000. Automotive Industries, vol. 40, no. 3, Jan. 16,

HUNT MACHINERY

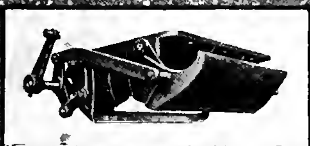
for

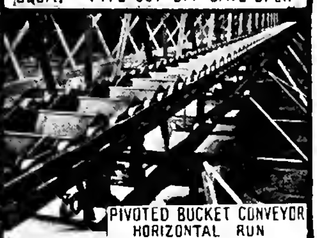
Economically Handling Bulk Material and Manufactured Products

- "Industrial" Railways
- Electric Industrial Trucks & Trailers
- Cut off Gates or Valves
- Cable Railways
- "Stevedore" Transmission & Hoisting Rope
- Coal Tubs. Contractors Tubs
- Coal Crackers


LOADING CAR

- Pivoted Bucket Conveyors
- Skip Hoists
- Automatic Railways
- Storage Battery Locomotives
- Trolley Locomotives & Cars
- Grab Buckets
- Scales – Track & Suspended


"SQUAT" TYPE CUT OFF GATE-OPEN


PIVOTED BUCKET CONVEYOR HORIZONTAL RUN

47 YEARS AGO

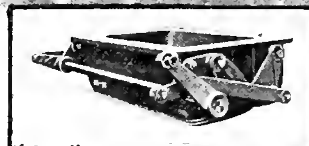
In 1872 the Automatic Railway, the first real improvement over the time-worn "Hand" method of handling coal, was invented by Charles W. Hunt.

Since that time the Company he founded, and which bears his name, has developed many other **UNIQUE LABOR SAVING AND LABOR AIDING DEVICES** for storing and transferring coal, ashes, ore, sand, gravel, fertilizer and other bulk materials, as well as manufactured packaged products.

The list above indicates the scope of the Hunt Line, and our Engineers will be glad to confer with those interested in this subject—

SAVING IN HANDLING MATERIAL

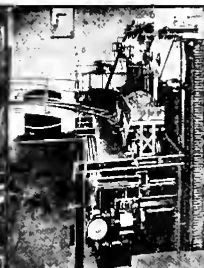
C. W. HUNT COMPANY, Inc.
501 Fifth Avenue, New York, N. Y.


"SQUAT" TYPE CUT OFF GATE-CLOSED


STORAGE BATTERY TRUCKS-PANAMA CANAL

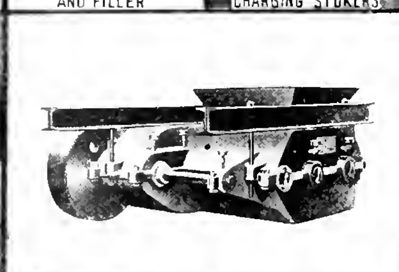

32 OF THE 60 HUNT ELECTRIC TRUCKS AT PANAMA CANAL

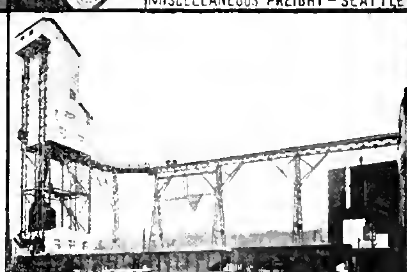

PIVOTED BUCKET CONVEYOR AND FILLER


CHARGING STOKERS


HUNT TRUCKS HANDLING MISCELLANEOUS FREIGHT - SEATTLE

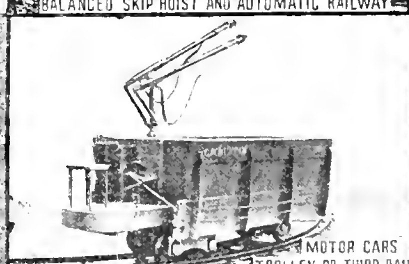

CABLE RAILWAY-SHOWING CURVE ARRANGEMENT


COAL CRACKER-ARRANGED FOR BELT DRIVE


BALANCED "SKIP HOIST" AND AUTOMATIC RAILWAY


INDUSTRIAL RAILWAY-3 TYPES "HUNT" CARS

HUNT


MOTOR CARS TROLLEY OR THIRD RAIL

1919, pp. 128-129, 1 fig. Gain of 32 per cent over 1917. Proportion of trucks of each regular capacity shown diagramatically.

Tanks

U. S. A. Two-Man Tank Fitted with Motor Car Engines. Motor Age, vol. 35, no. 2, Jan. 9, 1919, pp. 16-18, 6 figs. Automotive Industries, vol. 40, no. 2, Jan. 9, 1919, pp. 43-46, 6 figs. Motor Age: Adaptation of standard units in construction of Ford tank. Automotive Industries: Two-man fighting machine having a duplicate Ford automobile power plant, radiator mounted at rear, worm drive.

U. S. Tank and Tractor Details. Motor Age, vol. 34, no. 26, Dec. 26, 1918, pp 20-21, 4 figs. Cargo carrier Mark VII; Ford tank.

Tractors, Specifications for

Detailed Technical Specifications of Gasoline Farm Tractors for 1919. Automotive Industries, vol. 40, no. 3, Jan. 16, 1919, pp. 176-179. Tabulated data on 98 different makes of American types produced by 69 manufacturers with makes of principal parts, including engine, governor, lubricator, ignition system, air cleaner, gear set, clutch and axle.

Trucks, Specifications for

Detailed Technical Specifications of Gasoline Motor Trucks for 1919. Automotive Industries, vol. 40, no. 3, Jan. 16, 1919, pp. 112-127. Full particulars on types and makes of principal truck parts, including engines, clutches, gear sets, rear axles, steering gears, governors and electric and fuel sytems; 489 gasoline, 19 electric and one steam motor-truck chassis described.

Water Injection

Mixing Water with Gasoline. Motor Boating, vol. 23, no. 1, Jan. 1919, 25-26, 9 figs. Advantages gained by introducing limited quantities of water into intake manifold. Its use as a decarbonizing medium.

See also MINING ENGINEERING, Oil and Gas (Gasoline); MECHANICAL ENGINEERING, Mechanical Processes (Magnetos); Standards and Standardization.

PIPE

Electrolysis

Fuel Administration Interests Itself in Electrolysis in Natural Gas Mains, Frank H. West. Am. Gas Eng. Jl., vol. 110, no. 2, Jan. 11, 1919, pp. 22-23. Electrolytic action made patent by pipes taken from streets of Kansas City. Claimed that damage by electrolysis amounts to millions annually in U. S.

Reinforced-Concrete Pipe

On the Reinforced-Concerte Pressure Pipe (in Japanese), N Sugimura. Denki Gakkwai Zasshi, no. 365, Dec. 10, 1918.

Reinforced Concrete Pressure Pipe, Coleman Merriwether. Jl. Am. Water Works Assn., vol. 5, no. 4, Dec. 1918, pp. 419-429, 2 figs.; Water and Gas Rev., vol. 29, no. 7, Jan. 1919, pp. 11-12, 2 figs.; Can. Engr., vol. 36, no 3, Jan. 16, pp. 146-148, 2 figs. Jl. Am. Water Works Assn.: Details of joint with crimped copper band. Water and Gas Rev.: Action of joint constructed with crimped copper band, details of manufacturing 66-in. reinforced-concrete pressure pipe for 10 miles of Greater Winnipeg water conduit. Can. Engr.; Installation of plant for manufacturing 66-in. reinforced-concrete pressure pipe, details of manufacture, lead gasket cast iron joint. Paper before Ill. Section, Am. Water Works Assn.

Templates and Patterns

Templates and Patterns for Pipes, James Edgar, Brass World, vol. 14, no. 10, Oct. 1918, pp. 291-294, 34 figs. On construction of templates and patterns for special connections, especially in shipbuilding industry.

See also CIVIL ENGINEERING, Water Supply (Pipe Maintenance)

POWER GENERATION

Appalachians

New Plant of the Appalachian Power Company, H S. Slocum Elec. World, vol. 73, no. 3, Jan. 18, 1919, pp. 123-127, 9 figs. Steam station rated at 20,000 kw. just completed to supplement hydroelectric plants in meeting heavy industrial demands; development of rich mining district due largely to central station power supply.

Canada

Electric Power Generation in Ontario on Systems of Hydroelectric Power Commission, Arthur H. Hull. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 1, Jan. 1919, pp. 29-52, 16 figs. Systems of Hyroelectric Power Commission of Ontario.

Canada Builds 300,000 Hp. Niagara Hydro Plant, Louis R Black. Mine & Quarry, vol. 11, no. 1, Nov. 1918, pp. 1097-1101, 8 figs. Hydro Electric Power Commission of Ontario is engaged upon construction of a canal $8\frac{1}{2}$ miles long, which will divert a flow of 10,000 sec.-ft. of water from Niagara Falls and enable 300,000 hp. to be developed.

Centralization

Central Station Power for Mines, A. Tancig. Bul. Affiliated Eng. Societies Minn., vol. 3, no. 12, Dec. 1918, pp. 205-207. Advantages to each mine of centralized power generation.

Transportation and Power, C. G. Gilbert and J. E. Pogue. Can. Engr., vol. 36, no. 2, Jan. 9, 1919, pp. 128-130. Advantages and disadvantages of centralization of power stations and generation of electrical energy in bulk. Excerpt from report to Smithsonian Instn. on Power: Its Significance and Needs.

Centralizing Power Production. Power Plant Eng., vol. 23, no. 2. Jan. 15, 1919, pp. 99-104, 9 figs. Operation of dual driven auxiliaries, induced draft and modern coal and ash handling equipment features of Cromby Station of Philadelphia Suburban Gas & Electric Co.

Eastern States

Development of Hydroelectric Resources in Eastern United States, D. H. Colcord. Elec. Rev., vol. 74, no. 6, Feb. 8, 1919, pp. 207-209, 4 figs. Deterring influences and development outlined; brief review of what has been accomplished; urgent needs and benefits of hydroelectric developments.

Glaciers

Power from Glaciers. Electric Traction, vol. 15, no. 1, Jan. 15, 1919, pp. 1-4, 9 figs. Addition to White River Power Plants of Puget Sound Traction Light & Power Co. for electrification of Milwaukee Ry.

Hetch Hetchy

The Power Project at Hetch Hetchy, Rudolph W. Van Norden. Jl. Elec., vol. 42, no. 2, Jan. 15, 1919, pp. 65-66, 2 figs. Gives details of 66,000-hp. development at Moccasin Creek, a part of project planned by city of San Francisco.

Maine

Investigation of Maine Water Powers. Elec. World, vol. 73, no. 3, Jan. 18, 1919, pp. 120-121, 1 map. Public Utilities Commission sends to governor and council results of an exhaustive study of water-power resources; hydroelectric systems, power sites, plant locations and storage conditions dwelt on.

Massachusetts

Development of Massachusetts' Water Power. Elec. World, vol. 73, no. 6, Feb. 8, 1919, pp. 272-273, 1 map. From the report of a special commission to investigate the facilities and possibilities in this direction; Action urged; public ownership declared to be of doubtful value as a water-power policy.

Michigan

Simplicity Marks Michigan's Largest Hydroelectric Development. Elec. Rev., vol. 74, no. 5, Feb. 1, 1919, pp. 167-170, 6 figs. Simplicity of layout, coordination of turbines installed to water flow and 140,000 volt transmission line are features of the Junction Development.

Pacific Coast

Water-Power Development on the Pacific Coast, George F. Sever. Elec. World, vol. 73, no. 4, Jan. 25, 1919, pp. 177-178; Jl. Elec., vol. 42, no. 1, Jan. 1, 1919, pp. 6-10. Elec. World: Study of economic and financial conditions leads to outline of developments approximating $50,000,000 cost, all power furnished can be absorbed easily within two years after development. Jl. Elec.: Survey of projects in progress of construction in California, rules of Forest Service in their relation to hydroelectric development. From paper before San Francisco Association of Members of Am. Soc. C.E.

Tennessee

The Larger Undeveloped Water-Powers of Tennessee, J. A. Switzer. Gen. Meeting Am. Electrochem. Soc., Apr. 30, 1918, paper 24, pp. 169-202, 15 figs. Power sites and essential data pertaining to their development and exploitation.

Tides

Utilization of Power from Tides (Etude sur l'utilisation des marées pour la production de la force motrice), E. Maynard Revue Générale de l'Electricité, vol. 4 nos. 22, 23, 24, 25 and 26, Nov. 30, Dec. 7, 14, 21 and 28, 1918, pp. 823-843, 865-877, 903-914, 917-959 and 997-1007, 34 figs. Nov. 30: Derivation of continuous power from tide basins and sea reaches; application of system to St. Malo and La Rochelle regions. Dec. 7: Continuous power of operation at set intervals after high and low tides; application to St Malo and La Rochelle. Dec. 14: System comprising two basins to utilize ebb and flow currents respectively so as to produce continuous work; application of plan to St. Malo and La Rochelle. Dec. 21: Application of processes described in previous articles to Rotheneuf Bay, near St. Malo (Ille-et-Vilaine), and Bay of La Rochelle. Dec. 28: Possibilities at mouth of La Rance river in 21-km., region where action of tides is felt.

POWER PLANTS

Boiler Corrosion

Action of Water on Metals, S. W. Parr. Can. Engr., vol. 36, no. 3, Jan. 16, 1919, p. 148. Reactions involved when alkaline waters are used in steam generators. Paper before Ill. Section, Am. Water Works Assn.

Boiler Operation

Safety and Economy in the Boiler Room, W. E. Snyder. Iron Age, vol. 103, no. 5, Jan. 30, 1919, pp. 306-307. Practical suggestions for reducing hazards and increasing efficiency; thorough inspection and careful training of men required. From a paper before the Engineers' Society of Western Pennsylvania.

The Chemical and Physical Control of Boiler Operation, E. A. Uehling. Mech. Eng., vol. 41, no. 2, Feb. 1919, pp. 137-141 and 199, 1 fig. Formulæ for calculating heat losses in chimney gases and their application to data derived from autographic records of CO_2.

Boiler Settings

Combustion and Boiler Settings, A. D. Williams. Power, vol. 49, nos. 2 and 6, Jan. 14 and Feb. 11, 1919, pp. 57-59 and 205-208, 2 figs. Jan. 14: Notes on location of heating surfaces, placing of baffles, and formation of soot in relation to combustion. Feb. 11: Effect produced on combustion reactions and circulation of gases by the chilling due to contact with water-cooled surfaces.

Drip Water

Saving and Returning Drip Water, William E. Dixon. Power Plant Eng., vol. 23, no. 2, Jan. 15, 1919, pp. 105-109, 9 figs. Where drip taps should be made; methods employed for returning condensate; utilizing oily drips.

Economizers

Care of Economizers, J. F. Daggett. Power, vol. 49, no. 6, Feb. 11, 1919, pp. 192-193, 4 figs. Some suggestions as to the operation and care of economizers.

Equipment

Power Station at Mark Plant, Gordon Fox. Power Plant Eng., vol. 23, no. 3, Feb. 1, 1919, pp. 141-144, 4 figs. Describes power plant of the Sheet Tube Company of America, dealing with turbine generators and blower, condensing system and electric features. Second article.

Exhaust Steam

Utilizing Exhaust Steam in Knitting Mill, L. H. Stark. Nat. Engr., vol. 23, no. 1, Jan. 1919, pp. 2-6, 5 figs. How savings were effected by several changes in equipment and use of indicating and recording devices.

Firebox

Boiler Efficiency Increased by New Type of Firebox. Ry. Age, vol. 66, no. 2, Jan. 10, 1919, pp. 151-153, 2 figs. Eighteen per cent greater evaporation per pound of coal secured in tests on C., M. & St. P.

Hand-Fired Plants

Fuel Economy in Hand-Fired Power Plants. Power Plant Eng., vol. 23, no. 2, Jan. 15, 1919, pp. 110-113, 4 figs. Fifth installment of abstract of Circular No. 7, Univ. of Ill., Eng. Experiment Station.

Low-Grade Fuels

Peace Problems in the Power Plant, George H. Perkins and Perry Barker. Textile World Jl., vol. 55, no. 2, Jan. 11, 1919, pp. 391-392. Importance of continuing war economies; difficulties in use of low-grade fuels.

Operation

Turbine House Plant Operation, T. G. Otley and V. Pickles. Elecn., vol. 82, no. 2120, Jan. 3, 1919, pp. 4-6. Abstract of a paper read before the South African Institute of Electrical Engineers.

Stokers

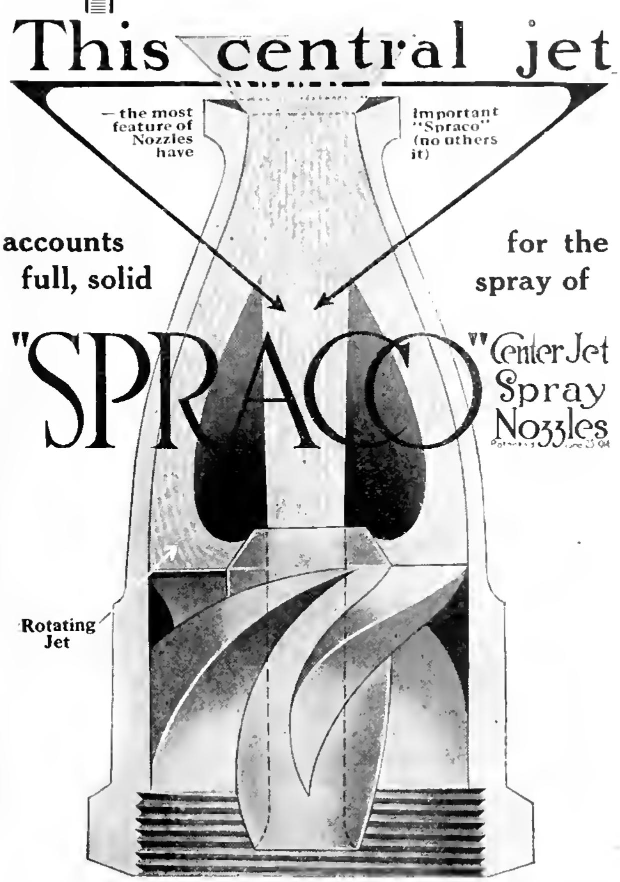
Power Plant Management—VII. Mechanical Stokers, Robert June. Refrig. World, vol. 54, no. 1, Jan. 1919, pp. 25-26, 2 figs. Adaptability of various types of stokers according to ratings of boilers; points to remember regarding stoker operation.

Automatic Cleaning Under-Feed Stoker Nat. Engr., vol. 23, no. 1, Jan. 1919, pp. 100-102, 4 figs. Type developed by Under Feed Stoker Co. is similar to standard Jones stoker but is self-cleaning.

See also RAILROAD ENGINEERING, Locomotives (Thermic Siphons); MARINE ENGINEERING, Auxiliary Equipment (Valves and Fittings)

SPRACO

Spraco Cooling System



The war is won, but the necessity for conservation is as great as ever. The whole world needs coal—we must save every pound possible. Spraco Equipment, which helped to put many plants on a basis of wartime efficiency, is ready for the work of reconstruction.

The Spraco Cooling System (with Spraco Center Jet Nozzle) saves fuel and cuts operating costs. Under ordinary conditions it will cool condensing water sufficiently to insure an average vacuum of 27 inches or better, throughout the year. And compared to a cooling tower the Spraco System costs much less to install, about one-half as much to operate and practically nothing to maintain.

Our engineers are at your service—ready to submit drawings, specifications and estimates covering an installation in your plant. A word from you will bring full details.

SPRAY ENGINEERING CO.

93 Federal St., - Boston, Mass.

Engineers *Manufacturers*

SEE OUR DATA IN 1918 A.S.M.E. CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT

PRODUCER GAS

German Producers

New Coke-Fired German Gas Producer. Iron Age, vol. 103, no. 3, Jan. 16, 1919, pp. 180-181, 1 fig. Makes gas low in moisture and sulphur; pig iron high in manganese and phosphorus a by-product.

Producer-Gas Users

Modern Applications of Producer Gas, Earl E. Adams. Am. Drop Forger, vol. 5, no. 1, Jan. 1919, pp. 41-44, 2 figs. Its use in heat-treating and carbonizing furnaces; economy and general advantages.

Wuerth Producer

The Wuerth Gas Producer. Foundry Trade Jl., vol. 20, no. 203, Nov. 1918, pp. 600-601, 1 fig. Features of apparatus which is worked on blast-furnace principle and consists of a hearth without grating, a bosh and a shaft. From Stahl und Eisen.

PUMPS

Centrifugal Pumps

High-Lift Centrifugal Pumps for Irrigation, B. P. Fleming. Power, vol. 49, no. 4, Jan. 28, 1919, pp. 133-136, 3 figs. Water forced through steel manifold to reinforced-concrete conduit leading up to canal; design features; pump tests show over 81 per cent efficiency under 90-ft. head.

Pump Station

A Non-Drowning Pump-Station, C. Erb Wuench. Min. & Sci. Press, vol. 118, no. 1, Jan. 4, 1919, p. 18, 1 fig. Design utilizing principle of hydraulic diving bell.

Vacuum Pumps

Automatic Variation of Gas Pressure and Its Application to a Vacuum Pump, Circulation of Gases, Magnetic Stirrer, O. Maas. Jl. Am. Chem. Soc., vol. 41, no. 1, Jan. 1919, pp. 53-59, 3 figs. Control apparatus by means of which pressure established by a Geissler, or any other suction pump, can be automatically varied between definite limits and the period of each variation can be adjusted to any desired length of time.

REFRACTORIES

Corrosion

Report on the "Corrosion Action of Flue Dust on Fire-Bricks," J. W. Mellor. Gas. Jl., vol. 144, no. 2897, Nov. 19, 1918, pp. 421-423. Experimental research by refractory materials committee of Instn. Gas Engrs.

Crushing Resistance

Crushing Resistances of Refractory Materials (Mesure des résistances à l'écrasement des matériaux réfractaires), A. Bigot. Chimie & Industrie, vol. 1, no. 7, Dec. 1, 1918, pp. 724-726, 7 figs. Gives results of experiments on 1-in. cubes of silica brick, refractory argil, white bauxite, carborundum, etc., in charts.

Production

Our Present Knowledge Concerning the Industry of Refractory Products (Nos connaissances actuelles sur l'industrie des produits refractaires), J. Bied. Chimie & Industrie, vol. 1, no. 6, Nov. 1918, pp. 579-600, 23 figs. Invention of processes for utilizing dolomitic clinkers; calcination of magnesia from Eubée and Italy; manufacture of bricks; high-temperature resistance of silica-aluminum products.

Silica Products

Silica Products (Les produits de silica). Chimie & Industrie, vol. 1, no. 7, Dec 1, 1918, pp. 712-723, 7 figs. Chemical and physical analyses of siliceous rocks; photomicrographs of bricks manufactured in Martin furnaces.

South Wales

The Refractory Materials of South Wales, J. Allen Howe. Quarry, vol. 24, no. 263, Jan. 1919, pp. 11-15. Geological characters of carboniferous strata from which are obtained silica rocks, fireclays and dolomitic limestones. Paper before Refractories Section of Ceramic Soc.

Tests

Standard Tests for Refractory Materials. Quarry, vol. 24, no. 263, Jan. 1919, pp. 19-20. Chemical analysis of fireclays, dolomite and magnesite; identification of various forms of silica in silica bricks; physical tests. Report of Committee on Standardization of Tests for Refractory Materials, Refractories Section, Ceramic Soc.

Zirconia

Zirconia — Its Possibilities in Metallurgy, Leopold Bradford. Foundry Trade Jl., vol. 20, no. 203, Nov. 1918, pp. 596-597. History, occurrence, composition and uses; its application in refractory brick industry.

REFRIGERATION

Ammonia Compressors

The Ammonia Compression Refrigerating System—XXVI, W. S. Doan. Refrig. World, vol. 54, no. 1, Jan. 1919, pp. 33-34, 2 figs. Remarks on oil-cup scheme for external lubrication of open-type ammonia compressors.

Capacity and Power Consumption of Ammonia Compressors, Charles H. Herter. Refrig. World, vol. 54, no. 1, Jan. 1919, pp. 11-13, 1 fig. Graphs for the varying capacity and power consumption of compressors, at different pressures, compared to 20 lb. and 185 lb. as standard pressures.

Ammonia Condensers

Ammonia Condenser Data, Henry Torrance. Power, vol. 49, no. 3, Jan. 21, 1919, pp. 106-109, 6 figs. Author shows that both flooded atmospheric and flooded injector types of condensers are wrong in theory and practice. From July Jl. of Am. Soc. Refrig. Engrs.

Ammonia Recovery

Effects of Ammonia Recovery, T. B. Smith. Gas. Jl., vol. 144, no. 2902, Dec. 24, 1918, pp. 661-662. Comparison of the effects of the direct and the indirect processes upon the working of other parts of plant.

Export Business

The Trend of the Foreign Situation, L. W. Alwyn-Schmidt. Refrig. World, vol. 54, no. 1, Jan. 1919, pp. 21-22 and 32. Hints to refrigerating-machine manufacturers as to future of export business and necessity for immediate action.

Freezing Tanks

Care and Maintenance of Freezing Tanks, F. L. Brewer. Ice and Refrigeration, vol. 56, no. 1, Jan. 1919, pp. 41-42. How to lower cost of freezing tank; erecting and insulating tank; causes of leakage in sides and corners. Paper before Nat. Assn. Practical Refrig. Engrs.

History

The Growth and History of Refrigeration, James F. Patton. Power House, vol. 11, no. 12, Dec. 1918, pp. 351-353, 5 figs. Dependence of cities, battleships and armies in field on refrigerating plant.

Ice Plants

Building Ice Plant Efficiency, G. B. Bright. Ice & Refrig., vol. 56, no. 1, Jan. 1919, pp. 55-56. Tonnage and cost of manufacturing ice, 1904, 1908, 1918; changes necessary in steam plants to meet new conditions.

Large Converted Steam-Driven Ice Plant. Ice & Refrig., vol. 56, no. 1, Jan. 1919, pp. 63-65. Steam plant replaced by electric-power air-agitating system; cost.

Packing Industry

Refrigeration in the Packing House Industry. Refrig. World, vol. 54, no. 1, Jan. 1919, pp. 14-16, 5 figs. Recent improvement and additions to equipment made at plant of Armour Co., Hamilton, Can.

Meat Packing in South America. Refrig. World, vol. 54, no. 1, Jan. 1919, pp. 23-24 and 32. Data and comparisons of requirements and capacity of meat-packing and freezing plants of various companies in Argentina, Brazil, Paraguay, Uruguay and Columbia.

See also INDUSTRIAL TECHNOLOGY, Ammonia.

RESEARCH

Chemical Research

Address by Charles Frederick Juritz. South African Jl. Sci., vol. 15, no. 1, Aug. 1918, pp. 1-30. Exhortation to establish chemical research stations. Position of science in the present age; its use and abuse; its part in the war; industrial potentialities in advancement of chemistry. Presidential address before South African Assn. for Advancement of Sci.

Industrial Research

Science and Industry, J. C. Fields. Can. Engr., vol. 36, no. 2, Jan. 9, 1919, pp. 133-135. What Britain, United States, France and Japan are doing in industrial research. Results being obtained by manufacturers.

Switzerland

Organization for Public Welfare in Switzerland Based on Scientific Research at the Federal University. (Stiftung zur Foerderung Schweizerischer Volkswirtschaft durch Wissenschaftliche Forschung an der Eidgenoessischen Hochschule), Schweizerische Bauzeitung, Zurich, vol. 73, no. 1, Jan. 4, 1919, pp. 1-2. Swiss engineers are raising a fund of at least 500,000 francs with which to conduct researches of the Federal University with the object of assisting Switzerland to practice greater economy and efficiency in national life than in the past, and to help the country in overcoming the losses suffered during the war. The present article describes the organization and its constitution.

STANDARDS AND STANDARDIZATION

S. A. E. Standards

S. A. E. Standardization Work in 1918. Automotive Industries, vol. 40, no. 3, Jan. 16, 1919, pp. 158-171, 31 figs. Tables of new standards put on record, mainly relating to aeronautical, motorcycle and marine work.

Tires for Motor Cars

New Standard List of Pneumatic Tire Sizes. Automotive Industries, vol. 40, no. 3, Jan. 16, 1919, pp. 172-174, 21 figs. Collection of recently adopted S. A. E. standards and recommended practices relating to tires and rims.

STEAM ENGINEERING

Boilers

Espujols Inexplosible and Demountable Boiler (Générateur de vapeur inexplosible démontable, système d'Espujols. Génie Civil, vol. 73, no. 23, Dec. 7, 1918, p. 455, 2 figs. Inclination of tubes and other arrangements contribute to facilitate active circulation of water and steam, thus protecting boiler and increasing its efficiency.

Feeding and Circulating the Water in Steam Boilers, John Watson. Jl. Am. Soc. Naval Engrs., vol. 30, no. 4, Nov. 1918, pp. 834-838, 3 figs. Review of adaptation of various appliances. Abstract of paper before Inst. Marine Engineers. From Shipbuilding Shipping Rec.

The Waste Heat Boiler as Practical Steps in Fuel Conservation, H. D. Baylor. Concrete, Cement Mill Section, vol. 14, no. 1, Jan. 1919, pp. 5-6, 1 fig. Comparative data taken on two cement kilns 10 x 150 ft., dry process, using coal as fuel, before and after installation of waste-heat boilers. Paper presented before Portland Cement Assn.

Condensers

The Steam Condenser, Victor J. Azbe. Power Plant Eng., vol. 23, no. 3, Feb. 1, 1919, pp. 145-158, 4 figs. Gain by condensing, influencing conditions, cleaning tubes, cooling water systems.

Superheat

Determination of Superheating Surface, C. H. Baker. Power, vol. 49, no. 3, Jan. 21, 1919, pp. 86-89, 4 figs. Author gives charts showing relationship between superheat and factors that influence it.

Turbine Governors

Steam Turbine Governors, J. Humphreys. Iron & Coal Trades Rev., vol. 97, no. 2650, Dec. 13, 1918, pp. 661-662, 5 figs. Discussion of several types.

Turbines

2500-Hp. Rateau Marine Geared Turbines. Jl. Am. Soc. Naval Engrs., vol. 30, no. 4, Nov. 1918, pp. 842-849, 8 figs. Arrangement of 2500-shaft-hp. turbine set and double-reduction gearing at works of British Westinghouse Co. From Engineer.

A New Theory of the Steam Turbine, Harold Medway Martin. Mechanical Engineering, vol. 41, no. 2, Feb. 1919, pp. 150-154, 3 figs. Theory is based on assumption that steam is never in thermal equilibrium until condenser is attained. Abstract of serial in Engineering.

Steam Leakage in Dummies of the Lungstrom Type. Engineering, vol. 107, no. 2766, Jan. 3, 1919, pp. 1-3, 2 figs. Comparison of the results obtained by the use of a formula with step by step calculations of the discharge through a labyrinth using the precise formula given by Professor Callendar.

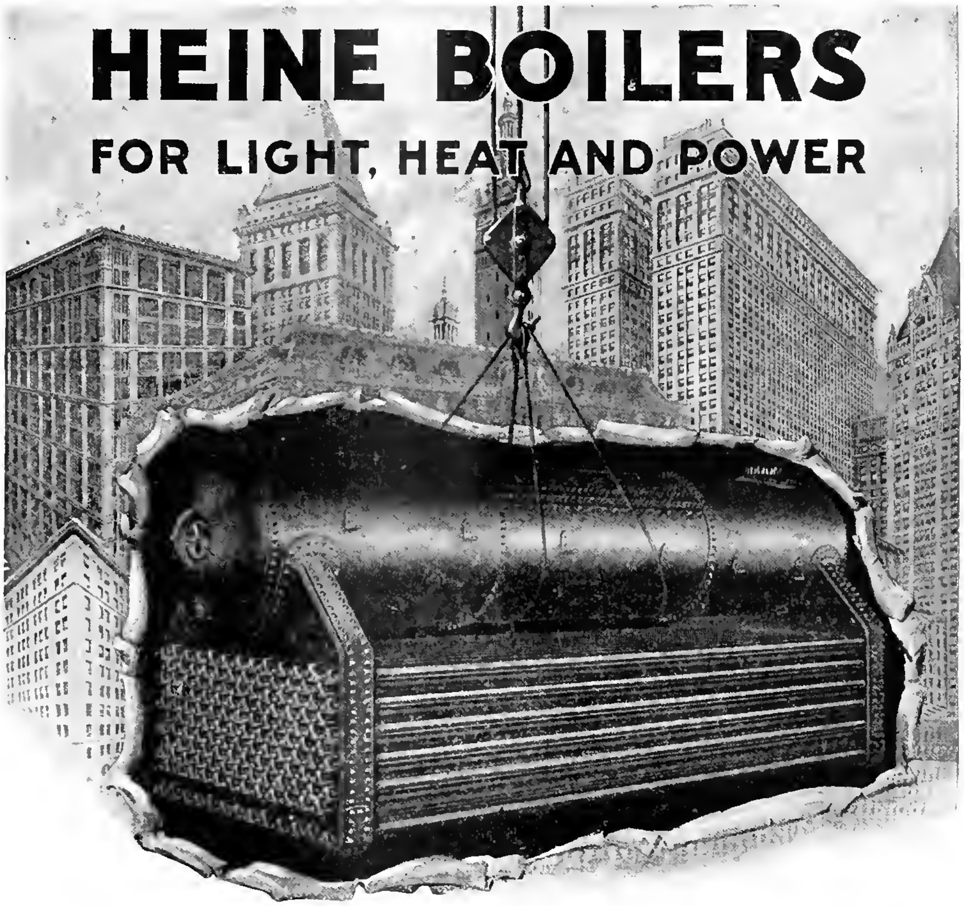
Steam Turbine Progress and Possibilities. Am. Drop Forger, vol. 4, no. 12, Dec. 1918, pp. 495-497, 5 figs. Higher boiler pressures. Intermediate steam reheating in large multiple-cylinder machines. Feedwater heating. Economy to be expected from extended use of economizer.

Historical Development of the Steam Turbine—II. Power House, vol. 11, no. 12, Dec. 1918, pp. 346-349, 12 figs. Growth in size of turbo-generator units in recent years.

Operation of Steam Turbines, J. Humphreys. Iron & Coal Trades Rev., vol. 97, no. 2642. Oct. 18, 1918, pp. 430-432, 4 figs. Deals with Parsons turbine.

Land and Marine Steam Turbines. Engineering, vol. 106, no. 27ye, Dec. 13, 1918, pp. 674-675, 13 figs. Illustrations of details and brief description of steam turbines constructed by the Atlas Engineering Co., Copenhagen.

45,000 kw. Cross-Compound Steam Turbine. Elec. News, vol. 27, no. 24, Dec. 15, 1918, pp. 24-27, 4 figs. Unit consists of separate high- and low-pressure elements, each coupled directly to its own generator. High pressure



THEY ENJOY A GOOD REPUTATION

BECAUSE

Maximum heat is absorbed by combined radiation and absorption. Circulation is ideal.

There is nothing to get out of order. The Heine is virtually a "one-piece boiler."

Tubes are arranged for large heating surface per unit floor area.

Permanently installed soot cleaner.

For high overloads we place the lower baffle over the third row of tubes.

Write for your copy of "Boiler Logic."

HEINE SAFETY BOILER CO.

5321 Marcus Ave. ST. LOUIS, MO.

element is a single-flow, reaction type turbine running at 1800 r.p.m. and expanding to atmosphere; low-pressure element is a double-flow turbine of same type, running at 1200 r.p.m. and expanding to vacuum.

TEXTILES

Fabric Looms

An Apparent Revolution in Fabric Looms. Flight, Dec. 26, 1918, pp. 1463-1464, 4 figs. New Trautvetter loom claimed to weave (auto and aero fabric) diagonal threads in two directions as well as ordinary warp and weft.

THERMODYNAMICS

Heat Transmission

The Transmission of Heat Through Heavy Building Materials. Engineering, vol. 106, no. 2765, Dec. 27, 1918, pp. 735. From bulletin issued from University of London, University College, Department of Heating and Ventilating Engineering, entitled Report of Research on Transmission of Heat Through Heavy Building Materials, by Arthur H. Barker and M. Kinoshita.

WELDING

Arc Welding

Electric Arc Welding in Tank Construction, R. E. Wagner. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 899-911, 35 figs. Practice followed at Pittsfield works of General Electric Co.

A Review of Electric Arc Welding, John A. Seede. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 881-886, 11 figs. Evolution of present practice of arc welding.

Equipment Accessories Desirable in Electric Arc Welding. Elec. Ry. Jl., vol. 53, no. 2, Jan. 11, 1919, pp. 93-95, 6 figs. Proper protection of operator is essential and conveniences added insure better workmanship. From 1918 report of committee of Assn. of Ry. Elec. Engrs.

Notes on Regulations for Arc Welding. H. M. Sayers. Elecn., vol. 81, no. 2118, Dec. 20, 1918, pp. 715-717. Abstract of paper with discussion before the Institution of Electrical Engineers, Dec. 1918.

Arc-Welding Systems, Otis Allen Kenyon. Elec. Wld., vol. 73, no. 4, Jan. 25, 1919, pp. 167-171, 10 figs. Welding system discussed in a broad way, showing advantages and special usefulness of each method.

Cutting of Metals

The Cutting of Iron and Steel by Oxygen—XX, M. R. Amedeo. Acetylene & Welding Jl., vol. 15, no. 182, Nov. 1918, pp. 199-200. Cost of cutting. Translated by a member of the Union de la Soudure Autogene.

Inspection

Inspection of Metallic Electrode Arc Welds, O. S. Escholz. Am. Mach., vol. 50, no. 5, Jan. 30, 1919, pp. 215-217, 6 figs. Outlines the methods for satisfactory inspection tests.

Determining the Characteristics of Metallic-Electrode Arc Welds, O. S. Escholz. Elec. Ry. Jl., vol. 53, no. 6, Feb. 8, 1919, pp. 280-282, 3 figs. By testing and inspection of the welds a reliable indication of their soundness may be obtained.

Lead

The Autogenous Welding of Lead, V. P. Rosenberg. Acetylene & Welding Jl., vol. 15, no. 182, Nov. 1918, pp. 205-206, 2 figs. Power of blowpipe. (To be continued.)

Lloyd's Tests

Lloyd's Experiments on Electrically Welded Joints, H. Jasper Cox. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 864-870, 15 figs. Nature and description of experiments; summary of experimental results.

Oxy-Acetylene

The Oxy-Acetylene Flame and Blowpipe Efficiency, Arthur Stephenson. Acetylene & Welding Jl., vol. 15, no. 182, Nov. 1918, pp. 194-196, and (discussion) pp. 196-198, 5 figs. Diagram giving length of luminous cone in mm. for respective consumption of acetylene in litres per hour; graph showing diversity in acetylene consumption as specified by various makers for welding iron and steel; blowpipe movements. Paper before British Acetylene & Welding Assn. Also abstracted in Jl. Acetylene Welding, vol. 2, no. 7, Jan. 1919, pp. 338-344.

Rail Joints

New Type of Electrically Welded Joint Successful. Elec. Ry. Jl., vol. 53, no. 4, Jan. 25, 1919, pp. 182-183, 8 figs. Process used at St. Louis believed to eliminate cracking of rail around joint; applicable to new and old track.

Railroad Shops

Oxy-Acetylene and Electric Welding, A. F. Dyer. Welding Engr., vol. 4, no. 1, Jan. 1919, pp. 45-46. Application of these processes at Grand Trunk railway shops.

Spot Welding

Research in Spot Welding of Heavy Plates, W. L. Merrill. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 919-922, 7 figs. Experients pointing to new and enlarged field for spot welding.

Spot Welding and Some of Its Applications to Ship Construction, H. A. Winne. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 923-927, 6 figs. Advantages of spot welding over riveting with respect to strength, time and labor; limitations of spot welding.

Thermit

Modern Welding and Cutting, Ethan Viall. Am. Mach., vol. 50, no. 6, Feb. 6, 1919, pp. 243-248, 6 figs. Thermit welding: its history, nature and uses. First article.

See also RAILROAD ENGINEERING, Shops (Welding); MARINE ENGINEERING, Ships (Welded Ships); Yards (Welding)

VARIA

Inspection and Theory of Probability

Application of the Theory of Probability to the Matter of Inspection (Sull' applicazione del calcolo delle probabilita ad una importante categoria di collaudi), U. Bordoni, L'Elettrotecnica, vol. 5, no. 30, Oct. 25, 1918, pp. 422-430, 8 figs. Mathematical analysis of the problem: what can be asserted of the properties of a number of objects after having examined and tested a determined percentage of the total number.

Silo Granaries

The Equipment of Silo Granaries, R. A. Sidley. Elecn., vol. 82, no. 2121, Jan. 10, 1919, pp. 68-73, 13 figs. General operations carried out in a silo granary.

Tanks, Storage

Round Storage Tanks for Liquids, H. Eisert. Monthly Jl. Engrs. Club of Baltimore, vol. 7, no. 8, Feb. 1919, pp. 155-168, 6 figs. Design formulæ and calculations.

Electrical Engineering

ELECTROCHEMISTRY

Electrolytic Cell

Influence of a Magnetic Field and of a Mechanical Agitation of Electrolyte on the Potential Difference at the Terminals of an Electrolytic Cell (Influence d'un champ magnetique et d'une agitation mécanique du bain sur la difference de potential aux bornes d'une cuve électrolytique), Toshikozu Mashimo. Revue Générale de l'Electricité, vol. 5, no. 1, Jan. 4, 1919, pp. 17-18. Experiments with platinum electrodes in semi-normal solutions of iron chloride. From Memoirs of the College of Science, Kyoto Imperial Univ., vol. 2, no. 6, Oct. 1917, pp. 341-347.

Storage Batteries

Hypothesis Concerning the Action of the Negative Plate in a Lead Storage Battery (Hypothèse sur le fonctionnement de la plaque négative de l'accumulateur au plomb), Ch. Féry. Industrie Electrique, year 27, no. 636, Dec. 25, 1918, pp. 467-468. Experiments with litharge and platinum and electrodes lead author to believe that negative electrode passes to Pb_2SO_4 during discharge.

ELECTRODEPOSITION

Nickel Plating of Cast Iron

Depositing Nickel on Cast Iron from a Hot Electrolyte, Roay F. Clark. Metal Rec. & Electroplater, vol. 4, no. 11, Dec. 1918, pp. 401-402. Results achieved by plater on shears and scissors with data extending over long period; advantages of hot process.

Silver and Gold Refining

Electrolytic Silver and Gold Refining at Perth Amboy, N. J., Geo. G. Griswold. Gen. Meeting Am. Electrochem. Soc., Apr. 3-5, 1919, advance copy, paper 1, pp. 1-7, 8 figs. Refining silver bullion by Moebius process at works of Am. Smelting & Refining Co.; Wohlwill plant for electrolytically refining gold bullion and recovering from it platinum and palladium.

ELECTROPHYSICS

Alternating Currents

Mean Power and Power Factor in a Non-Sinusoidal Alternating-Current Circuit (De la puissance moyenne et du facteur de puissance dans un circuit à courants alternatifs non sinusoïdaux), H. Pécheux. Revue Générale de l'Electricité, vol. 4, no. 22, Nov. 30, 1918, pp. 813-816, 2 figs. Calculation of cos ϕ from oscillographic records. Method followed for determining non-sinusoidal electromotive force is the one published in R. G. E., Feb. 8, 1918.

Cable, Armored, Resistance of

Effective Resistance and Reactance of a Three-Phase Armored Cable to Current Harmonics (Sur la résistance et la réactance effectives d'un cable armé triphasé pour les harmoniques du conrant), R. Swyngedauw. Revue Générale de l'Electricité, vol. 5, no. 1, Jan. 4, 1919, pp. 16-17. Deduces from results of experiments that for third harmonic of fundamental frequency 50 per sec. resistance is comprised between 0.67 and 0.78 ohm per km., and reactance between 0.45 and 0.56 ohm. per km.

Long Conductors

Some Experiments with Long Electrical Conductors, John H. Morecroft. Elecn., vol. 81, no. 2116, Dec. 6, 1918, pp. 658-660, 7 figs. From paper before Inst. of Radio Engrs.

Long-Line Phenomena

Long Line Phenomena and Vector Locus Diagrams, Edy Velander. Elec. World, vol. 73, no. 5, Feb. 1, 1919, pp. 212-216, 12 figs. Long-line transmission problems may be readily solved by the use of rigorous hyperbolic equations of very simple form; an anlysis of equations of this form with vector diagrams for graphical interpretation.

Parallel Conductors

Determination of the Resistance and Impedance of Any Number of Parallel Conductors (Détermination de la résistance et de l'impédance d'un nombre quelconque de conducteurs associés en parallèle), P. de Bancarel. Revue Générale de l'Electricité, vol. 4, no. 26, Dec. 28, 1918, pp. 989-990, 3 figs. Graphical process based on representation of resistances by trigonometric tangents. Simplification of method suggested by Haudié in Revue Générale de l'Electricité, vol. 3, Aug. 31, 1918, p. 297.

Paramagnetism

The Quantum Theory of Paramagnetism (Zum Quantentheorie des Paramagnetismus), Fritz Reiche. Annalen der Physik, Leipzig, vol. 54, no. 22, 1917, pp. 401-436, 7 figs. Discusses the kinetic theory of paramagnetism from the differential equations proposed by Jacobi, Hamilton, and Planck, and compares them with tests made by Kamerlingh Onnes and Oosterhuis.

Quenched Sparks

Processes Occurring in a Quenched Spark (Ueber die Vorgaenge in sogenannten Loeschfunken), V. Pieck. Annalen der Physik, vol. 54, no. 19, pp. 197-244, 14 figs., 3 plates. Relates to electrical vibrations leading to shock. Experiments with various gases at different pressures and with magnesium electrodes. Dynamic theory of quenched sparks. Ions and electrons. Tests at University of Goettingen.

Short-Circuits

Substation Short-Circuits, R. F. Gooding. Elec. Jl., vol. 16, no. 2, Feb. 1919, pp. 61-65, 6 figs. Calculations to determine stresses to which oil circuit breakers, disconnecting switches, bus supports, etc., may be subjected in substations fed by parallel feeders at a time of short circuit. Several typical examples of special systems are selected.

Transverse Magnetization

The Influence of Transverse Magnetization on the Electrical Resistance of Tellurium (Ueber den Einfluss transversaler Magnetisierung auf den elektrischen Widerstand von Tellur), Bengt Beckman. Annalen der Physik, vol. 54, no. 19, 1917, pp. 182-196. Measurements given of the electrical resistance of rods of tellurium and other rare metals at various temperatures.

See also MECHANICAL ENGINEERING, Motor-Car Engineering (Spark Plugs)

FURNACES

Electrically Heated Ovens

Electrically-Heated Ovens. Iron Age, vol. 1003, no. 3, Jan. 16, 1919, pp. 188-189, 2 figs. Construction and operation of enameling ovens; efficiency of different types compared.

Electrically-Heated Ovens. Metal Rec. & Electroplater, vol. 4, no. 11, Dec. 1918, pp. 395-396, 3 figs. Material for walls, insulation, floors; disadvantages of through metal; four general types; efficiency of the various forms.

Metallurgical Furnaces

Electric Furnace Developments, J. Bibby. Iron & Coal Trades Rev., vol. 97, no. 2652, Dec. 27, 1918, pp. 719-722, 7 figs. Abstract of paper before Cleveland Inst. of Engrs.

Application of the Electric Furnace to the Metallurgy of Iron and Its Alloys, H. Etchells. Elecn., vol. 81, no. 2119, Dec. 27, 1918, pp. 734-735. Abstract of paper read before the National Association of Industrial Chemists, November, 1918.

Electric Furnaces for Steel Foundry Work, W. E. Moore. Blast Furnace, vol. 7, no. 1, Jan. 1919, pp. 76-77. Basic steel recommended on account of possibility of working to closer phosphorus and sulphur limits. Advocates furnace shell of large diameter with shallow bath.

Rennerfelt Furnace

Developments in the Rennerfelt Furnace, H. A. De Fries and Jonas Hertenius. Iron Age, vol. 103, no. 3, Jan. 16, 1919, pp. 190-191, 1 fig. Important changes from original design; side electrodes now tilt; shape of shell is round.

Small Furnaces

Performance of Small Electric Furnace. Am. Drop Forger, vol. 4, no. 12, Dec. 1918, pp. 477-479, 9 figs. Operation and equipment of two-ton electric furnace installed at nichrome plant.

GENERATING STATIONS

Canada

Statistical Analysis of the Central Electrical Station Situation of Canada. Contract Rec., vol. 33, no. 5, Jan. 29, 1919, pp. 88-92, 7 figs. From data compiled by Dominion Water Power Branch of Department of the Interior, in cooperation with Bureau of Statistics of Department of Trade and Commerce.

Floating Station

Floating Electric Power Station. Engineering, vol. 106, no. 2762, Dec. 6, 1918, pp. 644-645, 6 figs. Description of flatting power station built and operated during war for providing current for variable conditions overseas where mobility and convenience were of importance.

Legal Liability

Liability of Central Station Company for Failure of Electric Power, Chesla C. Sherlock. Elec. Rev., vol. 74, no. 6, Feb. 8, 1919, pp. 216-217. Several decisions covering the question of power failure, both through negligence of employees of utility company and breach of contract.

Three-Phase-Two-Phase Type

Features of Three-Phase-Two-Phase Generating Station. Elec. Rev., vol. 74, no. 3, Jan. 18, 1919, pp. 85-88, 9 figs. Installation and operation features of Eastern Wisconsin Electric Co.'s Sheboygan plant.

GENERATORS AND MOTORS

Asynchronous Motors

Asynchronous Motor Diagram (Le diagramme des moteurs asynchrones), L. Lagron. Revue Générale de l'Electricité, vol. 4, no. 23, Dec. 7, 1918, pp. 861-863, 1 fig. Indicates method of constructing diagram knowing only value of currents in short-circuit, their angular displacements and resistance of stator and rotor.

Carbon Brushes

Characteristics of Carbon Brushes for Electrical Machinery, Warren C. Kalb. Power, vol. 49, no. 6, Feb. 11, 1919, pp. 202-204, 2 figs. Carrying capacities, contact drop, coefficient of friction, abrasiveness and hardness of carbon brushes defined and methods for determining these characteristics explained.

Cooling

Cooling Electric Motors, D. A. Mossay. Colliery Guardian, vol. 116, no. 3024, Dec. 13, 1918, pp. 1239-1240, 6 figs. From paper before Min. Inst. of Scotland.

Air-Cooled Electrical Search Light (Di uno speciale dispositivo ad arco raffreddato per proiettori di luce), Virgilio Bellini. Elettrotecnica, vol. 5, no. 21, July 25, 1918, pp. 286-287, 1 fig. Rotary positive carbon is cooled by air jet.

Design

The Advantages of Uniform Motor Design, James Burke. Elec. Wld., vol. 73, no. 4, Jan. 25, 1919, pp. 173-175. From a paper the Electric Power Club, Cleveland, Ohio, January, 1919.

Dynamical Theory

The Dynamical Theory of Electric Engines, Llewelyn B. Atkinson. Jl. Instn. Elec. Engrs., vol. 57, no. 277, Dec. 1918, pp. 1-26, 26 figs. Kelvin's ideas concerning mechanical values of distributions of electricity, magnetism and galvanism; energy relations of electric and magnetic systems; constructive fundamental types of electric engines converting electric energy into mechanical work; possible primary types of electric engines; engines converting mechanical work into electrical energy; combined generator and motor cycles; similarity between expressions for efficiencies of ideal electric engines and general form of expression for efficiency of a perfect heat engine. Tenth Kelvin Lecture.

Induction Motors

The Interchangeability of Induction Motors, Gordon Fox. Ry. Elec. Engr., vol. 10, no. 1, Jan. 1919, pp. 5-8, 4 figs. Indicates necessary alterations in windings which will adapt motors for use on currents of different frequency and phase.

Polyphase Induction Motor

Diagram of Polyphase Induction Motors Taking into Account Magnetic Saturation (Diagramme des moteurs polyphasés asynchrones tenant compte de la saturation magnétique), J. Berthenod. Revue Générale de l'Electricité, vol. 4, no. 25, Dec. 21, 1918, pp. 941-946, 6 figs. The various fluxes are reduced to three, a common flux and two others having leakages proportional to primary and secondary currents, respectively; an approximate diagram is thus formed; another diagram is then developed which takes into account actual operating conditions.

Power and Torque

Power and Torque in Electric Motors, Justin Lebovici. Elec. Rev., vol. 74, nos. 4 and 6, Jan. 25 and Feb. 8, 1919, pp. 134-136 and 213-215, 18 figs. Articles discussing principles of different types of motors from a common standpoint; relations in single-phase induction and repulsion motors.

Rebuilding Generators

Rebuilding 25,000-kw. Generator, Thomas Wilson. Power, vol. 49, no. 3, Jan. 21, 1919, pp. 76-79, 11 figs. Account of rebuilding of generator of Commonwealth Edison Co., Chicago, which required upturning of 200-ton unit within space of its own foundation.

Winding

A New Graphic Method for Winding Schemes, L. Fleischmann. Elecn., vol. 81, no. 2117, Dec. 13, 1918, pp. 689-690, 3 figs. Abstract of article in Elektrotechnische Zeitschrift, No. 7, 1918.

LIGHTING AND LAMP MANUFACTURE

Colored Light

Linking Science and Art in Lighting, M. Luckiesh. Elec. Rev., vol. 74, no. 1, Jan. 4, 1919, pp. 14-15. Possibilities of colored light. (Fourth article.)

Home Lighting

Linking Science and Art in Lighting, M. Luckiesh. Elec. Rev., vol. 74, no. 5, Feb. 1, 1919, pp. 171-173, 2 figs. Fifth of a series of six articles. The lighting of a middle-class home.

Light, Measurement of

Photometric Apparatus for Measuring the Illuminating Value of Fluctuating Sources of High Candle Power. Gas Jl., vol. 144, no. 2902, Dec. 24, 1918, p. 658, 3 figs. Tube photometer and supplementary flare photometer which permit measurements of detail revealing power in its relation to rapidly-burning flares of great intensity. From presidential address to Illum. Eng. Soc.

MEASUREMENTS AND TESTS

Boucherot Wheatstone Bridge

On Boucherot's Constant-Current Distributions (Sur les distributions à intensité constante de M. Boucherot), Tr. Lalesco. Revue Générale de l'Electricité, vol. 4, no. 26, Dec. 28, 1918, pp. 987-988, 3 figs. Shows that in Wheatstone-bridge arrangement for transforming constant-potential alternating current into one of constant intensity, it is not necessary that the four resistances be equal and operation may be secured by having two of the branches of equal resistance and opposite sign.

Indicating Instruments, Hysteresis of

The Determinateness of the Hysteresis of Indicating Instruments, F. J. Schlink. Jl. Wash. Acad. Sci., vol. 9, no. 2, Jan. 19, 1919, pp. 38-45, 2 figs. Hysteresis determinations of non-integrating mechanical measuring instruments require no unusual care, and are fully reproducible.

Magnet Testing

Testing Permanent Magnets by Means of a Voltmeter. Elec. Wld., vol. 73, no. 6, Feb. 8, 1919, pp. 267-268, 1 fig. Magnetometer may be devised by modifying a d'Arsonval type voltmeter; descriptions of useful tests.

Porcelain Insulators

Photographic Study of Porcelain Insulators, Harold G. Tufty. Elec. Wld., vol. 73, no. 6, Feb. 8, 1919, pp. 268-271, 3 figs. Polarized light employed in examination of thin sections of insulators some of which have been properly fired while others were underfired and still others overfired; observations on used insulators.

Railway Motor Testing

Railway Motor Testing—II. Elec. Jl., vol. 16, no. 2, Feb. 1919, pp. 76-79, 3 figs. Survey of practical methods accepted by operating companies. Armature testing of standard four-pole lap or two-circuit wound 500-volt railway motors.

Resistance Measuring by Voltmeter

On the Voltmeter Method of Measuring Resistances (Note sur la mesure d'une résistance par la méthode du voltmètre), H. Panchon. Revue Générale de l'Electricité, vol. 4, no. 25, Dec. 25, 1918, p. 972, 1 fig. In formula $X = (E - U)\ R/U$, RE is called K and expression reduced to $(X + R)\ U = K$. The graph presented gives X in terms of U. Discussion of Puget's method in R. G. E. Aug. 31, 1918.

Thermocouples and Pyrometers

Checking Calibration of Thermocouples and Pyrometers. Elec. Rev., vol. 74, no. 2, Jan. 11, 1919, pp. 56-59, 6 figs. Sources of error in thermocouples, pyrometers and leads; methods of testing works units against secondary and works standards; maintenance of standards; apparatus recommended for carrying on work.

Voltage Measurement

The Measure of High Voltages by Means of Klingelfuss Sclerometer (La mesure des hautes voltages au moyen du scléromètre Klingelfuss), Paul Joye. Archives des Sciences Physiques et Naturelles, vol. 46, Nov. 1918, pp. 243-251. An independent third circuit is introduced in induction coil in space which separates right and left portions of secondary winding; this circuit connected to a voltmeter is the sclerometer.

Watt-Hour Meters

Testing Single-Phase Watt-Hour Meters Using a Rotating Standard, P. B. Findley. Power, vol. 49, nos. 4 and 5, Jan. 28 and Feb. 4, 1919, pp. 118-121 and 168-171, 18 figs. Jan. 28: Considers meter used on distributing circuits and method of testing it, using an indicating watt-meter; Feb. 4: Construction of rotating standard watt-meter is described and application to testing single-phase watt-hour meters discussed.

See also RAILROAD ENGINEERING, *Street Railways (Tests)*; ELECTRICAL ENGINEERING, *Transmission, Distribution, Control (Meters)*

POWER APPLICATIONS

Agriculture, Italy

Application of Electricity to Agriculture in Italy (Applicazioni agricole dell' elettricita con riferimento speciale alle condizioni dell' Arzo Romano), D'Escani Alessandro. Annali d'Ingegneria e d'Architettura, year 33, no. 21, Nov. 1, 1918, pp. 330-332. Discusses necessity for wider application of electricity to agriculture, especially for ploughing, threshing, pressing hay and straw, and for pumping water for irrigation purposes.

Coal Mines

The Electric Installations of the Coal Mines in Blackhall, England (Les installations électriques des charbonnages de Blackhall, Angleterre). Génie Civil, vol. 74, no. 1, Jan. 4, 1919, pp. 1-4, 6 figs.

Shop Motors

Light, Electricity and the Shop, C. E. Clewell. Am. Mach., vol. 50, no. 4, Jan. 23, 1919, pp. 163-167, 11 figs. Motors for drilling and boring machines.

Steel-Mill Drives

Electric Steel Mill Drive Developments, Brent Wiley. Blast Furnace, vol. 7, no. 1, Jan. 1919, pp. 35-37, 5 figs. Consideration given to standardization; variation in mill schedule permitted by flexibility of electric drive; tendency toward central station and 60-cycle apparatus.

GTD
PRODUCTS
Taps and Dies
Screw Plates
Reamers
Gages
Pipe Tools
Opening Die Heads
Machine Tools
Threading Machines
Lathes & Screw Machines
Grinding Machines
Cutting Off Machines
Saw Sharpeners
GTD

Gages—*Not* Guesses—
Produce Interchangeable Parts

Through the employment of a GTD Limit Gaging System, during the process of manufacture, the percentage of off-size parts reaching the final inspection stage is reduced to a minimum.

By gaging the parts as they are made it is possible to keep the production steady, and the product to size, with a very small amount of scrap.

The use of Limit Gages is the *one* factor absolutely essential to the quantity production of interchangeable parts.

If you make a standard product—
"GAGE IT"
and we'll help you!

TRADE MARK REG. U.S. PAT. OFF.
GTD

GREENFIELD
TAP & DIE CORPORATION
Greenfield, Massachusetts, U.S.A.
World's Largest Manufacturers of Screw Cutting Tools

New York 28 Warren St.
Chicago 13 South Clinton St.
Detroit 74 Congress St. W.
Canadian Factory Wells Bros. Co. of Canada Ltd. Galt, Ontario

Electrically-Driven Plate Mills, G. E. Stoltz. Elec. Jl., vol. 16, no. 2, Feb. 1919, pp. 68-73, 10 figs. Typical steel mill drives; torque curves of induction motor at various r.p.m. rolling plate from slab; graphic chart of load on a 90-in. plate mill; power consumption. Paper read before Phila. Section Assn. Iron & Steel Elec. Engrs.

Modern G. E. Electric Steel Mill Drives. Blast Furnace, vol. 7, no. 1, Jan. 1919, p. 37. Electric drive operating 1200-ton hydraulic bloom shear with rapid acceleration and retardation and distance control.

POWER GENERATION

Hydroelectric Plants

See Power Generation, MECHANICAL ENGINEERING.

See also MARINE ENGINEERING, Ships (Electrical Installation Work; Electric Propulsion); ORGANIZATION AND MANAGEMENT, Transportation (Electric Trucks)

STANDARDS

Aluminum Conductors, Standards for

Proposed Specifications for Aluminum Electrical Conductors (Project de conditions de réception des conducteurs d'électricité en aluminum). Revue Générale de l'Electricité, vol. 4, no. 24, Dec. 24, 1918, pp. 931-933. Preliminary report submitted to l'Union des Syndicats by one of their sub-committees. Report comprises chemical definition, mechanical resistance, modulus of elasticity, flexibility, coefficient of expansion and electrical conductivity of aluminum.

Current and Potential Standards

A New Standard of Current and Potential, Chester T. Allcutt. Elecn., vol. 81, no. 2117, Dec. 13, 1918, pp. 684-685, 6 figs. Abstract of paper before the American Institute of Electrical Engineers.

Standardization Division in Plants

Standardization Division in a Plant Manufacturing Electrical Material (Organisation d'un service d'études des normalisations dans une usine de constructions électriques), J. Fièvez. Revue Générale de l'Electricité, vol. 4, no. 25, Dec. 21, 1918, pp. 975-978, 1 fig. Suggests division, under direction of technical department, to study selection of standards that will meet all conditions which may be required by public. Functions of proposed division and its relation to various other departments are outlined.

Wave-Shape Standards

Review of Work of Sub-Committee on Wave Shape Standard of the Standards Committee, Harold S. Osborne. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 1, Jan. 1919, pp. 1-28, 12 figs. Recommends that for the present the 10 per cent deviation rule should be retained and that trial use should be made of a supplementary wave-shape factor, based on the relation between voltage wave shape and interfering effect in telephone circuits when power and telephone lines parallel each other.

TELEGRAPHY AND TELEPHONY

Cables, Fault Location in

A Useful Arrangement of the Murray Loop Test, L. J. Sell. Post Office Elec. Engrs. Jl., vol. 2, pt. 4, Jan. 1919, pp. 225-228, 3 figs. Applicable in case of cable fault when some wires only are seriously affected and a good wire of same gage and length as faulty wires is available.

Fault Location Tests, J. B. Salmon. Post Office Elec. Engrs. Jl., vol. 2, pt. 4, Jan. 1919, pp. 215-224, 5 figs. Examination of difficulties incidental with location of cable faults by Varley and Murray loop tests, Anderson and Kennelly overlap test and Blavier test. Conditions under which each of these tests is most suitable.

Central Battery System Telephones

Note on the C. B. S. Telephone System. Post Office Elec. Engrs. Jl., vol. 2, pt. 4, Jan. 1919, pp. 197-203, 6 figs. Essential features of central battery system and comparison with present signaling system; study of main characteristics desirable in an exchange designed for local battery talking and automatic calling and clearing.

Multiplex Telegraphy

Modus Operandi of Multiplex Telegraphy. Elec. Rev., vol. 74, no. 2, Jan. 11, 1919, pp. 49-51, 6 figs. Further details concerning principles and application of recently developed system of multiplex telephony and telegraphy; equipment and operation of Washington-Pittsburgh circuit.

Multiplex Telephony

New Multiplex System of Telephony. Elec. World, vol. 73, no. 1, Jan. 4, 1919, pp. 11-13, 5 figs. System developed to increase manifold the message-carrying capacity of long-distance telephone and telegraph wires; suggestive value of earlier undertakings in this field.

Phanoplex

Phanoplex Telegraphy (in Japanese), Y. Fuseno. Denki Gakkwai Zasshi, no. 364, Nov. 18, 1918.

Quadruplex Telegraphy

Morse Quadruplex Working. Post Office Elec. Engrs. Jl., vol. 2, pt. 4, Jan. 1919, pp. 209-214, 2 figs. Discusses conditions under which stable quadruplex working on aerial wires may be contained at all times.

Radio Telephony

Some Aspects of Radio Telephony in Japan, Eitaro Yokoyama. Wireless World, vol. 6, no. 70, Jan. 1919, pp. 569-574, 8 figs. Experiments on influence of electrode materials on discharge and of supply voltage on operation of discharger; static frequency transformer of T. Kujirai (Concluded). From Proc. Inst. Radio Engrs.

The Vision of a Scientist. Wireless World, vol. 6, no. 70, Jan. 1919, pp. 554-57. Remarkable forecasts of Sir William Crooks on wireless telegraphy. From Fortnightly Rev., Feb. 1892.

Sounder Silencers

Sounder Silences, R. T. King. Post Office Elec. Engrs. Jl., vol. 2, pt. 4, Jan. 1919, pp. 206-208, 2 figs. Modification of departmental relay no. 1000A so as to cause bell to ring when distant station holds down key for period of about ten seconds.

Telephone Circuits, Loaded

A Graphical Method of Calculating the Attenuation Constant of Loaded Telephone Circuits, E. S. Ritter. Post Office Elec. Engrs. Jl., vol. 2, pt. 4, Jan. 1919, pp. 187-196, 3 figs. Applicable only to loaded lines, including open wire aerial lines, underground and submarine cable.

Vacuum Tubes

The Development of the Vacuum Valve. Jl. Elec., vol. 42, no. 1, Jan. 1, 1919, pp. 20-22, 8 figs. Manufacturing details; uses in the war; importance in wireless telephony.

Developments in Radio Apparatus, George O. Squier. Elec. World., vol. 73, no. 3, Jan. 18, 1919, pp. 129-130. Application to radio communication of vacuum tube; improvements during war; airplane radio-telephone and radio-telegraph sets. From lecture before A. I. E. E. on Aeronautics in the United States from the Beginning of the War to the Present Time.

Theory of the Electric Oscillations in Vacuum Tubes (in Japanese), Y. Nozuki. Denki Gakkwai Zasshi, no. 365, Dec. 10, 1918.

See also ELECTRICAL ENGINEERING, Electrophysics (Quenched Sparks)

TRANSFORMERS, CONVERTERS, FREQUENCY CHANGERS

Charts

Formulæ and Charts Relative to the Working under Load of Industrial Transformers (Formules et abaques relatifs au fonctionnement en charge des transformateurs industriels), L. Dubar. Revue Générale de l'Electricité, vol. 4, no. 22, Nov. 30, 1918, pp. 817-821, 7 figs. Output and voltage drop at various loads and with different angular displacements, obtained from construction data and test results.

Electric-Furnace Transformers

High Intensity Transformers for Electric Furnaces (Etude sur le calcul de transformateurs à forte intensité pour fours électriques), R. Jacquot. Revue Générale de l'Electricité, vol. 4, no. 17, Oct. 26, 1918, pp. 602-617, 2 figs. Classification of transformers used in electrometallurgy; their respective losses and cost.

Oils

Some Characteristics of Transformer Oils, O. H. Eschholz. Elec. Jl., vol. 16, no. 2, Feb. 1919, pp. 74-76, 2 figs. Test figures comparing vapor pressures of transformer oil with those of liquids of well-known characteristics.

Starting Current

Calculation of Starting Current in A. C. Transformers for Electric Traction (Der Einschaltstrom von Wechselstrom-Transformatoren fuer die elektrische Traktion), W. Kummer. Schweiz. Bauzeitung, vol. 72, no. 24, Dec. 14, 1918, p. 233, abstracted from M. Vidmar's article in Elektrotechnik & Maschinenbau, 1918, p. 273. Gives formulæ for calculating the resistance capacity of idle transformers.

TRANSMISSION, DISTRIBUTION, CONTROL

Cables, High Tension

Experimental Investigation of High-Tension Cables, Tsunezo Hada. Denki Gakkwai Zasshi, no. 364, Nov. 10, 1918, 27 pp. 15 figs. Establishes as result of experiments that in a strand cable the minimum potential gradient or the maximum breakdown voltage is practically at position where $D/2h = e$, as in case of a single-core concentric cable.

Distribution Problems

North-Eastern Centre: Chairman's Address, A. P. Pyne. Jl. Instn. Elec. Engrs., vol. 57, no. 277, Dec. 1918, pp. 35-40. Question of generating electricity in bulk and its distribution over wide areas.

Insulators, Line

An Operating View of High-Tension Insulators, P. Ackerman. Elec. World, vol. 73, no. 3, Jan. 18, 1919, pp. 116-119, 4 figs. Severe operating conditions that have caused failure of line insulators; later designs of pin and suspension types promise to solve insulator problem for some years to come.

Application of Theory and Practice to the Design of Transmission Line Insulators, G. I. Gilchrest and T. A. Klinefelter. Elec. Jl., vol. 16, no. 1, Jan. 1919, pp. 8-16, 28 figs. Laboratory tests of various new designs and comparison of these designs with those now in commercial use.

Line Poles

When a Line Pole Needs a Guy, Charles R. Harte. Elec. Ry. Jl., vol. 53, no. 3, Jan. 18, 1919, pp. 139-142, 7 figs. Summary of experience of telephone and power companies as guide to electric-railway transmission-line construction.

Meters

Notes on Demand Meters, H. W. Richardson. Elec. World, vol. 73, no. 5, Feb. 1, 1919, pp. 219-222, 2 figs. Indicating demand meters for small and recording or curve-drawing meters for larger installations; principles upon which modern demand meters operate.

Phase Conversion

The Supply of Single-Phase Power from Three-Phase Systems, Miles Walker. Elecn., vol. 81, no. 2117, Dec. 13, 1918, pp. 682-684, 5 figs. Abstract of paper before the Institution of Electrical Engineers.

Power Conductors

Arrangement of Power Conductors. Jl. Elec., vol. 42, no. 2, Jan. 15, 1919, pp. 72-74, 9 figs. Recommendations for spacing of power lines as made by Cal. Committee on Inductive Interference. Figures and comparisons given apply to non-transposed circuits; comparisons of different configurations hold also for transposed circuits, provided circuits are transposed identically.

Power Control

The Control of Large Amounts of Power, E. B. Wedmore. Power House, vol. 11, no. 12, Dec. 1918, pp. 363-367, 5 figs. Limitation by sectionalizing and employment of feeder or busbar reactances. Paper before Instn. Elec. Engrs. (To be continued.)

Power Factor

Improving Power Factor by Use of Synchronous Motors (Emploi des moteurs synchrones pour ameliorer le facteur de puissance), Paul Rieunier. Revue Générale de l'Electricité, vol. 5, no. 1, Jan. 4, 1919, pp. 3-16, 5 figs. Investigation of the nature and the properties of surface represented by general equation $y = \pm\sqrt{1 - z^2} - xz$, which is a modification of expression $S/R = \sin\phi_1 - \cos\phi_1 \tan\phi_2$ (R. G. E., vol. 4, Nov. 23, 1918, pp. 771-788), where S is current in quadrature supplied by synchronous motor, R current without synchronous motor, and ϕ_1 and ϕ_2 phase angles before and after introduction of synchronous motor respectively; former equation is obtained by making $S/R = y$, $z = \cos\phi_1$, and $x = \tan\phi_2$.

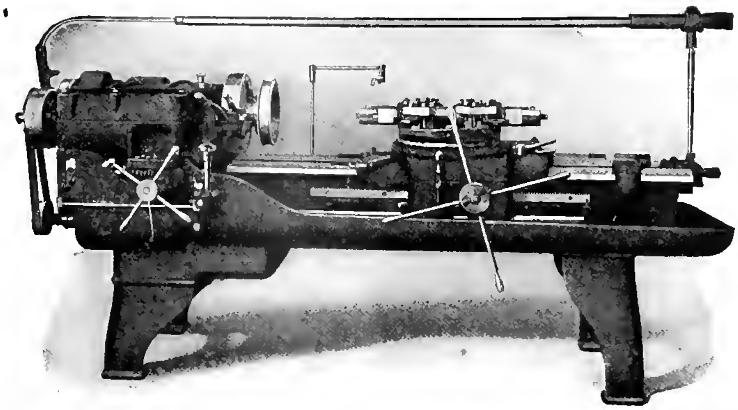
Power Transmission

Latest Developments in the Electric Transmission of Power, P. M. Lincoln. Jl. Cleveland Eng. Soc., vol. 11, no. 3, Nov. 1918, pp. 153-159 and (discussion) pp. 159-161. Limitation of direct-current transmission; early experiments in transmission by alternating current; Tesla's patents in 1889; Mershon's first observations of corona phenomena; the 40,000-volt installation at Telluride Power Co.; recent discoveries concerning nature of coronas.

Relays

The Orling Jet Relay (Le relais Orling à jet), J. Pomey. Revue Générale de l'Electricité, vol. 4, no. 24, Dec. 14, 1918, pp. 899-900, 2 figs. Usage in extensive cable lines of relays constructed on electrocapillary principles.

Hartness Flat Turret Lathes



The Hartness Flat Turret Lathe with cross-sliding head is made in two sizes, and may be furnished with an equipment of tools for either bar work or chuck work, or a double equipment for both bar and chuck work.

The smaller machine is called the 2¼ x 24-inch, and when equipped with the automatic die outfit of tools it turns nearly every conceivable shape from the bar, up to 2¼ inches diameter and 24 inches of length. On chuck work its capacity is 12½ inches diameter or less.

The 3 x 36-inch size handles bars of stock up to 3 inches in diameter, turning pieces up to 36 inches in length. It may also be equipped for chuck work up to 14½ inches in diameter.

SPECIAL FEATURES

The Original Flat Turret

The Flat Turret was put on the market in 1891. Over twelve thousand (12,000) machines equipped with them have been built and sold since, to the great satisfaction of the users. A large, steady tool clamping surface, a circular gib holding the turret down clear around its periphery, a locking pin directly under the cutting point of the tool—all these features combined to set a new standard of output, accuracy and range of work in turret lathe practice.

The unique set of tools employed covered at one leap the evolution from the old-fashioned "screw machine" to the modern turret lathe. It enabled the turret lathe to practically displace the engine lathe on bar, shaft and stud work.

The Cross-Sliding Head

This feature, introduced in 1903, still further extended the field of the turret lathe, making it the standard machine for most chuck work of moderate size. The Cross-Sliding Head has three advantages: (1) It offers a cross-sliding motion, gibbed directly and securely to the bed. There is no piling of slide on slide, no narrow bearing foundation for a lofty superstructure of slide, tool holder and tool. (2) It permits the cross feed to be applied to every tool on the turret if necessary. (3) By allowing a cross adjustment to every tool, complicated and costly special tools are minimized. The regular outfit covers all regular work. The design is so stable that the piloted type of holder is seldom needed.

JONES & LAMSON MACHINE COMPANY

SPRINGFIELD, VERMONT, U. S. A.

109 Queen Victoria Street, London, E. C.

France, Spain and Belgium: F. Auberty & Co., 91 Rue de Maubeuge, Paris
Holland: Spliethoff, Beeuwkes & Co., Rotterdam

SEE OUR DATA IN 1918 A.S.M.E. CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT

A 1

Substations

Automatic Substations on the North Shore Line, Charles H. Jones. Elec. Ry. Jl., vol. 53, no. 2, Jan. 11, 1919, pp. 84-90, 8 figs. Three new substations in operation and another under construction save 177 miles of 500,000-cir. mils cable worth $650,000.

Switches, Oil

Oil Switches (Considérations sur les disjoncteurs à l'huile), W-A. Coales and W-H. Wadmore. Revue Générale de l'Electricité, vol. 4, no. 23, Dec. 7, 1918, pp. 882-887, 7 figs. Provisions which must be made in designing them: their use in connection with time lag relays; characteristic factors; installation.

Wiring, Transmission

Ornamental Electric Transmission Wiring (Zur Aesthetik des Linienbaues bei elektrischen Freileitungen). Dr. P. Neusch-Sigrist. Bern. Schweiz. Elektrotech. Verein Bulletin, vol. 9, no. 12, December 1918, pp. 277-289, 13 figs. Calls attention to the desirability of underground wiring, where feasible, and to the need of using judgment and good taste in the design and location of exposed wire supports.

Civil Engineering

BRIDGES

Aqueduct

Aqueduct Crossing Under the Red River, for Winnipeg Water Supply, J. Armstrong. Contract Rec., vol. 33, no. 4, Jan. 22, 1919, pp. 63-67, 13 figs. Plans, cross section and details. Vertical shafts are 60 ft. deep, horizontal tunnel 1030 ft. long.

Bascule Bridge

138-Ft. Bascule Bridge at the Entrance of La Seyne Port, Toulon Roadstead (Pont basculant de 42 mètres de portée à l'entrée du port de la Seyne rade de Toulon). Génie Civil, vol. 73, no. 23, Dec. 7, 1918, pp. 441-444, 25 figs. Detailed description of new French design in which span is raised to perfectly vertical position by articulated system of levers.

Combination Girder and Arch

An Unusual Bridge Design. Contract Rec., vol. 33, no. 4, Jan. 22, 1919, p. 74, 1 fig. Reinforced concrete structure which is combination of girder and arch design.

Design

Finding the Most Advantageous Construction of a Bridge by Graphical Methods (Die wirtschaftlich guenstigste. Anordnung einer Brueckenanlage auf zeichnerzischem Wege), Prof. Robert Schoenhoefer, Braunschweig. Zeitschrift fuer Bauwesen, vol. 68, no. 10 to 12, 1918, pp. 502-515, 4 figs. Author refers to his book of same title, (1916, Berlin), as well as to 1916 volume of the Zeitschrift, in which he showed the layout for any bridge up to 10 arches. The present work extends this to bridges with any number of arches. The aim is to find the design involving the least cost of construction. The method succeeds where calculations alone would fail.

Long Span

The Reconstruction of a Notable Railroad Bridge. Ry Age, vol. 66, no. 4, Jan. 24, 1919, pp. 238-243, 9 figs. Reconstruction of the Ohio River Crossing at Louisville, containing the longest simple riveted span in the world.

Materials

Data on Concrete and Steel Bridges, John W Towle. Concrete Age, vol. 29, no. 3, Dec. 1918, pp. 16-18. Points out it is best to have shorter spans of concrete, longer ones of steel. Address delivered before North Carolina Good Roads Assn

Steel

Steel Bridge Replacements on the Sydney subdivision of Canadian Government Railways. A. H. Jones. Contract Rec., vol. 33, no. 2, Jan. 8, 1919, pp. 28-30, 6 figs. Account of alterations in masonry piers and replacements of light spans in 16 steel bridges and viaducts

Strengthening

Stokesay Bridge, Shropshire, W. Noble Twelvetrees. Engineering, vol. 107, no. 2766, Jan 3, 1919, pp. 3-6, 17 figs. Strengthening a Telford cast-iron bridge by ferro-concrete arch ribs.

Strengthening a Long Steel Viaduct. Ry. Maintenance Engr., vol. 15, no. 1, Jan 1919, pp. 9-10, 3 figs. Measures taken by Chicago & Eastern Illinois Ry. to reinforce long steel viaduct so as to permit of its use by heavy locomotives.

Stresses

Contraction Stresses in Bridge and Roof Trusses (Von der Schrumpfarbeit am Fachwerk), Leopold Ellerbeck, Berlin. Zeitschrift fuer Bauwesen, vol. 68, no. 10 to 12, 1918, pp. 474-502, 27 figs. Scientific analysis of the distortions found in all kinds of trusses. Considers the forces exerted upon a group of members.

Wilson Bridge, Lyons

The Sejourne System Wilson Bridge at Lyons, France. Eng. & Contracting, vol. 51, no. 4, Jan. 22, 1919, pp. 74-76, 1 fig. Description of certain features of design and construction.

BUILDING AND CONSTRUCTION

Caisson Method

The Caisson Method for Foundations and Mine Shafts. George R. Johnson. Proc. Engrs.' Soc. Western Pa., vol. 34, no. 7, Oct. 1918, pp. 489-514 and (discussion) pp. 514-518, 20 figs. General survey of applications of caisson method in building foundations, bridge piers, and mine shafts, with numerous illustrative examples.

Dams

See Earthwork, Rock Excavation, etc., on page 330.

Floors

Test of a Flat Slab Floor of the Western Newspaper Union Building, Arthur N. Talbot and Harrison F. Gonnerman. Univ. Ill. Bul., vol. 15, no. 39, bul. 106, May 27, 1918, 52 pp., 22 figs. Building was nine years old at time of test. Stresses up to 30,000 lb. sq. in. were developed in reinforcing bars. Information is given extensively on action of slab in its various parts.

Test of a Mixedstone Floor (Essai d'un plancher Mixedstone). Bulletin Technique de la Suisse Romande, year 44, no. 26, Dec. 28, 1918, pp. 233-235, 12 figs. Mixedstone floors are made of separate reinforced concrete standard parts which are placed and cemented together to form a continuous structure. Tests were conducted at University of Paris to ascertain modulus of elasticity, relative flexibility and ultimate strength of this construction.

Heathcote Precast Construction

A New System of Reinforced Concrete Construction. Engineer, vol. 126, no. 3287, Dec. 27, 1918, pp. 551-552, 4 figs. Description of the Heathcote system of precast concrete construction.

Houses

Fifty Double Wall Houses for Carnegie Employees. Concrete, vol. 14, no. 1, Jan. 1919, pp. 24-27, 8 figs. Five-and six-room houses with double 4-in. concrete walls.

281 Fireproof Dwellings Built of Large Precast Concrete Units, Harvey Whipple. Concrete, vol. 14, no. 1, Jan. 1919, pp. 3-8, 26 figs. Layout of housing development and details of houses built at St. Louis for Youngstown Sheet & Tube Co.

Pouring 75 All-Concrete Houses at Phillipsburg, N. J. Concrete, vol. 14, no. 1, Jan. 1919, pp. 9-14 15 figs. Twenty-five houses are of four-room, bath and basement Ingersoll mold and 50 are from new mold producing six-room and bath house. Plans of houses and construction are shown.

Seventy-five Dwellings of Monolithic Concrete at Claymont, Del. Concrete, vol. 14, no. 1, Jan. 1919, pp. 15-19, 19 figs. Plans of four-, five- and six-room houses.

Build 20 All-Concrete Houses: Plan 20 Bungalows. Concrete, vol. 14, no. 1, Jan. 1919, pp. 20-23, 13 figs. Six-room and bath models but with exterior variation in roof and porch treatment to make attractive row.

Joints, Riveted

Rigidity of Riveted Joints of Steel Structures. Engineering, vol. 106, no. 2762, Dec. 6, 1918, pp. 638-640, 9 figs. From Bulletin No. 104, Engineering Experiment Station, Univ. of Ill.

Mill Building

Erecting a Building of Pre-Cast Concrete Units. Contract Rec., vol. 33, no. 3, Jan. 15, 1919, pp. 46-47, 9 figs. Columns, beams and trusses first cast as separate units on the ground and then erected after manner of steel building. Building in question is 160 ft. long, 200 ft. wide and 14 ft. high.

Oil House

Modern Steel Mill Oil House Installation Blast Furnace, vol. 7, no. 1, Jan. 1919, pp. 49 and 59, 1 fig. Central distribution point for oil building is of concrete monolithic construction with brick curtain walls and steel sash 62 by 133 ft.

Reservoirs

18,000,000 Gallon Reservoir at Winnipeg. Engineer, vol. 126, no. 3287, Dec. 27, 1918, pp. 545-548, 11 figs. Features of design and construction.

Schools

High School at Ville St. Pierre, P. Q. Contract Rec., vol. 33, no. 1, Jan. 1, 1919, pp. 4-5, 2 figs. Elevation and plan of modern fireproof educational building.

Academy St. Bernard, Shawinigan Falls, Que. Contract Rec., vol. 33, no. 2, Jan. 1, 1919, pp. 8-9, 4 figs. Three-story brick building 140 × 58 ft.

Sewer

Rosedale Creek Sewer Extension, Toronto. Can. Engr., vol. 36, no. 3, Jan. 23, 1919, pp. 163-164, 4 figs. Circular brick sewer 2598 ft. long, 6 ft. 6 in. diameter, one per cent grade. Constructed partly in tunnel using compressed air.

Wing-Wall Abutments

Method and Formulas for Dimensioning Wing Wall Abutments, Benj. L. Parker. Eng. & Contracting, vol. 51, no. 4, Jan. 23, 1919, pp. 80-82, 5 figs.

CEMENT AND CONCRETE

Cement Manufacture, Economies in

Make Cement Cheaper; Save Two Million Tons Coal, F. G. McKelvy. Concrete, Cement Mill Section, vol. 14, no. 1, Jan. 1919, pp. 1-4, 7 figs. Theory and practice of power production by use of exhaust gases from cement kilns. Paper presented before Portland Cement Assn.

Cement, Properties of

Formation and Properties of Blast-Furnace Slag and Portland Cement (La formation et les propriétés des laitiers de haut fourneau et du ciment Portland), B. Neumann. Génie Civil, vol. 73, no. 26, Dec. 28, 1918, pp. 512-513. Chemical constitution and data of industrial value. From Stahl und Eisen, Oct. 17, 1918.

Concrete Strength and Mixing Lime

Effect of Time of Mixing on the Strength of Concrete, Duff A. Abrams. Am. Architect, vols. 114 and 115, nos. 2242, 2243, 2244 and 2246, Dec. 11, 18, 25, 1918 and Jan. 8, 1919, pp. 711-717, 745-750, 775-781 and 85-87, 30 figs. Report of tests conducted at Structural Materials Research Laboratory, Lewis Inst. Tests covered uniformity of machine-mixed concrete; study of time of mixing concrete on its consistency; effect of mix and size of aggregate on mixing time; study of rate of rotation of mixer drum; and effect of temperature of mixing water on strength of concrete. Paper for presentation to Am. Concrete Inst.

Concrete Tile

Making Concrete Tile for Government Housing. Concrete, vol. 14, no. 1, Jan. 1919, pp. 32-34, 4 figs. Concrete wall tile equivalent in volume to 10,000,000 common brick being manufactured for United States Housing Corporation of Department of Labor. Erection, equipment and operation of temporary factory on housing site.

Girder Poles

New Process for the Construction of Reinforced-Concrete Girder Poles (Nouveaux procédés pour la construction de pylones en béton armé), L. Perrin. Génie Civil, vol. 73, no. 23, Dec. 7, 1918, pp. 452-453, 6 figs. Manufactured in pieces of about 10 in. in height and provided with suitable grooves for steel members; when assembled grooves are covered with layer of cement mortar.

Iron Portland Cement

The Use of Iron Portland Cement in Reinforced Concrete, Edwin H. Lewis. Jl. West of Scotland Iron & Steel Inst., vol. 26, part 2, session 1918-1919, pp. 8-11 and (discussion) pp. 11-16, 5 figs. Records of furnace workings which show that in properly made iron portland cement (70 per cent clinker and 30 per cent water-granulated slag) there is no difficulty in keeping sulphur content below requirements of British standard specification.

Pneumatic Method of Concreting

The Pneumatic Method of Concreting, H. B. Kirkland. Contract Rec., vol. 33, no. 2, Jan. 8, 1919, pp. 25-27, 2 figs. Arrangement of plant. Pneumatic method consists in blowing batches of concrete through a pipe from a central point of supplies to their place in the concrete forms. Curve given shows amount of air required to convey concrete various distances.

Reinforced Concrete

The Factor of Safety in Plain and Reinforced-Concrete Bodies Subjected to Uniform and Eccentric Pressures. Based on the Experiments of C. Bach and O. Graf. (Ueber den Sicherheitsgrad von bewehrten und unbewehrten Betonkoerpern, die auf zentrischen und exzentrischen Druck beansprucht werden. Unter Zugrundelegung der Forschungsarbeiten Heft 166-169). Armierten Beton, vol. 11, no. 9, Sept 1918, pp. 174-179, figs. 19 to 24. Mathematical discussion of stresses resulting from eccentric loads. Graphical solution of examples of loading causing deformations. Concluded in vol. 11, no. 10, Oct. 1918, pp. 190-195, figs. 25-27. Maximum compression strength found was 172.6 kg. per cm², maximum tensile strength, 24.9 kg. per cm².

Reinforced Concrete Under Simple Bending Stress (Der auf einfache Biegung beanspruchte Eissenbeton Querschnitt). Max Schendera. Armierter Beton, vol. 11, no. 10, Oct. 1918, pp. 195-199. Calculations, formula and tables pertaining to deflections in slabs. (To be continued.)

Setting Action

Present Knowledge of the Setting Action of Cement and Plasters. Cement & Eng. News, vol. 31, no. 1, Jan. 1919, pp. 22-25. Brief summaries of addresses presented at international discussion of subject held by Faraday Soc. of Lond. From Concrete.

Wasteful Construction

Useless Waste in Concrete Construction Due to Legal Requirements, W. Stuart Tait. Am. Architect, vols. 114 and 115, nos. 2242, 2243, and 2246, Dec. 11, 18, 1918, and Jan. 2, 1919, pp. 717-718, 750-752 and 79-84, 6 figs. Draws attention to developments which have taken place in analytical side of reinforced concrete design and to improvements in materials used; shows that there is now in existence a large force of skilled mechanics and general contractors fitted to construct reinforced concrete, as compared with time when present methods of design and stresses were established. (To be continued.)

Wear of Concrete

The Wearing Resistance of Concrete, Duff A. Abrams. Contract Rec., vol. 33, no. 4, Jan. 22, 1919, p. 77. Methods for determining maximum resistance to wear.

Winter Concreting

Concreting in Cold Weather. Mun. Jl., vol. 46, no. 1, Jan. 4, 1919, pp. 7-8. Suggestions offered by Portland Cement Assn.

See also MECHANICAL ENGINEERING, Pipe (Reinforced-Concrete Pipe)

EARTHWORK, ROCK EXCAVATION, ETC.

Blasting Pole Holes

Digging Pole Holes with Dynamite, C. R. Van Druff. Telephone Engr., vol. 21, no. 1, Jan. 1919, pp. 11-12, 4 figs. Hole is bored with 1.5-in. auger to within 1 ft. of desired depth; then charge is inserted and tamped down with earth and fired by blasting cap and fuse.

Crushed Stone

Standard Sizes of Crushed Stone from the Standpoint of the Producer, R. W. Scherer. Contract Rec., vol. 33, no. 1, Jan. 1, 1919, pp. 11-13. Affirms that standard sizes of crushed stone throughout the states are possible and highly desirable and proposes that nomenclature be confined to stating maximum and minimum sizes. Suggests 3, 2, 1½, 1, ½, ¼ in. as screen sections.

Dams

Hollow Concrete Dam at the Outlet of Lake St. Francois, O. Lefebvre. Contract Rec., vol. 33, no. 3, Jan. 15, 1919, pp. 42-45, 6 figs. Plan, elevation, typical section and details of construction. Project calls for expenditure of $101,000.

Big Eddy Conservation Dam. Can. Engr., vol. 36, no. 2, Jan 9, 1919, pp. 136 and 138. General dimensions of dam under erection at estimated cost of $1,750,000.

The Engineering and Construction of a Concrete Diverting Dam, George M. Bacon. Monthly Jl. Utah Soc. Engrs., vol. 4, no. 11, Nov. 1918, pp. 181-190, 8 figs. Sketch of dam on Boise River, which forms part of Payette-Boise project of U. S. Reclamation Service. River at point of dam has extreme minimum flow of 650 and a maximum of 40,000 cu. ft. per sec.

Reservoir

Building a Reservoir in a Cavernous Country. Ry. Maintenance Engr., vol. 15, no. 1, Jan. 1919, pp. 15-17, 2 figs. How danger of leakage through subterranean channels was avoided.

Steam Shoveling

Steam Shovel Practice, Llewellyn N. Edwards. Can. Engr., vol. 36, no. 2, Jan. 9, 1919, pp. 123-126, 6 figs. Factors upon which economy of operation depends; essential characteristics of efficient operator.

Tunnels

Economics of the C. N. R. Tunnel at Montreal, H. K. Wicksteed. Can. Engr., vol. 36, no. 4, Jan. 23, 1919, pp. 157-162, 5 figs. Problems in location that arose when seeking entrance into that city; observations and incidents regarding construction difficulties. Paper read before Toronto Branch Eng. Inst. Can.

See also RAILROAD ENGINEERING, Permanent Way and Buildings (Landslip)

HARBORS

Hamilton

Recent Harbor Improvement at Hamilton, John Taylor. Contract Rec., vol. 33, no. 3, Jan 22, 1919, pp. 70-72, 4 figs. Completing construction of wharf wall and reclamation of enclosed area behind it.

Quebec

Champlain Dry Dock for Quebec Harbor, U. Valiquet. Engineering, vol. 106, no. 2762, Dec. 6, 1918, pp. 658-662, 16 figs. Illustrated description from paper before Canadian Soc. of Civil Engrs.

Singapore

Recent Harbor and Dock Works at Singapore, Straits Settlements. Engineering, vol. 106, no. 2761, Nov. 29, 1918, pp 603-608, 17 figs. Account of recent developments and improvements.

ROADS AND PAVEMENTS

Bituminous Roads

Bituminous Surfaces in York County, Ont., E. A. James. Can. Engr., vol. 36, no. 3, Jan. 16, 1919, pp. 145-146. Classifies bituminous surfaces into surface mats and wearing surfaces; method followed for each is given. Paper before Ont. Good Roads Assn.

Canada

Width of Provincial Highways, W. A. McLean. Can. Engr., vol. 36, no. 2, Jan. 9, 1919, pp. 131-133, 5 figs. Road sections proposed by Ontario Deputy Minister of Public Highway.

Concrete Roads

The Construction of Concrete Roads, William W. Cox. Contract Rec., vol. 33, no. 3, Jan. 15, 1919, pp. 52-53. Notes on drainage, preparation of subgrade, selection of materials, workmanship and prospection. Paper before Mich. State Good Roads Assn.

Cracking of Concrete Roads and Its Prevention by Reinforcing with Steel, W. B. Sawyer, Jr. Cement & Eng. News, vol. 31, no. 1, Jan. 1919, pp. 28-29. Expansion of concrete by change of temperature; change in moisture content; non-uniform bearing on sub-base; expansion or contraction of sub-base due to change in moisture content; placing reinforcing steel. From Western Eng.

Drainage

Drainage Methods and Foundations for County Roads, E. W. James, Vernon M. Peirce and Charles H. Moorefield. U. S. Department of Agriculture, bul. 724, Dec. 21, 1918, 86 pp., 33 figs. Discussion of important characteristics of different kinds of soils ordinarily encountered in highway construction; proper methods of draining roadbeds constructed of various kinds of soil and under different topographic conditions; explanation of how foundations may be designed to suit soil conditions, road surface and system of drainage.

Engineers, Highway

Engineers for Highway Work, John H. Mullen. Contract Rec., vol. 33, no. 3, Jan. 15, 1919, p. 48. Inadequate pay of highway engineers; qualifications of a highway engineer. From paper before Am. Assn. State Highway Officials.

French Roads

American Methods and Machinery Applicable to Construction and Maintenance of French Highways, Arthur H. Blanchard. Mun. Jl., vol. 46, no. 2, Jan. 11, 1919, pp. 23-32, 16 figs. Restoring of French roads that have been worn out by traffic or destroyed by enemy.

Heavy-Traffic Roads

Notes on Road Construction and Maintenance, Thomas Sawyer Bower. Quarry, vol. 24, no. 263, Jan. 1919, p. 18. Author's experience in regard to securing road which will stand abnormal traffic for long periods. Abstract of paper before Instn. Civil Engrs.

Minnesota Highways

Proposed Highway System for Minnesota. Good Roads, vol. 16, no. 26, Dec. 28, 1918, pp. 249-250, 1 fig. Description of 6000-mile system of main roads proposed by State Highway Department.

National Highways

A National Highway Policy and Plan, E. J. Mehren. Am. City, vol. 20, no. 1, Jan. 1919, pp. 1-5. Plea for selection, construction and maintenance by Federal Government of a national highway system that shall embrace entire country. From address before Joint Highway Congress.

Road Corrugation

Road Corrugation, Ernest Leonard Leeming. Surveyor, vol. 54, no. 1403, Dec. 6, 1918, p. 270. Probable causes; suggestions for preventing or alleviating it. Abstract of paper before Instn. Civil Engrs. Also in Times Eng. Supp., no. 530, Dec. 1918, p. 267.

San Francisco

Street Paving in San Francisco. Mun. Jl., vol. 46, no. 1, Jan. 4, 1919, pp. 1-3, 3 figs. Basalt blocks for heavy traffic, brick for steep grades, asphalt and bituminous concrete for easy grades. Methods of constructing base and wearing surface; grading streets; cost.

Subgrade

Methods for Subgrade Testing on Street Grading Work, E. Earl Glass. Am. City, vol. 20, no. 1, Jan. 1919, pp. 47-48, 2 figs. Use of two 8-ft. rods graduated to feet and tenths from middle as zero, fitted with spikes, and having adjustable targets.

Drainage and Preparation of Subgrade. Concrete Age, vol. 29, no. 3, Dec. 1918, pp. 10-13. Report of Committee on drainage and of subgrade, Nat. Congress on Concrete Road Building.

Wisconsin Highways

Marking and Mapping the Wisconsin Trunk Line Highway System, A. R. Horst. Good Roads, vol. 17, no. 2, Jan. 11, 1919, pp. 13-15, 3 figs. From a paper entitled The Underlying Principles Controlling the Laying Out, Marking and Maintaining of a State Trunk Highway System, presented at joint session of Am. Assn. State Highway Officials and Highway Industries Assn.

SANITARY ENGINEERING

Garbage

Methods of Garbage and Rubbish Collection and Disposal in Larger Cities. Contract Rec., vol. 33, no. 2, Jan. 8, 1919, pp. 32-34. Methods followed in Baltimore, Chicago, Cincinnati, Cleveland, Kansas City, Mo., Milwaukee, Minneapolis, New York, St. Louis and St. Paul.

Sewage-Plant Operation

Instructions for the Operation of State Sewage Plants. Contract Rec., vol. 33, no. 2, Jan. 8, 1919, pp. 35-37. Bulletin prepared by Bureau of Sanitary Engineers and issued by Texas State Board of Health.

Biological Purification of City Sewage (Die Klaeranlage der staedtischen Kanalisation in St. Gallen). Schweiz. Bauzeitung, vol. 72, no. 24, Dec. 14, 1918, pp. 231-233, 6 figs. Technical description of sewage purification plant for 60,000 inhabitants. The drip system used in conjunction with a small river. (To be concluded.)

Sewer Construction

Rideau River Intercepting Sewer, Ottawa, L. McLaren. Contract Rec., vol. 33, no. 2, Jan. 8, 1919, pp. 21-24, 9 figs. Design and construction of interceptor which will drain 1060 acres.

Some Sewer Construction Details. Mun. Jl., vol. 45, no. 26, Dec. 28, 1918, pp. 501-502, 2 figs. Laying a sewer above street grade; excavating and laying sewer in deep trench in sand and water.

WATER SUPPLY

Meters

Sizes of Service Meters, W. R. Edwards. Mun. Jl., vol. 46, no. 1, Jan. 4, 1919, pp. 4-5. Practices and experience of Passaic Water Co. in use of meters, specially in regard to desirable sizes. Paper before N. Y. Section, Am. Water Works Assn.

Pipe Maintenance

Lead Pipe Couplings, J. A. Jensen. Jl. Am. Water Works Assn., vol. 5, no. 4, Dec. 1918, pp. 407-411. Examples of water loss to municipality on account of service leaks occurring between water main and meter; results of experimental examination of conditions developing leaks.

Cold Weather and Mains in Duluth. Mun. Jl., vol. 46, no. 1, Jan. 4, 1919, pp. 6-7. Experience with freezing and thawing by electricity.

Water Main Cleaning in St. Louis. Mun. Jl., vol. 46, no. 1, Jan. 4, 1919, pp. 5-6, 4 figs. Methods and results in cleaning 50 miles of mains.

Dependable Power

DEPENDABLE POWER

Midwest Engine Company Products

Midwest—Diesel Engines
Midwest—Hvid Oil Engines
Midwest—Parsons Turbines (Reaction Type)
Midwest—Wait Turbines (Impulse Type)
Midwest—Hill Centrifugal and Reciprocating Pumps and Auxiliaries
Werkspoor Diesel American Licensees

MR. MILL OWNER—you know that it is impossible to secure any machinery that will not require some supervision in operation, but if you are on the lookout for apparatus that will give long and faithful service with a minimum of supervision, it will pay you to investigate Midwest products.

Take the Midwest pump and turbine shown here for example. They are constructed in the simplest possible manner, yet with the highest efficiency and the greatest rugged strength. You can put them in operation and run them for years with but the slightest amount of supervision.

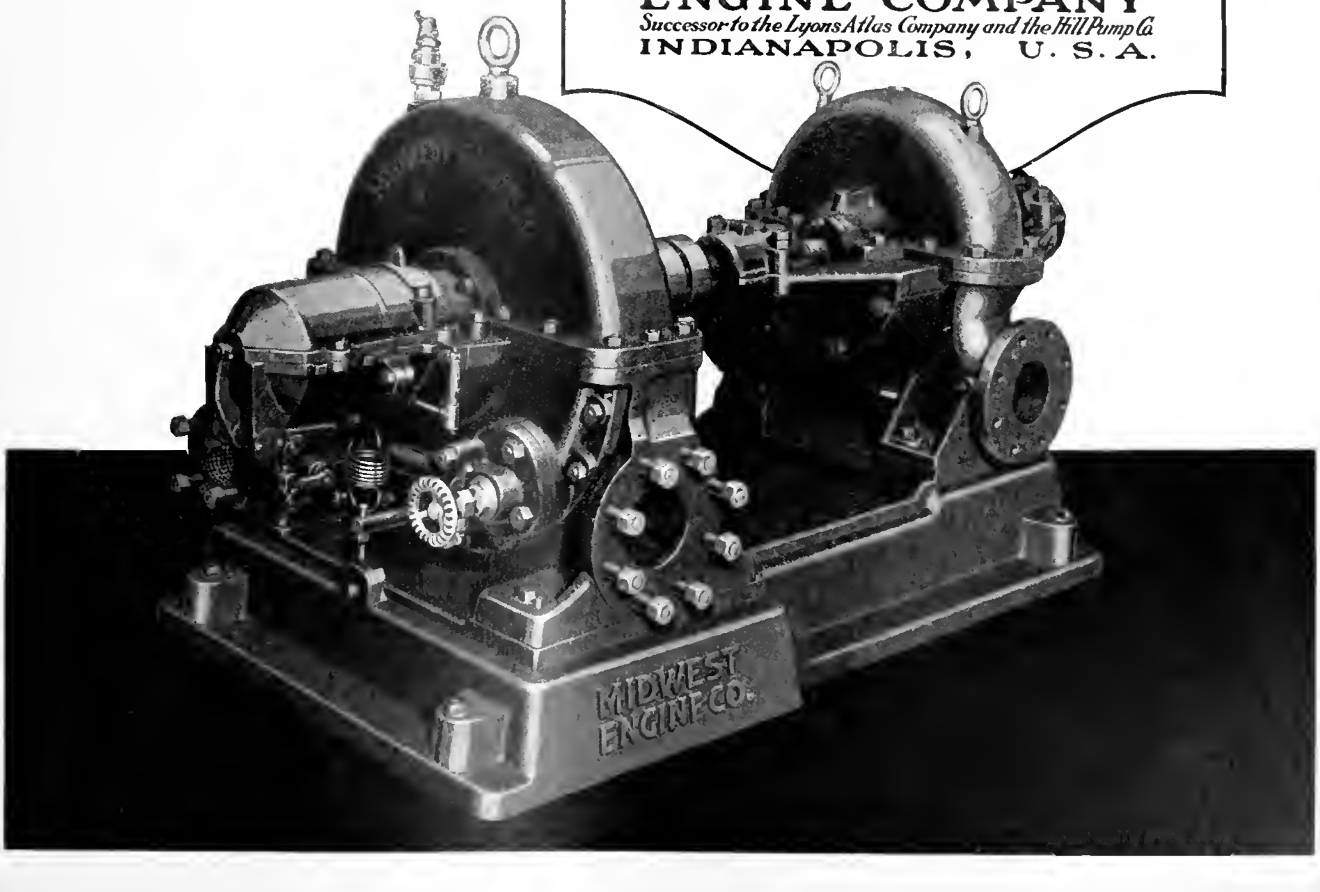
They comprise the least possible number of wearing parts, are so well balanced, both statically and dynamically, that there is absolutely no vibration. Particularly desirable where exhaust steam can be utilized for heating or cooking.

We stand behind every Midwest product to the limit; our Service Department is at your disposal at all times; and it is our creed that the sale begins rather than ends when the installation is made.

Midwest turbines are produced in all sizes from 5 H. P. to 1000 H. P.—pumps in all sizes and types from 1-inch to 42-inch.

Let our engineers assist you in solving your hydraulic problems. Quotations on any type steam turbine or pump on request.

MIDWEST
ENGINE COMPANY
Successor to the Lyons Atlas Company and the Hill Pump Co.
INDIANAPOLIS, U. S. A.



Reservoirs

Waterworks Operation: Maintenance of Reservoirs. Mun. Jl., vol. 45, no. 26, Dec. 28, 1918, pp. 506-507; vol. 46, no. 1, Jan. 4, 1919, pp. 10-12. Dec. 28: Features of maintenance of small reservoirs and of large impounding reservoirs, sodding and other treatment of embankments; Jan. 4: Causes of leakage from reservoirs, their location, stopping them by use of cement, asphalt, clay, etc. (To be continued.)

Construction Methods Employed in Building the New Intake and Remodeled Reservoirs of the Oshkosh, Wis., Water Works, T. B. Jorgensen. Cement & Eng. News, vol. 31, no. 1, Jan. 1919, pp. 26-27, 3 figs. Intake consists of 300 ft. of piping connecting shore line with suction well in filtration plant, and 1200 ft. of piping from shore line out in Lake Winnebago. It is constructed of 24-in. cast-iron piping.

Water Mains, Protection of

Protecting Water Mains, Fire Hydrants and Valves Against Freezing in Winnipeg, F. H. Hooper. Contract Rec., vol. 33, no. 1, Jan. 1, 1919, p. 3. Paper before Nat. Fire Protection Assn.

Water Purification

St. Louis Water Purification Plant. Mun. Jl., vol. 45, no. 26, Dec. 28, 1918, pp. 503-505. Amounts and prices of chemical used; methods and results of operation; cleaning filter sand; effects of chemicals on apparatus; itemized cost of operating plant.

Water Storage

Advantages and Disadvantages of the Storage of Water, Melville C. Whipple. Contract Rec., vol. 33, no. 2, Jan. 1, 1919, pp. 6-7. Claims that storage of surface water affords effectual means for safeguarding its hygienic quality and indicates means to overcome increase of color and production of tastes and odors from growth of microscopic organisms.

WATERWAYS

Georgian Bay Canal

The Georgian Bay Canal, J. J. Bell. Engineer, vol. 126, no. 3286, Dec. 20, 1918, pp. 527-528, 8 figs. Description of proposed Canadian canal connecting Georgian Bay with the St. Lawrence at Montreal.

Interior Navigation

Notes in Interior Navigation of Various Countries (Apuntes sobre la navegacion interior en algunos paises), Carlos Mendoza. Revista de Obras Publicas, year 66, nos. 2256 and 2257, Dec. 19 and 26, 1918, pp. 625-630 and 637-640. Dec. 19: Economical aspect of inland water transportation and railway construction in development of present network of canals and navigable rivers in France; Dec. 26: Data on navigable courses in England, United States, Germany and Italy. (Concluded.)

Italy

The Port of Ostia Nuova, near Rome, and the Railway from Ostia to Rome (Le port d'Ostia Nuova, près de Rome et le chemin de fer d'Ostia à Rome). Génie Civil, vol. 74, no. 1, Jan. 4, 1919, pp. 12-13, 2 figs. Project to build navigable canal connecting Rome and Ostia Nuova.

U. S. Rules for Water Transportation

Rivers. General Rules and Regulations Prescribed by the Board of Supervising Inspectors as Amended at Board Meeting of January 1918, and further Amended by Action of Executive Committee of the Board of Supervising Inspectors, Meetings of March 15, April 3, May 11, June 5, August 5, and September 24, 1918. Department of Commerce, Steamboat-Inspection Service, form 801D, Nov. 19, 1918, 145 pp. 5 figs. Concerning boilers, attachments, boats, rafts, fire apparatus, ferryboats, barges, lifeboats, steam pumps, safety valves, etc.

MUNICIPAL ENGINEERING

Town Planning

Town-Planning in New Zealand, A. G. Waller. Jl. Am. Inst. Architects, vol. 6, no. 12, Dec. 1918, pp. 567-577. Résumé of town-planning bill; conditions of trade, wealth and production in New Zealand; significance of town-planning in architectural developments.

Relation of the Curve to Town-Planning, H. L. Seymour. Can. Engr., vol. 36, no. 2, Jan. 9, 1919, pp. 119-121, 4 figs. Discussion of methods employed in laying out curves for streets or lot lines.

Mining Engineering

BASE MATERIALS

Rock Quarrying

Rock Quarrying for Cement Manufacturing, Oliver Bowles. Stone, vol. 40, no. 1, Jan. 1919, pp. 19-21, 2 figs. Efficiency and safety under modern conditions of operation. From Bureau of Mines bulletin.

COAL AND COKE

Coal Oxidation and Ignition

The Oxidation and Ignition of Coal, Richard Vernon Wheeler. Jl. Chem. Soc., vols. 113 and 114, no. 674, Dec. 1918, pp. 945-955, 2 figs. Account of work carried out during past nine years by British Coal Dust Experiments Committee, Min. Assn. Great Britain. Hypothesis is advanced that reaction responsible for self-heating of coal is mainly attachment of oxygen to molecules of high carbon content, and subsidiary to this, interaction oxygen thus loosely held, by carbon-like molecules, and other atoms or those molecules, or other portions of coal conglomerate.

Coal Production

Coal—Now and Next Year, C. E. Lesher. Coal Age, vol. 15, no. 3, Jan. 16, 1919, pp. 99-104, 4 figs. Statistics of production and consumption.

Coke-Oven Gas

Washing Light Oil Fractions from Coke Oven Gas, F. D. Schreiber. Gas Age, vol. 43, no. 1, Jan. 1, 1919, pp. 22-24, 1 fig. Suggestions from general foreman of benzol plant.

Coke Plant Producing Gas for Domestic Purposes. Gas Age, vol. 43, no. 1, Jan. 1, 1919, pp. 11-12, 3 figs. Example of by-product coking practice. Plant consists of 65 Koppers cross-regenerative ovens (12¼ tons) with capacity of 1200 tons coal per day and is complete for recovery of gas, tar, ammonia and benzols.

Coke-Oven Gas and the Demand for Cheap Fuel. Gas Age, vol. 43, no. 1, Jan. 1, 1919, pp. 16-17. Extent of coke production in ovens and in beehive ovens; importance of metering gas.

Chester Producer Fired By-Product Coke Ovens, J. D. Shattuck. Gas Age, vol. 43, no. 1, Jan. 1, 1919, pp. 7-10, 6 figs. Operation of Philadelphia Gas & Elec. Co. plant for production of city gas and also for recovery of by-products.

Coke Ovens

Economic Considerations in Coke Oven Practice, W. Colquhoun. Colliery Guardian, vol. 116, no. 3020, Nov. 15, 1918, pp. 1022-1024. From paper before Midland Inst. of Civ. Min. and Mech. Engs., Nov. 1918. Also in Iron & Coal Trades Rev., vol. 97, no. 2647, Nov. 15, 1918, pp. 541-543.

Change in Beehive Coke Oven Construction Due to Mechanical Operation, George W. Harris. Coal Age, vol. 15, no. 2, Jan. 9, 1919, pp. 44-48, 12 figs. Details of coke ovens for mechanical operation.

A New Coke Oven Installation. Engineer, vol. 126, no. 3282, Nov. 22, 1918, pp. 430-432, 5 figs. Description of battery of thirty-seven 12-ton Semet-Solvay coke ovens with washer and by-product recovery plant at one of plants of Newton, Chambers & Co., Ltd.

Economic Considerations in Coke Oven Practice, W. Colquhoun. Gas World (Coking Section), vol. 69, no. 1794, Dec. 7, 1918, pp. 19-20. Deficiencies in present application of heat necessary to distil coal; advantages of hot direct-recovery process. Paper before Midland Inst. Min. Engrs.

Republic By-Product Coke Plant at Youngstown. Gas Age, vol. 43, no. 1, Jan. 1, 1919, pp. 13-15, 5 figs. Brief description of by-product coke-oven installation of 143 Koppers ovens, producing gas and coke for use in steel manufacture.

Plant of the Seaboard By-Product Coke Company, D. MacArthur. Gas Age, vol. 43, no. 1, Jan. 1, 1919, pp. 1-6, 9 figs. Oven installation consists of 165 Koppers ovens subdivided into three units. Daily capacity is 3000 tons of coal, yielding 2200 tons coke, 16½ million cubic feet surplus gas of 610 B.t.u. quality, 75,000 lb. ammonium sulphate, 24,000 gal. tar and 10,000 gal. light oil. (To be continued.)

Insulation for By-Product Coke Ovens, P. A. Boeck. Gas Age, vol. 43, no. 1, Jan. 1, 1919, pp. 24-26, 5 figs. How insulating bricks are placed in wall; heat gradient and saving due to heat insulation; advantages of insulation.

Rail Transportation

Railroad Readjustment Problems Confront Coal Operators, John Callahan. Coal Trade Jl., year 51, no. 3, Jan. 15, 1919, pp. 51-52. How mining is affected by transportation control as well as by maintenance or modifications of existing regulations.

ORE DRESSING

Tube and Ball Mills

Notes on Ore Dressing, A. W. Allen. Eng. & Min. Jl., vol. 107, no. 2, Jan. 11, 1919, pp. 100-102. Efficiency of tube mills; progress in ball-milling practice.

GEOLOGY AND MINERALOGY

Earth Movements

Earth Movements. Jl. Chem. Metallurgical & Min. Soc. S. A., vol. 19, no. 1, Oct. 1918, pp. 63-66. Analysis of probable causes which operated in movement of ground at Great Boulder mine. From Jl. Chamber of Mines of W. Australia.

Igneous Differentiation

A Type of Igneous Differentiation, Frank F. Grout. Jl. Geol., vol. 26, no. 7, Oct-Nov., 1918, pp. 626-658, 12 figs. Rocks of Duluth gabbro lopolith are found to fall into two series, one related to gabbro family, other more closely to granites.

Manganese Dioxide Banding

Rythmic Banding of Manganese Dioxide in Rhyolite Tuff, W. A. Tarr. Jl. Geol., vol. 26, no. 7, Oct-Nov. 1918, pp. 610-617, 5 figs. Explains origin of eccentric structures of manganese dioxide found near Tucson, Ariz., by manganese dioxide being derived from mineral located at nucleus of structure and being precipitated in successive rings by rhythmic precipitation following mingling of outwardly moving manganese solution with one of oxidizing character.

Radiolarian Charts

The Radiolarian Cherts of the Franciscan Group, E. F. Davis. Univ. Cal. Publications, Bul. Dept. Geol., vol. 11, no. 3, Dec. 23, 1918, pp. 235-432, 30 figs. Results of investigation to determine their origin.

Rock Diagrams

A Form of Multiple Rock Diagrams, Frank F. Grout. Jl. Geol., vol. 26, no. 7, Oct-Nov. 1918, pp. 622-625, 3 figs. Modification of Adams' method. Individual rock diagrams are not plastered but clamped into position leaving them free for rearrangement as they are studied from various points of view.

Tear Figures and Minerals

Tear-Figures on Certain Minerals, Mikio Kuhara. Memoirs College of Eng., Kyoto Imperial Univ., vol. 2, nos. 2 and 3, July and Nov. 1918, pp. 53-62 and 71-82, 45 figs. July: Characteristics on tear-figures on aragonite, alum and borax; Nov.: Characteristics on tear-figures on minerals belonging to tetragonal and triclinic systems, wulfenite and copper-sulphate crystals were selected as representatives of these systems.

IRON

Belcher Islands' Deposits

Iron Deposits on the Belcher Islands, Hudson Bay, E. S. Moore. Monthly Bul. Can. Min. Inst., no. 82, Feb. 1919, pp. 196-206, 4 figs. Topographic features and geology; photomicrographs of granules from iron field; results of analysis of sample.

Production

World's Division of Iron Analyzed, A. J. Hain. Iron Trade Rev., vol. 64, no. 1, Jan. 2, 1919, pp. 28-32, 3 figs. Pig-iron and steel production in United States, United Kingdom, France and Germany for years 1913-1918.

COPPER

Kennecott District

Mining Copper at Kennecott, Alaska. Min. & Sci. Press, vol. 118, no. 2, Jan. 11, 1919, pp. 53-56, 3 figs. Mining possibilities.

Mineral Determination

Sulphur Dioxide Method for Determining Copper Minerals in Partly Oxidized Ores, Charles E. Van Barneveld and Edmund S. Leaver. Department of Interior, Bur. of Mines, tech. paper 198, 14 pp., 1 fig. Sources of error in sulphuric acid method and ammonia method for selective determination of copper minerals; procedure in sodium tartrate method; sulphur dioxide method; results of leaching chalcocite and chalcopyrite with 5 per cent solution of different reagents; results with four methods compared.

Utah

The Utah Copper Enterprise—IX, T. A. Rickard. Min. & Sci. Press, vol. 117, no. 26, Dec. 28, 1918, pp. 853-860, 9 figs. Smelting of concentrate at Garfield smelter of Am. Smelting & Refining Co.

LEAD

Hydrometallurgy

Innovations in the Metallurgy of Lead, Dorsey A. Lyon and Oliver C. Ralston. Department of Interior, Bur. of Mines, bul. 157, 1918, 176 pp., 13 figs. Application of new hydrometallurgical and other methods. Results of experiments conducted by Salt Lake City station of Bur. of Mines in coöperation with department of metallurgical research, Univ. of Utah.

Smelting

Metallurgy of Lead, H. O. Hofman. Eng. & Min. Jl., vol. 107, no. 2, Jan. 11, 1919, pp. 88-90. Lead smelting practice; modern silver-lead smeltery.

MAJOR INDUSTRIAL MATERIALS

Manganese

Electric Smelting on the Pacific Coast, W. L. Morrison. Jl. Elec., vol. 42, no. 2, Jan. 15, 1919, pp. 67-68. States that while absence of cheap power precludes general development of electric furnace, nevertheless there is real opportunity in electric smelting of silicon manganese.

Metallurgical Investigations During 1918, Van H. Manning. Blast Furnace, vol. 7, no. 1, Jan. 1919, pp. 65-67. Production of ferromanganese; smelting low-grade manganese ores in electric furnace; use of low-grade iron; problems studied by Bureau of Mines.

Manganese Deposits of East Tennessee—II, G. W. Stose and F. C. Schrader. Resources of Tennessee, vol. 8, no. 4, Oct. 1918, pp. 235-324, 14 figs. Report prepared under coöperative agreement between State Geol. Survey and U. S. Geol. Survey.

Nickel

A Process for Electrolytically Refining Nickel, Geo. A. Guess. Gen. Meeting Am. Electrochem. Soc., Apr. 3-5, 1919, advance copy, paper 2, pp. 9-12. Impure nickel containing copper and iron is used as anode; both iron and copper go into solution, but copper is precipitated by keeping powdered calcium carbonate suspended in electrolyte; cathode is enclosed in canvas bag; glue is used in solution.

Zinc

Metallurgy of Zinc, W. E. Ingalls. Eng. & Min. Jl., vol. 107, no. 2, Jan. 11, 1919, pp. 87-88. Roasting; distillation furnaces; distilling practice.

Foreign Zinc-Smelting Capacities and Prospects, W. R. Ingalls. Eng. & Min. Jl., vol. 107, no. 5, Feb. 1, 1919, pp. 227-228. Refers particularly to England, Australia, Belgium and Silesia.

MINES AND MINING

Cars, Mine

Standardization of Mine Cars in Metal Mines, R. M. Raymond. Eng & Min. Jl., vol. 107, no. 5, Feb. 1, 1919, pp. 220-224, 9 figs. Paper read at Seventh Annual Safety Congress, Nat. Safety Council.

Cement Gun

Use of the Cement Gun in a Bituminous Coal Mine, M. S. Sloman. Mine & Quarry, vol. 11, no. 1, Nov. 1918, pp. 1092-1095, 2 figs. Results of United Coal Corporation said to prove that a cement coating properly applied will form permanent barrier to action of weathering on roofs susceptible to air slacking; gives cost figures.

Drilling

The Technique of Diamond-Drilling, J. A. MacVicar. Min. Mag., vol. 20, no. 1, Jan. 1919, pp. 18-25. History and utility of the diamond-drill; patent specifications of Leschot diamond-drilling apparatus; operations followed in process of drilling; recent uses of diamond-drills in testing of foundations for dam sites. Paper read before Cornish Inst. Engrs.

Hammer Drills—Their History, Design and Operation, Henry S. Potter. Jl. S. A. Instn. Engrs., vol. 17, no. 4-5, Nov.-Dec. 1918, pp. 68-80, 17 figs. Refers especially to the popular jack hammer type. (To be concluded.)

The Hand Hammer Drill, James P. Cotter. Monthly Bul. Can. Min. Inst., no. 82, Feb. 1919, pp. 207-211. Purpose in applying water and air to bottom of drill hole while drilling; uses of hammer drill in coal mines.

Hydraulic Stowing

Primary Considerations in Hydraulic Stowing, C. A. John Hendry. Colliery Guardian, vol. 116, no. 3016, Oct. 18, 1918, pp. 805-807, 14 figs. From paper before Geol. and Min. Soc. of India.

Inspection, Idaho

Mining in Idaho in 1918, R. N. Bell. Eng. & Min. Jl., vol. 107, no. 5, Feb. 1, 1919, pp. 236-238. Account of State inspection of mines.

Laws

Collection of Laws, Decrees, Resolutions and Other Acts Concerning Mines, Quarries, Sources of Mineral Waters, Steam Apparatus and Railroad Exploitation (Recueil de lois, décrets, arrêtés et autres actes concernant les mines, les carrieres, les sources d'eaux minerales, les appareils à vapeur et l'exploitation des chemins de fer). Annales des Mines, Partie Administrative, series 11, vol. 7, 1918, pp. 81-185. Documents of second quarter of 1918 issued by Ministry of Public Works, France.

Prospecting

Hydraulic Prospecting at the Rooiberg Tin Mines, E. R. Schoch. Jl. S. A. Instn. Engrs., vol 17, no. 4-5, Nov.-Dec., 1918, pp. 61-67, 9 figs. Surface prospecting by means of hydraulic jets or monitors on level ground with artificially conserved return water.

Utah

Mining in Utah in 1918, Edward R. Zalinski. Eng. & Min. Jl., vol. 107, no. 4, Jan. 25, 1919, pp. 178-183.

1918 British Columbia

Mining in British Columbia in 1918, Robert Dunn. Eng. & Min. Jl., vol. 107, no. 2, Jan. 11. 1919, pp. 110-111.

1918 U. S.

General Review of Mining in the United States in 1918. Eng. & Min. Jl., vol. 107, no. 2, Jan. 11, 1919, pp. 103-107.

See also MECHANICAL ENGINEERING, Handling of Materials (Coal Handling, Coke.)

MINOR INDUSTRIAL MINERALS

Graphite

Alabama Graphite in 1918, W. F. Prouty. Eng. & Min. Jl., vol. 107, no. 4, Jan. 25, 1919, pp. 194-195. Processes in milling; classification of washers; costs.

Monazite

Monazite as a Source of Incandescent Light-ing Material, Sydney J. Johnstone. Gas World, vol. 69, no. 1794, Dec. 7, 1918, pp. 350-351. Sources and history of mineral monazite from which are obtained the rare earths composing luminous portion of incandescent gas mantle. From Jl. Soc. Chem. Indus.

Molybdenum

Molybdenum Within the Empire, Sydney J. Johnstone. Jl. Soc. Chem. Indus., vol. 37, no. 23, Dec. 16, 1918, pp. 448R-450R. Statistics of world production and particularly of progress in mines throughout British Empire.

Tungsten

The Tungsten Industry in 1918, Geo. J. Young. Eng. & Min. Jl., vol. 107, no. 2, Jan. 11, 1919, pp. 78-80. Difficulties of mining; inconvenience of not having standard specifications for buying tungsten ores; domestic and total world production figures.

Tungsten and the War, Julius L. F. Vogel. Min. Mag., vol. 20, no. 1, Jan. 1919, pp. 12-17. Qualities possessed by high speed tungsten steel; development of tungsten industry in Great Britain; manufacture of tungsten.

The Occurrence, Chemistry, Metallurgy and Uses of Tungsten, with Special Reference to the Black Hills of South Dakota, J. J. Runner and M. L. Hartmann. South Dakota School of Mines, bul. 12, Departments of Geol. & Chem., Sept. 1918, pp. 1-159 and 257-262, 20 figs. Parts relating to deposits of Black Hills are the result of field work and laboratory research of authors.

A Bibliography of Tungsten Mines, Louis Hartmann. South Dakota School of Mines, bul. 12, Departments of Geol. & Chem., Sept. 1918, pp. 160-255 and 262-264.

Tungsten and Molybdenum

Manufacture of Tungsten and Molybdenum, Paul McJunkin. Am. Mach., vol. 50, no. 3, Jan. 16, 1919, pp. 99-100. How tungsten wire is made; coiling the spiral; properties; applications; use of tungsten disks in wireless apparatus; development of X-ray; tungsten wire data.

Vanadium

Analysis of Vanadium in the Ferrovanadiums (Método de valoración del vanadio en los ferrovanadios), Vicente García Rodeja. Boletín de Minas, vol. 10, nos. 7-9, Sept. 30, 1918, pp. 122-128. Survey of methods in use; special reference to Slavig method by treatment with nitric and hydrochloric acids; fusion method of Pinerúa (reagent is sodium bi-oxide).

OIL AND GAS

Crude Oil Production

Production of Crude Oil at New High Level. Automotive Industries, vol. 40, no. 3, Jan. 16, 1919, pp. 154-157, 2 figs. Exports of all mineral-oil products except kerosene show steady increase for 21 years.

The Passing of Petroleum. Engineering, vol. 106, no. 2762, Dec. 6, 1918, pp. 633-635, 3 figs. Review of present situation.

Petroleum — A Resource Interpretation, Chester G. Gilbert and Joseph E. Pogue. Jl. Soc. Automotive Engrs., vol. 4, no. 2, Feb. 1919, pp. 100-110, 4 figs. Discussion of available resources and their conservation.

Gasoline

Making Gasoline from Gas. Motor Boating, vol. 23, no. 1, Jan. 1919, pp. 13-14 and 47, 2 figs. General arrangement of apparatus employed in process of recovering gasoline from casing-head gas.

Determining Gasoline in Natural Gas, W. P. Dykema and Roy C. Neal. Automotive Industries, vol. 40, no. 2, Jan. 9, 1919, pp. 57-59, 2 figs. Method evolved at Bartlesville Experiment Station, Bureau of Mines.

Testing Gas for Its Gasoline Content, W. P. Dykema and Roy C. Neal. Oil and Gas Jl., vol. 17, no. 32, Jan. 10, 1919, pp. 42 and 44, 2 figs. Absorption apparatus developed by Bureau of Mines experts.

Mexico

Mexico as a Source of Petroleum and Its Products, R. De Golyer. Jl. Soc. Automotive Engrs., vol. 4, no. 2, Feb. 1919, pp. 74-76. Estimates of reserves in Mexican oil fields; development since 1910; present conditions.

Oil Recovery

Production of Oil from Mineral Sources, F. Mollwo Perkin. Gas Jl., vol. 144, no. 2902, Dec. 24, 1918, pp. 658-660. When to use high or low temperature for carbonizing bituminous material. Paper read before Instn. Petroleum Technologists.

Petroleum Industry

Some General Observations on the Petroleum Industry, V. H. Manning. Jl. Soc. Automotive Engrs., vol. 4, no. 1, Jan. 1919, pp. 35-38, 2 figs. Coöperation between Bur. of Mines and petroleum industry; possible technical research work; utilization of oil shales; foreign supply situation. From address by Director, Bur. of Mines, before Reconstruction Conference of Indus. War Service Committees.

Shale

Commercial Possibilities of Oil Shale, Harry J. Wolf. Eng. & Min. Jl., vol. 107, no. 5, Feb. 1, 1919, pp. 217-219, 2 figs. Oil-bearing shales in Colorado and Utah and their present development; methods of mining and milling, comparison with Scottish shale deposits.

Water, Shutting Off

Methods of Shutting Off Water in Oil and Gas Wells, F. B. Tough. Department of Interior, Bur. of Mines, bul. 163, 122 pp., 27 figs. Summarizes existing knowledge of methods and devices for protecting oil or gas sands from encroachment of water; California laws relating to protection of natural resources of petroleum and natural gas flow. Also in Water & Gas Rev., vol. 29, no. 7, Jan. 1919, pp. 28-29.

One of the Problems Involved in Excluding Water from Oil or Gas Wells, F. B. Tough. Water & Gas Rev., vol. 29, no. 7, Jan. 1919, pp. 28-29. Making watertight joint between string of casing and wall of hole at impervious stratum above productive sands and below water horizons; formulæ for collapsing pressures of modern lay-welded bessemer-steel tubes.

PRECIOUS MINERALS

Gold

The Value of Gold in the Economic System, Henry Strakosch. Min. & Sci. Press, vol. 117, no. 26, Dec. 28, 1918, pp. 861-863. Classifies gold mines and suggests means for stimulating production of gold.

The Gold Problem. Min. Mag., vol. 20, no. 1, Jan. 1919, pp. 28-31. Report of the British Government committee, appointed to investigate problem of maintaining output of gold in face of increasing costs at mines.

822 POWER Vol. 48, No. 23

Coal Saving by the Scientific Control of Steam Boiler Plants*

BY D. BROWNLIE

THE author has been associated for about ten years with the investigation on scientific lines of the working of every description of steam-boiler plant, and in the present article it is proposed to give the average figures for 250 typical steam boiler plants, with the object of supplying accurate data as to the tremendous national economy that can be effected by the adoption of scientific methods in the boiler-house.

In the burning of coal for the generation of steam, the loss because of lack of scientific methods is hardly realized and, apart from the national point of view, offers to the individual firm a means of most substantial economy in running expenses.

Economizers—Out of the 250 plants, 155 were fitted with economizers, the other 95 plants having no means of utilizing the waste heat from the boiler flues.

Taking the 155 plants fitted with economizers, the average saving is 11.4 per cent. of the coal bill. The highest figure found was 19 per cent. on a cotton-mill plant. The ordinary figure obtained on a well-managed plant is 15 to 20 per cent. saving, depending on the conditions.

Power
December 3, 1918

Engineers sometimes question the claims of the manufacturers regarding the savings made by their apparatus.

GREEN'S FUEL ECONOMIZERS

do show large savings and we quote above some very interesting figures by Mr. Brownlie. These are the result of ten years' experience and detailed tests on 250 steam plants.

We think you will agree with us that these fully substantiate the statements that we have made in our advertising.

Our Engineers will be glad to tell you what savings Economizers can make in your plant.

THE GREEN FUEL ECONOMIZER Co.
BEACON, N.Y.

Gold and Silver

Metallurgy of Gold and Silver, A. W. Allen. Eng. & Min. Jl., vol. 107, no. 2, Jan. 11, 1919, pp. 92-96. Amalgamation practice; reinstatement of charcoal as precipitant; South African metallurgical progress; gold extraction with colloidal carbon; refining gold bullion; sodium sulphide in cyaniding.

RARE MINERALS

Radium

How Radium-Bearing Ore Is Mined, Wallace T. Roberts. Min. & Sci. Press, vol. 118, no. 1, Jan. 4, 1919, p. 30, 3 figs.; Mine & Quarry, vol. 11, no. 1, Nov. 1918, pp. 1106-1110, 8 figs. Nov.; Prospecting carnotite areas in Colorado; Jan. 4; Methods of prospecting followed by Colorado companies.

Radium: Its Properties and Occurrence in Nature—II, Richard B. Moore. Metal Rec. & Electroplater, vol. 4, no. 11, Dec. 1918, pp. 391-393. History of metal; location of principal ores and method of working each; present uses and future possibilities; mesothorium as substitute.

New Minerals

Review of New-Mineral Species (Revue des espèces minérales nouvelles), P. Gaubert. Bulletin de la Société Française de Minéralogie, vol. 41, nos. 4-5-6, Apr-June 1918, pp. 93-96. Occurrences of crestmoreite, riversideite, katoptrite, ektropite, and flokite, pp. 117-130. Occurrences of crandallite, leifite, griffithite, mullanite, tetarkaite, didymolite, angaralite, arseno-bismite, arseno-ferrite, heliodore, creedite, sulphated cancrinite, cebollite, pintadoite, uvanite, hogbomite, minasragrite, aurobismuthinite, stibiobismuthinite.

Uncommon Ores

Uncommon Ores and Metals, H. C. Meyer. Eng. & Min. Jl., vol. 107, no. 2, Jan. 11, 1919, pp. 124-125. Uses and demand of palladium, selenium, strontium ore, thorium ore, titanium, uranium and zirconium.

TIN

Conservation

Symposium on the Conservation of Tin. Metal Rec. & Electroplater, vol. 4, no. 11, Dec. 1918, pp. 387-390 and 403. Methods by which tin can be saved and its use reduced; tin alloys; bearing metals, soldiers, babbitts, bronzes and their substitutes.

VARIA

Laws, Mining

Mining Law and Economics. Minerals, Mines and Quarries, David Bowen. Quarry, vol. 24, no. 263, Jan. 1919, pp. 5-7. Review of authoritative definitions of mineral, ore, mine and quarry with reference to English and continental European legal decisions establishing scope of signification.

Minerals, International Control

International Control of Minerals, C. K. Leith. Department of Interior, U. S. Geol. Survey, Mineral Resources of U. S., 1917—part 1, Dec. 31, 1918, pp. 7a-16a. Movement of minerals under pre-war conditions of international trade; possibility of post-war international control; specific plans of international control of minerals; position of U. S.; general conclusions from standpoint of U. S.

Production, U. S. for 40 Years

40 Years of Domestic Metal Production. Automotive Industries, vol. 40, no. 3, Jan. 16, 1919, pp. 180-181, 2 figs. Steady increases shown throughout last 50 years; efforts being made to increase production.

Metallurgy

ALUMINUM

Alloys

Aluminum and Its Light Alloys—IV, Paul D. Merica. Metal Rec. & Electroplater, vol. 4, no. 11, Dec. 1918, pp. 384-386. Importances of these light-weight metals for motor and aircraft construction; metallography of commercial aluminum; chemical and physical properties at high and low temperatures; tensile properties of zinc-aluminum alloys. (To be continued.)

Analysis

The Analysis of Aluminum Alloys and Metallic Aluminum, J. J. Fox, E. W. Skelton and F. R. Ennos, Jl. Soc. Chem. Indus., vol. 37, no. 24, Dec. 31, 1918, pp. 328T-333T. Methods writers have found suitable for general work. Reagents used are a 10 per cent solution of pure sodium hydroxide, and nitrosulphuric acid made by mixing 300 cc of concentrated sulphuric acid with 300 cc of water, cooling, and adding 200 cc of pure nitric acid.

Analysis of Hard Aluminum Alloys (Analyse des alliages durs d'aluminium), A. Travers. Chimie & Industrie, vol. 1, no. 7, Dec. 1, 1918, pp. 708-711. Methods in use at Creusot works for quantitative analysis of zinc, aluminum, magnesium and copper in light alloys.

Dust, Inflammability of

The Inflammability of Aluminum Dust, Alan Leighton. Department of Interior, Bur. of Mines, Tech. Paper 152, 15 pp. Review of available literature; experimental work; properties affecting explosibility; precautions to be observed.

Metallography

The Metallography of Aluminum, Robert J. Anderson. Jl. Franklin Inst., vol. 187, no. 1, Jan. 1919, pp. 1-47, 65 figs. Discussion of amorphous theory and plastic deformation; observations on grain-growth phenomena; micrographs of various forms of aluminum, cast, worked, and annealed; annealing and recrystallization of aluminum which has undergone plastic deformation; experimental investigation of exaggerated grain growth in aluminum; process of polishing and etching aluminum microsections preparatory to microscopic examination.

BLAST FURNACES

Car Dumper

Movable Car Dumper with Rotary Cradle, A. F. Case. Blast Furnace, vol. 7, no. 1, Jan. 1919, pp. 60-61, 2 figs. Machine located near storage yard for handling ore and limestone at blast-furnace plant. Said to be capable of unloading 30 to 35 cars an hour.

Gas Operation

Blast Furnace Plant Blows in First Stack. Blast Furnace, vol. 7, no. 1, Jan. 1919, pp. 50-56, 6 figs. Installation of combined blast-furnace gas and chain-grate stokers firing on heavy mill loads. Gas cleaning designed to keep both stoves and washer clean and in operation throughout entire blast.

Potash

Potash Content of Blast Furnace Charges, N. H. Gellert. Iron Age, vol. 103, no. 6, Feb. 6, 1919, pp. 355-356. Alabama iron ores and foreign manganese ores contain the most; potash in the burden of American furnaces.

Slag

Widening Demand for Blast Furnace Slag, Clarence E. Wright. Iron Age, vol. 103, no. 4, Jan. 23, 1919, pp. 241-243, 5 figs. Uses to which it has been put; a possible \$20,000,000 income to industry.

Thickener

Dorr Thickener in Blast-Furnace Field. Iron Age, vol. 103, no. 2, Jan. 9, 1919, pp. 112-115, 3 figs. Used in clarification of washer discharge water it eliminates troublesome problems and yields valuable product; simplicity of operation.

COPPER

Boron Deoxidizer

The Boronic Deoxiding of Copper, James Scott. Foundry Trade Jl., vol. 20, no. 203, Nov. 1918, pp. 598-599, 3 figs. Experimental research of procedure followed by boronic compounds when acting on copper and its alloys.

Bronze Heat Treatment

Effect of Heat Treatment on Bronze, F. F. Hansen and O. A. Knight. Iron Age, vol. 103, no. 6, Feb. 6, 1919, pp. 347-349, 12 figs. Characteristics disclosed by Brinell hardness tests and photomicrographs; quenching and drawing give greater hardness than quenching alone.

Bronze Inclusions

Nonmetallic Inclusions in Bronze and Brass, G. F. Comstock. Foundry, vol. 47, no. 318, Feb. 1919, pp. 79-83, 21 figs. From a paper presented at the October meeting of the Institute of Metals Division of the Am. Inst. of Min. Engrs.

Heap Leaching

Metallurgy of Copper, Arthur L. Walker. Eng. & Min. Jl., vol. 107, no. 2, Jan. 11, 1919, pp. 90-92. Heap-leaching experiments being conducted in southwestern copper centers; Anaconda fume-dust collector.

FERROALLOYS

Production

Ferroalloys Production Stimulated. Iron Trade Rev., vol. 64, no. 1, Jan. 2, 1919, pp. 118 and 120. Imports and domestic production of manganese alloys; imports of manganese ore; stimulation in production of spiegeleisen.

1918

Ferro-Alloys in 1918, Robert J. Anderson. Eng. & Min. Jl., vol. 107, no. 2, Jan. 11, 1919, pp. 83-86. Technical advances in metallurgical processes.

FLOTATION

Flotation Machines

The Flotation Process, A. W. Allen. Eng. & Min. Jl., vol. 107, no. 2, Jan. 11, 1919, pp. 97-100. New flotation machines; progress in selective flotation; development of Galena flotation; separate treatment of colloids.

IRON AND STEEL

Blast Furnaces

See preceding column.

Case-Hardening

Ancient and Modern Carbonizing Methods, Theodore G. Selleck. Am. Drop Forger, vol. 5, no. 1, Jan. 1919, pp. 7-12, 4 figs. Discusses use of compounds for case-hardening and describes improved methods. Uniform results secured by preheating.

Chrome Steel

Physical Qualities of High Chrome Steel, L. R. Seidell and G. J. Horvitz. Iron Age, vol. 103, no. 5, Jan. 30, 1919, pp. 291-294, 4 figs. Relation between hardness and double carbides in solution; critical temperatures; maximum tensile strength and ductility.

Density

Specific Density of Steel, H. E. Roerr. Iron Age, vol. 103, no. 3, Jan. 16, 1919, p. 184, 1 fig. Extent to which forging compresses or consolidates metal. From paper for Feb. meeting of Am. Inst. of Min. Engrs., New York.

Furnaces

Pulverized Coal for Metallurgical Furnaces, Charles E. Longenecker. Iron Age, vol. 103, no. 6, Feb. 6, 1919, pp. 351-352, 1 fig. Greater efficiency claimed for furnaces of correct design; continuous service more certain; average combustion figures for different furnace types.

Germany

The Future of the German Iron Industry, H. Müngesheimer. Cassier's Eng. Monthly, vol. 54, no. 6, Dec. 1918, pp. 340-341. Opinion of General Director of Gelsenkirchen Steel and Iron Works.

Heat Treatment and Grain Size

Grain Limits in Heat-Treated Alloy Steels, R. S. Archer. Iron Age, vol. 103, no. 6, Feb. 6, 1919, pp. 366-367, 12 figs. New etching process which defines the crystals, boundaries and assists in detecting faulty heat treatment. From paper for February meeting of American Institute of Mining Engineers, New York.

High-Speed Steel

Durability of High Speed Steels, R. Poliakoff. Iron Age, vol. 103, no. 5, Jan. 30, 1919, pp. 295-296, 2 figs. Russian cutting tests with nine brands; chemical composition and requirements; results compared with Taylor's conclusions.

Hot Deformation of Steel

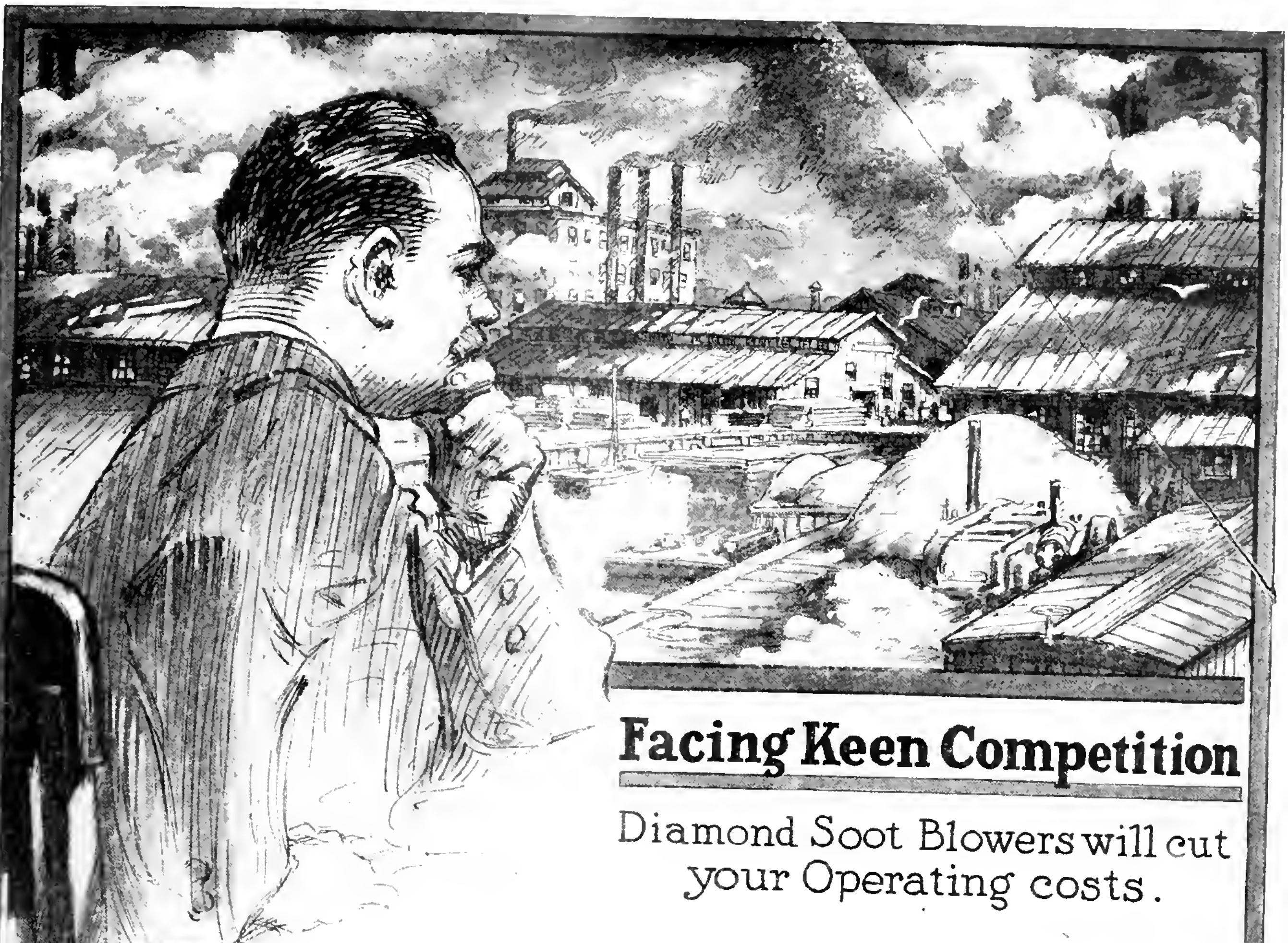
Influence of Hot Deformation on Steel, George Charpy. Am. Drop Forger, vol. 4, no. 12, Dec. 1918, pp. 482-488, 3 figs. Technical discussion on effect of rolling and forging on structure of steels; data concerning changes on exterior and interior of forgings. From paper presented before Iron & Steel Inst.

Literature for 1918

Review of Iron and Steel Literature for 1918, E. H. McClelland. Blast Furnace, vol. 7, no. 1, Jan. 1919, pp. 73-75. Classified list of important books, serials and trade publications.

Molybdenum Steel

Molybdenum Steel Versus Gun Erosion, Masatosi Okôchi, Massaichi Majima and Naoshi Sato. Jl. College of Eng., Tokyo Imperial Univ., vol. 9, no. 5, Oct. 15, 1918, pp. 153-195, 50 figs. Experimental determination of modulus of elasticity, modulus of rigidity, Brinell hardness number, thermal dilatation, thermal conductivity and magnetization at high temperatures of specimens of gun steel, nickel steel, nickel-molybdenum steel and tungsten steel.



Phosphorus

Effect of Phosphorous in Soft Acid and Basic Open Hearth Steels, J. S. Unger. Proc. Steel Treating Research Soc., vol. 2, no. 1, 1919, pp. 11-23, 11 figs. None of the steels used in experiments showed brittleness under cold working, due to phosphorus. Results of various mechanical tests, cold bending of rivets under hammer, upsetting in making barrels, automobile parts and cream separator large-headed nails or rivets, or fabrication of bowls, indicated increase of hardness with increase of phosphorus.

Phosphorus in Malleable Cast Iron, J. H. Teng. Iron & Steel Can., vol. 1, no. 11, Dec. 1918, pp. 445-453, 7 figs. Effects of proportions of phosphorus varying from 0.05 to 0.5 per cent on mechanical properties of malleable cast iron. Writer concludes that ill effects become marked at 0.2 per cent. Paper presented before Iron & Steel Inst., Sept. 1918.

Refractories

See Refractories, under Mechanical Engineering.

Rolling and Grain Size

The Grain Size in Steel as Influenced by Rolling, W.G. Dauncey. Monthly Bul. Can. Min. Inst., no. 82, Feb. 1919, pp. 164-166, 4 figs. Photomicrographs of portion of rolled basic steel bar

Rolling Mills

See Mechanical Processes (Plate Mills), under Mechanical Engineering.

Steel Failures

The Cause and Mechanism of Steel Failures, Z. W. Zimmerschied. Proc. Steel Treating Research Soc., vol. 2, no. 1, 1919, pp. 24-25 and 28-29 Analysis of reasons for usual failures of automobile parts.

Steel Industry in 1918

General Review of Steel Industry for 1918, B. E. V. Luty. Blast Furnace, vol. 7, no. 1, Jan. 1919, pp. 62-65. Quantity and character of output; alignment of belligerents; labor and wages; necessity of labor-saving machinery.

Tests

Tension, Impact and Repeated Impact Tests of Mild and Hard Steels, Tsuruzo Matsumura. Memoirs College of Eng., Kyoto Imperial Univ., vol. 2, no. 2, July 1918, pp. 63-69, 16 figs. Experiments on six flat bars varying in percentage of carbon from 0.102 to 0.65, to detect cause of unexplained fractures.

NON-FERROUS ALLOYS

Stellite

Stellite—Its Manufacture and Uses. Can. Mfr., vol. 39, no. 1, Jan. 1919, pp. 77-78, 2 figs. How it is manufactured at Deloro, Ont.

Welding

Behavior of Non-Ferrous Metals Under the Oxy-Acetylene Torch—II, J. F. Springer. Metal Rec. & Electroplater, vol. 4, no. 11, Dec. 1918, pp. 381-383. How copper alloys are welded; process when working with magnesium, nickel, silver, gold, lead, tin and zinc.

Zinc Alloys

Zinc Alloys Instead of Copper Alloys. Iron Age, vol. 103, no. 3, Jan. 16, 1919, p. 175. French experiments on certain combinations of zinc, aluminum and copper as cast, rolled or drawn under a press.

See also ELECTRICAL ENGINEERING, Electrodeposition.

OCCLUDED GASES

Reactions

Notes on the Occlusion of Gases in Metals, Alfred W. Porter. Chem. Engr., vol. 26, no. 13, Dec. 1918, pp. 499-500 and 509, 1 fig. Phases of reactions between gases and metals as determined by various experimenters.

Aeronautics

AEROPLANE PARTS

Starters

The Bijur Airplane Engine Starter. Aviation, vol. 6, no. 1, Feb. 1, 1919, pp. 33-34, 3 figs. Characteristics of starter designed with minimum weight and low current consumption combined with maximum of cranking power to break away a stiff engine. It is used particularly on seaplanes.

Bijur Starters for Seaplanes and Blimps. Automotive Industries, vol. 40, no. 2, Jan. 9, 1919, p. 51, 3 figs. Fitted to Liberty engines at propeller end and crank engine through double-reduction gear with Bijur automatic screw shift.

AEROSTATICS

Airship Possibilities

The Case for the Airship, W. Lockwood Marsh. Aviation, vol. 5, no. 11, Jan. 1, 1919, pp. 697-699. Salient features and adaptabilities of lighter-than-air and of heavier-than-air craft.

Future of the Helium Airship, Ladislas d'Orcy. Aviation, vol. 5, no. 11, Jan. 1, 1919, pp. 695-697, 2 figs. How helium was produced; military aspects of discovery.

See also INDUSTRIAL TECHNOLOGY, Helium.

AIRCRAFT PRODUCTION

Naval Aircraft Factory

The Naval Aircraft Factory. Aviation, vol. 6, no. 1, Feb. 1, 1919, pp. 28-30, 7 figs. Site, dimensions and internal organization; naval flying boats.

The Naval Aircraft Factory. Mech. Eng., vol. 41, no. 2, Feb. 1919, pp. 142-146, 14 figs. Organization of staff and working force; employment of women; operation of the various departments; features of standardized seaplane manufacture at the plant.

APPLICATIONS

American View

The Opportunity of Aviation, William B. Stout. Jl. Soc. Automotive Engrs., vol. 4, no. 1, Jan. 1919, pp. 39-41 and (discussion) pp. 41-42. Difficulties to be overcome; engine development in the war; problem of landing; cost of production.

British View

Lord Weir on the Future of Flying. Flight, vol. 11, no. 1, Jan. 2, 1919, pp. 16017. Measures upon which development of operational side of air transport depends and part the State is to play in this development.

Commercial Aeronautics

Problems of Commercial Aeronautics, G. Lepere. Aviation, vol. 5, no. 11, Jan. 1, 1919, p. 694. Commercial uses of existing military planes; present possibilities of design.

Commercial Transport by Airplane. Aviation, vol. 6, no. 1, Feb. 1, 1919, pp. 31-32; Aeronautics, vol. 15, nos. 270 and 271, Dec. 18 and 25, 1918, pp. 577-592 and 608-638; Flight, vol. 10, nos. 50, 51, 52 and vol. 11, no. 1, Dec. 12, 19, 26, 1918 and Jan. 2, 1919, pp. 1413-1418, 1413-1445, 1465-1470, and 22-27 Report of special committee on law and policy; interim report of special committee on technical and practical questions of aerial transport; memorandum on experimental air service; business questions relating to aircraft industry and aerial services; labor; research and export education.

DYNAMICS

Aerofoil Sections

Selecting Aerofoil Sections for Speed Range, V. E. Clark. Aviation, vol. 6, no. 1, Feb. 1, 1919, pp. 20-22, 2 figs. Charts for selecting approximately best aerofoil section for speed range and to estimate speed performance to be expected in a given airplane.

Calculation of Performance

Performance of Aeroplanes, W. L. Cowley. Flight, vol. 11, no. 1, Jan. 2, 1919, pp. 13-15, 7 figs. Mathematical relations between horsepower, rate of climb and turning circle; conditions under which circular flight may be extended with greatest rapidity.

Flattening-Out of Aeroplanes

Flattening-Out of Aeroplanes After Steep Glides, Genjiro Hamabe. Memoirs College of Eng., Kyoto Imperial Univ., vol. 2, no. 1, June 1918, pp. 7-52, 8 figs. Derivation of general equations of rigid dynamics with center of gravity of aeroplane as origin; discussion of symmetric motion of aeroplane; problem of recovery from a steep dive at high speed treated by method of approximate calculation; application of approximate calculation to various cases of sharp flattening out of a military Curtiss JN2 tractor.

PLANES

Christmas

The Christmas Strutless Biplane. Aerial Age, vol. 8, no. 19, Jan. 20, 1919, pp. 948-949, 8 figs. Struts, cables and wires are entirely eliminated in machine reported to make 170 miles an hour with a 6-cylinder Liberty motor.

German Planes

The Trend of German Aeroplane Design. Engineer, vol. 127, no. 3289, Jan. 10, 1919, pp. 25-26. From a report issued by the Aircraft Production (Technical Department), Ministry of Munitions.

Halberstadt

Report on the Halberstadt Two-Seater Type C. L. IV. Aeronautics, vol. 15, no. 269, Dec. 11, 1918, pp. 550-552, 12 figs; Flight, vol. 10, no. 50, Dec. 12, 1918, pp. 1404-1407, 12 figs. Biplane equipped with 180-hp. Mercedes engine; carries one fixed and one movable gun. Similar to C. L. II type. Issued by Technical Department, Aircraft Production, Ministry of Munitions.

Loening

The Loening Two-Seater Fighting Monoplane. Aviation, vol. 5, no. 11, Jan. 1, 1919, p. 689, 1 fig. Brief description of simplified type of fighting airplane designed to facilitate production.

L. V. G.

The L. V. G. Two-Seater Biplanes. Engineer, vol. 126, nos. 3284 and 3286, Dec. 6 and 20, 1918, pp. 483-486 and 525-527, 26 figs. and 17 figs.; Flight, vol. 10, nos. 51 and 52, Dec. 19 and 26, 1918, pp. 1426-1431 and 1457-1461, 20 figs.; Aeronautics, vol. 15, no. 267, Nov. 27, 1918, pp. 496-503, 48 figs. Engineer, Dec. 6; Description and illustrations of details of construction; Flight, Dec. 19; C. V. and C. VI. types; Dec. 26; Wing construction, struts, ailerons, undercarriage controls, engine mounting, oil system, accessories. Issued by technical Dept., Aircraft Production, Ministry of Munition; Aeronautics, Nov. 27, C. V. and V. I. types. Report of Technical Department of Air Ministry.

Martin

The Martin Twin-Engined Bomber, Donald W. Douglas. Aviation, vol. 5, no. 11, Jan. 1, 1919, pp. 677-680, 9 figs. Machine built to fulfill requirements of night bomber, day bomber, long-distance photography, and gun machine.

Pfalz

Report on the Pfalz (D xii) Single-Seater Fighter. Aeronautics, vol. 15, no. 269, Dec. 11, 1918, pp 544-549, 19 figs. Biplane equipped with 180-hp. Mercedes engine; carries two Spandau fixed guns. By technical Department, Aircraft Production, Ministry of Munitions.

Standard C-1

The Standard C-1 Single Seater. Aerial Age, vol. 8, no. 20, Jan. 27, 1919, pp. 985-987, 6 figs. Characteristics of Standard Aero Corporation biplane designed as secondary training machine.

ENGINES

Altitudes

Performance of Aeronautic Engines at High Altitudes, H. C. Dickinson. Aeronautics, vol. 15, no. 269, Dec. 11, 1918, pp. 542-543, 3 figs. Describes a laboratory building where it is contemplated to study engine performance in general, including carburation, under conditions corresponding to highest altitudes reached by aviators.

Carburation

Carbureting Conditions Characteristic of Aircraft Engines. Jl. Soc. Automotive Engrs., vol. 4, no. 1, Jan. 1919, pp. 9-12, 9 figs. Tests to determine changes in engine performance with changes in atmospheric temperature and pressure at various levels above earth's surface, with special reference to variables affecting functioning of carburetor and changes in performance resulting from variables in carburetor itself. From Bur. of Standards report no. 10 on aeronautic power plants.

Curtiss

The Curtiss Model K 12 Cylinder Airplane Engine. Aviation, vol. 5, no. 11, Jan. 1, 1919, pp. 685-689, 7 figs. Principal features. Engine is of fixed cylinder type and consists of 12 cylinders in two groups of six each, with included angle of 60 deg.

Dusenberg

The Dusenberg Model H 850-Hp. Motor, G. Douglas Wardrop. Aerial Age, vol. 8, no. 20, Jan. 27, 1919, pp. 991-995, 12 figs. General dimensions and particulars. Motor is of 16-cylinder V type with cylinders at an angle of 45 deg.; weight of power plant with gear drive is 1575 lb.

Hispano-Suiza

The Model H, 300-Hp. Hispano-Suiza Engine, Aviation, vol. 6, no. 1, Feb. 1, 1919, pp. 23-26, 4 figs. Points in which model H differs from other Hispano-Suiza engines, and particularly with regard to lubrication.

Liberty Engine

Ignition on Liberty Engine. Motor Age, vol. 35, no. 2, Jan. 9, 1919, pp. 20-21 and 39, 10 figs. Wiring diagram; arrangement of three arms of circuit breaker; diagram of firing order. Generator-battery type; special Delco system is used.

Miller

The Miller 125-Hp. Aircraft Engine. Aviation, vol. 6, no. 1, Feb. 1, 1919, pp. 30-31, 2 figs. Features and dimensions of this four-cylinder engine.

Radio Cylinder

Fixed Radial Cylinder Engines, John W. Smith. Jl. Soc. Automotive Engrs., vol. 4, no. 1, Jan. 1919, pp. 24-26, 5 figs. Weight of power plant; reliability, durability and balancing; fuel and oil consumption; streamline mounting; cooling. Radial engine is considered as having more advantages than V type.

Specification of Engines

Complete Technical Specifications of Important American and Foreign Airplane Engines. Automotive Industries, vol. 40, no. 3, Jan. 16, 1919, Supplement, chart between pp. 134-135. Details of 37 different types as compiled by Technical Section, Division of Military Aeronautics.

MATERIALS OF CONSTRUCTION

Plywood

Plywood in Aeroplane Construction, Henry Harrison Suplee. Aerial Age, vol. 8, no. 19, Jan. 20, 1919, pp. 945-947 and 961, 7 figs. Design and construction of plywood monocoque fuselages, plywood wing ribs and fuselage taps.

MECHANICS

Stress Determination

Stress Optical Experiments, A. R. Low. Flight, vol. 10, nos. 50 and 51, Dec. 12 and 19, 1918, pp. 1409-1410 and 1435-1439, 20 figs. Dec. 12: Examples of optical observations. Dec. 19: Deflection curves for top spar calculated and observed for total loads of 10, 20, 30, 35 and 40 lb.; principle of dynamical similarity applied to deformable elastic structures. (Concluded.)

Struts

Design of Aeroplane Struts, W. H. Barling and H. A. Webb. Aeronautics, vol. 15, nos. 268 and 269, Dec. 4 and 11, 1918, pp. 521-525, and 538-541, 9 figs. Dec. 4: Analytical determination of shape which will cause strut, when endload rises and it deflects, to be subjected to the same maximum stress at every section; Dec. 11: Mathematical theory and formulae, numerical examples, crinkling stress of steel tubes. Paper read before Roy. Aeronautical Soc.

An Approximate Graphical Treatment of Some Strut Problems, John Case. Engineering, vol. 106, no. 2764, Dec. 20, 1918, pp. 699-670, 7 figs. Mathematical article discussing crippling load of a pin-jointed strut of verying section; deflection of a strut with lateral load; deflection of a strut subjected to lateral load and terminal couples; continuous beams with end load; proofs of formulæ.

Wing-Structure Calculation

Incidence Wires in the Strength Calculations of Wing Structures, John Case. Aeronautics, vol. 15, nos. 268, 270 and 271, Dec. 4, 18 and 25, 1918, pp. 516-517, 566-570 and 602-607, 25 figs. Dec. 4: Ordinary processes of statics and principle of least work, as methods of computing thrust in members of frame. Physical aspect of difference between the two methods; Dec. 18: Formulæ for estimating loads in spars, struts, etc., and numerical examples of the methods of using these formulæ; Dec. 25: derivation of formulæ.

MILITARY AIRCRAFT

British Planes

British Airplanes and Seaplanes. Automotive Industries, vol. 40, no. 3, Jan. 16, 1919, pp 142-143. Principal types of engines and planes in use in the Royal Naval Air Service and in the Army.

U. S. Le Pere

The Le Père Fighter. Aerial Age, vol. 8, no. 18, Jan. 13, 1919, pp. 904-905, 5 figs. General dimensions, weights and performances of reconnaissance plane fitted with 400-hp Liberty engine.

U. S. Planes

Record of Performance of American Planes. Automotive Industries, vol 40, no. 3, Jan. 16, 1919, p. 103. Table illustrating types and principal features of airplanes built by U. S. Government since June 1917.

MODELS

Model Construction

Model Aeroplane Building as a Step to Aeronautical Engineering. Aerial Age, vol. 8, nos. 18, 19 and 20, Jan. 13, 20 and 27, 1919, pp. 913, 957 and 1001, 11 figs. Jan. 13: Details of wings; Jan. 20: Making tail surfaces, fin and rudder; Jan. 27: Details of stabilizer, elevators, fin and rudder for Ford motored airplane.

Model Aeroplanes—XIX, F. J. Camm. Aeronautics, vol. 15, no. 268, Dec. 4, 1918, p. 529, 6 figs. Notes on driving mechanism.

PROPELLERS

Charts

Nomographic Charts for the Aerial Propeller, S. E. Slocum. Aerial Age, vol. 8, no. 20, Jan. 27, 1919, pp. 988-990, 4 figs. Power, thrust, torque and efficiency charts representing formulæ derived from experimental data. Formulæ were discussed in Aerial Age, Aug. 26 and Nov. 18, 1918.

Marine Engineering

AUXILIARY EQUIPMENT

Condensers

Auxiliary Machinery on British Standard Ships. Shipbuilding and Shipping Rec., vol. 12, no. 25, Dec. 19, 1918, pp. 595-596, 5 figs. General arrangement of auxiliary machinery for A and B types; details of auxiliary condenser incorporated in main engine structure on marine engines.

Propellers

Chart for Diameters of 3-Bladed Propellers. Motor Boat, vol. 16, no. 1, Jan. 10, 1919, p. 12, 1 fig. To determine diameter of propeller from desired revolutions and hp. delivered.

Screw Propellers, C. W. Dyson. Jl. Am. Soc. Naval Engrs., vol. 30, no. 4, Nov. 1918, pp. 753-805, 4 figs. Theoretical discussion covering thrust deduction and wake gain; slip block coefficients; wing screws; correction of slip block coefficient for variation of midship section coefficient from standard; mean relative tip clearance of propellers; resistance of hull appendages; basic conditions for analysis and design of screw propellers; general formulæ for power correction for "cavitation" and "dispersal of thrust column"; standard forms of projected area ratio; standard forms of blade sections; problems in propeller design.

Valves and Fittings

Marine Practice in Valves and Fittings, A. G. Christie. Mech. Eng., vol. 41, no. 2, Feb. 1919, pp. 135-136. Suggests that certain features of central-station practice be extended to marine practice.

SALVAGE

Salvaging Device

Making the Sea Give Up Its Wealth. Am. Marine Engr., vol. 14, no. 1, Jan. 1919, pp. 12-14, 1 fig. Patented salvaging device consisting of dual system of non-capsizing pontoons to serve as lighters for salvage and quarters and workshops for wrecking crews as well as for raising vessels on an even keel.

S.S. St. Paul

The Salvage of the St. Paul. Engineer, vol. 126, no. 3284, Dec. 6, 1918, pp. 480-483, 7 figs. Account of raising of liner which sank at her pier in New York harbor.

SHIPS

Camouflage

Principles Underlying Ship Camouflage, Alon Bement. Int. Mar. Eng., vol. 24, no. 2, Feb. 1919, pp. 90-93, 9 figs. Complementary colors to produce low visibility; dazzle system of ambiguous perspective to disguise ship's course; special color effects.

Castings

Castings Used in Ship Construction, Ben Shaw and James Edgar. Foundry Trade Jl., vol. 20, no. 203, Nov. 1918, pp. 579-584, 26 figs. Methods adopted in making pattern for and casting rudder; general considerations on large and small castings.

Concrete Vessels

Reinforced-Concrete Steamer "Armistice." Engineering, vol. 107, no. 2767, Jan. 10, 1919, pp. 46-48, 8 figs. Illustrations with general description of a 205-ft. concrete steamer constructed by the Ferro-Concrete Ship Construction Company, Limited, Barrow-in-Furness.

Concrete Ships. Times Eng. Supp., no. 530, Dec. 1918, pp. 252-253. Program at Lancashire yards; equipment of yards.

New Type of Reinforced Concrete Boat. Concrete Age, vol. 29, no. 3, Dec. 1918, pp. 24-25. System followed at Aberthaw yard for building 500-ton lighters.

Structural Details of Concrete Ships, W. Noble Twelvetrees. Nautical Gaz., vol. 95, no. 2, Jan. 11, 1919, pp. 24-25. Systems of concrete shipbuilding followed in British shipyards and advantages claimed by advocates of each system. From the Shipbuilder.

The Waller System of Reinforced Concrete Ship Construction, W. Noble Twelvetrees. Engineering, vol. -06, no. 2760, Nov. 22, 1918, pp. 580-583, 16 figs. Description of system introducing precast concrete slabs into construction.

Detail Drawing Methods

Detail Drawing Method Used for 8800-Ton Steel Ships. Eng. News-Rec., vol. 82, no. 4, Jan. 23, 1919, pp. 188-190, 3 figs. Adapted successfully to old-style ships of fully curved shape; permits checking pieces before they leave shop.

Electrical Installation Work

Cutting Time on Installation Work. Jl. Elec., vol. 42, no. 1, Jan. 1, 1919, pp. 25-26. Systematic planning of electrical installation work as carried out in large shipyard.

Electric Propulsion

The Ljungstroöm Turbo-Electric System of Ship Propulsion. Jl. Am. Soc. Naval Engrs., vol. 30, no. 4, Nov. 1918, pp. 813-834, 60 figs. Ljungström turbine consists of two disks carrying intermeshing rings of reaction blading; each disk is direct-coupled to a generator. Turbine, equipment, auxiliaries and mountings are treated at length. From Engineering.

Electric Propulsion on the New Mexico, Wingrove Bathon. Elec. World, vol. 73, no. 1, Jan. 4, 1919, pp. 7-10, 1 fig. Interview with Rear-Admiral Griffin of U. S. N. New system of driving ships adopted as national policy; Great Britain and France probably will follow American lead.

Fabricated Ship

The Fabricated Ship in America. Engineer, vol. 126, no. 3286, Dec. 20, 1918, pp. 523-524, 12 figs. Description and discussion of the "fabricated" ship.

Ferry Steamers

Train Ferries to France. Times Eng. Supp., no. 530, Dec. 1918, p. 251, 3 figs. Engineering features of ferry steamers and of bridges for loading and unloading them.

Ford Chasers

Ford Methods in Ship Manufacture—II, Fred E. Rogers. Indus. Management, vol. 57, no. 2, Feb. 1919, pp. 119-124, 12 figs. Layout, equipment and tools of shop where 200 tons of interchangeable steel parts for the Eagles are produced in a working day. (To be continued.)

The Building of American Submarine Chasers. Engineering, vol. 106, no. 2761, Nov. 29, 1918, pp. 608-609, 3 figs. Account of construction of Ford "Eagles."

Groton Shipyard

Groton Shipyard Built on Sloping Limestone Ledge. Eng. News-Rec., vol. 82, no. 3, Jan. 16, 1919, pp. 135-138, 6 figs. Fabricating and storage yards level with rails on concrete craneways and 22 ft. above concrete shipways set into rock.

Hog Island Ship

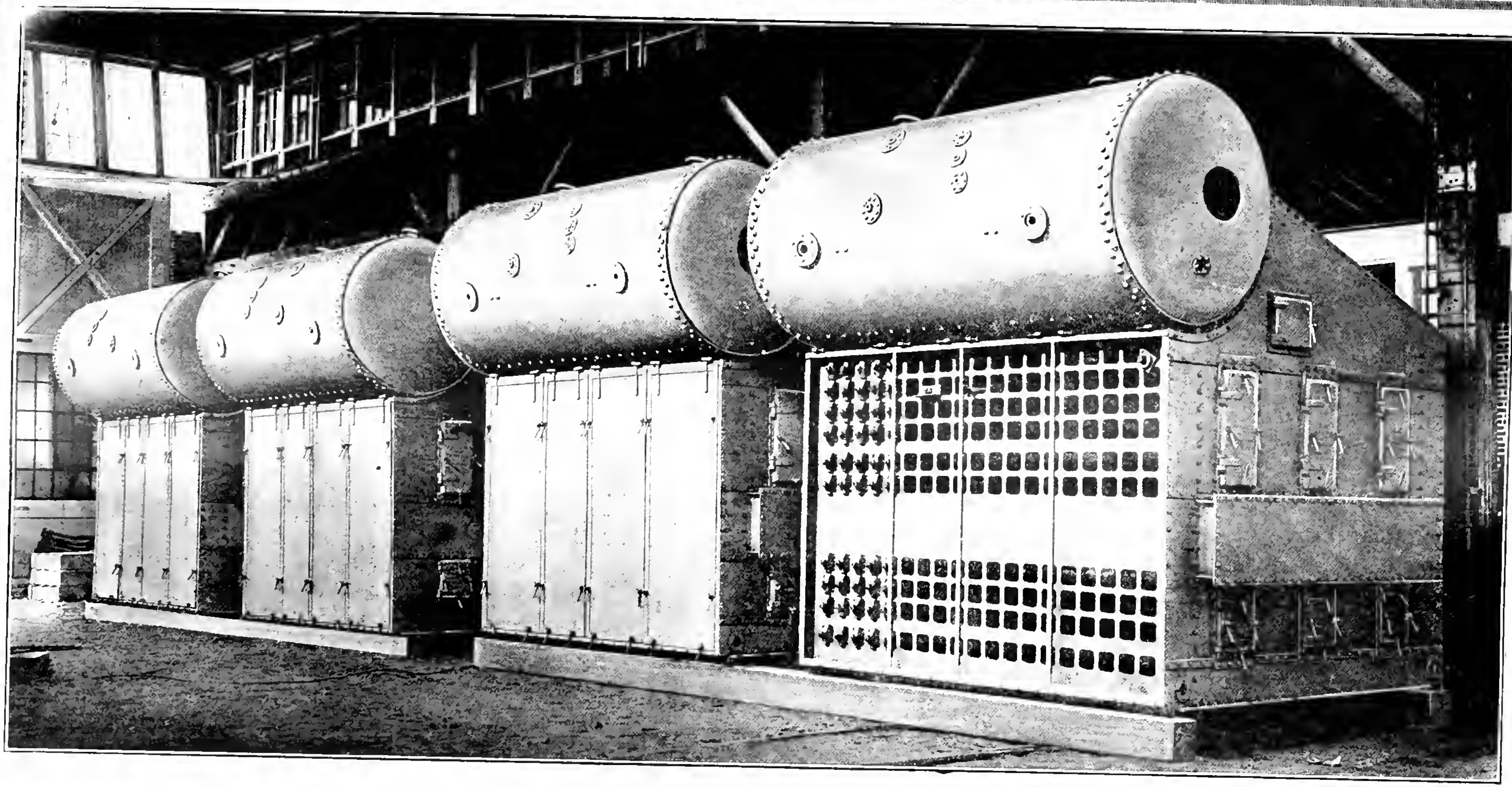
Plans for Hog Island Steel Cargo Ship. Int. Mar. Eng., vol. 24, no. 2, Feb. 1919, pp. 71-74, 3 figs. Design and construction of single-screw vessel of 7500 tons deadweight type; cargo space 380,000 cu. ft.

Launching

Notes on Launching, William Gatewood. Engineering, vol. 106, no. 2764, Dec. 20, 1918, pp. 710-711, 7 figs.; Int. Mar. Eng., vol. 24, no. 2, Feb. 1919, pp. 83-87, 7 figs. Paper before Society of Naval Architects and Marine Engineers, Philadelphia, Nov. 1918.

Refrigerator Ships

The Refrigerator Ship "Belle-Isle" (Le navire frigorifique "Belle-Isle"), Emile Gouault. Génie Civil, vol. 73, no. 26, Dec. 28, 1918, pp. 501-504, 7 figs. Conformation and plans. Ship is three-decked and of awning-deck type, with capacity of 12,000 beeves.



Turbine Propulsion

Italian Geared Turbine Cargo Steamer. Int. Mar. Eng., vol. 24, no. 2, Feb. 1919, pp. 94, 2 figs. Brief description with plan of ship. Built by N. Odero & Company, at Sestri Ponenti, and fitted with Tosi geared turbine propelling and auxiliary machinery.

Progress in Turbine Ship Propulsion, Francis Hodgkinson. Engineering, vol. 107, no. 2767, Jan. 10, 1919, pp. 42-45, 9 figs. Report, slightly abbreviated, read before the Society of Naval Architects and Marine Engineers, Philadelphia, Nov. 1918.

Progress in Turbine Ship Propulsion, Francis Hodgkinson. Shipping, vol. 5, no. 13, Dec. 28, 1918, pp. 15-16, 1 fig. Auxiliaries used and practice followed. Abstract of paper before Soc. Naval Architects and Marine Engrs.

Ventilating and Heating

Ventilating and Heating from the Marine Point of View, Chas. F. Gross. Jl. Am. Soc. Naval Engrs., vol. 30, no. 4, Nov. 1918, pp. 728-736. Systems followed in merchant ships; design and installation of ventilators; allowance of square feet of radiator surface by leading shipbuilding companies.

Manufacturing a Ship's Ventilator, H. E. McCauley. Am. Mach., vol. 50, no. 2, Jan. 9, 1919, pp. 47-51, 15 figs. Describes manufacture of American-type ventilator cowls.

Welded Ships

The First Electrically Welded Boat, John Liston. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 844-848, 10 figs. Particulars of boat built in 1915 at Ashtabula, Ohio, and still in service on Great Lakes.

The Adequacy of Welding in Constructing Hulls of Ships, H. M. Hobart. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 840-843. Author expresses belief in adequacy of method.

Rules for Electrically-Welded Ships. Jl. Engrs. Club, St. Louis, vol. 3, no. 6, Nov.-Dec. 1918, pp. 331-334. Regulations adopted by general committee of Lloyd's Register of Shipping, London. From Nauticus, Sept. 7, 1918.

YARDS

Reduction Gears

Mechanical Reduction Gears, J. A. Davies. Jl. Am. Soc. Naval Engrs., vol. 30, no. 4, Nov. 1918, pp. 705-727, 11 figs. Formulæ for designing pinions; considerations on selection of material for bearings; types of couplings; undesirability of flexible couplings in high-powered, high-speed machinery; contour used for teeth of marine reduction gears of double-helical type; accidents and changes due to wear or operation.

Shipbuilding. United States and Canada

Shipbuilding Development in the United States and Canada, W. R. Gray and Edward F. Clarke. Engineering, vol. 106, no. 2765, Dec. 27, 1918, pp. 740-742, 3 figs. Paper before North-East Coast Inst. of Engineers and Shipbuilders, December 1918.

Shipyards

Recent Developments in Shipyard Plants, S. M. Henry. Int. Mar. Eng., vol. 24, no. 2, Feb. 1919, pp. 74-76. From a paper before the Society of Naval Architects and Marine Engrs.

Welding

Electric Welding in Navy Yards, H. G. Knox. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 849-859, 20 figs. Arc-welding and resistance welding processes as related to their general application in navy yard; work conducted in each type of shop; recommendations as to kinds of welding equipment desirable; figures of speed and cost of welding ship structures.

Organization and Management

ACCOUNTING

Ice-Plant Auditing

Auditing and Supervision of Ice Plants, George E. Wells. Ice & Refrigeration, vol. 56, no. 1, Jan. 1919, pp. 48-49. Proposes auditing engineering conditions in a plant and gives particulars and audit forms for ice plants.

Appraisals, Industrial

Three Industrial Appraisals in One, Charles W. McKay. Indus. Management, vol. 57, no. 2, Feb. 1919, pp. 141-143. For excess-profits tax computation, for plant accounting and for insurance adjustment.

EDUCATION

Agricultural Instruction

Reference Material for Vocational Agricultural Instruction. Federal Board for Vocational Education, bul. 13 and 14, March and June 1918, 42 pp. and 25 pp. March: Outlines provisions to be made by states for meeting requirements of Smith-Hughes Act relating to agricultural instruction. June: Suggestions for cataloging and filing, bulletin, report, etc., for agricultural education.

Airplane Mechanics

Emergency War Training for Airplane Mechanics. Federal Board for Vocational Education, bul. no. 12, April 1918, 62 pp. Outline of course in airplane construction and repair.

Crippled Soldiers

The Evolution of National Systems of Vocational Reëducation for Disabled Soldiers and Sailors. Douglas C. McMurtrie. Federal Board of Vocational Education, bul. 15, May 1918, 318 pp., 33 figs. Fundamental principles of rehabilitation; categorical description of methods for vocational rehabilitation in force in the various warring countries, including Germany and Austria-Hungary; extensive bibliography of American and foreign literature, inclusive of news items in periodicals, relating to vocational rehabilitation.

Cripples

Reducing the Cost of Disability, Douglas C. McMurtrie. Iron Age, vol. 103, no. 6, Feb. 6, 1919, pp. 362-363. Rehabilitation restores and may enhance earning capacity; insurance costs lessened; the economy of liberal medical attention.

The Conservation of Industrial Man Power, Arthur J. Westermayr. Am. Drop Forger, vol. 4, no. 12, Dec. 1918, pp. 504-506, 3 figs. Question of rehabilitating crippled soldiers; how vocational rehabilitation act will be operated.

Engineering Colleges

The Effect of the War on Engineering Education, C. R. Mann. Bul. Soc. Promotion Eng. Education, vol. 9, no. 4, Dec. 1918, pp. 108-118. War experiences analyzed under (1) production of soldiers, and (2) production of supplies. Present college curricula described as aiming to impart knowledge of physical laws and properties of materials exclusively, and as insufficient to develop men who will accomplish reorganization of industrial production, for which task an understanding of the methods by which human wills are coördinated for team play is essential.

Export and Shipping

Vocational Education for Foreign Trade and Shipping. Federal Board for Vocational Education, bul. 24, Nov. 1918, 85 pp. Present importance of education for foreign trade; advanced courses in shipping; coöperative plans for teaching foreign trade; study outlines of fundamental courses; suggested study plans.

Industrial Education

Industrial Education in Wilmington, Delaware. Department of Interior, Bur. of Education, bul. 25, 1918, 97 pp. Report of survey made under direction of Commissioner of Education; suggestions for program of industrial education.

Industrial Schools

Buildings and Equipment for Schools and Classes in Trade and Industrial Subjects. Federal Board for Vocational Education, bul. 20, Nov. 1918, 75 pp., 25 figs. Type schools and classes; detailed description of building and equipment for a trade or industrial school; equipment, courses of study, and methods of instruction in carpentry.

Evening Industrial Schools. Federal Board for Vocational Education, bul. 18, Sept. 1918, 55 pp. Possibilities in evening schools under provisions of Smith-Hughes Act; suggestive courses which have been prepared and carried out at evening schools; approved methods of establishing and conducting evening industrial schools for trade workers.

Italy

Need for Increased Technical Education in Italy (Per l'avvenire della industria meccanica in Italia), G. Belluzzo. Industria, vol. 32, no. 21, Nov. 15, 1918, pp. 635-637. Points out defects of Italian system of training as at present conducted and outlines a system which follows closely that given in best shops in England and United States. (Concluded.)

Naval Architecture

The Requirements of a Course of Training in Naval Architecture, Lawrence B. Chapman. Bul. Soc. Promotion Eng. Education, vol. 9, no. 4, Dec. 1918, pp. 119-130. Outlines plan in which professional work starts early in course and parallels outside training.

Part-Time Schools

Part-Time Trade and Industrial Education. Federal Board for Vocational Education, bul. 19, Oct. 1918, 51 pp. Need for part-time schools in United States; school, man and employer as factors in promoting part-time education; part-time studies already established in U. S.; continuation schools in England, France and Germany; types of part-time schools; federal aid; principles which should underlie compulsory legislation.

Physical Education

Recent State Legislation for Physical Education, Thomas A. Storey and Willard S. Small. Department of Interior, Bureau of Education bul. 40, 1918, 35 pp. Chronological analysis of laws enacted in eight states since the beginning of the war; analysis of purpose and scope of state laws; principles of state legislation for physical education; state laws for physical education.

Radio Operators

Emergency War Training for Radio Mechanics and Radio Operators. Federal Board for Vocational Education, bul. no. 16, Sept. 1918, 74 pp., 8 figs. Outline of course for preliminary training.

Secondary Education

Cardinal Principles of Secondary Education. Department of Interior, Bur. of Education, bul. 35, 1918, 32 pp. Report of Commission on the Reorganization of Secondary Education, appointed by Nat. Education Assn.

Shop Training

Training Operators at Winchester Plant, W. E. Freeland. Iron Age, vol. 103, no. 3, Jan. 16, 1919, pp. 178-179, 2 figs. Short intensive course in training shop for men; three years' apprenticeship in school for boys; details of system. (Eleventh article of series on Winchester plant.)

The Training Department — Past and Future, John C. Spence. Iron Age, vol. 103, no. 4, Jan. 23, 1919, pp. 237-239. The crippling of one plant for another; real and pretended interest in workmen; some training plans for the common good.

Technical Education, Primary

Toronto Builders' Exchange Urges Forward Movement in Technical Education. Contract Rec., vol. 33, no. 3, Jan. 15, 1919, p. 49. Deputation recommends Ministry of Education that technical schools be owned by Government, that education be made compulsory between 14 and 20 years and that parents decide boy's vocation.

Trade and Industrial Education, Organization and Administration. Federal Board for Vocational Education, bul. no. 17, Oct. 1918, 124 pp. Contains information and suggestion concerning organization and administration of trade and industrial schools and class under Federal law.

U. S. Training Service

The U. S. Training Service and Its Work, Charles T. Clayton. Indus. Management, vol. 57, no. 2, Feb. 1919, pp. 103-104. Value of service in saving to manufacturers expense of hiring men; industrial training as a means of lessening turnover and increasing output.

Universities

The Universities and the New World, Geo. F. Swain. Jl. Elec., vol. 42, no. 1, Jan. 1, 1919, pp. 12-14. Readjustment of schools and universities to fulfil new demands in education created by general reconstruction of past conditions.

Welders

The Training of Electric Welders, H. A. Horner. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 876-881, 9 figs.

Emergency War Training for Oxy-Acetylene Welders. Federal Board for Vocational Education, bul. no. 11, June 1918, 86 pp., 30 figs. History of development and application of oxy-acetylene in industry and war; U. S. Army course of instruction in oxy-acetylene welding and oxygen cutting.

Operators and Instructors Necessary for Electric Arc Welding. Elec. Ry. Jl., vol. 53, no. 4, Jan. 25, 1919, pp. 191-192, 4 figs. From 1918 report of Committee of Association of Railway Electrical Engineers.

The Future of Army Welding Schools, Cyrus K. Rickel. Jl. Acetylene Welding, vol. 2, no. 7, Jan. 1919, pp. 331-335, 7 figs. Discusses qualifications of successful welding school.

Women Workers

Little Causes and Great Effects (Petites causes et grands effects), Francois Villain. Société Industrielle de d'Est, bul. 142, Nov. 1918, pp. 7028, 8 figs. Plea for enforcing law which requires teaching of household arts to young girls in elementary schools; influence of this policy on welfare of women. Conference before the Société Scientifique d'Hygiene Alimentaire.

Training Women for Record Output, Robert I. Clegg. Iron Age, vol. 103, no. 3, Jan. 16, 1919, pp. 169-174, 11 figs. General results abroad and at home; diligence and industry of women; practical system of schooling on shop production lines.

FACTORY MANAGEMENT

Employment Management

The "Conscience" of Modern Industry, C. T. Clayton. Jl. Engrs. Club St. Louis, vol. 3, no. 6, Nov.-Dec. 1918, pp. 352-354. Employment management as a factor to reduce industrial misunderstanding and friction.

Extreme Methods in Employing, Charles M. Horton. Indus. Management, vol. 57, no. 2, Feb. 1919, pp. 145-148. Criticises some practices of employment managers.

Industrial Fatigue

A Suggestion for the Prevention of Waste of Human Energy in Factories, H. G. P. Castellain. Cassiers Eng. Monthly, vol. 54, no. 6, Dec. 1918, pp. 303-307. Discusses industrial fatigue from a medical point of view and suggests improvement in medical education and establishment of courses for factory inspectors and medical men.

Investigations

Engineer and Plant Management, J. G. Worker. Aera, vol. 7, no. 6, Jan. 1919, pp. 596-599. Suggestions as to investigations, reports and installations of waste preventing boiler room methods.

Labor Management

Use of Non-Financial Incentives, Robert B. Wolf. Can. Mfr., vol. 39, no. 1, Jan. 1919, pp. 79-80, 2 figs. Stimulating production in industry by internal motives rather than by external discipline, that is, by making comparisons, cost sheets, etc.

Observation

The Value of Observation in Works Practice, H. H. Ashdown. Engineering, vol. 107, no. 2766, Jan. 3, 1919, pp. 11-14, 14 figs. A paper before the Society of Engineers and Metallurgists, Sheffield, Nov. 1918.

Plant Operation

Lifting Power Plant Capacity by Its Boot Straps, Charles L. Hubbard. Factory, vol. 22, no. 1, Jan. 1919, pp. 35-37, 1 fig. Improvements which contribute to increasing efficiency; how superheating steam increases capacity; how increasing speed affects engine; use of compound engines or low-pressure turbines.

Production Control

Graphic Production Control—VI, C. E. Knoeppel. Indus. Management, vol. 57, no. 2, Feb. 1919, pp. 113-118, 10 figs. Two ways to tie together and coördinate various features of control mechanism; by use of charts, and by control boards. Last article of series.

Overtime

Graphic Analysis of an Overtime Problem, R von Huhn. Indus. Management, vol. 57, no. 2, Feb. 1919, pp. 86-88, 5 figs. Casting delivery on a large contract and amount of overtime needed to machine pieces.

Reports

Facilitating Sewer Pipe Factory Management, W. B. Harris. Brick & Clay Rec., vol. 54, no. 1, Jan. 14, 1919, pp. 39-44, 10 figs. Forms and records of making reports; placing workmen.

Stokers

Power Plant Management: Mechanical Stokers, Robert June. Power House, vol. 11, no. 12, Dec. 1918, pp. 353-355, 2 figs. Efficiency; characteristics of chain grate; instructions for operation.

Storage of Materials

Principles of Purchasing and Storing Applied to Rough, Bulky Materials in Yard Storage, Dwight T. Farnham. Indus. Management, vol. 57, no. 2, Feb. 1919, pp. 108-112, 7 figs. Six principles are considered in planning yard storage: Effort required to transport; weight and material to be stored on each square foot of space; rate of stores turnover; storage unit; allotted space; efficient package.

Timekeeping

Providing a Double Check on Timekeeping. Factory, vol. 22, no. 1, Jan. 1919, pp. 48-50, 4 figs. Layout of Eastman Kodak Co. time-clock room.

Water Works

Office Records of the St. Louis Water Division, Distribution Section, Thomas E. Flaherty. Jl. Am. Water Works Assn., vol. 5, no. 4, Dec. 1918, pp. 412-418. Brief description of organization for planning, direction and execution of work.

Welfare Work

Promoting Employees' Welfare Brings Large Returns. Ry. Maintenance Engr., vol. 15, no. 1, Jan. 1919, pp. 5-8, 8 figs. Policies of Richmond, Fredericksburg & Potomac R. R. Co.

FINANCE AND COST

Cost Accounting

Cost Accounting to Aid Production—V, G. Carter Harrison. Indus. Management, vol. 57, no. 2, Feb. 1919, pp. 131-139, 4 figs. Diagrams illustrating coördinated cost, planning and production systems. (To be continued.)

Costing at National Factories, W. Webster Jenkinson. Iron & Coal Trades Rev., vol. 97, no. 2643, Oct. 25, 1918, pp. 455-458, 10 figs. Beginning series of articles abstracts from address before London School of Economics and Political Science.

Power Costs

Simple Method of Determining Power Costs, T. H. Fenner. Power House, vol. 11, no. 12, Dec. 1918, pp. 361-363, 1 fig. How to arrive at costs when no instruments are available.

Works Costs

The Economics of Works Costs, J. R. Dick. Elecn., vol. 81, no. 2115, Nov. 29, 1918, pp. 643-645, 2 figs. (First installment of a continued article.)

FOREIGN TRADE

Boilers

New Foreign Markets for American Made Boilers and Boiler Equipment, L. W. Alwyn-Schmidt. Boiler Maker, vol. 19, no. 1, Jan. 1919, pp. 3-4. Exports increased over one-sixth. New fields developed in South America and the Far East. European markets remain on war footing.

Canadian Exports

Canadian Industries and the Export Trade, J. F. Heffron. Can. Machy., vol. 21, no. 1, Jan. 2, 1919, pp. 9-12. Canadian possibilities in developing foreign trade; German credit methods of fostering export trade; articles for export.

Drop-Forge Equipment

Campaigning for Foreign Business, L. W. Alwyn-Schmidt. Am. Drop Forger, vol. 5, no. 1, Jan. 1919, pp. 3-6. Suggestions to obtain foreign drop-forge business.

German Methods

Effectiveness and Service in Foreign Trade. Textile World Jl., vol. 55, no. 2, Jan. 11, 1919, pp. 127 and 159. Necessity of considering customer's viewpoint; German commercial vices.

German Foreign Trade Extension Measures, Norman L. Anderson. Blast Furnace, vol. 7, no. 1, Jan. 1919, pp. 78-79. Private associations for promoting foreign trade; German exhibitions; government trade activities; purposes of suggested "Auslandamt."

Italian Market

Our Opportunities for Foreign Trade, V. Macchi di Cellere. Am. Drop. Forger, vol. 5, no. 1, Jan. 1919, p. 17. Market possibilities of Italy, from address before Am. Mfrs. Export Assn.

INSPECTION

Ordnance Department Methods

How Ordnance is Inspected, Fred H. Colvin. Am. Mach., vol. 50, no. 6, Feb. 6, 1919, pp. 263-267, 8 figs. Description of organization and methods of Ordnance Department for inspection.

LABOR

Bathhouses

Mine Bathhouses in Utah, A. C. Watts. Coal Age, vol. 15, no. 1, Jan. 2, 1919, pp. 4-8, 4 figs. Description of typical bathhouses with comparison of American and European costs.

Blind

An Experiment in Employing the Blind, Dale Wolf. Indus. Management, vol. 57, no. 2, Feb. 1919, pp. 105-107. How blind men have been put to work on jig drilling of shackles for locks.

Bonus System

Bonus System in Power Generation, W. L. Whitlock. Nat. Engr., vol. 23, no. 1, Jan. 1919, pp. 9-11, 2 figs. Standing order to employees and scale for computing bonus. System of Denver Tramway Co., which is said to effect saving of $150,000 per year.

Bonus System Reduces Coal Consumption at Denver, W. E. Casey and E. Weber. Elec. Ry. Jl., vol. 53, no. 6, Feb. 8, 1919, pp. 266-271, 7 figs. By installation of new turbine and introduction of bonus system, coal consumption on Denver Tramway System is reduced to less than 2.5 per kw-hr., with saving in operating expense of $150,000 per year.

Coal-Economy bonuses in a Central Electric Power House (Prime au personnel sur les économies de charbon dans une centrale électrique thermique), M. Grospaud. Revue Générale de l'Electricité, vol. 5, no. 2, Jan. 11, 1919, pp. 58-63. From data showing variations in thermal efficiency of coal, writer concludes it is illusory to base bonus system on coal consumption; he proposes instead a system based on scientific and methodic thermal control and outlines its practical working details.

The Engineer—Worker and Organizer, G. W. Tripp. The Central (Jl. City & Guilds Eng. Col.), vol. 15, no. 44, Dec. 1918, pp. 46-54, 1 fig. Comparison between Rowan bonus scheme and system based on 50 per cent payment. Abstract of lecture to Woolwich Arsenal apprentices.

British

Paper on "The Industrial Future," Cecil Walton. Jl. West of Scotland Iron & Steel Inst., vol. 26, pt. 2, session 1918-1919, 19-24 and (discussion) pp. 25-31. Labor conditions and the future development of Glasgow. Reference is made to question of wages.

Labor Administration, Edward T. Elbourne. Engineer, vol. 126, nos. 3282, 3283, 3284, 3285, and 3287, Nov. 22 and 29, Dec. 6, 13 and 27, 1918, pp. 432-435, 7 figs.; pp. 453-454, 3 figs.; pp. 478-480, 5 figs.; pp. 504-507, 5 figs.; pp. 548-550, 4 figs. Nov. 22: Control of production. Nov. 29, The wages office. Dec. 6; Wages office continued. Dec. 13: Accidents. Dec. 27: General discipline and general facilities. (Articles 9-13 inclusive.)

Canada

Education and Coöperation the Wisest Course in Dealing with Labor, Gideon Robertson and T. Moore. Contract Rec., vol. 33, no. 2, Jan. 8, 1919, pp. 19-20. Opinions and suggestions of Canada Minister of Labor and of the President Trades and Labor Congress.

Crippled Workers

Human Reconstruction Reclaims War's Disabled for Industry, W. H. Lloyd. Iron Trade Rev., vol. 64, no. 1, Jan. 2, 1919, pp. 80-86, 11 figs. Courses being offered to disabled soldiers and employments being secured for them.

How to Deal with Our Crippled Workers, T. Norman Dean. Am. Drop Forger, vol. 4, no. 12, Dec. 1918, pp. 498-500. Indicates that rehabilitation should be carried on scientifically.

The Conservation of Industrial Man Power, Arthur J. Westermayr. Am. Drop Forger, vol. 4, no. 12, Dec. 1918, pp. 504-506, 3 figs. Question of rehabilitating crippled soldiers so that they can stand on their own merits; discussion of rehabilitation vocational act.

Employment Department

The Principles of Employing Labor, E. H. Fish. Indus. Management, vol. 57, no. 2, Feb. 1919, pp. 81-85. Fundamental principles underlying establishment and maintenance of employment department, promotion of personal relations. First of five articles.

Federal Control

What Federal Control Has Done for Labor, W. S. Carter. Ry. Maintenance Engr., vol. 15, no. 1, Jan. 1919, pp. 11-12. Résumé of measures taken to improve relations between managements and employees. Abstract from address delivered before convention of Acad. Political Sci.

Housing

Housing the Workers—An Unfinished Job, George Gove. Am. City, vol. 20, no. 1, Jan. 1919, pp. 23-25. Present status of Government housing projects. Challenge to local chambers of commerce to meet emergency.

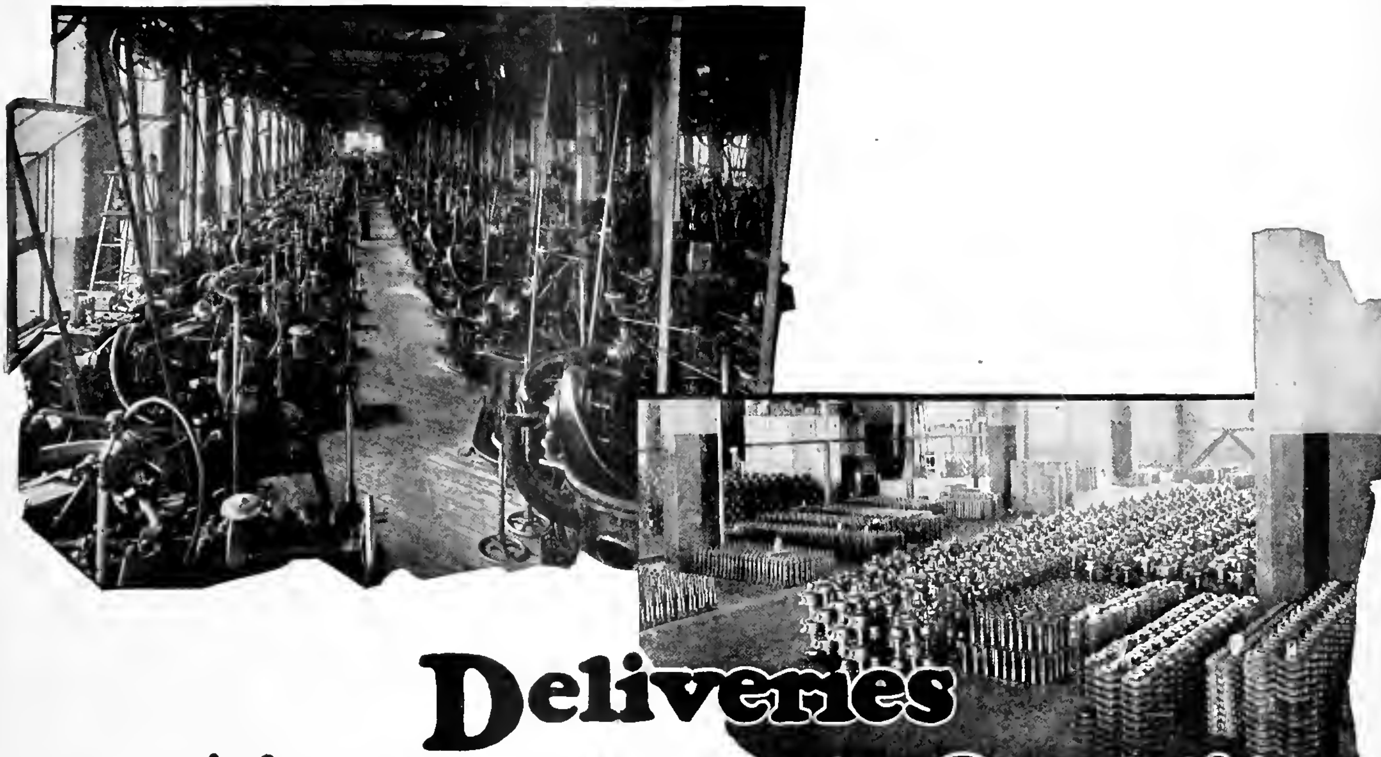
The Present and Future Government of War-Created Communities, Ernest Cawcroft. Jl. Am. Inst. Architects, vol. 6, no. 12, Dec. 1918, pp. 553-558. Suggestions in regard to housing projects undertaken by War Department, Navy Department, U. S. Housing Corporation and U. S. Shipping Board.

Labor Problem

The Labor Problem Analyzed, Magnus W. Alexander. Open Shop Rev., vol. 16, no. 1, Jan. 1919, pp. 3-16. Social, political and economic aspects of labor problem. Address delivered at convention of Nat. Founders' Assn. (To be continued.)

Lunch Rooms

Mill Lunch Room for Employees, A. W. Anderson. Textile World Jl., vol. 55, no. 2, Jan. 11, 1919, pp. 397 and 401, 4 figs. Description of employees' rooms used by several companies.



Deliveries on Time and in any Quantity

Whether it's a rush order for special gears needed on a set date—or gears to be delivered in even quantities on delivery dates running over a long period.

Our plant and physical equipment can absorb your gear business, and handle it with the care and attention it needs—make our deliveries on the specified date without rush, without having to speed up any *one* department beyond the working speed that means careful work.

Your gears will be delivered accurately cut from steel, every ingot of which is tested in our laboratories for agreement with the specifications ordered, and each finished gear tested and checked within the limits set as safe.

There will be no rejects. The gears delivered will be the gears ordered—and the price less than the cost to do this work in your plant.

If you are now cutting your own gears get in touch with us and let us show you how our plant can save you money.

NEW PROCESS GEAR CORPORATION
SYRACUSE NEW YORK

New Process Gears

Older Men

Superannuation of Technical Men. Times. Eng. Supp., no. 530, Dec. 1918, p. 257. Proposes that industrial firms take over policies of technical men in their employment and keep them on same basis as adopted in federation of universities.

Profit Sharing

Enlisting Labor in Production. L. W. Schmidt. Am. Mach., vol. 50, no. 6, Feb. 6, 1919, pp. 253-256, 3 figs. Some methods of making labor interested in the part it is playing in production.

Wage Questions Must Be Handled from Inside the Industrial Unit, Harry Tipper. Automotive Industries, vol. 40, no. 2, Jan. 9, 1919, pp. 62-63. Importance of profit-sharing collective agreement.

Representation of Employees

Where the Men Settle Their Own Troubles. Factory, vol. 22, no. 1, Jan. 1919, pp. 29-31, 1 fig. A board of appeals, consisting of two representatives from each department, one elected by the workers, the other appointed by management, has jurisdiction over all controversies concerning wages, hours of work, discharges, promotions, etc.

Turnover of Labor

Labor Maintenance and Its Indices. Winthrop Talbot. Indus. Management, vol. 57, no. 2, Feb. 1919, pp. 127-130, 2 figs. Criticism of accepted theories of labor turnover and methods for computing it as percentage; presentation of theory of labor maintenance and a way of calculating indices to show stability, maintenance and replacement of working force.

Wages

Notes on the Formulæ of Modern Wages (Quelques réflexions sur les formules de salaire moderne). Génie Civil, vol. 73, no. 22, Nov. 30, 1918, pp. 425-428, 5 figs. Graphical representation and study of characteristic functions of form $s/s_0 = f(m)$ where s is actual wages, s_0 wages per day or hour and m activity, i.e., ratio of work actually produced to work corresponding to wages paid.

Labor's Share. Min. & Sci. Press, vol. 117, no. 26, Dec. 28, 1918, pp. 864-866. Conditions brought about by abnormal requirements of war; objections raised by workmen to changing war scale.

The Human Factor in Shop Production. Margaret K. Strong. Am. Drop Forger, vol. 4, no. 12, Dec. 1918, pp. 489-490. Points out that high wages gives high productiveness because workman who is well fed and nourished can do greater amount of work.

Wages in War and in Peace. Open Shop Rev., vol. 16, no. 1, Jan. 1919, pp. 19-23. Impossibility of maintaining present high wages.

The Modern Wage Rates and the Public Works and Construction (Les tarifs de salaire moderne et l'entreprise de travaux publics et du bâtiment). G. Bouf. Génie Civil, vol. 74, no. 1, Jan. 4, 1919, pp. 9-11, 1 fig. Study of Taylor's system of rational wages; instituting bonuses.

Women

The Employment of Women in Acetylene Welding, Helen G. Fisk. Jl. Acetylene Welding, vol. 2, no. 7, Jan. 1919, pp. 348-354. Abstract of preliminary report of Chicago district ordnance office on activities of women in acetylene-welding field during the war.

The Employment of Women in the Machine Tool Industry. Alfred Herbert. Eng. Rev., vol. 32, no. 6, Dec. 16, 1918, pp. 161-163. Scope for their employment after war; plea for fixing minimum wage or maximum working hours. Text of memorandum submitted by Machine Tool & Eng. Assn. to War Cabinet Committee on Women in Industry.

Mental Function in the Work of Women (La fonction mentale dans le travail féminin). Jules Amar. Comptes rendus des seances de l'Académie des Seances, vol. 167, no. 22, Nov. 25, 1918, pp. 788-791. Psycho-motor reactions in women; physiological examination of their endurance.

Women a Fixture in Electrical Industry. Iron Age, vol. 103, no. 6, Feb. 6, 1919, pp. 353-354, 3 figs. Special provision for employment, welfare and safety are made by the Westinghouse Co.; shop and technical courses are provided.

Women Workers—Have They Made Good? Mary N. Winslow and Edgar E. Adams. Am. Drop Forger, vol. 5, no. 1, Jan. 1919, pp. 12-16, 5 figs. Records of past year; part played by women in war-time industries; present problems; fact concerning employment of women in various plants.

LEGAL

Accident Compensation

When is an Industrial Accident? Business Digest & Investment Weekly, vol. 23, no. 3, Jan. 21, 1919, pp. 92-93. Phraseology of compensation insurance laws in various states and legal decisions by different courts in United States and Great Britain.

"Pre-Existing" Condition of the Workman and Its Relation to Compensation for Injury, Chesla C. Sherlock. Am. Mach., vol. 50, no. 2, Jan. 9, 1919, pp. 67-69. Explanation with citations of zone court decisions.

Patent Laws

United States Patent Law and Procedure, E. E. Huffman. Jl. Engrs. Club St. Louis, vol. 3, no. 6, Nov.-Dec. 1918, pp. 335-351. Outline of patent system; suggested changes. Address delivered at joint meeting of Assoc. Eng. Soc., St. Louis.

The Rights to Patents and Inventions, Chesla C. Sherlock. Am. Mach., vol. 50, no. 3, Jan. 16, 1919, pp. 115-118. Quotes some notable decisions in respect to patent rights.

The New Patent Law Drafted for Hungary and Its Influence Upon Engineers (Der neue ungarische Patengesetzentwurf mit besonderer Ruecksicht auf die Stellung der Techniker), Dr. Rudolf v. Schuster, President of Patent Court. Zeitschrift des Oesterr. Ingenieur- und Architekten-Vereines, Vienna, vol. 70, no. 37, Sept. 13, 1918, pp. 399-402. Defends the provisions of the proposed patent law for Hungary. Advocates coöperation of engineers and lawyers.

The Crucial Question of Patents, Robert Hadfield. Eng. Rev., vol. 32, no. 6, Dec 16, 1918, pp. 157-160. How Board of Trade can provide strong stimulus to British scientific and engineering progress by applying its present powers to effect modification of patent law.

Patent Law Amendment. Jl. Instn. Elec. Engrs., vol. 57, no. 277, Dec. 1918, pp. 64-71. Report of patent-law committee adopted by conference of representatives of 30 leading scientific and technical societies, convened by Instn. Mech. Engrs.

The Patent Situation in the United States. Mech Eng., vol. 41, no. 2, Feb. 1919, pp. 147-149 and 199. Report of Patent Committee to the National Research Council.

See also MINING ENGINEERING, Mines and Mining (Laws); ELECTRICAL ENGINEERING, Generating Stations (Legal Liability)

LIGHTING

Industrial Lighting

Artificial and Natural Industrial Lighting, C. E. Clewell. Elec. World, vol. 73, no. 1, Jan. 4, 1919, pp. 22-25, 8 figs. Their interrelations considered; predetermination of artificial lighting requirements; variation in natural lighting intensities; importance of daylight factor; methods of measurement.

Engineering Aspects of Industrial Lighting, C. E. Clewell. Elec. World, vol. 73, nos. 2 and 6, Jan. 11 and Feb. 8, 1919, pp. 68-71 and 260-262, 7 figs. Jan. 11: Industries should take advantage of studies made under stress of war conditions to promote efficiency of production; specific data now available which aid in selection and location of lighting units. Feb. 8: Economic considerations of the accident rate; relation to coal conservation; well-lighted versus poorly-lighted aisles; desirability of more widespread and intelligent use of reflectors for all lamps.

Mill Lighting

Modern Lighting and Power Installation for Canadian Knitting Mill. Elec. Rev., vol. 74, no. 4, Jan. 25, 1919, pp. 127-130, 7 figs. Electrical equipment complete and designed to minimize fire and accident hazards; details of lighting and power facilities.

Progress in Mill Lighting Practice, H. H. Magdsick. Textile World, Jl., vol. 55, no. 2, Jan. 11, 1919, pp. 401 and 403, 5 figs. State and Federal regulations; developments in accessories.

Street Lighting

The Street Lighting of the City of Buffalo, W. F. Schwartz. Am. City, vol. 20, no. 1, Jan. 1919, pp. 48-50, 4 figs. System comprises type C nitrogen-filled lamps, luminous arcs, pendent magnetite arcs, and enclosed carbon arcs, as well as gas lamps of Welsbach boulevard and ornamental types, and gasoline lamps. Number and cost of each type are given.

Yard Lighting

Light as an Aid to the Movement of Materials, A. L. Powell and R. E. Harrington. Ry. Elec. Engr., vol. 10, no. 1, Jan. 1919, pp. 9-13, 7 figs. Expedition of freight handling at transfer platforms and piers. Abstract of paper before Illum. Engr. Soc.

PUBLIC REGULATION

Plant Management

Industrial Economy (Economia Industrial), V. Posada Gavira. Boletin de Minas, vol. 10, nos. 7-9, Sept. 30, 1918, pp. 129-149, 1 fig. Coördination and harmonization of the technical, economical and human elements in industry by central administration, standardization and specialization.

Public Works

A National Department of Public Works, C. E. Grunsky. Jl. Elec., vol. 42, no. 1, Jan. 1, 1919, pp. 16-17. Advisability of creating department of public works to be represented in President's cabinet. Gain in efficiency is claimed over present distribution of engineering work under five different departments.

Street Cars

The National Aspect of the Public Utility, Franklin T. Griffith. Jl. Elec., vol. 42, no. 2, Jan. 15, 1919, p. 78. Question of higher street-car fare discussed from standpoint of what may legitimately be done to keep them low.

RECONSTRUCTION

British Plans

England's Vast Plans for Peace Work, Carroll E. Williams. Mfrs. Rec., vol. 75, no. 3, Jan. 16, 1919, pp. 90-92. New shipyards built in record time; building of concrete ships; recommendation of British reconstruction committee on relations between employers and employees; reconstruction of iron and steel business.

Engineering Problems

The Economic Duties of the Engineer, W. R. Ingalls. Eng. & Min. Jl., vol. 107, no. 4, Jan. 25, 1919, pp. 184-190. Engineering problems in reconstruction.

Engineering Societies

What Engineering Societies Should Do to Assist in Providing Work for Soldiers and Others Who Will Soon Be Out of Work. Bul. Affiliated Eng. Societies Min., vol. 3, no. 12, Dec. 1918, pp. 221-222. From Eng. & Contracting.

France

America and Reconstruction in Europe. Jl. Elec., vol. 42, no. 1, Jan. 1, 1919, pp. 18-19. Plans of directors and representatives of large power stations and electric lighting plants situated in devastated regions of France; work done by British Ministry of Reconstruction; post-war preparations in Spain.

Helping France an Aid to America, John V. Schaefer. Iron Trade Rev., vol. 64, no. 3, Jan. 16, 1919, pp. 207-208. Sending of vast stores of army construction material and experts to help rehabilitate country urged as a means of solving our labor problem, securing war loan and laying foundation of future trade.

Reconstruction Plans

Industrial Relations After the War, Henry P. Kendall. Textile World Jl., vol. 55, no. 2, Jan. 11, 1919, pp. 121, 247 and 249. Need of constructive plan acceptable to all; basic principles that should control.

The Human Factor in Industry, A. P. M. Fleming. Jl. Instn. Elec. Engrs., vol. 57, no. 277, Dec. 1918, pp. 47-56. Means which make for improvement in material prosperity of those engaged in industry; pressing problems in industrial reconstruction.

Research

Science and the After-the-War Period, George K. Burgess. Jl. Wash. Acad. Sci., vol. 9, no. 3, Feb. 4, 1919, pp. 57-70. Importance, during transition period, of proper balance and distribution of scientific forces; advisability of retaining more than a nucleus of an organization of scientific men in service of Government and especially in military and naval establishments.

Scientific Leadership

Human Instincts in Reconstruction, William Henry Smyth. Indus. Management, vol. 57, no. 2, Feb. 1919, pp. 89-91. Suggests leadership of a national council of scientists as means for directing forces of human instincts.

Steel Trade and Shipbuilding

The Steel Trade and Shipbuilding Competition, E. T. Good. Cassier's Eng. Monthly, vol. 54, no. 6, Dec. 1918, pp. 342-345. Interdependence of steel trade and shipbuilding industries; warning against separation of their common interests and against German dumping methods.

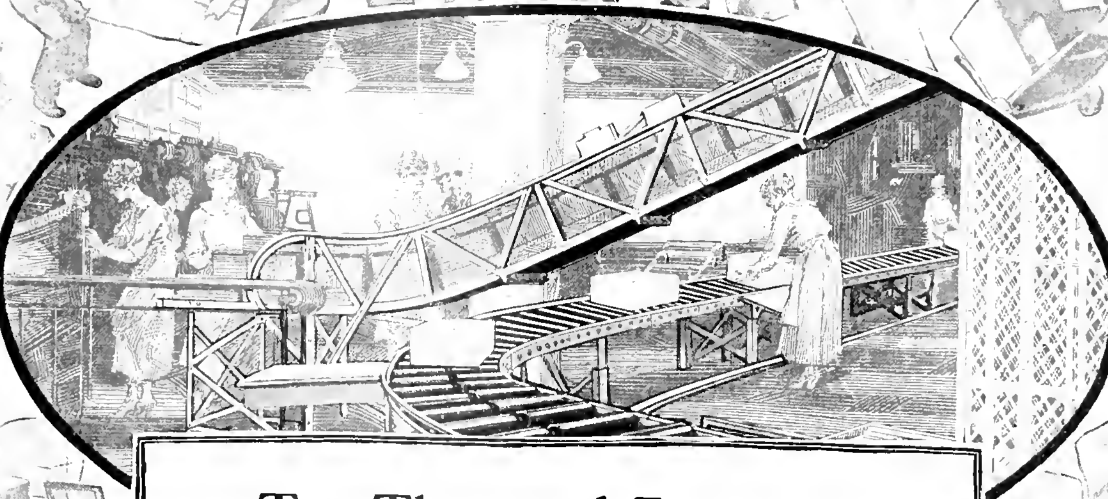
War Developments

War Developments in Industry, Kellaway. Engineering, vol. 106, no. 2763, Dec. 13, 1918, pp. 672-673. Address before Industrial Reconstruction Council, November 1918.

SAFETY ENGINEERING

Accidents and Output

Welfare and Safety. Cassier's Eng. Monthly, vol. 54, no. 6, Dec. 1918, pp. 316-324, 4



Ten Thousand Footsteps You Could Have Saved

WE hear a great deal about overhead charges — but there isn't much said about *underfoot* expense. How much of it is there in your plant? How much does footwork eat into your profits? How much man-power do you employ in toting, carrying and fetching, that *could* be doing a man's real work in production? Yesterday, one man alone took ten thousand footsteps that could have been saved by Lamsonizing your factory.

Lamson Conveyors are the mechanical toters and carriers. They put a stop to footwork and *underfoot* expense. They reduce overhead charges. They collect and deliver parts from one machine room to another. They tote merchandise. They assemble orders and take the goods to the shipping room — and from there to truck or freight-car.

Lamson Conveyors take heavy castings or fragile china to the place that you want them to go. They can't tire. They never lag. They can't make mistakes. Lamson Conveyors operate with orderly, organized regularity. Their route is direct. Nothing can divert them from their work. Their daily capacity is constant—and walls or floors can't stop them.

They go through, while a man goes 'round. They make production flow smoothly and *get the goods out of the works*. The illustration pictures a Lamson Gravity Conveyor. It puts the right thing into the right hands at the right time. Its uses are almost countless.

There's a Lamson Conveying method for every peculiar business, and made to fit *requirements*. Perhaps you need only one Lamson method. It may be that you need a combination. If you are using man-power for toting, for carrying, for pushing a hand-truck, a Lamson man can quickly show you how the Lamson Idea will make a daily saving that will mean much to you—in hard cash. He'll come at your call. If you prefer, send first for our concise Conveyor Book. We'll start it toward you quick-step.

THE LAMSON COMPANY
BOSTON, MASS.

LAMSON SERVICE

Lamson Conveyors

figs. Effect of industrial accidents upon output; means whereby incidence of industrial casualties may be considerably diminished.

Cement Industry

Safety Hazards of Cement Industry, O. C. Soderquist. Concrete Mill Section, vol. 14, no. 1, Jan. 1919, pp. 11-12. Itemizes cement-mill dangers and suggests safety principles and rules.

Fire Protection

Automatic Sprinklers for Fire Protection, Arthur Bateman. Domestic Eng., vol. 86, no. 2, Jan. 11, 1919, pp. 81-83, 4 figs. Notes on their construction, installation and operation.

Grain-Dust Explosions

Experiments with Grain Dust Explosions, Earle William Gage. Am. Miller, vol. 47, no. 2, Feb. 1, 1919, pp. 137-138, 4 figs. Investigations to determine possible cause of explosion and to test various preventive measures.

Lighting

Relation Between Light Curtailment and Accidents, R. E. Simpson. Nat. Engr., vol. 23, no. 1, Jan. 19, 1919, pp. 6-8. Survey of accidents due to improper or inadequate illumination; effect of diminished lighting; suggestions. Paper presented at convention of Illum. Eng. Soc.

Overheating Workmen

The Problems of Overheating Workmen, Chesla C. Sherlock. Am. Drop Forger, vol. 4, no. 12, Dec. 1918, pp. 506-507. Methods of protecting workmen who are in contact with high temperatures; liabilities of employer.

Safety Fuse

Use and Abuse of Safety Fuse. Eng. & Min. Jl., vol. 107, no. 5, Feb. 1, 1919, pp. 229-231. Abstracted from bul. 9 of Indus. Accident Commission, Cal.

See also RAILROAD ENGINEERING, Safety and Signaling Systems.

SALVAGE AND WASTE PREVENTION

High-Speed Steel

The Salvage of High-Speed Steel Tools. J. H. Vincent. Am. Mach., vol. 50, no. 4, Jan. 23, 1919, pp. 169-170, 4 figs. Salvaging milling cutters at comparatively small cost by method of grinding without drawing temper of cutter.

Rust Prevention

Rust Prevention as a Steel Conservation Measure, Denis O'Brien. Elec. Ry. Jl., vol. 53, no. 5, Feb. 1, 1919, pp. 243-244. Writer's experiences in removing rust from steel cars and preventing its spreading to a damaging extent.

Scrap

Saving the Waste with an Electric Furnace, C. B. Merrick. Jl. Elec., vol. 42, no. 1, Jan. 1, 1919, pp. 30-31, 5 figs. Installation of a two-phase Rennerfelt furnace of 750-lb. capacity by Pacific Foundry Co. to utilize small pieces of waste iron such as nails, borings, etc.

Scrap Organization and Scrap Salvaging, Charles A. Reagan. Jl. Soc. Automotive Engrs., vol. 4, no. 1, Jan. 1919, pp. 47-48. Work of the Stores and Scrap Section of Ordnance Department; suggestions in regard to scrap segregation.

Waste Utilization

Possibilities in Saving and Utilizing Industrial Wastes, H. E. Howe. Indus. Management, vol. 57, no. 2, Feb. 1919, pp. 92-96. Points out three responsibilities of manufacturers: To use material of no higher grade than necessary for proper production of goods; to reclaim every particle where a salvaging process is known; to search for means to utilize wastes now thrown away.

TRANSPORTATION

Industrial Trucks

Shop Trucks. Am. Drop Forger, vol. 5, no. 1, Jan. 1919, pp. 18-22, 16 figs. Discussion and description of different types of industrial trucks.

Electric Truck as a Means of Shop Transportation. Can. Machy., vol. 21, no. 5, Jan. 30, 1919, pp. 103-105, 4 figs. Illustrates uses of electric storage battery trucks in industry for automatic transportation in loading and unloading ships and railway cars, and in the machine shop, tire factory, textile mill and electric wire insulating and manufacturing plants.

Industrial Electric Trucks, Tractors and Narrow-Gage Locomotives, Raymond J. Mitchell. Elecn., vol. 82, no. 2121, Jan. 10, 1919, pp. 51-57, 16 figs. Conditions under which electric trucks are to be desired; rapidity with which goods may be handled; main features of electric trucks now on the market; results achieved at the Natua Transfer Station of Pennsylvania Railway.

See also MINING ENGINEERING, Mines and Mining (Cars, Mine); MECHANICAL ENGINEERING, Handling of Materials; Hoisting and Conveying.

VARIA

Acceptances

Trade Acceptances in the Forging Trade, M. A. McCann. Am. Drop Forger, vol. 4, no. 12, Dec. 1918, pp. 475-477. Presents different phases of subject from viewpoint of salesman. Method of procedure explained.

Engineering Societies

American Engineers Locally and Nationally Associated, Alfred D. Flinn. Jl. Cleveland Eng. Soc., vol. 11, no. 3, Nov. 1918, pp. 163-173 and (discussion) pp. 173-178. Plea to engineering organizations to give earnest consideration to problem of coöperation; brief account of growth of Founder Societies and creation of Engineering Foundation; service given by the Engineering Societies Library; advisability of publishing an Engineering Societies periodical.

Engineers

What the War Has Done for Engineers, and the Part Engineers Have to Play in Reconstruction. Engineer, vol. 127, no. 3289, Jan. 10, 1919, pp. 41-42. Abstracted from the Presidential Address of R. E. B. Crompton before the Junior Institution of Engineers.

International Chapters

A New Factor in World Commerce, Richard S. Harvey. Textile World Jl., vol. 55, no. 2, Jan. 11, 1919, pp. 127 and 197. Considerations on advisability of forming international chapters for commercial corporations.

Social Problem

Organizing the State to Assist Individuals—A War Lesson (Die allgemeine Naehrpflicht in Licht der Kriegserfahrung), Max Singer. Zeitschrift des Oesterr. Ingenieur-und Architekten-Vereines, vol. 70, no. 38, Sept. 20, 1918, pp. 409-411, Part 1. Indorses the principles propounded by Josef Popper-Lynkeus, that it is the duty of the State to enable each individual to make a fair and useful living. Discusses solutions of the social problem. Part 2 in no. 39, concluded in no. 40, Oct. 4, 1918.

Industrial Technology

Alcohol

A New Opening for the Electrometallurgical Industry. The Manufacture of Alcohol from Calcium Carbide (Un nouveau débauché pour l'industrie électro-métallurgique. La fabrication de l'alcool en partant du carbure), Revue Générale de l'Electricité vol. 4, no. 24, Dec. 14, 1918, p. 934. A current of acetylene is passed over dilute solution of sulphuric acid having mercury salts as catalyser; resulting acetaldehyde is boiled and vapor passed over layer of finely powdered nickel. From Chemische Technische Wochenschrift, vol. 23, p. 55.

Ammonia

Commercial "Concentrated Ammonia-Liquor" and Its Impurities, H. G. Colman and E. W. Leoman, Jl. Soc. Chem. Indus., vol. 37, no. 24, Dec. 31, 1918, pp. 319T-323T and (discussion) 323T-324T. Analyses of samples from different plants.

Barium

Future of the Barium Industry—A Protective Tariff Required, Hugh Rollin. Mfrs. Rec., vol. 75, no. 3, Jan. 16, 1919, p. 97. Importance of industry and its present undeveloped stage in U. S. Paper before Am. Inst. Chem. Engrs.

Benzols

Analysis of Commercial "Pure" Benzols, F. Butler Jones. Jl. Soc. Chem. Indus., vol. 37, no. 24, Dec. 31, 1918, pp. 324T-327T, 2 figs. Experimental determination of depression of freezing point of benzene occasioned by presence of carbon bisulphide, thiophen, toluene and paraffin. A graph gives volume percentages of four solutes in terms of observed temperatures and specific gravity.

By-Products

Relation of By-Products to Chemical Industries, W. H. Blauvelt. Gas Age, vol. 43, no. 1, Jan. 1919, pp 19-21, 2 figs. Industries built up by Semet-Solvay Co. to utilize by-product chemicals.

Carbide

Practical Points on Carbide Sizes. Jl. Acetylene Welding, vol. 2, no. 7, Jan. 1919, pp. 330 and 354. Method of classification according to sizes; relative value of different sizes of carbide. From Bulletin du Journal Suisse d'Acétylène.

Coal-Gas Products

Some Observations concerning (a) Liquid Purification of, and (b) the Simultaneous Recovery of Sulphur and Ammonia from Coal Gas, P. Parrish. Gas Jl., vol. 144, no. 2897, Nov. 19, 1918, pp. 413-418 and (discussion) pp. 418-420, 4 figs. Brief historical account; theoretical phases of processes; design and arrangement of plants; details of Trepex washer; principles governing dissociation; treatment of waste gases. Paper before Southern district Assn. Gas Engrs. & Mgrs.

Coal-Tar Industry Products, British

Progress in the British Coal Tar Industry, J. B. C. Kershaw. Gas Age, vol. 43, no. 2, Jan. 15, 1919, pp. 77-79, 2 figs. English practice in tar distillation and treatment of light oil fraction with dilute caustic soda; brief note on American methods of working up.

Coloring and Lacquering

Approved Practice in Coloring and Lacquering, James Sleetman. Brass World., vol. 14, no. 11, Nov. 1918, pp. 315-317, 6 figs. (Fourth and concluding article.)

Dust Recovery

Dust Recovery from Gas Scrubber Water. Blast Furnace, vol. 7, no. 1, Jan. 1919, p. 48, 1 fig. Dorr thickener installed in blast-furnace plant to provide automatically for settling of dust from gas scrubbers.

Enamels

The Control of the Luster of Enamels, Homer F. Staley. Jl. Am. Ceramic Soc., vol. 1, no. 9, Sept. 1918, pp. 640-647. Effect of crystallization, viscosity, concentrations, sulphur compounds and index of refraction on brilliancy of enamel. Suggestions given are based on considerations regarding chemical and physical phenomena taking place in manufacturing processes.

Fertilizers

Valuation of Fertilizers, J. Alan Murray. Jl. Soc. Chem. Indus., vol. 37, no. 23, Dec. 16, 1918, pp. 317T-318T. Proposes scheme of valuation based on formula, $x = k + np$ where x is price, k cost of production, p percentage of fertilizing ingredients, and n a coefficient which depends upon x and k.

France

Recent Progress and Future Possibilities of the Chemical Industry in France (Les progrès récentes et l'avenir des industries chimiques en France), Paul Razons. Génie Civil, vol. 73, no. 22, Nov. 30, 1918, pp. 429-433. Pharmaceutical products; petroleum distillation; conditions of growth for industry. (Concluded.)

Gas Manufacture

New Signaling Pyrometer a Means of Contending Against Effects of Inferior Labor. Am. Gas Eng. Jl., vol. 110, no. 2, Jan. 11, 1919, pp. 36-37, 2 figs. Lights inform attendant when damaging variation is approached.

The Utilization of Waste Heat in Gas Works (Die Gewinnung und Verwertung der Abwaerme im Gaswerksbetriebe). A technical and economic study by Director Wenger. Journal fuer Gasbeleuchtung, vol. 61, no. 43, Oct. 26, 1918, pp. 509-513, 3 figs. Continued from p. 501. Concluded Nov. 2. Description of experiments made to secure a higher yield of coke from coal. Waste heat used for heating water of municipal bathhouse.

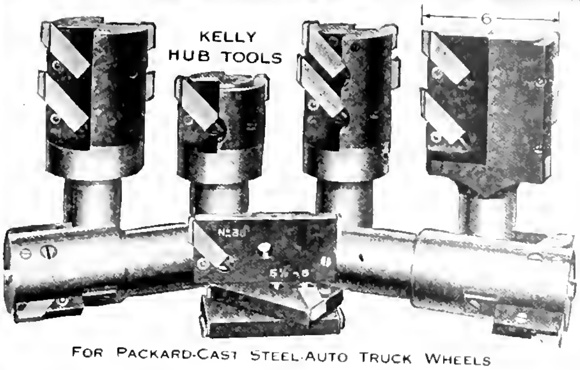
Annual Report of Technical Inspection of Swiss Gas Works (Geschaeftsbericht des Technischen Inspektorates schweizerischer Gaswerke), Journal fuer Gasbeleuchtung, vol. 61, no. 43, Oct. 26, 1918, pp. 505-509, 2 figs. Covers 94 of the 96 gas works of Switzerland and describes equipment used, economies introduced to offset partly the excessively high cost of fuel, accidents, extraction of tar; safety rules and suggestions for further improvements.

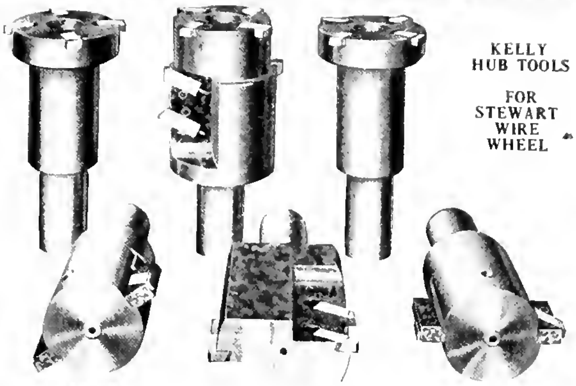
Glass Pots

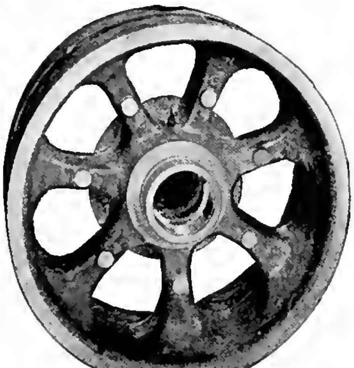
Observations on Apparent Causes of Failure of Lead Glass Pots, A. F. Gorton. Jl. Am. Ceramic Soc., vol. 1, no. 9, Sept. 1918, pp. 648-659. Examination of remains of pots leads writer to conclude that cracking and corrosion are chief causes of failure. Cracks attributed principally to insufficient preheating and corrosion to slagging action of iron on clay.

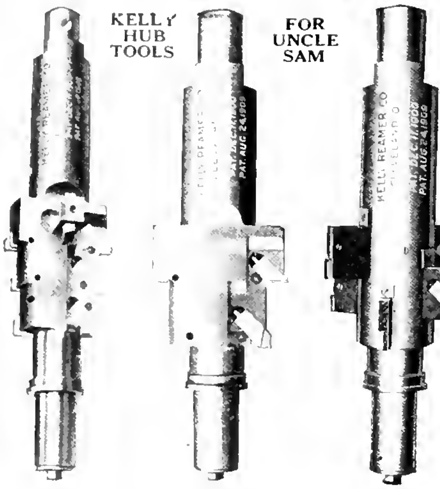
Helium

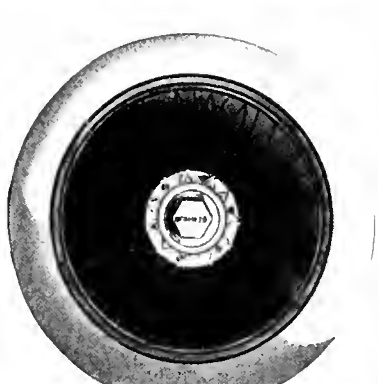
The Production of Helium from Natural Gas, Frederick G. Cottrell. Mech. Eng., vol. 41, no. 2, Feb. 1919, pp. 155-158 and 188, 6 figs. Reviews recent work in liquefaction and separation of gases and production of helium for use in balloons.

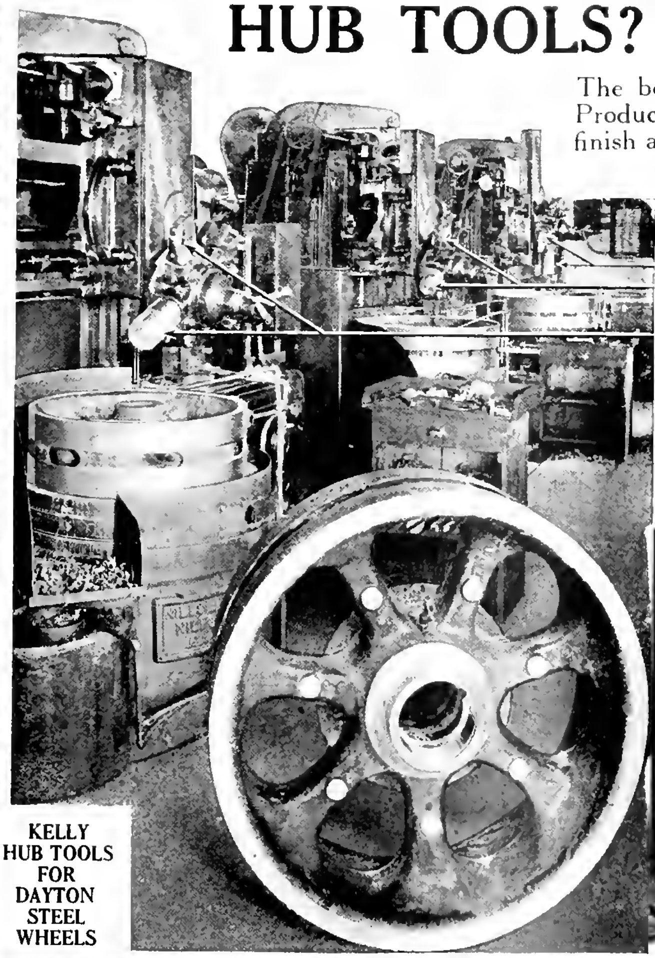

KELLY
HUB TOOLS
6
No.36
FOR PACKARD-CAST STEEL-AUTO TRUCK WHEELS

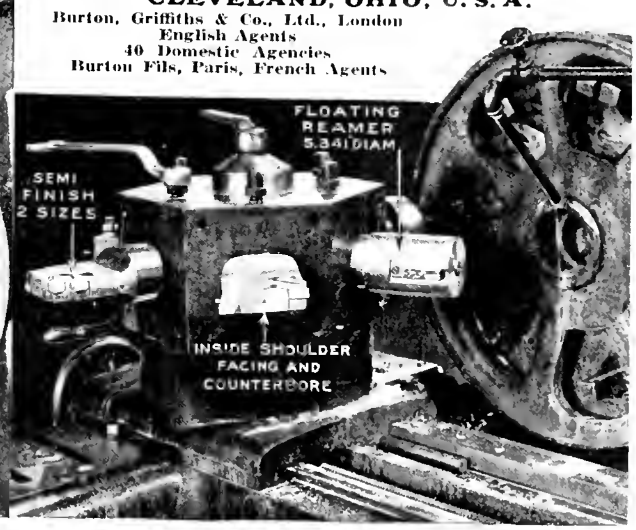

KELLY
HUB TOOLS
FOR
STEWART
WIRE
WHEEL




KELLY
HUB
TOOLS
FOR
UNCLE
SAM




KELLY
HUB TOOLS
FOR
DAYTON
STEEL
WHEELS


FLOATING
REAMER
5.341 DIAM
SEMI
FINISH
2 SIZES
INSIDE SHOULDER
FACING AND
COUNTERBORE

Lime

Reconstruction and Peace Time Problems of Lime Industry, Charles Warner. Concrete, Cement Mill Section, vol. 14, no. 1, Jan. 1919, pp. 7-9. Address by representative of War Service Committee on Lime at Peace Preparedness Congress.

Nitrogen Products

Nitrogen Industry in Germany during the War (L'industrie de l'azote en Allemagne pendant la guerre). Revue Générale de l'Electricité, vol. 5, no. 2, Jan. 11, 1919, pp. 75-76. Details of partial application of Birkeland-Eyde process and more extensive application of Ostwald process.

Industrial Electrochemical Manufacture of Nitrogenous Compounds: Nitric Acid and its Derivations, Cyanamide, Nitrides (La production électrochimique industrielle des composés nitrés: acide nitrique et derivés, cyanamide, azotures), Jean Escard. Revue Générale de l'Electricité, vol. 4. Scheme of installation for manufacturing nitric acid and nitrates from the air. Following furnaces and processes for producing synthetic nitric acid are described: Birkeland-Eyde, Schonherr, Pauling, Moscicki, Kilburn-Scott and Helbig. Dec. 28: Manufacture of cyanamide by reaction of nitrogen on calcium carbide; fixation of nitrogen in boron, magnesium and calcium nitrides; preparation and properties of these compounds.

Fixation of Nitrogen. Jl. Soc. Automotive Engrs., vol. 4, no. 1, Jan. 1919, pp. 16-17. Electric-arc process; building of concrete dam 100 ft. high and 1 mile long at Muscle Shoals to deliver 500,000 hp. for nitrogen-fixation work; cyanamid and Haber processes.

Note on the Bucher Cyanide Process for the Fixation of Nitrogen, Eugen Posnjak and H. E. Merwin. Jl. Wash. Acad. Sci., vol. 9, no. 2, Jan. 19, 1919, pp. 28-30. Experiments with varying amounts of sodium carbonate, carbon and iron; object to determine whether sodium cyanide was formed by Bucher's reaction.

Potash

Various Methods of Obtaining Potash. Commercial Fertilizer, vol. 17, no. 6, Jan. 1919, pp. 42-46. Developments since 1860.

Rubber

Imitation Caoutchoucs or Vulcanized Oils (Les caoutchoucs factices ou huiles vulcanisées), André Dubosc. Chemie & Industrie, vol. 1, no. 7, Dec. 1, 1918, pp. 727-732. Historical note of development; processes of manufacture; classification.

Railroad Engineering

ELECTRIC RAILWAYS

Braking, Regenerative

Brake System with Recuperation of Energy for Vehicles Operated by Single-Phase Commutator Motors (Système de freinage avec récupération d'énergie pour véhicules actionnés par moteurs monophasés à collecteur), Behn-Eschenburg. Revue Générale de l'Electricité, vol. 4, no. 23, Dec. 7, 1918, pp. 877-881, 5 figs. Description and theory of system adopted at Oerlikon Construction Works for the Saint-Gothard locomotives, which permits operation of brakes with recuperation, at all loads and speeds. A coil of known reactance is only apparatus added to normal installation of motor. Also abstracted in Elecn., vol. 81, no. 2118, Dec. 20, 1918, pp. 708-710, 4 figs.

Coasting Clock

The Electric Coasting Clock. Ry. & Locomotive Eng., vol. 32, no. 1, Jan. 1919, pp. 22-23, 3 figs. Instrument which records actual number of minutes an electric train is operated without use of power or brakes.

Government Ownership

Public Ownership the Obvious Policy for Electric Railways, Richard McCullough. Elec. News, vol. 28, no. 1, Jan. 1, 1919, pp. 27-28. Analysis of present situation; advantages of public ownership to public and investor. Paper before Elec. Ry. Assn.

Locomotives

Oscillations of Electric Locomotives (Oscillations des locomotives électriques), P. Leboucher. Revue Générale de l'Electricité, vol. 4, no. 24, Dec. 14, 1918, pp. 914-930, 35 figs. Mathematical analysis of forces developed in members when continuous torque is transmitted by a crank.

Motor-Generator Sets

Performance of Motor Generator Sets for the Chicago, Milwaukee & St. Paul Ry., F. T. Hague. Elec. Jl., vol. 16, no. 2, Feb. 1919, pp. 47-52, 11 figs. Power-factor curves of synchronous motor, temperature curves at full load and 1.5 load, and direct current short-circuit test at 9.25 load. Special reference is made to commutating machinery of large units.

Track Circuits

The Influence of Zinc Ties on Track Circuits. Ry. Age, vol. 66, no. 5, Jan. 31, 1919, pp. 305-306. Report of discussion at the convention of Ry. Signal Assn.

ELECTRIFICATION

Advantages

Railroad Electrification Facts and Factors, A. J. Manson. Ry. Elec. Engr., vol. 10, no. 1, Jan. 1919, pp. 3-4, 1 fig. Reason for adoption of electric motive power and advantages obtained from its use.

C., M. & St. P.

Chicago, Milwaukee and St. Paul Electrification in Washington, W. A. Scott. Elec. Rev., vol. 74, no. 1, Jan. 4, 1919, pp. 1618, 1 fig. Principal features of power, feeder and trolley lines, substation and locomotive equipment.

France

The Partial Electrification of the French Southern Railway (L'électrification partielle des chemins de fur de la Compagnie d'Orléans). Génie Civil, vol. 74, no. 1, Jan. 4, 1919, pp. 4-9, 4 figs. Program of the Paris & Orleans R. R. Conference before the Société d'Encouragement pour l'Industrie Nationale.

South Africa

S. A. R. Annual Report. S. A. Min. Jl. & Eng. Rec., vol. 28, pt. 1, no. 1416, Nov. 16, 1918, pp. 227-228. Electrification and control of shipping in South African Railways. From report of general manager of railways and harbors.

Western States

Transportation and Western Power Problems, John H. Lewis. Jl. Elec., vol. 42, no. 1, Jan. 1, 1919, pp. 14-15. Suggestions in regard to railway electrification and development of navigable streams.

EQUIPMENT

Cinder-Handling Plant

A New Type of Locomotive Cinder-Handling Plant. Ry. Age, vol. 66, no. 5, Jan. 31, 1919, pp. 319-320, 2 figs. Description of a plant for the Pittsburgh and Lake Erie at Hasleton Yard, Youngstown, O., which includes an inclined hoistway to a storage bin.

Coaling Station

New Philadelphia and Reading Coaling Station. Ry. Rev., vol. 64, no. 5, Feb. 1, 1919, pp. 171-176, 6 figs. Plant arranged to handle both anthracite and bituminous; elaborate sand-handling features; general description of what is believed to be the largest concrete coaling station in the world.

FOREIGN

British

British Railways Under War Conditions. Engineer, vol. 126, no. 3283, Nov. 29, 1918, pp. 454-455, Railwaymen with the colors. (Tenth Article)

Government Ownership, British

Nationalization of British Railways. Ry. Gaz., vol. 29, no. 24, Dec. 13, 1918, pp. 671-674, 1 fig. Factors bearing on policy of railroad Government ownership; discussion of basis for arriving at price which will be fair alike to State and shareholders.

Peru

Peru and Its Principal Railways, Clayton Sedgwick Cooper. Ry. Rev., vol. 64, nos. 1 and 2, Jan. 4 and 11, 1919, pp. 1-5, 6 figs. and pp. 61-65, 8 figs. Geography and history of railway construction in Andes.

LOCOMOTIVES

British Express

The New Express Engines of the London & South-Western Railway. Ry. Gaz., vol. 29, no. 14, Dec. 13, 1918, pp. 662-669, 13 figs. Sectional drawings, photographic illustrations, general dimensions and data of 4-6-0 passenger locomotives recently completed at Eastleigh Works.

Diesel-Electric

Diesel-Electric Locomotives (Automotrices Diesel-électriques). Bulletin Technique de la Suisse Romande, year 44, nos. 14, 15, 16 and 17, July 13 and 27, Aug. 10 and 24, 1918, pp. 129-132, 137-140, 145-149 and 157-158, 13 figs. Extensive descriptions of mechanical arrangement and electrical schemes. A Diesel engine operates a d.c. dynamo; current from dynamo feeds traction motors; Ward-Léonard system followed. Abstract in Revue Générale de l'Electricité, vol. 4, no. 23, Dec. 7, 1918, pp. 891-896, 6 figs.

Feedwater Heating

Locomotive Feed Water Heating, H. S. Vincent. Ry Mech. Eng., vol. 93, no. 1, Jan. 1919, pp. 44-47, 4 figs. Discussion of exhaust-steam and waste-gas methods of preheating for locomotive boilers. (Second article.)

Fireboxes

A New Departure in Firebox Construction. Ry. Rev., vol. 64, no. 2, Jan. 11, 1919, pp. 47-51, 5 figs. Means of taking advantage of principle of radiant heat transfer.

Lubricators

Force Feed Lubricator. Ry. & Locomotive Eng., vol. 32, no. 1, Jan. 1919, pp. 11-12, 1 fig. Records obtained with Schlacks system of forced-feed lubrication as applied to locomotives.

Mallet

The U. S. Standard Light Mallet Type Locomotive. Ry. Age, vol. 66, no. 5, Jan. 31, 1919, pp. 290-292, 4 figs. 2-6-6-2 wheel arrangement with weight on drivers of 358,000 lb. and tractive effort, compound, of 80,000 lb. Description with principal data and drawings.

Mallet Type Locomotive for Utah Railway. Ry. Rev., vol. 64, no. 3, Jan. 18, 1919, pp. 85-86, 1 fig. Description with principal data of articulated compound built for heavy freight and pusher service.

Mountain Type

Mountain Type Locomotives for the Atchison, Topeka & Santa Fe. Ry. & Locomotive Eng., vol. 32, no. 1, Jan. 1919, pp. 3-4, 1 fig. Particulars of 4-8-2 type recently completed at Baldwin Locomotive Works.

New Zealand Narrow Gage

Express Locomotives for 3-ft., 6-in. Gauge. Engineering, vol. 106, no. 2760, Nov. 22, 1918, pp. 576-579, 31 figs. Principal data, drawings of details, test results and general description of certain locomotives on New Zealond Government Railways.

Pennsylvania 2-10-2

Heaviest 2-10-2 Type Built for Pennsylvania Lines. Ry. Age, vol. 66, no. 4, Jan. 24, 1919, pp. 249-251, 4 figs. Principal data, drawings and description.

Rock Island 2-10-2

Rock Island 2-10-2 Locomotive. Ry. Mech. Eng., vol. 93, no. 1, Jan. 1919, pp. 41-43, 5 figs. New designs of cab and spark arrester; grease lubrication used on crossheads and trailer.

Stokers

New Locomotive Stoker Tested Out on Erie. Ry. Age, vol. 66, no. 3, Jan. 17, 1919, pp. 202-204, 4 figs. Mechanical distribution of coal; maintains light fire and reduces cinder and standby losses.

The Elvin Mechanical Stoker for Locomotives. Ry. Rev., vol. 64, no. 4, Jan. 25, 1919, pp. 132-134, 4 figs. Important features are minimum power requirements and a mechanical means of fuel distribution.

Switches, Geared

Lima Locomotive in Switching Service With the Tennessee Coal, Iron and Railway Company. Ry. & Locomotive Eng., vol. 32, no. 1, Jan. 1919, pp. 10-11, 2 figs. Service given by geared locomotive in industrial switching; its special advantages.

Tenders

Canadian Pacific Railway Locomotive Tenders. Can. Ry. & Marine World, no. 251, Jan. 1919, pp. 11-12, 4 figs. Coal container with slope and bottom sheets independent of tank. Coal automatically delivers itself at shovel sheet without coal passer.

Thermic Siphons

Chicago, Milwaukee & St. Paul Railway Test of Locomotive Equipped with the Nicholson Termic Syphons. Ry. & Locomotive Eng., vol. 32, no. 1, Jan. 1919, pp. 7-9, 1 fig. Principal dimensions, data and performances of two engines. Firebox of one was equipped with Nicholson thermic syphons supporting brick arch; other had ordinary type of arch supported on four 3-in. arch tubes.

Tires

Shrinkage of Locomotive Tyres. Ry. Gaz., vol. 29, no. 25, Dec. 20, 1918, pp. 703-704, 1 fig. Methods adopted at Doncaster Works for determining tire shrinkage and for checking allowance of tires.

U. S. Standard

Two More Standard Locomotives. Ry. Mech. Eng., vol. 93, no. 1, Jan. 1919, pp. 25-30, 12 figs. Heavy 4-8-4 and light 2-10-2 types are well proportioned and have essentially same boiler.

Standard 2-10-2 and 2-8-2 Type Locomotives. Ry. Rev., vol. 64, no. 1, Jan. 4, 1919, pp. 7-12, 9 figs. Principal data and drawings with general description. Two government standard engines whose boilers come nearest interchangeability.

New Locomotives of Standard Design. Boiler Maker, vol. 19, no. 1, Jan. 1919, pp. 1-2, 4 figs. Dimensions of four locomotives recently delivered to U. S. R. R. Administration. Totals of boiler-heating surfaces vary from 1891 to 4285 sq. ft.

NEW CONSTRUCTION

Avlona-Monastir

Avlona-Monastir Railroad Project (Proyecto del ferrocarril Avlona-Monastir). Revista de Obras Publicas, year 66, no. 2257, Dec. 26, 1918, pp. 645-647, 2 figs. General plan for consolidation of various lines into a Trans-Balkan Italian System with ferry boat service across Otranto Canal. From Giornale del Genio Civile.

Kalka-Simla

The Kalka-Simla Railway and Rolling Stock. Engineer, vol. 126, no. 3283, Nov. 29, 1918, pp. 455-458, 18 figs. General illustrated description of railway and of rolling stock.

Katanga

The Katanga Railway. Engineer, vol. 126, no. 3285, Dec. 13, 1918, pp. 501-504, 17 figs. Description of its construction, some engineering features and equipment.

OPERATION AND MANAGEMENT

British

British Railways Under War Conditions. Engineer, vol. 126, no. 3286, Dec. 20, 1918, pp. 528-529. The dispatch of the expeditionary force. Vol. 127, no. 3289, Jan. 10, 1919, pp. 38-39. The first six months.

Freight Handling

Proper Methods of Handling Freight, E. P. Nowlin. Ry. Rev., vol. 64, no. 1, Jan. 4, 1919, pp. 5-6. Introducing scheme of reorganization whereby to reduce loss and damage expense.

French

French Railroads During the War (Los ferrocarriles franceses durante la guerra) Boletin de Minas, vol. 10, nos. 7-9, Sept. 30, 1918, pp. 106-110. Organization and operation. Executive direction of each road in hands of a commission composed of a military officer and a technical expert. From documents published by Chamber of Commerce, Paris, June, 1918

Post-War Conditions

The Railway Situation Created by the War (La crisis ferroviaria antes de la guerra y situacion creada por esta). Revista de Obras Publicas, year 66, no. 2246, Oct. 10, 1918, pp. 509-514. Points out critical financial condition of railways in Spain and generally throughout the world, shown by constantly diminishing scale of profits due to rising expenses for fuel, labor and materials. Financial results obtained by railway working in France, England and Germany for period 1901-1913 are given in tabular form.

Supervision

Supervision, J. L. Wilkes. Ry. Club of Pittsburgh, vol. 18, no. 1, Dec. 19, 1918, pp. 6-17 and (discussion) pp. 17-26. Duties of railroad supervisors; qualifications required to fill position completely; suggestions to supervisors in regard to efficiency in discharge of their functions.

U. S. Railroad Administration

The Federal Railroad Administration of the United States, W. M. Acworth. Ry. Gaz., vol. 29, no. 24, Dec. 13, 1918, pp. 651-660. Historical account of conditions in the railroads during the years of the war, specially since the Government took over their operation. Compiled from newspapers, unofficial reports, private correspondence, and public documents.

PERMANENT WAY AND BUILDINGS

Landslip

A Railway Landslip. Times Eng. Supp., no. 530, Dec. 1918, p. 253. Incidents attending movement of wall at Wembley on Great Central Ry.; method of reconstruction.

Montreal Tunnel

The Canadian Northern Railway's Montreal Tunnel from an Economic Point of View, H. K. Wicksteed. Can. Ry. & Marine World, no. 251, Jan. 1919, pp. 1-5, 1 fig. Economical considerations which decided on selection of tunnel route at Montreal with general reference to economical aspect of tunnel construction in railway lines.

Spikes

Screw-Spikes versus Dog-Spikes. Indian Eng., vol. 64, no. 16, 17, 18, 19 and 20, Oct. 19, 26, Nov. 2, 9, 16, 1918, pp. 223-224, 237-238, 251-252, 265-266, 279-280. Reports of experience on Indian railways of comparative efficiency of dog-spikes and screw-spikes for hard and soft wood sleepers. Following points are touched: holding power, gage keeping, creep holding, ease of maintenance and estimated comparative costs, relative advantages in construction, and relative cracking effect on sleepers. (To be continued.)

Water Tanks

Concrete Railway Water Tanks. Ry. Gaz., vol. 29, no. 26, Dec. 27, 1918, p. 728, 2 figs. Details of type commonly used for settling basins

RAILS

Corrugation

Rail Corrugation. Ry. Gaz., vol. 29, no. 26, Dec. 27, 1918, pp. 725-728, 3 figs. Wheel tire is provided with groove, the corners of which present angular cutting edge or edges. This form is said to prevent tendency of rails to develop corrugation.

ROLLING STOCK

Couplers

Development and Construction of Standard Couplers. Ry. & Locomotive Eng., vol. 32, no. 1, Jan. 1919, pp. 5-6, 4 figs. Review of work done by committees of Master Car Builders' and Master Mechanics' Assns. to standardize various parts and contour of couple.

Northern Pacific Box Cars

Northern Pacific Builds Box Cars. Ry. Mech. Eng., vol. 93, no. 1, Jan. 1919, pp. 37-40, 7 figs. Interesting design of underframe and end on cars being constructed in company shops.

Timber

Use of Treated Timber in Car Construction. Ry. Age, vol. 66, no. 5, Jan. 31, 1919, pp. 295-298. Influence of decay on life of wooden car parts, methods of treating and results secured. From a report presented at the convention of the Am. Wood Preservers' Assn.

Trucks

Car Trucks, L. Brown. Can. Ry. Club, vol. 17, no. 9, Dec. 1918, pp. 17-28 and (discussion) 28-35, 1 fig. Manufacture and mounting of wheels; uses of Master Car Builder's standard mounting; preparation of journal bearings and dust guards; requirements of bolsters; location of brakes.

SAFETY AND SIGNALING SYSTEMS

Car Repairmen

To Prevent Injuries to Car Repairers, H. W. Johnston. Official Proc. Car Foremen's Assn., Chicago, vol. 14, no. 3, Dec. 1918, pp. 13-25, 4 figs. Records of accidents on N. Y. C. R. R. show that accidents are minimized by careful observation of practices of employees and thoughtful instruction of new men as to hazards peculiar to work; hence responsibility for accidents is placed on foremen.

Grade Crossings

The Prevention of Accidents at Grade Crossings, C. L. Addison. Am. City, vol. 20, no. 1, Jan. 1919, pp. 7-10, 1 fig. Plan of the grade-crossing publicity campaign conducted by Long Island R. R. Co.; means of grade-crossing protection.

SHOPS

Balboa Shops

War Time Work at Balboa Shops, Panama Canal, R. D. Gatewood. Am. Mach., vol. 50, no. 5, Jan. 30, 1919, pp. 191-194, 11 figs. A brief description of some of the great variety of work being done at the Balboa shops.

Supervision

Efficient Supervision of Railroad Shops, Frank McManamy. Boiler Maker, vol. 19, no. 1, Jan. 1919, pp. 4-5. Locomotive mileage increased by speedy repair work at roundhouse; essentials of adequate supervision; responsibility of executives.

Welding

Arc Welding in Railroad Shops, B. C. Tracy. Gen. Elec. Rev., vol. 21, no. 12, Dec. 1918, pp. 887-898, 20 figs. Describes more important applications of electric welding in making locomotive repairs.

West Burlington Shops

West Burlington Shops of the C. B. & Q. Ry. Mech. Eng., vol. 93, no. 1, Jan. 1919, pp. 5-16, 21 figs. Equipment and operation of new erecting and machine shop, blacksmith shop and power plant.

SPECIAL LINES

Narrow-Gage Railroads

Narraw-Gage Railroads (Chemins de fer à voie étroite), G. Mangin. Génie Civil, vol. 73, no. 26, Dec. 1918, pp. 504-510, 32 figs. Material used in construction of German strategical military railways. Gage 23.6 in. (60 cm.). Data taken from inspection of evacuated areas. Organization of road construction given from official documents left in field by retreating Germans. Supplements article in Génie Civil, vol. 72, no. 14, Apr. 6, 1918, p. 229.

STREET RAILWAYS

Emergency Work

Some Emergency Special Work Construction, Thomas B. McMarth. Elec. Ry. Jl., vol. 53, no. 3, Jan. 18, 1919, pp. 145-146, 4 figs. Indianapolis company utilizes acetylene cutting and thermit welding in building up curve crosses.

Fares

Is the Zone System the Fare Solution? Thos. Conway, Jr. Elec. News, vol. 27, no. 24, Dec. 15, 1918, pp. 29-31. Comparison of fare collection and regulation systems used in U. S. Paper before Am. Elec. Ry. Assn. Also in Street Ry. Bul., vol. 18, no. 12, Dec. 1918, pp. 519-521.

Franchises

Features of Service-at-Cost Plan Franchise. Elec. News, vol. 28, no. 1, Jan. 1, 1919, pp. 29-30. Ordinance containing following principal provisions: General transfer system; complete control of service and operation by city; right of city to reroute; authority of council to order extensions and establish new and additional routes; and franchise tax to be paid to city.

Motors, High-Power

High Power Motors in Tramway Service (Sur l'emploi de moteurs puissants par les tramways), Lucien Pahin. Industrie Electrique, year 27, no. 636, Dec. 25, 1918, pp. 464-467, 6 figs. Equipment of 95-hp. Westinghouse motors used by the Compagnie de Chemins de fer de Paris.

Skip Stops

Skip-Stop Proves Safety Measure. Electric Traction, vol. 15, no. 1, Jan. 15, 1919, pp. 4-6, 3 figs. Diagrams showing reduction in hazard of collisions and boarding and alighting with skip-stop operation, prepared from records of Detroit United Ry.

Tests

Car Equipment Service Tests Determine Fitness of Apparatus, C. W. Squier. Elec. Ry. Jl., vol. 53, no. 3, Jan. 18, 1919, pp. 128-133, 12 figs. Method of making operating tests and heat runs; how sections of track can be best laid out to represent actual service requirements; organization necessary for proper test force; results obtained in specific case.

Track Circuits

Leakage Resistance of Electric Railway Roadbeds, E. R. Shepard. Elec. Ry. Jl., vol. 53, no. 4, Jan. 25, 1919, pp. 172-178, 7 figs. Results of tests covering a period of more than three years made upon railway tracks in Washington, D. C., and upon short sections of experimental track on the Bureau of Standards grounds.

Track Construction

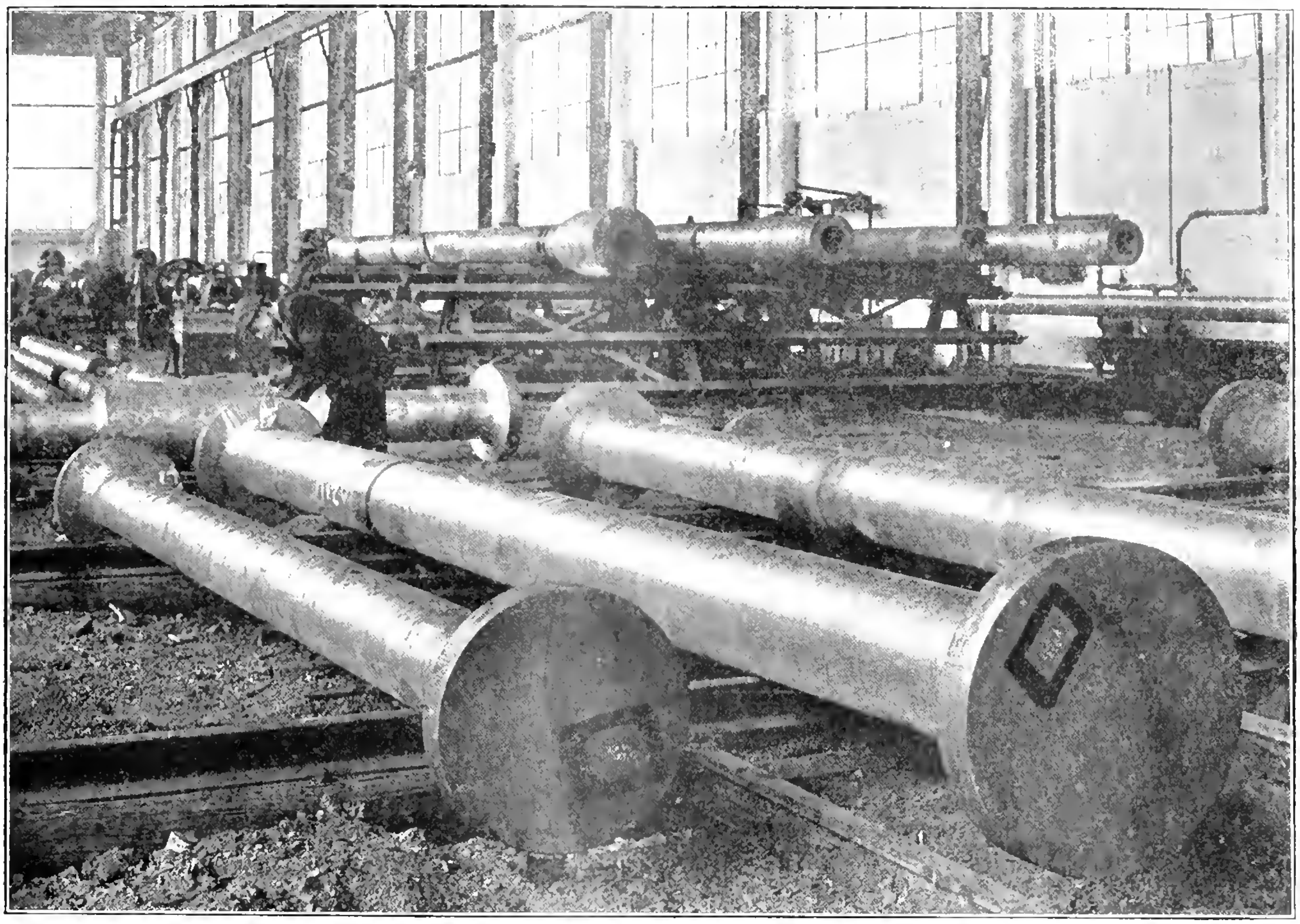
Removing Old Paving for New Track Construction, C. W. Geiger. Elec. Traction, vol. 15, no. 1, Jan. 15, 1919, pp. 30-31, 8 figs. To cut through asphalt a flange was heated and shrunk onto roller of a heavy steam-roller; flange was then sharpened so as to cut down through asphalt when roller was run over it.

TERMINALS

Cleveland Union Station

Union Depot Project for Cleveland, W. E. Pease. Jl. Cleveland Eng. Soc., vol. 11, no. 3, Nov. 1918, pp. 179-185 and (discussion) pp. 185-191. Studies of traffic movements undertaken at New York preliminary to designing some of its terminals; application to conditions in Cleveland.

CAMDEN



COMING THRU

our shops we can see all types and sizes of forgings. Some are smooth forged, some rough turned and some finished complete. We call them all

CAMDEN FORGINGS

If you could but see this variety and could but know of our product and of us, there would surely come a time when you would say,

"SEND CAMDEN THAT FORGING INQUIRY"

BUYERS' MEMO

High and Low Carbon Bars
Press Columns and Rams
Pull Back Cylinders
Water Cylinders
Valve Bodies
Plungers
Weldless Steel Rings
Lathe Spindles, solid and hollow bored
Long Feed Screws
Power Press Crank Shafts
Rudder Arms

Rudder Stocks
Cam Shafts
Eccentric Shafts
Crusher Shafts
Gear and Pinion Blanks
Rolls: Bending, Feed, Straightening, *Embossing*
Large Wrenches
Saw Arbors

Locomotive: Side and Main Rods, Crank Pins, Axles, Rod Straps, Guides, Parts of frame both in iron and steel
Hammered Iron Bars for locomotive repairs
Marine Shaft
Marine Connecting and Eccentric Rods

Steam Engine Forgings
Pump Crank Shafts
Pump Connecting Rods
Large Nuts
Turbine Shafts
Mill Shafting
Trolley Car Axles
Electric Motor Axles
Any forging to your print, and specifications, in either iron or steel

CAMDEN FORGE CO.
CAMDEN, N.J., U.S.A.

Erie

New Car Barn and Trainmen's Room at Erie, H. P. Amthor. Elec. Traction, vol. 15, no. 1, Jan. 15, 1919, pp. 15-19, 4 figs. Description of terminal of Buffalo & Lake Erie Traction Co., giving details of construction, type of skylight, pit construction and method of fastening rails to pit piers.

Richborough

The Richborough Transportation Depot and Train Ferry Terminus. Engineer, vol. 127, no. 3289, Jan. 10, 1919, pp. 31-34, 9 figs. Construction; railway facilities; traffic organization; signalling arrangements; rolling stock; barge and train ferry services.

St. John, N. B.

The Railway Terminals, etc. at St. John, N. B., C. C. Kirby. Can. Ry. & Marine World, no. 251, Jan. 1919, pp. 9-11, 1 fig. Problem of their future extension to meet development of port.

Sebastopol, Cal.

New Passenger Depot at Sebastopol, California. Elec. Traction, vol. 15, no. 1, Jan. 15, 1919, pp. 19-21, 2 figs. Layout of station of central point where railroad radiates in three directions.

Munitions and Military Engineering

Anti-Submarine Devices

The American Destroyer. Sci. Am., vol. 119, no. 26, Dec. 28, 1918, p. 515, 3 figs. 1200-ton destroyer, depth bomb and other accessories which have contributed to the destruction of U-boats.

Camps

Engineering Features of Camp Dodge, L. P. Wolff. Bul. Affiliated Eng. Societies Minn., vol. 3, no. 12, Dec. 1918, pp. 208-220, 1 fig. Waterworks; sewerage system; railroads; streets and highways; heating.

Gun Mounts

Making Naval Gun Mounts, Franklin D. Jones. Machy., vol. 25, no. 6, February 1919, pp. 485-492, 17 figs. First of two articles describing special tools, gages and fixtures used at the plant of the Mead-Morrison Mfg. Co., where 1000 complete mounts for 4-inch guns are being constructed for the United States Navy.

Hand Grenades

Making the American Hand Grenade, Edward K. Hammond. Machy., vol. 25, no. 6, February 1919, pp. 519-524, 18 figs. Second of two articles on methods of machining and loading the bodies and assembling the bouchons.

Howitzers

How a 155-Mm. Howitzer is Made, J. V. Hunter. Am. Mach., vol. 50, nos. 5 and 6, Jan. 30 and Feb. 6, 1919, pp. 199-204 and 249-252, 32 figs. The breech.

Inspection

The Inspector's Standpoint in Munition Production, John T Marsh. Jl. Cleveland Eng. Soc., vol. 11, no. 3, Nov. 1918, pp. 131-152, 9 figs. Qualifications required by inspectors; conditions likely to be found in relations between manufacturers and inspectors; rejections for pipe; duties of inspectors in regard to brinelling.

Lewis Machine Gun

The Manufacture of the Lewis Machine Gun, Frank A. Stanley. Am. Mach., vol. 50, no. 2 Jan. 9, 1919, pp. 55-60, 17 figs. The radiator, locking piece and magazine. (Fourteenth article.)

Motor Transport

Engineering Division of the Motor Transport Corps, John Younger. Jl. Soc. Automotive Engrs., vol. 4, nos. 1 and 2, Jan. and Feb. 1919, pp. 5-8 and 77-85, 2 figs. Jan.: Functions of engineering division; organization scheme; work of technical service branch. Feb.: Function of design section, standardized directions for heat treatment of steel; chemical analysis and physical properties of carbon steel; chart of steel specifications, chemical and physical properties.

Ordnance Depot

Huge Steel Buildings at Ordnance Base Depot in France, Robert K. Tomlin. Eng. News-Rec., vol. 82, no. 3, Jan. 16, 1919, pp. 124-129, 10 figs. Project includes both shops and warehouses; all material supplied from United States; transmission line built to supply electric power for machine-tool operation.

Railway Batteries

The 14-in. Naval Railway Batteries, C. L. McCrea. Am. Mach., vol. 50, no. 4, Jan. 23, 1919, pp. 141-149, 11 figs. Story of design, construction, shipping, reërecting abroad and placing in action on the fighting front of the U. S. Navy's 14-in. guns on railway mounts.

Railways

Our Railway War Forces Aboard. Ry. Mech. Eng., vol. 93, no. 1, Jan. 1919, pp. 19-22, 6 figs. Account of problems encountered in France and shop facilities for erecting equipment.

Shell Manufacture

Unique Shell-Profile Turning Attachment, Donald A. Baker. Am. Mach., vol. 50, no. 4, Jan. 23, 1919, pp. 161-162, 1 fig. Design made to start cut at small end of shell, turn the radius and continue to turn parallel until disengaged.

High Explosive Shells and Shrapnel, J. M. Hall. Am. Drop Forger, vol. 4, no. 12, Dec. 1918, pp. 500-504. How shells are heat treated; physical and chemical requirements; heating of steel for forgings. From paper presented before Steel Treating Research Soc.

Manufacture of Six Inch High Explosive Shells for the United States Army, T. D. Lynch. Elec. Jl., vol. 16, no. 1, Jan. 1919, pp. 17-25, 23 figs. Description of Shadyside Plant of Westinghouse Electric & Mfg. Co., equipped to manufacture 6-in. shells at the rate of 3000 per day, working day and night.

Shell-Manufacturing Tools

Special Tools for Shell Manufacture, George A. Neubauer and Erik Oberg. Machy., vol. 25, no. 6, February 1919, pp. 534-537, 12 figs. Second of two articles describing a number of devices used by the Buffalo Pitts Co.

See also METALLURGY, Iron and Steel (Molybdenum Steel); MECHANICAL ENGINEERING, Motor-Car Engineering (Tanks).

General Science

CHEMISTRY

Analytical Chemistry

Method of Least Squares Applied to Estimating Errors in Coal Analysis, J. D. Davis and J. G. Fairchild. Department of Interior, Bur. of Mines, Tech. Paper 171, 36 pp., 6 figs. Following limits of error are calculated: for sampling, 0.20 per cent; for ash determination, 0.40 cent; for moisture determination, 0.20 per cent; for heating-value determination, 0.75 per cent. Thus writers conclude that limits allowed by committee on coal analysis of Am. Soc. Testing Materials represent values within which a large percentage of errors will actually fall.

Flame Reactions

Flame Reactions: Selenium and Tellurium in the Hydrogen-Air Flame, Jacob Parish. Jl. Phys. Chem., vol. 22, no. 9, Dec. 1918, pp. 640-646. Extension of writer's previous experiments (Jl. Phys. Chem., 22, 430, 1918) to behavior of selenium dioxide, tellurium dioxide, hydrogen telluride, and of elements themselves, in hydrogen-air flame.

Physical Chemistry

Physical Chemistry and Its Bearing on the Chemical and Allied Industries, James C. Philip. Jl. Roy. Soc. Arts, vol. 67, nos. 3450 and 3452, Jan. 3 and 17, 1919, pp. 94-102 and 122-131, 1 fig. Jan. 3: Factors which determine equilibrium in a reversible reaction; thermodynamic equation expressing influence of temperatnre on equilibrium constant of a reaction, and its relation to heat effect of reaction. Jan. 17: Laws and principles governing absorption of gases and dissolved substances.

Structure of Matter

The Atomic Weight of Lead from Samarskite, Arthur L. Davis. Jl. Phys. Chem., vol. 22, no. 9, Dec. 1918, pp. 631-639. Separation of lead from samarskite, its purification, and determination of its atomic weight by means of analyses of lead chloride; parallel experiments with ordinary lead and comparison of relative values under same conditions of experimentation; correlation of results with theory of radioactive changes involved by determination of percentages of uranium and thorium.

The Determination of the Molecular Complexity of Liquid Sulphur, Alex. Mitchell Kellas. Jl. Chem. Soc., vols. 113 and 114, no. 671, Dec. 1918, pp. 903-922, 4 figs. Series of experiments to determine surface tension of liquid sulphur between melting point and boiling point by means of capillary tubes.

Ultra-Violet Light

Ultra Violet Light. Its Application in Chemical Arts—XX, Carleton Ellis and A. A. Wells. Chem. Engr., vol. 26, no. 13, Dec. 1918, pp. 505-506 and 521. Ultra violet absorption of aliphatic ketones and aldehydes. Compilation of researches by different experiments.

MATHEMATICS

Elliptical Functions

Elementary Solution of the Inversion of Elliptical Functions (Solution élémentaire du problème de l'inversion des fonctions elliptiques), René Garnier. Comptes rendus des séances de l'Académie des Sciences, vol. 167, no. 22, Nov. 25, 1918, pp. 748-750. Generalization of Landen's transformation.

Logarithms

Logarithms of Hyperbolic Functions to Twelve Significant Figures, Frederick E. Pernot and Baldwin M. Woods. Univ. of Cal. Publications in Eng., vol. 1, no. 13, Nov. 16, 1918, pp. 297-467. Tables of logarithms to base 10 of three principal hyperbolic functions for range from 0 to 2 with tabular interval of 0.001, and auxiliary tables of log (sinh x/x) and log (x/tanh x) for range from 0 to 5 with same tabular interval.

PHYSICS

Capillary Layers

Thickness and Structure of a Capillary Layer of a Liquid in Contact with Its Saturated Vapor (Die Dicke und Struktur der Kapillarschicht einer Fluessigkeit in Beruehrung mit ihrem gesattigten Dampf), G. Bakker. Annalen der Physik, vol. 54, no. 20, 1917, pp. 245-295, 5 figs. Discussion of potential function of the forces of attraction. Application to thermodynamics. Comparison of theoretical results in the experimental determinations made on gases, hydrocarbons, water, alcohols, including their freezing points. Mathematical treatment.

Compressibility of Solutions

Compressibility of Aqueous Solutions, Especially of Urethane, and the Polymerization of Water, Theodore W. Richards and Sven Palitzsch. Jl. Am. Chem. Soc., vol. 41, no. 1, Jan. 1919, pp. 59-61, 1 fig. Compressibilities of aqueous solntions of urethane were measured at 20 deg. cent. over pressure range from 100 to 300 megabars, as were also surface tension, specific volume and viscosity. Bearing of results on theory of Harold Whiting ascribing polymerization to water is emphasized.

Heat Conductivity

Experiments on the Heat Conductivity of Gases (Experimentelle Untersuchungen ueber die Waermeleitfaehigkeit der Gase), Sophus Weber. Annalen der Physik, vol. 54, no. 21, 1917, part 1, pp. 325-356, 9 figs.; no. 22, part 2, pp. 437-462, 2 figs. Theory and correction factors employed in accurate determinations of heat conductivity using an electric calorimeter which is a modified Schleiermacher apparatus, applied to air and pure gases at various pressures and suitable for other insulators. For dry air with convection and CO_2 eliminated, $K_0 = 0.000056S1$ gram calories, deg. cent., sq. cm. In part 2 is given the heat conductivity of hydrogen, neon, helium, argon, nitrogen, oxygen, methane, CO_2, N_2O. Tests were conducted at the incandescent lamp works of N. V. Philips, Eindhoven, Holland.

Internal Friction

On the Interior Friction of Quartz Fibers at Low Temperatures (Remarque sur le frottement intérieur des fils de quartz aux basses températures), C.-E. Guye and P. Barbier. Archives des Sciences Physiques et Nautralles, vol. 46, Dec. 1918, pp. 326-328. Experiments to determine cause of slow variation of internal friction as temperature diminishes from +80 to —194 deg. cent.

Radiations

The Gamma Ray Activity of Thorium, D. Herbert N. McCoy and G. H. Cartledge. Jl. Am. Chem. Soc., vol. 41, no. 41, Jan. 1919, pp. 50-53. Determination of Th D; The ratio in order to ascertain whether combined mesothorium and thorium D activities would give total γ activity.

Sound Waves, Reflected

Submarine Range-Finding by Means of Reflected Sound Waves. Sci. Am., vol. 120, no. 4, Jan. 25, 1919, pp. 67 and 82. Modification by Elias Ries of his apparatus for accurate positioning of icebergs. Subaqueous device consists of two megaphone receivers pivoted at ends of horizontal arm and a sound projector mounted in center; operation similar to that of aerial apparatus.

THE LARGE STEAM TURBINE

Development of Large Units to Meet Modern Power Requirements—Records of Performance—Notes on Design and Construction

By J. F. Johnson,[1] Pittsburgh, Pa.

THE remarkable growth of the electric-power industry during recent years has been paralleled by an equally remarkable development of steam-turbine-driven generating units. So rapid has been this development that frequently before the first machine of a new design was completed another of materially greater capacity and higher efficiency was being designed.

While machines of 15,000 kw. capacity were put into operation as early as 1908, their use did not become general until 1913; and yet today nearly every one of what may be called our large generating stations has at least one unit of 30,000 kw. capacity or larger.

Has this growth been natural and healthy, or has it been forced? Will the tendency be toward larger units or will a reversion to smaller sizes occur? If such reversion occurs, will it be the result of faulty engineering, born of overconfidence on the part of the builders or users of the apparatus, or because units of 30,000 kw. and larger are too large for the present and immediate future requirements of our large power-generating stations?

In our chief industrial centers, the electric-power industry has attained its broadest development. Here the appeal of "Do It Electrically" has gained a universal response. As a result power consumption per unit of area has reached high values and this has encouraged the formation of large public-service companies, both by means of development, and by means of consolidation of smaller ones. Moreover, a careful analysis of the present applications of electric power will not disclose a likelihood of serious decrease in any of them. On the other hand, there are many applications in which marked future growth seems certain. Important among these are the separation and purification of metals, the use of the electric furnace in metallurgy, and the electrification of our present steam railroads. There can be no doubt that the electric power industry is today only in the midst of a rapid and healthy growth.

In designing machines of large capacity, the selection of the number and sizes of units in a station of given capacity is most important since this selection materially affects the total cost of power generated. If the sizes of units be too small, the cost per kilowatt of the completed station will be greater, the maintenance and operating expenses higher, the efficiency lower, and the reliability at least no greater than if the proper sizes are used. On the other hand, if the units be too large, the cost per kilowatt installed may be too great because of the greater reserve capacity required, and the efficiency may even be lower by reason of the units operating at loads too far below their points of best efficiency.

Take for example a district with a maximum peak requirement of 600,000 kw. To insure proper reliability it is decided to generate in three stations of approximately equal sizes. Assume that these stations will normally always operate in parallel and that there will be one spare unit for each five in service during the peak. If 20,000-kw. units were used, there would be 30 operating and six spares, a total of 36 units, 12 in each station. If 30,000-kw. units were used, there would be 20 operating and four spares, a total of 24 units, eight in each station. If 40,000-kw. units were used, there would be 15 operating and three spares, a total of 18 units, six in each station. If 60,000-kw. units were used, there would be ten operating and two spares, a total of 12, four in each station.

If, in order to remove from this consideration of ideal size of units conditions imposed by the design of the apparatus, it is assumed that, irrespective of the size, the reliability, efficiency, and purchase price per kilowatt will be the same, then the best results are to be expected with either the 40,000- or 60,000-kw. sizes, because the installation and operating costs would be less per kw.; the efficiency higher because of the higher efficiency of the larger units; and the reliability greater because of the smaller number of operations of starting and stopping and cutting in and out of service of units necessary.

In so far as conditions affected by the design of units are concerned, it is quite generally appreciated that in sizes up to at least 30,000 kw. capacity higher efficiency at the same cost per kilowatt is obtainable purely by reason of the larger size, and a still higher efficiency for a slight increase in cost per kilowatt; and it has been quite conclusively demonstrated that as high a degree of reliability is obtainable in these larger units as in the smaller ones. Fig. 1 shows the approximate relative steam-consumption rate of units varying from 5,000 kw. to 40,000 kw., but all designed for the same cost per kilowatt.

Appreciating the need of generating units of large capacities in the future growth of the electric power industry, the engineering staff with which the writer is associated took up several years ago the work of designing such machines, assured themselves of their feasibility, and advocated their use. A number of them have been in operation several years, and their expected excellence as to reliability and efficiency has been fully verified.

Record of Performance of Large Turbine Units

Up to the present time 14 units have been sold, varying in capacity from 30,000 to 70,000 kw. maximum. Of these 10 have been placed in service and seven of them have been in service for periods varying from 1 to 5 years. The record of these machines in operation should emphatically remove any doubt as to the commercial possibility of units of large capacity, and satisfactorily prove that at least within limits not yet reached, increase in size need not impair reliability, and may improve efficiency.

The first three of these units, which are exact duplicates of each other, were sold to the Interborough Rapid Transit Company of New York. They are of the two-cylinder, cross-compound, pure reaction type; 30,000 kw. maximum rating with point of highest efficiency at 25,000 kw., operating with 205 lb. steam pressure, 120 deg. fahr. superheat and 29 in. of vacuum referred to 30 in. The high-pressure cylinder operates at 1500 r.p.m., and the low-pressure at 750 r.p.m.

The first one was put in service December 30, 1914, the second in February and the third in August, 1915. Very elaborate and exact steam-consumption tests were conducted by the purchaser on the first of these units.[1]

These units have been operating on an average of from 16 to 20 hours per day, on fluctuating railway loads of from 10,000 to 30,000 kw. With the first and third no trouble has been experienced and they have been ready at all times for any service within their designed capacity except during periods of inspection. In the case of the second the labyrinth packing on the balance pistons of the high-pressure element has failed three times, requiring renewal of some parts. The cause of these failures was supposed to have been improper adjustment, but investigations following the third failure indicated excessive lost motion in the thrust bearing and heavy distortional stresses due

---

[1] Engr. Turbine Dept., Westinghouse Elec. & Mfg. Co., Mch. Works. Mem.Am.Soc.M.E.

Abstract of paper presented at a meeting of the Philadelphia Section of The American Society of Mechanical Engineers, November 26, 1918.

[1] See paper by Messrs. H. G. Stott and W. S. Finlay, Jr., presented at May 1916 meeting of New York Section of the A.S.M.E.

to rigid bracing of the steam pipe near the turbine as the probable causes.

The fourth unit, placed in operation in the Northwest Station of Commonwealth Edison Company, Chicago, in September 1917, consists of a tandem-compound, pure reaction turbine, direct-connected to a single generator. It has a rating of 30,000 kw. with an overload capacity of 5000 kw. operating with 220 lb. steam pressure, 200 deg. superheat, 29 in. of vacuum, 1200 r.p.m. (See Fig. 2.)

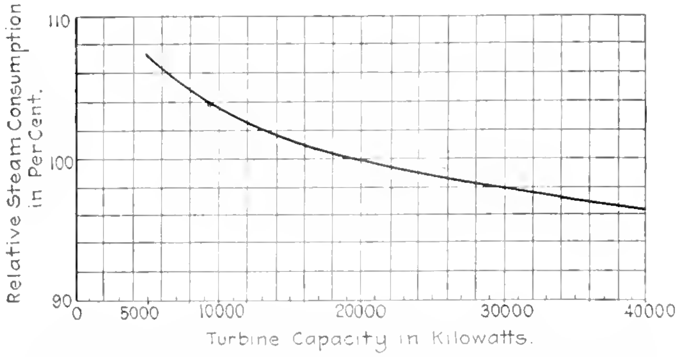


Fig. 1 Relative Steam Consumption for Units of Various Capacities Designed for Equal Cost per Kilowatt

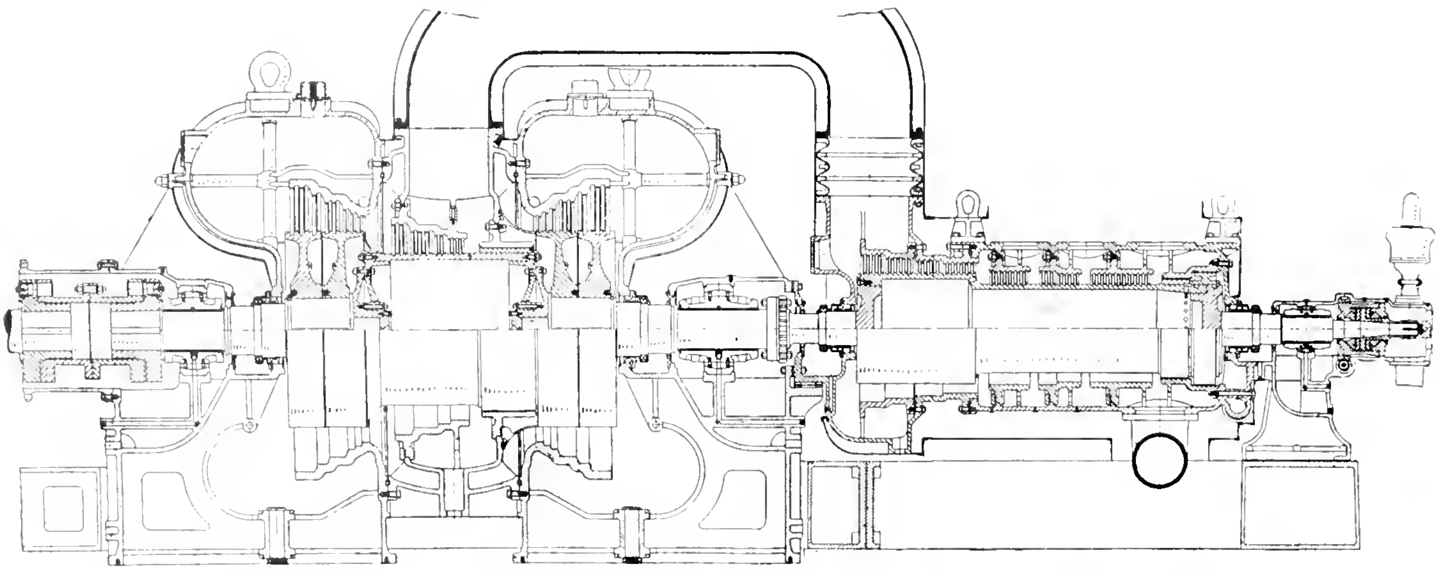


Fig. 2 30,000-Kw. Tandem-Compound Reaction Turbine, Commonwealth Edison Co., Chicago

A few hours after being put into service, subsequent to completion of erection, the labyrinth packing on the low-pressure element failed, due to buckling of the turbine cylinder, caused by rigid piping connections between the two surface condensers, which are bolted rigidly to the two exhaust openings on the turbine, and thus preventing the condensers from translating with the turbine as its temperature increased. Temporary repairs were made locally and the unit put in service in about four weeks. It has been operating almost continuously since carrying loads as high as 40,000 kw. In one instance it was kept on the line for 71 days and then taken off only in order to clean the condenser. Material for making permanent repairs to the labyrinth packing was shipped to the station within a few months after the accident, but the purchaser has not yet given permission to take the unit out of service long enough to install it.

The fifth unit, a 30,000-kw. pure reaction single-cylinder machine, operating on 200 lb. steam pressure, 100 deg. superheat, 29 in. vacuum, was placed in operation in the Gold Street Station of the Edison Electric Illuminating Company of Brooklyn, in October, 1917. Owing to congestion in the shops and urgency of shipment, this turbine was not operated prior to shipment. The overspeed test was made after installation. No correction of balance was necessary, and with the exception of a few leaks in the oiling system, and the breaking of a defective gear on the oil-pump drive, no trouble of any sort has been experienced. It has been available for service at all times and has been operating approximately continuously, except over Sundays and when necessary to clean the condensers, at average loads of approximately 23,000 kw., and peak loads as high as 32,000 kw. (See Fig. 3.)

The sixth unit, placed in service in December, 1917, in the Kent Avenue Station of Brooklyn Rapid Transit Company, is a duplicate of the fifth machine. Immediately after its installation a rebalancing of both turbine and generator rotors was necessary. After having been in service approximately 10 months, the thrust bearing overheated and wiped some, but did not damage any other part of the machine. When opened for inspection it was found that the labyrinth packing strips, which were made of an aluminum alloy, were considerably corroded by the action of strong alkalies used at this plant for treating feedwater; and two rows of blading in the high-pressure portion of the machine were found to have been damaged at some previous time, probably by foreign matter or a defective blade.

The seventh unit is a 40,000-kw., 60-cycle, cross-compound machine, installed in the Brunot's Island Station of the Duquesne Light Company, and placed in service in December, 1917. (See Fig. 4.) The high-pressure element of this machine operates at 1800 r.p.m., and the low-pressure at 1200 r.p.m. This unit has been in regular service carrying loads normally of from 30,000 to 40,000 kw. and peaks as high as 50,000 kw. On February 18, 1918, while operating the machine to correct the balance of one of the generators, the main bearing at the coupling end of the high-pressure turbine burned out, apparently due to interruption of oil service to that bearing. This let the spindle down sufficiently to cause rather heavy blade rubs throughout the machine. The bearing was rebabbitted and the machine put back into service without any other work being done except rechecking the clearances and placing a balance weight on the spindle to correct for the weight rubbed off the blades.

In July the generator was damaged by electrical trouble, and while this repair was being made, both elements of the turbine were dismantled. The high-pressure rotor was returned to the shops and the damaged blading replaced and rebalanced. New blading was also installed in the stator to restore original clearances and original efficiencies. Inspection of the low-pressure element revealed several broken blades which were defective and had slightly damaged the rest of the blading in their rows, requiring replacement of approximately $1\frac{1}{2}$ rows of blading on each end of the machine.

The eighth unit, practically a duplicate of the seventh, rated at 45,000 kw. maximum, was placed in service for the Narragansett Electric Light Company in Providence in January, 1918. In

placing this machine in service the labyrinth packing on the high-pressure was damaged, due to improper adjustment, which necessitated temporary repairs, keeping the machine out of service until about March. Since then no trouble has been experienced except some distortion of the couplings caused by a series of violent short-circuits. Permanent repairs to the labyrinth packing have been made and new coupling parts are to be installed in the near future. In the meantime the old parts are operating satisfactorily without any evidence of distress. This machine operates on loads as low as 5,000 kw., and has carried a peak load of 50,000 kw. for periods of from four to five minutes.

The ninth unit is a 70,000-kw., three-cylinder, cross-compound, 25-cycle machine, installed for the Interborough Rapid Transit Company in New York. The one low-pressure element was placed in service April 18, 1918, operating on high-pressure steam. The high-pressure element was placed in service August 21, operating in connection with the low-pressure already installed, and the second low-pressure element was placed in service October 9.

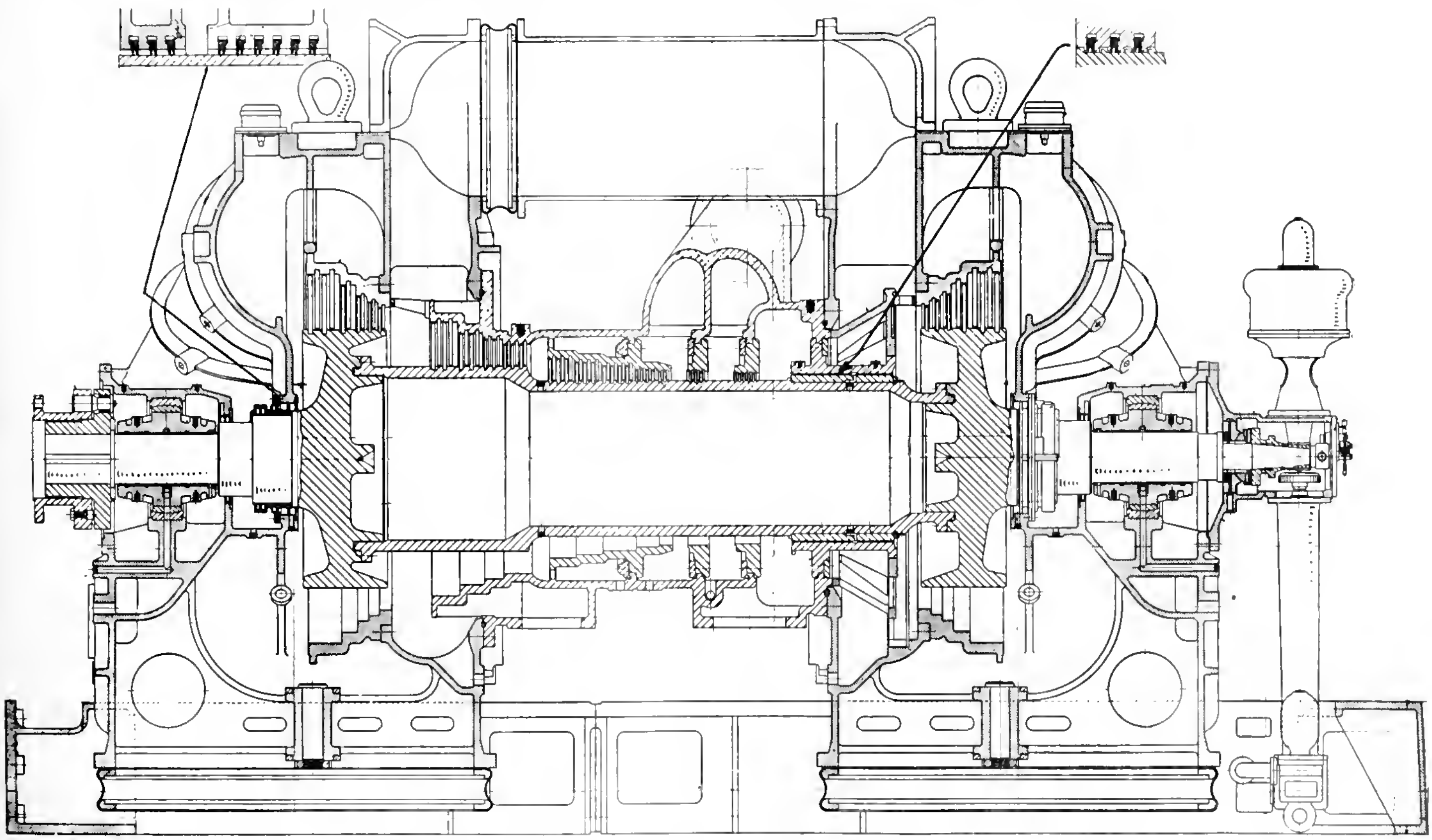


Fig. 3 30,000-Kw. Single-Cylinder Reaction Turbine, Edison Electric Illuminating Co., Brooklyn

Some intermittent vibration trouble appeared on the first low-pressure machine, the cause for which was found to be lack of sufficient clearance on one of the spindle rings, causing distortion during expansion. After this was corrected no further trouble was experienced except the breaking of a few defective blades on the intermediate stage of the second low-pressure element. This unit is equipped with a controlling mechanism for cutting any element out of service, either automatically or manually, without disturbing the other two. These features have been given a thorough tryout, and have verified all expectations as to flexibility. In regular service it has carried loads as high as 55,000 kw. with swings up to 61,000 kw. This turbine is shown in Fig. 5.

While these records do not show perfection in all respects, they do exhibit sufficient evidence to prove that no inherent or basic defects in design or difficulties in construction or operation have been encountered.

With one exception no important part of any one of these units has ever been returned to the works for replacement, alteration, or repair. The high-pressure rotor of the Duquesne Light Company unit was returned to the shops for checking for truth and reblading.

Notes on Design and Construction

The theoretical design of a steam turbine is in itself quite simple. The proper steam path for any assumed rate of steam flow, given the number of stages and areas through each for any assumed blade velocity and ratio of steam velocity to blade velocity, may be determined with the aid of a steam table or sufficiently accurate Mollier diagram.

The successful practical design, however, is quite involved, comprising many problems worthy of the highest engineering skill. Many conflicting factors must be judiciously combined in order to secure the best design and one which will best serve the intended purpose.

In this as in all other arts, experience is the great teacher, and highest success is attained only after years of growth and adherence to the same basic design, the principles of which must be right and therefore susceptible of the highest development.

To begin with, the engineer must have a clear vision of his ideal—his turbine made perfect in every detail. This must be the standard toward which he constantly strives, deviating from it only as compelled to in compromising between conflicting factors. In this ideal *reliability* and *general operative excellence* must stand out as the dominating characteristics, because above all things the machine must be dependable to deliver its rated capacity of kilowatts upon demand; second to this comes *efficiency,* because it must in competition with other units yield a profit for the owner; and third comes *cost*, because the unit must be salable in competition.

Steam Areas

The first and perhaps greatest single problem is suggested in the theoretical design: it is to provide areas suitable to accommodate the enormous increase in volume of the steam while passing through the turbine. Assume steam supplied at the throttle at 250 lb. gage pressure and 150 deg. superheat. This enters the first stage at a pressure of about 255 lb. absolute and specific volume of 2.28 cu. ft. per lb. (allowing 10 lb. drop through the throttle and inlet valves). It leaves the last stage at 380 cu. ft.

per lb. when 28½ in. is maintained by the condenser, and 550 cu. ft. per lb. when 29 in. is maintained; that is, the volume when exhausting to 28½ in. vacuum is 166½ times, and when exhausting to 29 in. is 241 times as large as it is at the entrance. This means that if the rate of steam flow is such as to require an 18-in. steam inlet pipe; and if its velocity were maintained the same through the exhaust as through the inlet pipe then, when expanding to 28½ in. vacuum, the exhaust opening would have to be 19 ft. 4 in. in diameter, and when expanding to 29 in. vacuum 23 ft. 4 in. in diameter. If, further, the mean diameter and exit angle of all the rows of blading be the same and the ratio of blade speed to steam speed be the same in each, thereby keeping the theoretical efficiency of all stages equal, and if these blade and steam speeds be so chosen as to fix the height of blades in the first stage at one inch, the last row would have to be approximately 13 ft. 10½ in. if designed for 28½ in. vacuum, and 20 ft. 1 in. if designed for 29 in. vacuum.

The impracticability of adhering to such proportions in actual designs is obvious.

Rotor Speed and Blade Proportions

Here is where the combining of conflicting factors begins. In the first stages the areas and blade heights should be kept large in order to reduce the losses, and in the low-pressure stages they must be sacrificed on account of practicable limits of mechanical design. In single-cylinder machines where the blading is all on the same spindle, the problem becomes doubly difficult.

The first determination is that of rotative speed which is usually not difficult to make since the frequency of the generator restricts the permissible speeds to a few and these are rather widely separated. The limiting capacities at the various permissible rotative speeds for which generators can be built must also be considered, although at the present time the practicable limits of turbines and generators are reached at approximately the same capacities except in the case of single-phase generators. With these the limiting capacities are very much less than with polyphase generators.

The chief factor in the selection of the rotative speed is the design of the last row of blades with reference to height, diameter and exit angle, because this is the most important stage in the entire turbine. In it the mechanical stresses and fatiguing effect of vibration, the B.t.u. drop, and physical dimensions, are all greatest. Consequently, upon it depends largely the reliability, efficiency, and cost of the unit.

Here must be considered the alternatives of a higher rotative speed with the low-pressure stage made multiflow as against a slower rotative speed and single-flow construction.

The length of blades must not be excessive with reference to the diameter, not only because of the higher stresses in the blades and rotor, but also because the difference in velocity of the blades at their tips and at their roots, as well as the difference in blade spacing, will, if too great, materially impair the efficiency.

On the other hand, if the area through the blades be restricted, the steam velocity will become too high and the bearing losses too great. If this restriction is carried to the extreme, the steam in passing through the last row of blades may reach its critical velocity without expanding entirely down to the condenser pressure, in which event the remainder of the expansion takes place in the form of an explosion upon leaving the blade passages, and from it only a small percentage of the energy is recovered.

In order, therefore, to secure the most satisfactory design for the last stages, and to permit the stresses or physical dimensions with the ever-present cost from becoming prohibitive, several compromise features should be employed.

The first of these consists of increasing the rotor diameter and blade heights, until the safe limit of stress is reached, keeping the blade height within approximately one-fourth of the rotor diameter as a limit of good practice. The materials of which the rotor and blades are made will of course determine the safe stres-

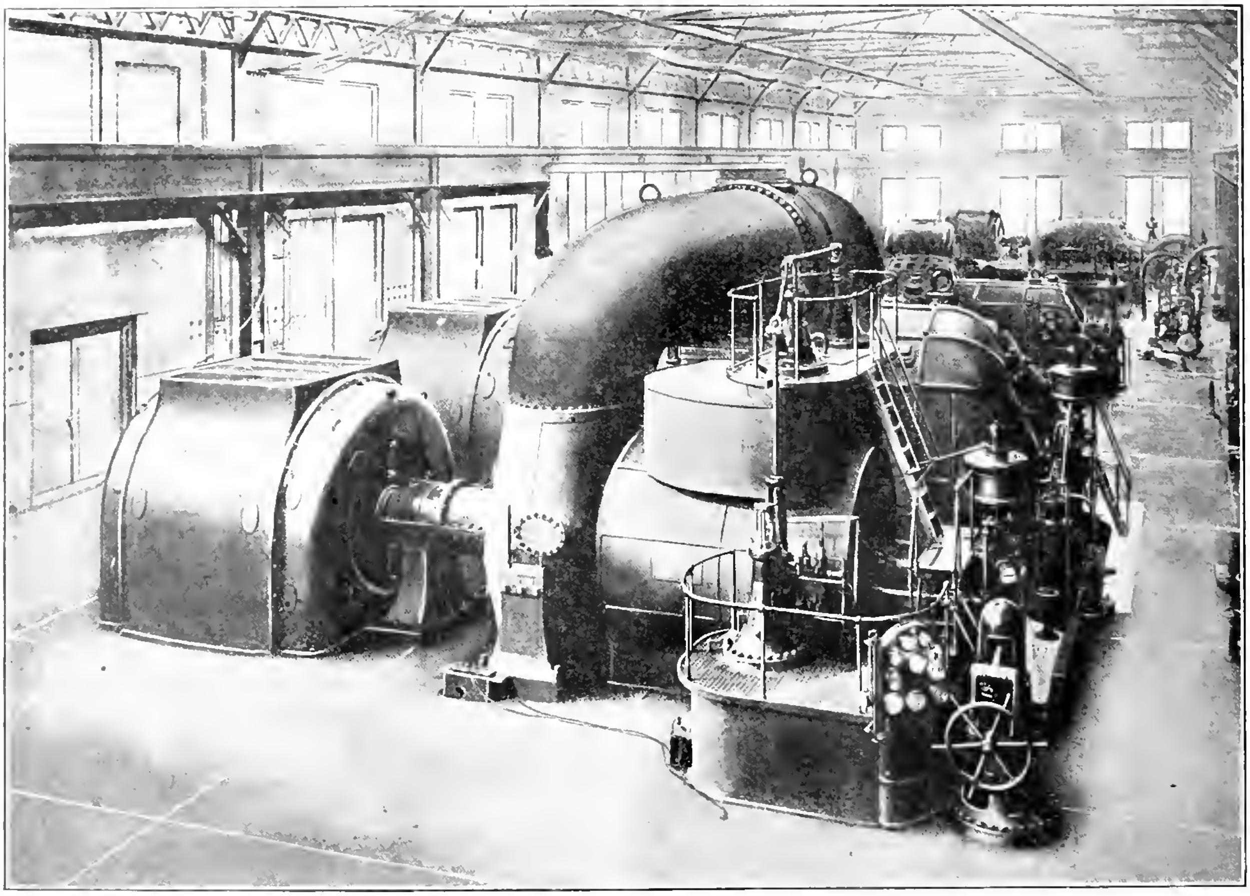


FIG. 4 40,000-KW. CROSS-COMPOUND TURBINE AND GENERATOR, DUQUESNE LIGHT CO. BRUNOT'S ISLAND STATION

ses, and on account of the great import of safety and reliability in these parts, only good quality of plain or 5 per cent nickel low-carbon steels should be used. These are commercially common materials, uniform in quality and do not require sensitive heat treatments.

For rotors cast or forged, steel having a tensile strength of 70,000 lb., true elastic limit of 28,000 to 30,000 lb. and elongation of 18 per cent. in 2 in. may be stressed to 20,000 lb. per sq. in., and for blades, 5 per cent nickel steel having a tensile strength of 85,000 lb., and true elastic limit of 35,000 lb., may be stressed to 25,000 lb., both at 20 per cent overspeed. The stresses at normal operating speed will therefore be 13,900 and 17,350 lb., respectively, and the factor of safety against rupture approximately five.

Increasing the diameter not only permits increasing the blade height, but also the steam speed without materially affecting the efficiency, by reason of the increase in blade speed. There is, however, a slight falling off in efficiency with the higher speeds even though the ratio of blade speed to steam speed be kept practically constant, because the actual velocity of the steam with reference to the blade being greater, the frictional losses will be greater.

The second compromise consists of increasing the steam-passage area through the blades by changing the blade shape. This change increases the angle between the direction of steam flow from the blade and the direction of the blade, and a slight impairment of efficiency results. However, this loss is slight compared to the gain from the higher ratio of blade speed to steam speed resulting from the increased area. This practice is standard on practically all condensing machines built for high vacuum.

Multiple Stages

The third compromise consists of permitting the steam speed to increase without a corresponding increase in blade speed, thereby decreasing the ratio of blade speed to steam speed and increasing the leaving losses. This compromise may properly be employed up to the point where the loss of efficiency will justify the increased expense of greater blade areas which may necessitate dropping to a lower rotative speed, or employing multiple stages.

Two or more low-pressure stages in multiple in connection with a single high-pressure stage are used when the required areas cannot be obtained with a single stage at the rotative speed chosen, and when it is more feasible to employ multiple stages than a lower rotative speed. Other considerations favoring multiple stages are reduced physical dimensions of the exhaust chambers, thus simplifying both the ribbing and bracing necessary to maintain the proper rigidity, and eliminating difficulties incident to shipping large units.

The design of the higher stages usually involves only an equitable selection of diameters, blade speeds, and steam speeds. Keeping these low, results in low stresses and high efficiency, but large number of stages and high cost; while keeping them high reduces the length, weight, and cost, but increases the stresses and impairs the efficiency.

If the steam volumes in the first stages are relatively small for the rotative speed employed, as would be occasioned by the use of high steam pressure or low rating, a double velocity-stage impulse element may often be employed to advantage; the advantages secured being reduction of length, increased diameter, reduced pressure and temperature inside the main cylinder, and adaptability for varying overload capacity, but not increased efficiency nor decreased cost.

Rotor Proportions

Having fixed the rotative speed to secure proper design of the low-pressure stages, and the diameters and steam speeds of the high-pressure stages to give the highest economy, the length of the rotor may become excessive, necessitating its division into two parts in order to maintain requisite reliability. These parts may be arranged either in tandem form, driving a single generator, or in cross-compound form, driving two generators. When arranged cross-compound it will often be found advantageous to increase the rotative speed of the high-pressure element, thus gaining reduced physical dimensions, weight, and cost, without sacrifice of efficiency or reliability. The multi-cylinder construction is especially desirable in the employment of high steam pressures and superheats in that the high-pressure turbine structure is small and there is no danger of stress complications resulting from wide temperature differences and no transmission of heat through the cylinder walls from the high-pressure to low-pressure stages. It has a further advantage in these days of increasing steam conditions since a unit may be designed for given steam conditions and later redesigned for materially higher conditions, the redesign being carried out entirely in the high-pressure element.

In units of 60,000 kw. or larger, the three-cylinder cross-compound construction employing one high-pressure and two low-pressure elements possesses the advantages of high efficiency and reliability without employing excessively large structures, and has greater flexibility than is possible with either of the other constructions. This flexibility, enabling the high-pressure element to operate with either low-pressure element, or either of the three elements to operate alone, admirably adapts it for us in systems not yet large enough to permit employing a single unit of such

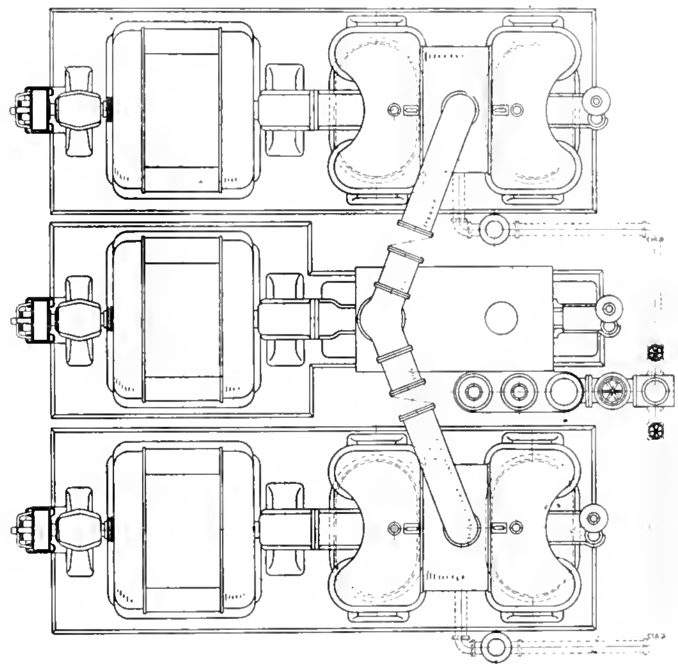


Fig. 5 70,000-Kw. Three-Cylinder Cross-Compound Turbine, Interborough Rapid Transit Co., New York

large capacity. These units may be provided with a control mechanism by means of which either of the elements may be taken out of service either automatically or manually, and the remaining ones carry loads up to the maximum ratings of their generators. The low-pressure elements, when operating on high-pressure steam direct, may be made to carry loads for short periods considerably in excess of the rated capacities of their generators.

Construction Details

Reliability and general operative excellence of a large turbine are largely dependent on the excellence of design of details such as the blading and blade fastenings, provisions for maintenance of clearances and alignment under all possible variations of operating conditions, bearings and oiling system, control mechanism, glands, couplings, and protective devices against overspeeding. The standard practice with regard to these as applied to all large units built by the company with which the writer is connected will be here given.

All low-speed reaction blading in which the stresses do not exceed about 15,000 lb. per sq. in. at 20 per cent overspeed are made of a special bronze composed chiefly of copper and a small percentage of tin and phosphorus. Upon the base of each blade a

foot is forged, and the cross-section of the blade near its base taperingly increased, adding approximately 40 per cent to its area at the point of attachment. These blades are installed in double dovetail grooves by means of specially constructed spacers or interlocking pieces, the spacers being locked in the groove and the feet of the blades locked underneath the spacers. In larger sizes where it becomes difficult to drive up the blades and spacers tight enough to insure perfect fitting between the parts and perfect filling of the grooves, compound side wedges are employed to secure the requisite tightness.

The chief destructive element of all blading is vibration caused by the flow of steam and by vibration of the entire rotor when operated under conditions of defective balance or alignment. The

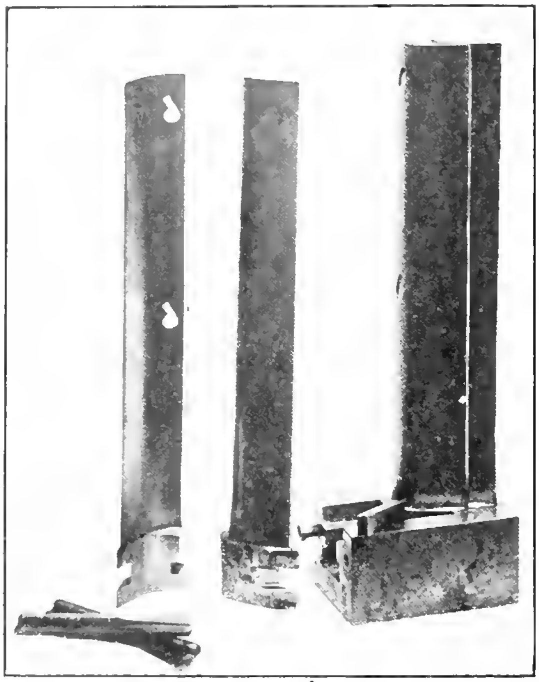


FIG. 6 METHOD OF INSTALLING HIGH-SPEED BLADES

thickening of the blade section near its base serves to very considerably reduce the amplitude of its vibration and to prevent concentration of deflection with its attendant crystallization at the point of attachment, where the ordinary blade is weakest. Blades for higher speeds, in which the stresses may go as high as 25,000 lb. per sq. in., are drop-forged of a very pure electric-furnace iron containing about 5 per cent nickel. They are installed in grooves as shown in Fig. 6.

The spacers are made integral with the blades, and compound side wedges are used to insure a tight fit at the top of the groove and protect the reduced portion of the blade foot against vibrational stresses. Impulse blading when used is installed in the same manner.

All blades are lashed together to minimize the vibration and maintain uniform spacing. Blades up to 4 in. in height have a single lashing near the top, from 4 in. to 12 in. have two, and those above 12 in. three.

A proper design of the turbine stator so as to insure maintenance of clearances and alignment under all possible variations of operating conditions, such as reduction of steam pressure and total or partial loss of superheat or vacuum, is difficult but essential. In such large structures the amount of expansion and contraction due to temperature changes is considerable, and usually occurs simultaneously with important stress changes caused by varying stage pressures, consequently there is no friction of rest to overcome and a comparatively slight uneven temperature change or unbalanced stress will cause a distortion.

The introduction of high vacuum, bringing with it large diameters in the low-pressure stages and enormous exhaust chambers, necessitates a considerable amount of carefully devised ribbing and bracing in order that the bearings supported in the exhaust chamber structures will under all conditions remain concentric with the stationary blade- or nozzle-carrying elements.

Fig. 7 shows such reinforcing. Cast-in braces when employed are always provided with an open joint which is made up after the rough machining and annealing have been done, thus avoiding all distortional stresses.

The main cylinder castings are made as plain, simple and symmetrical as possible, and the blade-carrying elements are almost invariably cast and finished separately.

The turbine cylinder is always supported on the bedplate by means of chairs or pedestals engaging it as near the center line as possible, and independent of temperature changes caused by varying load or operating conditions. The steam chest and throttle valves are supported on springs so as to move freely with the turbine, consequently the alignment of the main turbine and generator bearings is not affected by these changes.

Practically every turbine element contains three bearings; two to support the rotor, and one to maintain the longitudinal alignment. The supporting bearings consist of heavy cast-iron shells lined with babbitt and split horizontally to facilitate removal. They are so bored that for two-thirds of the circumference the minimum clearance between the bearing and journal is approximately 0.020 in., the journal being normally supported and guided by less than the lower third of the bearing circumference. This large clearance reduces to a minimum the power lost and heat generated in the bearing. The journal speed is not allowed to appreciably exceed 100 ft. per sec. and pressure 100 lb. per sq. in. projected area. A sufficient quantity of oil is supplied through

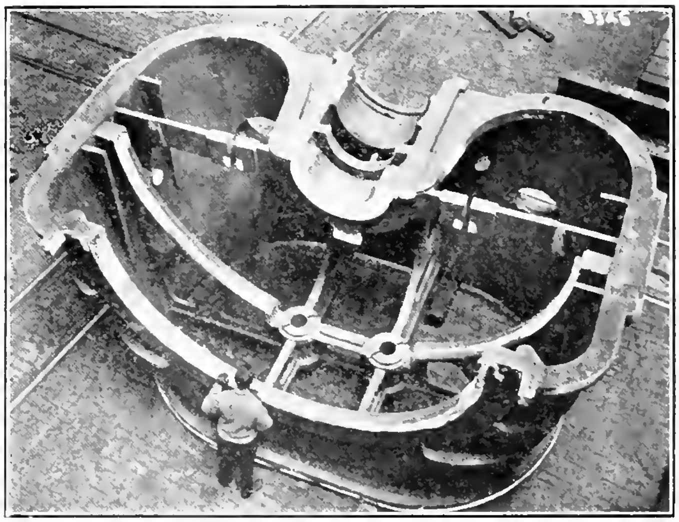


FIG. 7 RIBBING AND BRACING OF LOW-PRESSURE CHAMBER

a longitudinal groove in the top of the bearing to provide both lubrication and cooling; consequently no water cooling of the bearings is necessary. The oil pressure normally carried on the bearings is 5 lb. gage, although they will continue to operate satisfactorily as long as the oil supply is sufficient to keep the oil groove filled without any pressure whatever. The bearing is of course self-aligning, being provided with four large spherically machined pads (one each at the top, bottom and either side), which fit a spherical supporting ring in the housing. Underneath each of the four pads several sheet-steel liners of varying exact thicknesses are placed to enable easy and accurate adjustment of alignment. For example, to change the alignment 0.010 in. either vertically or horizontally a 0.010-in. liner is taken from underneath one pad and placed underneath the opposite one.

The alignment bearing is of the Kingsbury type, modified in detail design to best serve the requirements of the turbine upon which it is employed. This is believed to be the most perfect form of bearing yet devised for the purpose.

The oil-circulating and cooling system maintains an ample supply of oil at approximately 60 lb. pressure for operating the

governor-controlled valve mechanism, in addition to supplying all bearings at approximately 5 lb. pressure. It is designed with special reference to positive circulation, effective cooling, straining, and settling for separation of foreign matter or impurities, accessibility for thorough cleaning and longevity of the lubricating qualities of the oil. It consists of a cooler, strainer box, settling and separating reservoir, direct-driven pump, and a separate steam-driven auxiliary pump, together with the necessary piping. It ordinarily has a capacity of approximately 1000 gal. The oil flows by gravity from the settling reservoir into the oil pump from which it is delivered under 60 lb. pressure to the valve operating mechanism, thence to the oil cooler, bearings, strainers, and back to the reservoir. A spring-loaded valve located close to the valve-operating cylinder by-passes the surplus high-pressure oil direct to the oil cooler. Units in which a considerably greater quantity of oil is required for lubrication than for operating the valve gear are provided with double pressure pumps to reduce the power required, and the stress on the oil. Under normal operating conditions the maximum temperature of the oil is from 140 deg. to 150 deg. fahr.

The oil cooler is built along the lines of an ordinary surface condenser, and employs regular straight condenser tubes. Every part, including the inside and outside surfaces of the tubes, is readily accessible for thorough cleaning so that the original efficiency of the cooler may be restored at every cleaning. The cooling water makes a sufficient number of passes to raise its temperature close to that of the oil so as to decrease the quantity required.

The strainer box contains three strainers of different meshes which may be removed and cleaned while the unit is in service. If they are allowed to become choked up, the oil will overflow them without interrupting the circulation.

The reservoir is designed to cause impurities and foreign matter to settle to the bottom from whence they cannot get into the oil pump suction, but may be drawn off either manually or automatically to a filtration system.

The oil pump is of the reciprocating-plunger type, direct-driven from the main governor spindle, and is accessible for inspection or repairs without complete removal from the turbine.

Since constant voltage and frequency are insisted upon by public-service companies, good governing of a turbine unit becomes important. The governing mechanism must be extremely sensitive, positive, and quick to adjust itself to small or large changes in load and at the same time rugged, reliable, and unaffected by such variations as occur in ordinary wear and care. For these reasons the following several features of design are employed.

On account of the power required to operate the large valves, some form of fluid pressure relay mechanism is necessary. For this the regular turbine lubricating oil under suitable pressure has proven most satisfactory.

The governor, which is of the flyball type, is made very large and powerful so that it can control the oil relay valve with ease and accuracy. It has a minimum number of moving parts and is made as frictionless as possible by the employment of hardened knife-edge bearings in all connections between the weights and clutch. It is driven from the main turbine rotor through worm and wheel gears at a speed of approximately 300 r.p.m.

Unavoidable inaccuracies in machining of the oil relay control valve, friction and lost motion in the governor and valve linkage, and inertia of the operating fluid are the chief obstacles to good regulation, since the speed must change sufficiently to move the governor weights far enough to overcome all these before there will be any response from the valves, and when they do move they will probably overtravel. These difficulties have been overcome by giving the linkage, adjacent to the governor, a small positive oscillating motion, sufficient to overcome any reasonable lost motion and inaccuracy of the relay control valve, and still cause a very slight oscillation of the main inlet valves. The oil relay control valve and high-pressure-oil by-pass valve are placed as close to the operating cylinder as possible, and a positive or constant-volume oil pump is used. The oil flow is therefore continuous in nearly all of the piping to and from the oil-operating cylinder. Consequently the slightest change in speed will be quickly responded to by a proper change in steam flow.

To prevent leakage of steam or air where the rotor shaft passes through the casing, combination labyrinth and water glands are used. These constitute an ideal sealing arrangement. They are absolutely tight and permit no leakage of steam, vapor, or water into the engine room. They require no adjustments for varying load conditions, and do not depend upon the operation of any automatic devices. There is no mechanical contact between stationary and rotating parts, and therefore no wear. They are extremely simple in design, require no special attention, and are as durable as any other part of the machine.

The simple water gland being ill adapted for operation against high pressures or at speeds very much less than normal, the labyrinth is added to enable establishing a vacuum before starting up, and also to reduce the pressure on the water gland when the pressure against which the gland must seal is high. The operation is very simple. In starting up, high-pressure steam is turned on the labyrinth glands. When about three-fourths speed is reached, the water is turned on and the steam off.

The coupling between the turbine and generator is of a flexible-pin type, and has important advantages over the solid-claw type which it replaced. Sufficient elasticity is provided in the pins to distribute the shocks produced by heavy short-circuits and both the pins and bushings are renewable in case excessive wear takes place.

Ratchet teeth are machined into the circumference of the coupling flange, in connection with which a barring-over device is employed to turn the rotor for inspection or for connecting or disconnecting the two halves of the coupling.

In order to secure the maximum protection against overspeeding, all the steam entering the turbine is made to pass through the primary governor-controlled inlet valve; consequently, if this one valve is kept in proper operating condition it is impossible for the speed to get beyond the control of the governor, regardless of whether or not the overload valves leak or stick. Should either the governor or primary inlet valve become inoperative, a small but powerful overspeed stop mechanism installed in the end of the rotor shaft will come into operation at approximately 10 per cent overspeed, and release the pressure on one side of two small steam pistons which normally have full steam pressure on both sides of them. The resulting movement of one of these pistons will release the main spring on the main throttle valve, causing it to close quickly and the other will admit high-pressure oil to the valve operating cylinder, and close if possible the primary inlet valve.

Reports of several disastrous explosions of aluminum dust in manufacturing establishments induced the Bureau of Mines to investigate the physical and chemical properties of the dust with special regard to inflammability and to the problem of extinguishing fires and of minimizing the force of explosions once started. The results of this investigation together with a review of the literature on the subject are published in the Bureau's Technical Paper 152.

It is reported that aluminum dust burns quietly when in a pile, but if this pile be disturbed in such a manner as to raise a cloud of the dust into the air, the burning takes place with explosive violence. Also, that if a dust cloud already formed having a density within the explosive limits be ignited, a violent explosion results. Moisture is said to be most dangerous if the dust has become heated; hence, as the dust is hygroscopic, a proper system of ventilation is strongly recommended as a precautionary measure. It is equally pointed out that if, when the dust starts to burn from whatever cause, water be added to the mass, hydrogen will be liberated and a terrific explosion result. In one case on record a violent explosion resulted from pouring molten aluminum through a screen into a bucket of water.

The tests did not show the exact conditions under which ignition of the aluminum dust is obtained, but it was concluded that it may ignite at temperatures even lower than those necessary for the ignition of 200-mesh standard Pittsburgh coal dust.

Refrigerating Plant Efficiency

By Victor J. Azbe,[1] St. Louis, Mo.

The cost of ice and of refrigeration is a composite figure of many different expenses coming under the heads of manufacturing, selling and general expenses. The cost of fuel is usually the largest item, and it may easily represent the difference between profit and loss.

During the last two years the cost of fuel per ton of ice has doubled, and many plants are now paying $1.50 to $2.00 per ton of ice for fuel alone. In spite of these conditions the majority of refrigerating plants are very wasteful of fuel as a result of improper design, run-down equipment or poor operation. While the possible savings are enormous and can usually be secured with little effort and slight expenditure, the necessity for improving equipment and operating conditions is not realized in the majority of plants.

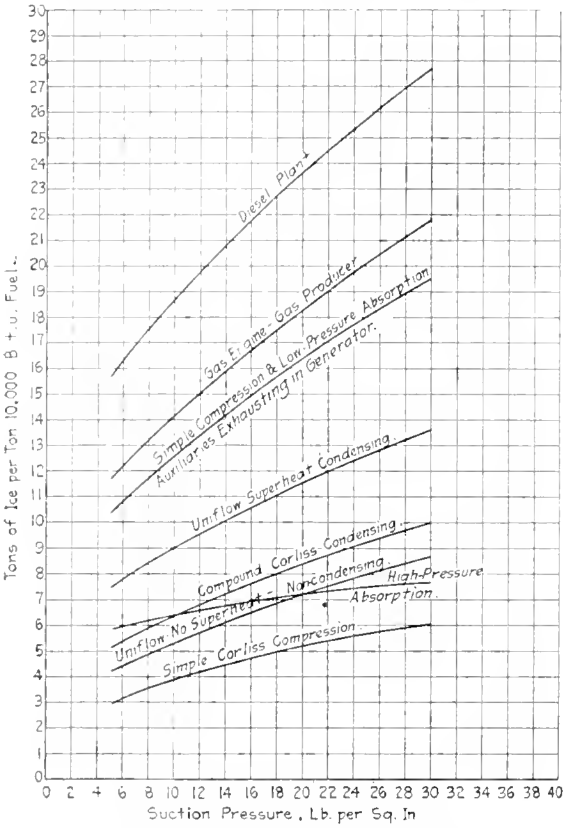


Fig. 1 Relative Efficiency of Various Ice-Plant Installations

It should be the aim to improve the economy of the plants from year to year by making necessary improvements to reduce costs of fuel and labor. Fuel cost, while most important, is not all-important, however, and there are ice plants having a very high fuel economy that are losing money. A high efficiency must be maintained generally in the design of the plant, in its load factor and in its labor and sales organization. There are far more plants making on the average, per year, 1.5 to 2.5 tons of ice per ton of fuel than plants making 5 tons, having simple non-condensing plants in mind.

In this paper the writer expresses himself frequently in terms of tons of ice per ton of 10,000 B.t.u. fuel, to equalize the value of the various fuels (semi-bituminous, bituminous, lignite, oil, etc.), since by a simple recalculation it places them on a common basis.

As the load factor of most refrigerating plants varies greatly, the boiler installation should be such as to give flexibility of operation. In small plants arrangements should be made to reduce the grate surface during the winter periods. Each boiler must be equipped with a draft gage, and the draft should be maintained at the minimum and varied with the load. The boiler setting should be high, even with return tubular boilers, with a space of from 4 to 5 ft. between grate and boiler shell, and the combustion chamber should be so arranged that the benefit of this increased space is obtained. Gases tend to take the shortest path, and with most of the combustion-chamber space devoid of drop walls there will be circulation of the gases and many eddy currents or dead spaces.

Any fuel can be burned if proper provisions are made—shavings as well as oil or semi-bituminous coal. The selection mostly depends upon cost and availability. Lignite, for example, is a most excellent fuel for localities such as Texas. Burning this under return tubular boilers efficiencies were obtained of 63 to 68 per cent.

Prime Movers

The prime mover most generally used in refrigerating plants is the Corliss non-condensing steam engine. Next in order are the compound Corliss, electric motor, oil engine, and uniflow steam engine. If this order were reversed, however, enormous sums of money would be saved to ice manufacturers, for the following reasons:

In selecting the prime mover for an ice plant, the two most important items to consider are efficiency at rated load and efficiency at half load. While the average Corliss non-condensing engine consumes 20 per cent more steam at half load than at full load, the uniflow engine uses only about 8 per cent more. This is of great importance because of the great variations of load factor. Many engines can be found operating at one-eighth cut-off. This is the reason, also, why a steam cylinder should be adapted to the back pressure at which the compressor operates. It is most unwise to have a steam cylinder large enough for economical cut-off at 25 lb. suction pressure when the pressure to be maintained is 15 lb. or less.

Fig. 1 shows the results to be expected from various types of installations. The allowance made for auxiliaries ranges from one-half to one horsepower per ton of ice, depending upon conditions. The condenser pressure was taken at 185 lb. gage, and it was assumed that at the suction pressure given the machine would operate at about full load.

In small plants preference should ordinarily be given to the use of superheated steam, since as high an economy may be obtained from a uniflow non-condensing engine operated with superheated steam as from a compound Corliss condensing engine using saturated steam, and the former equipment is a great deal simpler and necessitates less auxiliary power. Furthermore, the steam-consumption curve is flat and the efficiency of the plant will be maintained during the winter time.

Superheaters can be installed with facility even in existing installations, and since the gain is greater with simple non-condensing engines, uneconomical ice plants will derive great benefit from this procedure.

In order to gain in economy, a simple engine is often made to operate as a condensing engine. As a result, the temperature difference in the cylinder is increased and the cut-off is shortened, which increases the wall area at cut-off as compared to volume. This greatly increases cylinder condensation, which is directly proportional to the temperature difference and the area exposed. It therefore seldom pays to operate such a machine at more than 20 in. of vacuum, and if the plant is to be changed over to condensing operation, it is best to replace the simple Corliss by com-

[1] Consulting Engineer, St. Louis, Mo. Assoc.-Mem.Am.Soc.M.E.

Abstract of paper presented at the Annual Meeting December 1918, of The American Society of Mechanical Engineers.

pound cylinders or by a uniflow engine and leave the rest of the machine intact.

Under proper conditions the ideal and most efficient prime mover for the ice manufacturer is the Diesel oil engine. By "proper conditions" is meant conditions of oil supply and cost, and kind of operating force to be employed. It cannot be overemphasized that with the Diesel engine a high-grade engine-room force must be maintained, and especially during the overhaul period.

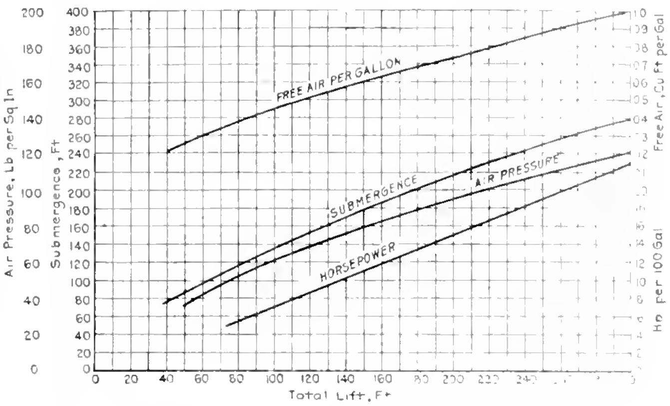


FIG. 2 STANDARD AIR-LIFT PERFORMANCE

If the men in charge are intelligent, the Diesel engine is a very dependable unit. There is a plant in California that produces a ton of ice for 5 gal. of fuel oil, and this not under the best conditions. There are oil-engine installations on record, not necessarily Diesel engines, that have given a ton of ice for less than 10 cents fuel cost, with oil at 2 cents a gallon.

Table 1 gives the average results obtained with Diesel engines over a long period. The net work produced was 1,119,801 kw-hr. The auxiliary power represented the power required for injection in the air compressor, and in the water-jacket circulating pumps. The load factor having been highly variable, the results are not quite as good as they otherwise would have been, consequently the figures may be taken as being conservative and dependable.

TABLE 1 DIESEL POWER-PLANT PERFORMANCE

	Total	Per net Kw-hr.
Wages paid	$4545.10	$0.00405
Fuel-oil consumption	3416.49	0.00305
Lubricating oil	466.86	0.00042
Repairs and supplies bought	1116.50	0.00100
Repairs and supplies, home work	1367.49	0.00122
	$10912.44	$0.00974

MONTHLY RESULTS

Month	Total Power Generated, Kw-hr.	Total Power for Auxiliaries, Kw-hr.	Net Power Generated, Kw-hr.	Fuel Oil Consumed, Gal.	Cost of Fuel Oil per Gal., Cents	Gal. of Fuel Oil per 100 net Kw-hr.
April	65770	7176	58594	5141	3.63	8.774
May	95270	10712	84558	8142	3.63	9.629
June	119340	13785	105555	10671	3.61	10.109
July	132150	14482	117668	10843	2.9	9.215
August	131540	16275	115265	12593	2.65	10.925
September	114840	12973	101857	10125	2.33	9.94
October	114120	12567	101540	9431	2.31	9.288
November	110160	12737	97423	9459	2.56	9.709
December	113330	12159	101071	9660	3.00	9.558
[redacted]						
January	86640	11213	75427	7220	3.13	9.572
February	84490	9489	74991	6993	4.5	9.325
March	128570	14413	114157	11175	4.5	9.789
April	100350	11656	88694	8766	7.0	9.883
May	108950	12871	96079	9232	6.15	9.605
June	176000	19100	156900	15488	6.15	9.871
July	168490	17333	151167	14946	4.25	9.89
August	150890	18652	132238	13569	4.25	10.261
September	90450	11029	79421	8052	4.5	10.138
October	61700	8201	53499	5591	4.87	10.45
November	42540	5867	36673	4076	4.87	11.114

In many localities electric power can be obtained cheaply, and when this is the case electric drive is to be favored. The main advantage of an electric installation is that high efficiency can be obtained through the whole load-factor range and that economy increases as the load factor drops, contrary to the condition in ice plants.

Induction motors are not very well adapted for ice-plant work because of the high speeds required for high efficiencies. Synchronous motors, on the other hand, have characteristics that make them ideal, even for direct connection to refrigerating machines. Their efficiency curve is quite flat and their efficiency is rather high at part loads.

An electrically driven raw-water plant is a great deal simpler than a steam-driven plant. Many factors which influence plant efficiency are eliminated, and consequently the operating man does not have to be as high grade as for the efficient operation of steam plants. Labor cost and repair expenses and the cost of real estate, buildings and machinery are all less. Dependability is also fair, and with proper installation as good as in the case of a steam plant.

AUXILIARIES

The curse of most ice plants is the auxiliaries. In many cases the steam consumption of the auxiliaries is as great as that of the

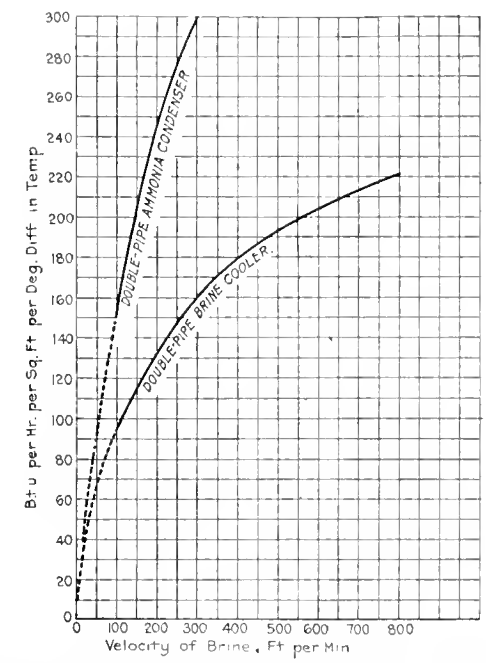


FIG. 3 HEAT TRANSMISSION WITH DOUBLE-PIPE BRINE COOLERS AND AMMONIA CONDENSERS

engine running the compressor. In a certain ice plant of 100 tons capacity the following auxiliaries were found in operation: Electric-light engine; duplex circulating pump for ammonia condenser; duplex circulating pump for steam condenser; duplex brine pump; duplex boiler-feed pump; ice-hoisting compressor; single-stage single-steam-cylinder deep-well compressor; agitator engine and cooling-tower fan engine.

One of the most uneconomical auxiliaries as usually operated is the air lift. This statement is meant as no reflection upon the air-lift pump as such, but on the way in which it is usually operated. Fig. 2 shows the performance of properly designed air lifts; the efficiency decreases somewhat as the lift increases, but should not be less than 60 to 80 per cent, whereas, actually in some cases it will be found as low as 20 per cent; the trouble is usually too great or too little submergence.

It is seldom advisable to use an air-lift pumping system for

the circulation of water over the steam condenser because of the increased head required. The use of a cooling tower is ordinarily to be preferred, and any water needed for make-up may be taken from the air-lift system and passed over the distilled-water and liquid-ammonia coils, thus cooling the latter below the temperature of the circulating water proper.

For driving auxiliaries, electric current from generators driven by uniflow engines it to be preferred in the majority of installations, and the various units must be selected with a view to obtaining a flat efficiency curve between half and full loads; all motors on the larger units should have variable speed control. Duplex steam pumps or steam-driven deep-well pumps should not be used except possibly as a reserve.

Wet versus Dry Compression

Theoretically, dry compression is inferior to wet, both in regard to refrigeration produced per pound of ammonia circulated and the work required for compression. The difference in economy ranges between 6 and 10 per cent, being greater with low suction pressures and high condenser pressures. Practically, however, dry compression is the more economical; that is, it is capable of producing a greater amount of refrigeration per horsepower expended. The reason for this discrepancy is that when wet gas is admitted into the cylinder the liquid is not suspended, but accumulates at the bottom of the cylinder. There it evaporates so slowly during the compression stroke that the evaporation continues after the discharge valve opens, and often even after it again closes when the piston is upon the return stroke, thus causing a certain amount of reëxpansion loss which tends to reduce compressor capacity. Any liquid that evaporates after the discharge valve opens is utterly wasted.

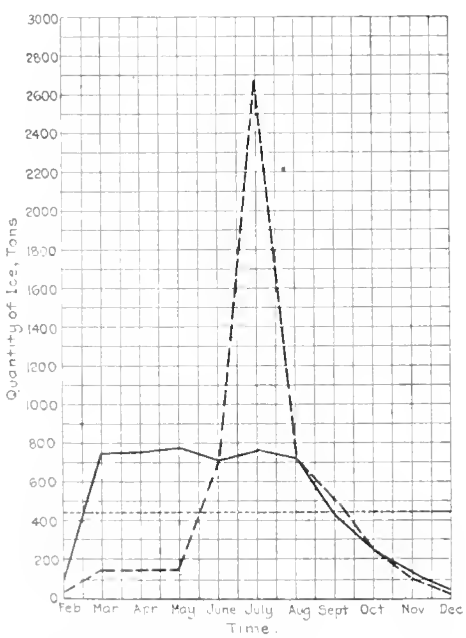


Fig. 4 Effect of Ice Storage on Extreme Load Factor Variations

That there is no benefit in wet compression, as ordinarily practiced, is proven by the compression curve and its relation to the adiabatic and isothermal curves when the machine is operated wet, even to such an extent that the discharge gas leaving the compressor is saturated. In such cases the compression curve will only slightly approach the isothermal, which proves that most of the cooling of the gas by evaporation of the liquid is done after the compression valve opens and thus no benefit accrues from that time on. Liquid and vapor flow separated within the same pipe the same as in the case of saturated steam.

So long as theory indicates an advantage in wet compression, it would seem that further studies and experiments regarding its successful application are justified. Could not some method be devised to atomize the liquid before it reaches the compressing cylinder, or to inject it in the form of a spray during the compression stroke? In any event, precautions must be taken not to introduce liquid into the cylinder in an undivided state, otherwise dangerous accidents are likely to follow.

Wet compression is not only beneficial upon thermodynamic principles, but posesesses a number of other advantages. By its use the temperature difference in the cylinder is reduced by practically two-thirds, which greatly lowers the cylinder superheat and consequently should increase the volumetric efficiency of the machine. Further, with wet compression far less oil is required for lubrication, and the oil does not vaporize, and thus is

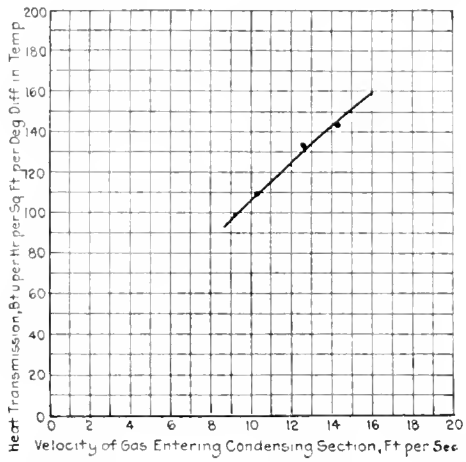


Fig. 5 Effect of Velocity Upon Heat Transmission

easily kept out of the condensing and evaporating coils. Wet compression represents also a saving in ammonia and, in addition, permits a somewhat lower condenser pressure.

Ice Tanks

All the details incidental to the process of ice making should be so regulated as to secure a high rate of heat transmission, coupled with a low temperature difference. The ice tank is a most important member of the ice plant. As far as handling is concerned, great improvement can be made. In a certain plant in St. Louis it was arranged to hoist a row of eighteen 200-lb. blocks by one operation, and the blocks were all thawed and dumped at the same time.

Circulation of the brine in the freezing tank is a very important item. This circulation is at times produced by centrifugal pumps, but ordinarily by propeller agitators. Often these agitators are very inefficient and tend more to churn the brine than to circulate it. It is ordinarily difficult to determine what the circulation in an ice tank is, due to the fact that the speed of the brine varies and its velocity in the lower part of the tank is not the same as in the upper part. About the most practical way is to measure the difference in the height of the brine in the tank on the suction and discharge sides of the bulkhead close to the agitator. With tanks as ordinarily constructed, 1 in. difference of level for each 10 cans of tank length is assumed by the writer as a standard. This method should be fairly accurate since brine flow is the result of difference in level.

In agitating the brine, its level should never be below the level of the water in the can. Too low a brine level will greatly reduce the capacity of the tank and also the plant efficiency. A wide, shallow hole in the top of the block toward the end of the freezing period is always an indication that the can is too full or the brine too low.

Since with long tanks or very strong agitation, considerable brine level difference is produced, in some cases as much as 5 in., it is best to construct long ice tanks with agitators on each end. Brine velocity is helpful in two ways; it increases heat transmission between the brine and the can, and between the evaporating coil and the brine.

The average transmission of heat from the ice in the can to the

brine outside is very poor, only about 2.5 B.t.u. per deg. per hr. per sq. ft., due to the insulating effect of the ice. The thicker the ice, the slower the heat exchange, consequntly tank brine velocity has not nearly so great an effect upon heat transmission on the can side as it has on the coil side. The heat transmission between ammonia and brine through metal is between 10 to 20 B.t.u. per sq. ft. per hr. per deg. This comparatively low figure is primarily due to the superheating of the gas in the coil, which causes one side of the surface to be dry, and secondarily, to the low brine velocity.

Fig. 3 gives York Mfg. Co. curves showing heat transmission with double-pipe brine coolers and ammonia condensers. The curves were extended by dotted lines to show probable transmission at low velocity. These curves purely from their characteristics show the importance of velocity, an item which from the economy standpoint is certainly worthy of very careful investigation.

Ammonia Evaporating Systems

With expansion coils in ice tanks and cold-storage rooms a high heat transmission is very desirable, and it can be obtained

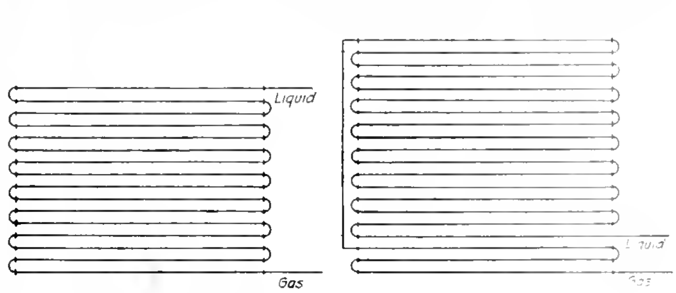


Fig. 6 Ammonia Condenser Types

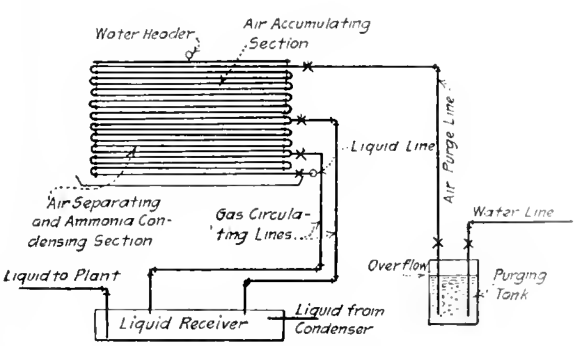


Fig. 7 Non-Condensable Gas-Purging Arrangement

inside of the pipes either by flooding them or using a high gas velocity. The objection to high gas velocity in this connection is pressure drop, which for thermodynamic reasons is rather more important on the evaporating side than on the condensing side. For this reason, the length of the evaporating coil should be limited so that the velocity will never exceed the average figure of 500 ft. per min. Some tank coils are 1500 ft. long and their rather high velocity causes a great pressure drop. For long tanks 2-in. pipe is to be preferred, since the relative surface of $1\frac{1}{4}$-in. and 2-in. pipe is in the ratio of 1 to 1.5, while the sectional area is in the ratio of 1 to 2.2. Coils should be short so that they are thoroughly effective, and even flooded coils should be as short as possible. The size of suction lines leading to the machines should be governed by permissible gas velocity, friction, and radiation loss.

Ice Plant Load Factor—Ice Storage

Ice storage is profitable in most cases if the storehouse is filled to capacity during the winter and emptied entirely in the summer. The cost of storehouse will be from \$6 to \$12 per ton capacity and the investment will net a substantial return in most cases. The objections to it are the cost of refrigeration for the storage and the increased cost of handling the ice.

As far as plant economy goes, the value of ice storage is due to the equalization of the load factor. That is, the plant can be operated at higher rate during slack seasons and there may not be the necessity for forcing the plant beyond its economical limit in summer. The ice plant and ice storage can be so proportioned that the plant will have a load factor of 80 to 90 per cent, while without ice storage it would be only about 40 per cent, taking the whole year into consideration.

The small ice vault, or daily ice storage, exerts also quite an influence upon plant economy and it cannot be overemphasized that it is advantageous to make it amply large. The idea is to remove ice from tanks as quickly as possible—to use ice tanks for storing ice is a very poor practice.

In Fig. 4 the full line represents the output of ice; the broken line indicates the sale of ice, and the dotted line the proper rate of manufacturing ice. These curves were plotted from the figures actually obtained in a plant. An exact determination of the proper rate of manufacturing ice will permit stopping the plant altogether for a certain time and attending to repairs.

To operate with low suction pressure is far less economical than is indicated by the analysis of compressor performance alone, for the reason that the economy of the engine is also affected by the reduction of load. For this reason, when the condenser pressure drops off during the cold season it is doubly important that the suction pressure be increased and the machine maintained fully loaded. The practice of shutting down one or more ice tanks in winter should be strongly condemned, and no tank should be shut off (except in case of absolute necessity) until the back pressure is at the highest point. Efforts should be made to maintain a back pressure of 30 lb. in winter, and the plant should be designed with that in view. The largest loss is occasioned by the non-adjustment of the various elements to the load factor.

The various rooms or tanks in an ice plant should either be maintained at the same temperature or designed especially for low temperatures. To try to maintain one or two rooms at a low temperature and sacrifice the economy of the whole plant is bad practice, since the suction pressure will always correspond to the lowest temperature. The temperatures should be maintained uniform. When this is not possible, and the difference in the various temperatures is great, then either a multiple effect or a booster compressor should be installed.

Forecoolers and Multiple-Effect Receiver

In a well-designed and efficiently operated ice plant the water to be used for ice making is cooled down to within a few degrees of the coldest circulating water, or ordinarily to a temperature of 70 or 80 deg. fahr. This water then passes into the forecooler to be precooled by ammonia. The heat absorbed by the forecooler can be anywhere up to 30 per cent of the total heat to be extracted in making ice, and the water will be cooled down to about 40 deg. fahr. There are two methods of forecooler refrigeration: by feeding liquid ammonia directly into a coil, or by passing wet return gas from the tank through the water cooler. The first has the advantage that it can be connected to a machine working independently from the freezing tank and thus enable the maintenance of very high suction pressure. The only advantage of passing the suction line through the forecooler is that the expansion valves on the tank can be kept open wider, thus insuring that the freezing coils will work throughout their whole length without danger of getting any liquid to the machine. But this same thing can be accomplished far better by means of liquid separators and it is of greater advantage to use the high suction pressure which is possible with direct feeding.

Refrigerating plants should also be equipped with double-pipe liquid precoolers, cooling the liquid from the temperature of the coldest circulating water down to the temperature corresponding to the highest suction pressure used. In this connection a multiple-effect liquid receiver can also be used, by means of which a greater amount of work can be done at high suction pressure than by the use of the double-pipe cooler alone.

Every refrigerating plant should have an auxiliary compressor for high-pressure work. The size of this compressor may be relatively small for the reason that it will operate at double its rated capacity. One of the most valuable inventions ever made in the refrigerating field is the multiple-effect compressor, which allows gas of higher suction pressure to enter the cylinder after it has been filled with gas of a lower pressure.

Ammonia Condenser

There is no reason for a condenser pressure as high as 200 lb. It always indicates improper conditions, and even in a hot climate the condenser pressure should be below 175 lb.

The cooling tower should cool the water within three degrees of the wet bulb. The relative positions of the condenser and cooling tower should be such that five to six gallons of water can be pumped economically; that is, the pressure due to the head should be less than 15 lb. The condenser should give a heat transmission of at least 150 B.t.u. per sq. ft. per hr. per deg. There should also be sufficient surface, and if the condenser gives better results, less than the specified surface will be needed. In actual practice, results ordinarily are far inferior, due to the water being too warm, to the lack of a sufficient amount of water or of the required condensing surface, to the use of a poor type of condenser, or to the presence of oil or air in the condenser or scale on the outside.

The condenser should be located on the roof of the building, with the cooling tower immediately underneath and so placed that the coils will be parallel with the prevailing direction of the wind in the summer.

The cooling of the water over the condensers is important, not only because it simplifies the action of the cooling tower, but also because it produces a greater temperature difference between the wataer and the ammonia and thus lowers the condenser pressure. Theoretically the ideal arrangement would be for the initial and final temperatures of the water to be the same. This is often realized in winter and is also quite possible in summer in a dry climate with good wind velocity and sufficient condenser surface. It is important to protect atmospheric condensers from the sun.

Condensing coils give a much greater heat transmission per degree difference in temperature than evaporating coils. Better results are obtained with the double-pipe condenser than with the atmospheric because of the higher water velocity of the former. Taking into account the question of initial cost, however, an atmospheric condenser, well exposed, should give, for the same expenditure, as good results as the double-pipe condenser.[1]

TABLE 2 AMMONIA CONDENSER PERFORMANCE

No. of test	1	2	3
Type of condenser	A	B	B
Internal surface per stand, sq. ft.	174	222	216
Refrigeration per stand, tons	13.8	5.7	6.5
Surface per ton of refrigeration, sq. ft.	12.6	39	33.2
Water on, deg. fahr.	73	93	84
Water off last condensing pipe, deg. fahr.	98.5	94	90
Water off bottom superheat pipe, deg. fahr	104	94.5	92
Condenser pressure, lb.	195	190	210
Condensing temperature, deg. fahr.	98	97	103.4
Temperature entering gas, deg. fahr.	240	230	245
Temperature leaving liquid, deg. fahr.	98	97	100
Logarithmic temp. diff., condensing section, deg. fahr.	6.6	3.5	16.5
Logarithmic temp. diff., superheat section, deg. fahr.	24	37.5	57
Superheat extracting surface per stand, sq. ft.	21.7	22.2	32
Condensing surface per stand, sq. ft.	152.3	199.8	184
Entering velocity superheat section, feet per second	8.2	3.3	3.7
Entering velocity condensing section, feet per second	6	2.4	2.7
Mean heat transmission per deg., sq. ft. per hr., B.t.u.	155	91.6	26

[1] For articles on Performance of Ammonia Condensers see *A. S. R. E. Journal*, November 1914, and July 1918.

Table 2 gives the results obtained from tests performed upon condenser sets in actual operation. Type A was a counter-current flooded atmospheric condenser. Type B was a condenser installation consisting of ordinary atmospheric condensers with three superheat pipes at the bottom of each stand. The result in Tests 2 and 3 were obtained with type B. When Test 2 was conducted the condenser surface was very clean both inside and outside and the condenser was free from any non-condensable gases; this probably accounts for the favorable performance secured. The values in Test 3 fairly agree with the ordinary performance of condensers similar to B. The writer possesses data of tests performed upon a dozen of these installations, which show practically the same figures.

Fig. 5 presents the effect on the transmission of heat of the velocity of the water in the pipes of a condenser. The points in the graphs were plotted from values obtained with a 12-pipe condenser of the drip-pipe type.

The velocity of the water in the pipes of a double-pipe condenser may be increased by allowing a greater amount of water to flow through them. The gas velocity increases when the height of the stand is increased by the addition of more pipes. In selecting between high and low condensers, however, other factors must be considered in addition to the water or gas velocity. Generally speaking, high condensers are preferable when the available water is cold.

When a condenser is operated with superheated gas, this should not enter at the top of the stand, as is often done in practice. Type B in Fig. 6 is a convenient form of condenser for use with superheated gas.

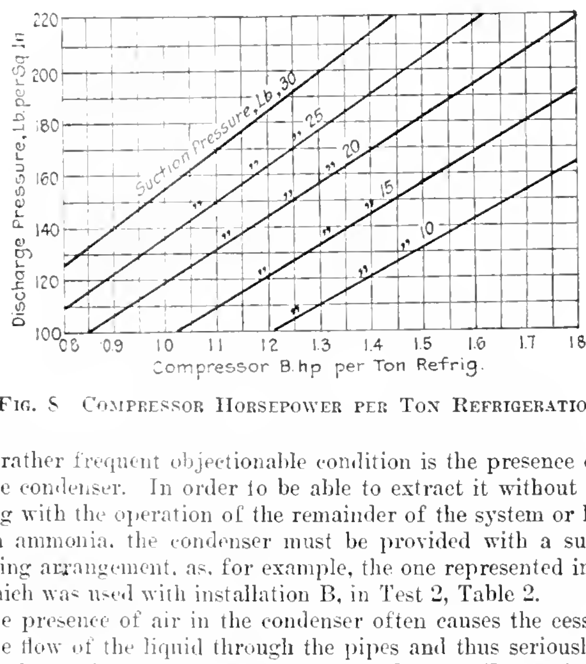


Fig. 8 Compressor Horsepower per Ton Refrigeration

A rather frequent objectionable condition is the presence of air in the condenser. In order to be able to extract it without interfering with the operation of the remainder of the system or losing much ammonia, the condenser must be provided with a suitable purging arrangement, as, for example, the one represented in Fig. 7, which was used with installation B, in Test 2, Table 2.

The presence of air in the condenser often causes the cessation of the flow of the liquid through the pipes and thus seriously impairs the efficient performance of the condenser. The author has had occasion to observe in certain plants he inspected that the condenser pressure dropped 20 to 30 lb. after the air was removed from the system.

Fig. 8 shows distinctly how the compressor horsepower per ton of refrigeration increases with rising condenser pressure, and decreases with rising suction pressure.

Fig. 9 shows how the consumption of condenser water per minute per ton of refrigeration increases as its temperature range over the condenser is decreased, it being assumed that for each ton 350,000 B.t.u. must be removed per 24 hours, inclusive of the heat equivalent of the compressor horsepower.

Cooling Towers and Spray Systems

The economy of a refrigerating plant depends largely upon the temperature of the water circulated in the condenser. Water for ammonia-condensing purposes can be obtained from deep or

surface wells, flowing streams or city distribution systems; or by recirculating water that is being cooled in forced-draft, natural-draft or atmospheric cooling towers or spray cooling systems. Which method is to be preferred depends upon the temperature of the water, the dependability of the supply and the relative pumping level. The cost of pumping water from wells is ordinarily so great that a recooling system is preferred.

The proper construction of a cooling tower is far more important in a refrigerating plant than in a steam plant. In the latter we can get 25 in. of vacuum with water at 105 deg. fahr.; but in the refrigerating plant, with the same temperature, the ammonia condenser pressure would be about 280 lb.

The limit of atmospheric cooling depends upon the wet-bulb temperature. The rate of cooling depends upon the vapor-pressure difference between the dewpoint and the temperature of the cooling water as modified by the wet-bulb depression. Roughly speaking, each degree of water temperature is equivalent to three pounds of condenser pressure.

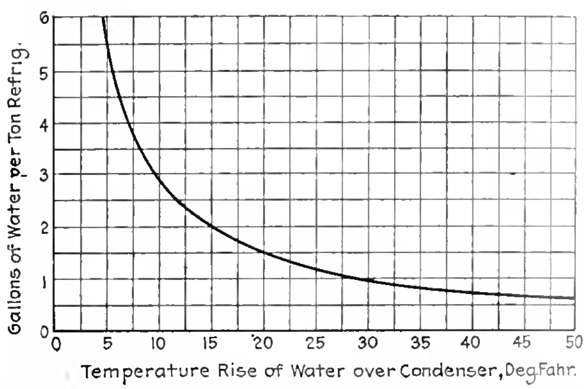


Fig. 9 Temperature Rise of Water Over Condenser with Various Amounts of Water and No Atmospheric Cooling

The use of a properly designed cooling tower is preferable to pumping water from a well, except when the well water is very cold. In summer, in even the hottest and most humid parts of the United States, the temperature of the water in the cooling tower will hardly ever be 85 deg. fahr.; it will ordinarily be below 80 deg. fahr. and in winter 50 deg. fahr. and even less. In fact, with a cooling tower it is not impossible to obtain in winter a condenser pressure of 65 lb., while with well water, the temperature of which keeps more uniform throughout the year, the pressure is higher in winter. The towers should not be built square but rectangular, twice as long as they are wide, and should be placed so that the wind strikes on the longer side.

The proper relative position of the cooling tower, as regards the condenser, is a most important feature. It must be remembered that the auxiliary power should be kept down to the minimum of ½ hp. per ton of ice, also that if the head is reduced more water can be pumped with the same power and thus lower condenser pressures are obtained. In many plants the cooling tower and the condenser are placed on the same level with the result that two circulating pumps are operated in place of one. The relative position of the cooling tower and the condenser should always be one above the other, with the preference of the condenser being in the higher position, since unobstructed air access is more important with an atmospheric condenser than with a cooling tower. Both are more conveniently located upon a roof.

The spray system has recently been introduced in connection with ammonia condensing systems and very good resuls are being obtained. Its cooling efficiency varies from 45 to 70 per cent, depending upon humidity, wind velocity, fineness of spray and pressure at the nozzles. In the calculations which must be made for designing a spray system, however, it is advisable to figure its operating efficiency at 50 per cent. This value has been assumed in the preparation of the curves in Fig. 10, which show the value of the temperature of the water before spraying and the corresponding values after spraying, for various wet-bulb temperatures.

The advantage resulting from the use of a spray system in an ammonia condensing installation is that it reduces the power required, because a spray system does not involve the action of a fan, and a pressure at the nozzle of only six or seven pounds, that is, the equivalent of a tower 14 ft. high is sufficient. Also, the cost of construction and maintenance is less for a spray system than for a cooling tower.

Distilled- and Raw-Water Systems

The advisability of using water evaporators should be carefully considered before adopting a raw-water system in a steam plant. Where the quantity of the available water is such that raw-water ice cannot be made successfully, the installation of evaporators is highly desirable.

There are two types of evaporators, high-pressure and vacuum. Under proper conditions both give satisfactory service and neither one develops as much trouble from the formation of scale as is ordinarily assumed. The writer knows of evaporators operated successfully in a region where the water contains a large amount of salt, a large amount of carbonates, and considerable calcium and magnesium sulphate. Of course, they will have to be cleaned and blown off the same as a boiler, but their use contributes to securing a high economy and simplifies the operation of the plant.

It may be added that a plant short of distilled water is wasteful, as also is the plant that wastes distilled water. A simple steam-driven ice plant should have just enough distilled water to make the ice.

Ammonia Conservation

The chief sources of ammonia loss are blow-outs, careless purging, and leaky stuffing boxes. The first can be prevented by testing the system and keeping up with repairs continuously. Condensers, ice tanks and coils should be frequently inspected, repaired when found deficient, and tested with air of not much above atmospheric temperature. Leaks develop in the stuffing boxes through carelessness in packing them or from the bending of the rod. The only remedy is strict supervision, education of the workmen and the granting of bonuses.

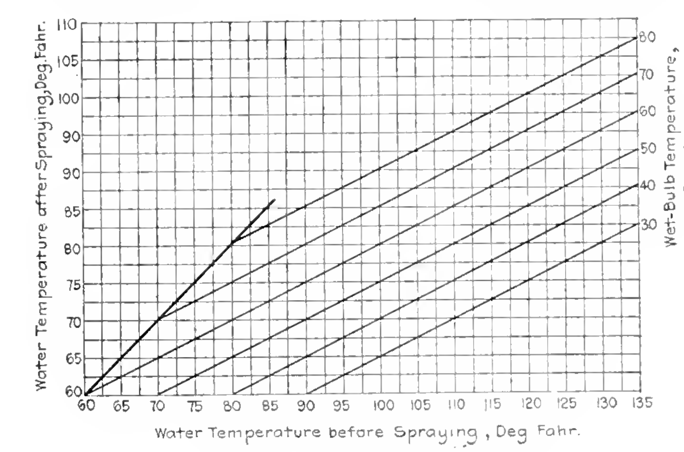


Fig. 10 Performance of Spray System

Bonuses

Bonus systems in ice plants may include bonuses paid for fuel economy, ammonia conservation, quality of ice, quantity produced and service.

The economy and ammonia-consumption bonuses are the most important, but they are defined with difficulty. In regard to economy bonuses, the best system of granting them is devised by taking the quntity of fuel used per tons of ice made in one season as an expected minimum at which no bonuses will be given, and then making a very thorough examination of the plant for the purpose of ascertaining the possibilities of increasing the output. For instance, in an ice plant making 15,000 tons of ice per year

at the rate of 1.5 tons of ice per barrel of oil, a thorough examination proved that with a slight reconstruction and improved operation, 2.3 tons of ice per barrel of oil could be expected; accordingly, Table 6 was drawn up, giving the value of the savings made and the bonus, which was taken as 20 per cent of the saving effected. The monetary value of the saving was based upon the cost of oil, in this case 80 cents per barrel.

The percentage of saving to be paid out as economy bonus will depend upon the size of the plant, the facility of making the saving, the magnitude of saving possible and the cost of fuel, but will range from 50 per cent in small plants to 10 per cent in large plants, or in plants where large savings are possible. Every plant should have an economy standard and the aim should be to do better every year.

TABLE 3 BONUS OUTLINE

Tons of Ice per Bbl. of Oil	Saving, per Cent	Cost of Fuel per Ton Ice, Dollars	Total Saving, Dollars	Bonus, Dollars	Clear Saving, Dollars	Tons of Ice per Ton of 10,000 B.t.u. Fuel
1.5		0.533		...	....	4.8
1.6	6.2	0.50	495	99	396	5.16
1.7	10.9	0.475	870	174	696	5.49
1.8	16.7	0.444	1335	267	1068	5.81
1.9	21.0	0.421	1680	336	1344	6.13
2.0	24.9	0.40	1995	399	1596	6.46
2.1	28.5	0.381	2280	456	1824	6.78
2.2	31.2	0.363	2550	570	2040	7.10
2.3	34.7	0.348	2775	555	2260	7.42
2.4	37.5	0.333	3000	600	2400	7.75
2.5	40.0	0.32	3195	639	2556	8.07

The bonus outline should be simple so the men can understand it, otherwise their interest will be greatly reduced. The bonus should be preferably paid at the end of the season, although this depends upon conditions, and any man leaving the company during the season without a good reason, or any man discharged through fault of his own, should forfeit the bonus.

The ammonia-consumption bonus should not be based only upon the amount of ammonia purchased, but rather upon the amount of ammonia in the system at the beginning and end of the season, as apparent from the liquid receiver plan gage and the amount introduced during the season.

Quantity bonuses are usually granted when the plant is operating above its rated capacity.

Quality bonuses are based on the number of good blocks of ice made, with a deduction equal to two blocks for every poor block turned out.

The service bonus consists of a certain sum which is given to the faithful employees at the end of the season. It can be based upon the earnings of the plant and be thus converted into a profit-sharing bonus; this becomes every day more advisable with the present labor situation and the high cost of operation.

DISCUSSION

Fred Ophuls spoke regarding two-stage ammonia compression. He stated that during the last few years two-stage compression had been used in refrigerating plants where it was desired to cool brine down to 10 or 20 deg. below zero (fahr.). With the higher brine temperatures, 10 to 20 deg. above zero, as used in ice-making plants, the advantage of compound compressors was not so great, and it was still a question whether in this case the increased friction of the two-stage machine did not wipe out the saving derived from compounding. There was, of course, an opportunity in ice-making to cool down the water at a high and favorable intermediate ammonia evaporating pressure, such as 40 lb. gage, but this would not exceed 20 per cent of the total work and should be done in more efficient water coolers than those used heretofore.

Regarding Mr. Azbe's statement that theoretically wet compression was more economical than dry compression, Mr. Ophuls believed the opposite to be true, as would be apparent from a careful analysis of the entropy diagram, as well as from accurately made tests. He said that in wet compression it was necessary to feed extra liquid to the compressor to take up the heat of compression, which meant an increase in volume to be handled by the piston, and therefore an increase in horsepower. He held that dry compression, in which the suction gas reaches the compressor inlet as near its saturation temperature as possible, was the most economical method known today.

Edward N. Trump spoke on the increased steam economy obtained with the uniflow type of engine over the former types in which the initial steam condensation was considerable owing to the fact that the steam on entering came in contact with a relatively cool surface. In the uniflow engine the steam traveled only in one direction, the wall and head temperature was much higher, and therefore the cylinder condensation was almost eliminated, so that a 150-hp. engine non-condensing would use only 18 lb. of steam per i.hp-hr., and condensing, 11 lb. of steam, if the steam was supplied at 125 lb. pressure. Its consumption curve was also very much flatter than with a Corliss engine, and the surface within the cylinder was kept very small. At light load the uniflow engine was therefore nearly as economical per horsepower as at full load. Again, it made very little difference in the total heat consumption whether the steam was highly superheated or dry saturated.

Halbert P. Hill[1] spoke in favor of the electrically operated ice plant, driven by a constant-speed synchronous motor direct-connected to the ammonia compressor. He said such motors were now obtainable for speeds as low as 50 r.p.m. without excessive cost, and that their efficiency was higher than with any other type.

George A. Horne also was in favor of electric drive, because it was mutually advantageous to both the user and the central station. The central stations had to maintain large equipments to take care of peak loads during the winter. Ice and refrigerating plants required most of their power in summer. For a number of years the central stations in large cities had offered to such plants "off-peak" contracts at attractive rates. This off-peak period might extend over two to four months in winter, during which time the customer agreed to use from 4 to 8 p.m. not to exceed 20 per cent of the preceding maximum demand. Any current used in excess of this must be paid for at a high rate, but with judicious management this penalty did not arise. In fact, it was found in two 500-ton plants that the shutting down of the main compressors for four hours was hardly noticeable in well-insulated cold-storage rooms filled with chilled goods, and even in a pipe-line system there was so much reserve capacity stored up that the heat influx during such idle time could be easily removed when the machines were started at 8 p.m. In other words, an interruption of 4 hours out of 24 proved to be entirely practical, so long as the auxiliaries were kept going, and thus large ice and refrigerating plants were in position to secure a rate as low as 0.9 cent per kw-hr.

An interesting utilization of the energy available in the steam jets emitted from the soil in volcanic regions is found at Larderello, Italy, where a central plant of 16,000 hp. is operated continuously and distributes current to Florence, Livorno and Grosseto.

The Larderello region is extensively covered with volcanic formations, the most wonderful being the so-called "soffioni," which are certain volcanic vents emitting powerful jets of very hot steam. By boring holes, powerful jets at a pressure of two to three atmospheres have been obtained. The first utilization of this steam was made in 1905 when the steam ejected at the Nenella fissure was applied to a 40-hp. engine. Later in 1912 satisfactory results were obtained with a 300-hp. turbo-alternator. The subsequent increase in the price of coal, especially during the years of the war, has stimulated the exploitation of the thermic energy of these soffioni on a much larger scale. As other substances are emitted with the steam, among them sulphuric acid, the steam from the soffioni is used only for heating. Three turbo-alternators of 3000 kw. each are supplied with low-pressure steam from boilers heated by the natural steam which is piped and carried to them.

[1] Consulting Engineer, 112 W. 42d St., New York, N. Y.

ECONOMICAL SECTION OF WATER CONDUIT FOR POWER DEVELOPMENT

By CARY T. HUTCHINSON,[1] NEW YORK, N. Y.

THE literature of water-power engineering accessible to the writer does not include a discussion of the method of determining the economical section of a water conduit for supplying water to a power plant.

In what follows a formula for the best slope and size of conduit is deduced, which takes into account in a practical manner the construction costs, the value of the power recovered, and the rate of returns expected on expenditures made, as well as the other physical conditions of the problem. The resulting relation between the best area and the quantity of water is shown in Fig. 2, for chosen values of factors entering the problem, and it is pointed out how, by a simple modification of the graphs of this figure, the relation for other costs and unit prices can be easily determined. One interesting result is that for a flume, or for any conduit, for which the increment cost for increasing the capacity by a relatively small amount is proportional to the surface, the best speed of flow of the water is constant, independent of the size of the conduit.

The economical section is evidently that resulting in the greatest net earnings of the power plant under the conditions controlling the market where the power is delivered. Inasmuch, however, as this section must be determined in advance of complete knowledge of market conditions, it is clear that only an approximation can be made, and that a ready method to determine the variation in net earnings for a large range of sections and shapes of water conduit may be useful.

Assuming that a certain shape and slope of water conduit is fixed upon provisionally, the question is whether some change either in the slope or in the shape or size of the section will result in an increase in net earnings. Any increase in the dimensions of the conduit will obviously entail an increase in construction cost, and hence an increase in annual charges. This increase in annual charges is limited, practically speaking, to interest, amortization and profit, inasmuch as only small changes in a quantity which itself is a small part of the total are under consideration. For instance, under ordinary conditions the loss in the water conduit may vary from, say, 5 per cent to 10 per cent of the total power; it is a variation of possibly 25 per cent one way or the other in this 5 per cent or 10 per cent that is involved.

It is therefore evident that no increase in operating charges, or maintenance, or repairs need be considered, and that the changes in design of the conduit should carry charges only for interest, amortization, and profit. An allowance for profit on the additional expenditure must be included, since every dollar invested should earn its share of profit as well as its fixed charges.

The increase in power resulting from an increase in the size of the conduit brings in a certain addition to gross earnings. Against this, in theory, should be charged the costs of operation and maintenance on the additional equipment and machinery required to deliver this power to the market; but for the same reasons stated in considering the water conduit, all these charges against the additional gross earnings may be ignored in this analysis, as they are negligible in amount, due to the fact that the increase in the power output is small. There would, in fact, be no increase in operating charges, and under practical conditions there would be no increase in equipment, and therefore no increase in fixed charges on equipment.

The matter then reduces to the comparison of the additional gross earnings from the power recovered by an increase in the size of the conduit on the one hand, and the additional interest, amortization, and profit on the cost of the enlargement of the conduit on the other.

The determination of additional power is simple, involving merely the overall efficiency from the water to point of delivery. A consideration of the value of this increased power is a matter of judgment on the part of the engineers and executives of the enterprise, giving attention to the market conditions under which the power is sold, and particularly to the load factor.

The determination of the additional cost of the conduit, however, is more difficult, inasmuch as this cost depends in theory not only on the area of the cross-section of the conduit, but also upon its shape; that is, upon the hydraulic radius or the wetted perimeter. The relation between the area and the wetted perimeter differs, for example, for a rectangular, a circular or a hexagonal conduit, and cannot be expressed in a simple equation to cover all shapes of conduit. The practical way to handle the problem is to fix upon one shape of conduit, determine the economical area and slope for this shape, and then follow out a similar procedure for such other shapes as may be practicable in the case under consideration. This determination being made for the several possible shapes, the best result is then selected.

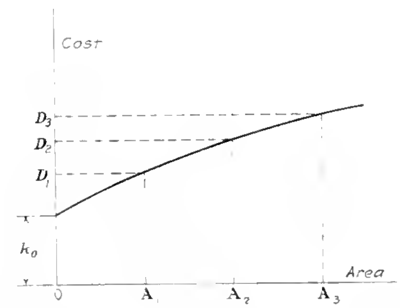


FIG. 1 RELATION BETWEEN SECTIONAL AREA OF CONDUIT AND COST

The procedure indicated in the foregoing general discussion can be expressed symbolically as follows:

Let Q = flow in sec-ft., taken as constant
L = length of conduit, ft.
A = area of conduit, sq. ft.
s = slope of conduit, ft. per ft. of length
r = hydraulic radius of conduit, ft.
w = wetted perimeter of conduit, ft.
v = speed of flow, ft. per sec.
C = constant in the Chézy formula
e = efficiency from water to point of delivery $\times$ 0.085.

Then the power loss p in the conduit in kilowatts will be

$$p = eQsL \qquad [1]$$

In this equation s is the variable, and any change of p is due to a change of s and is expressed by

$$dp = eQLds \qquad [2]$$

If m is the annual value of one kilowatt under the ruling conditions, then

$$mdp = meQLds \qquad [3]$$

is the added gross (and net) earnings due to the change in s.

As to the cost of increasing the capacity of the conduit, the flow is assumed to be given by the Chézy formula

$$v = \frac{Q}{A} = C(rs)^{0.5} \qquad [4]$$

The best size of conduit is to be determined for a known value of the flow Q; that is, in Equation [4] Q is to be taken as constant. In this case,

$$\frac{dQ}{ds} = 0$$

and

$$\frac{dA}{ds} = -\frac{2}{5}\frac{A}{s}; \quad \frac{dw}{ds} = -\frac{1}{5}\frac{w}{s}; \quad \frac{dr}{ds} = -\frac{1}{5}\frac{r}{s} \qquad [5]$$

[1] Consulting Engineer. Mem. Am. Soc. M. E.

For presentation at the Spring Meeting, Detroit, Mich., June 16 to 19, 1919, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

With Q constant, a change in s can be offset by a change in either A or r, or in both: that is, either the size or the shape of the conduit can be varied to keep Q constant.

There is no way of expressing a general relation between A and r, but for any chosen shape, as, for example, a rectangle or semicircle, the area is proportional to the square of any linear dimension: that is,

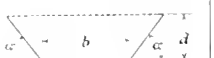
$$A = ar^2 = wr = \frac{w^2}{a} \ldots\ldots\ldots\ldots\ldots\ldots [6]$$

The value of a, of course, varies, but for usual forms the differences are not great, and the influence of changes in a on the economical section is slight; in fact, it can be shown that for the best section

$$A \propto a \; [illegible]$$

for the conditions of Equation [7a]. Table 1 gives values of a

TABLE 1 VALUES OF SECTION CONSTANT a FOR VARIOUS SECTIONS

Shape of Section	Hydraulic Radius	Cross-Section	Section Constant a	Section Constant $\sqrt{a}$
Semicircle, radius $=r$	$r/2$	$\pi r^2/2$	2π	2.51
Square, side $=d$	$d/3$	d^2	9	3.00
Half-square, depth $=d$	$d/2$	$2d^2$	8	2.83
Hexagon, half-full, depth $=d$ 	$d/2$	$\sqrt{3}d^2$	$4\sqrt{3}$	2.55
Prism: 				
Tan $\alpha = 1/1.5$, $b = 4d$	$0.72d$	$5.5d^2$	10.6	3.26
Tan $\alpha = 1/2$, $b = 10d$	$0.83d$	$12d^2$	16.0	4.00

for the usual shapes. For preliminary calculations $a = 9$ may be used.

The cost of a water conduit can be expressed as a constant, representing the cost of a large part of the preliminary work and plant, plus an amount depending on the size and surface area. In general, the cost per foot may be expressed by

$$D = k_0 + kA^n \ldots\ldots\ldots\ldots\ldots\ldots [7]$$

where D = cost per foot, dollars
k_0 = constant part of cost per foot
k = a constant
n = an exponent whose value lies between 1 and 0.5.

In any specific case, when all the conditions are known, estimates of the total cost per foot of the conduit should be made for three or more different cross-sections; plotting these values will enable both k and n to be determined.

For example, let Fig. 1 represent the cost per foot for a certain conduit; then k_0 is given at once by the curve, and from

$$\frac{D_2 - k_0}{D_1 - k_0} = \left(\frac{A_2}{A_1}\right)^n$$

n is determined. Each pair of points should be used and the value of n found. The values of n and k_0 being known, k may be obtained from

$$k = \frac{D_1 - k_0}{A^n}$$

Other methods could be used. The gist of the matter is that the accurate way is to make detailed estimates for several cross-sections and determine the constants from an analysis of these estimates.

Two extreme cases simplify the formula: First, when the increment cost is proportional to the area, as in a heavy rock cut, then

$$D = k_0 + kA \ldots\ldots\ldots\ldots\ldots\ldots [7a]$$

and, second, where the increment cost is proportional to the surface, or the wetted perimeter, as for a flume, then

$$D = k_0 + kA^{0.5} \ldots\ldots\ldots\ldots\ldots [7b]$$

These are considered later.

If i represents the total rate of returns expected on all expenditures on the property, including interest, amortization and profit, then

$$I = iL(k_0 + kA^n) \ldots\ldots\ldots\ldots\ldots\ldots [8]$$

gives the total returns from this investment, and a change ds in s calls for a change in returns of

$$dI = niLkA^{n-1}\frac{dA}{ds}\,ds \ldots\ldots\ldots\ldots\ldots [9]$$

or, from Equation [5],

$$dI = -\frac{2niLkA^n}{5s}\,ds \ldots\ldots\ldots\ldots\ldots [10]$$

This saving, due to an increase in s, must be at least equal in value to the power lost, and indeed should exceed it by some margin; this margin can be included in the overall rate of return i, and therefore

$$dI = mdp \ldots\ldots\ldots\ldots\ldots\ldots [11]$$

Substituting in [11] from [10] and [3], there results

$$5meQs = 2kniA^n$$

Substituting further from [6] and [4], namely,

$$s = \frac{v^2}{C^2 r} = \frac{v^2}{C^2(A/a)^{0.5}}, \text{ and } Q = Av,$$

gives finally

$$A^{n-0.5} = \frac{2.5mea^{0.5}}{nikC^2}\,v^3 \ldots\ldots\ldots\ldots\ldots [12]$$

This may also be written

$$A^{(n+2.5)} = \frac{2.5mea^{0.5}}{nikC^2}\,Q^3 \ldots\ldots\ldots\ldots\ldots [13]$$

If

$$N = \frac{2.5mea^{0.5}}{nikC^2} \ldots\ldots\ldots\ldots\ldots\ldots [14]$$

then

$$A^{(n+2.5)} = NQ^3 \ldots\ldots\ldots\ldots\ldots\ldots [15]$$

The best way to handle this equation for engineers is by logarithmic plotting. From [15]

$$\log A = \frac{\log N}{(n+2.5)} + \frac{3}{(n+2.5)}\log Q \ldots\ldots\ldots [16]$$

When n is known, this can be readily plotted for any range of Q desired. As an illustration, assume:

$$m = \$10,\ e = 0.67 \times 0.085 = 0.057$$
$$i = 0.15, \quad C = 120$$

then

$$N = \frac{10^{-3} \times 2}{nk}$$

If, further, $n = 0.75$ and $k = \$0.10$,

$$N = 10^{-2} \times 2.67$$

and

$$\log A = \frac{\log 10^{-2} \times 2.67}{3.25} + 0.925 \log Q$$
$$= -0.485 + 0.925 \log Q \ldots\ldots\ldots\ldots\ldots [18]$$

Fig. 2 is the logarithmic graph of Equation [18] for values of Q from 100 to 10,000, in four parts; for the line BC the ordinates are to be multiplied by 10 and the abscissæ by 100; for CD, by 100 and 100; for DE, by 100 and 1000; for EF by 1000 and 1000—all as indicated by the figure. From this figure, Table 2 is readily computed.

TABLE 2 VALUES COMPUTED FROM FIG. 2

Q	A	V	r	s (Ft. per 1000)
100	23	4.35	1.60	0.830
500	100	5.00	3.34	0.520
1,000	191	5.22	10.50	0.180
2,500	450	5.56	16.70	0.128
10,000	1,650	6.08	33.30	0.077

Two special cases are of particular interest: First, when $n = 0.5$ and the increment cost is proportional to the surface; this would approximate the case of a flume or a concrete-lined canal in earth. Here

$$A^3 = NQ^3$$

and, since $v = Q/A$,

$$v^3 = \frac{1}{N} \dots\dots\dots\dots [19]$$

or there is one best speed of flow independent of the size of conduit. This is a somewhat surprising result.

The second case is when the increment cost is proportional to the amount of excavation, as for a costly rock cut: here $n = 1.0$, and

$$A^{3.5} = NQ^3 \dots\dots\dots\dots [20]$$

This can be solved either by plotting, as in Fig. 2, or as follows:

$$A^{0.5} = Nv^3 \dots\dots\dots\dots [21]$$

and

$$Q = Av$$

Calculate $A^{0.5}$ and A from [21], assuming values for v; then find Q, which can be plotted to A.

Variations in A resulting from other values of the unit costs than those used in plotting Fig. 2 can be easily taken into account without replotting these curves. Put

$$N^1 = fN$$

then

$$\log N' = \log f + \log N$$

and a length equal to $\log f/(n + 2.5)$ added to the ordinate of the curve at any point will give the value of Y for $N' = fN$. If f is less than unity the length is to be subtracted. For example, for the point P of Fig. 2, $Q = 2500$, $A = 450$, $v = 5.56$. If $f = 1.5$, then P_1 is the point where $PP_1 = \frac{\log 1.5}{n + 2.5} = \frac{\log 1.5}{3.25}$. If $f = 1/1.5$, P_2 is the point. These values are given in Table 3.

TABLE 3

N	Q	A	v
$10^2 \times 4.00$	2500	510	4.90
$10^2 \times 2.67$	2500	450	5.56
$10^2 \times 1.78$	2500	395	6.32

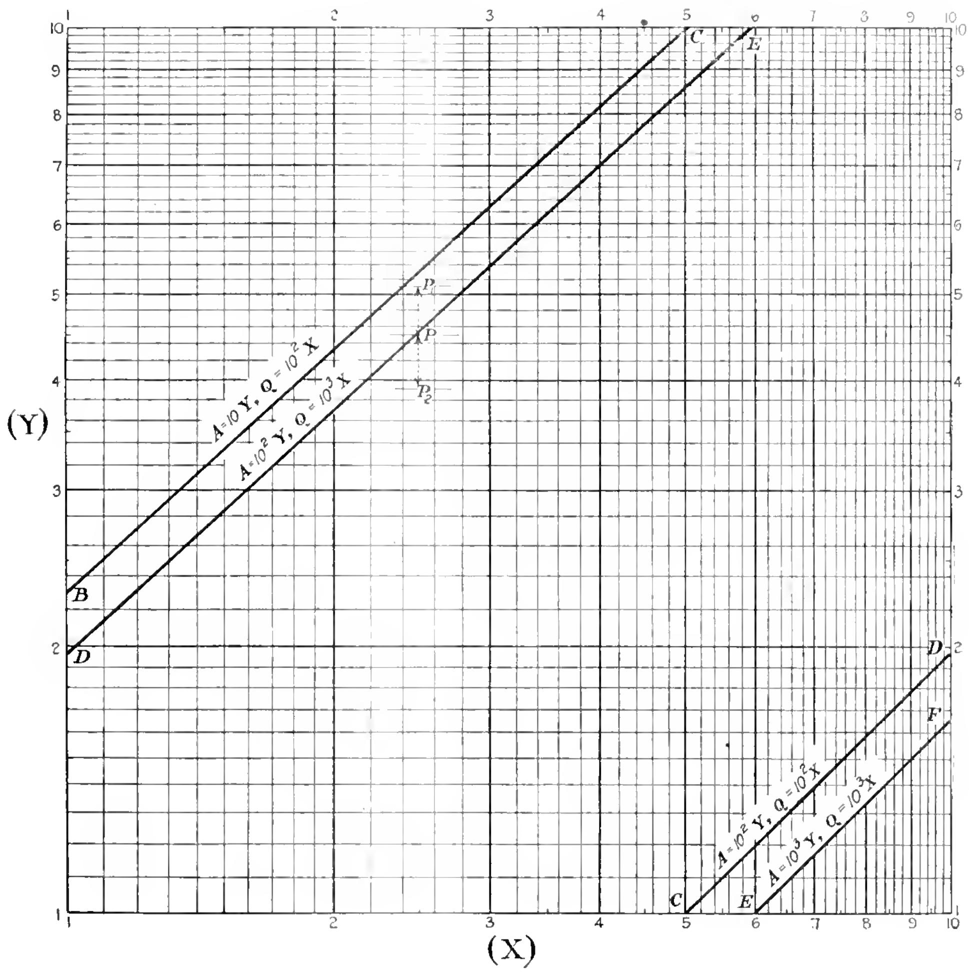


FIG. 2 LOGARITHMIC GRAPH OF EQUATION [18] FOR VALUES OF Q FROM 100 TO 10,000 SEC-FT.

The usefulness of this analysis is limited by the accuracy of the determination of n, and this in turn depends upon the definite knowledge of construction costs.

Natural gas, valued conservatively at $9,000,000, was wasted in a year in a group of Kansas and Missouri cities and towns, according to figures just gathered by the United States Fuel Administration. These figures show wastes varying from 27 to 73 per cent of the gas delivered to the gates of the cities and towns. The main cause of this great wastage is leakage due to poor construction of pipe lines.

To prevent further waste and to determine whether the fault lies with the wholesale or the distributing companies, arrangements have been made to have all wholesale meters in the affected district checked by the Division of Weights and Measures of the Bureau of Standards.

The figures of the Fuel Administration were obtained from the statistics of the wholesale companies as to the number of cubic feet of gas delivered to the gates of the cities and from the figures shown by the meters of the domestic consumers, the difference being the waste. (*Official Bulletin*, Jan. 6, 1918, p. 7)

Engineering Achievements of the Army

AMERICAN Engineers will always be remembered as the "Fighting Engineers," and yet their professional achievements during the Great War are also cause for just pride, for success has invariably attended their endeavors. During the war it is obvious that nothing could be learned of their work, but now that the struggle is over, publicity is quite proper, and an exhibition at which many war devices were shown for the first time was accordingly held at Washington, D. C., on February 21, 1919, under the direction of General Black, Chief of Engineers, U. S. A.

Before describing the various exhibits it may be well to state that the Engineering Department is charged with a great variety of duties. Throughout the war this Department not only organized and trained its own troops but also purchased, stored and supplied engineering material and equipment of every conceivable kind. The organization of the Department was also such that it could control production to meet its particular needs in the field, and early in the war, therefore, the Department found itself actively engaged in engineering research and development of new equipment.

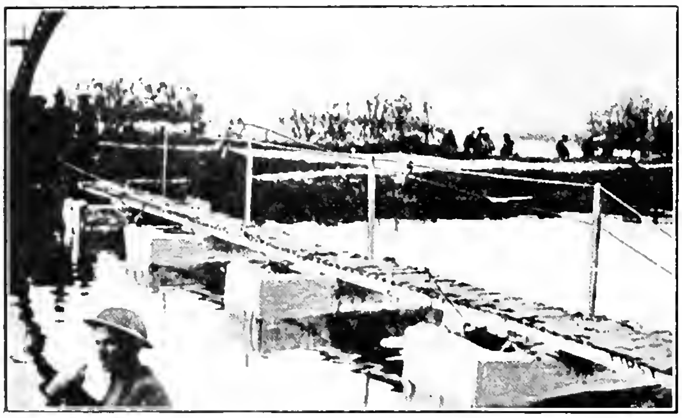


Fig. 1 Portable Foot Bridge

To carry on their work the Engineers rapidly grew from 1.6 per cent of the total army at the beginning of the war to 10.8 per cent at the end, increasing 131½ times their original size, whereas the entire army increased only 19½ times. This tremendous growth naturally demanded considerable tonnage to maintain oversea troops and it is therefore not surprising to find that at the end of the war the engineers were using 27 per cent of all shipping to France.

Railroads

One of the first difficulties encountered by the A. E. F. was the transportation of troops and supplies from French seaports to front-line trenches. The solution of this problem was shown in an interesting exhibit of photographs. Both narrow- and standard-gage equipment were shipped overseas as rapidly as tonnage could be obtained, the latter being supplied in enormous quantities.

Locomotives, tenders and cars, usually 35 at a time, were loaded completely assembled into ships. In this manner over 1300 locomotives were shipped to France and a great saving in labor, time and money thus resulted. In this connection it is of interest to note that the Atchison railroad which operates 1400 miles of track in France has but 1000 standard-gage locomotives.

The number of cars sent abroad, if placed end to end, would extend 140 miles, and if the armistice had not been signed there would have been by July next 682 miles of cars alone.

That the cost of railroad equipment could be lowered in war time seems incredible, but by adopting American manufacturing methods locomotives which were costing the French $51,000 were obtained, even at a time when the price of material was rising, for $37,000.

The narrow-gage railroad proved of great value, especially near the front, because the tracks could be more easily and quickly repaired than roads, and in addition the cost of transportation was only about one-seventh that of haulage by trucks.

Bridges

An exhibit which invited special attention was a collection of photographs showing several types of portable and pontoon bridges designed especially to support heavy loads occasioned by the introduction of the tank and heavy mobile artillery.

Portable steel bridges were manufactured in sections 10 ft. long. They are designed so as to be rapidly bolted together and thus could easily be transported on trucks; and because they can carry loads as high as 30 tons, even tanks could be driven over them. They were used extensively along the fighting fronts, as the forces advanced, to replace bridges that had been destroyed by the enemy.

The construction of the ordinary pontoon bridge was also so modified that in place of the usual loads of 3½ tons per axle the bridges were able to support a load of 15 tons per axle and in addition 30 men. These bridges can easily carry the heaviest mobile artillery, and a raft is now being developed from pontoon material which it is expected will carry the famous 30-ton tank.

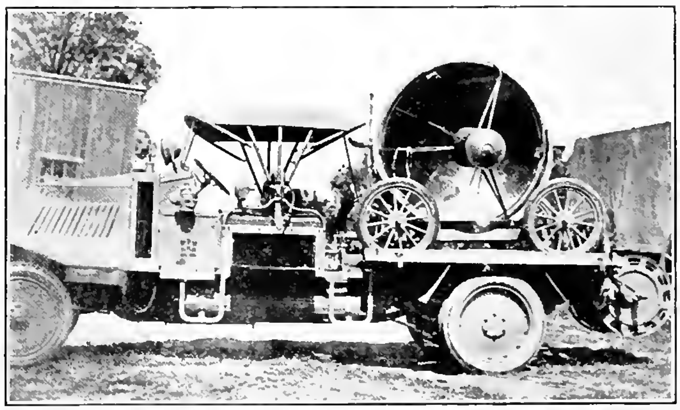


Fig. 2 60-in. Portable Searchlight on Truck ready for Transportation

Not all the design and development work was done in this country, however, for one of the most valuable bridges was a light foot type, designed and perfected by an engineer officer in France. This bridge is supported on boats made of canvas stretched on wooden frames. Duckboards form the floor. A single truck can carry 285 ft. of this bridge and it can be erected by a few men in a very short time.

In the crossing of the Meuse and the taking of the heavily fortified heights on the east of the river these bridges proved invaluable. In some cases they were put up under heavy fire, and the bridge which was thrown across the Canal de l'Est near Dun-sur-Meuse (Fig. 1) was under machine-gun and shell fire 26 hours before the infantry could cross.

Searchlights

As an example of American method of development an exhibit of searchlights showed what could be accomplished even in a short time.

At the opening of the war the Army-type searchlight had been developed only for battlefield illumination and seacoast defense. The best-known type of such lights was the 60-in. seacoast model which weighed 7500 lb. and cost approximately $10,000. By the

elimination of heavy fittings and the protecting glass doors in front and substituting Ford wheels and axles for the cumbersome old type of mounting, an equally powerful light was obtained which costs, however, but two-fifths as much, weighs but 900 lb. and can be much more rapidly manufactured. This new light is known as the portable open type, and Fig. 2 shows how easily it can be transported.

In connection with the development of these lights the subject of mirrors naturally arose, with the result that metal mirrors will perhaps soon replace all glass ones. It was found that the glass mirrors required considerable time to manufacture, and that only one firm in the United States was properly equipped to do the work. Research was at once started and metal mirrors were soon being manufactured at a cost one-third that of glass. The process is an interesting one, and is briefly as follows:

The glass portion of a mirror is first made in the usual way. This glass first receives a silver coating, and next metal is deposited on the silvered surface. When the deposit has reached the required thickness of about $^3/_8$ in. the glass is pried from the metal. Thus the glass is used only as a form, and the process can be easily repeated. Unskilled labor, it is stated, can produce very satisfactory mirrors and an adequate supply was thus assured.

These mirrors have given very satisfactory results. They run cold even when used in lights carrying from 400 to 500 amperes, and their freedom from all ordinary accidents to which glass mirrors are subject makes them very popular.

Map Production

The demand for maps of all kinds was tremendous, as military operations could not be successfully carried out unless charts were available in large quantities. An exhibit of a portable map-reproducing set which went with each division disclosed the fact that American engineers could turn out 1,300,000 maps every 24 hours. The United States Engineers' map-reproduction plant in France was said to be larger than any similar plant used by the Allies.

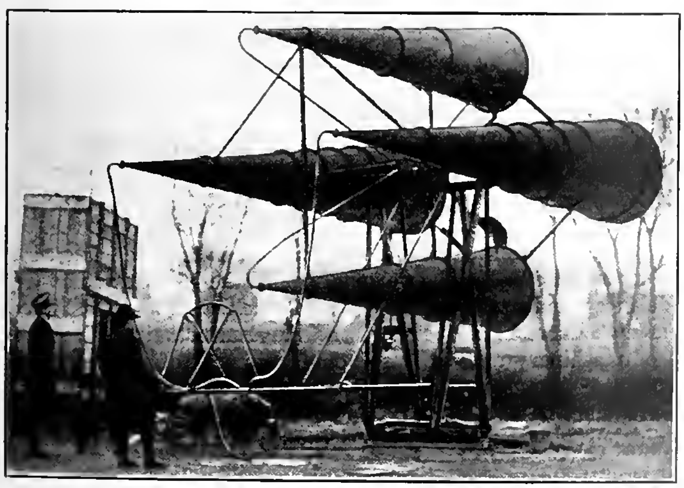


Fig. 3 Long-Horn Listening Device for Locating Enemy Aircraft

Lithographic machinery on portable truck bodies, which could be lifted from the truck and placed on the ground, thus releasing the truck for other service, were also available, and the 29th Engineers had as part of their equipment machinery of this type whose capacity was greater than that of the permanent Geological Survey map-reproduction plant in Washington.

Map production from aerial photographs was made possible by the Bagley cartograph. This machine takes three pictures at a time from an airplane, mapping a strip 3 miles long and $\frac{1}{2}$ mile wide at an elevation of 4000 ft. The pictures can be easily matched together, and an exceedingly accurate map is thus obtained.

Forestry Operations

As illustrating still another field in which the engineers were engaged, one exhibit treated of lumbering in France. In one month alone 50 million board feet of sawed lumber was produced, a pile 10 ft. high, 12 ft. wide and 6.6 miles long. Eighty thousand cords of wood were also cut, and this if piled 4 ft. high and 8 ft. wide would extend 60 miles. In addition standard-gage railway ties were produced sufficient to build a single-track road 1091 miles long.

Camouflage

Camouflage in all its various forms has been treated of time

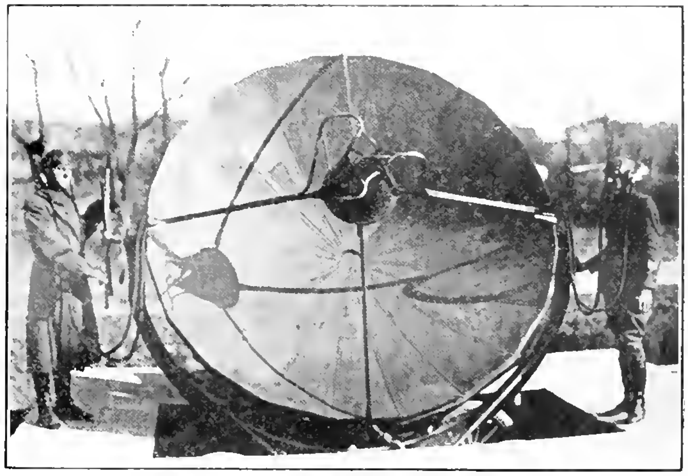


Fig. 4 American Paraboloid—A Development of the Long-Horn Set

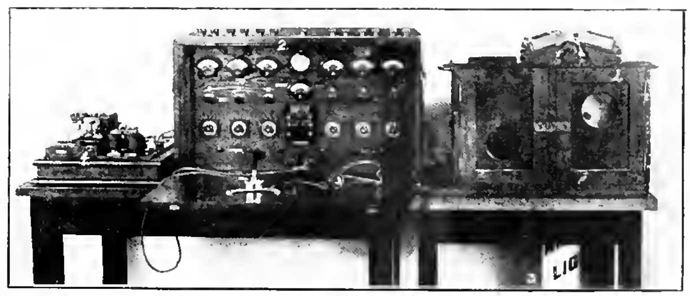


Fig. 5 Phonotelemeter—American Sound-Ranging Set for Locating Enemy Batteries

and time again, but the following facts as brought out by one of the exhibits may perhaps be of interest.

The Central Camouflage Works at Dijon produced daily 50,000 sq. yd. of camouflage cover. This tremendous output soon exhausted both the European and American supply of burlap, which formed the chief material for sniper suits, camouflage loopholes, observation posts, etc. A more economical material was soon developed and produced in the United States. This consisted of a 2-in. wire mesh partly covered with a light cloth and sprayed with paint. This proved very satisfactory and could be very easily and economically manufactured.

Listening and Sound-Ranging Apparatus

The exhibit of devices for locating mining operations, for detecting the approach of hostile aircraft, and determining the positions of the enemy guns was perhaps the most complete and entertaining of all.

Geophones and microphones, both mechanical and electrical types, were successfully used in stopping mining operations. These instruments, which operate in manner similar to the stethoscope, were developed by American engineers to such a point that their value was increased about 30 per cent.

Listening devices for determining the direction of approach of hostile aircraft at night had long been in use. The original long-horn listening device as built by the French (Fig. 3) was, however, a cumbersome affair and could be moved only with the greatest of difficulty. Again American methods came to the rescue, and an equally effective but portable apparatus of the parabolic type (Fig. 4), with the famous Ford wheel and axle again in evidence, with plaster-board detecting surfaces, was soon available; and, as might have been expected, at nearly one-third the original cost.

Perhaps the most delicate technical instrument developed and in use during the entire war was the phonotelemeter, shown in Fig. 5. This instrument not only locates an enemy battery, but it gives the caliber of the gun as well. These remarkable results are obtained merely from the report of the gun. The operation of the instrument is chiefly electrical, and, surprising as it may seem, it is not affected by rifle fire. A single set covers a 5-mile front, and it is reported that one section located 117 guns or batteries in 24 hours.

The English apparatus, known as the Bull-Tucker, makes a photographic record of the disturbance caused by the report of each gun. The French and American developments used a smoked tape for recording the firing, and to make the record permanent the tape is afterward sprayed with wax. This method gives the information desired in a much shorter time.

According to all reports, the Germans never possessed any such remarkable instrument, nor anything that could even be called similar in its nature.

It was by means of this instrument that one of the long-range guns which fired upon Paris was finally located and destroyed. After the armistice was signed, a survey taken by an American officer showed that in every case the location of enemy guns was within 20 to 30 ft. of that as determined by the phonotelemeter.

A flash-ranging device, also electrically operated, was extensively used upon the western front. This device is used in conjunction with observation telescopes for locating enemy batteries from the flash of their guns, and it proved very effective. It can be used either for day or night work.

The exhibits just described comprise the more important developments of the Engineering Department in the United States, and touch only here and there upon the activities of the Engineer Corps in France. "Over there," of course, the real construction work was done, for all fortifications, roads, railways, docks and warehouses, camps and hospitals, water-supply systems and sewers were the work of the engineers.

READJUSTMENT OF INDUSTRIES TO PEACE CONDITIONS

By JAMES D. MAGEE,[1] CINCINNATI, OHIO

BEFORE discussing the problem of readjusting to peace conditions, it will be well to recall something of the organization of modern business. In pioneer days each family was nearly self-sufficing. It produced the things which it needed to eat and wear. Now, as the result of ever greater and more complex division of labor, the ordinary man spends all of his time performing some small part in the manufacture or marketing of a product. The result of the change is greater interdependence. The individual is dependent upon the proper functioning of the whole system for the disposal of the product in which he is interested and for the possibility of purchasing the things he desires. Again, it is well to recall the method by which the decision is reached as to what will be produced. With few exceptions things are produced because some one thinks it will be profitable to produce them. That is, price levels and profit margins are relied upon to direct production.

The problem confronting us as we entered the war may be stated in general terms as follows: We had certain limited amounts of labor, land, materials and equipment. Some of the men were to be taken as soldiers and sailors. The remaining labor and resources had to be utilized to provide the food and clothing and munitions for the army and navy or equipment to make them, as well as to support the home population. The problem was how to shift labor and equipment from non-essential to essential industries. The readjustment was brought about by the appeal to the desire for profits and by the use of priorities in the supply of materials and in transportation. Any quick readjustment is difficult, but this one was made easier because it took place in connection with an almost unlimited demand for the products of industry which showed itself in rising prices.

Now we have another problem of readjustment. The men are returning from France and the training camps. The Government demand, backed by unlimited purchasing power, has fallen off. The labor, land, materials and equipment must be used to make things wanted by people in general. This readjustment will be more difficult as it will probably take place with prices falling.

The nearest analogy to this condition in our history is the situation of the North after the Civil War. Then an army of a million men was demobilized without any trouble. Agriculture, manufactures, mining and foreign trade all increased. It will be instructive to examine the two cases to find wherein they are alike and wherein different.

The cases are alike in that the fighting in the Civil War was done mostly in the South and in the present war in Europe.

Our general economic organization has become more complex since the Civil War. Specialization and division of labor have been carried to a greater degree. At present many men's chances of employment depend upon whether people will want enough of a certain article to justify some one ordering a machine which will be used in making it. This complexity makes our present problem more difficult.

After the Civil War many of the men went west to take up the free fertile land which the Homestead Act of 1862 had made available. They could take up this land and at least make a living without needing to bother about markets. At present the free fertile land is exhausted, so this easy solution is not possible. Secretary Houston proposes to reclaim and irrigate land to give to the returning soldiers, using the labor of the soldiers, in this way helping to give employment in the transition period.

After the Civil War many of the returning soldiers helped build railroads in the West. While at present there is not much need for new railroads, there is certainly a great deal of deferred maintenance which should provide employment.

The Civil War brought an increased use of agricultural machinery in the North. By this means the total product was increased, although the labor force was smaller. The increased production lasted after the war and formed the basis for an export trade in agricultural products. Much machinery was introduced in manufactures also. The present war has both intensified the use of machinery and increased our equipment of various types of plants. It remains to be seen whether our initiative will be great enough to use the plants for peace goods and develop large production as was done after the Civil War.

It is hard to form a judgment in the matter of possibilities for foreign trade. Europe had not been involved in the Civil War, and when it was over was ready to take large quantities of our exports. At present there is no question about the need for food and equipment in Europe, but the credit arrangements present a serious problem.

We are decidedly better off with regard to our monetary system than the country was after the Civil War. The inconvertible greenbacks had driven gold out of circulation and prices moved wildly. Our present monetary system is sound. Prices rose compared with pre-war prices in both cases. Prices in 1866 were higher than in 1865 and after that declined gradually.

The whole problem of readjustment is one of producing things which satisfy the new demands. People desire many things they have been forced to do without for the period of the war, and many of them, for example, the railroad employees, have greater purchasing power than they have ever had before.

[1] Associate Professor of Economics, University of Cincinnati.

Synopsis of remarks before the Engineers' Club of Cincinnati, November 21, 1918.

Heavy Field Piece With Mobile Mount

By ENSIGN C. L. McCREA,[1] U. S. N. R. F.

DURING the war the Navy Bureau of Ordnance originated a number of remarkable projects, and their success has been due in no small measure to the sound engineering principles applied in design and construction. Practically all of this development work was done by officers of the reserve force, graduate engineers and men of high standing in their profession. Among their many remarkable achievements was the design and construction of an entirely new type of mount for a high-power 7-in. gun. The evolution of this mount dates back to our entry in the war.

The Navy was naturally charged with the organization of a convoy system and ships of the *Connecticut* class were at once assigned to this duty. This of course meant that the convoy was to engage submarines that might appear, and it is generally conceded that submarine-offensive guns must be light, quick, and hard-hitting.

It was therefore decided that an improvement in the armament of the battleships could be made by substituting 5-in. 51-caliber guns for the 7-in. 45-caliber battery. This change was approved early in 1918 and the substitution of guns was begun at once. This left a number of 7-in. guns available for other service, and the urgent need of our forces in France for artillery turned attention to the possibility of placing these excellent guns in action on the western front.

The Army soon received a number of these 7-in. guns, which they mounted on railway cars especially built with a drop-frame bed so that the entire gun and its mount, exactly as it was used on board ship, could be placed on it.

This method of mounting the gun was unfortunately limited in its use by the fact that the elevation set by the naval mount, 15 deg., was still maintained, which limited the range to 14,000 yd., or about 8 miles. Furthermore the heavy trunnion pressures arising from the short length of recoil, while entirely satisfactory on board ship, were troublesome on a railway mounting, and strong outriggers and considerable bracing of the car and bed were required when the gun fired at targets at an angle to the line of the track on which it was located.

The Navy, in considering the uses to which these guns might be put, naturally first thought of placing them upon railway mounts. They planned however to give the gun an elevation of 30 deg., to lengthen the recoil and to modify the mount so that little or no bracing would be required when the gun was fired. While designs for this type of railway mount were being worked out, word was received that better use could be made of the guns if a suitable field mounting were developed, and on March 15, 1918, work was therefore started along such lines of design.

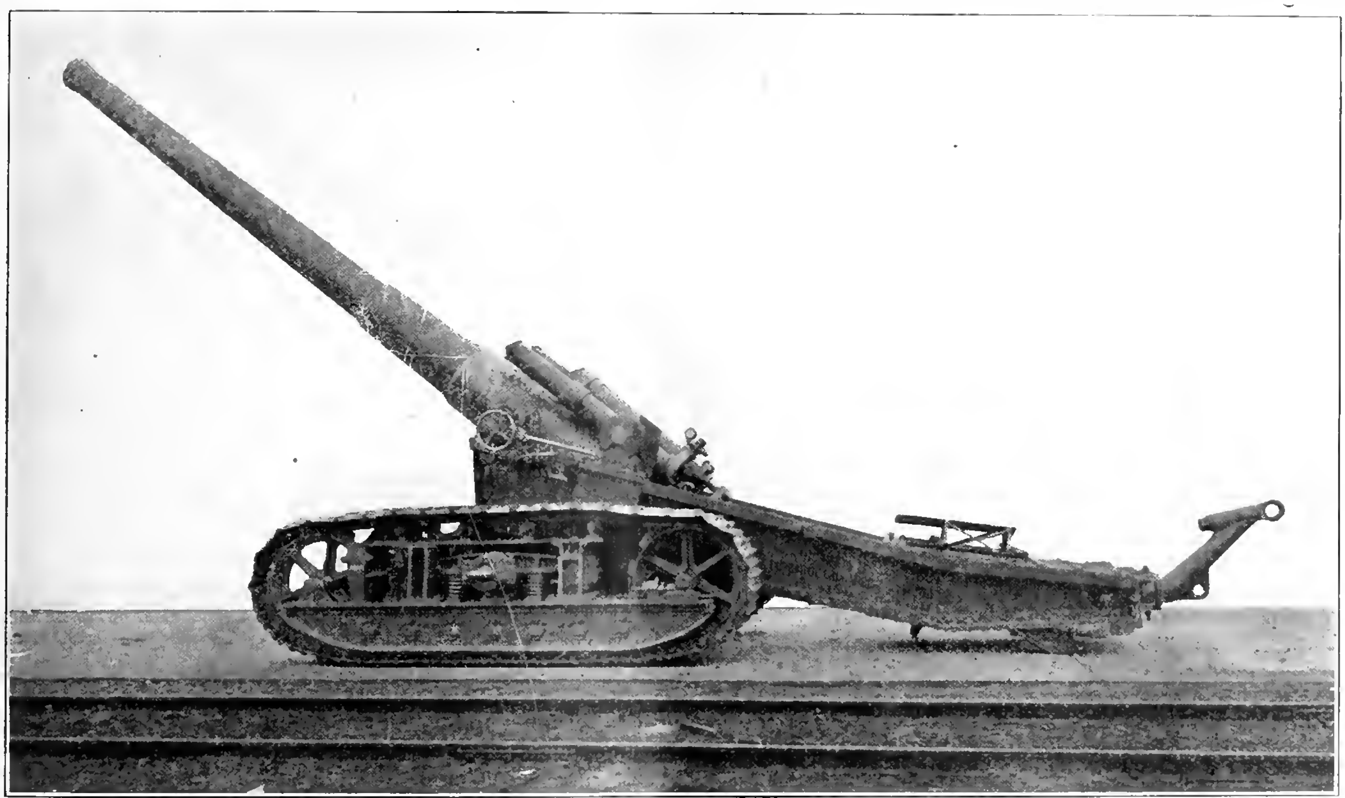


Fig. 1 High-Power 7-in. Gun with Caterpillar Mounting

The problem was to obtain a mobile field mounting for a gun weighing nearly 15 tons. The mount was also to permit transportation of the gun and mount as a unit, so that no preliminary preparation of the gun was necessary before firing. The 7-in. gun was the heaviest and hardest-hitting gun for which a mobile field mount of this kind had ever been contemplated, and in addition, the time allotted for design and construction was exceedingly short, as the mounts were desired in France before the close of the year 1918.

A study of existing designs was immediately commenced and it required but little study to show that a wheeled mount for the 7-in. gun was not practicable. The weight of the completed mount would be in the neighborhood of 70,000 lb. Assuming a 6-ft. wheel and an arc of contact of 25 deg. with the ground, the total bearing surface to carry the load would be about 6 sq. ft. This gave a ground pressure of about 6 tons per sq. ft., or 88 lb. per sq. in., a pressure of course out of the question, as the gun would undoubtedly become hopelessly mired

[1] Bureau of Ordnance, Washington, D. C.

when it encountered even slightly soft ground. Furthermore, large-wheeled mounts are difficult to place into position and correctly aim, and their tendency to roll back on firing makes rapid and continuous fire a difficult task.

In the face of these difficulties, a search was made for some better method of mounting the gun, and the principles of the so-called "caterpillar" belt for transporting the mount were suggested. Instead of wheels it was proposed to use a steel frame with rollers carrying a link belt presenting a large surface to the ground. Such a mount had never been used for a gun in which the reactions and weights were so great, and yet there appeared to be no serious objection to the idea. Sufficient strength could be given to the construction to carry the loads imposed, and preliminary calculations showed that a ground-contact area of 28 sq. ft. would be obtained, giving a pressure of 18 lb. per sq. in.—less than that of a horse. Designs for a mount of this construction were accordingly commenced.

It was hoped that a number of parts, such as the gun slide, recoil mechanism, etc., from the marine type of mount might be incorporated into the new land mount, but on consideration it appeared more desirable to lengthen the recoil of the gun as much as possible, reducing the trunnion pressure on firing, and in turn the weight of the mount, rather than to build a heavy mount capable of standing the heavy recoil forces. Furthermore, the counter-recoil mechanism was designed to return the gun to battery only at elevations up to 15 deg., and as an elevation of 40 deg. was contemplated in the new mount, a new design of counter-recoil mechanism was necessary. The designers therefore soon found that they must work from the ground up. Every part of the mount had to be newly designed, only the gun and yoke being used of the material taken from the battleships.

The Naval Gun Factory had preliminary designs for the new mount out within a fortnight. They called for a mount with caterpillar-belt wheels, a structural-steel carriage, made of shapes easily obtained, a gun slide equipped with hydraulic recoil and pneumatic counter-recoil systems and having an allowable travel of 32 in. in recoil, which reduced the trunnion pressures to approximately 120,000 lb.

The designs submitted were at least a year ahead of current development, yet they were so carefully worked out that they met with instant approval, and authority was given to proceed with the details. On May 25, 1918, the detailed designs were pronounced complete, and, shown on 164 separate drawings, were ready for submission to the bidders.

Design of the Mount

Caterpillar Wheels. The caterpillar wheels, on which the gun and carriage rest, are of the naval type. The wheel itself consists of an endless belt of cast-steel links connected by hardened pins. Each link carries a corrugated forged-steel plate which makes contact with the ground, the plates overlapping so that a continuous surface is presented. Detachable grousers are provided to prevent slipping when descending hills in rainy weather.

Within the belt are arranged the sprocket and roller wheels, all carried on a steel beam of special design. The sprocket wheels carry but little of the load, except when the gun is descending a hill or the brake is applied. Eleven truck and idler wheels, 7 below and 4 above, support the belt and carry the load.

A brake is provided to permit control of the mount when descending hills, and also to lock the caterpillar in position when the gun is set up for firing. This brake consists of a toggle joint operating on the rim of one of the sprocket wheels, and although exceedingly simple, has proved very satisfactory.

Gun Carriage. In the design of the gun carriage, standard structural shapes were utilized as far as possible, as it was realized that under existing war conditions special work could be obtained only with difficulty. The carriage consists of two side girders, cross-braced at each end to form a unit with a central well into which the gun recoils. A traversing gear is built into the rear end of the carriage to permit of accurate aim. This gear consists of a cast-steel plate which rests on the ground underneath the structural work of the trail, being held thereto by clips. A worm shaft operated by ratchet wrenches shifts the trail with reference to the plate and enables the gun to be accurately trained.

The trunnion seats are placed at the upper end of the carriage. Navy guns do not carry the trunnions attached directly to the gun, but are turned to a smooth surface on the outside. A cylindrical casting, known as the gun slide, to which the trunnions are attached, carries the gun. The gun slide also carries the recoil and counter-recoil mechanisms. These are contained in cylinders, and operate through pistons attached to the gun yoke. The slide is fitted with bronze liners, on which the gun bears when it slides in and out on firing.

In the 7-in. caterpillar mount the trunnions of the gun are mounted sufficiently high so that at maximum angles of elevation only a shallow trench about a foot in depth is required to allow clear space for the recoil of the gun.

Recoil and Counter-Recoil Systems. Recoil of the gun is taken up by means of a simple hydraulic brake, in which the energy is absorbed by forcing a mixture of glycerine and water through orifices of gradually decreasing diameter.

An elevation of but 15 deg., it will be remembered, was permitted by the mount in which the gun was carried on board ship. When so mounted springs were used to return the gun to the battery, or firing, position, and these functioned satisfactorily. The high elevation of 40 deg. permitted in the new type of mount, however, made spring return impossible.

Pneumatic system for counter-recoil return are in quite extensive use abroad, and these were investigated in the search for a proper mechanism. After a considerable study it was decided that the French type of mechanism, as used on 155-mm. guns, would do the work. In this type when the gun fires, a piston attached to the gun yoke moves backward in an airtight cylinder containing air at a pressure of several hundred pounds per square inch, and this air pressure brings the gun back when the gun has reached the end of its recoil.

The objections to the adoption of the French system were the exceedingly close limits to which it was required to machine the parts, and complications in the mechanism itself. Moreover, all the parts are arranged in one cylinder with a view to extreme compactness. Accordingly, the entire mechanism was redesigned to adapt it to American methods of manufacture.

In Fig. 1 the counter-recoil mechanism can be seen located on top of the gun slide (the recoil cylinder is located below). As redesigned, it is a combination of three cylinders, connected at the lower end by a cast bronze head. The piston attached to the yoke operates in the central cylinder. A simplified system of liquid packing is retained. The entire system is made up of shapes and materials easily secured, requires the minimum of machining, and on the whole is well adapted to American manufacturing methods.

Tests

On September 26, just one hundred days from the date the contract was placed, the first two gun mounts, complete and ready to fire, were shipped to the Naval Proving Ground, at Indian Head, Md. On their arrival the guns were first given a road test. Up hill and down they were hauled, over rough ground, and along hillsides at an angle. They proved themselves able to negotiate any ground over which the tractors themselves were able to operate. Obstructions were mowed down, and yet the weight of the gun and mount was so evenly distributed that no damage was done even to roads when it was necessary to traverse them.

The guns were proof-fired, and every expectation of the designers was fulfilled. The range of the gun, at its maximum elevation of 40 deg., was 24,000 yd., as predicted. No bracing of the mount was necessary other than a few timbers laid in the ground under the trail to distribute the load. The caterpillar tread, locked in position by the brakes, was as steady as a concrete foundation, and the gun remained steady on the point of aim even during continued firing. The counter-recoil mechanism and all the other parts of the mount functioned perfectly.

Diesel Engines and the Merchant Marine

Review of Developments on the Pacific Coast

In an endeavor to answer the question: Why is the internal combustion engine not used more extensively for marine propulsion? the San Francisco Section devoted its meeting of December 19, 1918, to a discussion of the Diesel engine as applied to the merchant marine. The papers presented were chiefly a record of past performances of motorships on the Pacific Coast, but it was also pointed out that the internal-combustion engines are rapidly assuming greater importance, and may ultimately replace the steam engine.

Bruce Lloyd, marine engineer for the Concrete Ship Section of the Emergency Fleet Corporation, discussed the attitude of the ship owner and gave valuable data of performances. George A. Dow, president of the Dow Pump & Diesel Engine Co., presented a paper on the Diesel oil engines of the motorship *Libby Maine*. Both of these papers are abstracted below.

J. H. Hanson, president of the Scandia Pacific Oil Engine Company, also read a short paper illustrated by about forty slides, covering the history and development of Diesel engines and showing some of the more recent installations on ocean-going vessels.

Perhaps the most interesting fact brought out by Mr. Hanson's remarks was the statement that there are nearly 800 motorships varying from 1000 to 12,000 tons capacity now in operation. Some of these ships are making from 40- to 50-day continuous runs covering more than 10,000 miles and carrying cargo of 11,000 tons. These ships consume during such voyages 400 tons of fuel oil instead of the usual 1500 tons of coal of the ordinary steamer, with a resulting saving of approximately 1000 tons in fuel and in addition making available another thousand tons of cargo space.

Diesel Engines on the Pacific Coast

Bruce Lloyd

The development of the steam engine, extending over a period of about one hundred years, has now reached such a stage that it is probably one of the most perfect machines that has ever been produced. The steam engine is wonderfully smooth-running and possesses great flexibility of power. And yet the ship owner is constantly being urged to discard his steam engine and install internal-combustion engines, and for the simple reason that the steam engine is not complete in itself. Its future is doomed by its necessary adjunct, the steam generator, which has never been improved so as to remove its attendant danger and other well-known disadvantages.

The space occupied by the boiler in a steamship, together with the large amount of room necessary for fuel, is the most perplexing problem that presents itself in the construction of a serviceable and economical cargo carrier. Attempts have been made to overcome this objectionable feature by placing the boilers on the upper deck of the ship, which is not so valuable for cargo space, but the fact remains that the boilers are still on board, adding at least their weight and detracting just so much from the general efficiency of the vessel.

In spite of the fact that the internal-combustion engine overcomes this difficulty and gives a tremendous advantage in cargo-carrying capacity, steam-driven vessels have been clung to with a tenacity equaled only by our forefathers in their unwillingness to discard the sailing ship and adopt the steamer. So strong was their distrust of the steam engine that it is only within the last fifteen years that owners of steamships were able to overcome their fears that the steam engine might break down and dependence have to be placed on sails, as all ships up to that time were provided with considerable sail area.

There are, however, other and perhaps more weighty reasons which prevent the ship owner from adopting the internal-combustion engine. Almost every port is provided with facilities for repairing the boilers and engines of the ordinary steamship; and engineers skilled in the operation of a steam engine are always available. On the other hand, facilities for ships whose motive power is the fuel-oil engine are not even now available.

Despite these disadvantages, however, the internal-combustion engine is rapidly being adopted by ship owners, and any reliable record of performance is at once a source of interest.

During the past two and one-half years 16 vessels on the Pacific Coast have been equipped with the Bolinder crude-oil engine, manufactured by J. C. Bolinder, of Sweden. Ten of these are so-called auxiliary ships in which the sail power predominates. All of them are engaged in overseas trade, visiting ports where fuel is either not available or only at prohibitive prices. Fuel tankage had therefore to be provided, of sufficient capacity to supply the engines, when running at full speed, for a voyage outward and homeward of nearly 17,000 miles.

These ships vary in size from 1500 to 3500 deadweight tons, and the size of the engines with which they are equipped ranges from 320 to 600 hp. These engines are of the direct reversible type. They have no camshafts or intricate gearing; a small compressor driven off the forward end of the crankshaft supplies air for vaporizing the fuel on entering the cylinder; and the reversal of the engine is affected by preignition.

The first large auxiliary ship equipped was the *City of Portland*, one of the three sister ships built and owned by the McCormick Steamship Company, of San Francisco. These vessels are approximately of 3500 deadweight tonnage and are equipped with twin engines of 320 b.hp. each. The engines have often run continuously for 45 days. The average speed maintained was 6.8 knots, but when the engines were allowed to develop their full power the speed averaged 7.5 knots. The sails were of practically no use on any of these voyages, and these vessels would more properly be designated as low-powered motorships.

The daily fuel consumption averaged 23 bbl. of oil of 24 deg. B. gravity, and for a voyage covering 17,000 miles, 1997 bbl. of fuel oil were used.

The motorships that have attracted the greatest attention, however, are the full-powered vessels, as these afford the best opportunity of comparison with steamships. Four such motorships (twin-screw) have lately been added to the fleet of W. R. Grace & Co. They are excellent examples of the possibilities of moderate-sized ships equipped with fuel-oil engines. These ships, all of the same design, are the *Santa Elena, Santa Isabel, Santa Cristina* and *Santa Flavia*, and their dimensions are as follows: Length, 235 ft.; breadth, 42 ft.; depth, 29 ft.; cargo capacity, about 2000 tons on 18 ft. 6 in. draft. The propelling machinery of each ship consists of two 320-b.hp. Bolinder engines. The main fuel supply is carried in steel tanks having a total capacity of 1770 bbl., sufficient for nearly 75 days' running, and the extensive radius over which these vessels are able to travel without refueling gives them an immense advantage over the ordinary steamer. The auxiliary machinery consists of one 15-b.hp. Bolinder engine direct-connected to a 10-kw. generator and one rotary pump of 2500 gal. capacity; also one 8-b.hp. Bolinder engine connected to a 5-kw. generator and rotary compressor. These ships carry a refrigerating plant consisting of a 1-ton Brunswick motor-driven ice machine, and each has about 600 cu. ft. of refrigerating space. All of these vessels have completed voyages to New York, via Valparaiso, calling at other South American ports and the Panama Canal—a distance of over 14,000 miles, at an average speed of 180 nautical miles per day.

The engine troubles that developed have been chiefly cracked cylinder heads and broken compressor shafts. It was noted that the fracturing of the cylinder heads always occurred while maneu-

vering the engine in entering or leaving port, and never at sea. This, it was found, was caused by the overheating of the head when the engine stopped, as the circulating pump of the water-cooling system was driven from the main crankshaft. The sudden cooling and contraction which thus took place when the engine was started again has been entirely eliminated by devising means to keep a constant circulation of water through the cylinder heads even while the engine is at rest.

The breaking of the compressor shaft which occurred in the first three installations was due to a mistake in design which was quickly and easily rectified, and there has never been a recurrence of this trouble.

A steel motorship of 3500 tons carries on a direct voyage of 8,000 to 10,000 miles nearly as much revenue-producing cargo as a steel steamer of 5000 tons of the same speed, as the following table clearly shows:

	Motorship.	Steamer.
Deadweight tonnage	3500	5000
Fuel oil for 45 days at 5 tons per day, tons	225	....
Coal for 45 days at 25 tons per day, tons	....	1125
Water for boiler, tons	...	100
Net paying cargo, tons (deadweight tonnage minus fuel and water)	3275	3875

It is not intended, however, to advocate the internal-combustion engine for passenger ships, or for vessels carrying cargoes which must be transported within the shortest possible time, since in these cases the necessity for speed relegates the question of economy to a place of secondary importance.

Merchant ships and steamers, on the other hand, are operated solely for profit, and the hull that can carry the most cargo at the lowest cost is obviously the best.

In 1911 a ship propelled by a new type of engine entered our port after making a most successful voyage from Copenhagen, Denmark. This vessel, the motorship *Siam*, was owned by the East Asiatic Co., and equipped with a type of engine known in Europe as the Diesel engine. Vessels propelled by this new type of engine repeatedly visited our coast and soon were making the trip to the Pacific Coast and thence to the Orient and back in a perfectly satisfactory and efficient manner.

In 1916, when ships were greatly needed to carry our products to Europe and were being built as rapidly as possible, the great problem of obtaining machinery presented itself. Engine manufacturers were building steam engines and boilers for large steel ships and could give no time to the building of engines for smaller craft. The average ship owner was therefore glad to get whatever he could.

When the wooden sailing vessel was decided upon to meet the great emergency, the so-called semi-Diesel type of engine was adopted as an auxiliary. Subsequently, however, it was used as a full-powered propelling unit and thus a practice new to the shipping men of the Pacific Coast and untried by the manufacturers came into vogue. Since this proposition at once had associated with it the successful practice of the Europeans, the semi-Diesel gained great popularity.

A good many types of American-built Diesel engines have been installed and tried out. Marine engineers have had their opportunities to prove their skill in operating them, and the time is rapidly approaching when the ship owner will see that the American-built internal-combustion engine occupies a front-rank position as a prime mover in ship propulsion.

Performance of the "Libby Maine"

George A. Dow

A Diesel-engine installation watched with unusual interest on the Pacific Coast is that on the *Libby Maine*. This vessel is a 2000-ton wooden ship of very rugged construction, and built especially for severe arctic service. She is 240 ft. long, 43 ft. beam, 24 ft. molded depth, has a mean draft of 22 ft. 8 in., and is equipped with two 424-i.hp. Dow full-Diesel-type oil engines. These are direct reversible and are connected through Falk reduction gears and Nutall flexible couplings. Each unit is tied to an engine bedding designed to give the maximum stiffness and greatest security against deflection. Heavy timbering securely bolted to the ship's frames run in single lengths the entire length of the engine unit. The Nutall flexible coupling is placed between the main engine and reduction gear to relieve any possible strains between these units, as well as to act as a float. The reduction gear and thrust block are bolted to a single heavy cast-iron sub-base. By the use of the reduction gear the most efficient engine speed of 250 r.p.m. and the most efficient propeller speed for this size of ship, 100 r.p.m., are obtained.

The engines installed in the *Libby Maine* are of the six-cylinder open A-frame type of construction. Six cylinders were used in order to give maximum flexibility and positive starting positions, and the A-frame design was adhered to because it afforded the greatest accessibility to the bearings and pins. Marine engineers are anxious to know where their pins and bearings stand and feel more secure when they are able to "feel" parts subject to heating.

The cylinders are separate castings; cylinder heads are of standard box construction and pistons are of the long trunk type. The crankshaft is in two sections, the forward and after section being interchangeable. The lubricating system is controlled by drip oilers, the oil being measured into individual positively timed oil pumps attached to each A-frame. One plunger of this pump supplies the piston lubrication and the other the piston pin. The main bearings are lubricated by ring oilers and the crankpin by centrifugal oil rings.

The operation of the entire engine is controlled by three levers centralized at one station. A novel feature of this installation is that one man is able to control both engines from one platform. Even in the treacherous waters of the Bering Sea this control was absolutely responsive to the captain's wish.

Two levers are used to govern the action of the engine, while the reversing mechanism is manipulated by the third lever. Reversing is accomplished by the single movement of a vertical sliding cam, actuated by an oil-compensated air piston, which automatically lifts the cam rollers clear of all the cams, then slides the camshaft to the desired position and finally returns the cam rollers to the cams, thereby giving the proper timing of the valves for the new direction of rotation.

Air pressure is then applied to the pistons of the engine through the air starting valves by a single movement of the control lever until momentum is acquired, when another single movement of the same control lever automatically cuts off the air pressure and admits the fuel oil to the cylinders. The entire mechanism is thoroughly interlocked to guard against any false move on the part of the operator. Automatic locking devices block the execution of any movement not made in the proper sequence. The speed of reversal is controlled by the pressure of the air applied to the air piston of the reversing cylinder and the regulation of the velocity of oil displacement from one side of the piston to the other.

In order to obtain flexibility of operation, economic use of starting air, and added security against a shutdown of the entire unit, two control levers are provided, one lever for each set of three cylinders.

The general characteristics of the engine are: i.hp., 425; bore, 12 in. stroke, 18 in.; crankshaft diameter, $7\frac{1}{2}$ in.; speed, 250 r.p.m.; floor space, 20 ft. by 5 ft. 1 in.; height above center of crankshaft, 8 ft. 10 in.; approximate net weight, 125,000 lb.

An ideal trip from Seattle to Honolulu and return to San Francisco was experienced and a record in fuel economy made. Extracts from the official log indicate the following:

Fuel-oil consumption, bbl.	259.5
Total distance, miles	2440
Time of voyage	14 days, 18 hr. 15 min.
Average economy, gal. per nautical mile	4.46
Average speed, knots	7

From San Francisco to Seattle very heavy weather was encountered. The chief engineer reported that the screw was out of the water half of the time, but no racing occurred at any time, due to the perfect action of the governors.

The engines of the *Libby Maine* are an example of approved European practice adapted to the needs of the Pacific Coast and stand as a milestone of progress in the use of the internal-combustion engine as applied to marine propulsion.

Mechanical Features of Vertical-Lift Bridge

A Veteran Bridge Engineer's Comments on Mr. Van Cleve's Annual Meeting Paper, Together with Details of a Recently Constructed 260-ft. Double-Track Lift Span

By DR. J. A. L. WADDELL, KANSAS CITY, MO.

At the 1918 Annual Meeting a paper of the above title, presented by Mr. H. P. Van Cleve, dealt with the important developments in the operating mechanisms of vertical-lift bridges during the past 25 years, and devoted special attention to structures designed and constructed under the supervision of Dr. J. A. L. Waddell, the eminent bridge engineer and author of treatises on bridge engineering. Dr. Waddell has been good enough to supplement Mr. Van Cleve's presentation by the following additional particulars of some of the structures described in the paper, as well as by details of a new lift bridge at Louisville, Ky., embodying his most recent ideas in design. A comprehensive abstract of Mr. Van Cleve's paper appeared in The Journal of November 1918, p. 938.

MR. VAN CLEVE'S excellent paper has proved of special interest to the writer, who may justly claim to be the father of the modern vertical-lift bridge. His first design, made in 1892, was for a 250-ft. span at Duluth, Minn., to cross the canal which forms the entrance to the harbor of safety for lake vessels in that vicinity. The War Department prevented the building of the structure, but in 1902 permitted at the same location the construction of a *transbordeur*.

Soon after the rejection of his plans for that proposed bridge, the writer was retained to design and supervise the construction of a similar but shorter-span bridge at South Halsted Street, Chicago, the first bridge mentioned by Mr. Van Cleve in his paper. This structure was built under great difficulties and in spite of many discouragements. The Chicago engineers as a body were opposed to this type of bridge; and the then highest authority on bridges in America, the late George S. Morison, stated flatly that it could not possibly operate, and that it would be impracticable to raise the span off the piers. On the strength of this statement the City Engineer, Mr. Geraldine, made all the arrangements for canceling the contract for the construction, although some of the substructure had been completed and a large portion of the metal-work had been manufactured. It took some very earnest pleading by the writer to persuade him to permit the work to proceed; and the said pleading would not have been successful had it not been for an important fact pointed out, viz., that the city of Chicago would have had to pay the full contract price for the structure whether it were built or not.

The specifications called for the lifting of the span to the full height (involving a raise of 140 ft.) in 60 sec.; and, much to the surprise of everybody, on the first trial the span went up in about half of that time. Afterward the writer timed the operation, both up and down, and found that the span could be moved over the full height in 28 sec. This was certainly a great triumph for a comparatively young engineer in a struggle with the local technical body, including the highest bridge authority in America.

Referring to the Keithsburg bridge which Mr. Van Cleve mentions, the heavy-duty, slow-speed gasoline engine used is clumsy, ponderous, and conducive to jar, although undoubtedly effective. It is quite certain that a light, high-speed type, such as the automobile or tractor engine, will prove more satisfactory for future lift bridges.

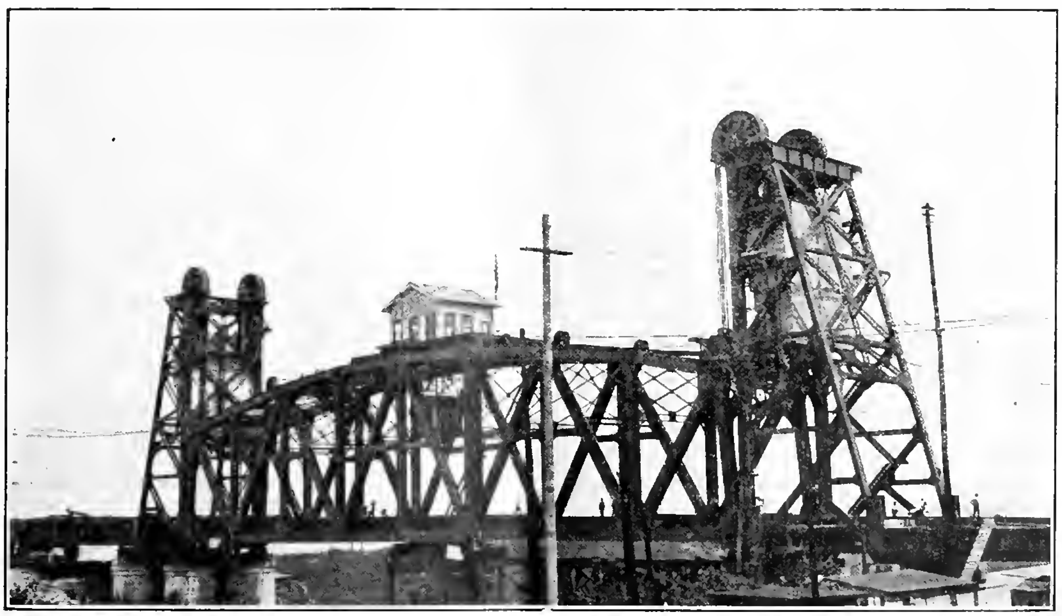


Fig. 1 Double-Track Lift Bridge of Pennsylvania Lines at Louisville, Ky.

In truth, though, gasoline engines are to be used for lift bridges only as a last resort or as an auxiliary; because electric motors are far superior in every respect. Again, direct-current motors are much more satisfactory than alternating-current motors; and, consequently, they should be used whenever an ample direct-current supply of power is obtainable. The writer is pleased to see that Mr. Van Cleve has called attention to these important points.

Mr. Van Cleve mentions that the heaviest sheaves yet used for any vertical-lift bridge were those for Bridge No. 458 of the Pennsylvania Lines West of Pittsburgh, and that each sheave weighs 31 tons. Within the last few weeks there has been completed for the same railway company a vertical-lift bridge, designed by Waddell & Son, Inc., across the Louisville and Portland Canal that lies adjacent to the Ohio River at Louisville, Kentucky; and the sheaves for this structure weigh 38 tons each.

As this is the very latest thing in lift-bridge construction, the following description of the structure should prove of interest:

The double-track span, which is 260 ft. long between centers of end bearings, weighs about 3,000,000 lb., and is lifted 32.4 ft. in 45 sec. There are 64 counterweight ropes $2\frac{1}{8}$ in. in diameter, passing over the four 15-ft. sheaves. The motive power consists of two 150-hp., 220-volt, a.c., 60-cycle, 580-r.p.m. motors equipped with solenoid brakes. Magnetic control is used. Speed reduction from the motors to the winding drums is made through a train of three sets of spur gears to a cross-shaft having a pinion at each end meshing with two drum gears.

The span is shown complete in Fig. 1 and the operating machinery in Figs. 2 and 3. Fig. 4 shows the operating drums which

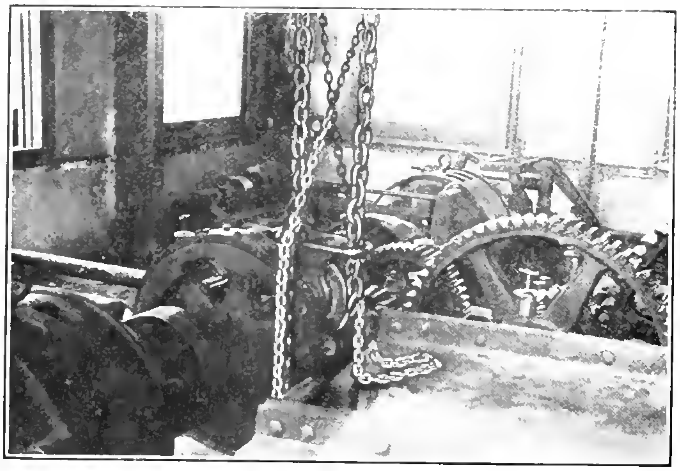


FIG. 2 MACHINERY HOUSE OF LIFT BRIDGE SHOWN IN FIG. 1

raise or lower the span and which are quite similar to those used in the Don River bridge in Russia. However, the detail of the cross-shaft has been improved by adding two bearings and two couplings, thus giving more rigid supports for the pinions and making the lengths of shaft between the center main frame and the drum frames truly flexible. This detail eliminates entirely any trouble from errors in the alignment of the three frames, which otherwise would cause considerable friction and loss of power. Hand operation is provided for by two 4-arm capstans.

There are 16 plow-steel operating ropes, each 1 in. in diameter, the drums and sheaves over which they run being 36 in. in diameter. These ropes work in pairs, i. e., there are two up-haul and two down-haul ropes at each corner of the span. The take-up devices for the ropes are eyebolts threaded over the entire length, with anchorage attachments at top and bottom of towers.

The counterweight sheaves, the heaviest yet built, are constructed of steel plates, angles and castings. In their designing special care was taken to eliminate the troubles which had arisen in connection with the built-up sheaves described in Mr. Van Cleve's paper. Each rim segment is fastened to the side plates by a sufficient number of rivets to take the entire load coming upon it from the ropes; and $\frac{1}{2}$-in. spaces were left between the segments, so that there might be no trouble if the lengths of the segments should overrun. It was originally intended to fill these spaces with hemp; but the cutting tools gave trouble when the machining of the grooves was begun; and it was found necessary to fill them with babbitt. The trouble previously experienced from bad fit of side plates on the hub casting was eliminated by making the said side plates bear directly on the shaft instead of on the hub casting. The hole for the shaft was bored out after the sheave was completely assembled and riveted. The journals are $22\frac{1}{2}$ in. in diameter and 24 in. long, the overall length of the shaft being 7 ft. 8 in. The hub is keyed to the shaft by three keys $1\frac{1}{2}$ in. wide and 1 in. deep, secured from longitudinal movement by set screws. The bearings are lined with phosphor-bronze bushings for high pressure and low speed. Oil grooves are cut into the bushings, the lubricant being supplied from marine-type, screw-feed, compression grease cups.

The rail locks are of sliding-tongue type, standard with the Pennsylvania Lines. The four tongues at each end of the span are driven by a 5-hp. motor. Limit switches are provided to cut off the current at each end of the travel. The controllers for the rail-lock motors are interlocked with the signal system, so that the locks cannot be opened until the signals are set against train movements over the bridge, and so that clear signals for train operation cannot be given until the locks are closed. The controllers are also interlocked with those for the main operating motors so that current cannot be supplied to the latter until the locks have been opened, and so that the locks cannot be closed until the bridge has been seated.

The span is kept in correct position during motion by guide rollers, which roll on vertical guides on the outsides of the tower columns. There are eight rollers for transverse guiding, one at each L_0 point and one at each U_0 point. Longitudinal guiding is effected by two rollers at each L_0 point at the fixed end of the span. There is considerable play in the guides, so as to eliminate any possibility of binding. On account of this play they do not center the span closely enough for the rail locks, which have very little play. For this reason there is placed a transverse centering casting, having very little play, at the middle of each end floor beam. In earlier designs a transverse centering casting was placed at each L_0 point; but considerable play had to be left in these castings to provide for expansion and contraction, and they did not center the span accurately enough for the rail locks.

The train thrust is cared for by two thrust castings, one at each L_0 point at the fixed end of the span.

In order to eliminate jar when the span seats, there are provided air buffers near each end of each of the end floor beams. Adjustable needle valves on the exhaust ports of the buffers enable the resistance of the said buffers to be varied at will.

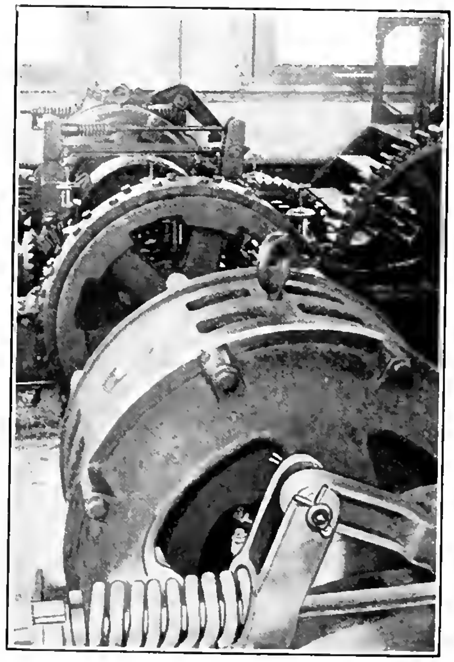


FIG. 3 MOTORS AND BRAKE SHAFT OF BRIDGE SHOWN IN FIG. 1

Bridge locks were not used, but the counterweights were made about six tons lighter than the span, the excess weight of the latter overcoming any tendency for it to rise.

The span can be handled from the machinery house, which is located at the center thereof, or from an interlocking tower on shore about 100 ft. from the south end of the span. It is intended to operate the span from the machinery house until the operators become thoroughly familiar with the manipulation, after which it will be operated from the interlocking tower. Duplicate switchboards, with indicator lamps, meters, etc., are placed in each house. The main switchboards and the resistances are located in the machinery house.

As was stated previously, each motor is equipped with a solenoid brake. In addition there are a hand brake and a motor-operated brake. The lever of the hand brake is in the machinery

house on the span, and gives the operator graduated braking power, so that he can stop the moving mass without jar. The controller of the motor-operated brake, which has three degrees of braking power, is located in the interlocking tower. These braking devices are not of great importance in a slow-moving bridge like this one; but for a high-speed bridge, which will coast for several feet after the current has been turned off, they are much more important.

The erection of the lift span was quite difficult, as traffic had to be maintained over the bridge and navigation could not be interfered with. The old moving span was a swing. It was at first proposed to erect the new span in its fully lifted position. As the counterweights would then have to be built at the lowest point of their travel, it would have been necessary to leave large notches in them for the passage of trains. This scheme was abandoned for that and other reasons, and a new one was worked out. Permission was secured from the United States Government to leave only a 100-ft. channel near the north tower. This channel was spanned by a plate-girder lift span of the same type as the main span, worked by hand-operated crabs. After the main-lift-

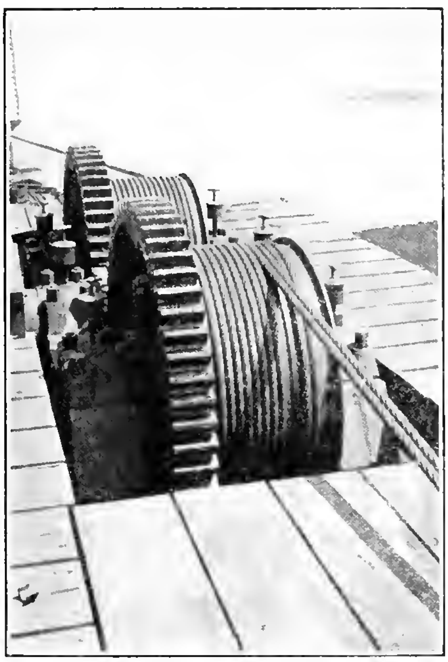


FIG. 4 UPSTREAM DRUM OF BRIDGE SHOWN IN FIG. 1

span towers were partly erected, navigation was stopped for a few hours while one end of the swing span was removed, the gallows frames for the plate-girder-span towers were erected, and the plate-girder span placed in position. The remainder of the swing span was then removed, the towers erected, the sheaves and ropes placed thereon, and the counterweights constructed on falsework resting on the piers and floor beams. The south portion of the lift span was then erected, also the north hangers; and the counterweight ropes were attached. The machinery was erected complete and thoroughly tested out. Navigation was then closed for a day, the plate-girder span removed, the remainder of the lift span erected and riveted, and the operating ropes connected up.

Special care was taken in the aligning of the main-sheave bearings. This was done by means of a steel straight-edge as long as the shaft. The bushings had been scraped to fit the shafts in the shop, the shafts and bushings being matchmarked. The aligning was so carefully done that when the sheaves were hoisted up they fitted perfectly in the bearings, and each 38-ton sheave could be rotated by one man. The machinery and motors were also aligned and tested out very carefully. The motors were run for several hours before the operating ropes were attached to the drums, in order to get the machinery into smooth-running condition and to determine if there were any poorly aligned bearings. Any hot bearings which developed were realigned. The machinery and the electrical equipment were in perfect operating condition before the operating ropes were attached to the drums and before the plate-girder swing span was removed.

Waddell & Son, Inc., has lately designed deflection bearings for main sheaves which insure a uniform pressure over the entire length of the journal. With the high bearing pressure used in the design of journals for lift-bridge sheaves and bascule trunnions this is extremely advisable. The use of this type of support greatly simplifies the problem of aligning the bearings.

One general fault of the electric equipment of movable bridges may be pointed out—that of using too small power lines. The overload capacity of the motors for vertical-lift bridges is called into play if a span becomes unbalanced, and, for bascules, when operating against a high wind; and this requires power lines of ample capacity. This point is not quite so serious in the case of direct-current motors, as the drop in voltage in the power line will merely cause the motors to run slower; but with alternating-current motors the drop in voltage reduces the torque materially, because the torque of such a motor varies as the square of the voltage. For instance, a 10 per cent drop in voltage means nearly a 20 per cent drop in torque. This point requires special attention when the power lines are long.

In spite of all the opposition which the vertical-lift type of movable bridge has encountered in the last quarter of a century (some of it being very bitter and most of it totally unfair), that type has come to stay; and it will be used more and more in the future, after railroad and city officials overcome their prejudice against the use of wire rope and learn that, for economy in first cost, simplicity of design, quickness of operation, rigidity under load, and economy in maintenance and repairs, it is unequaled by any other type yet evolved.

COMMENTS ON DR. WADDELL'S COMMUNICATION BY MR. VAN CLEVE

The writer has been much interested to read Dr. Waddell's comments on his Annual Meeting paper, and also to learn something of the details of the Louisville lift bridge, the only one so far constructed with which he is unfamiliar.

The guiding, centering, and interlocking details described have all been used on previous bridges, but the operation of the span from a point on shore a distance as great as 100 ft. from one end of it, is new and deserves some comment.

To the writer this feature seems objectionable, mainly because it would put the operator somewhat out of touch with the requirements of passing boats, but also because it would prevent that vital contact with the movement of the span which goes a long way toward preventing careless operation. The writer has been present during operation on ten lift spans of this type, sometimes as operator, and sometimes as observer, and he feels that the presence of the operator on the span is, while not absolutely necessary, at least very desirable; and that if it seemed best to have one man operate both the track signals and the lift span, it would be better to place the signal stand on the lift span than the span master controller in the signal tower. This alternative may have been considered in the case under discussion, and found impossible, but it was done very satisfactorily in the case of the C. & N. W. Ry. bridge over the Illinois River at Pekin, Ill. In this installation all track switches and signals are thrown electrically, but this is not necessarily the case, as demonstrated by the fact that at least one of the lift spans now in operation carries on its deck some twenty lines of pipe of the signal system which automatically unjoint at both ends of the span when the latter is lifted.

Referring to Fig. 1 in the paper on The Conservation of Heat Losses From Pipes and Boilers by Glen D. Bagley, published in the November 1918 issue of THE JOURNAL, p. 918, the heat loss per square foot per hour, per degree fahrenheit difference, should have been given *without* the decimal points, in the first vertical column.

Properties and Preparation of Glues

Data on the Properties, Preparation, Classification, Grading and Testing of Glues, Strength of Glued Joints, etc., Based on Experimental Work of Bureau of Aircraft Production

GLUE is a subject which has become of particularly great importance since the development of the use of veneer construction in aeronautics, and the following data, abstracted by special permission of the Bureau of Aircraft Production, War Department, from a confidential bulletin,[1] and based on experimental work done in the laboratories of the Bureau at McCook Field, Dayton, Ohio, are accordingly of more than ordinary interest.

Glue is defined as an impure form of gelatine possessing the property of adhesion, which differs somewhat from the popular understanding of the word, which is taken to include all substances having adhesive qualities with the exception of certain types of cements, shellacs, etc. Glue, however, is really a compound consisting of a large proportion of gelatine with certain other substances, such as chondrin, keratin and mucin, associated with it, and, in general, the glue advances in the scale of purity as the ratio of gelatine to the other substances present increases.

Classification and Most Desirable Properties

Glues are classified in accordance with the substances from which they are made, as follows:

1 Bone glues from the horns, raw bones of heads, ribs, shoulder blades, etc., of domestic animals.

2 Hide glues from tannery waste, such as skin trimmings, etc.

3 Sinew glues from the sinews of cattle.

4 Fish glues from fish offals, air bladders and membranes.

5 Casein glues from fermented milk and other milk products.

6 Egg-albumen glues.

7 Blood-albumen glues.

8 Vegetable glues from certain non-nitrogenous vegetable growths, such as Irish or Iceland moss, agar-agar, seaweeds, gums and dextrines.

The above classification includes all the most important groups. Other divisions are possible, such as hot and cold glues, liquid and solid products, etc., but these will be considered later.

The most desirable properties of a glue are:

1 Strong adhesiveness.

2 Tenacity, which is slightly different from adhesiveness, and which may be defined as the power to resist the disruptive effect of a stress in any direction.

3 Elasticity, or the power to stretch slightly without fracture. In this connection the moisture content is a very important factor, as glues which are too dry are often inclined to be brittle. While such glues may stand an enormous stress under a steady load, the sudden application of a comparatively light load is liable to cause failure. The constant vibrations, varying stresses and shocks to which airplane members are subjected make it vitally important to select for airplane construction a glue with a fair amount of elasticity as well as high strength.

4 Covering power. This can be determined by estimating the water absorption, the tenacity of the jelly and the viscosity of a solution of known strength.

5 Practical working qualities. Among the most important properties of glue are its workability in the shop, rapidity of setting, etc.

Casein and Blood-Albumen Glues

The original paper describes the process of manufacture of the various types of glues and the manufacturing elements which determine the properties of the final product. From this point of view the most interesting parts are those referring to casein glues and blood-albumen glues, on which very little printed information is available. The following data are presented in the Bulletin:

When the sugar of milk ferments, producing lactic acid, the milk turns sour, and casein, the characteristic proteid of milk, is separated in a coagulated mass, due to bacterial action. Casein also may be produced by adding acetic acid to fresh milk which has been diluted and warmed. An appreciable excess of acid must be employed, however, as exact neutralization of the diluted milk with acid does not precipitate the casein, owing to the interference of the alkaline phosphates present in the milk.

In the manufacture of casein glue, the commercial casein is purified by alternate solution in alkali and precipitation with acid, the precipitate being thoroughly washed each time. The number of these treatments determines the purity of the product, and hence its price.

Certified casein glue is supplied by the manufacturer in the form of dry powder, the chief constituent of which is the casein derived from milk as just described.

There is not very much information available at present concerning the manufacture of blood-albumen glue. It is made from blood, or from serum albumen resulting from the evaporation of the separated serum of fresh blood. The evaporation is conducted at about 50 deg. cent., and the albumen is obtained in the form of flakes varying in color from grayish to black. Three or four qualities of blood albumen are known, the purest being a dirty yellow and the poorest, black. Similar to the casein glues, the blood-albumen variety is waterproof.

The article gives some data as to the preparation for use and method of application, especially in regard to casein glues. From this it appears that the principal difficulty encountered with the casein glues lies in the rapidity of setting after mixing with water, as it seems they set at periods from 30 min. to 5 hr., depending on the brand.

Strength of Glued Joints

Factors affecting the strength of a glued joint are enumerated in the following order:

In the first place is mentioned the skill of the operator; next, and being of almost equal importance, is the quantity of glue which penetrates into the pores of the wood; and, finally, the avoidance of the formation of air bubbles which frequently cause the failure of a joint. With blood-albumen glues the question of mixing and application, especially as regards temperature, is very important, as the glue does not spread properly if too cold.

In another part of the investigation, referring, however, more specifically to casein glues, the following enumeration of factors affecting the strength of the joint is given:

1 Kind and quality of the wood to be used.

2 Nature of the joint.

3 Quality and condition of the glue.

4 Temperature of the glue, of the surfaces of the joint, and of the surroundings.

5 Hygroscopic condition of the wood.

6 Method of application of the glue.

7 Amount and duration of pressure to be employed.

8 Time and conditions of setting, and subsequent drying of the glued joint.

9 Nature of the strain to which the glue is to be subjected.

A highly interesting section of the paper refers to the subject of testing of glues. This is a matter of considerable difficulty, as

[1] Bulletin of the Experimental Department, Airplane Engineering Division, U. S. A. (Bureau of Aircraft Production, War Department—Confidential), vol. 2, no. 3, December 1918, pp. 5-26, 10 figs., *cpA*.

there are no specific standards for such tests, and the whole subject is on a very indefinite and unsatisfactory footing. In fact, it appears that under one class of test a good glue may show up excellently, while under some other testing method the same material may not indicate nearly as good results.

Testing of Glues

The tests may be divided into two main classes; chemical and physical. The former are of particular value only in special cases. The physical tests appear to be of more immediate value.

The first examination is sometimes instructive. Thus, the odor of the glue affords some indication of its quality, as a glue having an offensive smell is not considered of the highest grade.

The preservative quality of a glue is determined by allowing the jelly left from the jelly strength test, during manufacture, to stand in the laboratory at room temperature for a number of days. The odor and condition of this stock are noted at intervals. Glues with good keeping qualities will stand several days without developing an offensive odor or showing any appearance of decomposition.

The consistency of the jelly test suggested by Lipowitz in 1861 has been extensively adopted for commercial purposes. For this test 5 grams of glue are soaked in water at room temperature and then dissolved in enough water at 70 deg. cent. to make the total volume 50 cu. cm. when cold. The solution is allowed to stand in cylinders $\frac{1}{2}$ in. internal diameter for 12 hr. at 18 deg. cent., and the consistency value of the jelly is then determined by inserting in the jelly a small pointed plunger with a funnel at its upper end, which is gradually loaded with the lead shot until the load is just sufficient to force the plunger entirely through the

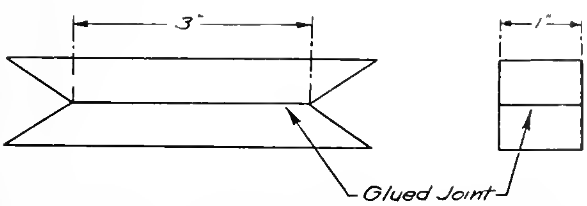


Fig. 1 Joint Used by the British Royal Aircraft Factory for Testing Glues

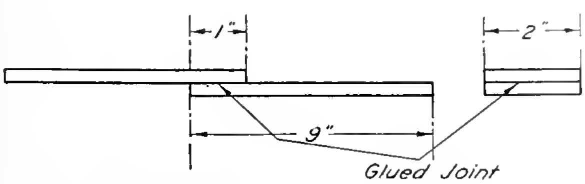


Fig. 2 Standard Test Block Used for Testing Glues by the Aeronautical Inspection Directorate, U. S. Army

jelly from its top surface to the bottom of the cylinder. The weight of shot necessary to effect this gives the Lipowitz number.

At the Aeronautical Inspection Directorate Laboratories a round-ended glass rod is employed instead of a pointed steel plunger, and the results obtained have been found to be more consistent and satisfactory.

The jelly consistency test is usually accompanied by a viscosity determination of glue solutions. The American Air Service criterion, formerly used, that "the strength of the glue in shear shall not be less than that of the wood," is not sufficient, it is stated. A very poor glue could be made to pass the specification merely by selecting for the test wood which was considerably below the average of the species in tenacity. The test may be made unfair by using a wood of unsuitable grain.

The method officially adopted in Germany is the Spandau test, described as follows:

It consists in gluing together with a plain butt joint, end grain to end grain, two blocks of wood 40 mm. in cross-section and 210 mm. long. Glue stock for the test joint is prepared by dissolving 250 grams of glue in 500 cu. cm. of water, and reducing the solution thus obtained to half of its original volume by evaporation. This is done in order to ascertain whether the prolonged boiling necessary to evaporate the solution will have any tendency to reduce the adhesive properties of the glue.

The blocks of wood having been glued together, one is fixed horizontally to a table in such a manner that the joint between the two blocks overhangs a few millimeters beyond the edge of the table. A scale pan is attached to the block a given distance beyond the edge of the table, and weights are placed in the scale pan until fracture of the glue joint takes place.

The British Royal Aircraft Factory has a standard glue test which is a modification of the Spandau method.

According to R. A. F. specification dated Nov. 21, 1916, a double-wedge-shaped test block is made up by gluing together two pieces of black American walnut, as shown in Fig. 1. The glue solution is prepared according to the instructions issued by the manufacturers of the material. Thus made, the test joint, meas-

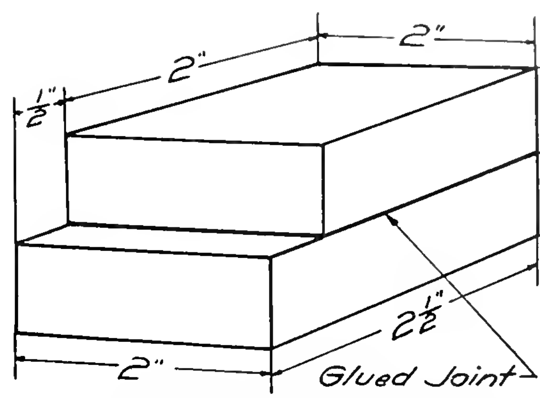


Fig. 3 Test Specimen Described in Bureau of Aircraft Production Glue Specifications

uring 3 in. by 1 in., is required to support a static load of 187 lb. per sq. in. under the following conditions:

1 Dry-heat test. The test piece must support its static load at 122 deg. fahr. for 30 min.

2 Humidity test. It must support its static load in a fully saturated atmosphere for 25 min.

3 Submerged test. The test piece, submerged in water, must support its static load for 36 hr.

It is to be noted that the Spandau test subjects the glue to a combined shear and tensile stress, while by the R. A. F. method a direct tension seems to be intended.

Strength tests conducted by the laboratories of the Aeronautical Inspection Directorate on glue intended for use in the construction of aircraft are unlike either of those methods previously described, and do not appear to afford a measure of any clearly defined physical constant. The disruption of the glue in these tests is more nearly a shear than anything else; but in any case the results have been found in practice to be reasonably comparable.

The procedure adopted in carrying out the A. I. D. strength tests is as follows:

1 Test pieces. Consist of carefully selected pieces of hard, dry American walnut 2 in. wide by 9 in. long and $\frac{3}{8}$ in. thick. The flat 2 in. sides are planed true and slightly toothed with a fine smoothing plane. See Fig. 2.

2 Constant temperature. In order to obtain a constant temperature in both the wood and the glue solution under test, a constant-temperature oven, maintained at 35 deg. cent. or 95 deg. fahr., is employed. The wooden test pieces are allowed to remain in this oven for several hours before the test joint is made.

3 Preparation of glue solution. Following the maker's instructions, a weighed quantity of glue is soaked in the required volume of water at room temperature. When thoroughly soaked, which is usually in about 24 hr., the glue is heated in a water-jacketed pot to a temperature of 60 to 80 deg. cent. (140 to 175 deg. fahr.) for $\frac{1}{2}$ hr. The inner vessel or kettle of the glue pot

is then transferred to a constant-temperature oven maintained at 60 deg. cent. (140 deg. fahr.), and is allowed to stay there for about 1 hr., or long enough to bring its contents up to the temperature of the oven.

4 Preparation of test joints. Two pieces of the warm wood are then removed from the oven, and the glue is quickly applied to the faces to be joined, using a finger to spread the glue in order to avoid air bubbles. The two pieces are then pressed together so that they form a simple overlap joint 1 in. long and having a total glued area of 2 sq. in. The details of the joints are given in Fig. 2.

5 Number of test joints. Nine joints, made as above described, are prepared for each sample for glue to be tested. They are clamped for 12 hr. in hand presses, such as are ordinarily used in modern gluing practice. The pressure is then removed and the joints allowed to set for 24 hr. at room temperature.

6 Tests. Three tests are applied to these nine specimens, three being subjected to each of the following tests:

a Regular dry test. Three of the joints are broken in turn by clamping the two ends and pulling the component parts of the joint apart in a testing machine. It is necessary that the load be applied without jerks, and that bending of the test pieces be avoided as far as possible. The load is put on at the rate of about 3000 lb. per min., and the amount necessary to break the joint is recorded.

b Heat test. Three of the remaining six joints are then placed in an oven at 45 deg. cent., and are subjected to dry heat at this temperature for 72 hr., after which they are removed from the oven and broken as above.

c Immersion test. The remaining three joints are immersed for 3 hr. in water at 25 deg. cent. (77 deg. fahr.). On removal from the water they are broken as above.

The three sets of joints are broken on the same day in order that the results may be comparable.

Glues are classified in three divisions by the A. I. D., and in order for a glue to be put into one of these classes it must attain the following values in the tests:

Division.	Breaking point in tests, lb. per sq. in.		
	Regular test	Heat test	Immersion test
Propeller Class	1100	1100	900
Class I	1000	1000	800
Class II	900	900	700

It will be noticed that the best glues are thus retained for propeller work. Class I glues are sanctioned for all important construction exclusive of propellers, while the Class II material is approved for smaller and less important work.

In conducting the above tests it usually is found that the break occurs in the glue, but should the fracture be located wholly or partly in the wood, the result is discarded if the value obtained is below the minimum figure given above.

One other point deserves attention, namely, that the figures given in the table relate to the 2-sq.-in. test joint specified. A larger test joint would not show a proportionate increase in strength. For instance, if the area is doubled, the strength will be increased only about 50 per cent.

Grading of Glues

Interesting data are also presented on the subject of grading of glues, and also on their waterproof qualities. There are several methods of grading glues which, however, are entirely arbitrary. The oldest scheme in use in this country, and which is still generally employed, is the Cooper system, which was originated by Peter Cooper. No rational basis is used in grading glues by this method, the various Cooper grades representing simply those which were put out by Peter Cooper's glue factory, and which, being remarkably uniform, came to be adopted as standards of comparison. The Cooper grades are eleven in number, as follows: A extra, 1 extra, 1, 1X, $1\frac{1}{4}$, $1\frac{3}{8}$, $1\frac{1}{2}$, $1\frac{5}{8}$, $1\frac{3}{4}$, $1\frac{7}{8}$, 2. Of these, A extra is the strongest and 2 the weakest.

It is frequently found, however, in attempting to grade different glues by this system that there are varieties which are stronger than the A extra grade, and it is also evident that glues may be of almost any intermediate strength between the various Cooper grades. It is also a fact that a glue corresponding to one of these grades in gelatinizing power may agree with an entirely different rating in viscosity. There is in this respect a marked difference between bone glues and hide glues, and between acid-treated types and those not so treated. For instance, an acid-treated glue may rate as high as 1X in gelatinizing power and as low as $1\frac{3}{4}$ in viscosity. There are numerous discrepancies of this sort which must be taken into account by the glue tester, so that the rating of glue by this system is full of difficulties.

Relative Merits of Different Glues

The following data on the relative merits of different glues are also of considerable interest. No one best glue has so far been found, since very few records of systematic strength tests are available. Most types of glue suitably selected and manufactured can be made fairly water resistant.

The three kinds of glue suitable for use in airplane construction are the hide, casein and blood-albumen varieties. Of these only the casein and blood albumen types are satisfactory for plywood construction, as hide glue is not truly waterproof. Tests to date show that both these glues can be used to advantage, and it therefore seems advisable to allow plywood manufacturers to apply whichever preparation they prefer.

Since the latest Bureau of Aircraft Production specifications for plywood do not bar the use of any glue, it is very important that the soaking and baking tests be carefully made in order to detect the use of any non-waterproof or otherwise unsuitable glue which might show very great strength if not subjected to deteriorating conditions, but which would lack the necessary lasting qualities.

Hide glue has so far been very satisfactory for propeller construction, provided sufficient care be taken to properly guard against moisture and changes in atmospheric conditions. Casein glue may eventually prove more satisfactory for this use, however.

Blood-albumen glue is not altogether suitable for general work, except in the manufacture of plywood, on account of the care and expense necessary in its use, the hot presses and other costly equipment required, etc. Its high strength and waterproof qualities, however, make it excellent for laminated construction. Blood-albumen glue has been found to be even more water-resistant than the casein types.

For general airplane use, including splices in spars and longerons, plywood and built-up members, casein glue seems to offer the most advantages. It is nearly as strong as the best hide glues, while it is comparatively waterproof, is fairly easy to mix and apply, and is quite dependable if proper care is exercised.

The original paper contains a list of manufacturers of glues, with addresses, and a short bibliography on the subject.

LUBRICATION OF AIR COMPRESSORS

Satisfactory lubrication of air-compressor cylinders is attained by securing (1) the reduction of friction to a minimum and (2) elimination of carbonization of the oil as far as possible.

Carbonization of the oil allows the accumulation of deposits of carbon which are sticky in the early stages of their formation but hard and flinty later. Such deposits accumulate on the cylinder valves, in the cylinder passages, in the pipes and eventually in the air receiver.

Sticking or partial closing of the valves and their consequent failure to act properly is probably the chief objection to this action from the standpoint of the efficient operation of the compressor.

The formation of excessive carbon deposits is apt to be due to any one or more of the following causes:

[1] From a report prepared by H. V. Conrad, 30 Church Street, New York, Secretary of the Compressed Air Society, and issued by the Technical Committee of that society.

1 The ill-advised use of some oil, such as a steam-cylinder oil, which easily decomposes in the heat of the air cylinder.

2 The use of oils of too great a viscosity—commonly referred to as "too heavy oils." These do not atomize readily and, therefore, remain too long upon the hot cylinder walls, etc., thus baking down to sticky carbon deposits.

3 The use of too great quantities of oil, which has the same effect as the use of too heavy an oil as far as the carbonization is concerned.

4 The failure to provide a proper screen over the air intake of the compressor, thus allowing free entrance of dangerous dust (especially coal dust).

Heat of Air Compression. The selection of an air-cylinder lubricant, of course, is governed to a considerable extent by a knowledge of the cylinder temperature it must withstand. Knowing the air pressures, the corresponding temperatures are ascertained fairly accurately, as shown in Table 1. This table gives the final temperature in the cylinder at the end of the compression stroke, for single-stage, also for two-stage (or compound) compression, when the free air entering the cylinder is at 60 deg. fahr.

TABLE 1 CYLINDER TEMPERATURES AT END OF PISTON STROKE

Air Compressed to (pounds, gage)	Single-Stage, Final Temperature, deg. fahr.	Two-Stage, Final Temperature, deg. fahr.
10	145	. .
20	207	. . .
40	302	. . .
60	375	203
80	432	224
100	485	243
150	589	279
200	672	309
250	749	331

The natural inference after noting the temperatures in Table 1, is that an air-cylinder oil should be selected whose flash point is higher than the maximum temperature apt to be encountered within the air cylinder. As a matter of fact, this is not the case.

Qualities of Cylinder-Lubricating Oils. For average normal conditions, the oil should be a medium-bodied pure mineral oil of the highest quality, not compounded with fixed oils such as animal or vegetable, and should be carefully filtered in the final process of manufacture. A distinction must be made between those oils having a paraffin base as distinguished from those having an asphaltic base. Carbon deposited by the asphaltic-base oils is of a light, fluffy nature and easily cleaned out, whereas, that deposited by the paraffin base oil is very adhesive, and characterized by the hard, flinty nature.

Paraffin-Base Lubricating Oils. Merely as a guide to aid the operator in specifying the qualities to be possessed by an air-cylinder lubricant recommended for average duty, Table 2 is presented.

It is suggested that those oils within the range expressed by the minimum figures be used for light duty of low pressures and temperatures, while those expressed by maximum figures should be used for high pressures and temperatures.

It is recommended that any paraffin-base lubricant intended

TABLE 2 PHYSICAL TESTS OF PARAFFIN-BASE OILS

	Minimum	Average	Maximum
Gravity, Baumé ..	28 to 32 deg.	25 to 30 deg.	25 to 27 deg.
Flash Point, Open Cup...........	375 to 400 deg. fahr.	400 to 425 deg. fahr.	425 to 500 deg. fahr.
Fire.............	425 to 450 deg. fahr.	450 to 475 deg. fahr.	475 to 575 deg. fahr.
Viscosity (Saybolt) at 100 deg. fahr.	120 to 180 sec.	230 to 315 sec.	to 1500 sec.
Color............	Yellowish	Reddish	Dark Red to Green
Congealing Point (pour test, deg. fahr)...........	20 to 25 deg. fahr.	30 deg. fahr.	35 to 45 deg. fahr.

for use in "all standard air compressors," should meet the physical tests imposed by the average range of figures given in the middle column of Table 2. The above wording "standard air compressors" is to be interpreted as including the following types of machines:

a Low-pressure up to 100-lb. compressors, which may be either small-sized single-stage units, or larger-sized compound machines.

b High-pressure compressors which are constructed with the proper number of stages so that no excessive temperatures are ever reached.

In other words, this lubricant of average test figures is always recommended unless a compressor manufacturer specifies in his literature that a high-flash-point oil should be used to meet the conditions peculiar to his machine. It is thus obvious that it is never necessary that a lubricant should possess a flash point as high as 500 deg. unless abnormal conditions of high temperature prevail. Such high-flash-point oils have an unusual tendency to produce carbon deposits.

Asphaltic-Base Lubricating Oils. This group of oils is considered separately for the reason that the lower limit of gravity stated in Table 2, viz., 25 deg. Baumé, eliminates the entire group from consideration—which is not the intention. As a guide for the selection of suitable oil, Table 3 is given.

TABLE 3 PHYSICAL TESTS OF ASPHALTIC-BASE OILS

	Minimum	Average	Maximum
Gravity, Baumé...	20-22 deg. fahr.	19.8-21 deg. fahr.	19.5-20.5 deg. fahr.
Flash Point, Open Cup....	305-325 deg. fahr.	315-335 deg. fahr.	330-375 deg. fahr.
Fire.............	360-380 deg. fahr.	370-400 deg. fahr.	385-440 deg. fahr.
Viscosity (Saybolt) at 100 deg. fahr.	175-225 sec.	275-325 sec.	475-750 sec.
Color............	Pale Yellow	Pale Yellow	Pale Yellow
Congealing Point (pour test).....	0 deg. fahr.	0 deg. fahr.	0 deg. fahr.

Proper Quantity of Lubricating Oils. The quantity of lubricating oil to feed to the air cylinders of compressors cannot be stated in exact terms due to the varying viscosity of different oils, the heat of compression and the size of cylinder. It may be stated in general, however, that after the cylinders have acquired smooth and polished surfaces, the quantity should be reduced to the lowest limit to avoid the possibility of the accumulation of carbon and sooty deposits.

TABLE 4 QUANTITY OF AIR-CYLINDER LUBRICANT REQUIRED PER 10-HOUR DAY

Diameter of Cylinder, Inches	Size of Cylinder, Inches	Displacement per Minute, Cubic Feet	Piston Speed, Feet Per Minute	Sq. Ft. of Cylinder Wall Swept by Piston	Drops Oil per Minute	Drops Oil per 10 Hr.	Sq. Ft. Oiled Per Drop	Number Pints Oil Required Per 10 Hr
8	8 x 8	120	344	718	1	600	718	0.0375
12	12 x 12	320	408	1230	2	1200	613	0.0750
18	18 x 18	880	496	2340	4	2400	585	0.1500
24	24 x 24	1730	550	3450	6	3600	575	0.2250
30	30 x 30	2940	600	4700	8	4800	590	0.3000
36	36 x 36	4550	644	6070	10	6000	607	0.3750
42	42 x 42	6700	696	7600	12	7200	633	0.4500

Figures of last column are based upon an estimated 16,000 drops per pint of oil at 75 deg. fahr.

The basis of quantity given in Table 4 is recommended, subject to above modifications for these cylinders or equivalent sizes, operating under normal conditions.

A leading authority on compressor engineering contributes the following: "The best way to determine the proper amount of lubrication is to take out the valves from time to time and examine the cylinder. All parts should feel that there is oil thereon. If they feel dry, the lubricators should be adjusted to feed a little

more oil, whereas if oil lies in the cylinder and its parts show excessive oil thereon, the quantity fed by the lubricators should be reduced. By thus examining the machine a few times, the proper amount of oil can be determined to suit the characteristics of the particular lubricant used and the conditions under which the machine operates." This is a better way to finally determine the quantity of oil required than by adopting without this experimenting any tabulated number of drops.

BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York City.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in THE JOURNAL, in order that any one interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee in Cases Nos. 208-214, inclusive, as formulated at the meeting of January 17, 1919, and approved by the Council. In this report, as previously, the names of inquirers have been omitted.

CASE NO. 205

Inquiry: An interpretation is requested of the distinction between the term *staybolt* and the terms *stay* and *brace* as used in the A.S.M.E. Boiler Code. Under what conditions may a reinforcing member be considered a *staybolt*, or a *stay* or *brace?*

Reply: The term "staybolt" as used in the Boiler Code refers to a bolt screwed through the plate or plates, with the ends of the bolt riveted over or fitted with nuts.

CASE NO. 207

Inquiry: Is it the intention of the Boiler Code Committee that in the application of Par. 214, item (1) means that the radius of the flange is not to exceed eight times the thickness of the head, or that *d* is so limited while the radius may be as large as desired?

Reply: It is the intention of the Committee that the restriction implied in Par. 214 shall apply only to item (1).

CASE NO. 208

Inquiry: Is it permissible under the requirements of the Boiler Code to use extra heavy steel pipe for superheater drum of a header type boiler, this pipe drum being connected to a steam drum by tubes which form part of the boiler heating surface?

Reply: Under the requirements of Pars. 9 and 11, the header or drum under discussion must be of wrought steel or cast steel of class B Grade. It is the opinion of the Committee that the words "wrought steel" in these paragraphs, mean wrought steel in accordance with one or the other of the specifications for various classes of wrought steel that are incorporated in the Code.

CASE NO. 209

Inquiry: If it becomes necessary to change the setting of a safety valve by putting in a new spring, what is the procedure necessary in connection with the marking on the body of the valve? Also in the case of a boiler whose total safety-valve area exceeds that of the orifice of the nozzle by 25 per cent, is it necessary to put on a larger nozzle to accommodate this safety-valve capacity? The owner points out that if they could substitute flat-seated valves, the present nozzles would be amply large.

Reply: If a safety valve is fitted with a new spring which changes its relieving capacity, it is the opinion of the Committee that it should be considered as a new valve which will necessitate remarking. In the case of two safety valves whose total area exceeds that of the nozzle by 25 per cent, it should be understood that if this applies to the case of an existing installation, the requirement of Par. 278 of the Boiler Code is not applicable; to a new installation, on the other hand, the requirement of Par. 278 is applicable and cannot be modified.

CASE NO. 210

Inquiry: An interpretation is requested of Par. 328 of the Boiler Code with regard to its applicability to soot-blower doors in the settings of water-tube boilers where the doors are made 8 by 8 in. in size and are seldom located less than 10 or 12 ft. from the floor.

Reply: In specifying latching devices for firing doors, furnace inspection doors and clinker doors in Par. 328, it was the intent of the Boiler Code Committee that all outward-opening doors, excepting explosion doors, shall be latched, unless they are so located that the attendant will not be injured by an explosion of the gases or tubes within the boiler setting.

CASE NO. 211

Inquiry: Is it the intent of Par. 277 of the Boiler Code to prevent the use of a connection to a spool or Y-pipe between the boiler and the safety valve for supplying steam to soot blowers which are subject to only occasional use? It is pointed out that such a connection would avoid an extra opening in the steam drum.

Reply: It is the opinion of the Boiler Code Committee that there should be no auxiliary connection of any sort made to the fitting between the boiler and a safety valve, if there be any such fitting.

CASE NO. 212

Inquiry: An interpretation of Par. 274 is requested which will show whether the safety valves should be proportioned with capacities as rated in Table 8 (Table 15, Edition of 1918) to relieve the total steam generated by the boiler, or of an arbitrary rating per sq. ft. of heating surface.

Reply: The sizes of safety valves should be determined on the basis of the total relieving capacity, the minimum value of which is to be determined in accordance with Par. 274 and on the basis of the relieving capacity of the safety valves stamped thereon by the manufacturer. Table 8 (Table 15, Edition of 1918) does not govern the relieving capacity of safety valves, but simply shows the computed relieving capacity for various lifts of safety valves. There is no limit set in the Code to the amount the safety valve may lift, provided the valve operates properly, and it may be that the relieving capacity stamped on the valve by the manufacturer will be greater than any of those given in Table 15.

CASE NO. 213

Inquiry: Can vertical tubular boilers up to 54 in. in diameter which are built of flange steel with punched rivet holes, drilled tube holes and cast-iron fire-door ring and mud ring, be stamped under the A.S.M.E. Boiler Code standard when the operating pressure does not exceed 50 lb.?

Reply: The boilers referred to in the inquiry, if used as steam boilers, may carry 15 lb. pressure as a maximum under Par. 338 of the Boiler Code, or if used as hot water boilers, may carry 50 lb. pressure as a maximum under Par. 335*a* and *b*. If, as steam boilers, they carry more than 15 lb. pressure or as hot water boilers, they carry more than 50 lb. pressure, they must conform to the Rules for Power Boilers.

CASE NO. 214

Inquiry: In the case of a gas-fired vertical-tubular boiler which is so encased that the products of combustion pass outside of the shell as well as through the tubes, is it permissible under Par. 430*d* and *e* to locate the fusible plug in the outside shell?

Reply: The fusible plug may be placed in the shell of a boiler of this type where the hot gases pass around the shell, provided the height of the plug corresponds to that it would occupy if placed in the tube as specified in Par. 430*d*.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Departments of MECHANICAL ENGINEERING by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in this journal, or brief articles of current interest to mechanical engineers.

Improvements in Locomotive Boilers

TO THE EDITOR:

In the Engineering Survey Section of MECHANICAL ENGINEERING for March, pages 284 and 285, I notice a description of certain improvements in locomotive boilers which were recently tried out on the Chicago, Milwaukee and St. Paul Railroad by Mr. Nicholson. As I have been a designer and constructor of all kinds of boilers for a great number of years, as well as the designer and builder of tools for making boilers—having equipped practically two-thirds of the boiler shops in the United States with my tools—I am sufficiently interested in the subject-matter of the abstract in question to submit the following comments:

1 Pockets in fireboxes are not new, but their connection with the leg of the boiler, where all the mud and dirt is supposed to collect, is a new idea. Presumably this has been suggested by the arch tubes which have been placed in boilers with a view of improving circulation and for accommodating the brick arches. This connection, I believe, will prove difficult and costly to maintain.

2 Locomotive boilers some years ago were very much smaller than they are today, and their present abnormal size makes it very difficult to control expansion and contraction, two great evils in connection with rigid firebox construction which railroad men have been trying to control with flexible stays instead of flexible fireboxes.

3 The desirability of placing obstacles in fireboxes to save fuel is questionable, and the fact that the construction described is installed where the heat in the firebox is greatest proves how valuable firebox heating surface is. The application of this idea requires a construction of greater rigidity than that of the ordinary firebox, and rigidity, it is agreed by all boiler experts and engineers, is the cause of all the troubles in fireboxes. It is also to be noted that a greater number of stays have been added to the firebox, which, I may state, is very undesirable.

Should this arrangement be generally adopted, I predict it will prove a very costly experiment to the railroads; the Government is not warranted in allowing such ideas to be made to appear practical when it is known by experts that the advantages it affords are obtainable only at the expense of its upkeep. It is well known, too, that the locomotive is already loaded up with more improvements than the upkeep warrants.

WILLIAM H. WOOD.

Media, Pa.

Labor Dilution as a National Necessity

TO THE EDITOR:

The Great War has been the means of educating the masses in things that are vital to the nation, and of the many important projects which have come to our attention, the training of semi-skilled and unskilled labor in the arts of manufacturing has become a necessity that all are bound to recognize.

Before the War very few manufacturers had any idea of the meaning of Labor Dilution. What does this Labor Dilution mean? In so many words it means the utilization of the army of misfits into productive industrial units. Except as applied to female workers, Labor Dilution has hardly had a fair start, notwithstanding the immense amount of constructive work that has been done through the Army and Navy instruction centers.

The Curtiss Aeroplane and Motor Corporation was one of the first to appreciate the value of maintaining a school for the purpose of training our female workers on exactly the same operation they would be expected to perform in the production departments. The success of this work is evident to all employers who have recently used women on operations formerly performed by male labor. They have made good, and it is the universal opinion that on many jobs women are better than men.

Will industry, now that it understands what results can be accomplished by Labor Dilution, revert to the old state of affairs? I think not. We have been accustomed to measure our needs by the other fellow's experience, but now it is plain to us it is not necessary to strive for the high standards of mechanical ability we have heretofore demanded.

For years we have overlooked a valuable source of labor supply right at our doors simply because we had no means of utilizing their labor. We have neglected to study the mental progress of semi-skilled and unskilled laborers. We have, without thinking, assigned them to the laboring positions, never giving them the benefit of an ambition to aspire for advancement.

During the past year our experience has been that men who formally applied for laboring positions were asking for machine jobs. In questioning them we found they had no special experience to qualify them for the important positions, and the result was that many of them were turned away. However, in the aeroplane business it was not possible for us to draw from an available supply of expert aeroplane mechanics, and there were operations where we could take some of the brightest applicants and place them on work where they could, in a short time, master the details.

In looking back we recollect with amazement the avidity these men and women displayed when they were given a chance to break the bonds which held them in check. They have played an important part in the battle for liberty because they themselves have become liberated, and now that the war is over, are they to become an industrial asset or liability?

These men and women have had the benefit of specialized industrial training, and while they are not full-fledged mechanics, they are, nevertheless, better equipped to qualify for industrial work. The next question is, Are they going to be able to capitalize their experience? Naturally one would say, "Yes, if they can find the same class of work." I do not think this has any bearing in the case, because these people have demonstrated to their own satisfaction that if they can learn one job they can learn another. If this is not true, then is not all the study and work that has been put into labor dilution been in vain?

The force of habit in some concerns is bound to manifest itself in the readjusting period now before us. They are going to cast about for the high-grade skilled mechanic in the thought that they are going to beat their competitors in the rush for peacetime business. The wise manufacturer, however, will "father" the idea of building an organization of operators which can be very easily developed by intensive training methods.

For instance, large employers of labor throughout the country, who, for the past year or more, have spent a lot of time and money on intensive training, are not going to set this all aside and proceed to hire and train their operators by the old methods. It is not necessary to prove to them how much it costs to replace workmen taken into the shop and turned over to a foreman on production work for instructions under the old system. This is by far the most expensive way, figuring it from all angles.

In the Curtiss Aeroplane and Motor Corporation we have found that it costs, on an average for a three months' period, \$34.27 to

train a girl or woman for production work. It is reasonable to assume that if the worker was placed in the shop without going through the training department, the cost would be two or three times as much.

The soldiers and sailors who have been trained intensively in the various technical schools and manufacturing plants throughout the country, are they going back to their old line of endeavor, or are they going to follow the work in which they have been instructed? Again the theory of labor dilution must be upheld or else the efforts which have been put forth to train these men have been wasted.

For example, the Navy has periodically sent batches of men to our plant to receive intensive training in the construction of flying boats. Many of these men never had a woodworking tool in their hands before, but in a short time were able to perform a very creditable job, so much so that they were able to make all necessary repairs without outside assistance.

These men have received a training they never would have acquired under normal conditions. They have "found" themselves and are not going back to the old pursuits. Industrially these men are an asset, and as such we are duty bound to provide them a means of livelihood.

The part that organized labor will play in this scheme must necessarily wait developments, but we must not overlook the fact that Samuel Gompers, President of the American Federation of Labor, is the motive power which called into being the committee on Training and Dilution, responsible for the propaganda of specialized industrial training.

Even before the war employment managers were unanimous in the statement that there was a shortage of qualified mechanics. Manufacturers and employers of labor generally were responsible for this state of affairs, because when there was a mechanical position to be filled they demanded an A1 man for the job. We had long since given up the practice of the indentured apprenticeship, and it was not so much the question of where the man received his training as it was to get the right man. The idea of doing their part in replacing and developing the inevitable loss of expert mechanics due to old age and death did not concern them until the war came, and their best men either enlisted or were drafted into the Army and Navy. It was then the necessity of labor dilution manifested itself. Industry and the workers have benefited by the introduction of intensive training methods, and it is not reasonable to suppose they are going to turn their backs on a system which has enabled the Government to provide the sinews of war. We have taken a step forward which does not permit retraction.

CHARLES E. FOUHY,
Employment Manager,
Curtiss Aeroplane and Motor Corporation.

Buffalo, N. Y.

Industrial Service Education

TO THE EDITOR:

At the Thirty-ninth Annual Meeting of The American Society of Mechanical Engineers, Mr. D. R. Kennedy, Employment Manager of the American International Shipbuilding Corporation, expressed in a splendid way the changed conditions in industry as follows:

"Permit me to prophesy that the executive of the next decade will be the man who best knows men. He will be an organizer, a handler of men as individuals, a handler of men in the mass, a leader, not a driver; a very human man. The science of human engineering is here to stay. The study of human characteristics is the most enduring, as well as the most fascinating, in the world, and still the most complex."

The big question is, How are we to develop this new type of engineer, manager, employer, business executive? Some of these men will be self-made. A large proportion of them will probably come from among the graduates of our engineering schools and colleges. This raises the really fundamental question. To what extent are our engineering colleges giving the type of instruction which will tend to build this new type of executive? It is encouraging to see that, from a rather comprehensive study of practically all the important engineering colleges of the country, many of these are beginning to readapt their curricula to include more on the human side of the job. Much more of this must be done. A thorough investigation of engineering education made by C. R. Mann, of the Carnegie Foundation for the Advancement of Teaching, revealed clearly this need. The Industrial Service Movement of the Young Men's Christian Association has been responsible for a suggested college course on the Human Side of Engineering, which includes such studies as the following: The Human Factor in Industry, Human Factors in Production, The Ethics of Engineering and Business, Employment Management, Vocational Guidance, Scientific Management in Its Human Relations, The Engineers' Responsibility for Service, and Industrial and Social Readjustment and Reconstruction. (Copies of this course and bibliography will be furnished on request.) Already a number of leading institutions have adopted this, or a similar course, in whole or in part.

Remarkable results have attended such courses wherever given, but even this is not enough. With this fact in mind, the Y. M. C. A. has, for over ten years, been promoting a thoroughly comprehensive scheme for the education of our coming engineers in the human side of their work. In addition to counseling with leading employers, labor men, engineers and professors throughout the country, and suggesting helpful courses of study, the organization has worked out, in its Industrial Service Movement, helpful lists of lecturers, lists of books and welfare literature, a series of pamphlets intended to inspire the engineering student and graduate along lines of industrial betterment and service, etc. The movement has enlisted as many as 4500 college students from over 250 engineering schools and universities, in fifty varieties of worth-while service with working men and boys. About 2000 of these students have taught classes in English, citizenship and Americanization. Approximately 1000 others have led technical classes and taken charge of other lines of work with American workingmen, and the rest have been helping with boys' clubs and other forms of constructive endeavor among working boys and apprentices. The amount of actual service rendered has been extraordinary, and 100,000 industrial workers have been reached. The quality of the service has been surprisingly high, and the appreciation of the men served very great. Needless to say, however, the students themselves have gained far more then they have given. They have inevitably come to understand actual industrial conditions and the problem of handling men whom they will be obliged to handle after graduation. Their practical service has given them a sympathy and understanding which could be gained in no other way.

Under normal conditions our colleges are graduating approximately a thousand men a year who have had a real touch with this movement, and who, from all probability, scatter throughout the industrial world into larger spheres of influence. Whatever their occupations, they will never cease to be human engineers. This is the big objective. It will be these men, and others like them, together with many of our returned soldiers, upon whom the burdens of industrial and social reconstruction will fall.

FRED H. RINDGE, JR.

347 Madison Avenue, New York.

In a pamphlet on International Control of Minerals recently issued by the U. S. Geological Survey, the strategic position of the United States is graphically shown by a table compiled by Dr. C. K. Leith. The United States controls about one-third of the world's mineral production of 1,700,000,000 tons. The few minerals for which this country is dependent on foreign countries are offset by so many in which we have a dominance of supply and our financial position is so strong that it appears certain that in this respect our entrance into a league of nations would not be based on self-interest. The interests of conservation clearly require an international control of minerals; whether the time has come to establish a league of nations with economic control, he says, can be determined only by the collective answers to the question of whether the nations are willing to make the necessary economic sacrifices in the interest of world harmony.

ENGINEERING SURVEY

A Review of Progress and Attainment in Mechanical Engineering and Related Fields, as Gathered from Current Technical Periodicals and Other Sources

AERONAUTICS

Balancing Aeroplane Propellers (Baudisch, *Der Motorwagen,* December 20, 1918). A perfectly balanced propeller has its center of gravity exactly on the center line of the propeller shaft on which it rotates. In practice, although the propellers are made out of wood, as homogenous as possible, and the two blades are nearly identical as can be attained, one blade is invariably heavier than the other.

The balancing of the propeller to make the center of gravity of the propeller coincide with the center of gravity of the propeller shaft can be done either statically or dynamically. The method of procedure for the static balance only requires simple appliances, but is very tedious and slow to carry out.

The dynamic balance can be done much more quickly, but it requires a rather complicated and expensive balancing machine, and in consequence the static method is in more general use than the dynamic.

The author proceeds to explain a dynamical balancing process built up on the same principles as the statistical method, which is such that while the results are as exact as those obtained statically, it has the great advantage of being rapid in execution. An additional point is that the apparatus required is as simple as that for the static test.

The propeller is fitted to a horizontal testing axle, which rotates on ball or roller bearings so that it is as frictionless as possible. The bearings are rigidly mounted sufficiently high above the floor level to allow the propeller to rotate freely. If the propeller be left to itself it will after several vibrations, come to rest with the center of gravity in its lowest position. The weight which must be added to obtain the true balance can be obtained mathematically by following out a simple system of calculation given by the author, the data for which are gained from the results obtained by fixing known weights both above and below the propeller center, at different given distances.

The article is concluded by some hints on errors to be avoided in making the tests, such as insuring that the testing axle has no bend in it through the weight of the propeller, that the propeller does not slip on the axle, and that the bearings on which it runs are perfectly rigid. (*Technical Supplement to the Review of the Foreign Press,* vol. 3, no 4, Feb. 18, 1919, pp. 128-129, no. 4308)

AIR MACHINERY (See Heating and Ventilation)

ENGINEERING MATERIALS

Toughness: Its Nature and Measurement

Static, Dynamic and Notch Toughness. According to the author, the point of view presented in the paper here abstracted is that toughness, like hardness or tensile strength, should be regarded as an independent property and of sufficient importance to require, in so far as that may be possible, quantitative determinations. If so, it becomes necessary to devise experimental means for measuring or valuating toughness and the notched-bar impact

Fig. 1 Left Side of Keyseat

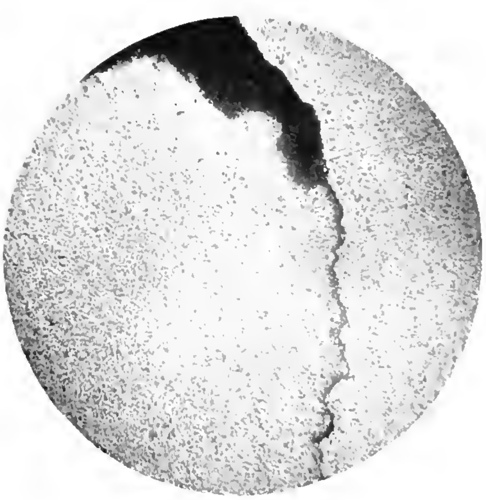


Fig. 2 Right Side of Keyseat

test or the Charpy test is advanced as the most logical test that has so far been developed for this purpose. It is also claimed that there are two kinds of toughness, which have to be dealt with independently.

Tough materials have been defined as those that offer consider-

able resistance to permanent deformation, but which, once resistance has been overcome, may be deformed plastically, though only by the expenditure of considerable energy. In other words, tough materials may be deformed plastically, but they absorb a considerable amount of work in the process. This kind of toughness may be called "static" when the rate of loading is reasonably slow, or "dynamic" when the rate of loading is comparatively rapid, as in the impact test. In all cases the stress distribution is essentially uniform, but static toughness does not imply resistance to shock, or dynamic toughness; and dynamic toughness may be equal to, greater than, or less than static toughness, a fact illustrated by numerous cases on record.

In addition to the foregoing there is what the writer calls "notch toughness," defined as the ability of a material to withstand stresses when in the notched condition. (It is a well-known fact that if the change in cross-section is in the form of a nick or a groove, the strains at the base of the nick multiply and are much greater than the average strain over the cross-section.)

Attention is called to the fact that the notch effect is quite frequently met with in engineering practice. At times it may be intentionally introduced through the design of the part, sometimes faulty, and at times may be unintentionally introduced through faulty or careless workmanship. It is also important to consider the microstructure and the desirability of heat treatment as a means of overcoming or counteracting the effect of the notch.

Several examples showing the danger of the presence of notches in various forms are considered, among others being the danger of a keyseat in an axle. Photomicrographs, Figs. 1 and 2, are given showing the extensions of two cracks leading from the angles of the keyseat. If it is necessary to use such a keyseat, the material should be suitably heat-treated to give a high notch toughness, or better, perhaps, both the material and the heat treatment should be selected with reference to its notch toughness.

The writer recommends that a notched-bar test should supplement the usual tensile and hardness test and its results be used as an index of the resistance of the material to the notch effect.

Objection has been raised to the adoption of such a test on the basis of lack of uniformity of results. In a number of cases the results of the notched-bar impact test are not as concordant as might be desired, but it is the opinion of many experimenters that variations in the impact resistance of supposedly similar test bars are due to actual variations in the material. The truth of this contention is demonstrated by the recent work of Charpy and Cornu-Thênard, who, by using exceptionally uniform and homogeneous bars, secured check results as close as 1 to 2 per cent and scarcely ever varying as much as 4 per cent. The results obtained by the commission of the German Society for Testing Materials were sufficiently concordant to lead to the adoption of the test and the minor variations were not permitted to mask the fact that the notched-bar test is capable of yielding valuable information that the tensile strength does not.

The writer is informed that at least one steel plant, which has done considerable work on the notched-bar test including the Charpy test, has found the concordance of results to be very satisfactory and capable of yielding possible differences of impact resistance of the order of magnitude of 1:30. Thus, it would seem that lack of concordance can now no longer be advanced as an objection to the adoption of the Charpy test. (*Bulletin of the American Institute of Mining Engineers*, no. 146, Feb. 1919, pp. 339-351, 10 figs., *cpA*)

TESTS ON CONCRETE (*Beton und Eisen*, December 4, 1918). Concrete test pieces (8-in. cubes) for the purpose of ascertaining safe crushing loads were prepared in porous and alternatively in iron molds. Those from the latter proved much inferior to the former.

The Government Testing Station in Berlin-Lichterfelde has therefore proposed that test pieces should be prepared in porous molds. Wooden molds were found unsatisfactory, as they did not retain their shape, but plaster-of-paris molds gave good results.

Test pieces prepared from one volume of cement and four volumes of carefully graded conglomerate mixed with 12 per cent of water failed under a pressure of 3400 lb. per sq. in. when made in plaster molds, and under 2235 lb. when made in iron molds, thus showing an increase of strength of 54 per cent in favor of porous molds. Similarly, one part of cement to six of conglomerate failed under 2025 and 970 lb. per sq. in., respectively, showing an increase in strength of 107 per cent. A large number of test pieces have been prepared in molds of iron, wood and plaster of paris, and it has been conclusively proved that the latter are the most reliable, and produce results closely approximating those obtained from test pieces cut out of actual work.

The German Concrete Institute has therefore framed the following regulations:

1 Iron molds as generally used for concrete are unsuitable for concrete grout because water is retained in the concrete and reduces the strength.

2 Molds of wood saturated with oil are also unsuitable. Molds of porous wood give satisfactory results, but must not be used more than five or six times, as they soon become saturated.

3 Plaster-of-Paris molds give test pieces that correspond closely to concrete found in structures. Each side of the plates may be used four or five times without losing the power to absorb water. They are cheap, and large numbers can be made simultaneously. The values found for crushing loads are reliable, and the progress of solidification is regular and in definite proportion to test pieces made in iron molds. (*Technical Supplement to the Review of the Foreign Press*, vol. 3, no. 4, Feb. 18, 1919, p. 109, no. 4192, *e*)

DEFINITIONS OF CEMENT (*Zeitschrift für angewandte Chemie*, December 3, 1918). The short descriptive word "cement" is usually understood to mean portland cement, composed of hydraulic lime and sand. But recently other substances have been substituted for the sand, so that some wider definition is required. In Germany the three now much-used types are thus defined: (1) Portland cement, consisting of a hydraulic binding substance, with less than 1.7 parts to one by weight of soluble silica, plus clay and oxide of iron: and manufactured by fine grinding and intimate mixing, burning, and again grinding; (2) ferro-portland cement, a hydraulic binding substance, consisting of at least 70 per cent portland cement and at most 30 per cent of blast-furnace slag; and (3) blast-furnace cement, a hydraulic binding substance, which, with a portland-cement content of not less than 15 per cent, consists mainly of blast-furnace slag, which, by sudden cooling of the molten mass, is converted into the granular form. (*Technical Supplement to the Review of the Foreign Press*, vol. 3, no. 4, Feb. 18, 1919, p. 109, no. 4191, *t*)

HEATING AND VENTILATION

Ventilating Fan with Air-Reversing Arrangement

MINE VENTILATING PLANT. Description of a British mine-ventilating-plant installation with an engine of 300 b.hp. The most interesting features are the general arrangement at the air end and the connection between the engine and the fan.

At the fan end of the crankshaft there is a flange forged on solid to which a small flywheel is bolted. The latter forms part of a flexible coupling (Fig. 3) which acts as a driving medium for the fan. On the fanshaft there is another similar wheel and between these two wheels there is a fanshaft about 2 ft. 6 in. over all with a flange forged solid on each end. On these flanges are bolted two steel plates which, near their outer peripheries, are bolted to the two flywheels. The arrangement forms a flexible coupling and the reason for employing it is to provide for any slight settlement such as sometimes occurs on a colliery pit bank and might, if not allowed for, cause trouble with the bearings.

A special arrangement shown in Fig. 4 is provided by which the air instead of being abstracted from the mine and discharged into the atmosphere may be driven in the reverse direction. In the left-hand view of the figure the plan is shown sucking air from the mine and delivering it to the atmosphere through the discharge opening or evasee. In order to reverse the direction of flow the discharge door shown at the bottom of the evasee and

counterbalanced by a cord and weight is drawn up so as to close the orifice at the base of the evasee, as shown in the right-hand view of the illustration. At the same time inlet doors in the casing (shown in the plan views at the bottom) are swung from the position shown in the left-hand view into that shown in the right-hand view which has two effects. It closes the passage leading to the inlet from the line shaft and opens the fan section to atmosphere. Then since the air cannot be discharged through the evasee, it is forced by the fan through the opening leading to a discharge passage into the mine which has been uncovered by

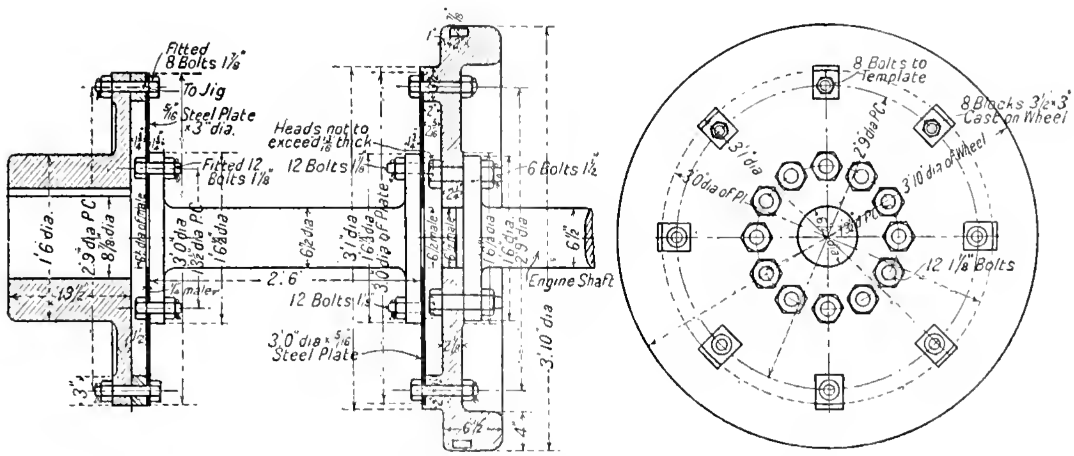


Fig. 3 Flexible Coupling between Engine and Fan

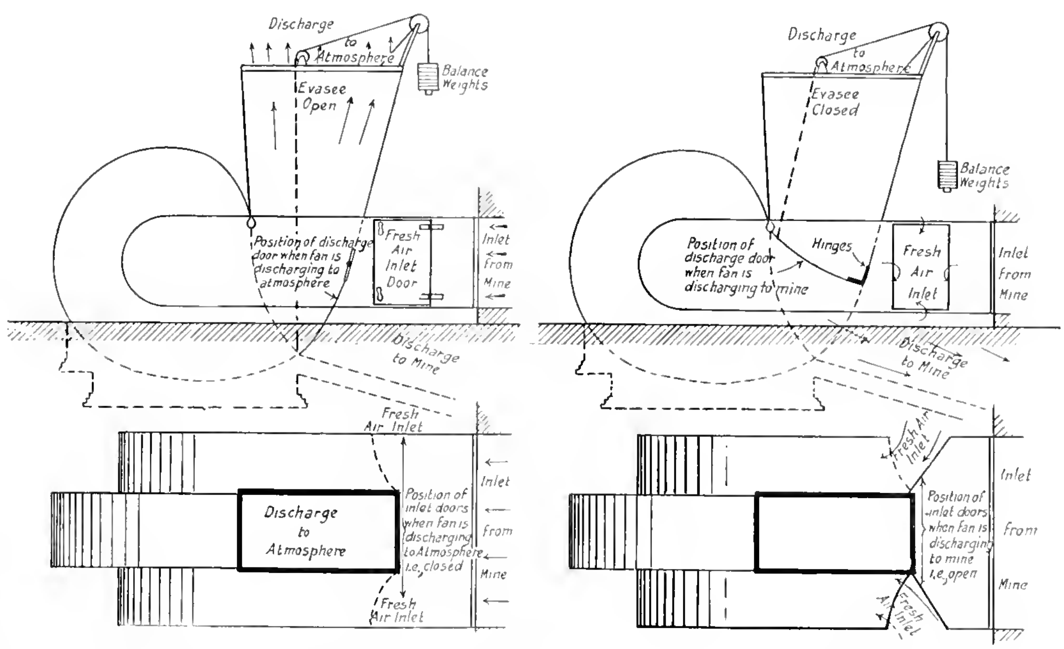


Fig. 4 Arrangement for Changing Direction of Flow of Air in a Mine-Ventilating Plant

the raising of the discharge door. It is stated that the necessary changes to bring about these reversals can be effected without stopping the engine it being only necessary simply to slow the fan slightly. (*The Engineer,* vol. 127, no. 3292, Jan. 31, 1919, pp. 110-111, 6 figs., *d*)

HEAT-TREATING

Hardening and Tempering Certain Railway Materials (*Stahl und Eisen,* December 5, 1918). G. Schultz, in *Organ,* describes the hardening processes to which keys, bolts, brake rods, parts of springs, screw nuts, valves and other moving parts of railway rolling stock are subjected. For all such parts basic Martin steel with at most 0.12 per cent carbon is used. The pieces are packed in the usual way into sheet-iron boxes, in which the surfaces to be hardened are in close contact with some hardening material. The closed and airtight boxes are kept, according to the thickness of the hardened outer skin required, from 10 to 18 hours in a muffle furnace at a temperature of 900 to 1000 deg. cent. Pieces, of which only a portion is to be hardened, are so packed that only those surfaces which are to be acted upon are in contact with the hardening materials, while the other portions are protected by some ready means. When the heating has been sufficient, the pieces are taken out and cleaned with a wire brush, and while still at a good red heat quenched in cold water. This gives a very hard skin; but, as a consequence of the long heating, leaves the metal coarse-grained and brittle. The quality of this hardened skin is greatly improved by a second heating at 800 deg. and quenching. By this process a fine grain is produced, and increased tensile strength is given to the hardened zone. In the case of important parts of the valve connection of locomotives, the good effect may be increased by several repetitions of the process. The duration of the repeat heats is from 15 to 90 min., according to the sectional dimensions of the piece. Such parts, as cranks and crankpins, which require long heating, are protected from burning by a thin covering of the hardening powder in an asbestos envelope. (*Technical Supplement to the Review of the Foreign Press,* vol. 3, no. 4, Feb. 18, 1919, pp. 112-113, no. 4213, *p*)

HYDRAULIC ENGINEERING

Single-Wheel Compound Water Turbines and Multi-Stage Centrifugal Pumps. H. Baudisch. (*Zeits. ges. Turbinenwesen*, 1 and 2, 1918. *Elektrot. u. Maschinenbau*, 36, p. 422, Sept. 15, 1918). Very narrow Francis turbines yield unsatisfactory efficiency. The lower limit of runner-wheel entrance breadth to runner-wheel entrance diameter is from 1/15 to 1/20, corresponding to a specific speed of about 60 r.p.m. There is a range of applicability of the Francis slow runner and that of the free-jet high-speed runner, the highest specific speed of which with single nozzle is about 35 r.p.m. This gap is filled by the Pfarr compound turbine in which water flows in series through several runners on one shaft. It is claimed that better results can be obtained at lower capital cost by allowing the water to flow twice or more through the same wheel. The guide and outlet chamber are divided into two equal parts. Half of the guide equipment is connected to the high-pressure pipe and half of the outlet chamber to the turbine suction pipe; the second half of the outlet chamber is connected to the second half of the guides. This single-wheel compound turbine has 100 per cent higher specific water volume than the Pfarr turbine and the same specific speed. It can be built as an axial or radial turbine or as a combination type; it can also be built as a spiral turbine with the spiral for each stage over one-half of the runner wheel. The use of a double-sided outlet on the runner wheel overcomes the axial thrust of the axial-radial turbine. Taking the lower limit of the specific speed of a runner wheel to be 60 r.p.m., the specific speed of the Pfarr compound turbine is 35.7 r.p.m., of the single-wheel compound turbine, 25.2 r.p.m.; and of the single-wheel, double-sided-outlet compound turbine, 35.7 r.p.m. Certain conditions which must be fulfilled by the single-wheel compound turbine, particularly in respect to pulsation, are noted in the original. The converse of the single-wheel compound turbine is the single-wheel multi-stage centrifugal pump. Both of these machines are of special importance where low capital cost rather than maximum efficiency is the primary consideration. Also, space is saved by the reduced axial length. (*Science Abstracts*, Section B—Electrical Engineering, vol. 22, pt. 1 (no. 253), Jan. 31, 1919, p. 8. *e*)

INTERNAL-COMBUSTION ENGINEERING

Performance of Marine Diesel Engines

Tests of Merchant-Ship-Type Diesel Engines. Data of official trials of two 1200-i.hp. (750-b.hp.) Diesel engines built by J. Samuel White & Co. for the British Admiralty. The trials were carried out in accordance with the special requirements of the British naval authorities and in the presence of their representatives.

The engines are direct reversible, two-cycle, single-acting, stepped-piston type, six-cylinder, 14½ in. bore by 24 in. stroke, and have a weight complete of 70¾ long tons.

The trials of the first engine consisted of 96 hr. of uninterrupted running at the full load of 750 b.hp. at a speed of about 200 r.p.m.

During the whole trial the engine ran satisfactorily without any stoppage and without any sign of overheating either in the cooling system or working parts. The exhaust was quite invisible and very little soot was observed after the completion of the trial. The temperatures at the end of the trial were practically the same as those attained at the end of the first hour.

The circulating water was passed through the engine by steam pumps, the quantity per brake horsepower being approximately 11.2 gal.

Additional maneuvering trials were carried out with the port engine consisting of astern running, time taken to pump up the starting reservoirs, slow-speed running and the drop in pressure of the starting air after each start.

Table 1 is representative of the results obtained in the 96-hr. trial of the starboard engine, while Table 2 gives data on lubrication and also the heat balance of the engine. (*Motorship*, vol. 4, no. 3, March 1919, pp. 17-20, illustrated. *eA*)

TABLE 1 DATA ON 96-HR. TRIAL OF STARBOARD ENGINE

Mean b.hp.	751.8
Mean r.p.m.	190.5
Mean i.hp.	1215.6
Mechanical efficiency, per cent	61.84
Total revolutions for 96 hr.	1,097,307
Total lb. of fuel oil used during 96 hr.	35,205
Fuel per b.hp. per hr., lb.	0.487
Total lubricating and cooling oil used for 96 hr., lb.	887.7
Mean lubricating and cooling oil per b.hp. per hr., lb.	0.0123
Mean temperature of cooling water, inlet, deg. fahr.	61.5
Mean temperature of cooling water, outlet, deg. fahr.	99.5
Mean temperature of piston oil cooling, inlet, deg. fahr.	90
Mean temperature of piston oil cooling, outlet, deg. fahr.	125
Atmospheric temperature of test shop, deg. fahr.	61.5
Injection air pressure (mean), lb. per sq. in.	1000
Scavenge air pressure (mean), lb. per sq. in.	7
Air Compressors:	
I.P. air cooler pressure (mean), lb. per sq. in.	127
L.P. air cooler pressure (mean), lb. per sq. in.	27
Circulating cooling water pressure (mean), lb. per sq. in.	5
Piston cooling and lubricating oil pressure (mean), lb. per sq. in.	61.56
Compressor suction open, per cent of total	5.35
Mean indicated pressure of No. 1 cylinder, lb. per sq. in.	110
Mean indicated pressure of No. 2 cylinder, lb. per sq. in.	106.7
Mean indicated pressure of No. 3 cylinder, lb. per sq. in.	108.4
Mean indicated pressure of No. 4 cylinder, lb. per sq. in.	103.4
Mean indicated pressure of No. 5 cylinder, lb. per sq. in.	117.0
Mean indicated pressure of No. 6 cylinder, lb. per sq. in.	102.5

Blast air used per b.hp. = 0.22 cu. ft.

TABLE 2 DATA ON LUBRICATION—HEAT BALANCE OF ENGINE

	Lb.	Oz.
Oil for power and scavenge pistons and L. P. compressor pistons	80	0
Oil for crankshaft and valve gearing	112	0
Oil for piston cooling and bearing lubrication	693	0
Total	885	0

(i.e., 0.22 lb. per hour or 0.0123 lb. per b.hp. per hr.).

Heat Balance

Calorific value of fuel, B.t.u. per lb.	19,510
Consumption per b.hp. per hr., lb.	0.487
Consumption per i.hp. per hr., lb.	0.303
b.hp. = 751.8, i.hp. = 1215.6 — Mech. efficiency, per cent	61.84

$$1 \text{ b.hp.-hour} = \frac{33{,}000 \times 60}{778} = 2550 \text{ B.t.u.}$$

1 b.hp. requires 1.62 i.hp., therefore frictional

$$\text{Heat per b.hp.} = \frac{0.627 \times 33{,}000}{778} \times 60 = 1578 \text{ B.t.u.}$$

Heat taken in per b.hp. per hr. = 19,510 × 0.487 = 9500 B.t.u.

$$\text{i.hp. heat units per b.hp.} = \frac{1.62 \times 33{,}000}{778} \times 60 = 4120 \text{ B.t.u.}$$

	B.t.u.	Per cent	
Heat converted into work on brake	2550	26.9	43.5 per cent
Heat lost in engine friction	1578	16.6	
Heat converted into indicated work	4120	43.5	100 per cent
Heat lost in cooling water	2480	26.1	
Heat lost in exhaust gases	2900	30.4	
Heat taken in per b.hp. per hour	9500	100.0	

Thermal efficiency of engine = 26.0 per cent

MACHINE DESIGN

Tests on Crankshaft Lubrication

Intermittent-Oil-Feed Investigation. Data of tests intended to determine the relations between quantity, pressure and seepage in bearings under various operating conditions, and a description of a special testing apparatus set up at McCook Field, Dayton, Ohio, for the present work.

The general appearance of the testing apparatus is indicated in Figs. 5 and 6. Essentially, the apparatus consists of a section of shaft of the same size as the main-bearing portion of the Liberty-12 crankshaft and mounted in a special test bearing with various sizes of inlet and outlet, as well as provision for driving the shaft and for making various measurements. The shaft used in most of the tests was 2⅝ in. in external diameter with a 1¼-in. hole drilled through its center, except at the driven end, which was left solid. The bearing housing consists of a special casting with bearing liner of standard construction. On one side there are four oil inlets A, B, C and D, Fig. 6, and opposite to these but staggered with relation to them, there are four outlets A_1, B_1, C_1 and D_1, all equipped with individual stopcocks so that any combination of the inlet and outlet sizes can be used and proper arrangements made for measuring the flow as to quantity (tank F), pressure (inlet gage J and outlet gage L), and

temperature (inlet thermometer N and outlet thermometer P).

In addition to the four side outlets there is an end outlet, shown at E, which takes the oil direct from the center of the hollow shaft and delivers it to a drainage tank I in which the quantity passing through the center of the shaft can be measured. The thermometer O indicates the temperature at this outlet.

The inlet connection M on the top of the test bearing is used in experiments to determine seepage along the length of the bearing. This inlet is located approximately one-third of the length of the shaft from one end and outlets are provided at the ends of the bearings (G and H) leading direct to separate drainage tanks in which the amount of oil seepage at each end of the bearing can be measured.

The oil is supplied to the various inlets under air pressure which can be varied from 25 to 100 lb. per sq. in. The oil line between the supply tank and the inlets is surrounded for part of its length by a steam coil which is used to regulate the temperature of the inlet oil. The test apparatus is water-jacketed to provide means for controlling the temperature of the oil in the bearing itself during the tests.

The first set of tests was made to determine the quantity of oil passing through the bearing under various conditions of shaft speed, inlet pressure, size of inlet openings, etc. These tests were again divided into several series, of which the first dealt with measurements of the quantity of oil that passes through the different sizes of inlet holes and out the center of the shaft at various speeds and inlet pressures.

In these tests it was found that the quantity of oil passing through the bearing decreases with speed and that the decrease is much more rapid in the range from 250 to 1000 r.p.m. than

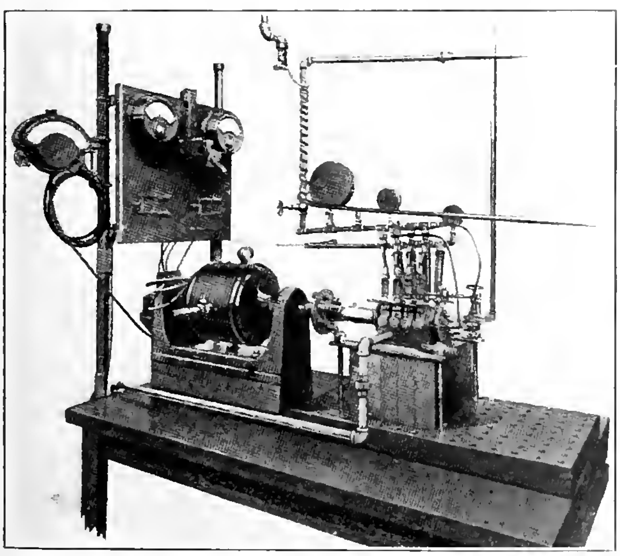


Fig. 5 General View of Dynamometer for Oil-Feed Tests

between 1000 and 2000 r.p.m., the curves having a more gradual slope at the higher speeds. As the latter represent normal engine speeds, an effort has been made to derive an empirical formula to cover oil flow in this range.

It was found that the quantity varies directly as the product of the pressure and the inlet-hole area. That is, when the area of the inlet hole is halved, the pressure must be doubled in order to obtain an equal quantity of oil at any fixed speed.

The formula derived from the results of these tests is as follows:

$$Q_b = \frac{1810\ (PA)}{S} \qquad [1]$$

where Q_b = quantity of oil in gallons per hour
P = inlet pressure in pounds per square inch
A = area of inlet hole in square inches
S = speed of shaft in revolutions per minute.

This formula may be slightly low with high pressures and large inlet holes, but it is substantially correct when the product of pressure and inlet-hole area does not exceed 5.

The next series of tests dealt with the quantity of oil flowing through the shaft from side inlet to side outlet; that is, through the inlet holes designated as A, B, C and D in Fig. 6, through the hollow shaft and out through the outlets A_1, B_1, C_1 and D_1 at various speeds and inlet pressures.

Centrifugal force set up in the oil inside the shaft complicates the problem of establishing a formula for the quantity values

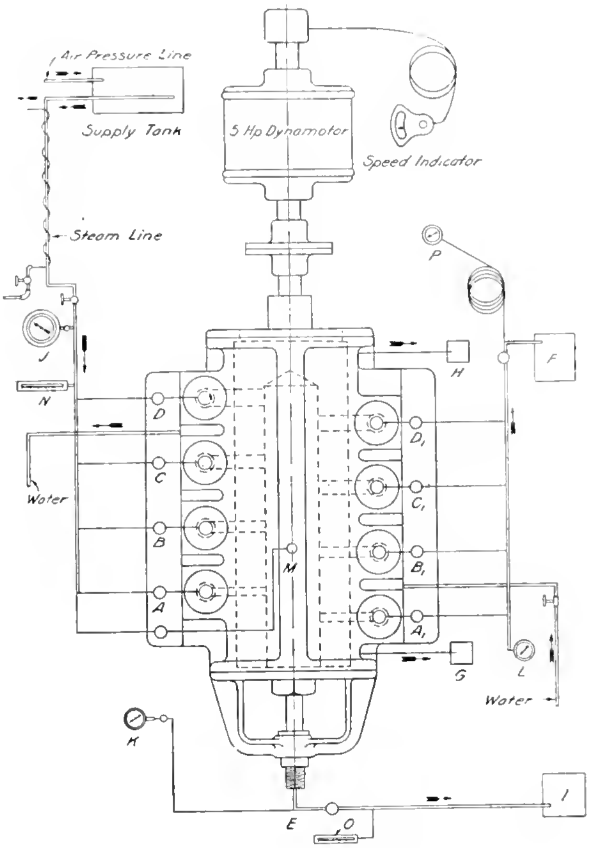


Fig. 6 Diagram of Installation for Oil-Feed Tests

obtained in these tests. The data of tests are presented in the original paper in the form of curves, in which, however, it is said that only the parts referring to speeds between 1000 and 2000 r.p.m. should be taken into consideration owing to the more abrupt character of the curves at lower speeds.

A formula to cover all cases has been derived from these tests, namely:

$$Q = \frac{1810\ (PA)}{S + \dfrac{6.9}{A_1}} \qquad [2]$$

where Q = quantity in gallons per hour
P = inlet pressure in pounds per square inch
A = area of the inlet hole
A_1 = area of the outlet hole
S = r.p.m. of shaft

Formula [2] is of the same form as the previous one. It may be used to cover all quantity calculations, because if it is considered that there is no outlet hole when the oil is not taken from the side of the shaft, A_1 becomes zero, and although not mathematically correct, it may be considered as canceled out, thus leaving the equation as it was first given. Values obtained with this formula do not in all cases correspond exactly with the results obtained in the tests, but they will be found to be sufficiently accurate to cover the entire quantity range in all ordinary design considerations.

An interesting series of tests were made to measure the amount

of seepage which took place around two special solid shafts used for this purpose. The results of these tests are summarized in the original article as follows:

1 The amount of seepage increases with the speed of shaft

2 The amount of clearance of shaft, within the usual range, has very little effect on the amount of seepage at normal speeds and pressures

3 The amount of seepage varies approximately inversely as the distance of the entering oil from the end of the shaft, being changed principally by the pressure

4 The amount of seepage varies directly with the inlet pressure.

An unusual result obtained in the two seepage tests was that in every case the seepage was greater with the smaller amount of clearance, which is quite contrary to expectations. This condition is difficult to account for, and it may be that it is peculiar only to the test apparatus used.

The effect of the distance through which the seepage must pass also was not according to expectations, and at lower speeds apparently was affected greatly by the amount of shaft clearance. For pressures of 40 lb. per sq. in. and over, the ratio of the seepage at the two ends G and H was practically the same for both shafts. The pressure seemed to play a part in the seepage ratio as between G and H, in that usually at pressures below 60 lb. per sq. in. the ratio was less than 2 to 1, but became larger as the pressure and speed increased, being as high as 3 to 1 at high speeds.

Tests were also made to determine the pressure inside of the shaft when the oil was led into any of the connections A, B, C and D. These tests have shown that the measured pressure in the hollow center of the shaft varies directly as the inlet pressure and also as the diameter of the inlet holes instead of as the area, as in the case of the quantity tests. Another conclusion drawn from these tests is, that with constant inlet pressure and a given size of inlet the drop in pressure due to speed increases more rapidly at high than at low pressures.

A formula has been derived from the data of these tests which provides mathematical means for determining the pressure in the hollow center of the shaft when the conditions are known. It is as follows:

$$p = \frac{5\ (PD)}{\sqrt{S}} \qquad [3]$$

where p = oil pressure inside shaft
P = inlet pressure
D = diameter of inlet hole
S = r.p.m. of shaft.

This equation will be found approximately correct from 500 to 1500 r.p.m. Above the latter speed it may be slightly in error, giving results as much as 4 per cent for each 100 r.p.m. above 1500.

Similar tests were made to determine the pressures at the side outlets of the bearing and it was found that the results corresponded in a general way with those obtained in the previous tests except that they were somewhat higher, so that the formula for pressure outside outlet is of the same form as [3], except that the coefficient is 6.8 instead of 5.

The final series of tests was conducted to determine the intermediate pressures for those in the center of the shaft with oil passing through from either of the side inlets to any one of the side outlets. When oil passed freely through the shaft the pressure in the hollow center portion varied considerably and did not follow any simple rule. In general, however, it was found that the internal pressure increased with the inlet pressure and also with increase of the size of the inlet hole, and decreased with increasing speed. Further, the drop in pressure due to speed is greater with the higher inlet pressures.

The original article is accompanied by a number of interesting curves. (*Bulletin of the Experimental Department, Airplane Engineering Division*, Bureau of Aircraft Production, War Department (Confidential) vol. 2, no. 3, December 1918, pp. 122-142, 18 figs., *e.t.* Abstracted by special courtesy of the Bureau of Aircraft Production, War Department).

MACHINE TOOLS

Automatic Arresting Motion for Power Presses

Automatic Arresting Motion for Power Presses. Illustrated description of a mechanism developed in England which it is claimed can be applied to that type of machine in which a flywheel revolves freely on its shaft until a positive connection is established between the two parts by rocking the spring-pressed rolling pin or bolt into engagement with the longitudinally recessed key or striking piece extending the entire length of the flywheel hub, this rolling pin or bolt being usually either kept in engagement so that the intermittent movement of the slide is continued or automatically disengaged after each complete revolution so that the slide may be stopped at its highest point after each single stroke. The inventors have provided an automatic mechanism whereby the slide might be brought to rest at the bottom of the down stroke, in addition to stopping at the highest part of its stroke. The holding at the bottom of the stroke is intended primarily to give the article being stamped a longer period in which to assume the desired form while still under pressure in the dies.

Referring to Fig. 7, A is the side frame of the press, and B the slide-operating shaft upon which the flywheel C revolves freely, until a positive connection is established between them through the spring-pressed trip lever D^1 rocking the rolling pin or bolt D of the shaft B into engagement with the longitudinally recessed key or striking piece E of the flywheel C, all of which are of ordinary construction.

In the invention under consideration there are fixed to the side frame of the press over the shaft B a bracket F having bearings G carrying a bar H formed with a tappet lever J, and being connected by means of a lever K to the upper end of a rod L of an eccentric M mounted on a countershaft N carried in bearings O of a bracket P, which is also attached to the side frame of the press. To the frame, too, but below the shaft B, is a fixed bracket Q, having bearings R carrying a bar S formed with a tappet lever T, and being connected by means of a lever U to the lower portion of the rod L. Rotary motion is imparted to the countershaft N from the flywheel C through the medium of chain gearing V, the chain wheel V^1 of which is loosely mounted on the countershaft N. The chain wheel V^1 is adapted to be locked to the countershaft N at will, through the medium of a slidable clutch W mounted on the countershaft.

On the countershaft N being driven by the chain gearing V the eccentric M has the effect, through the medium of the rod L and levers K U, of rocking the bars H S in their bearings G R, so that the two tappet levers J T are alternately rocked into the path of the spring-pressed trip lever D^1 of the rolling pin or bolt D, so as to cause the shaft B to be disengaged from the flywheel C twice during each revolution of the said shaft, the first disengagement being effected when the slide is at the highest point of its upstroke, and the second disengagement at the time the slide is at the bottom of its downstroke. The ratio of the chain gearing V and the action of the eccentric M may be proportioned as to give any desired amount of dwell to the slide to suit the work to be performed. For instance, with a 3 to 1 gear, such as is that which is fitted to the machine shown in Fig. 0, one revolution of the flywheel C would give a single reciprocation to the slide, while each of the other two revolutions would be rest periods for the slide at the top and bottom of its stroke respectively.

The countershaft N is fitted with a brake block X which is pressed upon by a spring, and which serves to arrest the movement of the shaft when it is thrown out of gear by the clutch W. The tappet-carrying bars H S are also fitted with springs H^1 S^1 for absorbing the shock set up when the trip lever D^1 strikes the tappet lever J T. (*The Engineer*, vol. 127, no. 3293, February 7, 1919, p. 135, 2 figs., *d.t*)

MARINE ENGINEERING (See Internal-Combustion Engineering)

MECHANICAL PROCESSES

New Process for Casting Formed Tools

DAVIDSON PROCESS OF CASTING FORMED TOOLS, J. E. Johnson, Jr., Mem.Am.Soc.M.E. The production of formed tools such as milling cutters, large drills, countersinks and other shapes from high-speed steel by methods hitherto known is an expensive operation. First, a blank of suitable size must be produced by forging an ingot or large bar. After forging, the rough blank is annealed and then sent to the toolroom for machining. This must be done with great care and accuracy and usually involves a multiplicity of operations, since, for example, the formation of each tooth in a milling cutter involves several cuts.

The notable features are three: First, the extraordinary freedom from blowholes; second, the fluidity of the metal; and third, the entire absence of coarse crystallization anywhere in the casting.

In regard to the first of these features, it may be stated that the foundry ran for several weeks before the completion of its baking oven, pouring the steel largely into green-sand molds, and yet made satisfactory tools, there being only a few steam holes near the surface. Since the drying oven was put into operation, blowholes of any description are practically unknown. In regard to the second, the metal, instead of having a comparatively ropy pour, is thin and fluid—more like hot cast iron than like steel. As a result the details of small cutters are cast practically perfect.

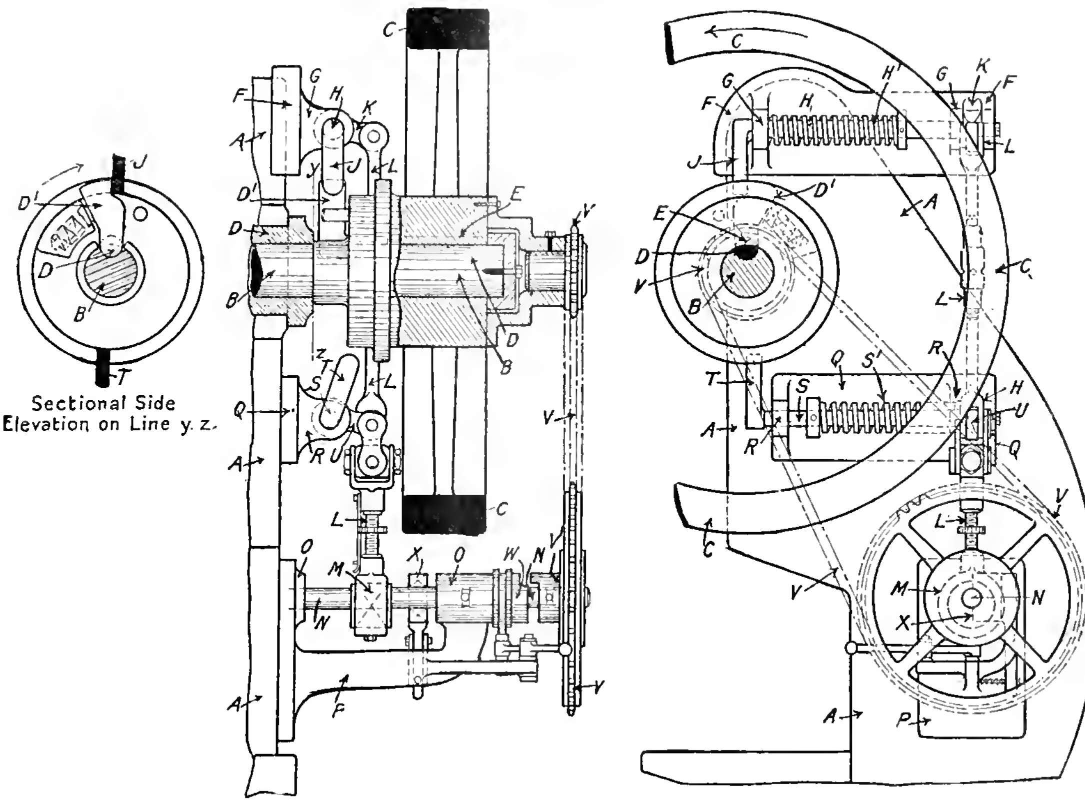


FIG. 7 "WHITE GLOVE" AUTOMATIC ARRESTING MOTION FOR POWER PRESSES

Various processes have been tried for casting tools to shape in the last two or three years and it is understood that one large manufacturer has such a process in more or less regular commercial use. There are three difficulties with this process from the point of view of ordinary steel-melting practice: (1) That of getting the steel killed so dead that it will be free of blowholes as cast; (2) that of producing a metal fluid enough to flow into the fine parts of the mold and give sharp, true castings. (If this cannot be done, only the rough cuts in machining the cutters are saved and the difficulty involved in cutting the scale may easily offset this gain); (3) that of producing a satisfactory structure to give great endurance and long life to the steel without the refining of the grain, which is often considered to come only from the forging operation.

A new direct casting process has been developed by A. C. Davidson with the assistance of Mr. Johnson, the author, and this is described in the paper and certain data on the history of the development of the process are presented.

From what is stated in the paper it appears that milling cutters are cast with a projecting lip on the cutting edge. This is finished entirely by grinding and with little more expense than the grinding of a machined tool. A perfect edge is obtained in this way with a minimum of labor and lost steel, while the possibility of local defects is avoided.

The material used for killing is a secret of which the author has no knowledge; he is, however, very enthusiastic over the results. The results described in this paper are not picked samples but represent the general run of the work done.

In regard to the third feature, it is well known that most steel, when cast, has a coarsely crystalline or fiery structure, but an examination of the fresh fractures of this steel shows that this is almost wholly absent; in fact, the structure of this steel, as cast, looks much more like that of forged steel than it does like a casting.

Various photomicrographs of a tool manufactured by the Davidson process are presented. From them it appears that the structure consists of a light matrix in which are embedded three other constituents. One is a dark, mottled material resembling troosto-sorbite in ordinary carbon steel and also resembling the dark constituent in a cast high-speed steel of ordinary composition. The second constituent is a light, hard one forming a herringbone design and is plainly a eutectic of some sort. The third constituent consists of a series of separate, small, rounded, hard, white spots similar to the excess carbide found in an ordinary high-speed steel both before and after hardening, provided the sum of the carbon, tungsten and chromium contents are high enough.

The author concludes with the following statement:

"Since the feathery constituent mentioned by Mr. Boylston, and shown in the photomicrographs of the Davidson tool, appears from Mr. Boylston's statement to be rather rare and is abundant in this steel, I am led to think that the surprising quality of these

tools may be due, in some degree, to the presence of this constituent. It seems well to point out here, however, that the metallography of the cutting tools is not sufficiently developed to enable us to say, even from a good photomicrograph, that a certain tool is definitely good or bad. The science will undoubtedly reach a state of development where this will be possible, but for the present the only safe gage of the quality of high-speed steel tools is a test under working conditions, the test to be continued to destruction if possible. Judging from the number of cases in which the cast tools have outstripped all others in such tests, a suggestion not unworthy of consideration is that the structure shown by the Davidson tools is that at which other toolmakers should aim." (*Bulletin of the American Institute of Mining Engineers*, no. 146, Feb. 1919, pp. 353-360, 6 figs., *d*A)

MEASURING INSTRUMENTS

Resilience Factor in Instrument Calibration

The Concept of Resilience with Respect to Indicating Instruments, Frederick J. Schlink, Mem.Am.Soc.M.E. In an earlier paper entitled Variance of Measuring Instruments and Its Relation to Accuracy and Sensitivity (Bureau of Standards Scientific Paper No. 328, 1918), the writer discussed the so-

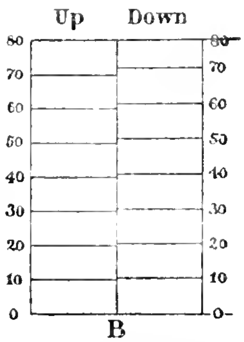


Fig. 8 Calibration of Ordinary Steam-Engine Indicator

(Reproduced from a textbook on the indicator; shows the equivalent, when pencil displacement is plotted against pressure, of a closed hysteresis loop)

called hysteretic types of errors. The hysteresis loop obtained upon the performance of a proper cyclic calibration gives a representation of the behavior of an instrument as regards the consistency or reproducibility of its calibration. Furthermore, a simple quotient of the areas marked out by the cyclic calibration curve defines a factor which may be called the resiliency of an indicating or controlling instrument.

There are actual energy losses which occasion the hysteresis in the calibration and the nature of which is discussed, and it appears that the variability of a non-integrating instrument can always be expressed in the form of a lost-work diagram, although in some cases the transformation of the coördinates must be resorted to to permit direct planimetric evaluation of the losses.

In order to give such a hysteresis loop definiteness and value for the purpose in hand, the instruments must be operated a number of times over the cycle under investigation in order to get it into the cyclic state, just as is done in determining the hysteresis characteristics of magnetic specimens and in exact determinations of the stress-strain relations of structural materials. Moreover, between the points of reversal, the change of the independent variable, that is, the quantity which the instrument is intended to measure, must take place slowly and aperiodically and without jarring or vibration, so that the pointer at no time overshoots its reading, since all revertive or vibratory movement of the mechanism tends to displace the corresponding part of the hysteresis loop toward the normal or ideal calibration line to an extent dependent upon the magnitude and number of the precedent excursions. Setting up the cyclic state as defined above, has the effect of obliterating, as it were, the previous operational history of the instrument and of making the hysteresis loop a closed figure of definite area. It is recalled that the hysteresis effect observed in common indicating instruments is in large measure due to journal friction, and that the slack-bearing condition or backlash, so-called, is responsible in a quite definite way for the phenomena noted. It appears that the cyclic state can be readily set up in all indicating instruments except those in which transient phenomena are of importance even at relatively slow rates of change of indication, and second, those in which an uncompensated backlash exists. Even in the latter case, the difficulty in setting up the cyclic state applies only to a fraction of the range of indication or operation, while in the former it has been shown that if the rate of change of the independent variable be constant, cyclic performance is ultimately possible.

It has been already shown experimentally that the normal loop corresponding to cyclic operation of a typical instrument without viscous drift or elastic after-effect, over its full capacity range of operation, is a maximum of all loops obtainable for any two turning points lying between the chosen extreme turning points, and, moreover, completely encloses and circumscribes all such minor loops, a result which involves conclusions of direct value in permitting the utilization of indicating instruments of very ordinary quality for work of relatively exact character, to which they have not hitherto been considered adaptable.

Both the shape and the area of the hysteresis loop come into consideration, in defining distribution of the energy loss in the

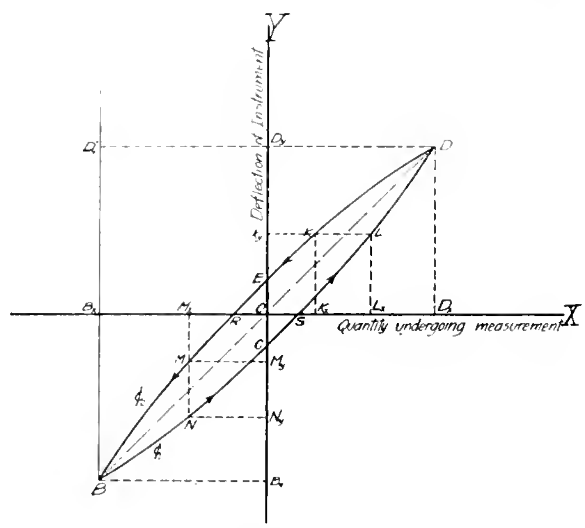


Fig. 9 General Form of Hysteresis Loop of an Instrument Reading in Both Directions From a Central Zero

$K_x L_x$ = range of values of the quantity measured for a given deflection K_y

${}_yN$ = range of deflection or indication for the value M_x of the quantity undergoing measurement

Area $BCDE$ = energy dissipated in the instrument during the cycle

Area $BEDD'_y$ $= \int_{By}^{By} [\phi_1(y) - \phi_2(y)]dy$

Area $BCDD'_y$ = efficiency of resilience or *resiliency* of the instrument over the cycle BDB.

instrument over the operating range, as well as the amount of such loss.

The diminution of frictional lag, occasioned by properly applied vibration treatment, is very striking, and it would appear that in cases where the determinate nature of the hysteresis observed under the stated conditions does not suffice to make the instrument usable for a given purpose, in-built mechanical or electrical vibrators analogous to that used in the Cuttriss modification of the Kelvin siphon recorder would be distinctly serviceable. It seems reasonable to suppose that vibration will also reduce that portion of the hysteresis which arises in imperfect elasticity or other molecular causes, including even irreversible time effects, since it has been shown to act with that

tendency in the case of transient and intransient magnetic and electric phenomena.

Experimental data are not available to permit of satisfactory analysis of the energy loss associated with the movement of a liquid meniscus in a tube and in similar circumstances, which is the problem offered by manometers, spirit levels, hydrometers, etc. It is definitely known, however, that a measurable intransient instrumental lag exists in such instruments, and the author ventures the suggestion that the effect may be the one well known in inverse form in the capillary electrometer or possibly the thermodynamic transfer involved in all changes in the configuration of a free liquid surface, as treated in the work of Kelvin. It is undoubtedly true that the irreversibility of a liquid-column instrument must often be taken into practical consideration, and the common assumption that such effects are absent or negligible is by no means a safe one. The case of a dirty liquid surface, such as is sometimes seen in a barometer, is of course simple, and the action easily accounted for on the basis of a granular type of friction. The evidence, however, appears to indicate that this is by no means the sole or even the most potent cause of the difficulties with respect to variability met with in liquid-column instruments.

Quantitative comparison of instrument performance by the use of their resiliences requires equivalence of the range of reading or operation for the instruments compared or determination of the function connecting energy loss with the range of observation. This latter is now known for but a limited class of instrument elements. (Elastic Hysteresis in Steel, F. E. Rowett, Roy. Soc. Proc., vol. 89A, p. 528, 1913.)

Distinction is drawn between the utilization in the performance rating of instruments, of the ordinary methods based upon calibration errors and of the proposed method based upon efficiency in energy restoration; and it is held that the latter affords a generally applicable means for distinguishing between the performances of diverse types, while the former method judges rather between individuals. An instrument having high resilience is capable of being given precise adjustment and of utilizing it to advantage in affording a minimum average departure of readings from the mean. When it is recalled that the mean error at any point of the instrumental scale can be readily reduced as nearly to zero as we may desire, by proper adjustment of the instrument or by remarking the graduations, it will be seen that the calibration error affords but limited information as to the possibilities of the instrument. On the other hand, the variance errors as completely exhibited in the hysteresis loop are in large measure inherent and cannot be eliminated by any such adjustment, so representing within certain limitations rather the performance of the class to which a given operating principle or mechanism pertains. It is shown that the true criterion for the utility of a given operating element, when ultimate accuracy is the dominant consideration, is the measure of the contribution of that element to the hysteresis loss of the instrument whether that contribution be the effect of frictional resistances or of imperfect elacticity. (Bureau of Standards, Advance publication, *tA*)

METAL-WORKING TOOLS

British Inserted-Tooth and Thread Milling Cutters

British Milling Cutters. Abstract of two articles in recent issues of *The Engineer* (London), the first describing the so-called Francis inserted-tooth milling cutter, as to which very little information was available until quite recently.

This cutter was developed at one of the British National Shell Factories in order to permit the production of howitzers on tools previously used for shell manufacture, the problem being to perform by means of a lathe operations which would have been performed in the usual course of things by means of a planing machine. In this instance it was desired to remove surplus metal in an operation on a howitzer tube by means of two lathes converted into a horizontal milling machine. To do this it was necessary to take the cut not along the length of the barrel but around it, and for this the cutter would have to be something over 2 ft. in length. The Francis cutter was developed to take care of such operations as this. There are two particular points of novelty about it, viz., the manner in which the teeth are arranged on the body and the manner in which they are attached to it. The first point is illustrated diagrammatically in Fig. 10. In the ordinary type of inserted-tooth milling cutter the body is grooved with a number of spirals in the direction indicated at *C*; that is, approximately parallel with the axis of the cutter. Each slot is filled either with a single blade or with a number of individual cutters *B* separated by distance pieces *E*. In the latter case the teeth in one slot are arranged to slightly overlap longitudinally the teeth in the succeeding slot, so that taken as a whole the teeth

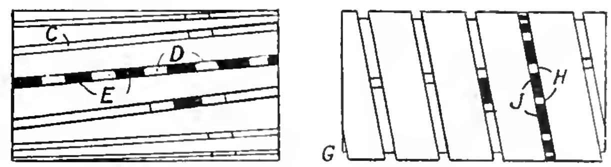


Fig. 10 Methods of Inserting Teeth in Milling Cutters of the Ordinary (left) and Francis (right) Types

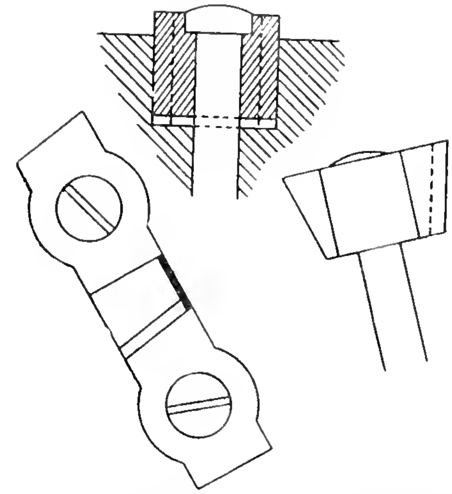


Fig. 11 The Most Recent Type of Francis Cutter

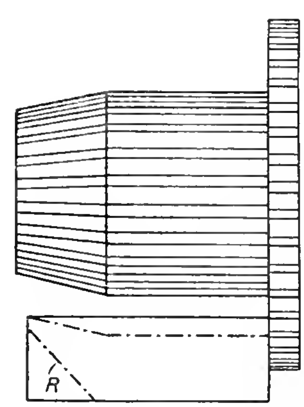


Fig. 12 Method of Forming the Teeth in the Francis Milling Cutter

follow one another round the body in a spiral, approximately at right angles to the axis of the cutters. This is shown in the left-hand view. In the Francis cutter (right-hand view) the grooving forms one continuous spiral around the body of the cutter substantially parallel with that on which the teeth lie in the ordinary cutter. The groove is filled with teeth *H* and distance pieces *J*, the teeth being disposed so as to form rows substantially parallel with the grooves in the ordinary cutter. Therefore the teeth in both cutters occupy the same relative position, with the difference, however, that in the ordinary cutter they are forced by the

pressure of the cut against the edges of the grooves, that is, against the metal of the body, while in the Francis cutter the teeth are pressed against the distance pieces. This difference is of considerable practical importance. In the ordinary cutter the tendency is for the pressure of the cut ultimately to widen the cross-section of the grooves so that the teeth become loose, and the cutter body is rendered useless until the grooves have been reshaped. In the Francis cutter the distance pieces are case-hardened. The pressure of the cut does not tend to deform the cross-section of the groove, and should slackness develop as a result of the cutting pressure it can readily be taken up by simply tightening the wedges or distance pieces. In actual practice, though,

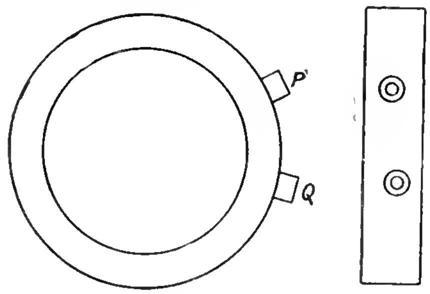


Fig. 13 Special Jig Used for Drilling Holes in Francis Cutter

it is found that the pressure of the cut renders the teeth not slacker but tighter, so much so that when it is desired to recharge the cutter it is invariably found that the teeth and wedges have settled down so firmly that after the securing screws have been loosened the wedges have to be jarred from their seats before the teeth can be removed.

The most recent form of the cutter is shown in Fig. 11, this form being convenient both from the point of view of operation and from that of toolroom production. The wedges which formerly had rectangular ears are now formed with circular swellings on their faces and are plane surfaced both on the top and bottom. It is found possible to produce them in this form with sufficient accuracy by drop-forging the parts requiring only to be drilled and touched up by grinding before being case-hardened. Furthermore, the substitution of the round swellings for the square ears permits the undercutting of the groove to be dispensed with and the concave recesses can very readily be formed by drilling after the groove has been cut. A special jig shown in Fig. 13 has been developed for this when the holes are being bored. It is in the form of a ring which is clamped round the cutter body by means of set screws and carries two drill guides P and Q, the pitch of which is accurately fixed as the value required to give the desired alignment of the teeth. With the jig fixed in position the first hole is drilled through the guide P, the jig is then rotated until an accurately fitting plug can be passed down the guide Q into the hole already drilled. The second hole is then drilled through the guide P, the plug is removed and the whole operation repeated until the whole surface of the cutter body has been covered.

The method of forming the teeth is illustrated in Fig. 12. The block of high-speed steel, cut roughly to length, is placed in a small vise which holds it at the required angle, and a milling cutter of special form is fed across it to face the base and form the front flank. It will be noticed that the milling cutter is coned so that the tooth is formed with a rake at the cutting end. The angle of this rake is sufficient to bring the front flank of the tooth five or six degrees beyond being radial when the tooth is assembled on the body. Thus the teeth are given a positive front rake. It is usual in ordinary milling cutters, at least such as are used for finishing cuts, to make the front flanks of the teeth radial. A positive front rake is, however, advocated by some as a means of increasing the life of a roughing cutter, and this has been followed in this case. The corner R, Fig. 12, has still to be removed. At present this operation is performed by an additional milling process, but as the surfaces at R, when the teeth are completely assembled on the body, lie in a series of spirals—see Fig. 10—it is proposed to assemble the cutters R by grinding. The relief and sharpening—and subsequent resharpening after use—of the actual cutting edges of the teeth are effected by means of the arrangement illustrated in Fig. 14. In this arrangement the cutter is fed longitudinally over toward the left past a grinding wheel. The pressure of the wheel on the edges of the teeth holds each tooth, as it passes the wheel, down on to a pointed guiding plate up which the under surface of the tooth travels by reason of the longitudinal feed. In this way the cutter is automatically rotated by just the right amount as it moves along. The axis of the cutter is of course set a little below the axis of the wheel, so as to give the requisite relief to the cutting edge.

The article describes in considerable detail many of the applications of the Francis cutter; for example, its use for the machining of 6-in. howitzer breech rings and the machining of staybolts for naval 10-in. bomb throwers on an adapted lathe. (*The Engineer*, vol. 127, no. 3288, Jan. 3, 1919, pp. 6-8, 18 figs., *d*).

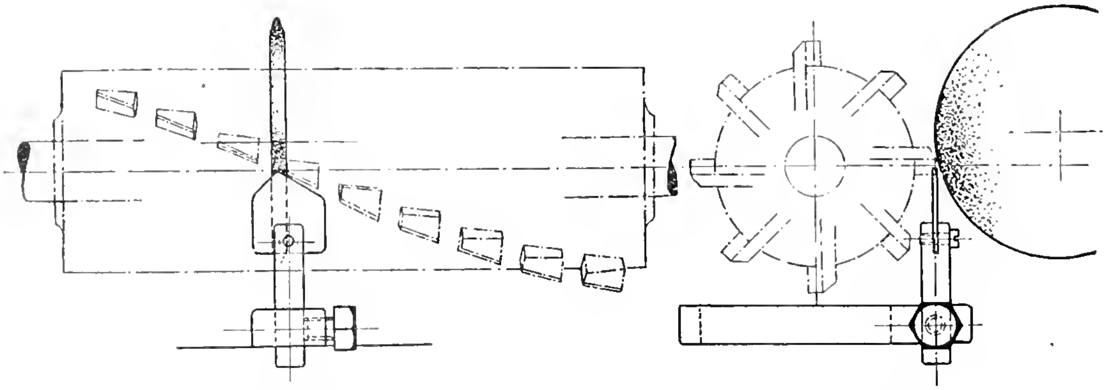


Fig. 14 Relieving and Sharpening Teeth of Francis Milling Cutter

Another British type, in this instance for thread milling, is represented by the "Cycloid" cutter, Fig. 15. It has been found in external thread milling that the ordinary thread-milling hob has a tendency to produce "waves" and "flats" on the work. By "flats" is meant any portion around the circumference of the work at which the diameter of the work is less than elsewhere and the tendency to produce them may be ascribed to the fact that the thread-milling hob has a concave cutting action in relation to the work; in other words, that the cutter tends to get into and below the arc line of the circle it is operating upon.

The Cycloid cutter is claimed to be capable of overcoming this. The cutter head is designed as a hollow cylinder and is attachable to an ordinary chuck plate. The cutter end of the head is milled at intervals to receive a series of independent thread-milling cutters, which are clamped in position in the cutter head by means of slotted studs, fitted with nuts. The independent cutters are backed off, or relieved, and are adjusted internally by means of diametric gages, which enable each cutter to be set truly to any

given diameter within the scope of a given size of head. The cutter, when assembled, has the general appearance of an inserted-tooth die head, but there are the following differences: The inserted teeth are backed off; they are of less width; the thread cutting angles have no thread pitch; the cutter circle exceeds the diameter of the work.

The cutter rotates on the live spindle of the machine. The work, on a work-holding spindle fitted with a leading screw, is brought within the plane of the cutters to the desired extent, and is then moved transversely on the slide toward the cutters until the desired depth of cut is obtained. The work is then rotated until the thread-milling operation is completed.

It will be seen that the cutting teeth of this cutter move in a circle around the work, and therefore describe an arc of a circle which is more or less parallel with the arc of the circle it is desired to produce on the work. Each cutter makes a convex sweeping cut on the work, and at least three cutting teeth, it is stated, are usually actually cutting on and around the work at the same time. A more perfect circle can thus, the designers claim, be produced by their cutter than by one made on the old method. It is further claimed that in the event of an inserted cutter being broken it can be taken out and another substituted at little cost. The independent cutters do not distort in hardening, and can be relied upon to run true, so that "waves" are avoided. They can be quickly removed from the cutter head, and ground on any ordinary type of grinding wheel which is in good condition, and can be replaced by any mechanic of average ability. The cutter head will take a fair range of work of varying diameters, and can be made on the hollow-spindle principle to run in bearings for screwing shafts, etc. (*The Engineer*, vol. 127, no. 3294, Feb. 14, 1919, p. 159, 1 fig.)

POWER-PLANT ENGINEERING

High-Pressure and High-Temperature Steam in Large Power Stations

The Use of High-Pressure and High-Temperature Steam in Large Power Stations. The writer discusses the subject from the point of view of expediency, mainly on the basis of British practice. He says that a good case can be made out for a jump to 600 lb. pressure with the total temperature of 700 to 800 deg. fahr., which will, however, involve a considerable amount of development and experimental work being borne by the enterprise first to adopt such a pressure. On the other hand, it appears that practically all designs of existing apparatus can be so modified as to admit of pressure from 350 to 400 lb. per sq. in. He believes therefore that the pressure of 350 lb. can safely be adopted.

When considering any results of tests on high-pressure or high-temperature steam-generating plant, it is essential that the tests on the boiler side and the tests on the turbine side be studied separately; furthermore, it must be remembered that any results obtained on an extra-high-pressure boiler can be obtained and considering the boiler apart from the economizer, surpassed on a similar and similarly equipped low-pressure boiler. The use of the temperature-entropy diagram is recommended to determine the gain due to increasing the working pressure and temperature ranges of steam.

The writer makes up several schedules showing the comparisons of coal, steam and heat consumptions in various plants operating under various conditions.

Table 1 is a schedule of particular interest in this connection. It was made for a 20,000-kw. machine running at 200 lb. and 350 lb. pressure by gage at various superheats; also at 500 lb. pressure absolute and 268 deg. superheat, at which pressure and superheat the total temperature will be 736.5 deg. fahr., which is about the maximum temperature at present recommended for materials now used in turbine construction. For the purpose of these calculations a turbine ratio efficiency of 80 per cent is assumed at both 200 and 350 lb. pressure, with the steam superheated 150 deg. and a constant vacuum of 28.5 in.

This schedule shows that the cost for coal when generating 175.2 million kw-hr. with a load factor of 100 per cent will be £64,400 at the higher pressure and superheat 250 fahr., and £69,200 at the lower pressure with corresponding superheat. Unfortunately the load factor of 100 per cent is impossible and the conditions under which power stations are operated must be considered before even an approximate estimate of working costs can be arrived at.

In this instance the writer proposes to assume the same standing loss of coal due to no-load consumption for the station design for 200 lb. as in an actual British power station of approximately the same dimensions, which is 1583 lb. per hr. For a 20,000-kw. set the no-load consumption will be approximately 22,000 lb.

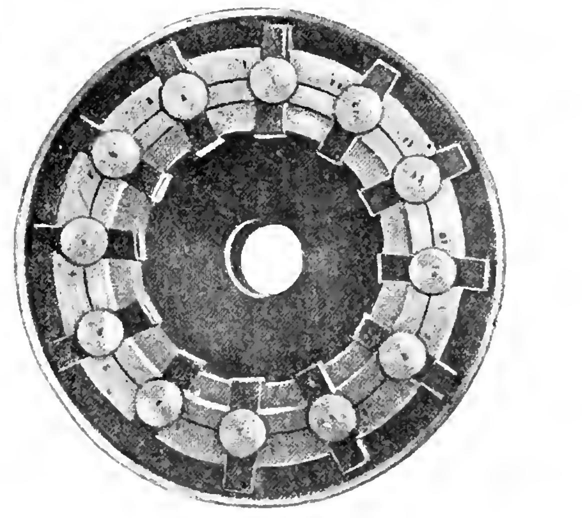


Fig. 15 Cycloid Thread-Milling Cutter

of steam, or 3666 lb. of coal per hr., and these figures plotted in conjunction with the steam consumption shown in Table 1 give the total steam consumption at any load as 22,000 lb. plus 9.54 lb. of steam per kw-hr. for the plant operating at 200 lb. pressure; 22,000 plus 8.6 lb. of steam per kw-hr. and 3729 lb. plus 1.45 lb. of coal per kw-hr. for the plant operating at 350 lb. pressure and 250 deg. superheat.

With regard to the practical difficulties, it is only to be expected that, before pressures of 500 or 600 lb. per sq. in. are adopted, a radical departure will have to be made in present boiler construction. All square boxes and headers will be eliminated, the drums and tubes will be smaller in diameter, and the design of the boiler made more elastic. The type of boiler will no doubt assume the appearance of a flash boiler, with practically no steam or water reserve, and fired by gas on the surface-combustion principle.

For the more moderate pressures, up to 350 lb. per sq. in., the existing type of boiler can be modified and successfully used. At the Carville power station Babcock & Wilcox marine-type boilers are being used at 275 lb. per sq. in. gage pressure, and at the British Thomson-Houston Company's works at Rugby a Babcock & Wilcox boiler is installed and successfully working at 350 lb. per sq. in. Further, Messrs. Babcock & Wilcox state that they have at present two boilers on order for a working pressure of 475 lb. per sq. in. with steam superheated to a final temperature of 700 deg. fahr., and that they are quite prepared

to supply boilers in their ordinary business for such pressure and superheat.

With higher steam pressure the temperature of saturation is raised and, due to this, greater care must be exercised in the quality of the water used for the boiler feed. A feedwater that is perfectly satisfactory at 380 deg. fahr. in a modern tubular boiler might be quite unsuitable for use in a flash boiler. The quantity of air, CO_2, and oxygen will have to be kept down to a minimum, and also the non-soluble salts which are generally in the water discharged from an ordinary lime-soda water softener. A natural development, and one which is already taking place, is to heat the feedwater under atmospheric pressure by means of live or exhaust steam in order to drive off the entrapped and dissolved gases as much as possible. According to a table extracted from Lunge's Technical Chemist's Handbook, it is necessary to raise the temperature of the water to 100 deg. cent. before the quantity of air in the water is appreciably reduced.

The source of water for use in high-pressure plants will have to be carefully traced, and the treatment of the water should be such that a minimum of unsoluble salts remains in it after treatment. The purer the water the greater affinity it has for air, CO_2, and oxygen, and every care should be taken that it is not exposed to the air between the condenser and the boiler. In order to avoid such exposure to the air it is suggested that the feed pump should be an extension of the condensate pump and the condensed water pumped direct into the feed line.

The natural development of the turbine for higher pressures appears to be in a line with the Parsons two-cylinder machine, with a flexible claw-type coupling between the cylinders and a thrust bearing for each cylinder. For very large sets, above 50,000 kw., the cross-compound turbo-generator will no doubt be used, with each side connected to a separate generator. Each set can then be run at its most suitable speed, with resulting high efficiency. This arrangement will no doubt lead to reheating the steam after it leaves the high-pressure turbine and before entering the low-pressure machine. Dr. Ferranti has already done valuable work on this subject, the results of which have unfortunately not been published.

The design of the condensing plant is not likely to be modified because of the use of high-pressure or high-temperature steam, but the fact must not be lost sight of that with steam initially at the same temperature but at different pressures the plant using the high-pressure steam will reject less heat units to the condenser per pound of steam used in the turbine.

The steam pipes to be used in a station where both high pressures and high temperatures are employed will have to be very carefully designed. (*The Journal of The Institution of Electrical Engineers*, vol. 57, no. 278, Jan. 1919, pp. 73-82, *pt.1*).

TABLE 1 TESTS OF A 20,000-KW. TURBINE AT HIGH STEAM PRESSURES AND SUPERHEATS

Absolute Pressure at Turbine Exhaust, 1.5 in. Mercury (91.7 deg. fahr.). Condensate Temperature, 85 deg. fahr.

Steam Pressure at Turbine	215 lb. per sq. in. (abs.)					365 lb. per sq. in. (abs.)						500 lb. per sq.in.(abs)
Superheat of Steam at Turbine, Deg. Fahr.	100	150	200	250	300	50	100	150	200	250	300	268
Total temperature of steam at turbine, deg. fahr	487.9	537.9	587.9	637.9	687.9	486.4	536.4	586.4	636.4	686.4	736.4	736.4
Total heat in steam from 32 deg. fahr., therms per lb	1,265.0	1,293	1,319	1,345.5	1,371	1,249	1,278.5	1,307	1,335	1,363	1,389	1,382.7
Heat drop per lb. of steam, therms	379.1	391	403.4	416.1	429.2	402.4	415.4	428.7	442.2	456	470.2	485
Ratio efficiency of turbo-alternator	76.5 %	77.6 %	78.4 %	78.9 %	79.2 %	75.1 %	76.5 %	77.6 %	78.4 %	78.9 %	79.2 %	79.0 %
Internal efficiency of turbine	80.86%	82 %	82.8 %	83.3 %	83.64%	79.4 %	80.86%	82.0 %	82.8 %	83.34%	83.6 %	83.4 %
Steam consumption of turbine, lb. per kw-hr.	11.77	11.255	10.79	10.402	10.04	11.30	10.746	10.265	9.85	9.491	9.17	8.913
Total steam consumption of turbine, lb. per hr.	235,500	225,100	215,960	208,000	200,800	226,000	214,930	205,300	197,000	189,800	183,400	178,300
Heat rejected to condenser from 32 deg. fahr., therms per lb	950	973	984	998	1,010	929	940	955	969	983	996	975.7
Ratio of circulating water to steam condensed	44	45	46	46.5	47.0	43	44	45	45.5	46	46	45
Circulating water, quantity, gal. per hr.	1,035,000	1,012,500	993,600	967,200	940,000	971,800	946,000	925,200	897,200	874,000	840,000	800,000
Power for circulating pumps, b. hp.	163	160	157	153	149	154	149	146	143	138	133	124
Power for air and condensate extraction pumps b.hp.	89	86	83	80	77	86	82	80	77	74	72	70
Power for boiler feed pumps, b.hp.	104	100	96	92	89	166	157	151	145	140	135	177
Power for induced-draft fans, b.hp.	222	220	220	216	212	218	212	207	203	200	195	186
Power for small auxiliary motors, b.hp.	57	56	55	54	51	61	58	57	55	54	54	56
Total power for auxiliaries, b.hp.	635	622	611	595	578	685	658	641	623	606	589	613
Total power for auxiliaries, kw	530	515	510	495	485	565	540	530	515	500	485	510
Net output to busbars, kw.	19,470	19,485	19,490	19,505	19,515	19,435	19,460	19,470	19,485	19,500	19,515	19,490
Heat in steam from temperature of hotwell, therms per lb	1,212	1,240	1,266	1,293	1,318	1,196	1,226	1,254	1,282	1,310	1,336	1,329.7
Steam consumption per effective kw-hr. lb.	12.096	11.552	11.08	10.666	10.296	11.628	11.044	10.545	10.110	9.735	9.398	9.146
Pounds of steam evaporated and superheated per lb. of coal, lb.	6.394	6.25	6.121	5.99	5.88	6.48	6.32	6.18	6.045	5.91	5.8	5.83
Coal consumption per effective kw-hr., lb.	1.891	1.848	1.810	1.78	1.751	1.794	1.747	1.706	1.672	1.645	1.62	1.569
£Cost of coal at 10s. per ton, generating 175.2 x 10⁶ kw.-hr.	74,100	72,400	70,800	69,200	68,500	70,250	68,400	66,750	65,500	64,400	63,400	61,400

Improved Method of Firing Oil Under Steam Boilers (*Zeitschrift für Dampfkessel und Maschinenbetrieb*, December 13, 1918). Oil blown into a furnace through a nozzle usually spreads conically, and there is difficulty in intimately mixing the spray with air so as to obtain perfect combustion.

Excess of air is usually admitted, even to the extent of 320 cu. ft. per lb. of oil, instead of the 170 cu. ft. theoretically required.

Good results have been obtained by permitting air to enter through a nozzle discharging to the interior of the conically shaped oil spray. The air should be heated by passing it through tubes embedded in the brickwork of the furnace, and meet the oil close to the orifice of the nozzle. The outer portion of the oil spray is supplied with air through the fire door in the ordinary way. It is possible in this manner to obtain intimate mixture before combustion takes place, and a high temperature of the internal air supply still further increases the efficiency.

It is advisable to have separate fans for the internal and external air supply, although they may be driven from the same motor in order that the air discharge may remain proportionate. The pressure of the latter must, however, be sufficient to overcome

resistance in the preheating pipes. (*Technical Supplement to the Review of the Foreign Press*, vol. 3, no. 4, Feb. 18, 1919, p. 113, no. 4216, *p*)

REFRIGERATION

Vapor Refrigeration Processes and Their Entropy Diagrams

Vapor Refrigeration Processes, Prof. P. Ostertag. A good way to secure a simple and clear comprehension of the cycle in the vapor-compression refrigerating machine is by using the entropy diagram. Heat energy dQ at temperature T may be considered as being a product TdS and may be represented as a strip on a plane surface with temperatures T as ordinates and entropy increments dS as abscissæ.

As long as the carrier of cold is in a liquid state the points representing the state of the matter are all located on the lower limit curve (specific volume of vapor $x = 0$) and the saturated state of the vapor is designated by the upper limit curve ($x = 1$). The curves to the left of the lower limit curve indicate the region of the elastic fluid and those to the right of the upper limit curve the region of the superheated steam, while the points between the two curves indicate the wet vapor. The Carnot cycle may be considered as an ideal process. The fluid carrier of cold (point A in Fig. 16) is superheated to the high pressure p_1 and to the correspondingly high temperature t_1. The high temperature t_2 necessary to produce cold is secured by adiabatic expansion (AB) in cylinder EZ, Fig. 17, whereupon a part of the liquid is gasified. The rest of the liquid in the evaporator V takes up an amount of heat Q_2 from the surrounding medium and thereby produces a cooling effect represented in Fig. 16 by the rectangle BCO_2O_1. Now the cooling material must be compressed to its initial pressure p_1, which is carried out adiabatically in cylinder KZ (CD, Fig. 16). If the end point D in Fig. 16 is still in the region of saturation (wet process), then as the last variation of state

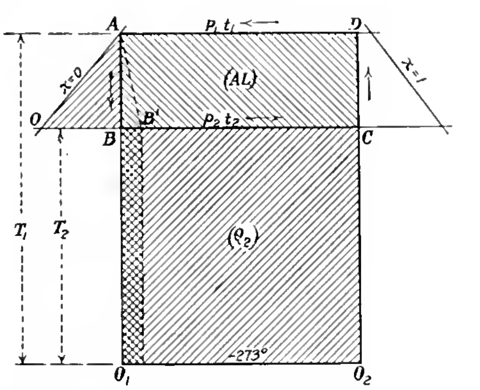


Fig. 16 Entropy Diagram, Carnot Cycle and Wet Process

DA, the heat Q_1 (rectangle DAO_1O_2) has to be abstracted, which is done in the condenser K.

The closed process gives a cold output K_2 and requires an expenditure of work K, of which the heat value AL ($A = 1/428$) is shown as the rectangle $ABCD$. From Fig. 16 it follows that

$$\frac{Q_1}{T_1} = \frac{Q_2}{T_2},\quad Q_1 = Q_2 + AL$$

The cold output per hp. is

$$q_s = \frac{Q_2 \times 3600 \times 75}{L} = 632\frac{T_2}{T_1 - T_2}$$

Hence the output of a plant is the greater the less the temperature difference between the cooling water and the brine.

The first deviation from the described process consists in replacing the expansion cylinder by a simple throttling valve (R in Fig. 17). In the diagram the line AB is replaced by the throttling curve AB'; the output of cold decreases by the rectangle comprised under BB' and the consumption of work increases by OAB.

The second change consists in the introduction of the *dry process*. There the compressor sucks in only vapor which is provided by the introduction of a liquid separator A_1 (Fig. 18) in front of the compressor. This carries the heat absorption in the evaporator up to the upper curve (point C in Fig. 19).

The compression at once brings the vapor sucked in into the state of superheat represented by the adiabatic line CD. Among the advantages of this process it was found that the cylinder contains no liquid which would condense on the walls and hinder the flow of heat from the walls to the vapor; furthermore, the

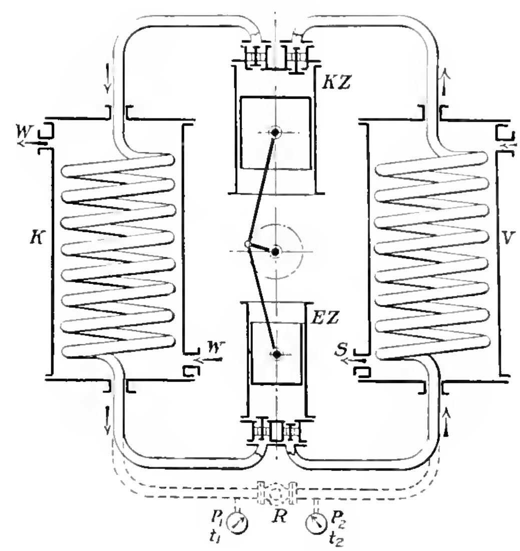


Fig. 17 Elementary Vapor Refrigeration Type Machine

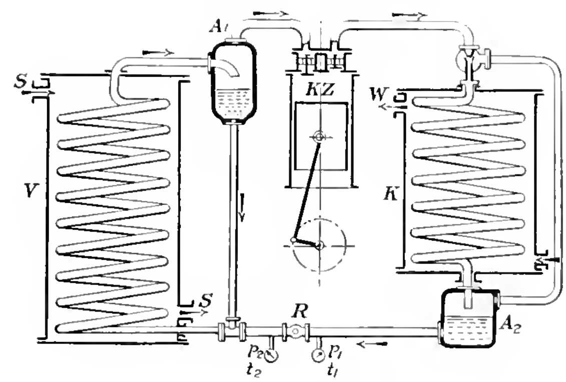


Fig. 18 Diagrammatic Representation of Dry-Process Vapor Refrigeration Type Machine

same condensed liquid decreases the efficiency of operation through evaporation from the clearance during expansion, which makes all presence of moisture in the compressor undesirable.

On the other hand, flooding is necessary to enable the flow of heat to occur freely. This is achieved by placing the liquid separator A_1 high and by leading back to the evaporator (Fig. 18) the liquid which has separated.

The compressor KZ forces the hot gas from above into the condenser K. If desired it is possible to produce a nozzle action at the entrance into the coil in order to suck away any gases that may remain in the collector A_2 and drive them once more into the condenser.

If the condenser has been so designed as to have a surface of liberal dimensions and the cooling water W is circulated in countercurrent at a lively rate, it is possible to cool the condensate below the temperature of saturation (from t_1 to t_u). In the diagram Fig. 19 the throttling curve AB shifts to A_uB_u and the gain in undercooling is represented by the rectangle of width BB_u. This action becomes particularly noticeable when carbon dioxide is used as the carrier of cold, since this material has a

very large heat of liquid. Frequently in plants of this type a special liquid cooler is placed behind the condenser as was done for example in the installation exhibited by Escher Wyss & Co. at the National Exposition in Berne in 1914.

For example, let it be assumed that in the evaporator there is a

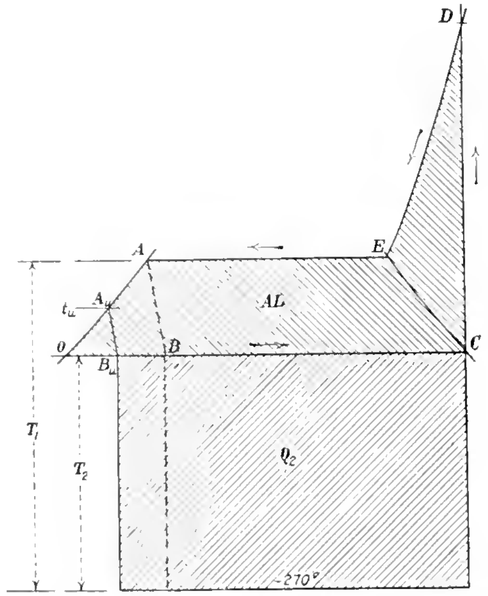


FIG. 19 ENTROPY DIAGRAM, TO ACCOMPANY FIG. 18

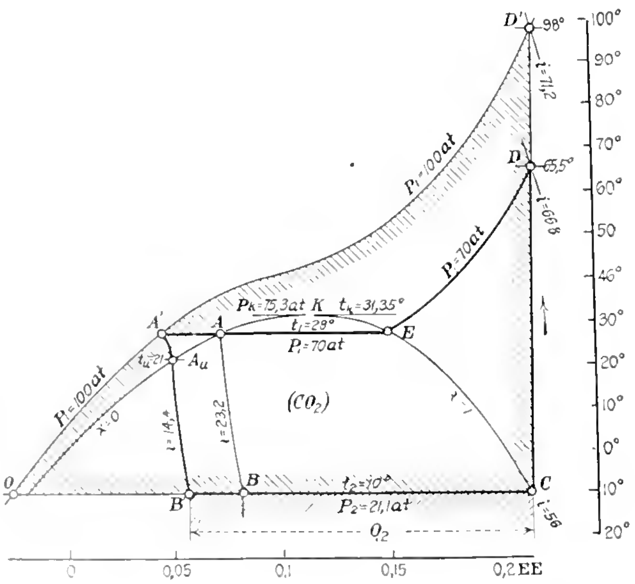


FIG. 20 ENTROPY DIAGRAM FOR CARBON DIOXIDE REFRIGERATING MACHINE

temperature of −10 deg. cent. and in the condenser one of 28 deg. cent. The compressor then has to compress the vapor from 27.1 atmos. abs. to 70 atmos. abs. (CD in Fig. 20). The work necessary for this purpose may be represented as the difference of heat content between D and C, or $AL = 66.8 - 56 = 10.8$ cal.

The condenser has to get rid of a considerable amount of heat in order to attain the state of saturation (area under EE) and still more heat (rectangle under EA) in order to liquefy the vapor. If no undercooling can take place, the material carries its heat of liquid $i = 23.2$ calories through the throttling valve into the evaporator (AB) where the heat output is $Q_2 = 56 - 23.2 = 32.8$ cal.

This gives per hp. $q_2 = 632 \times \dfrac{32.8}{10.8} = 1920$ cal.

The Carnot cycle would have given $q_0 = 632 \times \dfrac{263}{38} = 4370$ cal.

Hence, the efficiency as referred to the Carnot cycle is 44 per cent.

The results will be more favorable if we assume that the cooling water is capable of undercooling the liquid carbon dioxide to 21 deg. (AA_u). Then only 14.4 calories will be carried over into the evaporator and

$$Q_2 = 56 - 14.4 = 41.6 \text{ cal.}; \; q_2 = 632 \times \frac{41.6}{10.8} = 2440 \text{ cal.}$$

The efficiency will now be 56 per cent or 12 per cent higher than before.

In order that the same output of cold may be possible without there being an opportunity for undercooling the gas must be compressed to 100 atmos. (CD') and the consumption of work must be $AL = 15.2$ cal. The cooling occurs then above the

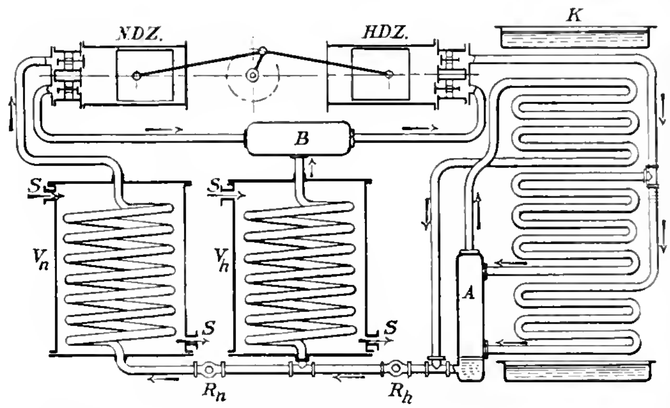


FIG. 21 REFRIGERATION MACHINE WITH INTERMEDIATE EVAPORATOR AND TWO-STAGE COMPRESSION

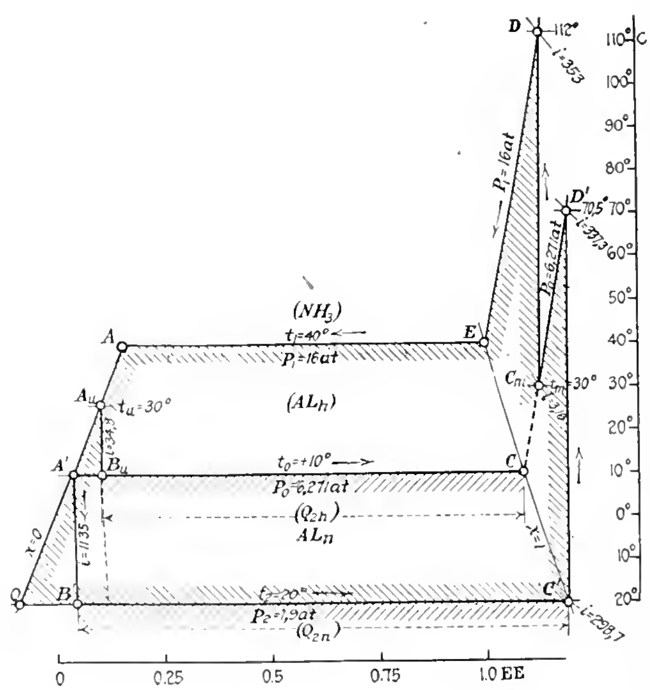


FIG. 22 ENTROPY DIAGRAM, TO ACCOMPANY FIG. 21

critical point K ($D'A'$) and the transition into the elastic or liquid state occurs without a sharply defined vapor formation.

Another process has been proposed by R. Plank. The gas is compressed only to 70 atmos. After the cooling the liquid undergoes an increase of pressure from 70 to 100 atmos. in another pump (AA') so that the same cooling effect is secured. The work of the pump in Fig. 20 is shown as a rectangle under AA', but on the other hand, the work of the compressor is somewhat less as indicated by DD'.

In Fig. 21 is shown a scheme of an *intermediate evaporator with a two-stage compression.* Such a system is useful when cold has to be produced in two places at different temperatures. The colder vapor flows from the evaporator V_n to the low-pressure cylinder (*NDZ,* Fig. 21) and from there to the high-pressure cylinder *HDZ.* On the way it mixes in container *B* with the warmer vapor which has already produced a cooling action within smaller temperature limits in the evaporator V_h. Both kinds of vapor are forced from the high-pressure cylinder *HDZ* into the condenser *K* and thence flow through the regulating valves R_h and R_n into the evaporator. The scheme as shown comprises a spray condenser of the Riedinger type in which the coil is divided into three zones.

The two lower zones produce the cooling and the condensation and the remaining vapor rises from the separator *A* to the uppermost coil where the fresh cold water produces a most powerful cooling effect. The diagram of this process (Fig. 22) applies to the case of ammonia under the assumption that the cooling water is capable of producing undercooling from 40 to 30 deg. (AA_u). Upon throttling (A_uB_u) to the pressure p_0 in the evaporator V_h, a part of the liquid produces an output of cold (B_uC') equal to $Q_{2h} = 271.8$ cal. The other part of the liquid goes through the second valve (*A'B'*, Fig. 22), and produces in the evaporator V_n a cooling effect (*B'C'*) equal to $Q_{2n} = 287.35$ cal.

During the compression in the low-pressure cylinder *NDZ,* the steam is superheated to 70.5 deg. (*C'D'*) and enters the container *B,* together with the steam from V_h having a temperature of + 10 deg. This produces a combined temperature which

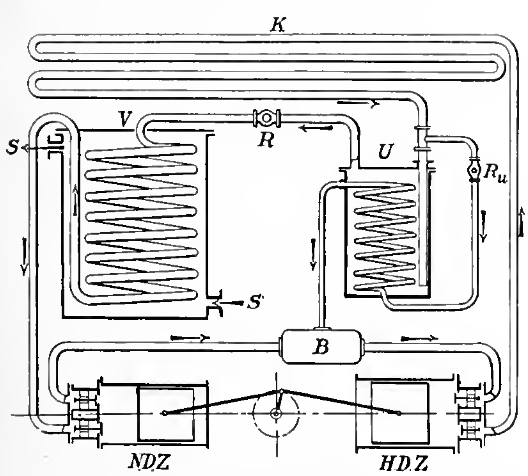


Fig. 23 Refrigeration Machine of Large Size; Two-Stage Compression with Undercooler

may be at first estimated as $t_m = 30$ deg., which is the temperature making it possible to close the diagram with the line C_mD. The two work areas of the diagram comprise then

$$AL_h = 353 - 316 = 37 \text{ cal.}$$

and

$$AL_n = 337.3 - 298.7 = 38.6 \text{ cal.}$$

If we assume a desired output of cold of 500,000 cal. so distributed that 200,000 come from V_n and 300,000 from V_h, then the respective weights of the circulating material are

$$G_h = \frac{300{,}000}{271.8} = 1104 \text{ kg}; \quad G_n = \frac{200{,}000}{287.35} = 696 \text{ kg.}$$

making altogether 1800 kg. From this it appears that the consumption of energy apart from incidental losses is

$$N_h = \frac{1800 \times 37}{632} = 105.5 \text{ hp.}; \quad N_n = \frac{696 \times 38.6}{632} = 42.5 \text{ hp.}$$

or altogether, 148 hp. Hence, the plant delivers an output of cold per hp. of $q_2 = 3380$ cal.

In the ideal process the two rectangles AL_h and AL_n have to be differentiated, and from them may be developed the equation

$$q_0 = 632 \frac{G_h Q_{2h} + G_n Q_{2n}}{(G_n + G_h)\, AL_n + G_n AL_n} = 632 \frac{G_h T_0 + G_n T_2}{(G_n + G_h)\,(T_1 - T_0) + G_n\,(T_0 - T_2)}$$

In our example it appears that $q_0 = 4120$ cal. per hp., which in the present process gives an efficiency, apart from incidental losses, of 82 per cent.

In the container there will be a combined temperature of

$$t_m = \frac{(696 \times 70.5) + (1104 \times 10)}{1800} = 33.4 \text{ deg. cent.}$$

Therefore there must occur in the container a cooling amounting to 3.4 deg. in order to arrive at the assumed initial combined temperature. As regards the dimensions of the cylinder, the specific volumes *d* at the points *C'* and C_n give the necessary information. It is found that

For the low-pressure cylinder: $v = 0.637$ m³ kg.; Total volume = $0.637 \times 696 = 444$ m³/h.

For the high-pressure cylinder: $v = 0.24$ m³ kg.; Total volume = $0.24 \times 1800 = 432$ m³/h.

Both cylinders are therefore of approximately the same size.

In large plants two-stage compression may be used either to produce lower temperatures or to increase the effect when only warm cooling water is available. The undercooler *U* is built in the manner of an auxiliary evaporator to which a small part of the cooling liquid goes through the throttling valve R_u (Fig. 23), while the main part creates a pressure in the closed boiler *U.* The undercooling is therefore produced by the liquid acting as a carrier of cold. Its effect is independent of the cooling water and is so regulated by the valve R_u that only vapor is permitted to reach the high-pressure cylinder *HDZ.*

The article describes also installations where several places (as, e.g., cellars) at a distance from each other are supplied with cold from the same central plant (Entwicklungsformen des Dampf-Kaelteprozesses, Prof. P. Ostertag, *Schweizerische Bauzeitung,* vol. 73, no. 4, January 25, 1919, pp. 33-35, 9 figs. *t*)

STEAM ENGINEERING

Water Circulation in Boilers, A. D. Williams. Discussion of conditions affecting the operation of boilers from the point of view of water circulation, in particular as applied to water-tube boilers. The discussion is of a rather general nature, the most interesting part of it being that dealing with the influence of steam bubbles on the circulation of water. The writer believes that a modification of the design of the Niclausse boiler having the filled tubes set vertically with the manifold at the top may offer almost unlimited forcing possibilities, greatly exceeding the evaporative capacity of existing boilers. On the other hand, such a design with an internal tube in each water tube would be extremely difficult to clean. In any design to secure increased circulation it is important that the course of the water and of the steam bubbles should be arranged in such a manner that they will not impede each other. Theoretically, there should be no limit to the amount of forcing which a vertical-tube boiler can stand except the heat-absorption capacity of its heating surface. With inclined tubes the boiler can be forced only to the extent of turning a sufficient amount of water into steam to occupy the full area of the hottest tubes at their highest point. Any further forcing with this type of boiler will cause it to destroy itself. (*Power,* vol. 48, no. 8, Feb. 25, 1919, pp. 285-286, *pt*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

MECHANICAL ENGINEERING
THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Published Monthly by the Society at
29 West Thirty-ninth Street, New York

M. E. COOLEY, *President*
WILLIAM H. WILEY, *Treasurer* CALVIN W. RICE, *Secretary*

PUBLICATION COMMITTEE:
GEORGE A. ORROK, *Chairman* J. W. ROE
H. H. ESSELSTYN GEORGE J. FORAN
RALPH E. FLANDERS

PUBLICATION STAFF:
LESTER G. FRENCH, *Editor and Manager*
LEON CAMMEN, C. M. SAMES, } *Associate Editors*
W. E. BULLOCK, *Assistant Secretary Editor Society Affairs*
FREDERICK LASK, *Advertising Manager*
WALTER B. SNOW, *Circulation Manager*
113 Federal St., Boston

Yearly subscription $3.00, single copies 35 cents. Postage to Canada, 50 cents additional; to foreign countries $1.00 additional.
Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

Spring Meeting

THE program for the Spring Meeting, to be held at Detroit, Mich., June 16 to 19, is to include several subjects which are considered by the Committee on Meetings to be of widespread interest to engineers at the present time. It should be remembered that the meeting will be opened on Monday, June 16, instead of on Tuesday as has usually been the custom, in order to provide for a large number who will probably come from a distance and who could most conveniently leave so as to reach Detroit on Monday and be permitted to return to their homes before the end of the week to attend to business matters.

The Business Meeting will be held on Monday afternoon, followed by the report of the Aims and Organization Committee. This Committee is shortly to have a meeting of its members who come from all parts of the country, representing as they do the different Sections of the Society, at which all the essential features of the report to be presented at the Spring Meeting will be prepared. The work of this Committee is regarded as among the most important of the recent activities of the Society and of far-reaching consequence to the membership and profession generally. Every member who can do so should arrange to be at the meeting on Monday afternoon to hear this report and to participate in the discussion. On the days which follow there will be a session devoted to the all-important subject of Engineering Research conducted by the Research Committee of the Society. Another session will take up industrial relations with reference to recent developments and tendencies, with a view to forming a clearer conception of what the relations must be between employer and employee in order to secure industrial peace. One session is to be under the auspices of the Detroit Local Committee and of the Mid-Western Local Sections, with papers contributed by the several Sections. There will further be several miscellaneous sessions of technical interest to the membership generally.

As would be expected, the Detroit Committee already has extensive plans under way to make the visit a pleasant and profitable one to all who attend. There will be a boat excursion on the Lake on Wednesday, extending into the evening, and one other evening will be spent at the playground of Detroit, Belle Isle; while on the third evening will be a lecture of interest to members and guests alike. Detroit, situated as it is, within reach of the great industrial Middle West, with its wonderful industries which every one wants to visit, ought to draw a large attendance. Every one who expects to go is asked to make early reservations of rooms at the headquarters, Hotel Statler.

The Aeronautical Exposition

In another column in this number will be found a brief account of the remarkably fine aeronautical exposition recently held in New York. The thousands of people who visited the exposition must have realized as never before that we are literally at the threshold of a new era in peace-time development, the ultimate outcome of which can scarcely be imagined.

The exhibits were the more striking in that almost all of the recent progress of the art of flying has been made under war conditions, and consequently was kept secret to a very large extent from the public. What we are seeing now revealed is the hitherto largely hidden accomplishment of three or four years of work.

The forerunner of changes and advancement in our conditions of living has very often been some extension of the means for transportation and communication. Even before this number of MECHANICAL ENGINEERING reaches its readers such an extension may occur through the effort at transatlantic flight by airplane or dirigible or both. If successful, this will be comparable in the matter of expediting travel to the memorable voyage of the *Great Western* in 1838 and the completion of the first transcontinental railroad in 1869.

Proposals for Technical Institutions to Obtain Government-Owned Machinery

The period of reconstruction through which we are now passing presents many problems of infinite possibilities and not the least of these is the disposing of over $2,000,000 worth of machine tools purchased by the Government for its war work.

The law provides that these machine tools must be disposed of so that the Government will obtain the greatest possible return. It is estimated that only about one-third can be utilized in existing Government shops and arsenals and to dispose of the remainder at sacrifice prices would unquestionably demoralize the machine-tool industry, as most machine shops are well supplied at the present time.

To guard against this possibility a bill was introduced in the House of Representatives on February 4, 1919, under the terms of which the Secretary of War would be empowered to lend to trade and technical schools and universities such machine tools as would be suited to their use but which are now owned by the United States Government. The bill makes proper provision for the protection of the Government's interest, as it makes each institution responsible for the proper care and for the return of such equipment when demanded. If this bill becomes a law the Government will thus be relieved of the expenses incident to storage, but its passage is chiefly desirable since it will provide the means for the training of many who might otherwise be deprived of such instruction if dependent upon the present facilities of many of our institutions.

Education of Disabled Soldiers and Sailors

As reported in MECHANICAL ENGINEERING last month, extended provision has been made by the Government and the Y. M. C. A. for the continued education of soldiers who remain in France, both by instruction at vocational schools established at camps and by courses at the universities.

The Government has also made provision for the further education of returning soldiers and sailors who have been disabled in

service. The Federal Board for Vocational Education has been charged by the Vocational Rehabilitation Act with the reëducation of disabled, discharged soldiers, sailors and marines. A central office has been established in Washington with 14 district offices in the following cities: Boston, Mass.; New York, N. Y.; Philadelphia, Pa.; Washington, D. C.; Atlanta, Ga.; New Orleans, La.; Cincinnati, Ohio; Chicago, Ill.; St. Louis, Mo.; Minneapolis, Minn.; Denver, Colo.; San Francisco, Cal.; Seattle, Wash.; and Dallas Tex.

Each district office deals with all cases arising in its own district, the procedure being as follows: A representative of the board, called the "Vocational Adviser," makes a survey of the situation in each case, getting information concerning general education, previous occupation, nature of disability, preference as to future occupation, etc. On the basis of this interview a recommendation is made, and if finally approved by the central office, arrangements are made for training, either in existing educational institutions or in industrial plants. It is the policy of the board to give each man a thorough education, not simply a superficial training in some one process, the length of training varying, of course, with different cases. Assistance is given in securing a suitable position in which is served a probationary period under the direct supervision of the board, in order to determine whether or not a man is successfully placed.

Novel Training Work Directed by Local Section Chairman

There are about 150 men in our Army who were totally blinded in the war and about 75 others whose vision has become so defective that they will need practically the same training as those who are totally blind. The work of training is to be carried on at the Red Cross Institute for the Blind at Baltimore, which will give courses in agriculture, business, commerce and industrial work. Mr. L. W. Wallace, Chairman of the Indianapolis Section of the Society, has just gone to Baltimore to become Director of Industrial Training at the Institute.

The work is being carried on at the Institute in a way that offers a most encouraging outlook for the blinded soldiers. It is not proposed to restrict the training to purely vocational work of elementary character, such as usual at institutions for the blind —work such as broom making, basket weaving, etc. Instead, a careful study is being made of the elements of skilled operations in the industries by the aid of motion pictures and otherwise for the purpose of adapting these operations to the capabilities of blind men and affording them the opportunity to secure important positions commanding good pay. One of the recent subjects to be studied and analyzed is that of core making. The training is conducted at the expense of the Government and the Red Cross.

Classification of Personnel Exhibit

Employers and others interested in personnel work will have an opportunity to examine the methods developed by the Committee on Classification of Personnel in the Army at an exhibit to be shown on the auditorium (third) floor of the Engineering Societies Building, 29 West 39th Street, New York City, April 1 to 12, 1919. The exhibit will consist of a collection of wall charts, forms, photographs and models showing how the Army finds out what men can do best and how it uses that information: how soldiers are trade-tested, and how officers are rated and fitted into place; how the work is checked and supervised, and its results in the war.

The collection is being shown under the auspices of the National Association of Corporation Schools and the United Engineering Society, representing the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers. It was on exhibition for several weeks at Washington, where it excited so much interest that in response to many requests the Adjutant General consented to its display in other cities. Two commissioned officers accompany the exhibit to explain its various features.

Regarding the Use of A. S. M. E. Headquarters for Army Training

One of the satisfactions experienced by the officers and office staff of The American Society of Mechanical Engineers during the war came from the allotment of two of the Society's rooms to the staff of District No. 2 of the S. A. T. C. The relations were most pleasant, and, although the reading room usually enjoyed by visiting members was temporarily given up, we found all members who called to be glad that the Society was able to make this contribution.

Recently the Secretary received the following letters of appreciation with regard to the occupation of the rooms:

My dear Mr. Rice:

On behalf of the Committee on Education and Special Training, War Plans Division of the General Staff in Washington, and on behalf of Colonel Barton and all persons connected with these headquarters during the past four or five months, I wish to thank you for the many courtesies and civilities extended to us collectively and individually by The American Society of Mechanical Engineers during the period that we were the guests of the Society in their home on West Thirty-ninth Street.

Cordially yours,
E. S. L. Price,
Colonel Inf., U. S. A., District Inspector.

My dear Mr. Rice:

Kindly allow me to add my personal thanks to those expressed to you in Colonel Price's letter of February 27th.

During the months that I was District Inspector, of District No. 2, S. A. T. C., and that we were the guests of The American Society of Mechanical Engineers on the eleventh floor of the Engineering Societies Building, we were so kindly and courteously treated and received so many favors and kindnesses from the Society, and from you personally, I want you to know that I individually appreciate it all.

The American Society of Mechanical Engineers rendered the United States a real service during the war, and your gracious kindness will always be remembered by all the War Department's representatives who were fortunate enough to be your guests.

Fraternally yours,
Frank A. Barton,
Lieut.-Colonel, U. S. Army.

A Step in the Direction of Textile Research

There are frequent evidences that need is felt for a larger amount of research work in connection with the industries of this country. A recent instance is the formation of the Textile Research Company, at 34 Batterymarch Street, Boston, Mass. This is an organization by textile manufacturers for the conduct of research or to have research conducted for them along textile lines. Mr. E. D. Walen, late chief of the Textile Section of the National Bureau of Standards, is the manager. Mr. Walen presented a paper at the last Annual Meeting of the A. S. M. E. on the development of a cotton fabric for use on airplane wings, which material proved to be one of the most important factors in the airplane equipment of the Allied Armies.

The need for textile research has been largely brought about through the necessity for using available raw stock and machinery to manufacture materials which have previously been made from specifically selected raw materials. Such a condition has emphasized the advantages to be gained from a more exact knowledge of the properties of raw stock and the effect upon it of various processes. The substitution of cotton for linen for airplane wings, above alluded to, the substitution of cotton webbing for leather straps and many similar accomplishments have demonstrated the feasibility of applying technical information to the manufacture of textiles.

Screw Thread Commission to be Continued

The very important work of the Screw Thread Commission is to be continued for another year. This was made possible on Friday, February 28, when the U. S. Senate passed the bill extending the life of the Commission until March 21, 1920. The promptness with which this bill was passed can be largely at-

tributed to the very favorable report issued by the Congressional Committee on Coinage, Weights and Measures, which, in reviewing the work of the Commission, found that four of the six months granted under the original act were required to compile data and that the real constructive work of the Commission is still ahead.

The chairman of the Commission, Dr. S. W. Stratton, Director of the Bureau of Standards, states in his report that the Commission has held a total of six meetings and that these were attended by 29 representatives of the Army and Navy and 108 manufacturers, as well as representatives of the British Ministry of Munitions and the French High Commission. Before making a final report, he states, the Commission believes that an international conference will be necessary to provide a basis for arbitrary recommendations. However, tentative reports on standards are now being prepared for: terminology, shape of thread, system of coarse screws, system of fine screws, system of small screws, system of pipe thread, system of hose couplings, system of instrument screws, and system of measurement and test.

The Commission also reports that as a result of its studies it has found:

(1) That there is not a common terminology among the users and manufacturers of screws; (2) that there is considerable deviation in many respects from the recognized standard shape of thread on the screws manufactured in the United States; (3) that there is considerable deviation in many respects in the accepted standard of pitch for screws manufactured in this country; (4) that there is not a standard whereby the accuracy of workmanship may be judged; (5) that there is not a standard method of measuring and testing for accuracy; (6) that there are numerous special screws used which are only slightly different, but just sufficiently different to prevent interchangeability; (7) that there is a desire among manufacturers of the United States for an international standard; (8) that an international standard is an absolute necessity if the present shipping and foreign trade program is to be successful; (9) the above conditions have seriously interfered with the naval and military operations during the war, and for many years have constituted a serious hindrance to commerce.

United Engineering Society

Extracts from Treasurer's Annual Report for Year Ending December 31, 1918

The Surplus Account on December 31, 1917, showed a balance of $8,116.10. This amount has been increased by the surplus from the operating accounts during the year of $5,417.33, making a total on December 31, 1918, of $13,533.43. Of this amount $8,000 has been transferred to Depreciation and Renewal Fund, leaving a balance in Surplus Account of $5,533.43.

The Gross Operating Expenses for the year 1918 were $66,505.57. The General Operating Expenses during the year 1917 were $53,791.97, showing an increase for the year 1918 of $12,713.60, partly due to the three additional stories first occupied in October 1917.

The funds available for the Library Board, and spent under their direction during the year, amounted to $28,740.29.

The General Reserve Fund of $10,000 created by the Board of Trustees at a meeting held November 18, 1914, to be available to take care of unforeseen fluctuations of income and outlay, has been preserved intact, there arising no calls on this fund during the year 1918.

The Depreciation and Renewal Fund at the beginning of the year 1918 amounted to $75,037.41. During the year this fund has been increased by the sum of $3,126.37 for interest earned by the investments for this fund during the year and accruals, and by $8,000 added from the surplus at the end of the year, making a total of $86,163.78 on December 31, 1918.

In accordance with the authorization of the Board of Trustees September 26, 1918, the sum of $10,000 was invested in Fourth Liberty Loan Gold Bonds (4¼ per cent).

The following summary shows the amounts of the funds held by U.E.S. as of December 31, 1918:

Depreciation and Renewal Fund Dec. 31, 1917	$75,037.41
Interest on invested funds during the year 1918	3,126.37
Transfer for the year 1918	8,000.00
Total	$86,163.78
General Reserve Fund	10,000.00
Engineering Foundation Fund	303,374.80
Library Endowment Fund	102,559.70

Assets and Liabilities, December 31, 1918

Assets	
Real Estate	$1,947,171.16
Investments Engineering Foundation Fund	303,321.25
Investments Library Endowment Fund	102,297.50
Investments General Fund	85,725.00
Cash	12,869.60
Petty Cash	100.00
Unexpired Insurance	5,958.76
Accrued Interest Receivable	2,392.02
Accounts Receivable, General	542.58
Bills Receivable	12,500.00
Total	$2,472,877.87

Liabilities	
Founders' Equity in Property	$1,947,171.16
Due the General Reserve Fund	10,000.00
Due the Depreciation and Renewal Fund	86,163.78
Due the Library Endowment Fund	102,559.70
Due the Engineering Foundation Fund	303,374.80
Due for Notes Payable A.S.M.E	12,500.00
Due for Accounts Payable	2,090.24
Due for Library 1918, Unexpended Balance	274.26
Due for Library Service Bureau, 1918 Surplus	800.29
Due for Engineering Council, 1918 Unexpended Balance	2,410.21
Surplus (Dec. 31, 1918)	5,533.43
Total	$2,472,877.87

NEW YORK AERONAUTICAL EXPOSITION

The second aeronautical exposition to be held in the United States took place in New York City in Madison Square Garden and the 69th Regiment Armory, March 1 to 15, under the auspices of the Manufacturers' Aircraft Association.

The first exposition, it will be remembered, was held in Grand Central Palace, New York City, a short time before the entrance of this country into the war, and was mainly remarkable in showing how far behind the state of the art was the domestic development of aircraft engineering and manufacture. From this point of view the show this year was a distinctly pleasant surprise to those who have not been able to follow the advances made in America during the past two years.

The show impressed one as a distinctly big undertaking. The two immense structures were filled to overflowing with exhibits, each of which was of interest. Judging by the number of manufacturers, the quality of the product and the evident organization of the plants which could produce the many exhibits shown, the aircraft industry has come to stay in the United States. It has passed the experimental stage, and is now on a strictly commercial basis in the sense that it is capable of producing planes for certain definite purposes.

As regards the purposes themselves, the situation is perhaps less attractive. The majority of planes shown, if not all, were military types with very large power plants, apparently of short life and requiring considerable skill for their operation. It must not be forgotten, however, that the show as it stood represented an industry created for military purposes and devoted 100 per cent to war work. Since the signing of the armistice the industry has not had time to reorganize on a peace basis, but the show may well be considered as the first important step taken in this direction.

There were many planes of various types displayed—from the immense Caproni and Curtiss triplanes and Dayton-Wright bombers to the tiny Ballila plane of the Ansaldo Company (Italian manufacture) and the Messenger plane made in this country by the Dayton-Wright Company. None of these planes, however, can be as yet considered as suitable for what might be termed everyday use. It is significant, however, that so great is apparently the prospective field of application of aircraft that even these planes will doubtless soon be employed for various peaceful purposes. In fact, it was announced at the show that a New York steamship company will use a fast plane to deliver final manifests and other papers to ships at sea which had to leave port before these papers were ready.

There is a certain amount of difficulty in describing the show, in that in other expositions, such as automobile shows, it has been customary for manufacturers to exhibit new devices or constructions previously unknown to the trade or the engineering profession. From this point of view the show was disappointing, as there was scarcely anything displayed the existence of which was not already fairly widely known. This, however, is only natural, as practically all the manufacturers who exhibited had been working for the Government, largely to Government specifications.

The exhibits referred to in the following paragraphs may be considered as among those with which engineers outside of the still narrow field of aeronautical engineering have little or no acquaintance. No attempt is made, however, to give an exhaustive enumeration.

Among the planes shown the big Curtiss triplane developed just before the armistice is noteworthy from the fact that it combines a very powerful structure having great load-carrying capacity with a certain flexibility of the wings which should give it a high speed. In this respect the Curtiss plane differs essentially from the other big triplane shown, namely, the Bi-motor Caproni machine. Another machine possessing the wing-flexibility feature to a still greater extent is the Christmas biplane exhibited by the Cantilever Aero Company, which, in addition to having flexible wings, is also strutless. These two features in combination should give it a very high speed, provided it proves possible to make the whole structure strong enough to withstand the various stresses in the air.

The Gallaudet machine embodies the novel idea of locating the propeller neither in front nor in the rear of the plane, but right into the fuselage so that the propeller hub and the base of the blades are entirely concealed in the streamline cover of the fuselage body, only the acting tips of the blades projecting. It is claimed that such a structure not only materially reduces the head resistance caused by the propeller, but also creates a different distribution of air pressures that is of advantage in obtaining the maximum effect.

As regards power plants, the show did not bring out anything which was not fairly well known before. Several Liberty engines were on the floor, as well as an aero-marine motor, two Hispano-Suiza engines—one of 160 hp. and the other of 300 hp.—a Packard motor, and several Hall-Scott engines. While none of these engines exhibited any mechanical features not well known in the art, they gave an impression of careful workmanship and average good design.

The B. F. Sturtevant Company exhibited an engine with a centrifugal blower attached for purposes of supercompression. Unfortunately, however, the representatives of the company were unwilling to give any information as to its efficiency or the mechanical details of operation of the supercompressor.

In the field of accessories there were numerous interesting exhibits showing the work done by American manufacturers during the war. The Delco Company had on view the ignition system developed for the Liberty engine, and side by side with it the Splitdorf Company exhibited the Dixie magneto developed for multi-cylinder aero engines of the Liberty type.

The Zenith Carburetor Company showed the enormous carburetors built for the big 12-cylinder Liberty engine, while other companies exhibited the various recording and indicating instruments used in military flying.

Of the Government developments, the Navy had probably the most interesting exhibit, comprising both planes and their armament, including the Lewis gun. A dirigible balloon, a stationary balloon and an exhibit of fabrics in their manufacture revealed the part taken by aerostatics in our military preparedness. On the whole, however, the visitor at the show carried away an impression that while American aeronautics was probably not behind that of England and France at the present moment, it was certainly far behind at least that of the first-named of these countries in lighter-than-air engineering developments.

Several meetings of engineering societies and other bodies were held during the show, the most interesting of which was that of the Aeronautical Society of America, at which Capt. W. R. Schroeder, of the Technical Service, Aircraft Section, War Department, gave a brief talk on high-altitude flying.

Captain Schroeder told of his flights to determine the ceilings of the various types of machines, in the course of which he made what is probably the world's record for altitude, namely, an actual ceiling of about 29,000 ft. This was possible only by using oxygen both for the engine and flier in the last few thousand feet.

A highly significant feature of the last attempt in which the record altitude was reached lay in the following fact: Captain Schroeder rose in a westerly direction, so governing his flight as to come down in a volplane as near as possible to the place from which he rose, which was McCook Field, Dayton, Ohio. He

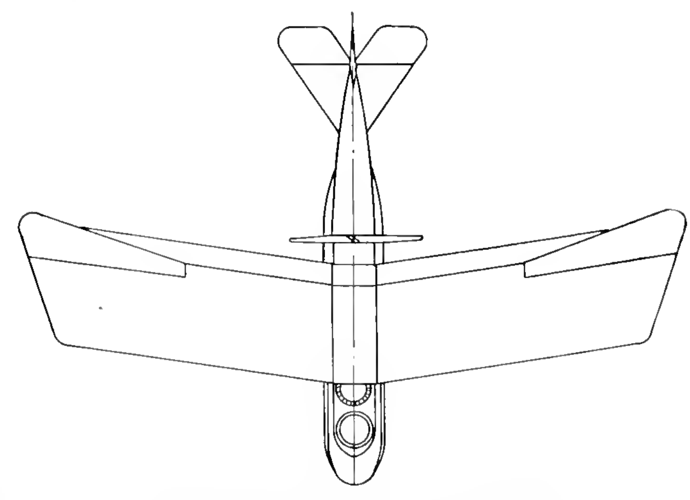


Diagram of Gallaudet Aeroplane

went up for a period of 85 min. and did not give up until all of his gasoline was exhausted. It took him 20 min. to come down in a volplane with the motor dead from the altitude which he reached, and the significant point is that he landed nearly 200 miles east of Dayton, which shows he either encountered extremely powerful winds at the high altitude, or that in some way his flight was affected by some other factor not yet determined—possibly the rotation of the earth. In any case this confirms the statement previously made by Lord Montague de Beaulieu to the effect that in long-distance and high-altitude flights it is very important to take into consideration the winds prevailing at the altitude where the flight is made.

The general impression made by the show is that the American aeronautical industry has come to stay. Apparently it has not yet developed an actual commercial aeroplane, which could not be expected, however, since up to a few months ago it has been working exclusively for our military establishment; but such products as have been shown in the way of planes, engines, and accessories represent a high grade of workmanship and an earnest effort at producing careful designs.

Washington Announces Abandonment of Neville Island

The War Department has officially abandoned the $50,000,000 Neville Island project. A recent announcement of the Department states that the buildings erected there are to be torn down and the island restored to the original owners, but denies the report that the plant is to become the principal ordnance storage depot for the Eastern United States. It will, however, be used temporarily for storage purposes. The Neville Island plant was one of the largest undertakings of this kind during the war. It was intended chiefly for the production of heavy artillery, as no guns of less than 14 in. were to have been built there. Congress appropriated $40,000,000 for the plant and a total appropriation of $140,000,000 had been asked for.

ENGINEERING COUNCIL

Extracts from Annual Report

ENGINEERING COUNCIL has completed its second year. Notable in the year's history are its service to the Government in connection with the German war, the creation of the Engineering Societies Employment Bureau, the establishment of a Washington office, the appointment of a committee on Licensing of Engineers, and the admission of an additional member society. Through visits made by the Secretary mutually helpful relationships with engineering societies in twenty-five or more localities were established.

Engineering Council held six regular meetings beginning with the Annual Meeting, February 21, 1918, and one special meeting on November 21, all in Engineering Societies Building, New York. There was no change in the officers as elected at the beginning of the year: J. Parke Channing, Chairman, Harold W. Buck, First Vice-Chairman, George F. Swain, 2nd Vice-Chairman, Alfred D. Flinn, Secretary. For the year's expenses the sum of $16,000 was provided, and there remained unexpended January 1, $2400. Particulars regarding the activities of the Council's various committees follow.

Executive Committee. Eight meetings were held. The principal business of most of these meetings was the preliminary study of matters to be brought before Engineering Council so as to economize time at Council meetings.

January 6, 1919, an urgent meeting was called to determine what action Engineering Council could take concerning the sudden dismissal, by the Public Service Commission for the first District of New York, of approximately 350 engineers and assistants engaged on subway construction.

January 28 a meeting was held to instruct Council's Washington representative as to his course of action before committees of Congress on matters demanding immediate attention, especially propositions relating to a National Department of Public Works.

Rules Committee. This committee prepared and submitted for adoption at the February meeting, 1918, "Rules for Guidance of Business" and "Rules for Admission of Additional Societies to Membership in Engineering Council." The latter rules were subsequently duly approved by United Engineering Society and the four Founder Societies. A tentative list of societies eligible for membership was prepared and sent to all representatives. From this list six societies were selected for immediate consideration and three ultimately elected, subject to approval by United Engineering Society and the Founder Societies. These approvals were all received by December 1918.

Public Affairs Committee. This committee made preliminary investigations which led to the appointment of a Patents Committee and a Committee on Licensing of Engineers. It presented a resolution to the December meeting of Council, requesting favorable attention of Congress to land reclamation on a large scale as a "reconstruction" measure under thorough engineering supervision. This resolution was adopted by Council and later followed up by the Washington representative. The committee also reported upon the allocation of labor and equipment for production of war materials, an "Institute for History of Science" as a branch of the Patent Office, engineering experiment stations at Land Grant Colleges, assistance to members of faculties of colleges of pure and applied science engaged on war work by relieving them of certain routine duties; no activity was undertaken by Council in any of these matters.

American Engineering Service devoted its energies and those of its small staff almost exclusively to aiding governmental departments in procuring technical men for war service. With the assistance of the four Founder Societies and other engineering societies, classified records of many thousands of engineers were assembled and from these, in response chiefly to more than two hundred requisitions from thirty principal and subordinate governmental departments, names of approximately four thousand engineers were supplied, all carefully selected. Many interviews between Army and Navy officers and candidates were arranged and other services rendered. Besides, a number of engineers were assisted in finding engagements in civilian work and several offices were aided in obtaining engineers. This committee was disbanded at the end of November on account of the armistice and succeeded by Engineering Societies Employment Bureau.

War Committee of Technical Societies. During its latter months the committee had 22 members representing 11 societies. Financial support was provided by Engineering Council. The Naval Consulting Board provided offices in New York, and for the last few months, also in Washington, together with frank for mail and other assistance. This committee was closely allied with the Naval Consulting Board, and, beginning in the summer of 1918, also with the Inventions Section of the Army General Staff; the latter provided the services of Capt. Scott as secretary. On account of the armistice, this committee ceased to exist December 31. During the year this committee aided the Army and Navy in examining 135,000 inventions and suggestions for war devices. To stimulate intelligent solution of war problems, the committee with the Naval Consulting Board issued two pamphlets, the first entitled "The Enemy Submarine" and the second "Problems of Airplane Improvement." Before the bulletins were issued 0.4 per cent only of suggestions received had any value; afterward, 4.7 per cent. One of the most important services rendered was to demonstrate to the War and Navy Departments how the civilian engineers of the country could be mobilized for the aid of the Government in war, and to establish direct communication for this purpose between the departments named and the engineering societies.

Fuel Conservation Committee. This committee has collaborated with the Bureau of Mines and the Fuel Administration, one of its members being Advisory Engineer to the latter, and its Secretary, Chief Mechanical Engineer to the former. This committee also cooperated with committees of various engineering societies, working along similar lines in many parts of the country. Its work will be continued.

Patents Committee. Appointed so that Engineering Council might have a share in endeavors to improve patent-law practice and the organization of the Patent Office. This committee interlocked with a similar committee of National Research Council and accepted the able report of the latter. This report, recently made public, proposes the following changes in the patent system:

1 Establishment of a single Court of Patent Appeals
2 Separation of Patent Office from Department of Interior
3 Increase in force and salaries of Patent Office
4 Modification of that section of the law granting compensation for infringement of patents.

Water Conservation Committee. Was created to deal with questions concerning the utilization and control of water for various purposes in all parts of the country. It has defined its general policies and is prepared to furnish broad information on large problems, particularly to committees of Congress, to State Legislatures, or to governmental departments. The committee proposes to deal with those facts of engineering which are beyond reasonable controversy.

Engineering Societies Employment Bureau. Following the termination of hostilities, Engineering Council at its special meeting November 21, established an Employment Bureau with the secretaries of the Founder Societies as a Board of Directors. The Bureau took over the staff and equipment of American Engineering Service at the end of November. From the beginning of its work to February 15, it has received applications for positions from 1375 engineers in all branches of the profession. For a total of 200 applicants employment has been found. The services of the Bureau are not restricted to members of the engineering societies represented in Engineering Council, but nonmembers are expected to present letters of introduction from a member. Extensive efforts have been made to inform employers of engineers of the Bureau's resources for serving them. No charge is made for services.

Reconstruction Committee. At the November meeting of Council, in order to deal with several matters falling under the head of "reconstruction" and especially to work out the details of the organization and personnel of the proposed National Service Committee, the Reconstruction Committee was appointed. At meetings held November 29 and December 16, 1918, it selected the personnel of the National Service Committee and determined sufficient elements in its organization to permit that committee to begin work before the end of the year. It was understood that the chairman should be the executive head of the National Service Committee with reasonable independence in action for the effective performance of his duties, and that the other members of the committee would be expected to serve principally in the capacity of an advisory board to the chairman. January 28, the Reconstruction Committee held a joint meeting with members of the Public Affairs and National Service Committees to discuss the establishment of a National Department of Public Works.

National Service Committee. At the November meeting of Council, representative Philip N. Moore presented a communication entitled "Representation of Engineers at National Capital." From this proposal grew the National Service Committee with a permanent representative and office in Washington, which was established through the agency of the Reconstruction Committee. The office is Room 502, McLachlen Bldg., 10th and G Streets, Washington, D. C. The committee has taken up a number of subjects with committees of Congress and the departments. Most important among these have been (1) Land Reclamation, following resolution adopted by Council November 21 (Tyrnes Bill S. 13651, proposing an appropriation of $100,000,000 for reclamation of arid, swamp and stump lands); (2) National Public Works Department in connection with Kenyon Bill, S. 5397, and hearings before Committee on Education and Labor to which this bill was referred, and the Committee on Public Buildings and Grounds which was investigating certain work of the Army Construction Division.

License Committee. There is active interest in several states in proposed legislation relating to the licensing of engineers, and a number of inquiries from engineering societies have been referred to this committee. The License Committee is endeavoring to coordinate and direct these activities.

Americanization Committee. Is prepared to coöperate with the Division of Americanization in the Department of Interior and with the National Americanization Committee. Since engineers have more or less direct contact with large bodies of foreign-born employees, it is expected that they will render substantial help in this important work. An instructive report has been written by the committee summarizing the present status of Americanization activities.

Publicity Committee. Is a committee of volunteers to help the Secretary in some of the publicity work, principally in preparing and distributing material for publication in technical journals and daily newspapers after authorization by Council. Besides this New York committee, there are twenty-six correspondents in engineering centers scattered over the country to aid in the transmission of information between Engineering Council's office and local societies of engineers.

American Academy of Engineers. Organizers of the proposed Academy sought the support of Engineering Council in securing a charter from the Federal Government. After several conferences and mature deliberations, Engineering Council declined to support the bill before the House of Representatives.

Classification and Compensation of Engineers in Railroad and Government Employment. A communication prepared by Engineering Council addressed to the Railroad Wage Commission was presented by the Secretary in person to a meeting of that Commission in Washington, February 25, 1918. This matter was pursued from time to time, and with that of the compensation of engineers in Government employment is now in the hands of the Public Affairs Committee.

Reconstruction. Under date of November 15, a letter was sent to President Wilson regarding the appointment of engineers on the proposed Federal Reconstruction Commission. To this letter the President replied briefly under date of November 20, that existing instrumentalities were being utilized. Letters to the governors of all states, urging the inclusion of engineers in any reconstruction commissions which might be appointed, were sent out in February 1919.

Field of Activity of Engineering Council was outlined at the November meeting by carefully prepared preambles and resolutions which have been generally announced to engineering societies.

Information to Federal and State Authorities. At its November meeting, Engineering Council expressed its attitude in the following resolution: "That Engineering Council should be prepared to furnish to Federal and State authorities information regarding engineering and allied facts and opinions which are beyond the field of controversy, and shall take such steps as are consistent with the standing of the societies it represents to inform such Federal and State authorities of its willingness so to act."

Smith-Howard Bill for the establishment of engineering and industrial research stations at educational institutions in all the states was discussed at length. While favoring research when properly carried on, Engineering Council refrained from expressing opinion on the proposed legislation in the form in which it was brought to its attention. Council's Washington representative was directed to attend a meeting January 6, of delegates from organizations interested in redrafting the Smith-Howard Bill; a report of this conference was submitted. The parties interested are still widely at variance and there is nothing further for Council to do at present.

Curricula of Engineering Schools. The subject of changes in curricula of engineering schools was discussed in a general way at more than one meeting. It was brought formally to the attention of Council by resolutions adopted by the War Committee of Technical Societies at its final meeting, suggesting that as a measure of future military preparedness engineer students in the large universities and colleges should receive instruction in the art of war. A committee was appointed December 19 to study this matter. This committee has reported.

Committee of Engineering Council Considering Engineers' License Laws

ENGINEERING Council has appointed a committee on Licensing of Engineers, of which Theodore L. Condron of Chicago is chairman and the other members, 12 in number, are representative of different sections of the country. This bids fair to become one of the most important of the Council's committees in view of the active interest which engineers are taking in various parts of the country in projects for state legislation to regulate the practice of engineering.

Engineers' license laws are already in force in Florida, Louisiana and Illinois, and bills for this purpose have been introduced or proposed in California, Colorado, Nevada, Washington, Iowa, Michigan, Ohio and Indiana. The license law in Florida requires the registration and licensing of all professional engineers practicing in the state, whereas the law in Illinois is limited to the registering and licensing of structural engineers only.

The Louisiana law is "to regulate the practice of civil engineering and surveying; to create a State Board of Engineering Examiners, and regulate the fees and emoluments thereof, to prevent the practice of the said callings or professions by unauthorized persons."

The great changes in conditions which engineers with all other classes of the community face as a result of the war make it desirable that the question of the licensing of engineers should be investigated broadly and impartially by a committee representative of various sections of the country and of different branches of the profession.

Engineering Council, therefore, has divided the country into districts and the different members of its committee, each assigned to a district, are undertaking to gather information regarding the laws in force or proposed and the bearing which they may be expected to have on the welfare of both the engineer and the public. Among the questions now being investigated are the following:

1 Should state laws be enacted requiring definite qualifications for the practice of specific branches of engineering? If so, what branches of engineering work should be included?

2 Should such laws provide for the examination of candidates and formal license to practice, by a state board of duly qualified engineers?

3 Can the dangers be obviated that such legislation would operate to confine engineering work within state boundaries and that it would ultimately be used to raise state revenue by a special tax on engineers?

4 If the legislation above outlined is found to be inadvisable, are other laws or methods possible by which those employing engineers in specific branches of work may be more effectually aided in ascertaining their competence?

In this connection attention should be called to the thorough investigation of the question of a state license law for engineers made four years ago by an expert commission in Pennsylvania. This commission of five eminent engineers was appointed by the governor under authority of an act of the legislature. The commission held public hearings in different parts of the state—and collected a large amount of testimony from engineers representing all branches of the profession. While the commission at the outset apparently was inclined to favor the general proposition of state regulation, its final reports opposed any legislation for the control of the work of engineers engaged in private industry and recommended only examinations for engineers engaged in various branches of public work.

Other Engineering Council Activities

An invitation has been extended to various engineering societies by the Engineering Council to attend a conference in Chicago, April 23 to 25, to discuss the advisability of a National Department of Public Works. There appears to be promise of the passage of a bill by the next Congress for the establishment of such a department if the different societies interested will unanimously agree on and support such a measure.

A new committee about to be appointed by the Council relates to the Classifications and Compensation of Engineers, having as its object the securing of better conditions for employment of engineers, including their classification into grades and a statement of what it is considered should be the relative salaries of the different grades. It is proposed to consider:

1 Engineers engaged in civil, mechanical, electrical and railway engineering, etc.

2 Engineers in Government (national) employ.

3 Engineers in municipal employ.

Still another activity which has recently developed relates to International Affiliation of Engineers, a committee for which has been appointed with Charles F. Loweth as chairman. The primary object is to secure closer coöperation between the engineers and engineering societies in this country and those of Canada.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A. S. M. E.

IN discussing the relation of the Mechanical Engineer to his work in conducting and assisting research, the subject naturally divides itself into two parts: The relation of the individual engineer and the relation of the collective engineer, that is, the Society to which the engineer belongs.

The relation of the individual engineer is one of action and one of encouragement. At present there is, and in fact at all times there has been, a great need for those who would devote themselves to the determination of the unknown, for pioneers to go into the regions of science and lay hold of some of its domain for the use of their fellows. That need is great today since the small chance for a large financial reward and the necessity for close attention to details has taken many men who have started life as investigators out into the more productive fields of commercial life or science after a few close years of research work.

The value of the investigator is quite evident to many manufacturers, and men who have shown ability in their work on large general problems have, on account of greater financial returns, given up this work to the small special problems of commercial plants. It is in this commercial work that the individual engineer can be of great assistance in endeavoring to carry his problems of research to a general conclusion, rather than stopping when a particular or the partial commercial result of his investigations has been attained. Where possible, he should endeavor to influence those under whom he is working to see the necessity of making the investigation general and then giving the result to the world.

Of course many investigations are undertaken for commercial reasons, and the results of such investigations are not to be made public until the commercial purpose for which they were started has been protected. This is undoubtedly the reasonable point of view, although a broader plan would be to open up to the world the results of all research; but this is not to be expected under present conditions. According to the daily press a convention of dental societies agreed to make all special processes or inventions resulting from research the property of the profession at large, giving to all a free use of these results. This broad and altruistic view is to be commended and desired, but in ordinary business it is feared that little support would be given by commercial organizations if there was not some possible gain for them in view.

The individual engineer should realize the importance of research since the physical data which he uses every day have been the result of the researches of others, and for that reason he should endeavor to emulate the action of such, in not being satisfied to use rule-of-thumb methods in new problems, but when data are lacking, he should proceed by research to ascertain the necessary information. He should, where possible, endeavor to encourage others in this field of work. One of the great needs at present is for men with the training, enthusiasm and disinterestedness of investigators and a proper attitude of the individual engineer to encourage young men to enter this field.

Turning now to the interest of the engineers in collective units, I feel that one function of an engineering society is to aid those engaged in research by the six methods which have been undertaken in the present program of the Research Committee of The American Society of Mechanical Engineers, and in addition to these six, the Society should give financial aid to those engaged in general work.

To aid the investigator the Committee is planning to bring together information regarding the researches in various parts of the country, informing the investigators and the engineers of the country about methods and subjects of research, giving information which will bring together those who are interested in the same problems for conference and coöperation, and preventing unnecessary duplication of work. The spirit of coöperation is an important one to foster and by coöperative endeavor great work can be done.

To encourage research the Society should organize committees to superintend actual work. In regard to subjects of general interest, and where present data seem to be in conflict, these committees could investigate the problems further for the purpose of harmonizing the data or by proving which of them are correct. In many cases this work may have to be financed by the Society, while in other cases small grants may be all that are necessary. By its clearing-house methods for research information the Society will discover those requiring assistance, and by a small aid in the time of need, certain researches may be carried to a conclusion, and without such aid they would remain incomplete.

As a duty to the profession the Society should collect and publish the results when such results are not published. It should endeavor to have reports made in a regular way, and even though the results of research have not been published in a limited way, it is advisable to abstract these for publication in our Journal for the benefit of the whole profession.

To help those who have research problems to solve but who have no equipment or other facilities, the Society, through its Research Committee, can aid in bringing together the man with the problem and the man with facilities for research. There is much equipment which is idle for the lack of suitable problems on which work is to be done. It is hoped that this clearing-house method will aid in utilizing some of the equipment.

To those about to undertake research a survey of the present conditions of the field to be covered is necessary, and a study should be made of the literature of this field of endeavor to discover this condition. Bibliographies are necessary, and in many cases persons are situated at such a distance from large libraries that this work could not be done by them. The Society can come to the aid of such persons in preparing for them bibliographies founded on careful searches in the large library of the United Engineering Society. In this way the whole Society can aid. Of course it is realized that this should only be done for those who are working on a general problem and also for a research which is to be given to the profession at its conclusion. Where the research is of a commercial nature, it would be manifestly unjust and improper to give such aid.

To recapitulate, I feel that the activities of the individual engineer should be devoted to carrying on research to such a degree that results would give a general relation rather than the solution of particular problems, that he should endeavor where possible to have these results made public, that he should encourage others in the field of research, and should endeavor to lead those with the proper preparation of spirit to enter such fields. The engineer in a collective sense, represented by the Society, should aid research by financial support of those needing it, by the preparation of bibliographies, by the publication of research problems and of information regarding research equipment for the purpose of bringing it to the knowledge of those who have not the equipment for a problem at hand, by publishing news relating to research in progress, and by publishing research results.

ARTHUR M. GREENE, JR., *Chairman.*

Reports Upon Research

A—Research Results

Electricity 1-19 Lightning Protection. Circular No. 1 of Engineering Experiment Station, Purdue University, Lafayette, Ind. A collection of facts relative to lightning protection.

Hydraulics 1-19 Flow of Water Through 1½-in. Pipes and Valves, Frederick W. Greve, Jr., Purdue University,

Lafayette, Ind. From Bulletin No. 1, Engineering Experiment Station.

CONCLUSIONS. The loss of head can be represented by equation $h = MQ^n$ for valves and pipes with the exception of check valves at low velocities. In the above formula h = loss of head in feet and Q = cubic feet flowing per second. The values of M and n are given in the Table 1.

TABLE 1 VALUES FOR USE IN LOSS-OF-HEAD FORMULA

Description.	M	n
1½-in. pipe per 100 ft.	831.0	1.817
1½-in. check valve for Q above 0.043 c.f.s	1276.3	1.944
1½-in. gate valve:		
0.2 in. rise from seat.	10067.2	1.946
0.45 in. rise from seat.	1854.2	1.946
0.65 in. rise from seat.	818.4	1.901
1.00 in. rise from seat.	476.3	1.865
Wide open.	363.5	1.843
1½-in. globe valve:		
One turn open.	5257.4	1.947
1.5 turns open.	1703.7	1.881
2.0 turns open.	1379.7	1.940
3.0 turns open.	1041.9	1.922
5.5 turns open (wide).	953.7	1.915

Fig. 1 shows arrangement of apparatus used in the experiments and Fig. 2 a logarithmic diagram of loss of head and quantity.

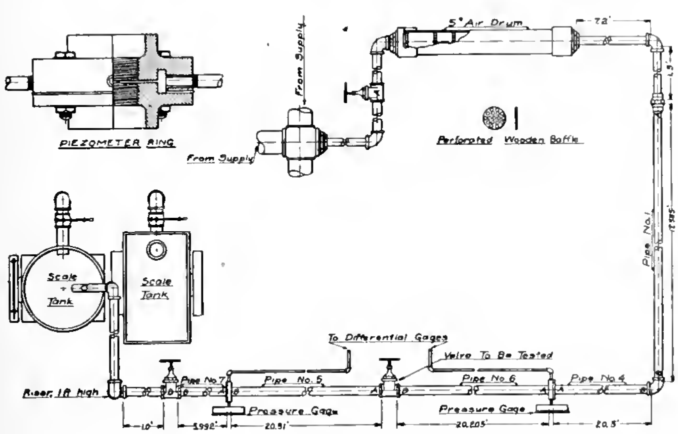


FIG. 1 APPARATUS USED IN LOSS-OF-HEAD EXPERIMENTS

The bibliography given by Mr. Greve is as follows:

1 Donnelly, J. A....Flow of Water Through Check Valves. *Power*, vol. 32, p. 510.
2 Folwell, A. P....Notes on Lost Heads in Water Systems. *Eng. News*, vol. 47, p. 303.
3 Kuichling, E....Loss of Head Resulting from Passage of Water Through a 24-in. Stop Valve. *Trans. A. S. C. E.*, vol. 26, p. 439.
4 Magruder, W. T....The Flow of Water Through Valves. *Eng. Rec.*, vol. 40, pp. 78-79.
5 Pillmore, F....Influence of Valves on the Flow of Water. *Power*, vol. 29, p. 603.
6 Weisbach, J....Tests on Flow of Water Through Valves. Coxe's Translation of "Mechanics."

B—RESEARCH IN PROGRESS

Air 1-19 The Flow of Air Through Orifices. Ohio State University, Columbus, Ohio. Prof. W. T. Magruder.

Automotive Vehicles and Equipment 1-19 Investigation of Oil Constituents in the Crankcases of Automobile Engines After Long Usage. Armour Institute of Technology, Chicago, Ill. Prof. G. F. Gebhardt.

Electrochemistry 1-19 Fixation of Atmospheric Nitrogen by High-tension Currents. Engineering Experiment Station, Purdue University, Lafayette, Ind. Address Director C. H. Benjamin.

Electric Power 1-19 The Efficiency of Electric Ranges. Engineering Experiment Station, Purdue University, Lafayette, Ind. Director C. H. Benjamin.

Fuel Utilization 1-19 The Process Underlying Carburetion. Ohio State University, Columbus, Ohio. Prof. W. T. Magruder.

Fuel Utilization 2-19 Standardization of Gasoline Carburetors. Engineering Experiment Station, Purdue University, Lafayette, Ind. Director C. H. Benjamin.

Heat 2-19 Heat Transmission Through Various Building Materials, Thickness ½ in. to 4 in. Armour Institute of Technology, Chicago, Ill. Prof. G. F. Gebhardt.

Hydraulics 1-19 Friction—Coefficients of Pipe Friction and Constants of Orifices for Pipe Sizes from Two to Four Inches. Armour Institute of Technology, Chicago, Ill. Prof. G. F. Gebhardt.

Internal-Combustion Motors 1-19 Test of 14-in. by 18-in. Single-Acting Tandem Buckeye Engine with Natural Gas Under Varying Conditions. Ohio State University, Columbus, Ohio. Prof. W. T. Magruder.

Lubrication 2-19 A Research on Lubricating Oils. Committee on Lubricating Oils, Bureau of Standards, Washington, D. C.

The program of the Committee is made out under the following heads: 1, General Purpose; 2, General Statement; 3, Some Specific Problems; 4, Engines and Engine Tests Methods; 5, Theory of Lubrication; 6, Routine Tests; 7, Special Laboratory Examinations; 8, Oils for Investigation; 9, Effect of Adulteration; 10, Regeneration of Used Oils.

Metal Manufactures, Miscellaneous 1-19 The Strength of a Fillet Experimentally Determined. Ohio State University, Columbus, Ohio. Prof. W. T. Magruder.

Properties of Engineering Materials 1-19 Alloy-Steels at Varying Temperatures from — 100 to 1500 Deg. Fehr.; Tensile Strength Yield Point, Elongation and Reduction of Area. Armour Institute of Technology, Chicago, Ill. Prof. G. F. Gebhardt.

Road Materials and Equipment 1-19 A Survey of Road Materials of Indiana. Engineering Experiment Station, Purdue University, Lafayette, Ind. Director C. H. Benjamin.

Railroad Rolling Stock and Accessories 1-19 (1) Testing of Street-Railway Car-Axle Boxes, 4½ in. by 8 in. on Their Own Axles. (2) Test of Freight-Car Boxes 5½ in. by 10 in. on Their Own Axles. Ohio State University, Columbus, Ohio. Prof. W. T. Magruder.

Railroad Rolling Stock and Accessories 2-19 Force of Impact of Flat Wheels on Rails. Engineering Experiment Station, Purdue University, Lafayette, Ind. Director C. H. Benjamin.

Railroad Track and Signals 1-19 The Breaking of Steel Rails at Low Temperatures. Engineering Experiment Station, Purdue University, Lafayette, Ind. Director C. H. Benjamin.

Steam Power 1-19 Influence of Back Pressure on the Performance of Small High-Speed Steam Engines. Armour Institute of Technology, Chicago, Ill. Prof. G. F. Gebhardt.

Transmission 1-19 Determination of Belt Slips and Creeps. Belt 4 in. Wide. Armour Institute of Technology, Chicago, Ill. Prof. G. F. Gebhardt.

Transmission 2-19 Bearings—Coefficient of Friction of Annular Ball Bearings Subjected to Combined End and Radial Thrust. Armour Institute of Technology, Chicago, Ill. Prof. G. F. Gebhardt.

Transmission 3-19 Tests with Multiple-Bearing Testing Machine with Speeds at 400 R.P.M. and Under Loads of 15,000 Lb. for 4-in. Shifts. Ohio State University, Columbus, Ohio. Prof. W. T. Magruder.

C—RESEARCH PROBLEMS

During the past month the Research Committee of The American Society of Mechanical Engineers has received word from a number of laboratories that they would gladly help in the work of the Committee if they knew of problems which are worth while. They are willing to work, they have good equipment, but they do not know just how to aid. It is hoped that those who have research problems of a general nature will send in their problems to the Committee, so that these may be published in MECHANICAL ENGINEERING, and those prepared to undertake work can communicate with those having problems.

D—RESEARCH EQUIPMENT

Apparatus 1-19 Screw Threads—Testing Device for Pitch. Communication B514, Gage Section, Bureau of Standards, Washington, D. C. February 10, 1919.

The Gage Section of the Bureau of Standards has installed in its laboratory devices for measuring the pitch of straight and tapered screw-thread gages. The communication describes the construction of the apparatus, giving a list of the parts required. The general scheme of the apparatus is to advance the gage one pitch by means of a micrometer screw, and to determine whether or not the gage has been advanced exactly one pitch by the movement of an image from a lens at the end of a multiplying indicating bar, the other end of which fits into the threads of the gage. The image is reflected by two prisms to a ground glass in front of the apparatus, and when this image is brought to the same point as that occupied before movement, the gage has been advanced one pitch. The construction of the apparatus is seen from Figs. 3 and 4.

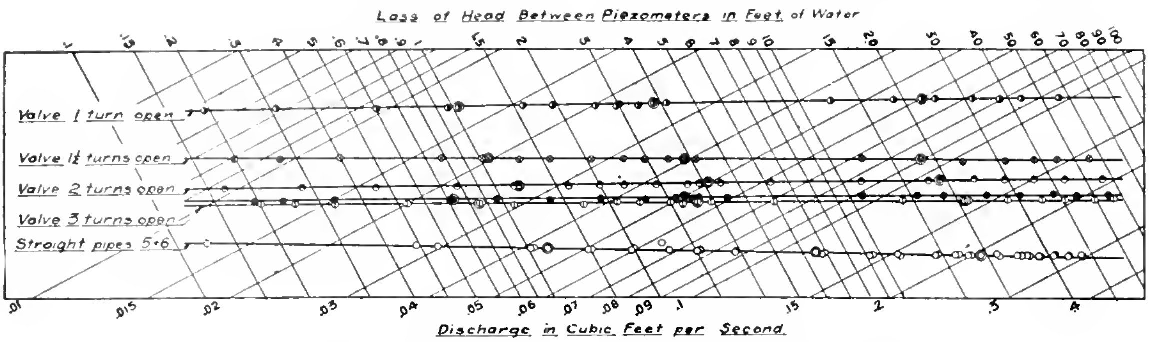


FIG. 2 LOGARITHMIC DIAGRAM OF LOSS OF HEAD AND DISCHARGE

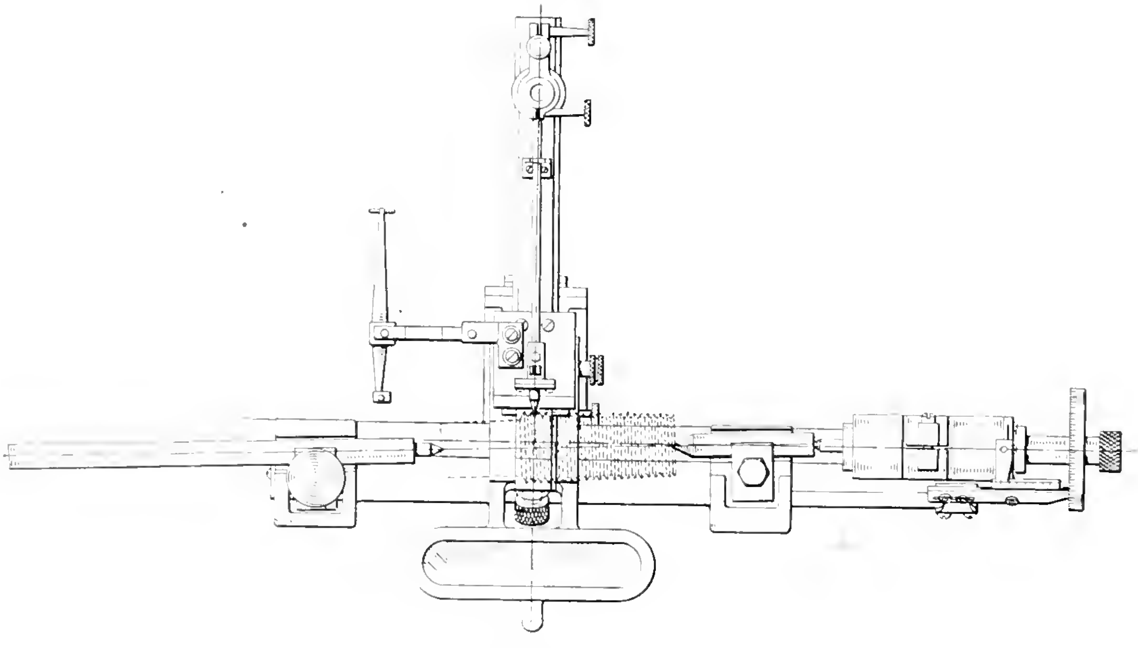


FIG. 3 PLAN OF BUREAU OF STANDARDS APPARATUS FOR TESTING PITCH OF SCREW-THREAD GAGES

Apparatus 2-19 Screw Threads Apparatus for Measuring Profiles of Screw Threads. Communication B510, Bureau of Standards, Washington, D. C. December 9, 1919.

The Bureau of Standards has built and installed in the Gage Laboratory apparatus for examining the profiles of screw-thread gages. The principle of the apparatus is to cast a shadow from the profile of the gage through a lens to a mirror placed about 10 ft. above the gage, and to reflect this shadow back to a point near the projecting apparatus. The magnified profile can then be studied and measured. This communication describes the apparatus necessary for the complete installation, and indicates what may be bought in the open market.

Apparatus 3-19 Length Measurements. Communication B508, Gage Section, Bureau of Standards, Washington, D. C. November 12, 1918.

The Gage Section of the Bureau of Standards has prepared a communication on the Precision of Length Measurements. The communication discusses:

A Total Length of Line Standards
B Calibration of Intervals
C Length of End Standards
D Notes on Micrometer Microscopes.

The communication then gives the history of length standards in a brief form, tracing the yard, the toise, the U. S. Standards and the metric standards. The communication refers to Circular No. 2 of the Bureau of Standards, and reprint No. 256 of the Bureau Bulletins for the method of comparison with fundamental standards, and also to the Hansen Calibration of Intervals as given in *Trav. et Mem. du Bur. Int. des Poids et Mesures*, 5-1886. For length of end standards it refers to article by Fischer in *Bulletin of Philosophical Society of Washington*, vol. 13, p. 241. For the calibration of micrometer microscopes it refers to the Bureau of Standards, vol. 10, p. 375, Reprint No. 215.

Purdue University 1-19 Farm-tractor and motor-truck testing plant. Plant for the standardization performance of tractors in a similar way to standardization of locomotive and automobile performance by the same laboratory. Purdue University, Lafayette, Ind. Director C. H. Benjamin. (See MECHANICAL ENGINEERING, March 1919, p. 295.)

Ohio State University 1-19 Belt-testing machine in process of design. Pulleys to 60 in. in diameter and speeds to 10,000 ft. per min.

E—Research Personal Notes

General 1-19 Coöperative Research.

The Experiment Station of the University of Illinois is undertaking a study of hot-air furnaces and hot-air heating systems using these furnaces. The unknown problems of this system of heating are numerous. Many of the present data are based on experiments made years ago, and much practice and many methods of installation are based on trade practice and not on

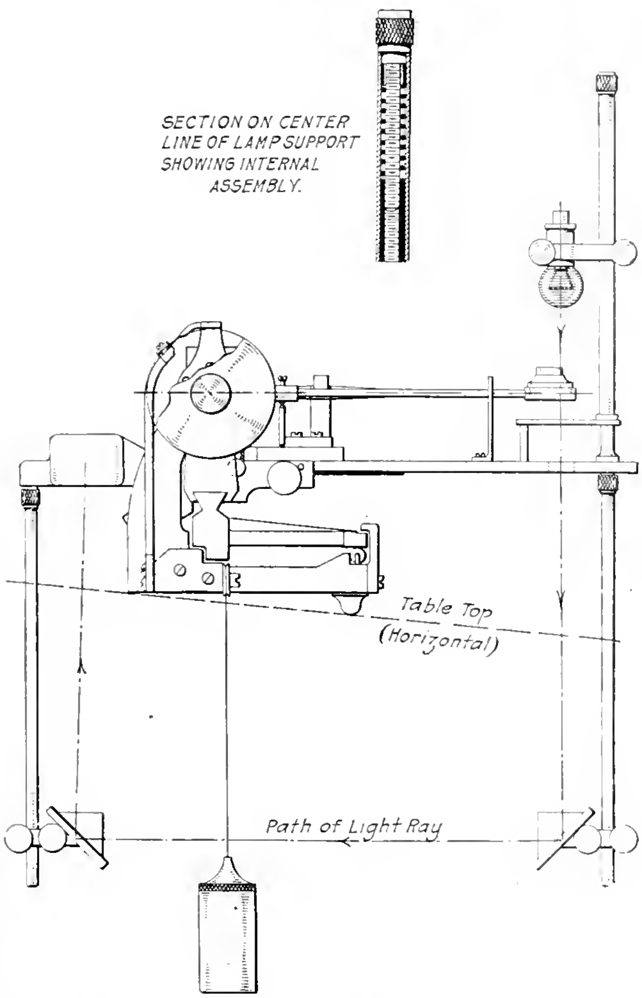


Fig. 4 End Elevation of Apparatus Shown in Fig. 3

scientific data. Such problems as heat losses, velocities, temperature changes, combustion, and multiplicity of risers from one heater are being studied by constructing within the laboratory a model of a house of several floors. In this way the results from actual installations are expected. This work is being done by the Experiment Station, using a grant of funds from an Association comprised of hot-air-furnace manufacturers.

This problem is unique in that it will not only solve many disputed and unknown questions relating to an important system of heating dwellings, but it indicates what may be done by coöperation.

It is one of the hopes of the Research Committee that those who are interested in obtaining definite information relating to problems in their field of activity will combine and make a joint investigation. When the individual companies have not the necessary equipment, personnel and capital for such work, they may, by coöperative effort, arrange with some one having the equipment to carry on the work, the united industries bearing the expense. By this united effort the work may be carried on in a disinterested way, and the results be removed from any suspicion of commercial influence or bias.

Table 2 Diameter Modification of United States or British Standard Whitworth Threads for Interchangeability

Pitch		Change in effective diameter for interchangeability, in.	Difference in full diameter required for assembly, in.	
Threads per inch	Inches	Minus on bolts or plus on nuts	U. S. nut B. S. W. bolt	B. S. W. nut U. S. bolt
20	0.0500	0.0024	0.0029	0.0019
18	0.0556	0.0027	0.0032	0.0022
16	0.0625	0.0031	0.0037	0.0025
14	0.0714	0.0035	0.0042	0.0028
12	0.0833	0.0041	0.0048	0.0034
11	0.0909	0.0045	0.0053	0.0035
10	0.1000	0.0049	0.0059	0.0039
9	0.1111	0.0054	0.0065	0.0043
8	0.1250	0.0061	0.0073	0.0049
7	0.1429	0.0070	0.0083	0.0057
6	0.1667	0.0082	0.0098	0.0066
5	0.2000	0.0098	0.0116	0.0080
4.5	0.2222	0.0109	0.0129	0.0089
4	0.2500	0.0122	0.0145	0.0099

If the Research Committee of The American Society of Engineers can bring about a combination of any interests for coöperative research, it will be very glad to act as the intermediary for this purpose.

General 2-19 Research in Engineering Laboratories.

During the past month the Research Committee has communicated with a large number of the engineering laboratories of our educational institutions, and most of the engineering institutions have reported that war work has so interfered with their regular schedule that little or nothing is being done. However, they expect that after next summer work will again become normal and research investigations will be carried on.

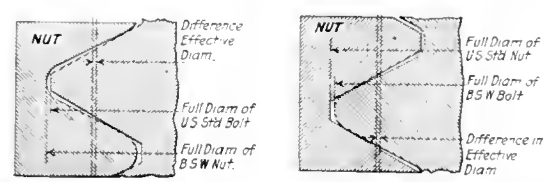


Fig. 5 Interchangeability of U. S. Standard and Whitworth Threads

Apparatus 1-19 Screw Threads—Interchangeability of U. S. Standard and British Standard Whitworth Threads. Bureau of Standards, Gage Section, Sept. 21, 1919. Communication B512.

The Bureau of Standards has issued a table showing that by a slight modification of the diameter of the U. S. or of the Whitworth thread or by a change in both, interchangeability can be secured without changing the form of either. Contact occurs near the crest of the Whitworth thread form or near the root of the U. S. form as shown in Fig. 5. The stress developed in the thread would be the same in both types. The required modification is given in Table 2.

Despite the failure of Congress to pass the Urgency Deficiency Bill, the United States Employment Service will continue to carry on the work of finding jobs for the men who have served their country in its hour of need. While the Service has been cut down 80 per cent, the representatives of the Bureau are still retained in the demobilization camps, and through the coöperation of individuals not connected with the Government, it is believed that many of the offices which it has been announced would be closed, will be kept open. Instead of two offices in New York State, there are indications that the number will reach at least twelve, and the Service has also arranged to continue a total of fifty-six offices throughout the country. John B. Densmore, Director-General of the Employment Service, urges that business, labor, welfare and all other interests in every community in which a federal employment office has been abandoned, take over the office and its work, in order to help meet the emergency.

NEWS OF THE ENGINEERING SOCIETIES

Reports of Annual Meetings of Mining and Electrical Engineers and Electric Railway Association —The Aims of an Engineering Society, etc.

Taylor Society to Locate in Engineering Societies' Building

The Taylor Society, which is perpetuating the doctrines of the late Frederick W. Taylor, Past-President Am.Soc.M.E., hopes soon to secure headquarters in the Engineering Societies' Building. Meanwhile the society is being temporarily accommodated in the rooms of our Society.

Rochester Engineering Society

Members of the Rochester Engineering Society, at its monthly meeting in its rooms, No. 131 to No. 135 Sibley Building, March 14, were addressed by LeGrand Brown, who has been in San Francisco for several years practicing as a consulting engineer, on "California's Development of Natural Resources."

Mr. Brown has been intimately connected with electric railway, power, irrigation and water-supply projects, and has also been brought into constant touch with the economic and engineering development of the Pacific Coast.

He described at length the development of California's electric transportation and natural resources. The Los Angeles aqueduct was shown on the screen and explained, as well as the proposed Hetch Hetchy water-supply project for San Francisco.

Mr. Brown is a charter member and past-president of the Rochester Engineering Society. Before he left Rochester he was connected with the street railway, the building of the Hemlock lake conduit by the city, and earlier electric suburban lines.

Material-Handling Machinery Association Formed

The organization has been completed of an association of manufacturers of machinery for handling materials. The suggestion for the organization was made by the Department of Commerce and the U. S. Shipping Board to facilitate the study of freight-handling methods at railroad and ocean terminals. By mobilizing the experience and ability of all manufacturers of handling devices into a single organization, the Government will not only be able to reach this industry in an effective way when it needs coöperation, but the industry itself can more effectively attack the large and difficult problems presented at terminals and ports.

Other lines of activity are to be taken up, however, in relation to the material-handling problems of the various industries. The president of the association is Calvin Tomkins, formerly Commissioner of Docks, New York City. Headquarters will be at 35 West 39th Street, New York, and the active conduct of the association's work will be in the hands of Mr. Zenas W. Carter, the secretary and manager.

American Welding Society to be Organized

The representatives of over 90 societies, institutions and corporations who during the war greatly developed the art of welding, will meet on March 28, 1919, at the Engineering Societies Building, 29 West 39th Street, New York, with a view of forming The American Welding Society. This Society will merge the Welding Committee of the Emergency Fleet Corporation and the National Welding Council, both of which were created during war times by the Council of National Defense.

The discussions, researches, lectures and conferences, as well as the interchange of views with foreign countries which were carried on during the war, aroused in this country a great interest in the use of electric welding and it is expected that the advance in welding thus made will be continued and extended to the entire field of joining metals. The American Welding Society proposes to bring together, in the manner usual for scientific societies, persons from all branches of the industry who may be interested in any of the welding processes, whether it be forge welding, electrical resistance welding, gas welding or thermal welding.

The society will also create and assist in maintaining a bureau of welding, which will be a separate organization designed to take advantage of the principle of coöperation in research and standardization.

As part of its routine the society plans to conduct a research of the methods of welding and to determine, if possible, the conditions under which the best welds may be secured. This involves investigations of the best current to use with various sizes of electrode and different types of work, and a determination of the proper method of procedure in making up both gas and electric-arc welds, coupled with an adequate system of inspecting the work as it progresses. In arc and gas welding the proper angle of bevel and the space to be allowed between plates must be selected and an investigation made of "electrode" wire and of "welding wire."

In gas, spot, or arc welding, methods of assembling large structures to eliminate initial or locked-up stresses due to contraction on cooling, are also to be investigated.

The benefits of standardization are also well recognized by the new society, for they intend to carry on this important work in a way to meet the approval of the American Engineering Standards Committee.

The Aims of an Engineering Society

At the annual meeting of the Engineers' Society of North-Western Pennsylvania, held at Erie, in January, the newly elected president, Mr. Armin Schotte, C.E., outlined what he believed should be the aims of the society and its part in public affairs. He said:

During the pioneer days, and up to near the close of the last century, engineers organized themselves into societies, which became national in scope. The purpose of these societies was to enlarge the sum total of technical knowledge by the interchange of information among themselves. Such work was of the utmost importance at that time, and was a material factor in adding to the store of available data.

During the last twenty years, however, conditions have changed, and in many cases successful steps have been taken to remedy them. What has proved antiquated and practically useless in the case of the national societies would be still more so in smaller local organizations such as ours. So, since we can hope, as a body, to add but little to the sum total of new engineering knowledge, and if we tried, would probably be wasting time which might be put to a better purpose, why undertake it?

The question naturally arises, What are the aims which justify us in maintaining and fostering our society? Without concerted effort in any way, but rather sporadically, new methods have been developed in the conduct of local engineering associations, and I am happy to say that we have, unconsciously perhaps, generally pursued a policy in harmony with them, to which I believe this society owes a large part of its successful growth.

The ultra-serious consideration of any technical subject has either very little or no place in this new policy. The programs are made up and the subjects treated in a manner to interest not merely specialists, but all classes of technically trained men; and in a large number of cases even laymen. The meetings thus assume an attractiveness which will assemble a maximum number of engineers of various lines, and also laymen, thus aiding to establish proper and pleasant relations among the engineers themselves, and to bring the profession before the public in an effective manner. By continuing this policy we shall soon be able to extend our work and help ourselves and every other engineer to conserve and maintain all of the rights and privileges, both mental and legal, to which the individual and the profession at large are justly entitled; to render to the public such service as we are

qualified to perform; to create the proper appreciation of the function of the engineer generally, be he employee or maintaining an office of his own, and to compel a recognition for ourselves as a necessary factor in the civic and political growth of our community and the nation.

The retiring president, Mr. R. C. Stevens, who was unable to attend the meeting, sent a communication in which he referred to The American Society of Mechanical Engineers as follows:

Another very interesting sign of the times is the increased interest in the human element of engineering. Witness the December meeting of the A. S. M. E., when they held an all-day session on Engineering of Man Power. We have long had papers and discussions on wage systems; but now we have increased interest in welfare, safety and the personal relations of employer and employee. Success in engineering is not alone the mastery of mechanisms and securing output from machines, but also, and more important, the organization and training of men and the guiding of industry to augment the usefulness and happiness of mankind.

American Electric Railway Association

THE meeting of the American Electric Railway Association held in the Engineering Societies Building on March 14 was well attended by electric executives from all over the United States and Canada. The most important and valuable discussion during the convention centered around the report of the Association's Committee on Readjustment. The chairman of this committee, Mr. P. H. Gadsden, president of the Charleston Consolidated Railway & Light Co., submitted a preliminary report embracing the fundamentals of a plan for readjusting the relations between the communities and the electric-railway companies.

The committee reported that the present state of the industry was largely the result of a fixed rate of fare made with little consideration of the adjustment of price to meet cost. It was therefore necessary, if the railways are to survive and continue service, that some system of flexible fares, to increase and decrease as the cost of furnishing the service increases or decreases, be established.

Following the report of the committee there was a discussion of the so-called "service at cost" franchises such as are now in effect in Cleveland, Cincinnati, and Montreal. In these cities the fares are automatically regulated, the company receiving a stipulated return upon its money and the city specifying the service which the company shall furnish for the public.

A. Merritt Taylor, a former manager of the Division of Passenger Transportation for the United States Shipping Board and president of the Philadelphia and Westchester Traction Company, also spoke on Modern Regulatory Plans and Theories.

In the afternoon Francis H. Sisson, vice-president of the Guaranty Trust Company of New York, read a paper on Electric Railways and the Investor; and Hon. Charles E. Elmquist and Hon. William D. B. Ainey spoke on Electric Railways and Regulatory Commissions.

In the evening a dinner was held at the Waldorf-Astoria at which Hon. Francis Burton Harrison, Governor-General of the Philippines; Hon. Lindley M. Garrison, Receiver of the Brooklyn Rapid Transit Company; and B. A. Hegeman, Jr., spoke. John H. Pardee, president of the association, presided.

American Institute of Electrical Engineers

THE Seventh Annual Midwinter Convention of the American Institute of Electrical Engineers was held at New York on February 19 to 21. The opening session was a joint meeting with the American Institute of Mining Engineers, at which matters pertaining to the Engineering Council were considered. Mr. Leighton, representative of the Council at Washington, outlined the plans of the organization, which include a movement toward creation of a department of public works, and a federal engineering department under which all engineering activities of the Government shall be correlated and presided over by a member of the engineering profession.

C. A. Adams, president of the A. I. E. E., gave a brief account of the work of the welding committee, after which the technical papers for the session were presented.

On Wednesday evening Dr. J. A. Brashear delivered a lecture on The New Astronomy to an audience which completely filled the auditorium. The lecture was accompanied by numerous lantern slides showing disturbances on the surface of the sun. These slides had never been shown before. The lecture was followed by an exhibition of moving pictures illustrating the operation of the Burroughs adding machine and the telephone receiver and transmitter.

The technical session on Thursday morning was devoted to a discussion of the various phases of standardization in engineering work. Dr. C. P. Steinmetz presented in abstract his paper on General Equations of the Electric Circuit, and H. S. Osborne discussed the subject of Wave-Shape Standards.

Thursday afternoon was set apart for technical excursions. Inspection trips were made to the Brooklyn Navy Yard and the Bell System Laboratories of the Western Electric Company. Members and guests were transported from the Engineering Societies Building in busses to the foot of 23rd Street, where the Navy Department supplied large sea-going tugs to carry the party to the Navy Yard. The party spent an interesting afternoon inspecting the power plant, shops, dry docks, and various other features of the yard.

The Western Electric Company provided cabs for those who visited their plant. Members and their guests also had the leadership of a guide as they went through the Bell System Laboratories.

The final session was held on Friday and was exclusively devoted to technical papers. Of these the most valuable and interesting was on Radio Telephony, by E. B. Craft and E. H. Colpitts, both of the Western Electric Co. The paper described the development of the art of radio telephony to the accomplishment of transatlantic communication and the use of radio telephony between ships. The production of apparatus for both Army and Navy aircraft was also outlined, the essential features of which were the design of light and compact sets.

Mining Engineers Adopt a New Name

FROM the beginning to the end, the attendance and enthusiasm of the 119th meeting of the American Institute of Mining Engineers, which was held in New York, February 17 to 20, surpassed all expectations. Besides the ten technical sessions, one of which was in conjunction with the American Institute of Electrical Engineers and one a session of the National Research Council, there were two memorial meetings, one for Dr. Rossiter W. Raymond, for twenty-seven years secretary of the Mining Engineers, and one for the members who had died in service. Two joint sessions with the Canadian Mining Institute, and a meeting devoted to pictures of copper mining, milling, and smelting were also held.

One of the most important events in the history of the Institute took place at the annual business meeting on February 18, when the Institute voted to change its name from the American Institute of Mining Engineers to the American Institute of Mining and Metallurgical Engineers.

It is the consensus of opinion that this marks an epoch in the history and usefulness of this Institute, and it is expected that the change will presage a large and healthy growth in metallurgical fields. Many metallurgists who knew nothing about mining were loath to join a society of mining engineers, despite the fact that over 35 per cent of the papers published in its transactions during the past five years dealt with metallurgical subjects. Additional appropriateness in the new name lies in the fact that the American Institute of Metals is now an important part of the larger organization.

The choice of the name has the double advantage, much to be desired, of retaining the word Engineers and maintaining the former initials of the Institute, A. I. M. E.

At this session the announcement was also made of the election of Horace V. Winchell, Minneapolis, as president.

Technical Sessions

The technical sessions covered a wide field of engineering, and in the Engineering Survey Section will be found abstracts

of some of the more important papers which were presented. The sessions were devoted to problems of industrial organization, the Institute of Metals Division, and to petroleum and gas. Among the special features of these sessions were the topical discussions on housing and Americanization. Americanization, too, was the topic for discussion by the Woman's Auxiliary on Wednesday morning.

Canadian Mining Institute Day

On Tuesday, nearly 100 members of the Canadian Mining Institute were present to discuss the possibility of bringing about uniform mining laws for the United States, Canada, and Mexico, to obviate the maintaining of separate legal departments and managerial forces for the several countries; and to avoid the confusion which, it is said, has led to duplication of effort and has sometimes created a barrier to international coöperation.

Four joint discussions formed the program of the sessions with the Canadian Mining Institute. T. W. Gibson, the representative of the Canadian Mining Institute, opened the discussion on the subject of Principles of Mine Taxation, in which the American Institute was represented by Ralph Arnold, of the United States Treasury Department. Later, Alfred G. Heggem, of Tulsa, Okla., cited an instance in which a high rate of taxation decreased the Government's revenue by retarding the transfer of property. The second discussion of the morning was on the subject of Industry, Democracy, and Education. C. V. Corless represented the visitors and President Jennings the A. I. M. E.

In the afternoon, Mr. T. A. Rickard, of San Francisco, Cal., opened the discussion by a paper entitled The English-Speaking People. He was followed by Dr. A. R. Ledoux, of New York, who gave a brief talk on International Coöperation. In it he spoke of the necessity of closer coöperation, also, with Mexico. President Jennings later said that he is planning a trip to Mexico, when he expects to meet with the Local Section in Mexico, and hopes to initiate some discussion of problems that confront the American engineer. The question of a uniform mining law for North America provoked considerable discussion. While most of the talk was confined to the various Canadian laws, the possibilities of uniform laws with Mexico and Central America were also considered.

Wednesday was devoted to the work of the National Research Council, which occupied the entire day and not only the morning as was planned, to the problems of mining, milling, and geology, and to the study of welding problems, jointly with the American Institute of Electrical Engineers. In all cases the discussion was most animated.

Work of Bureau of Standards in 1918

In the recently issued annual report of the Director of the Bureau of Standards, it is stated that during the fiscal year ended June 30, 1918, the Bureau studied many interesting applications of science to warfare, such as methods for locating enemy batteries; development of new materials, appliances, and methods; and other technical researches of military problems.

The regular work of the Bureau, however, yielded interesting and important results. Apart from new researches, a large volume of testing was completed. The construction of the new industrial laboratory, the completion of the metallurgical laboratory, and the building of a number of emergency war laboratories for airplane investigators were events of interest and will be of great value in the development of the several branches of technology within the activities of the Bureau.

Congress has authorized the establishment of a Government coal yard, or yards, in the District of Columbia, from which all federal buildings will be supplied; this yard will be placed under the supervision of the Bureau.

Apart from confidential reports, the Bureau published during the year about 50 new publications, including scientific and technologic papers, circulars, and bulletins.

Altogether the report of the Director shows an extremely wide range of industrial-research problems in progress, which will be of material aid in readjusting industry to peace conditions.

ROLL OF HONOR

DIED IN THE SERVICE

Hoskins, Stephen Paul, Lieutenant, Co. L, 319th Infantry, American Expeditionary Forces, France.

Lynch, Thomas M., Major, General Supplies Division, Quartermaster Corps, U. S. Army.

Seed, Chas. R., Lieutenant, U. S. Naval Reserve Force.

The following list of names of members in the Service has been compiled during the last two months. It contains, in many cases, names of members who are now discharged from the Service but of whose connection with Army or Navy there has been no previous mention.

Armacost, W. H., Second Lieutenant, Refrigerating Plant Co. 501, American Expeditionary Forces, France.
Auerswald, H. R., First Lieutenant, Chemical Warfare Service, U. S. Army.
Baldwin, C. M., Lieutenant, U. S. Naval Reserve Force.
Barry, Ralph E., Lieutenant, U. S. Naval Reserve Force; Line detailed to Construction, Philadelphia Navy Yard.
Blank, B., Private, First Class, Co. D, 309th Infantry, 78th Division, U. S. Army.
Bunker, A. H., Lieutenant (junior grade), Aviation, U. S. Navy.
Buzby, Paul M., First Lieutenant, Ordnance Department, U. S. Army.
Carlson, C. A., First Class Private, 20th Company, Artillery, U. S. Army.
Cartwell, N. M., Chief Machinist's Mate, U. S. Naval Reserve Force, U. S. Navy Steam Engineering School.
Danks, R. L., Chief Petty Officer, Machinist Division, U. S. Naval Reserve Force.
Flickinger, H. W., Captain, Division of Military Aeronautics, Air Service, U. S. Army.
Goedkoop, Walter C., Corporal, Co. I, 2d Pioneers' Infantry, American Expeditionary Forces, France.
Goezenberger, R. L., Captain, Ordnance Department, American Expeditionary Forces, France.
Goodwin, Guy L., Second Lieutenant, Coast Artillery Reserve Corps, U. S. Army.
Graesser, C. F., Electrician, First Class, Communication Service, U. S. Navy.
Haasis, P. W., Flying Cadet, Squadron 65, S. M. A., Aviation Barracks, Berkeley, Cal.
Harris, W. A., First Lieutenant, Coast Artillery Reserve Corps, U. S. Army.
Hess, A. McD., Ensign, U. S. Navy.
Higley, F. R., Lieutenant, The Infantry School of Arms, Camp Banning, Columbus, Ga.
Igleheart, G. P., Ensign, U. S. Navy.
Johnson, H. S., Captain, 26th Artillery, Coast Artillery Corps, U. S. Army.
Kuttner, J., Warrant Machinist, U. S. Naval Reserve Force.
Macy, R. G., Lieutenant, Ordnance Department, U. S. Army; assigned to Sandy Hook Proving Ground, Sandy Hook, N. J.
Masser, Harry L., Ensign, U. S. Navy.
Nelson, J. E., Ensign, U. S. Navy.
Purinton, J. W., First Lieutenant, Ordnance Department, U. S. Army.
Rahner, Maxwell L., Corporal, Meteorological Section, American Expeditionary Forces, France.
Ralph, J. J., Lieutenant, Purchase, Storage and Traffic Division, General Staff, U. S. Army.
Ranton, J. L., Captain, Co. G, 1st Hawaiian Infantry, U. S. Army; stationed at Schofield Barracks, Hawaiian Territory.
Root, F. J., Major, Inspection Division, Ordnance Department, U. S. Army.
Smith, P. M., Second Lieutenant, 1st Co., Rep. Dep. Battalion, Signal Corps, American Expeditionary Forces, France.
Snyder, C. L., Second Lieutenant, Nitrate Division, Ordnance Department, U. S. Army.
Sparks, H. C., D.S.O., M.C., Colonel, 3d Army Labour Commandant, British Expeditionary Force, France.
Thee, W. C., Captain, Coast Artillery Corps, Amcrican Expeditionary Forces, France.
Uehling, E., Second Lieutenant, 6th Anti-Aircraft Machine Gun Battalion, U. S. Army.
Wilson, Leroy A., First Lieutenant, Air Service, Aeronautics, U. S. Army.
Windle, A. E., Second Lieutenant, Air Service, American Expeditionary Forces, France.
Woodbury, J. G., Major, Production Division, Ordnance Department, U. S. Army.
Woolner, S. A., Second Lieutenant, Air Service, Aircraft Production, U. S. Army.

NECROLOGY

J. SELLERS BANCROFT

J. Sellers Bancroft, a member of the Society since 1880, manager from 1909 to 1911, and vice-president from 1915 to 1917, died at his home in Philadelphia on January 29 after an illness of several months.

Mr. Bancroft was born in Providence, R. I., on September 12, 1843. His father, Edward Bancroft, a distinguished engineer, who made many inventions of machine tools and shafting appliances, founded the firm of Bancroft and Sellers, now Wm. Sellers & Co., Inc., Philadelphia. As a sidelight on the growth of the machine-tool industry in this country, it is interesting to note that Edward Bancroft built the first metal planer in the United States, the bed and table being chipped and filed by hand.

J. Sellers Bancroft was educated in Philadelphia, being graduated from the high school of that city in 1861. In February of that year he entered the employ of Wm. Sellers & Co., being apprenticed to his uncle, Wm. Sellers. In 1863, at the age of twenty, he was made gang foreman, and in 1866 general foreman. He was admitted to the firm in 1873, and when the business was incorporated in 1887 he was made general manager.

While with the Sellers Co. he was granted many patents on machine tools, injectors, shafting appliances, power cranes and their interlocking electrical devices.

For forty-one years he remained with this company, leaving in 1902 at the age of fifty-nine to become general manager and mechanical engineer of the Lanston Monotype Machine Co., Philadelphia. In the following sixteen years of his life he did his greatest engineering work; the perfection of the monotype and the special machines for making the molds and matrices used with it for casting and composing type in automatically justified lines. The organization of the monotype factory exemplifies his work as an executive and a leader of men.

A keen lover of books, it was a great joy to him that his work did much to raise the quality and reduce the cost of printing not only in the United States, but also throughout the world.

At the time of his death he was vice-president and treasurer of the Monotype Co., as well as its general manager and mechanical engineer.

More than 100 patents testify to the scope of Mr. Bancroft's engineering work and the range of his creative ability. To those who worked with him on the solution of any of the many problems that engaged his attention, his thoroughness, the result of his never-failing perseverance and patience will be an ever-inspiring memory.

J. Sellers Bancroft

GEORGE URQUHART BORDE

George U. Borde, consulting engineer, died in New Orleans, La., on December 17, 1918. He was born in January 1871 in New Orleans and was graduated from Tulane University in 1888. Mr. Borde was formerly district engineer for the southern district of the Edison General Electric Co. After a short period in the contracting business in Memphis, he opened consulting offices in New Orleans, which he still maintained at the time of his death. He became a member of the Society in 1908.

Mr. Borde, at the time of his death, was one of the most prominent consulting engineers in the City of New Orleans. He was retained as consulting engineer by the Great Southern Lumber Co. and also by the United States Industrial Alcohol Co. In connection with his work for the latter, his investigations in regard to the process of the manufacture of ethol alcohol from wood waste was possibly his most important work.

GEORGE K. GARVIN

George K. Garvin, president of the Garvin Machine Co., New York, died at his home in Garden City, Long Island, on February 20, 1919. Mr. Garvin was born on May 2, 1859, in Hartford, Conn. He was educated in the public schools of New York and Jersey City, later attending Hasbrouck Institute. At the age of sixteen he entered his father's business, then known as Smith & Garvin, and upon his father's death became president of the concern. He became a member of the Society in 1909.

WALTER V. TURNER

Walter V. Turner, manager of engineering of the Westinghouse Air Brake Co., died at the Columbia Hospital, Wilkinsburg, Pa., January 9. Mr. Turner was born in Epping Forest, Essex, England, in 1866, and was educated in the Textile Technical School of Yorkshire. He came to this country in 1888 and settled in the West, where he became the manager of a sheep and cattle company. For several years he was general air-brake inspector for the Atchison, Topeka and Santa Fé Railroad. In 1903 he became connected with the Westinghouse Air Brake Co. as engineer, remaining with that company and associated interests until his death.

Mr. Turner was an inventor of international prominence, patenting more than 400 devices in use on railroads and in industrial plants. For his achievements as an inventor in the development of the air brake, he was awarded the Elliott Cresson and the Edward Longstreth medals by The Franklin Institute of Philadelphia. In May 1918 the University of Pittsburgh conferred the degree of Doctor of Engineering upon him. He became a member of the Society in 1913.

CHARLES EDWARD JOHNSON

Charles E. Johnson, chief engineer of the Diamond Gasoline Co., Kansas City, Mo., died on January 5, 1919. He was born in December 1883 in East Atchison, Mo., and was a 1910 graduate of the University of Kansas. Mr. Johnson was formerly connected with the Santa Fe Railway Co. as draftsman and with the Lawrence Paper Mill, Lawrence, Kan., as chief engineer. He had also held the position of instructor in mechanical drawing in the high schools of Kansas City and Ottawa, Kan. He became an associate-member of the Society in 1918.

THOMAS M. LYNCH

Thomas M. Lynch, Major, General Supplies Division, Quartermaster Corps, U. S. Army, died on December 18, 1918. He was born on July 2, 1882, in Worcester, Mass., and attended the Worcester Polytechnic Institute. Major Lynch had formerly been connected with the Buena Vista Extract Co., as superintendent, and was also for two years staff member of the J. J. Lynch Co., New York. At the time of his death, Major Lynch was Chief of the Administrative Branch of the General Supplies Division, Quartermaster Corps, having been placed in charge of that department at the time of its creation. He organized this whole division and received his appointment as Major in recognition of his merit and the efficient results he had secured. Major Lynch became an associate-member of the Society in 1914.

HENRY GEORGE PULSCHEN

Henry G. Pulschen, of the inspection department of the J. G. White Engineering Corporation, New York, died on December 24, 1918. Mr. Pulschen was born in February 1891 in New York City and was a graduate of Cooper Union and of Pratt Institute. He had formerly been associated with the H. R. Worthington Co. as detailer on power-plant machinery and as designer and checker with the Alberger Pump & Condenser Co. Mr. Pulschen became a junior member of the Society in 1918.

HENRI LEAUTE

[News of the death of Henri Léauté, a distinguished Honorary Member of this Society, was received some time ago, but owing to war conditions it has not been possible to secure data for a suitable memorial notice until quite recently.—Editor.]

Henri Léauté, the great French engineer and mathematician, was born in 1847. In 1866, at the age of 19, he had the unique distinction of being accepted at the head of a long list of competitors for entrance into two of the best technical schools in France, the Ecole Polytechnique and Ecole Normale. He entered the latter and was graduated in 1869 with the degree of engineer.

The war of 1870 naturally interrupted his professional career, but, released from military service in 1871, the young man at once engaged in three lines of work requiring very dissimilar characteristics of mind

Henry Léauté

those of medicine, mathematics and mechanics, and rapidly established an important position for himself in each of these branches of science.

The first paper published by Léauté dealt with partial derivative equations of the first order. Of much greater importance was the second paper, dealing with friction in bearings. Other of his works covered the subjects of general kinematics, strength of materials, dynamics and theory of machines. In all of this work he made extensive use of higher mathematical methods in the solution of mechanical problems. It is significant, however, that in all his work he carefully avoided the use of mathematics for its own sake and never lost sight of the practical applications of his investigations.

In kinematics, Léauté introduced a new conception, namely, the order of proximity of two arcs of neighboring curves. Because of this concept he was enabled to formulate precise mathematical rules to take the place of former approximations, and these he applied in the design of gears and in the improvement of Watt's parallelogram and the Farcot governor.

In the field of the strength of materials, Léauté developed important data in relation to the elastic deformation of circular members and the distribution of stresses in cylindrical bands, especially in band brakes. Of the greatest importance, however, were his master papers dealing with dynamics and the theory of machines. His treatise on Telodynamic Transmission has become a classic. The transmission of power at a distance by means of cables was fully solved by him, both from the theoretical and practical points of view. The great importance of this work has failed to be realized only because the introduction of electric transmission has materially reduced the field of application of cable transmission.

The governing of engines formed the subject of several papers of great importance. Starting with the study of flyball governor, he gradually passed to that of oscillations having long periods and investigated the whole field, applying new and ingenious mathematical methods.

In addition to his scientific work, Léauté took a prominent part in national educational activties, and also in business, where he held important positions, such as that of president of the French Telephone Company and also of the Paris Electric Distribution Company.

In 1891 he was elected honorary member of The American Society of Mechanical Engineers. In 1915, notwithstanding a malignant disease which for years had sapped his strength, he took an active part in the management of war industries, on the running of which depended the defense of the country at that time. It is no exaggeration to say that this patriotic activity was the prime cause of his death.

ALFRED H. RAYNAL

Alfred H. Raynal, member of the Society since 1884 and manager from 1889 to 1902, died at his home in Washington, D. C., on March 1. Mr. Raynal was born on August 5, 1848, in Hamburg, Germany, serving his apprenticeship as mechanic and draftsman in a marine-engineering establishment there. In May 1862 he came to the United States and worked as a machinist and draftsman for private concerns in New York. In 1863 he was engaged by the Navy Department as draftsman on the design of twenty light-draft monitors. In 1864 he made the drawings for and superintended the construction of the monitor *Squando* at the works of McKay Aldus at East Boston, Mass.

He next entered the employ of the Babcock & Wilcox Co., Providence, R. I., working out details of their engine and boiler which latter is now used so extensively in the U. S. Navy. In 1870 Mr. Raynal became superintendent of the works of Poole & Hunt, Baltimore, who were building engines and boilers under the Babcock & Wilcox patents. From 1880 to 1884 he was superintendent of the Wheelock Engine Works, Worcester, Mass. He was next connected with the DeLamater Iron Works, New York, as superintendent, where he did considerable work for Capt. John Ericsson, building his submarine gun, high-expansion engine, sun motor, etc. In recognition of his services to him, Captain Ericsson presented Mr. Raynal with a rare and valuable book on his inventions. This book was presented to the Society by Mr. Raynal for record.

From 1890 to 1897 he successively held the following positions: Superintendent of the Richmond Locomotive Works, building the machinery of the U. S. battleship *Texas;* superintendent of Samuel Moore & Son's Shipyard, Elizabeth, N. J., building the revenue steamer *Maple* and the practice cruiser *Bancroft;* superintendent of the Corliss Engine Co., Providence, R. I.; superintendent of the Walker Co., Cleveland, Ohio. In 1897 Mr. Raynal studied patent law, working in an attorney's office in Cleveland.

In 1898, during the Spanish War, at the personal request of Admiral Melville, he entered the Navy Department as draftsman to design engines for the first sixteen torpedo-boat destroyers, as his experience in building successfully the spider-frame high-speed engines of the *Bancroft* had been unusually valuable.

From that time Mr. Raynal's work was in the Navy Department where he was of signal service in the Bureau of Steam Engineering. Mr. Raynal acted as expert engineer in the courts in suits resulting from explosions of boilers, bursting of flywheels, etc., and in admiralty cases.

He was a member of the American Society of Naval Engineers and Marine Architects, the American Society of Naval Engineers, the Washington Society of Engineers, and the American Society of Marine Draftsmen.

CHARLES R. SEED

Charles R. Seed, for the last seven years chief engineer of the Worcester Electric Light Co. and recently lieutenant in the United States Naval Reserve Force, died in Worcester on October 8, 1918, of pneumonia. Mr. Seed was born in April 1876 in Lawrence, Mass., and was educated in the schools of that city, later receiving training aboard the Massachusetts Nautical Schoolship *Enterprise*, for seven years serving as engineer on runs between Europe and America. When the United States declared war against Germany he offered his services, was commissioned ensign and assigned to overseas patrol duty in the war zone, later being promoted to lieutenant. He had formerly served as chief engineer with the Blackstone Manufacturing Co., Blackstone, Mass., and as superintendent of power with the Rockingham County Light & Power Co., Portsmouth, N. H. Mr. Seed became an associate-member of the Society in 1914.

ROY BROOKS SMITH

Roy Brooks Smith, assistant electrical engineer Pennsylvania Lines West, died on October 19, 1918. He was born in Uhrichsville, Ohio, in March, 1882. In 1904 he received his M. E. degree from Ohio State University, serving his apprenticeship during his vacations with the Pennsylvania Lines West. Upon graduation he became connected with the same company as assistant engine-house foreman. He was rapidly promoted to more responsible positions, and just previous to his death was made assistant electrical engineer. He became a junior member of the Society in 1905 and was promoted to full membership in 1912.

HENRY DREW EGBERT

It is with deep regret that we announce the death of the Secretary of our New York Section Committee, Henry Drew Egbert. Mr. Egbert died on Sunday, March 23, in his 33d year. A more extended notice will appear in an early issue of Mechanical Engineering.

PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by March 15 in order to appear in the April issue.

CHANGES OF POSITION

G. H. Cooper, formerly secretary and treasurer of the Electric Company, Hartford, Conn., has become identified with the H. T. Paiste Company, Philadelphia, Pa., in the capacity of mechanical superintendent.

Chester H. Mannion, until recently chief engineer, Kerr Mills, American Thread Company, Fall River, Mass., has entered the employ of the Nashua Manufacturing Company, Nashua, N. H., in charge of their steam plant.

Robert D. Koplin has left the employ of the Air Nitrates Corporation Agents of the U. S. Ordnance Department, to accept a position in the office of the chief engineer of construction of the Weirton Steel Company, Weirton, W. Va.

W. Harwell Allen has assumed the duties of secretary and assistant manager of the Memphis Heating Company, Memphis, Tenn. He was until recently associated with the J. G. White Engineering Corporation, Sheffield, Ala.

John Fisher, formerly chief engineer, Hartford district, of The Connecticut Company, Hartford, Conn., has accepted the position of chief engineer of the Quincy Point Power Station of the Bay State Street Railway Company, Quincy, Mass.

L. F. Merritt has severed his connections with the Bureau of Aircraft Production and has become associated with Joseph N. Smith and Company, of Detroit, Mich., as mechanical engineer.

E. T. Koskinen, formerly affiliated with the Nordberg Manufacturing Company, Milwaukee, Wis., as draftsman, has become connected with the machinery division of the Newport News Shipbuilding and Dry Dock Company, Newport News, Va.

Robert W. Schuette, recently mechanical engineer with the Mesta Machine Company, Pittsburgh, Pa., has become affiliated with the Harrisburg Pipe and Pipe Bending Company, Harrisburg, Pa.

William E. A. Walther has become associated with the United Glass Bottle Manufacturers, of London, England. He was formerly in the service of the Illinois Glass Company, Alton, Ill., in the capacity of mechanical engineer.

Norman G. Hardy has assumed the position of chief mechanical and electrical engineer for the Arizona Copper Company Ltd., Clifton, Ariz. He was formerly associated with the Old Hickory Powder Plant, Jacksonville, Tenn.

Mather W. Sherwood has left the employ of the Burke Electric Company and has entered the service of the Ball Engine Company, of Erie, Pa.

Louis Mardaga has assumed the duties of sales engineer for the Mickle Milnor Engineering Company, Philadelphia. He was until recently assistant naval inspector of Ordnance, Alloy Steel Forging Plant, Carnegie, Pa.

Ralph C. Chesnutt, formerly with the Willys-Overland Company, Toledo, Ohio, is now assistant chief engineer for the North American Motors Company, Pottstown, Pa.

C. L. Horne, formerly mechanical engineer with the Underfeed Stoker Company, Chicago, Ill., has become associated with The Texas Company, Roanoke, Va., in the capacity of lubricating engineer.

George A. Hickerson has resigned his position as a mechanical appraiser with Ford, Bacon and Davis, New York, to accept a position as chief engineer with the Rhodia Chemical Company, New Brunswick, N. J.

Howard M. Groff has assumed the duties of chief engineer of factories for Robert H. Ingersoll and Brother, of New York. He was recently affiliated with the Frankford Arsenal, Philadelphia, Pa., as gage expert.

Charles E. Beck, formerly sales engineer with Baker-Dunbar-Allen Company, Cleveland, Ohio, has accepted a similar position with the Busch-Sulzer Bros.-Diesel Engine Company, St. Louis, Mo.

J. A. Polson, professor of mechanical engineering at the Michigan Agricultural College, East Lansing, Mich., has resigned to accept a position of factory manager with the Milwaukee Stamping Company, of Milwaukee, Wis.

ANNOUNCEMENTS

Ray B. Whitman, formerly with the Emergency Fleet Corporation at Cleveland, is now inspecting the construction and machinery installation of steel river paddle steamers and barges for the Dravo Contracting Company of Pittsburgh, Pa.

V. L. Sanderson has had supervision of the Philadelphia district of the Terry Steam Turbine Company since the death of Charles E. Hague in April 1917.

E. D. Latter is a member of the firm of Harris, Latter and Company, New York, which has recently been formed to conduct business as constructive accountants and auditors.

John E. Muhlfeld has assumed the presidency of the Pulverized Fuel Equipment Corporation, which has recently been organized for the purpose of taking over the business of the Locomotive Pulverized Fuel Company. Mr. H. F. Ball is Vice-President Executive, and V. Z. Caracristi is Vice-President in charge of engineering, of the company.

Frederick A. Waldron, consulting engineer, announces that in addition to his consulting practice he has established a bureau for audit and inspection of organizations and factory methods. The object of this bureau is to provide periodical reports for boards of directors or the officials of corporations as to the efficiency of the operating and producing factors of their organizations. The services of this Bureau will also be available for consultation relative to the formation of new organizations and industrial enterprises.

Prof. W. H. Kenerson, of Brown University, is now in France organizing instruction in mechanical engineering in the Army of Occupation, and is a member of the committee secured by the Y. M. C. A. to advise the Army authorities there in these matters.

R. W. Baily has accepted the position of assistant general manager of the Jacksonville Dry Dock and Repair Company, Jacksonville, Fla.

Lieut. A. G. Kessler, U. S. N. R. F., who for six months past has been in charge of the Gun Division of the Bureau of Ordnance, Navy Department, has been released from active duty in the Naval Service and has become vice-president of the General Ordnance Company, Derby, Conn., and of the National Tractor Company, Cedar Rapids, Ia., in charge of purchasing and production at both plants. Mr. Kessler was formerly general manager of the Lakeside Forge Company, Erie, Pa.

Calvin L. Halladay has become affiliated with the Jackson Motor and Manufacturing Company, Jackson, Mich.

Lieut. R. K. MacMaster and Lieut. George S. Van Gelder, of the Ordnance Department Claims Board, will resume their work in the field of production and cost accounting under the firm name of MacVan Engineering Company, with offices at 50 East 42d Street, New York.

Charles Piez, director general of the Emergency Fleet Corporation, will resign his position, effective May 1, to return to Chicago to resume the presidency of the Link-Belt Company.

T. E. Butterfield, associate professor of mechanical engineering at Lehigh University, is back after service on the teaching staff of the Post Artillery School at Fort Monroe, Va., where he held the rank of Major.

Huntly H. Gilbert, who left the service of the Pressed Steel Car Company and the Western Steel Car and Foundry Company at the beginning of the war to enter the Army as captain in the Ordnance Department at Washington, and later was commissioned major and transferred to the Rock Island Arsenal, has reëntered the service of the above-named companies as assistant manager of sales of the western district, with headquarters in Chicago, Ill.

William G. R. Braemer has resigned as president of the Braemer Air Conditioning Corporation, Philadelphia, Pa., to open a consulting engineering office in the Stephen Girard Building, Philadelphia. He will specialize in air conditioning and drying and will also act as consulting engineer for the above company.

Lieutenant William P. Hayes, U. S. N. R. F., at present commanding one of the U. S. men-of-war on the China Station, has been promoted to the rank of Lieutenant Commander.

William F. Franket has become connected with the Wood-Mosaic Company, Inc., New Albany, Ind., manufacturers of parquetry, hardwood flooring, veneers and lumber, as manager of the timber department.

APPOINTMENTS

Chester W. Wilson, formerly engineer of the Garfield Smelting Company, has been transferred to El Paso, Tex., and appointed chief engineer of the Mexican Department of the American Smelting and Refining Company.

LIBRARY NOTES AND BOOK REVIEWS

Graphical and Mechanical Computation. By Joseph Lipka, Ph.D. John Wiley & Sons, Inc., New York, 1918. Cloth, 6 x 9 in., 264 pp., 205 figures, 2 folding charts, $4.

This book presents a systematic development of the construction of alignment charts, the value of which in facilitating computation is very generally recognized by engineers. The mathematical treatment employed is simple and the methods are abundantly illustrated by charts for many important engineering formulæ.

Many engineering and scientific formulæ are empirical, and the value of many investigations is much enhanced by the discovery of the laws connecting the results obtained. One chapter of the book deals with the fitting of equations to experimental data, and another considers the case where the data involved are periodic, as in alternating currents, sound waves, etc., and gives numerical, graphical and mechanical methods for determining the constants of the equation. When empirical formulæ cannot be fitted to the data available, the latter may still be efficiently handled for purposes of further computation by the methods for interpolation, differentiation and integration developed in the closing chapters.

The book embodies a course that has been given by the author for a number of years at the Massachusetts Institute of Technology.

The Elements of Wooden Ship Construction. By W. H. Curtis. First edition. McGraw-Hill Book Co., Inc., New York, 1919. Cloth, 6 x 9 in., 223 pp., 199 illus., $2.50.

A revised and enlarged edition of a course prepared for the education and training section of the Emergency Fleet Corporation. It is intended for the use of carpenters and others, who, though skilled in their work, lack the detailed knowledge of shipbuilding necessary for efficiency.

Fighting the Boche Underground. By H. D. Trounce. Charles Scribner's Sons, New York, 1918. One-quarter cloth, 5 x 8 in., 234 pp., 7 pl., 1 por., 1 diag., $1.50.

Captain Trounce, an American mining engineer, enlisted in the Royal Engineers in 1915, and transferred to the Engineers' Reserve Corps of the American Army in 1917. His book is a description of the underground fighting in which he participated in Flanders, at Arras, Vimy Ridge and elsewhere.

Industry and Humanity. A Study in the Principles Underlying Industrial Reconstruction. By W. L. Mackenzie King. Houghton Mifflin Co., Boston and New York, 1918. Cloth, 6 x 8 in., 567 pp., 10 charts, $3.

This volume by the former Minister of Labor of Canada is a statement of the underlying principles which are finding expression in the organization of industrial society and which should obtain in all efforts at reconstruction. The book is based on the author's twenty years of personal contact with labor problems, supplemented by a study of the literature on the subject.

Instincts in Industry. A Study of Working-Class Psychology. By Ordway Tead. Houghton Mifflin Co., Boston and New York, 1918. Cloth, 5 x 8 in., 222 pp., $1.40.

With the idea of contributing to a better understanding of people in their capacity as manual workers, Mr. Tead has analyzed in turn the ten basic instincts on which our life and conduct rest, has shown how each affects the worker's relation to his job, and how each must be studied and used in the task of attaining sound relations between the employer and the employed.

The Instructor, the Man and the Job. A Handbook for Instructors of Industrial and Vocational Subjects. By Charles R. Allen. J. B. Lippincott Co., Philadelphia (copyright 1919). Cloth, 5 x 8 in., 373 pp., $1.50.

The author, who has been agent for industrial training for the Massachusetts Board of Education and superintendent of instructor training for the Emergency Fleet Corporation, gives the result of his experience in this volume, which is intended as a handbook for instructors in industrial plants and as instruction notes in training courses for instructors.

Johnson's Materials of Construction. Rewritten by M. O. Withey and James Aston. Edited by F. E. Turneaure. Fifth edition. John Wiley & Sons, Inc., New York, 1919. Cloth, 6 x 9 in., 840 pp., illus., 1 pl., 1 por., tables, $6.

As the progress of the last twenty years in the knowledge of the properties of materials made Professor Johnson's book an inadequate account of the subject, it has been rewritten under the editorship of his successor at the University of Wisconsin.

The authors have aimed to retain the broad scope of the original work as a statement of the essential information concerning the sources, manufacture or fabrication of the principal materials, their important mechanical and physical properties and the influence of various factors upon them, the causes of defects and variations, the methods of testing and their general uses. The arrangement of the book is new and some changes have been made in its scope. Obsolete matter has been eliminated and modern data substituted. The volume is intended to serve both as a textbook and as a work of reference.

1919 Record of American and Foreign Shipping, New York. Published by the American Bureau of Shipping, "American Lloyds." New York, 1919. Morocco, 10 x 10 in., 1056 pp.

The 1919 Record presents no change in form from previous years. It provides a record of American and foreign vessels, classified according to the rules of the Bureau, and is endorsed by the Navy Department and the boards of marine underwriters of New York, Boston and San Francisco. In addition to the list of vessels, there are lists of owners, marine underwriters' representatives, surveyors, machinery constructors, dry docks, marine railways, and ship builders. An index of changed names is also included.

Our National Forests. A Short Popular Account of the Work of the United States Forest Service on the National Forests. By Richard H. Douai Boerker. The Macmillan Co., New York, 1919. Cloth, 5 x 8 in., 238 pp., 80 illus., $2.50.

The author presents a well-illustrated account of our national forest problem and of the work of the Forest Service. Written in popular form and based largely upon his personal experience and observation.

Petroleum Refined. By Andrew Campbell, with a foreword by Sir Boverton Redwood. Charles Griffin & Co., Ltd., London, 1918. Cloth, 6 x 9 in., 277 pp., 138 illus., 29 folding pl., 3 diag., 11 tables, $8.50.

This volume describes the ordinary methods used to prepare marketable products from petroleum, except "cracking" methods. The work is based on extended practical experience, is well supplied with illustrations and drawings and includes a bibliography.

Physics for Technical Students. Sound, Light, Electricity and Magnetism. By William Ballantyne Anderson. First edition. McGraw-Hill Book Co., Inc., New York, 1919. Cloth, 6 x 9 in., 794 pp., 373 illus., $3.

This book completes the author's textbook of physics, the first part of which has been published previously under the title Mechanics and Sound. The writer has aimed to produce a college text especially suitable for students of agriculture and engineering, in which particular attention is directed to practical applications of the subject.

Practical Ship Production. By A. W. Carmichael. First edition. McGraw-Hill Book Co., Inc., New York, 1919. Cloth, 6 x 9 in., 252 pp., 101 illus., $3.

The purpose of this book is to serve as an introduction to the subject by presenting the most important general principles of ship design and describing the various processes of shipbuilding. The treatment is practical rather than theoretical and matters of construction are more fully considered than problems of design.

The Rudder Directory. A Trade List of Shipbuilding and Marine Industries. Compiled and issued by the Rudder Publishing Co., New York, 1919. Cloth, 6 x 9 in., 332 pp., 1 pl., $5.

Included in this directory are lists of the steel, wood, composite and concrete shipyards, with the names of their officers, ship and engine repair plants, dry docks and marine railways, owners and operating companies, marine insurance companies, boat builders, engine builders, ship chandlers and manufacturers of equipment, parts, etc. A supplement, revised to February 6, 1919, brings the data concerning the U. S. Shipping Board and the Emergency Fleet Corporation up to date.

Thomas' Register of American Manufacturers and First Hands in all Lines. Thomas Publishing Co., New York (copyright 1919). Cloth, 10 x 12 in., 4200 pp., $15.

The tenth edition of this well-known trade directory is dated "October" as usual, although corrections were made up to December 20. The directory is divided into various lists, the chief one being a classified list of manufacturers in all lines, sub-classed geographically and provided with an extensive index to the classification. Other lists are of representative banks, boards of trade, chambers of commerce, etc., trade papers, leading trade names and an alphabetical list of manufacturers. The volume contains 4200 pages of information, conveniently arranged for quick consultation.

The Theory of Electricity. By G. H. Livens. The University Press, Cambridge, England, 1918. Cloth, 11 x 7 in., 717 pp. $8.25. (Gift of G. P. Putnam's Sons.)

Dissatisfaction with the treatment of this subject in standard textbooks, which the author believes to be incomplete, often unconvincing and sometimes erroneous, leads him to offer this work as a general textbook on the mathematical aspects of modern electrical theory in which an attempt is made to present the complete subject in a consistent form. Although his exposition is essentially a mathematical one, much of the purely analytical mathematics usually associated with the subject has been omitted. Particular attention has, however, been given to the rigorous formulation of underlying physical principles and to their translation into a mathematical theory. The dynamical aspects of the subject have been specially emphasized throughout.

Classroom Lecture Notes. Automotive Starting, Lighting and Ignition. By R. C. Fryer. Second Edition. John Wiley and Sons, Inc., New York, 1918. Cloth, 8 x 5 in., 210 pp., diag. $1.25.

The author provides a general, concise series of notes, including the essential knowledge needed by the student, but requiring enlargement by the instructor. Eighty-eight pages of wiring diagrams are given.

Practical Oil Geology. The Application of Geology to Oil-Field Problems. By Dorsey Hager. Third edition. McGraw-Hill Book Co., Inc., New York. 1919. Flexible cloth, 7 x 5 in., 253 pp., 126 illus., 37 tables. $2.50.

The author of this handbook has aimed to provide a clear, concise and practical work on the occurrence of oil and its geology, based on American practice. The present edition, the third since its appearance in 1915, has been thoroughly revised, enlarged and reset.

ACCESSIONS TO THE LIBRARY

Aids to Employment Managers and Interviewers on Shipyard Occupations, with Description of Such Occupations. Special Bulletin. Series on Employment Management in the Shipyard. U. S. Shipping Board Emergency Fleet Corporation. *Philadelphia, 1918.*

American Library Annual. 1917-18. *New York, 1918.* Purchase.

Axioms that Make Armor Plate Roads. *New York, 1919.* Gift of T. Hugh Boorman.

The Barite Deposits of Missouri and the Geology of the Barite Disrrict. By William Arthur Tarr. Univ. of Missouri Studies, Vol. 3, No. 1. Science series. Gift of author.

Bibliography of American Literature Relating to Refrigeration, with Synopsis of Papers and Reports Covering the Year 1915. By Peter Neff, compiled under the direction of the Committee on Papers and Lectures of the American Association of Refrigeration, *Chicago, n. d.* Gift of American Association of Refrigeration.

Boilers and Furnaces Considered in Their Relations to Steam Engineering. By William M. Barr. *Philadelphia, 1899.*

Carnegie Endowment for International Peace. Preliminary Economic Studies of the War. No. 6. Effects of the War upon Insurance with Special Reference to the Substitution of Insurance for Pensions. By William F. Gephart, New York, 1918. No. 7. The Financial History of Great Britain, 1914-1918. By Frank L. McVey. *New York, 1918.* Gift of the Carnegie Endowment for International Peace.

Changing Economic Viewpoints. Gift of Guaranty Trust Company of New York.

Chronocyclegraph Motion Devices for Measuring Achievement. Motion Study and Time Study Instruments of Precision. Motion Models: Their Use in the Transference of Experience and the Presentation of Comparative Results in Educational Methods. [3 pamphlets.] By Frank G. Gilbreth and Lillian Moller Gilbreth.

Civil War Experiences Under Bayard, Gregg, Kilpatrick, Custer, Raulston, and Newberry, 1862-64. By Henry C. Meyer. *New York, 1911.* Gift of Henry C. Meyer.

Cochrane Engineering Bulletin no. 20. The Scientific Treatment of Boiler Feed Water. *1917.* Gift of Harrison Safety Boiler Works.

Combinazioni Chimiche fra Metalli. By Michele Gina and Clara Giua-Lollini. *Milano, 1917.* Purchase.

Development of Magnetic Susceptibility in Manganese Steel by Prolonged Heat Treatment. By Charles F. Brush. (Reprinted from Proceedings of the American Philosophical Society v. 57, 1918). Gift of Author.

Diesel Engine Design. By E. Mortimer Rose. *Manchester, England, 1917.* Purchase.

Dynamic Heating of Air as a Cause of Hot Volcanic Blasts. By G. N. Cole. Reprint from Monthly Weather Review, Oct., 1918. Gift of author.

Economy Hints (2nd enlarged edition) from the Locomotive of the Hartford Steam Boiler Inspection and Insurance Company. Some Thrifty Suggestions for Meeting Your Fuel Emergency. *Hartford, 1918.* Gift of the Hartford Steam Boiler Inspection and Insurance Company.

Electric Light Arithmetic. By R. E. Day. *London, 1882.* Gift of B. F. Simmons.

Engineering Facts and Figures for 1863. An Annual Register of Progress in Mechanical Engineering and Construction. Edited by Andrew Betts Brown. *London, 1864.*

The Ethics of Coöperation. By James H. Tufts. *Boston, 1918.* Gift of University of California Press.

Federal Valuation of the Railroads in the United States. President's Conference Committee. Statement prepared by Frederick H. Lee, Secretary. Developments in connection with Federal Valuation as of November 30, 1918. Gift of Clemens Herschel.

Fifteen Sermons Preached on Various Important Subjects. By George Whitefield. *Glasgow, 1792.*

General Railroad Map Engraved . . . for The Official Guide of the Railways and Steam Navigation Lines of the United States, Porto Rico, Canada, Mexico and Cuba. *New York, 1919.* Purchase.

Guide du Mécanicien d'Aviation. A l'Usage des Mécaniciens, des Elèves Pilotes et des Candidats aux Troupes de l'Aéronautique Militaire. Two volumes. *Paris, n. d.* Purchase.

Handbook on Employment Management in the Shipyard. Dealing with Modern Methods and Practices of Employment Management. Bulletin I. Organizing the Employment Department. U. S. Shipping Board Emergency Fleet Corporation. *Philadelphia, 1918.*

Hendricks' Commercial Register of the United States for Buyers and Sellers. *New York, copyright 1918.* Gift of publisher.

The History and Development of Ball Bearings. *1918.* Gift of The Hess-Bright Manufacturing Co.

Industrial Arts Index. Annual cumulation 6th, 1918. Purchase.

Industrial Development of India. Nov. 3, 1918. Gift of Guaranty Trust Company of New York.

Inspector's Manual for Fuze Assembly. Second Edition. Compiled by Colonel R. Birnie, H. G. Bennett, W. J. Hawkins, J. R. Fifer. *New York, 1918.* Gift of International Arms & Fuze Co.

The Iron and Steel Institute. Carnegie Scholarship Memoirs. Vol. 9. *Lond., 1918.* Purchase.

Manual of Electrical Undertakings and Directory of Officials, 1918-1919. With which is incorporated the Imperial Directory and Statistics of Electric Lighting, Power and Traction Works in Operation or Projected in Great Britain, and Ireland, India, and all British Colonies. Compiled under the direction of Emile Garcke. Vol. 22. *Lond., n. d.* Purchase.

Metallurgia Generale e Siderurgia. Capisaldi e Riassunti. By Umberto Savoia. *Milano, 1919.* Gift of Engineering and Mining Journal.

Minerals and Mining—Nova Scotia. By R. Drummond. *Stellarton, N. S., 1918.* Gift of Hon. E. H. Armstrong.

Mineral Industry. Vol. 26, 1917. McGraw-Hill Book Co., *New York, 1918*. Purchase.

The New Foreign Representative. By Frank H. Taylor. *New York, 1918*. Gift of author.

Oil Fields of Texas. By F. Julius Fohs (Chart.)

Oil Sand Horizons of Texas. By F. Julius Fohs. (Chart.)

On the Motion of Points Constrained and Resisted and on the Motion of a Rigid Body. The Second Part of a new Edition of a treatise on Dynamics. By William Whewell. *Cambridge, 1834*.

Pennsylvania. Bureau of Standards. Annual Report. 8th, 1918. Purchase.

A Plan for the Development of the Village of Grand Canyon, Ariz. By F. A. Waugh, 1918. *Washington, 1918*. Gift of U. S. Department of Agriculture, Forest Service.

Portland Cement Association. Magazine List, October 1918. Gift of Portland Cement Association.

Present and Prospective Supply of Natural Gas Available in Pennsylvania. By Samuel S. Wyer. *1918*. Gift of author.

The Protection of Metals from Oxidation at High Temperatures. By W. E. Ruder. Vol. 1. *1918*. Gift of Diamond Power Specialty Company.

The Quebec Bridge Carrying the Transcontinental Line of the Canadian Government Railways Over the St. Lawrence River Near the City of Quebec, Canada. Gift of George F. Porter.

Radium and Uranium; Their Ores and Occurrence in Nature. By R. A. F. Penrose, Jr. *Albany, 1918*. Gift of author.

Red Cross Institute for Crippled and Disabled Men. Publications. Series 2, No. 4. Employment Opportunities for Handicapped Men in the Coppersmithing Trade. By Bert J. Morris. Gift of the Institute.

The Relative Corrosion of Cast-Iron, Wrought-Iron and Steel Pipe in House-Drainage Systems. By William Paul Gerhard. Gift of author.

Report on Proposed Belle Isle Bridge by the Consulting Board Belle Isle Bridge Division of Engineering and Construction, Department of Public Works, City of Detroit. *1918*. Gift of George H. Fenkell.

Representation in Industry. By John D. Rockefeller, Jr. *1918*. Gift of author.

Rules for the Construction of Stationary Boilers and for Allowable Working Pressures. Report of the Committee to Formulate Standard Specifications for the Construction of Steam Boilers and other Pressure Vessels and for their Care in Service, known as The Boiler Code Committee, The American Society of Mechanical Engineers. Edition of 1918.

The Science of Burning Liquid Fuel. A Practical Book for Practical Men. By William Newton Best. *1913*. Gift of author.

Sherwin's Mathematical Tables. Third edition, carefully revised and corrected by William Gardiner. *London, 1742*. Gift of W. Brokaw Bamford.

A Short Course in Oxy-Acetylene Welding. By Alfred S. Kinsey. Gift of Air Reduction Sales Co., N. Y.

Smoke Regulation. Compiled by Daniel Maloney. Issued by the Dept. of Parks and Public Property of the City of Newark, N. J. Gift of the Department of Parks and Public Property, Smoke Abatement Division, Newark, N. J.

South Dakota School of Mines. Bulletin No. 12. The Occurrence, Chemistry, Metallurgy and Uses of Tungsten with special reference to the Black Hills of South Dakota. By J. J. Runner and M. L. Hartmann. Including a Bibliography of Tungsten by M. L. Hartmann. *1918*. Gift of South Dakota School of Mines.

Steel Alloys Corporation. Gift of Kirby Thomas.

Steel Shipbuilders Handbook. By C. W. Cook. *New York, 1918*.

Tests of Moisture and Water Resistance of Various Coatings on Small Boat Construction. By Henry A. Gardner. Gift of Institute of Industrial Research.

Technical Handbook of Oils, Fats and Waxes. By Percival J. Fryer and Frank E. Weston. vol. 2. Practical and Analytical. *Cambridge, England, 1918*. Purchase.

Tide Levels and Datum Planes on the Pacific Coast of Canada. Supplement No. 1 to the 38th Annual Report of the Dept. of Marine and Fisheries. *Canada, 1906*. Gift of the Department of the Naval Service.

Tides at the Head of the Bay of Fundy. *1917*.

Tide Levels and Datum Planes in Eastern Canada. Published by the Department of the Naval Service. *Canada, 1917*. Gift of the Department.

A Treatise on Mechanics. By Captain Henry Kater and Rev. Dionysius Lardner. *London, 1830*. Gift of Reginald Pelham Bolton.

U. S. Board of Ordnance and Fortification. Annual Report to the Secretary of War. 28th, 1918. *Washington, 1918*. Purchase.

U. S. Bureau of Mines. Annual Report of the Director. 8th, for the year ending June 30, 1918. Purchase.

U. S. Department of Agriculture. Bureau of Chemistry. Report of the Chemist. *Washington, 1918*. Gift of the Bureau.

U. S. Geological Survey. Annual Report of the Director. 39th, 1918. *Washington, 1918*. Purchase.

U. S. Interstate Commerce Commission. Annual Report of the Statistics of Railways in the United States. 29th, 1916. *Washington, 1918*. Purchase.

Université de Liége. Overture Solennelle des Cours le 21 Octobre, 1902. Discours de M. le Recteur V. Dwelshauvers-Dery sur La Machine a Vapeur Moderne. *Liége, 1902*.

TRADE CATALOGUES

American Blower Company. Detroit, Mich. Sirocco Service. Vol. 7, No. 4. Jan. 1919.

The Baldwin Locomotive Works. Philadelphia, Pa. The Fifty-Thousandth Locomotive. Record No. 92, 1918.

Combusto Sales and Brokerage Co., Omaha, Neb. How to Make Heated Air Save Coal.

J. P. Devine Co., Buffalo, N. Y. Vacuum chamber dryers. Bulletin 101A. High efficiency perfectly balanced vacuum evaporators. Bulletin No. 106. High efficiency vacuum pumps. Bulletin No. 107.

Eastman Kodak Co., Rochester, N. Y. Price list Eastman Organic Chemicals. January, 1919.

Flannery Bolt Company. Pittsburgh, Pa. Staybolt. Tate Flexible Staybolt. Vol. 6, No. 4. Dec. 1918.

General Electric Co., Schenectady, N. Y.
Magnetic Control for Machine Tools.
CR 4409-B1 Crane Protective Panels for Direct-Current Motors.
G-E Type CP Circuit Breakers.
G-E Self-Contained Solenoid-Operated Circuit Breakers.
Bulletin No. 43400A. Sept. 1918. The Lighting of Woodworking Plants with Edison Mazda Lamps.
Bulletin No. 43413. Oct. 1918. The Lighting of Textile Mills with Edison Mazda Lamps.
Bulletin No. 40400B. Belt driven alternators, form PB. Jan. 1919. Index to supply part bulletins. Jan. 1919.

Heine Safety Boiler Co., St. Louis, Mo. Boiler Logic.

Herold China and Pottery Co., Golden, Col. Coors U. S. A. Chemical and Scientific Porcelain. Feb 1, 1919.

The Jeffrey Manufacturing Co., Columbus, Ohio. The Jeffrey Carrier. (Advance Bulletin to Catalog No. 210.) Bulletin No. 237.

Arthur Knapp Engineering Corporation, 101 Park Ave., N. Y. Modern thread inspection equipment. 1918.

Link-Belt Company. Philadelphia, Pa. Link-Belt Equipment for the Handling and Preparation of Coal at the Mine. Book No. 333.

A. M. Lockett & Co., Ltd., New Orleans. Lockett Oil Burning Apparatus. Automatic Fuel Oil Pumping Set. 1919.

National Company, Boston, Mass. National Quick Attaching I Beam and Channel Clamps. Bulletin No. 101.
Presto holder. For Engineers' and Architects' offices, drawing rooms, machine shops, construction jobs, ship yards, libraries and any place where records, charts or schedules are used.

Oakley Chemical Company. New York, N. Y. Oakite Service for the Manufacturer of Automobiles, Aeroplanes and Accessories. Oakite Munitions Service.

Oster Manufacturing Company, Cleveland, Ohio. Oster Threading Tools. Lists Nos. 30 and 31. May 1918.

Quigley Furnace Specialties Co., New York. Bulletin No. 10. Powdered Coal "flows like water." Oct. 1918.

Richmond Radiator Co., New York. "Richmond" Radiators. Catalog No. 15. "Norman" and "Tuscan" Radiators.

Royal Copenhagen Porcelain, New York. Royal Copenhagen Porcelain for Chemical and Scientific Purposes.

Ruth Company. Denver, Col. The Ruth Flotation Machine. Bulletin No. 11. Illustrated. Copy on request.

Chas. A. Schieren Co., 30-38 Ferry St., N. Y. Price list of Schieren Beltings.
The Story of Schieren Beltings. 1919.

Sperry Gyroscope Co., Brooklyn, N. Y. The Sperry Gyro-Compass and Navigation Equipment. 4th edition.

Spray Engineering Co., Boston, Mass. Representative list of purchasers of Spraco Pneumatic Painting Equipments. Spraco System for Cooling Condensing Water. Spraco Equipment for Washing and Cooling Air. Spraco Pneumatic Painting Equipments and Accessories.

Star Brass Works. Chicago, Ill. Spray Cooling Equipment for Condensing Water. Bulletin No. 4.

Steere Engineering Company. Detroit, Mich.
Bulletin No. 34. Gas Valves and Welded Steel Pipe.
Bulletin No. 36. Plant Models.
Bulletin No. 35. Tar Cameras for Calorimetric Tar Determination.

Supplee-Biddle Bulletin. Monel Metal. Vol. 5, No. 9.

Thwing Instrument Co., Philadelphia. Thwing Pyrometers. Catalog No. 9.

U. S. Metal Cap and Seal Co., New York. The Upressit Cap.

Walworth Manufacturing Co., Boston, Mass. The Walworth Log, Feb. 1919.

S. D. Warren and Co., Boston, Mass. What Warren's Printone Will Do. Warren's Silkote Dullo-Enamel.

Westinghouse Electric & Manufacturing Co. East Pittsburgh, Pa. The Advantages of Railroad Electrification. By W. H. Easton.

Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Westinghouse alternating-current motors. Catalogue 33, Dec. 1918.

Witte Engine Works, Kansas City, Mo. How to Judge Engines. No. 49. By Ed. H. Witte, 1918.

THE ENGINEERING INDEX

Published Monthly by The American Society of Mechanical Engineers

The Engineering Index was Founded in 1884 by the Association of Engineering Societies; Published from 1895 to 1919 by The Engineering Magazine Company; and Acquired January 1919 by The American Society of Mechanical Engineers

THE following pages form a descriptive Index to articles on engineering and related subjects in current periodicals. In its preparation the Society's engineering staff regularly examines all of the technical journals and society publications received by the Engineering Societies Library, which form one of the greatest and most complete collections of scientific periodicals in the world, comprising upward of 1100 distinct publications in some ten languages. Cross-references are freely introduced in the Index, and in all cases where the titles of articles are not sufficiently descriptive, explanatory sentences are appended. The main abbreviations used in the items are given at the bottom of this page.

PHOTOSTATIC COPIES OF ARTICLES LISTED

THE Society is prepared to supply photostatic copies (white printing on brown background) of any of the articles listed. Copies of the periodicals themselves, or clippings of articles, cannot be supplied.

Price of each print (up to 11 x 14 in. in size), 25 cents plus postage. A separate print is required for each page of the larger-size periodicals, but where possible two pages will be photographed together on the same print. Bill will be mailed with the prints.

Those holding coupon books for clippings formerly issued by The Engineering Magazine Company may use the coupons in payment for photostatic prints. In ordering, state plainly

(1) Page number of Index on which item appears
(2) Title of article
(3) Name of periodical.

Orders should be sent to

Harrison W. Craver, *Director,*
Engineering Societies Library,
29 West 39th Street, New York City.

DIVISIONS OF THE ENGINEERING INDEX

Note.—The abbreviations used in indexing are as follows:

Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
New York (N. Y.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

Mechanical Engineering

ABRASIVES

Microstructure

The Microstructure of Abrasives, J. Scott. Mech. World, vol. 64, no. 1666, Dec. 6, 1918, pp. 266-267, 2 figs. Remarks on physical and chemical phenomena in polishing, grinding and sharpening; photomicrographs of emery cloth and tripoli powder.

AIR MACHINERY

Blowers

Snow Gas Engine Blower at Parkgate Works. Iron & Coal Trades Rev., vol. 98, no. 2657, Jan. 31, 1919, pp. 132-133, 2 figs. Arrangement of twin-tandem gas-driven blowing engine at Parkgate Iron & Steel Works, Rotherdam.

Compressed-Air Application

Compressed-Air in a Shell Plant, R. E. C. Martin and S. B. King. Am. Mach., vol. 50, no. 9, Feb. 27, 1919, pp. 395-396, 3 figs. Illustrates convenience, adaptability and economy of air power for industrial and manufacturing purposes.

Compressors

Hydraulic Air Compressors. (Hydrokompressoren.) Engineer Heinrich. Zeitschr. fuel komprimierte und fluessige Gase, vol. 19, no. 5, June 26, 1918, pp. 45-49, 4 figs. Part II. Conclusion to follow. Describes C. H. Taylor's compressor, German types, Pohle's air-lift pump. Gives the theory of hydro compressors and their efficiency curves derived from tests. Part I in vol. 18, page 33.

Fans

Influence of Blade Inclination on the Power of a Centrifugal Fan (Influence de l'inclinaison des aubes sur la puissance des ventilateurs), M. Karrer. Génie Civil, vol. 73, no. 25, Dec. 21, 1919, pp. 486-489, 6 figs. Mathematical formula for the pressure exerted by blade and graphs showing volume against pressure for various inclinations of the blades.

Lubrication

Lubrication of Air Compressors, H. V. Conrad. Power Plant Eng., vol. 23, no. 5, Mar. 1, 1919, pp. 247-249, and Elec. Ry. Jl., vol. 53, no. 9, Mar. 1, 1919, p. 424. Difficulties encountered; suitable oils; proper quantities.

Pneumatic Delivery

Pneumatic Postal Delivery Systems. (Die Verwendung der Pressluft in der Verkehrstechnik mit besonderer Berücksichtigung der Rohrpost Anlagen), Baurat Kasten. Zeitschrift fuer Komprimierte und fluessige Gase, vol. 19, no. 3, 1917-1918, part 2, pp. 25-29, 8 figs. Compares the systems in use in the various large cities of the world, and claims more efficient performance for the systems in use in Berlin and Munich. Gives diagrams of air pressure fluctuations and switchboards. (To be continued.)

AUTOMOBILES

(See Motor-Car Engineering)

CASE-HARDENING

Shimer's Process

Shimer Case-Hardening Process, Joseph W. Richards. Iron Trade Rev., vol. 64, no. 7, Feb. 13, 1919, pp. 437-438, and Bul. Am. Inst. Min. Engrs., no. 146, Feb. 1919, pp. 431-433. Process employs bath of easily fusible noncase-hardening salts (usually a mixture of sodium chloride, calcium chloride, and barium chloride in equal proportions by weight) and fresh calcium cyanide, which latter imparts case-hardening properties.

CORROSION

Rustproofing

Rust-Proofing of Iron and Steel, Elmer S. Whittier. Metal Industry, vol. 17, no. 2, Feb. 1919, pp. 79-82. Description of Parker process.

FORGING

Hollow Forging

Improved Methods of Hollow Forging, S. A. Hand. Am. Mach., vol. 50, no. 9, Feb. 27, 1919, pp. 377-382, 20 figs. Methods described were used in France for making the 75-mm. shell. They have been adapted to American practice and it is asserted that they have been found more economical than former methods.

Smithing

The Engineer's Smithy, Joseph Horner. Mech. World, vol. 65, no. 1673, Jan. 24, 1919, pp. 42-43, 6 figs. Drawing-down process in anvil forging. Tenth installment. (Continuation of serial.)

FOUNDRIES

Brass Foundry Practice

Materials and Chemicals Used in Brass Foundry Practice, Charles Vickers. Brass World, vol. 15, no. 2, Feb. 1919, pp. 35-37, 1 fig. History, properties, appearance, physiological action and commercial use. Feathered tin; phosphor tin; phosphor copper. Third article.

Cores

Core Mixtures for Large Marine Engine Cylinder Cores, John F. Kellogg. Pacific Marine Rev., vol. 16, no. 1, Jan. 1919, pp. 128-129, 2 figs. Practices followed at various foundries.

Die Casting

Die Castings and Their Application to the War Program, Charles Pack. Bul. Am. Inst. Min. Engrs., no. 146, Feb. 1919, pp. 239-248, 9 figs. Survey of developments in manufacture of metal castings by forcing molten metal, under pressure, into a metallic mold or die, with brief descriptions of several casting machines and of methods used to avoid blowholes.

Ferrosilicon

Ferrosilicon as an Aid to the Iron Foundry, W. F. Sutherland. Can. Foundryman, vol. 10, no. 2, Feb. 1919, p. 39. Manufacture and properties of ferrosilicon.

Foundry Design

Foundry and Shops of Striking Design, Charles Lundberg. Iron Age, vol. 103, no. 7, Feb. 13, 1919, pp. 417-422, 11 figs. Result of studious effort to attain ideal in Michigan plant; storage building contains bins for all materials used.

Manganese-Steel Castings

Manufacture of Manganese-Steel Castings, B. S. Carr. Mech. World, vol. 65, no. 1674, Jan. 31, 1919, pp. 56-57. Physical characteristics; heat treatment; cleaning and machining. From Armour Engr.

Pattern Making

Contraction and Expansion, G. W. Lynes. Mech. World, vol. 65, no. 1673, Jan. 24, 1919, pp. 43-44, 4 figs. As affecting patternmaker. Paper before Sheffield Branch British Foundrymen's Assn.

Substitutes

Meeting the Situation with Substitute Formulæ, R. R. Clarke. Brass World, vol. 15, no. 2, Feb. 1919, pp. 47-48. Conditions in foundry industry.

Tool Casting

New Way to Cast High Speed Tools, J. E. Johnson. Bul. Am. Inst. Min. Engrs., no. 146, Feb. 1919, pp. 353-360, 6 figs., and Iron Trade Rev., vol. 64, no. 7, Feb. 13, 1919, pp. 435-437, 7 figs. Also Iron Age, vol. 103, no. 8, Feb. 20, 1919, pp. 481-483, 5 figs. The Davidson process and its advantages over method of shaping tools from forgings; the structure of the cast metal.

Waste

Modern Method Applied to the Foundry, W. R. Dean. Metal Industry, vol. 17, no. 2, Feb. 1919, pp. 69-70, 4 figs. Causes of waste; classification and prevention of losses. Second article.

See also MECHANICAL ENGINEERING, Standards and Standardization (Brass and Bronze Foundries); ELECTRICAL ENGINEERING, Furnaces (Rennerfelt Furnace Operation); INDUSTRIAL TECHNOLOGY, Graphite Crucibles.

FUELS AND FIRING

Anthracite

Burning Steam Sizes of Antharcite With or Without Admixture of Soft Coal. U. S. Fuel Administration, eng. bul. 5, 8 pp., 1 fig. Furnace equipment required for burning various percentages of steam anthracite and soft coal.

Ash

The Relation Between the Calorific Values and the Ash-Yields of Coal-Samples from the Same Seam, Thomas James Drakeley. Tran. Instn. Min. Engrs., vol. 56, part 2, Dec. 1918, pp. 45-56 and (discussion) pp. 56-60, 3 figs. From experiments and graphs the following formula is suggested, $y = C\ (1-X)\ S$, where C is a factor for the seam and stands for calorific value of mineral-free coal; S the percentage of ash yielded by impurities; y the required calorific value of sample, and X the percentage of ash yielded by sample.

Blending

The "Sandwich" Sytem of Fuel Blending, E. W. L. Nicol. Colliery Guardian, vol. 117, no. 3030, Jan. 24, 1919, pp. 192-193, 3 figs. Apparatus for mixing various grades of solid fuel as they are fed to burners.

Fuel Blending, E. W. L. Nicol. Times Eng. Supp., year 15, no. 531, Jan. 1919, pp. 40-41, 3 figs. Arrangement of "sandwich" system designed to cause blending of various grades of solid fuels as they are fed to furnace. Working results are given.

Briquetting

Economy of Briquetting Small Coal, J. A. Yeadon. Mech. World, vol. 64, no. 1668, Dec. 20, 1918, pp. 293. Abstract of paper before Min. Inst. Scotland.

Combustion Control

Combustion and Flue Gas Analysis. U. S. Fuel Administration, eng. bul. 4, 12 pp., 5 figs. Combustion-control apparatus; necessity of instructions to firemen.

Control of Combustible and Air in Burning Powdered Coal, W. G. Wilcox. Power Plant Eng., vol. 23, no. 5, Mar. 1, 1919, pp. 237-239. From a paper before the Western New York Section of the American Chemical Society.

Fuel Conservation

Fuel Conservation. Southern & Southwestern Ry. Club, vol. 14, no. 12, Nov. 1918, pp. 10-20 and (discussion) pp. 20-38. Discusses necessity of locomotive maintenance, constant education of enginemen and firemen, coöperation and necessity of complete understanding of importance of fuel conservation by operating officials.

Fuel Utilization. Times Eng. Supp., year 15, no. 531, Jan. 1919, p. 24. Reviews of efforts in coal conservation, particularly pulverizing coal and oil production and gas works.

Methods for More Efficiently Utilizing Our Fuel Resources, C. G. Gilbert and J. E. Pogue. Gen. Elec. Rev., vol. 22, no. 2, Feb. 1919, pp. 149-151. Part 25. The need for a constructive economic policy in developing the coal products industry. Extract from U. S. National Museum Bulletin 102, Part 5; "Power: Its Significance and Needs," 1918.

Worcester's Fuel Saving Campaign, S. E. Balcome. Power Plant Eng., vol. 23, no. 5, Mar. 1, 1919, pp. 236-237, 2 figs. First article of a series on the organization, work of committees and results obtained in industrial plants.

Conservation of Fuel, D. C. Randolph. Proc. Central Ry. Club, vol. 27, no. 1, Jan. 1919, pp. 529-536 and (discussion) pp. 536-554. Contrasts what are termed good and bad railway fuel practices in locomotives, shops, roundhouses, yards and on the road.

Gas and Oil Fuels

See Producer Gas, page 8a; items under INDUSTRIAL TECHNOLOGY; and Oil, under MINING ENGINEERING.

Low-Grade Fuels

On the Utilization of Low-Grade Fuels at the Montrambert Collieries (Note sur l'utilisation des combustibles pauvres par la société des houillères de Montrambert). Bulletin de la Société d'Encouragement, vol. 130, no. 6, Nov.-Dec. 1918, pp. 376-378. Materials tested contain 42 to 50 per cent ash and 18 to 20 per cent volatile matter.

Motor-Car Fuel

Gas as Automobile Fuel (L'emploi du gaz dans les automobiles), A. Grebel. Génie Civil, vol. 74, no. 5, Feb. 1, 1919, pp. 81-84, 11 figs. Applications in France and in England; experiments of the Société du Gaz, Paris.

Fuel. Automotive Industries, vol. 40, no. 7, Feb. 13, 1919, pp. 356-357. Possibilities of benzol, alcohol and shale distillate as substitutes for gasoline.

An Interpretation of the Engine-Fuel Situation, Joseph E. Pogue, Automotive Industries, vol. 40, no. 7, Feb. 13, 1919, pp. 357-361, 3 figs. Believes that lesser gasoline output, which writer considers as inevitable, can be met only by modifying engine design so as to secure higher thermal efficiency and to use less specified fuel.

Pacific Coast

Fuel Problems of the Pacific Coast. Mech. Eng., vol. 41, no. 3, Mar. 1919, pp. 264-269 and 292. Possibilities of fuel-oil conservation through its economic utilization and development of hydraulic power.

Peat

Possibilities of Peat, C. C. Osborn. Jl. Am. Peat Soc., vol. 12, no. 1, Jan. 1919, pp. 7-16 and 17-47. General conditions in industry; production in U. S., 1908-1917; manufacture of peat products; occurrence properties and uses; comparative calorific value of peat and other fuels; methods of preparation; peat industry in principal foreign countries. From U. S. Geol. Survey.

Powdered Coal

A Review on the Use of Powdered Coal, W. O. Renkin. Blast Furnace, vol. 7, no. 2, Feb. 1919, pp. 114-116 and 119, 3 figs. Graph showing comparative value and advantages of different fuels: comparison of installation and operating costs of producer gas, natural gas and hand-fired coal; early uses of powdered coal.

Powdered Coal as a Substitute for Fuel-Oil, Min. & Sci. Press, vol. 118, no. 7, Feb. 15, 1919, pp. 235-236, 1 fig. Layout of experimental plant using Buell-Santmyer system.

Pulverized Coal and Its Utilization, H. G. Barnhurst. Eng. World, vol. 14, no. 2, Jan. 15, 1919, pp. 45-46. Developments in pulverized-coal burning; plants using pulverized coal.

Pulverized Coal in an Industrial Plant, C. A. Dille. Power Plant Eng., vol. 23, no. 4, Feb. 15, 1919, pp. 188-189, 1 fig. Its preparation and method of application at plant of Mansfield Sheet and Tin Plate Co.

Characteristics of Powdered Coal, W. G. Wilcox. Brick & Clay Rec., vol. 54, no. 2, Jan. 28, 1919, pp. 127-131. Essentials of good combustion; flame length and air control; mixing coal with air; velocity of combustion.

U. S. Fuel Administration

Distribution of Coal Under U. S. Fuel Administration, J. D. A. Morrow. Bul. Am. Inst. Min. Engrs., no. 147, Mar. 1919, pp. 585-589. Method of controlling directing distribution.

Work of National Production Committee of U. S. Fuel Administration, James B. Neale. Bul. Am. Inst. Min. Engrs., no. 146, Feb. 1919, pp. 439-444. Method adopted for increasing production; need of stimulating ambition in workmen; industrial obligations of employers to men.

Wet Coal

Birds Nesting of Boiler Tubes, James Scott. Nat. Engr., vol. 23, no. 2, Feb. 1919, pp. 66-67, 3 figs. Suggests avoidance of wet coal highly impregnated with sulphur; also suppression of very high temperatures until sulphur has volatilized away. From Practical Engr.

FURNACES

Annealing Furnaces

Heating Furnaces and Annealing Furnaces—II and III, W. Trinks. Blast Furnace, vol. 7, nos. 2 and 3, Feb. 1919 and Mar. 1919, pp. 98-101, 9 figs., and pp. 134-137, 7 figs. Speed of heat transmission and required brick surface; curves showing rate of heat abstraction from exterior of furnace.

Heating Furnaces

Practical Pointers on Heating Furnaces, George J. Hagan. Blast Furnace, vol. 7, no. 3, Mar. 1919, pp. 153-155 and 163. Changes in hearth areas capacities and walls to improve product and reduce losses. Paper before Engrs.' Soc. Western Pa.

Kilns

Ovens and Kilns With a High Thermal Efficiency, A. Bigot. Engineering, vol. 107, no. 2768, Jan. 17, 1919, pp. 80-82, 6 figs. Paper before Refractory Materials Section of Ceramic Soc.

Open-Flame Furnaces

Open-Flame Furnaces at Government Gun Plant Accomplish Results That Munitions Specialist Believed Possible Only with Muffled Furnace or Electric. Am. Gas Eng. Jl., vol. 110, no. 5, Feb. 1, 1919, pp. 91-94, 4 figs. Large units measuring 37 ft. in depth and 9.5 ft. outside diameter are used to heat-treat big guns.

HANDLING OF MATERIALS

Coaling Station

Coaling Stations of the Philadelphia & Reading Railway. Eng. World, vol. 14, no. 4, Feb. 15, 1919, pp. 47-49, 6 figs. $270,000 locomotive coaling plant arranged to handle both anthracite and bituminous coal.

Coal Yard

An Efficient Chicago Coal Yard. Black Diamond, vol. 62, no. 4, Jan. 25, 1919, p. 65, 3 figs. Operates auto-crane in place of having elevated tracks.

Paper Mill

Handling Material in a Paper Mill, Henry J. Edsall. Indus. Man., vol. 57, no. 3, Mar. 1919, pp. 183-189, 18 figs. Boilerhouse machinery, conveyors for wet and dry pulp, machinery for handling black ash; track hauler, monorails and cranes. (Concluded.)

Steel Works

Handling Fuel and Materials in Iron and Steel Works, Frank Somers. Colliery Guardian, vol. 117, no. 3029, Jan. 17, 1919, p. 141. Concerning avoidance of passing materials backwards. Paper before Staffordshire Iron & Steel Inst.

GAGES

Limit Gages

Limit Gages, W. E. Wilson. Mech. World, vol. 65, no. 1672, Jan. 17, 1919, p. 27. Correction of gages for wear. First installment. (To be continued.) From Commonwealth Engr.

HEAT TREATING

Critical Points

Critical Points. Proc. Steel Treating Research Soc., vol. 2, no. 2, 1919, pp. 32-40, 1 fig. Discussions held before Detroit section on shrinkage and warpage in hardening steel parts and on development of soft spots in case hardened parts.

Low-Carbon Steel

Heat Treatment of Low-Carbon Steel, W. M. Wilkie. Mech. Eng., vol. 41, no. 3, Mar. 1919, pp. 239-244, 12 figs. Photomicrographs showing change in grain structure caused by annealing to various temperatures; effect of these structures on quality of steel.

Mass, Effect of

Effect of Mass on Heat Treatment, E. I. Law. Proc. Steel Treating Research Soc., vol. 2, no. 2, 1919, pp. 11-18 and (discussion) pp. 18-19 and 31, 3 figs. Chemical analyses, heating and cooling curves, and mechanical tests of cubes taken from 25-in. square ingot 10 ft. long after it was cogged down to 18 in. square. Paper before Iron & Steel Inst.

Springs

Manufacture, Heat Treatment and Physical Tests of Automobile Springs, N. E. Hendrickson. Proc. Steel Treating Research Soc., vol. 1, no. 10, July 1918, pp. 39-42 and (discussion) pp. 42-44. Calls attention to inconsistency of combining high-grade material with poor workmanship or heat treatment.

Steel Selection

The Composition and Properties of Steels, Howard Ensaw. Mech. World, vol. 65, no. 1671, Jan. 10, 1919, pp. 15-17. Suggests selection of few types of steel in order to avoid error in hardening and tempering. Tests of physical and chemical properties of steel.

Tempering

Phases on Tempering, E. W. Upham. Iron & Steel Can., vol. 2, no. 1, Feb. 1919, pp. 25-27. Discussion of methods of treatment and temperature control. Paper before Steel Treating Research Soc.

See also *METALLURGY, Iron and Steel (Aging Break).*

HEATING AND VENTILATION

Economics

Engineering Economics of Heating, M. William Ehrlich. Heat. & Ventilating Mag., vol. 16, no. 2, February, 1919, pp. 17-23, 6 figs. Containing also a method of predetermining coal requirements for steam and hot water heating systems. Abstract of a paper presented at the annual meeting of the American Society of Heating and Ventilating Engineers, New York, January, 1919.

Electricity

Heating Our Homes with Electricity. Elec. News, vol. 28, no. 3, Feb. 1, 1919, pp. 23-25 and 30, 7 figs. Pioneer installation in Toronto said to prove that electric heating is practical.

Heating Plants

The Enormous Heating Plant at the Great Lakes Naval Training Station, J. C. Foster. Domestic Eng., vol. 86, no. 7, Feb. 15, 1919, pp. 299-300. Plant supplies heat to 950 buildings covering area of 1210 acres.

Low-Pressure System

Saving Steam in Industrial Heating Systems. U. S. Fuel Administration, eng. bul. 6, 14 pp., 9 figs. Suggests utilization of exhaust steam and discusses chief requirements for a good low-pressure heating system.

See also *MINING ENGINEERING, Mines and Mining (Ventilation).*

HOISTING AND CONVEYING

Conveyors

Conveyors in Relation to Engineering Works, W. W. Atherton. Eng. World, vol. 14, no. 4, Feb. 15, 1919, pp. 27-30, 4 figs. Illustrations showing various types of conveyors.

Floating Cranes

Floating Crane of 75-Ton Capacity. Eng. World, vol. 14, no. 2, Jan. 15, 1919, pp. 63-64, 1 fig. Dimensions and arrangement of auxiliary parts.

Grain Elevators

Some Modern German Grain Elevators (Neuzeitlicher deutscher Getreidespeicherbau), Prof. M. Buhle. Zeitschrift fuer Baumwesen, vol. 68, no. 7 to 9, 1918, pp. 3195-314, 19 figs. Gives views and details of mechanical equipments of a number of grain elevators erected in Germany, Austria, Russia and Holland.

Wall Cranes

Wall Cranes, Ernest G. Beck. Mech. World, vols. 64 and 65, nos. 1669 and 1674, Dec. 27, 1918, and Jan. 31, 1919, pp. 306-307 and 54. Computation of stresses in members. Twentieth and twenty-first installments. (Concluded.)

HYDRAULIC MACHINERY

China

Age-Long Engineering Works of China. Middleton Smith. Engineer, vol. 127, no. 3291, Jan. 24, 1919, pp. 72. A description of some of the ancient hydraulic works in China.

Gates

Automatic Gates a Factor in Safety of Spillway Dams, Robert H. Moulton. Safety Eng., vol. 37, no. 2, Feb. 1919, pp. 58-60, 4 figs. Gates are operated by the water pressure.

INTERNAL-COMBUSTION ENGINES

Diesel Engine

The Diesel Engine on Shipboard, Bruce Lloyd. Jl. Electricity, vol. 42, no. 3, Feb. 1, 1919, pp. 116-119, 5 figs. Discussions of results obtained in trials on vessels built in Pacific Coast. Writer's opinion concerning marine acceptance of Diesel engine. Paper before San Francisco Section, Am. Soc. Mech. Engrs.

The Diesel Engine—I, Herbert Haas. South. Engr., vol. 30, no. 6, Feb. 1919, pp. 48-50, 4 figs. Three general types of liquid-fuel engines; explosion engines having four-stroke cycle; engines having two-stroke cycle.

Junkers Engine

The Junkers Engine, Philip Lane Scott. Pacific Marine Rev., vol. 16, no. 1, Jan. 1919, pp. 112-114, 4 figs. Operation of engine (Diesel type) having two pistons in one cylinders.

Semi-Diesel Engine

Combustion Engines and Their Applications (Les moteurs à combustion et leurs applications), M. Droesne. Revue Générale des Sciences, vol. 29, no. 23, Dec. 15, 1918, pp. 666-673, 1 fig. Origin and development of semi-Diesel engines; survey of results obtained in France and elsewhere in the construction of Diesel engines of various types.

The Leading Features of Semi-Diesel Oil Engine, James Richardson. Mar. Eng. Can., vol. 8, no. 12, Dec. 1918, pp. 295-300, 10 figs. Definition; nomenclature; classification; compression pressure; effect of compression; cycle of operation.

See also *MARINE ENGINEERING, Ships (Motorships).*

LUBRICATION

Grinding Lubricants

Proper Care of Grinding Lubricants, Howard W. Dunbar. Iron Trade Rev., vol. 64, no. 6, Feb. 6, 1919, p. 375. Contends that a tank for each machine is best way to handle grinding compounds and lubricants.

Lubricating Oils

Lubricating Oils, G. R. Rowland. Nat. Engr., vol. 23, no. 2, Feb. 1919, pp. 68-71, 1 fig. Physical characteristics and application; selection of oil most suitable for work required; distillation.

MACHINE ELEMENTS AND DESIGN

Bearings, Thrust

Single-Collar vs. Multi-Collar Thrust Bearings for Propeller Shafts, H. G. Reist. Gen. Elec. Rev., vol. 22, no. 2, Feb. 1919, pp. 133-137, 3 figs. From data available author assumes that substituting of single for multi-collar thrust bearings on average merchant ship would result in saving about one-half of one per cent of the total power, coal and size of boilers.

Flywheels

How Much Should a Flywheel Weigh? Rufus T. Strohm. Power, vol. 49, no. 8, Feb. 25, 1919, pp. 269-273, 7 figs. Simple method of calculating approximately weight of flywheel.

Gears

The Properties of Worm Axle Gears. Machinery, vol. 13, no. 331, Jan. 30, 1919, pp. 479-480. Formulæ and calculations.

Springs

Calculation of Helical Springs. (Berechnung zylindrischer Schraubenfedern unter Verwendung von Schaulinien.) Richard Seeman. Dinglers Polytechnisches Journal, vol. 333, no. 11, June 1, 1918, pp. 91-96, 11 figs., 5 tables. Concluded in no. 12, June 15, 1918, pp. 99-101. Large diagrams for solving all usual problems occurring with helical compression and tension springs. The second part contains typical examples, considering also the element of time, as in the closing of valves.

MACHINE SHOP

Boring and Lining

War-Time Repairs in the Navy, Frank A. Stanley. Am. Mach., vol. 50, no. 9, Feb. 27, 1919, pp. 383-387, 14 figs. Boring and lining operations. Fifth article.

Control of Tools

The Control of Electrically Operated Machine Tools, F. Ashton. Mech. World, vols. 64 and 65, nos. 1663, 1665, 1668, 1669, 1671 and 1672, Nov. 15, 29, Dec. 20, 27, 1918, Jan. 10

and 17, 1919, pp. 236-237, 259-260, 292-293, 304-305, 20-21 and 28-29, 17 figs. Description of various types in use; remarks on their operation; methods of starting; dangers from overloads.

Drive

Industrial Motor Installation, W. H. Wakeman. Southern Engr., vol. 30, no. 6, Feb. 1919, pp. 56-59, 10 figs. Detail of construction work in changing from belt drive to electric drive.

Grinding

Grinding as a Machine Operation. Ry. Gaz., vol. 30, no. 1, Jan. 3, 1919, pp. 25-27, 3 figs. Suggestions in regard to designing and operating grinding machines.

Grouting of Machine Bases

Grouting Electrical Machinery Bases—1, Terrell Croft. Southern Engr., vol. 30, no. 6, Feb. 1919, pp. 52-55, 3 figs. Function of grouting; mixing the grout; various materials for grout; preparing a machine bedplate for grout.

Hammering

Handier Hammering. Sci. Am., vol. 120, no. 9, Mar. 1, 1919, p. 208, 2 figs. Hammer provided with device to hold nail.

Shaft Pressing

Recent Developments in Shaft Pressing at Destination, N. L. Rea. Gen. Elec. Rev., vol. 22, no. 2, Feb. 1919, pp. 138-140, 3 figs. Description of methods that have been found successful in pressing on shafts at destination.

See also MECHANICAL ENGINEERING, Lubrication (Grinding Lubricants); RAILROAD ENGINEERING, Shops; METALLURGY, Iron and Steel (Tool Steel); INDUSTRIAL TECHNOLOGY, Pickling.

MACHINERY, METAL-WORKING

Drills

A New Method of Gang Drilling. Iron Age, vol. 103 no. 8, Feb. 20, 1919, pp. 489-492, 7 figs. Radical design based on detachable drill heads and chain drive; cutting cycle automatic; application in boiler shop.

Lathe, Roll

Japan to Have Massive Roll Lathe. Iron Trade Rev., vol. 64, no. 7, Feb. 13, 1919, pp. 451-452, 1 fig. Tool is motor-driven and is provided with several spindle speeds; bed is made in sections to facilitate transportation; total weight, 275,000 lb.

Lathe, Screw-Cutting

High-Precision Screw-Cutting Lathe. Mech. World, vol. 64, no. 1667, Dec. 13, 1918, p. 282, 1 fig. Machine built by Commission of Machine Tool Dept., Ministry of Munitions. Among other features "live" center is "dead," drive being obtained by catchplate revolving about spindle extension.

Milling Machine

Double-Spindle Milling Machine for Wrench Slot in Detonator Socket. Machinery, vol. 13, no. 331, Jan. 30, 1919, p. 495. 2 figs. Described as permitting manufacture of 4000 to 5000 fuse parts per day.

Trimmer

Bliss Flat-Edge Trimmer for Sheet Metal. Am. Mach., vol. 50, no. 9, Feb. 27, 1919, pp. 412-414, 4 figs. Description of a machine that will trim the scrap from metal stampings and leave a smooth, flat edge suitable for soldering, welding, brazing or other operations.

MACHINERY, SPECIAL

Evaporators

Industrial Vacuum Evaporators, Frank Coxon. Mech. World, vol. 65, nos. 1670 and 1673, Jan. 3 and 24, 1919, pp. 5 and 40, 7 figs. Classification and description. First and second installments. (To be continued.)

Reversing Machine

Reversing Value of Water-Sealed Type. Iron Trade Rev., vol. 64, no. 7, Feb. 13, 1919, pp. 452 and 467, 1 fig. Reversal of 36-in. hand-operated furnace valve is accomplished by a balanced hood and counterweights.

Trench-Digging Machine

German Excavating Machine for Tunnels and Mine Galleries (Machine allemande pour le creusement des tunnels et des galeries de mines), Francis Schmitt. Génie Civil, vol. 73, no. 22, Nov. 30, 1918, pp. 421-423, 10 figs. Details of excavator and of shaft with spiral blade for automatic removal of material.

MATERIALS OF CONSTRUCTION AND TESTING OF MATERIALS

Alternating Stresses

Effect of Cold-Working and Rest on Resistance of Steel to Fatigue Under Reversed Stress, H. F. More and W. J. Putnam. Bul. Am. Inst. Min. Engrs., no. 146, Feb. 1919, pp. 391-404, 9 figs. Report of research under auspices of Nat. Research Council.

Cast Iron

Cast Iron in Bending; Variation in Beam Strength, J. Harland Billings. Can. Machy., vol. 21, no. 7, Feb. 13, 1919, pp. 162-163, 2 figs. Tests to determine effect of varying cross section upon strength of beams in bending.

Glass

Strength Tests of Plain and Protective Sheet Glass, T. L. Sorey. Jl. Am. Ceramic Soc., vol. 1, no. 11, Nov. 1918, pp. 801-808, 4 figs. Claims that in both impact and cross-bend tests blown window glass was stronger than plate glass.

Toughness

Static, Dynamic, and Notch Toughness, Samuel L. Hoyt. Bul. Am. Inst. Min. Engrs., no. 146, Feb. 1919, pp. 339-351, 10 figs. Considers toughness as an independent property and proposes quantitative determinations of toughness by notched-bar impact tests (Charpy tests).

See also RAILROAD ENGINEERING, Rolling Stock (Lumber for Car Construction); METALLURGY, Iron and Steel (Aging Break)

MEASUREMENTS AND MEASURING APPARATUS

Dynamometers

Commercial Dynamometers, P. Field Foster. Mech. World, vol. 65, no. 1670, Jan. 3, 1919, pp. 6-7, 2 figs. "Transmission" types. Eighth installment. (Continuation of serial.)

Screw Measurements

A Machine for Measuring Screws, P. E. Shaw. Engineering, vol. 107, no. 2769, Jan. 24, 1919, pp. 104-108, 16 figs. Methods described depend upon a simple point contact in all cases. The machine used deals with the diameters and the pitch and is of a simple type, easy to use.

Spherometers

Mechanical Measure of a Spherical Surface. Spherometers. (Mesure mécanique d'une aire sphérique. Les sphérimètres), Paul Vanet. Génie Civil, vol. 74, no. 5, Feb. 1919, p 96, 6 figs. Principle of planimeter applied to measurement of area of closed figure drawn on a spherical surface.

Temperature Measurements

Measuring Gas Temperatures in Boiler Settings. Engineering, vol. 107, no. 2768, Jan. 17, 1919, pp. 75, 1 fig. Abstract of Bulletin 145, U. S. Bureau of Mines, by Messrs. Kreisinger and Barkley.

New Method of Measuring High Temperatures by the Coloration of the Light Emitted by an Incandescent Body (Sur une nouvelle méthode de mesure des températures élevées d'après la coloration de la lumière emise par le corps incandescent), A. Boutaric. Revue Générale de l'Electricité, vol. 5, no. 6, Feb. 8, 1919, pp. 210,217, 7 figs. Based principally on researches by Paterson and Dudding. (Phil. Mag., vol. 30, July 1915, p. 34.)

On the Lags of Thermometers with Spherical and Cylindrical Bulbs in a Medium Whose Temperature Is Changing at a Constant Rate, A. R. McLeod. Lond., Edinburgh & Dublin Phil. Mag., vol. 37, no. 217, Jan. 1919. pp. 134-144. Gives expressions for steady values of lags when surface conductivity is finite, and for lags at any instant when surface conductivity is infinite. Expression for surface conductivity $h = 0.0000515\ V$, where V is miles per hour, is suggested for thermometers moving through air at aeroplane speeds.

MECHANICAL PROCESSES

Bakelite Products

Making Moulded Bakelite Products. Machinery, vol. 13, no. 331, Jan. 30, 1919, pp. 481-485, 9 figs. Concerning design and manufacture of dies with provision for heating with steam.

Boilers

How to Design and Lay Out a Boiler—IV, William C. Strott. Boiler Maker, vol. 19, no. 2, Feb. 1919, pp. 46-47, 2 figs. Size of rivets; efficiency of joint. (Continuation of serial.)

Briquets

Notes on the Manufacture of Briquets, E. H. Robertson. Colliery Guardian, vol. 117, no. 3029, Jan. 17, 1919, pp. 136-137, 3 figs. Rolls for briquetting; cohesion testing machine and arrangement of bars. From Tran. Min. Geol. Inst. India.

Copper Driving Bands

The Manufacture of Copper Driving Bands, Wm. J. Reardon. Metal Industry, vol. 17, no. 2, Feb. 1919, pp. 63-68, 6 figs. How wartime needs developed way to produce pure copper castings in large quantities.

Crushing

Fine Crushing in Ball-Mills, E. W. Davis. Bul. Am. Inst. Min. Engrs., no. 146, Feb. 1919, pp. 111-156, 17 figs. Theoretical mechanics of fine crushing, ball-wear formulæ, and operating tests on siliceous rock comprising 35 per cent magnetite, the remainder being chiefly quartzite and iron silicates.

Presses

Manufacturing the Whitlock Pony Press, Robert Mawson. Can. Machy., vol. 21, no. 7, Feb. 13, 1919, pp. 159-161, 9 figs. Jigs and fixtures intended to simplify machining operations.

Rolling Mills

Builds Huge Plate Mill for Japan. Iron Trade Rev., vol. 64, no. 6, Feb. 6, 1919, pp. 387-388, 1 fig. 180-in. plate mill recently built by Morgan Eng. Co., Alliance, Ohio.

Novel Plate Turnover for Tandem Mill. Blast Furnace, vol. 7, no. 3, Mar. 1919, pp. 128-129, 2 figs. Arrangement at Youngstown Sheet & Tube Co.'s plate mill.

The Strip Mills of Trumbull Steel Co. Iron Age, vol. 103, no. 8, Feb. 20, 1919, pp. 475-479, 5 figs. Hot mill of wide range of speeds; interesting arrangement of finishing stands; motor speed control a feature.

Tractors

Manufacturing the Caterpillar Tractor, Frank A. Stanley. Am. Mach., vol. 50, no. 7, Feb. 13, 1919, pp. 299-302, 7 figs. Cylinders, pistons and crankshafts. Sixth article.

Wheels, Car

Slick Machines for Rolling Car Wheels at Johnstown Mill of Cambria Steel Company (Le laminage des roues de wagons par les machines Slick, aux usines de la Cambria Steel Co. à Johnstown, Pensylvanie, E.-U.), P. Calfas. Génie Civil, vol. 73, no. 24, Dec. 14, 1918, pp. 461-466, 18 figs. Description of a process of making car wheels in which they are formed directly from large rolled bars by a rolling-forging process as applied at the Cambria Steel Works.

See also MECHANICAL ENGINEERING, Heat Treating (Springs), Wood and Timber (Veneer Manufacture); ELECTRICAL ENGINEERING, Furnaces (Manufacture).

MECHANICS

Beams

Theory of the Hyperstatic Beam (Théorie de la poutre hyperstatique), D. Wolkowitsch. Génie Civil, vol. 74, no. 5, Feb. 1, 1919, pp. 84-89, 7 figs. Simple beam supported at one end and fixed at the other; continuous beams on supports at same level. (Concluded.)

Ropes, Wire, Stresses in

Stresses in Wire Rope, Shortridge Hardesty. Mech. Eng., vol. 41, no. 3, Mar. 1919, pp. 257-260, 4 figs. Development of new formula for determination of bending stresses.

Shafts, Critical Velocity of

On the Critical Velocity of Shafts. Dunkerley's Formula (Note sur la vitesse critique des arbres. Formule de Dunkerley), E. Hahn. Revue Générale de l'Electricité, vol. 5, no. 4, Jan. 25, 1919, pp. 123-130, 3 figs. Demonstration of Dunkerley's formula and calculation of its accuracy.

Struts

Critical Distributed Loads for Long Struts, Arthur Morley and F. F. P. Bisacre. Engineering, vol. 107, no. 2769, Jan. 24, 1919, pp. 99-100, 2 figs. Deals mainly with the compression flange or member of cantilevers or masts, developing a general formula applicable to a wide variety of distributed loads.

See also ELECTRICAL ENGINEERING Transmission, Distribution, Control (Suspension, Aerial).

MOTOR-CAR ENGINEERING

Axles

Parker Silent Internal Gear Axle. Automotive Industries, vol. 40, no. 6, Feb. 6, 1919, pp. 305-306, 3 figs. Gear is completely enclosed and runs in oil bath.

Carburetors

New Sunderman Carburetor Uses Floating Venturi. Automotive Industries, vol. 40, no. 7, Feb. 13, 1919, p. 377, 5 figs. Employs mushroom jet and air bypass for regulating depression at nozzle.

Design

Effect of Airplane Construction on the Automobile, O. E. Hunt. Eng. World, vol. 14, no. 4, Feb. 15, 1919, pp. 53-55. Claims that most important contribution has been the stimulus to thought of industry.

Possible Effect of Aircraft Experience on Automobile Practice, Howard C. Marmon, O. E. Hunt and Henry M. Crane. Automotive Industries, vol. 40, no. 6, Feb. 6, 1919, pp. 317-322. Comparison of plane and automobile engines; applicability to automobile manufacture of experience gained in producing light-weight results; development of alloy pistons. Paper before Soc. Automotive Engrs.


RILEY
UNDERFEED
STOKERS
A Peak Load Stoker
The evening peak at the Worcester Electric Light Co. calls for $2\frac{1}{2}$ to $3\frac{1}{2}$ times the normal output of the boilers. The RILEY STOKERS not only respond instantly but better still give sustained uniform performance regardless of poor coal or other trying conditions.
The Chief Engineer says *"Without moving grates* or the *continuous automatic ash discharge* such results are impossible." The engineer must know for he has operated many types of stokers.
If you are not acquainted with the advantages of the RILEY STOKER with its live grate surface, then you should send for catalog A-4.
SANFORD RILEY STOKER CO.
WORCESTER, MASS.
British Licensees: Erith's Engineering Co., Ltd., London.
French Licensees: Erith, Leroy & Cie., Paris, France.
Installation of 14-retort Riley Stokers under 1250 H. P. boilers.
TRADE MARK
Rx
REGISTERED

Engines

Motor Transport Under Difficulties, J. A. L. Gallard. Min. Mag., vol. 20, no. 2, Feb. 1919, pp. 90-91. Service given by sleeve-valve engine under stresses of war conditions.

Continental Adaptation of Class B War Truck Engine. Automotive Industries, vol. 40, no. 4, Jan. 23, 1919, pp. 211-213, 8 figs. Engine has aluminum crankcase and bell housing; designed originally for military use.

Gray Victory Four-Cylinder Engine. Automotive Industries, vol. 40, no. 7, Feb. 13, 1919, pp. 370-371, 5 figs. Block-cast engine of 3½-in. bore by 5 in. stroke, of valve-in-head type. Intended for passenger cars, trucks and tractors.

Ricardo Engine "Made Good" in Tanks. Automotive Industries, vol. 40, no. 8, Feb. 20, 1919, pp. 407-410, 7 figs. Piston design; means for cooling piston, for preheating carburetor air, and for preventing unvaporized fuel getting into crank chamber.

Fans

Radiator Cooling Fans, Louis Schwitzer. Automotive Industries, vol. 40, no. 4, Jan. 23, 1919, pp. 202-205. Fan design, mounting and drive; location of fan relative to housing.

Governors

Truck and Tractor Engine Governors, R. B. Shoop. Automotive Industries, vol. 40, no. 7, Feb. 13, 1919, pp. 374-375 and 392, 8 figs. Classification of various types; factors affecting design; adaptation of marine type.

Hotchkiss Drive

An Analysis of the Hotchkiss Drive, Otto M. Burkhardt. Automotive Industries, vol. 40, no. 4, Jan. 23, 1919, pp. 206-208, 5 figs. Resultant of weight carried and torque or brake reaction; effect of torque on spring.

Motorcycles

Harley-Davidson Co. Brings Out Sport Model. Automotive Industries, vol. 40, no. 7, Feb. 13, 1919, pp. 362-364, 6 figs. Design having a two-cylinder opposed engine, multiple-disk clutch and three-speed transmission.

Standards

S. A. E. Discusses Truck Subjects, B. B. Bachman, Cornelius T. Myers and G. E. Randles. Automotive Industries, vol. 40, no. 7, Feb. 13, 1919, pp. 349-351. Pneumatic tires for trucks; recommended inflation pressures.

Tractors

Case 15-27 Hp. Tractor, P. M. Heldt. Automotive Industries, vol. 40, no. 5, Jan. 30, 1919, pp. 256-261, 9 figs. Features of construction. Main frame is single iron casting designed to serve as main part of transmission case, crankcase and rear-axle housing.

Operating a Traction Engine, Thomas G. Thurston. Nat. Engr., vol. 23, no. 2, Feb. 1919, pp. 60-63, 2 figs. What is included in field operations; skill required in making repairs from scant and unsuitable materials.

Principles of the Wheeled Farm Tractor, Edward R. Hewitt. Automotive Industries, vol. 40, no. 6, Feb. 6, 1919, pp. 312-315, 3 figs. Factors determining maximum traction obtainable; results of experiments to ascertain rolling resistance. Paper before Soc. Automotive Engrs.

Valves

Small Inlet Valves Satisfactory in Overhead Valve Design—I, L. H. Pomeroy. Automotive Industries, vol. 40, no. 8, Feb. 20, 1919, pp. 432-435, 6 figs. Report of tests made with two engines of approximately same size, one a valve-in-head design and the other an L-head with valves side by side in valve pocket. Paper before Instn. Automobile Engrs.

Windshields

A New Windshield for Closed Bodies, George J. Mercer. Automotive Industries, vol. 40, no. 8, Feb. 20, 1919, pp. 416-417, 3 figs. Upper and lower parts in inclined planes cutting each other in line of vision.

See also AERONAUTICS, *Engines (Carburetors)*; MECHANICAL ENGINEERING, *Fuels and Firing (Motor-car Fuels), Standards and Standardization (Motor-car Parts)*; INDUSTRIAL TECHNOLOGY, *Gasoline*.

PIPE

Standards

Pipe Standards and Their Application to Commercial Work, A. M. Houser and C. C. Bartlett. Power Plant Eng., vol. 23, no. 5, March 1, 1919, pp. 250-252, 8 figs. Theoretical standards; Briggs standard gage; making tight joints.

POWER GENERATION

Argentina

Utilization of Waterfalls (Aprovechamiento de las caídas de aqua), A. Di Ció. Boletin de la Asociacion Argentina de Electro-Tecnicos, vol. 4, no. 9, Sept. 1918, pp. 816-820. Popular discussion of economical aspect of problem.

France

Hydraulic Energy in the Central Group of France (L'énergie hydraulique dans le Massif Central de la France), P. Morin. Revue Générale de l'Electricité, vol. 5, no. 6, Feb. 8, 1919, pp. 219-227, 4 figs. Geographical conditions and study of the water courses which are susceptible of immediate utilization.

Maine

Cost of Hydroelectric Development. Elec. Wld., vol. 73, no. 9, March 1, 1919, pp. 413-417. From a report based on the study of Maine water powers by H. K. Barrows to the Maine Public Utilities Commission. Effect of load factor; costs of water rights, power transmission lines, storage reservoirs; comparative utility of hydraulic and steam power.

Tennessee

The Larger Undeveloped Water-Powers of Tennessee, J. A. Switzer. Tennessee Geol. Survey, bul. 20, 1918, 55 pp., 30 figs. Report of field and office work; general scheme of development. Paper before Am. Electrochem Soc.

United States

Water Powers, O. B. Wilcox. Nat. Elec. Light Assn. Bul., vol. 6, no. 2, Feb. 1919, pp. 55-56. Estimate of available water power in U. S. From report of chairman of Committee on Public Service Securities, Investment Bankers' Assn. Am.

POWER PLANTS

Boiler Design

Modern Boiler Practice, F. A. Combe. Jl. Eng. Inst. Can., vol. 2, no. 2, Feb. 1919, pp. 109-119, 9 figs. Outline of principles governing boiler and furnace design, with review of present knowledge of laws related thereto, and trend of modern practice, together with general notes regarding boiler installation and operation.

Boiler Testing

Boiler and Furnace Testing, Rufus T. Strohm. U. S. Fuel Administration, Bur. of Conservation, eng. bul. 1, 20 pp., 3 figs. Suggests tests to be made everyday and apparatus required for making them.

Boilers, Uptakes for

How to Lay Out a Large Uptake for Stationary Boilers, Phil Nesser. Boiler Maker, vol. 19, no. 2, Feb. 1919, pp. 42-45, 7 figs. Method saves job of shearing.

Condensers

Condenser Engineering Practice, D. D. Pendleton. Mech. World, vols. 64 and 65, nos. 1669 and 1673, Dec. 27, 1918, and Jan. 24, 1919, pp. 309-310 and 41. Hotwell of low-type jet machine; air in surface condensers; heat transfer in surface condensers. Abstract of paper presented to Assn. Iron & Steel Elec. Engrs.

Vacuum Trouble in Turbine Condensers, James Brakes, Jr. Power, vol. 49, no. 8, Feb. 25, 1919, pp. 287-288, 4 figs. Discussion of an article "Keeping Up Condenser Performance," Power, Dec. 17, 1919.

Cost

Power Plant Costs Committee. Nat. Engr., vol. 23, no. 2, Feb. 1919, pp. 90-95, 4 figs. N.A.S.E. committee cost and production sheets.

Draft

Mechanical Draft, Charles L. Hubbard. Southern Engr., vol. 30, no. 6, Feb. 1919, pp. 40-43, 2 figs. Rates of combustion; draft pressure; air requirements; diagram of water-tube boiler equipped with mechanical draft.

Feedwater Softening

Boiler Water Treatment. U. S. Fuel Administration, eng. bul. 3, 8 pp. Examples of economies effected by softening water.

Water Softeners, C. E. Stromeyer. Colliery Guardian, vol. 117, no. 3031, Jan. 31, 1919, pp. 248-249, 2 figs. Abstracted from memorandum of chief engineer to Manchester Steam Users' Assn.

Firebox

New Type of Firebox Construction. Boiler Maker, vol. 19, no. 2, Feb. 1919, pp. 33-37 and 61, 4 figs. Customary arch tubes are replaced by "thermic syphons" or tubular sections extending from lower part of throat sheet up to rear end of crown sheet; upper part of tubular section is extended in form of flat plates, spaced 4 in. apart up to crown sheet for nearly entire length of firebox.

Heat Losses

Fuel Economy in the Boiler House—I, John B. C. Kershaw. Chem. & Metallurgical Eng., vol. 20, no. 4, Feb. 15, 1919, pp. 176-178, 3 figs. Study of heat losses and their control.

High Steam Pressures

Use of Higher Steam Pressures and Temperatures in Power Plants, J. H. Shaw. Elec. Rev., vol. 74, no. 7, Feb. 15, 1919, pp. 252-256, 5 figs. Practical and theoretical considerations involved; their effect upon turbine efficiency, design and plant layout. Abstract of paper before the Am. Inst. of Elec. Engrs.

The Use of High-Pressure and High-Temperature Steam in Large Power Stations, J. H. Shaw. Jl. Instn. Elec. Engrs., vol. 57, no. 278, Jan. 1919, pp. 73-82 and (discussion) pp. 82-108, 5 figs. Discussion of economical aspect of question; quotes data of various stations and suggests a schedule showing coal consumption, cost of coal, and amount of capital that can be expended to absorb estimated saving.

Isolated Plant

Saving Coal in Steam Power Plants. U. S. Fuel Administration, eng. bul. 2, 8 pp., 4 figs. Isolated plant vs. central-station power; typical distribution of heat in medium-sized hand-fired plant, chief losses in boiler-plant operation.

Oil Elimination

Oil Elimination, Charles L. Hubbard. Nat. Engr., vol. 23, no. 2, Feb. 19, 1919, pp. 75-79, 16 figs. Discussion of various methods used to eliminate oil from exhaust steam and condensation and their principles of operation; exhaust steam separators; purpose of baffle plates and corrugations; steam filtration; purifying condensate.

Operation

Improving Factory Steam Plants, H. A. Wilcox. Power Plant Eng., vol. 23, no. 4, Feb. 15, 1919, pp. 184-187, 1 fig. Case IV. Putting old plant into condition to finish its years of service efficiently. Sixth article.

Outline of Factors Governing Economical Boiler Operation, Robert June. Elec. Rev., vol. 74, no. 7, Feb. 15, 1919, pp. 257-260, 2 figs. Combustion, loss due to excess air and losses in burning coal; accounted-for and unaccounted-for losses. Second article.

Power Plants

New Philadelphia Power Plant, Walter C. Edge. Nat. Engr., vol. 23, no. 2, Feb. 1919, pp. 53-57, 6 figs. Designed to eliminate three old plants and to provide ample heat for process work from exhaust steam of engines and auxiliaries.

Safety

Placing Valves in Unsafe Positions, V. R. Hughes. Power, vol. 49, no. 8, Feb. 25, 1919, pp. 266-268, 17 figs. Examples of safe and unsafe arrangements.

Service Records

Memoranda of Office Records, Allan W. Cuddeback. Can. Engr., vol. 36, no. 7, Feb. 13, 1919, pp. 217-218, 2 figs. Records of location of service pipes, valves, hydrants and distribution mains of Passaic Water Co.

Stokers

New Travelling Grate Stoker for Forced Draft. Power Plant Eng., vol. 23, no. 5, March 1, 1919, pp. 262-263, 3 figs. Illustrated description of the Harrington stoker.

Design and Construction of Mechanical Chain Grate Stokers, W. H. Grantham. Mech. World, vol. 64, nos. 1668 and 1669, Dec. 20 and 27, 1918, pp. 294 and 307, 7 figs. Laclide-Christie design. Sixth and seventh installments. (Concluded.)

Turbines

Reliable Performance of Large Turbines. Blast Furnace, vol. 7, no. 3, Mar. 1919, pp. 147-148, 3 figs. Turbine generator of 35,000 kw. installed in Commonwealth Edison Co., Chicago.

Steam Turbine Operation, J. B. Wilson. Power Plant Eng., vol. 23, no. 5, Mar. 1, 1919, pp. 227-231, 5 figs. Points to be watched and conditions to be sought for best economy.

Waste Heat

The Utilization of Waste Heat from Open-Hearth Furnaces for the Generation of Steam, Thomas B. Mackenzie. Iron & Steel Can., vol. 2, no. 1, Feb. 1919, pp. 14-24, 3 figs. Data obtained from experiments with acid-lined furnaces or ordinary construction. Paper before Iron & Steel Inst.

See also MECHANICAL ENGINEERING, *Fuels and Firing (Wet Coal)*.

POWER TRANSMISSION

Mill Drive

Geared Versus Direct-Coupled Motors, R. W. Davis. Blast Furnace, vol. 7, no. 3, Mar. 1919, pp. 138-139, 3 figs. Example of 2000-hp., 81-r.p.m., 6600-volt, 3-phase, 25-cycle motor built with direct-coupled tandem plate mill drive.

PRODUCER GAS

Blast Furnace

The Blast Furnace as a Gas Producer. Blast Furnace, vol. 7, no. 3, Mar. 1919, p. 127. Concerning German blast furnace practice. From Stahl und Eisen.

PUMPS

Water-Works Pumps

Economic Value of Electrically Driven Pumps for Small Water Works, D. D. Ewing. Mun. & County Eng., vol. 56, no. 2, Feb. 1919, pp. 68-70. Illustrative examples. Figures are of pre-war type.

Electrically Driven Pumps in Small Waterworks, D. D. Ewing. Engineering and Contracting, vol. 51, no. 7, Feb. 12, 1919, pp. 170-171. Energy required by electrically driven pumps; power requirements; concrete illustration of motor-application principle; cost of changing to electrically driven pumps. From paper before Indiana Eng. Soc., 1919.

REFRACTORIES

Basic Refractories

Basic Refractories for the Open Hearth, J. Spotts McDowell and Raymond M. Howe. Bul. Am. Inst. Min. Engrs., no. 146, Feb. 1919, pp. 291-309, 7 figs. Report of laboratory tests. Low-line magnesite showed less tendency to slake, higher refractoriness and greater resistance to attack by firebrick and silica brick than high-lime magnesite; dolomitic materials highest in impurities and lowest in lime were most resistant to slaking; magnesites were more resistant than dolomites to slaking and to action of corrosive Fe_3P, Fe_2O_3, fireclay and silica.

Firebrick

How Slag Temperatures Affect Firebrick, Raymond M. Howe. Brick & Clay Rec., vol. 54, no. 2, Jan. 28, 1919, pp. 143-144. Results of tests indicating effects on life of brick. From Iron Trade Rev.

Great Britain

Refractories. Times Eng. Supp., year 15, no. 531, Jan. 1919, p. 19. Empire sources of supply; possibilities in manufacturing reforms.

See also MECHANICAL ENGINEERING, Furnaces (Kilns); METALLURGY, Blast Furnaces (Slag Action).

REFRIGERATION

Marine Refrigeration

Developments in Marine Refrigeration and Details of Brunswick Apparatus, W. O. Whitney. Jl. Am. Soc. Marine Draftsmen, vol. 6, no. 3, Oct. 1918, pp. 36-40, 6 figs. Features of the various types of refrigerating plants; discussion of their respective applicability.

Meat Industry

The Efficiency of the Frozen-Meat Industry, G. L. D. James. New Zealand Jl. Sci. & Technology, vol. 1, no. 6, Nov. 1918, pp. 341-345. Loss of dead weight in railing and droving, freezing, and transport.

RESEARCH

Gas Industry

The Place of Research in the Gas Industry, S. W. Parr. Gas Age, vol. 43, no. 3, Feb. 1, 1919, pp. 135-136. Points out fields of investigation. From paper before Western Soc. Engrs.

Great Britain

Research Progress. Times Eng. Supp., year 15, no. 531, Jan. 1919, p. 31. Work done by Dept. of Sci. & Indus. Research, Great Britain.

United States

American Engineering Research, W. R. Whitney. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 2, Feb. 1919, pp. 115-127. Calls attention to our national condition in relation to engineering research and expresses convenience of crystallizing research work into an acceptable form.

Research in America After the War, R. A. Millikan. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 2, Feb. 1919, pp. 129-140. Suggestions in regard to concerted action between similar committees of the various scientific societies.

STANDARDS AND STANDARDIZATION

Brass and Bronze Foundries

Standards for Brass and Bronze Foundries and Metal Finishing Processes, Lillian Eskine. Bul. Am. Inst. Min. Engrs., no. 146, Feb. 1919, pp. 263-275. Study of approved practices and equipment to safeguard health of workers.

German Machinery

Standardization in German Machine Building (Vereinheitlichung in deutchen Maschinenbau). Zeitschrift der Deutscher Gesellschaft fuer Mechanik und Optik, nos. 1 and 2, Jan. 15, 1918, pp. 1-6. Standardization to meet competition after the war. This installment contains the first five standard tables intended to be followed by "German Machine Industrie," including sizes of drawings, German standardization, etc.; also list of members throughout Germany engaged in this work. Effective since Feb. 15, 1918. From Zeitschrift ver d. Ing., vol. 61, p. 985, 1917.

Lengths

Industrial Length Standards (Les calibres industriels de longueur), Ch.-Ed. Guillaume. Bulletin de la Société Française des Electriciens, vol. 8, no. 75, Dec. 1918, pp. 383-400, 5 figs. Development of present principles of gaging; comparison of various standards; gaging machines of the Société Génevoise. Writer believes advisability of ascertaining from manufacturers their experience with the various metals used in manufacture of gages and deciding from study of reports on a standard which will satisfy all requirements.

Motor-Car Parts

Standards Committee Acts on Division Reports. Automotive Industries, vol. 40, no. 6, Feb. 6, 1919, pp. 307-311, 8 figs. Ball-bearing, electrical, engine, spring, tire and rim S.A.E. recommended standards.

Steel

British Adopt Twenty Standard Steel Specifications. Automotive Industries, vol. 40, no. 8, Feb. 20, 1919, pp. 418-419. Gives chemical and physical properties, together with definitions of terms used.

See also MECHANICAL ENGINEERING, Pipe (Standards); RAILROAD ENGINEERING, Rolling Stock (Standards for Freight Equipment); ELECTRICAL ENGINEERING, Generators and Motors (Standardization of Motors), Standards; ORGANIZATION AND MANAGEMENT, Factory Management (Standardization of Methods).

STEAM ENGINEERING

Boilers

Water Circulation in Boilers, A. D. Williams. Power, vol. 49, no. 8, Feb. 25, 1919, pp. 285-286. Notes on water circulation in water-tube boilers. Description of simple experiments by which observer can obtain an idea of flow of steam in tubes of varying pitch.

The Principles of Heat Absorption, Robert June. Brick & Clay Rec., vol. 54, no. 2, Jan. 28, 1919, pp. 133-136, 6 figs. Importance of maintaining clean surfaces in boiler.

Turbines

Notes on Large Steam Turbine Design, J. F. Johnson. Elec. Jl., vol. 16, no. 1, Jan. 1919, pp. 33-38, 4 figs. Operating records; load capacities; graph of relative steam consumption of large-capacity turbines; principles of turbine design. Paper before Phila. Section, Am. Soc. Mech. Engrs.

The Assembly and Adjustment of Steam Turbines, J. Humphrey. Machinery, vol. 13, no. 331, Jan. 30, 1919, pp. 486-492, 14 figs. Turbines considered are those working on Parsons principle and having a large number of fixed and moving blades, caulked into casing and on periphery of rotor.

High-Power Steam Turbines (Les turbines à vapeur de grandes puissances), Jean Guerner. Revue Générale de l'Electricité, vol. 5, no. 6, Feb. 8, 1919, pp. 227-230, 3 figs. Development of steam turbines, with reference to American models; economical comparison of the various types, from data obtained in American practice.

WELDING

Acetylene Welding

A Missing Link in Welding Equipment, Arthur W. Dohmen. Jl. Acetylene Welding, vol. 2, no. 8, Feb. 1919, pp. 388 and 392-393, 4 figs. Instrument which indicates flow of gases being used by welder.

Improvements in Guides for Oxy-Acetylene Blowpipes. Acetylene & Welding Jl., vol. 15, no. 183, Dec. 1918, p. 226, 3 figs. Guide consists of rotating plate having eccentrically mounted tube; supporting base for plate is provided with ball race.

Oxy-Acetylene Welding and Cutting. Eng. & Min. Jl., vol. 107, no. 6, Feb. 8, 1919, pp. 268-269. Abstract of bul. 11 of Federal Board for Vocational Education.

Oxy-Acetylene Welding Problems, W. L. Bean. Ry. Mech. Eng., vol. 93, no. 2, Feb. 1919, pp. 97-100, 3 figs. Discussion of flame structure and methods of handling; careful training of operators necessary. From paper before New England Ry. Club.

Oxy-Acetylene Welding. Power Plant Eng., vol. 23, no. 5, Mar. 1, 1919, pp. 244-246, 2 figs. Hints for beginners and pointers on power plant repair jobs. Second article.

Boiler Welding

Boiler Welding, P. F. Willis. Jl. Acetylene Welding, vol. 2, no. 8, Feb. 1919, pp. 393-398, 29 figs. Welding of a half side sheet in a locomotive firebox; welding of simple crack; welding half door sheets. From book on Oxy-Acetylene Welding and Cutting. To be continued.

Cast Iron

Welding Cracked Cast Iron Radiators, David Baxter. Metal Worker, vol. 91, no. 3, Jan. 17, 1919, pp. 83-85, 3 figs. Particulars of work and skill required for job. From Jl. Acetylene Welding.

Covered Electrode Welding

The Covered Electrode Process, E. G. Rigby. Jl. Engrs. Club Phila., vol. 35-10, no. 167, Oct. 1918, pp. 472-482, 6 figs. Its adoption in English shipyards; equipment; conditions required for good welding; its application to ship's deck structures, bulkhead structures, etc. Fourth discussion under auspices of U. S. Shipping Board Emergency Fleet Corporation.

Electric Welding

Electric Welding—A New Industry, H. A. Hornor. Jl. Engrs. Club, Phila., vol. 35-12, no. 169, Dec. 1918, pp. 537-543, 12 figs., and Elecn., vol. 82, no. 2122, Feb. 17, 1919, pp. 96-97. Present status; review of suggestions offered to develop scientific system of testing; methods of electric welding.

Electric Welding Practice, Comfort A. Adams. Jl. Engrs. Club Phila., vol. 35-12, no. 169, Dec. 1918, pp. 531-536, 7 figs. Testing; research; training; ship design and costs; shipyards committee. Seventh discussion under auspices of U. S. Shipping Board, Emergency Fleet Corporation.

Fusion in Arc Welding

Fusion in Arc Welding, O. H. Escholz. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 3, Mar. 1919, pp. 319-327, 16 figs. Characteristics of metallic electrode arc welding, and effect of arc length, welding procedure, electrode material, arc current and electrode diameter upon these characteristics.

Inspection

Inspection of Metallic-Electrode Arc-Welds, O. S. Escholz. Min. & Sci. Press, vol. 118, no. 8, Feb. 22, 1919, p. 26, 7 figs. Methods for indicating fusion, slag content, porosity, and crystal structure.

Mild Steel

Welding Mild Steel, H. M. Hobart. Bul. Am. Inst. Min. Engrs., no. 146, Feb. 1919, pp. 517-561, 17 figs. Investigation undertaken by welding research sub-committee of welding committee of the Emergency Fleet Corporation. Object was to extend use of welding in construction of merchant ships and to provide basis for obtaining the best economy and efficiency in employing welding in place of riveting in construction of hulls.

Pressure in Weld

Difficulties Encountered in Welding Steel, B. K. Smith. Boiler Maker, vol. 19, no. 2, Feb. 1919, pp. 39-40. Pressure of iron oxide in the weld; problems of expansion and contraction.

Pressure Vessels

Oxy-Acetylene Welding as Applied to Pressure Vessels. Acetylene & Welding Jl., vol. 15, no. 183, Dec. 1918, pp. 220-221, 1 fig. Example of welded gas containers. From Revue de la Soudure Autogène.

Radiograph

Radiograph Proves Successful "Jack-of-All-Operations." Jl. Acetylene Welding, vol. 2, no. 8, Feb. 1919, pp. 385-387, 6 figs. Account of exhibition of Davis-Bournonville apparatus.

Ruptures in Welds

Path of Rupture in Steel Fusion Welds, S. W. Miller. Bul. Am. Inst. Min. Engrs., no. 146, Feb. 1919, pp. 311-338, 82 figs. Report of research under joint auspices of Nat. Research Council and Emergency Fleet Corporation.

Thermit Welding

Modern Welding and Cutting, Ethan Viall. Am. Mach., vol. 50, nos. 7, 8 and 9, Feb. 13, 20 and 27, 1919, pp. 283-291, 20 figs., pp. 341-346, 10 figs., pp. 389-394, 16 figs. Thermit welding of crankshafts, mill pinions, etc. Second, third and fourth articles.

See also MARINE ENGINEERING, Yards (Welding).

WOOD AND TIMBER

Veneer Manufacture

The Manufacture of Veneer and Plywood, B. C. Boulton. Aerial Age, vol. 8, no. 25, Mar. 3, 1919, pp. 1240-1241, 1272 and 1285, 7 figs. Methods of cutting preparation of logs for sawing and slicing; slicer cutting; veneer sawing and drying.

VARIA

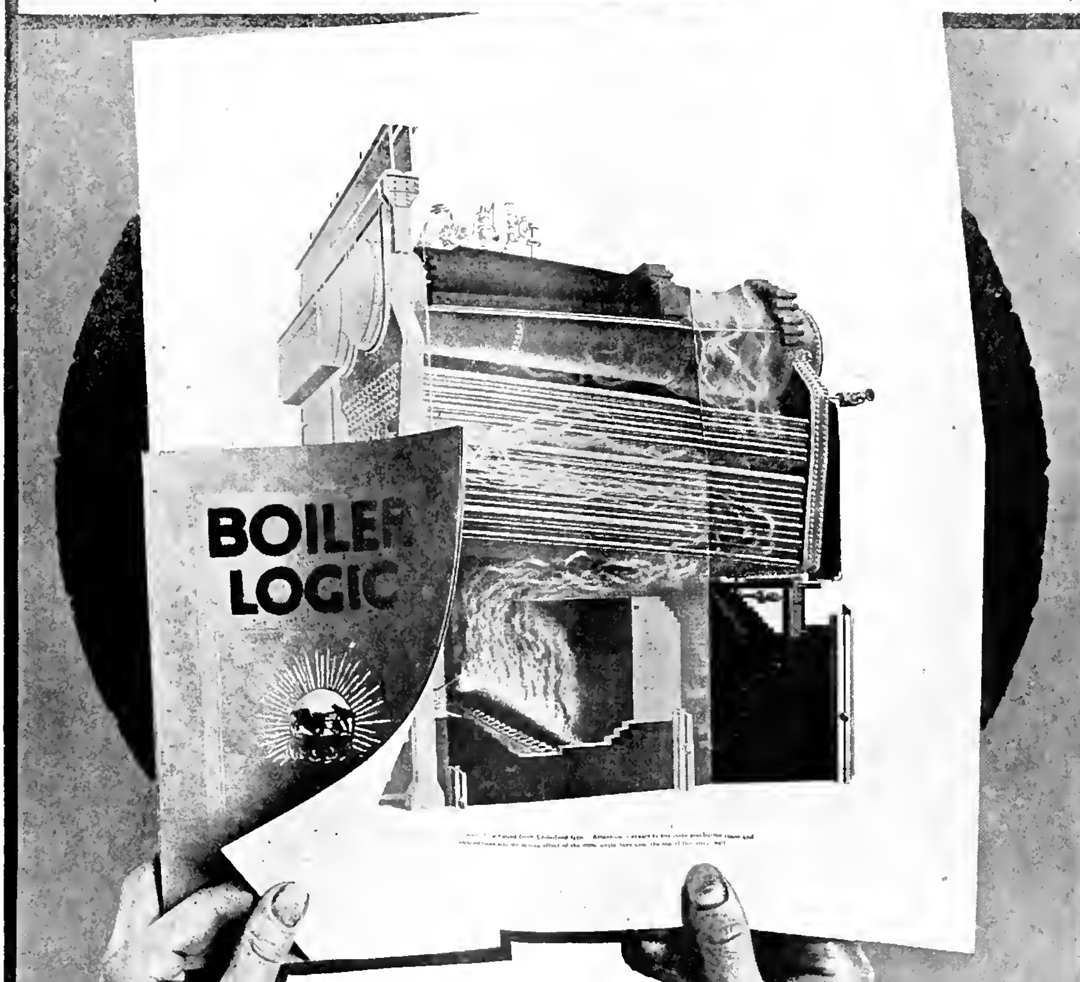
Engineering Societies

Address at the Annual Meeting, Arthur N. Talbot. Proc. Am. Soc. Civil Engrs., Papers & Discussions, vol. 45, no. 2, Feb. 1919, pp. 29-51. Review of activities of the year and discussion of outlook of Society.

Engineer's Part in Reconstruction

The Engineer's Part in After-the-War Problems, F. H. Newell. Sci. Monthly, vol. 8, no. 3, Mar. 1919, pp. 239-246. How the engineer and organizations of engineers, both indivi-

"BOILER LOGIC,"
OUR BOILER TREATISE, HAS BEEN REPRINTED
Contains colored frontispiece shown below.



Will you need a new boiler this year? Next year? Two years hence?

If so, begin "studying up" by reading the Heine authority BOILER LOGIC. It is a very comprehensive treatise on boilers, boiler theory, boiler practice—86 pages.

Every man responsible for economic steam production should *get, study,* and KEEP a copy.

HEINE SAFETY BOILER CO.
5321 Marcus Avenue - ST. LOUIS, MO.

RETURN COUPON
Tear off and mail it now.

TO THE HEINE SAFETY BOILER COMPANY,
5321 Marcus Avenue, St. Louis, Mo.

Please send a copy of Boiler Logic without any cost or obligation to:

Name .... Position ....

Firm .... Address ....

dually and collectively, can perform their largest service.

Hotels

Mechanical Equipment of a Modern Hotel. Power, vol. 49, no. 7, Feb. 18, 1919, pp. 230-233, 9 figs. First of series describing mechanical equipment of Hotel Pennsylvania, New York City.

Latin-American Engineering Conditions

Relation Between Engineering and Agriculture in Latin America. A. M. Shaw. La. Planter & Sugar Mfr., vol. 62, no. 7, Feb. 15, 1919, pp. 106-107. Present conditions in Latin America; opportunities these nations offer.

Licensing of Engineers

The Registration of Professional Engineers. Jl. Electricity, vol. 42, no. 3, Feb. 1, 1919, pp. 125-127. Act for licensing of engineers, prepared by San Francisco local sections of engineering societies.

Nomenclature, Scientific

Note on the Linguistic Nomenclature of Scientific Writers, Albert Campbell. Proc. Phys. Soc. London, vol. 31, part 2, Feb. 15, 1919, pp. 80-81 and (discussion) pp. 81-83. Comments on anglicizing terms from Latin and Greek introduced in the language. Suggests "pulsance" as name for $2\pi \times$ frequency.

State's Part in Industries

Engineers and the State. Times Eng. Supp., year 15, no. 531, Jan. 1919, p. 8. Opinions concerning part Government should take in problems confronting industry.

Electrical Engineering

ELECTROCHEMISTRY

Potentials, Signs

The Sign of Potentials, Oliver P. Watts. Brass World, vol. 15, no. 2, Feb. 1919, pp. 37-39, 1 fig. Argues that sign adopted for potential of a metal is of importance to electrochemistry and urges continuing established use of plus sign for potential of zinc.

ELECTROPHYSICS

Air Films, Dielectric Strength of

The Dielectric Strength of Air Films Entrapped in Solid Insulation and a Practical Application of the Problem for Alternator Coils and Cables, F. Dubsky. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 2, Feb. 1919, pp. 141-161, 7 figs. It was found from experiments that the dielectric strength of air films between insulations was practically the same as the dielectric strength of air films between conductors. Specific examples are given illustrating application of data to design of armature coils and cables.

Amplification of Currents

Amplification of the Photoelectric Current by Means of the Audion. Carl Eli Pike. Phys. Rev., vol. 13, no. 2, Feb. 1919, pp. 102-108, 8 figs. Experiments, it is reported, have demonstrated that photoelectric currents can be amplified by means of the audion from 1600 to 5000 times.

Current, Flow of

Propagation of the Current in an Electric Line (Propagation du courant dans une ligne), J. B. Pomey. Revue Générale de l'Electricité, vol. 5, no. 6, Feb. 8, 1919, pp. 204-209. Demonstration of Heaviside formula and derivation of a relation to cover case when variable electromotive force starts from a given condition of motion.

Electric Circuit, General Equation of

The General Equations of the Electric Circuit—III. Charles P. Steinmetz. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 3, Mar. 1919, pp. 249-318, 11 figs. Variation of constants r, L, C, and g, and its effects. Equations of line constants as function of equivalent frequency are derived, and applications thereof made to various problems.

Electromagnetic Fields

On the Flow of Energy in the Electromagnetic Field Surrounding a Perfectly Reflecting Cylinder, T. K. Chinmayan. Lond., Edinburgh & Dublin Phil. Mag., vol. 37, no. 217, Jan. 1919, pp. 9-33, 8 figs. Positions of maxima and minima of illumination and visibility of fringes when plane light waves are grazingly incident in a direction at right angles to axis of cylinder.

Electromagnetic Phenomena, Mechanical Representation of

Mechanical Representations of Electromagnetic Phenomena (Représentations mécaniques des phénomènes électromagnétiques), Artur Korn. Revue Générale de l'Electricité, vol. 5, no. 4, Jan. 25, 1919, pp. 150-151. Considerations on a mechanical representation of an electron, the electric current and a magnet. From Electrotechnische Zeitschrift, vol. 39, Sept. 12 and 19, 1918, pp. 363-375.

Electromagnetic Oscillations

Productions of Electromagnetic Oscillations (Production d'oscillations électromagnétiques), Ricardo Arnó. Industrie Electrique, vol. 27, no. 635, Dec. 10, 1918, pp. 443-444. Produced directly by alternating currents used in industry. Brief abstract of communication to Institute Lombard des Sciences et des Lettres.

Grid Currents in Vacuum Tubes

Note on the Effects of Grid Currents in Three-Electrode Ionic Tubes, E. V. Appleton. Lond., Edinburgh & Dublin Phil. Mag., vol. 37, no. 217, Jan. 1919, pp. 129-134, 2 figs. Conductance of grid circuit inside tube is treated as high-resistance leak across condenser of oscillatory circuit connected to grid and filament; effect of this leak in amplifying and oscilation circuits is investigated quantitatively.

Insulation, Electrical Stresses in

Ionization of Occluded Gases in High-Tension Insulation, G. B. Shanklin and J. J. Matson. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 2, Feb. 1919, pp. 163-210, 21 figs. Determination of safe working stress from measurements of stress at which ionization starts in different types of built-up insulation, such as used in cables and coils. Paper brings out importance of reducing gas spaces to minimum size and using materials of lowest possible permittivity, since the higher the permittivity the greater the stress on the gas spaces.

Insulators, Rupture of

Mechanism of the Rupture of Electric Insulators (Le mecanism de la rupture des isolants électriques). Génie Civil, vol. 74, no. 5, Feb. 1, 1919, pp. 92-93, 3 figs. Factors determining rupture; effect with alternating currents.

Iron Losses at Radio Frequencies

Note on Losses in Sheet Iron at Radio Frequencies, Marius Latour. Proc. Inst. Radio Engrs., vol. 7, no. 1, pp. 60-71, 1 fig. Calculation of power dissipated separately by Foucault currents and by hysteresis in a sheet of iron, assuming constant angle of lag between magnetic induction in sheet and magnetizing field producing it; thickness of iron sheet which will make total power a minimum; angle of lag between voltage and current in circuit of inductance coil.

Hysteresis and Eddy-Current Losses in Iron at Radio Frequencies, Christian Nusbaum. Proc. Inst. Radio Engrs., vol. 7, no. 1, Feb. 1919, pp. 15-26, 8 figs. Review of literature on heat losses per cycle at various frequencies; comparison calorimetric method whereby losses in soft-iron-wire core of a toroid are measured against similarly wound toroid without iron core.

Magnetic Flux Density

The Natural Frequency of an Electric Circuit Having an Iron Magnetic Circuit, H. G. Cordes. Proc. Inst. Radio Engrs., vol. 7, no. 1, Feb. 1919, pp. 73-82, 2 figs. Following Steinmetz procedure, magnetic flux density in laminated iron core with a.c. current excitation is found; then expressions and tables for determining natural frequency of circuits containing iron-core inductances are given; results obtained are numerically illustrated.

Magnetism, Kinetic Theory of

On a Kinetic Theory of Magnetism in General, Kōtarō Honda and Junzo Okubo. Phys. Rev., vol. 13, no. 1, Jan. 1919, pp. 6-26, 4 figs. Modifications in Langevin's theories of paramagnetic and diamagnetic substances in order to account for observed facts.

Resistance Measurements, Radio-Frequency

The Measurement of Radio Frequency Resistance, Phase Difference, and Decrement, J. H. Dellinger. Proc. Inst. Radio Engrs., vol. 7, no. 1, Feb. 1919, pp. 27-59, 9 figs. Relations between resistance, phase difference, sharpness of resonance, and decrement; derivation and classification of methods of measurement. Methods are comprised under resistance-variation and reactance-variation. Special direct-reading methods of measuring reactance.

Short-Circuit Current Calculation

Calculation of Short-Circuit Currents in Alternating-Current Systems, W. W. Lewis. Gen. Elec. Rev., vol. 22, no. 2, Feb. 1919, pp. 140-145, 8 figs. The author describes the use of a calculating table for solving complicated problems in the determination of short-circuit currents in large power networks.

Sinusoidal Current, Action of

Electrical State of a Line Carrying a Sinusoidal Current (Etat permanente sur une ligne parcourue par un courant sinusoïdal), M. E. Brylinski. Bulletin de la Société Française des Electriciens, vol. 8, no. 75, Dec. 1918, pp. 401-420. Formulæ for electrical quantities determined for various cases.

Steel Conductors

Resistance and Reactance of Commercial Steel Conductors, H. B. Dwight. Elec. Jl., vol. 16, no. 1, Jan. 1919, pp. 25-27, 15 figs. Curves showing amperes per wire against ohms per mile for different sizes; graphs drawn from results of tests.

Transient Oscillations

Theory of the Transient Oscillations of Electrical Networks and Transmission Systems, John R. Carson. Proc. Inst. Elec. Engrs., vol. 38, no. 3, Mar. 1919, pp. 407-489, 22 figs. Theoretical study with view to developing methods of calculation directly applicable to engineering problems. A formula is derived which expresses current in electric network due to suddenly applied e.m.f. in terms of applied e.m.f. as time function and a characteristic function of constants and connections of system.

See also ELECTRICAL ENGINEERING, Telegraphy and Telephony (Vacuum Tubes).

FURNACES

Manufacture

Furnace Company Completes New Plant. Blast Furnace, vol. 7, no. 3, Mar. 1919, pp. 152-153, 2 figs. Features of electric furnace manufacturing plant.

Plant of the Electric Furnace Co. Brass World, vol. 15, no. 2, Feb. 1919, pp. 61-63, 10 figs. Plant manufactures Baily furnaces for electrical heat-treating and annealing of steel, and melting of nonferrous metals.

Rennerfelt Furnace Operation

Melting Silver, Nickel and Bronze Alloys by Electricity. Eng. & Min. Jl., vol. 107, no. 7, Feb. 15, 1919, pp. 323-324. Results at Phila. mint with 1000-lb. Rennerfelt electric furnace.

Resistor-Type Experimental Furnace

Experimenting with the Electric Furnace. Wirt S. Scott. Jl. Electricity, vol. 42, no. 4, Feb. 15, 1919, pp. 173-174. Experimental work on resistor-type furnaces for forging.

Steel Furnaces

Electric Furnaces as Applied to Steel Making, Henry Lawrence Hess. Mech. Eng., vol. 41, no. 3, Mar. 1919, pp. 245-248, 5 figs. Methods of producing electric steel; Héroult type of furnace; cold method of producing electric steel; method of pouring, rolling and other furnace operations practiced in plant operating two 6-ton and four 7-ton Héroult furnaces.

See also METALLURGY, Iron and Steel (Electric Smelting).

GENERATING STATIONS

Canada

Statistical Analysis of the Central Electrical Station Situation of Canada. Elec. News, vol. 28, no. 3, Feb. 1, 1919, pp. 26-30, 7 figs. Synopsis of data prepared by Dominion Water Power Branch of Dept. of Interior, in coöperation with Dominion Bur. of Statistics of Dept. of Trade & Commerce.

Diesel Engines

Electric Generation by Diesel Engine, E. J. Richards. Jl. Electricity, vol. 42, no. 4, Feb. 15, 1919, pp. 167-169, 5 figs. Results obtained at large copper mine.

Hydroelectric Plants

Michigan's Largest Hydroelectric Development. Eng. World, vol. 14, no. 4, Feb. 15, 1919, pp. 21-24, 6 figs. Layout; coördination of turbines installed to water flow; equipment of 140,000-volt transmission line.

Single-Phase Current Generation

The Supply of Single-Phase Power from Three-Phase Systems, Miles Walker, Jl. Instn. Elec. Engrs., vol. 57, no. 278, Jan. 1919, pp. 109-139 and (discussion) pp. 139-148, 49 figs. Methods of obtaining single-phase power, particularly (1) by taking of single-phase current direct from one of phases of a three-phase supply system and use of balancer for balancing phases, and (2) by a rotating balancing transformer which absorbs balanced three-phase power in one winding and supplies a single-phase load from an independent winding. A calculation of a balancing transformer for feeding a 400-kw. electric furnace is worked out; figures obtained in tests of machine at no load and at full load are given.

GENERATORS AND MOTORS

Brushes

Application of Brushes to Electrical Machinery, Warren C. Kal, Power, vol. 49, nos. 7 and 8, Feb. 18 and 25, 1919, pp. 241-243 and 276-278, 9 figs. Feb. 18: Various types of brushes used on electrical machinery, their composition, method of manufacture and field of application. Feb. 25: Discussion of effect of conditions of service upon selection of carbon brushes.

Cooling of Motors

Cooling of Electric Motors, with Special Reference to Totally-Enclosed Machines. P. A. Mossay. Tran. Instn. Min. Engrs., vol. 56, part 2, Dec. 1918, pp. 103-115 and (discussion)pp. 115-117, 13 figs. Writer's experience and suggestions in regard to present systems of ventilating motors.

Demand Factors of Motors

Determination of Demand Factors to Save Copper, Henry C. Horstmann and Victor H. Tousley. Elec. World, vol. 73, no. 7, Feb. 15, 1919, pp. 308-310, 3 figs. Methods by which electrical inspectors can more accurately gauge in advance probable demand factors of different types of motor installations.

Induction Motors, Speed Control of

Speed Control of Induction Motors on Cranes and Hoists by means of Solenoid Load Brakes, R. H. McLain and H. H. Vernon. Gen. Elec. Rev., vol. 22, no. 2, Feb. 1919, pp. 117-125, 9 figs. Article covers different applications of solenoid brakes and gives a detailed description of a solenoid load brake.

Mechanically Connected Motors

The Operation of Mechanically-Connected Direct-Current Motors Permanently in Series or Permanently in Parallel, H. F. Stratton. Popular Engr., vol. 11, no. 2, Feb. 1919, pp. 10-13, 8 figs. Reasons why preference is given to several mechanically connected motors in preference to a single large motor. (To be continued.)

Standardization of Motors

Advantages of Uniform Motor Design. Rotary Apparatus. Elec. Power Club, bul. 6010, Jan. 2, 1919, 6 pp. Views of manufacturers and users concerning standardization of electric motors.

Synchronous Motors, Starting

Starting Synchronous Motors, E. E. George. Elec. Wld., vol. 73, no. 9, March 1, 1919, pp. 429-430. How to avoid excessive currents and mechanical strains in synchronous motors started as induction machines.

LIGHTING AND LAMP MANUFACTURE

Municipal Lighting

A Study in Municipal Electric Lighting. Stone & Webster Jl., vol. 24, no. 2, Feb. 1919, pp. 104-112. Comparative data showing results of municipal electric lighting in Massachusetts.

Pocket Lamps

Pocket Electric Lamps (Les lampes électriques de poche), L. Lindet. Bulletin de la Société d'Encouragement, vol. 130, no. 6, Nov.-Dec. 1918, pp. 398-399. Development of industry in France; details of manufacture.

Theatres

Electric Lighting of Theatres (L'éclairage électrique au théâtre), J. Reyval. Revue Générale de l'Electricité, vol. 5, no. 4, Jan. 25, 1919, pp. 133-145, 11 figs. Brief survey of progress in artificial lighting of theatres; description of electric installation of the Théâtre National de la Comédie Française, Paris.

See also RAILROAD ENGINEERING, Safety and Signaling Systems (Signal Lamps, Focusing).

MEASUREMENTS AND TESTS

Kenotron

Measurement of the Crest Values of alternating Voltage by the Kenotron, Condenser, and Voltmeter, J. R. Craighead. Gen. Elec. Rev., vol. 22, no. 2, Feb. 1919, pp. 104-109, 8 figs. Arrangement described embodies in one instrument a combination of qualities said not to be possessed by previous devices for the purpose. The theory and construction of the crest meter is described, test of its accuracy recorded and its advantages and limitations set forth.

POWER APPLICATIONS

California Campaign

California Coöperative Campaign Progress. Jl. Electricity, vol 42, no. 3, Feb. 1, 1919, pp. 108-110. Summary of accomplishments in 1918. Object of campaign is better electric service to public.

Electrometallurgical Industries

Electrometallurgical Industries in the Scandinavian Countries (Les industries électrométallurgiques dans les pays Scandinaves). Journal du Four Electrique, vol 28, no. 3, Feb. 1, 1919, pp 17-19. Statistical figures and notes on various projects.

Flour Mills

Electrical Equipment of New Pacific Coast Flour Mill. Elec. Rev., vol. 74, no. 8, Feb. 22, 1919, pp. 295-296, 5 figs. Mill at Pasco, Wash., is completely equipped electrically; labor-saving methods promote marked economy.

Heating

Electric Heating as a Profitable Load, Barry Dibble. Jl. Electricity, vol. 42, no. 3, Feb. 1, 1919, pp. 102-105, 2 figs. Data on cost and revenue of electric heating on Minidoka project, Idaho.

Laboratories

Electrically Equipped Laboratories, C. B. Merrick. Jl. Electricity, vol. 42, no. 4, Feb. 15, 1919, pp. 153-154, 2 figs. Installation at parasitology laboratories of Cal. State Board of Health.

Office Building

Electricity in a Large Office Building. Jl. Electricity, vol. 42, no. 4, Feb. 15, 1919, pp. 150-151, 3 figs. General description of electric equipment in Southern Pacific building, San Francisco.

Potteries

Electricity in the Ceramic Arts, J. P. Alexander. Gen. Elec. Rev., vol. 22, no. 2, Feb. 1919, pp. 113-116, 4 figs. Describes various processes employed in the pottery industry and the service afforded by electricity in this field.

Shipbuilding

Electricity in the Shipbuilding and Shipping Industries. Shipbuilding & Shipping Rec., vol. 13, no. 1, Jan. 2, 1919, pp. 13-14. Concerning efficient development in utilization of power as means to face international competition.

Signs

Portland Sign Ordinance . Jl. Electricity, vol. 42, no. 3, Feb. 1, 1919, pp. 114-115. Regulations in Portland and Oregon.

See also MINING ENGINEERING, Minor Industrial Materials (Electric Power); MECHANICAL ENGINEERING, Heating and Ventilation (Electricity).

POWER GENERATION

Hydroelectric Plants

See Power Generation, MECHANICAL ENGINEERING.

STANDARDS

Fundamental Units, Definitions of

International Electrotechnic Commission (La comision electrotécnica internacional), Germán Niebuhr. Boletín de la Asociacion Argentina de Electro-Técnicos, vol. 4, no. 9, Sept. 1918, pp. 807-815, 2 figs. Definitions adopted for the fundamental units. Continuation of serial.)

Standardization

Standardization of Edison Lamp Bases and Sockets (Projet d'unification des filetages des culots et supports de lampes à vis Edison), C. Zetter. Bulletin de la Société d'Encourage-

TELEGRAPHY AND TELEPHONY

Amateur Radio

Amateur Radiotelegraphy of the Future, Alfred N. Goldsmith. Wireless Age, vol. 6, no. 5, Feb. 1919, pp. 11-13. Advocates operating all amateur radio stations of the future on sustained waves between 100 and 300 meters.

The Fire Underwriters' Rules Applied to Amateur Stations. Wireless Age, vol. 6, no. 6, Mar. 1919, pp. 32-33, 2 figs. Advisability of modifying installation to conform to Underwriters' rules and method of doing so.

Automatic Telephone, Western Electric

The Western Electric Company's Automatic Telephone System, B. O. Anson. Instn. Post Office Elec. Engrs., paper no. 72, pp. 1-47 and (discussion) pp. 48-61, 23 figs. Operation, details of principal apparatus used, schematic connections of various line exchanges, and records of service.

Baudot Quadruplex System

Paris-London Quadruplex Baudot Communication (Communication Baudot quadruple Paris-Londres), M. Mercy. Annales des Postes, Télégraphes et Téléphones, vol. 7, no. 4, Dec. 1918, pp. 623-624. Condensation is reported to have been overcome in Anglo-French cable by interpolation of differential transmission between cable and aerial line in France. Device used described in Annales, Mar. 1917, p. 144

British Colonies

The Telegraph and the Telephone in the British Colonies (Le télégraphe et le téléphone dans les Colonies britanniques). Journal Télégraphique, vol. 43, no. 1, Jan. 25, 1919, pp. 3-6. Australia and New Zealand. (Concluded.)

Ceylon

Telegraphs and Telephones in Ceylon in 1917 (Les télégraphes et les téléphones en Ceylon en 1917). Journal Télégraphique, vol. 43, no. 1, Jan. 25, 1919, pp. 13-14. Constructions and revenues. From report of Postmaster General.

French Colonies

Wireless Telegraphy in the French Colonies (La télégraphie sans fil dans les colonies françaises). Revue Générale de l'Electricité, vol. 5, no. 6, Feb. 8, 1919, pp. 233-234. Present conditions; particulars of the Messimy project. From Economiste française, Jan. 11, 1919.

Government Ownership

Both Sides of the Government Ownership Question. Wireless Age, vol. 6, no. 6, Mar. 1919, pp. 11-21 and 46, 13 figs. Summary of opposing testimony given in congressional hearing on Alexander bill for Government ownership of wireless.

Interference Prevention

General Rules Followed in the United States for Protecting Telephone Lines Against Three-Phase Lines (Règles générales suivis aux Etats-Unis pour protéger les lignes téléphoniques contre les lignes triphasées), M. Valensi. Annales des Postes, Télégraphes et Téléphones, vol. 7, no. 4, Dec. 1918, pp. 526-607, 38 figs. Prepared from information obtained in conferences of writer with engineers of Am. Telephone & Telegraph Co. and his perusal of Proc. Am. Inst. Elec. Engrs., notably Interference as a Practical Problem by A. H. Griswold and R. W. Mastick, and The Design and Transposition for Parallel Power and Telephone Circuits by H. S. Osborne.

Lloyd's Semaphore, Radio Telegraphy

Wireless Telegraphy and the Safety of Navigation (La télégraphie sans fil et la sécurité de la navigation maritime). Journal Télégraphique, vol. 43, no. 1, Jan. 25, 1919, pp. 6-10. Lloyd's semaphore plan proposed to the Paris International Conference. (To be continued.)

Mercury-Vapor Rectifiers

Mercury Vapor Rectifiers (Les redresseurs à vapeur de mercure). Revue Générale de l'Electricité, vol. 5, no. 4, Jan. 25, 1919, pp. 146-149, 8 figs. Scheme of connections, efficiency curves and oscillograms of voltages and currents. From Schweizerische Bauzeitung, vol. 72, Sept. 28, 1918, pp. 117-120, 13 figs.

Molybdenite Rectifiers

Photoelectric Sensitivity vs. Current Rectification in Molybdenite, W. W. Coblentz and Louise S. McDowell. Phys. Rev., vol. 13, no. 2, Feb. 1919, pp. 154-155. Tests are said to have shown that low-resistance, photoelectrically-insensitive samples of molybdenite are more efficient rectifiers than high-resistance, light-sensitive specimens.

Multiplex Transmission

Multiplex Telegraphy and Telephony. Wireless Age, vol. 6, no. 6, Mar. 1919, pp. 22-23, 4 figs. Concerning use of radio frequency currents.

Multiplex Telephony and Telegraphy, Frank B. Jewett. Telegraph & Telephone Age, vol. 37, no. 2, Jan. 16, 1919, pp. 45-47, 4 figs. Development and possibilities.

Naval Radio Stations

A Brief Technical Description of the New San Diego, Pearl Harbor, and Cavite High Power Naval Radio Stations, Leonard F. Fuller. Proc. Inst. Radio Engrs., vol. 7, no. 1, Feb. 1919, pp. 11-13.

Radio Progress During War

Radio Development During the War, Nugent H. Slaughter. Elec. World, vol. 73, no. 7, Feb. 15, 1919, pp. 311-315, 4 figs. Problems with which Signal Corps was confronted when the United States first engaged in conflict; how it placed radio-apparatus production on quantity basis; nature of improvements made.

Resonance Measurements

Resonance Measurements in Radiotelegraphy with the Oscillating Audion. Proc. Inst. Radio Engrs., vol. 7, no. 1, Feb. 1919, pp. 9-10. The telephone click in an oscillating audion circuit when a coupled circuit is brought into tune with it is utilized to measure quickly and accurately antenna capacity, wave length of distant stations, capacities, inductances and wave lengths.

Rouzet Transmitting System

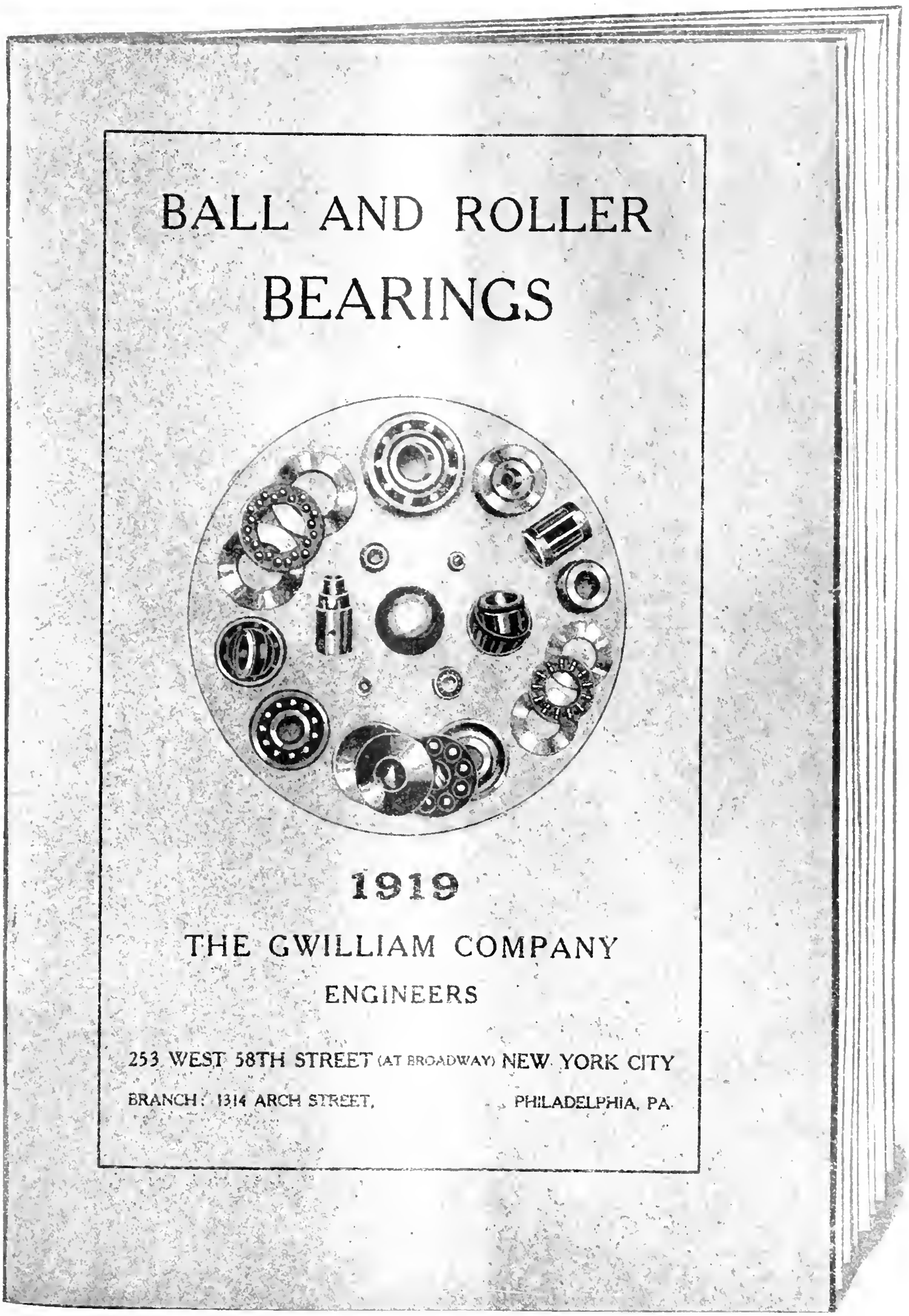
Rouzet Transmitting System for Increasing Spark Frequencies. Wireless Age, vol. 6, no. 5, Feb. 1919, p. 20, 4 figs. Wiring diagram.

Simultaneous Telegraphy and Telephony

The Van Rysselberghe System of Simultaneous Telegraphy and Telephony, the Marshall Electrical Condenser, Etc., Wm. Maver, Jr. Telegraph & Telephone Age, vol. 37, nos. 1 and 4, Jan. 1 and Feb. 16, 1919, pp. 21-23 and 95-97. (Concluded from Sept. 16, 1918.)

Telegraph Lines, Protection Against Lightning

Protection Against Lightning and High Tension Circuits. Telegraph & Telephone Age, vol. 37, no. 2, Jan. 16, 1919, pp. 42-44. Summary of experience of railroad telegraph de-


BALL AND ROLLER
BEARINGS
1919
THE GWILLIAM COMPANY
ENGINEERS
253 WEST 58TH STREET (AT BROADWAY) NEW YORK CITY
BRANCH: 1314 ARCH STREET, PHILADELPHIA, PA.

partments. Presented at convention of Assn. Ry. Telegraph Superintendents. (Concluded.)

Telephone Circuits

Telephone Circuits With Zero Mutual Induction. William W. Crawford. Proc. Am. Inst., Elec. Engrs., vol. 38, no. 3, Mar. 1919, pp. 377-405, 11 figs. Deals with reduction of inductive interference in telephone circuits. Several forms of construction involving various relative positions of two or more circuits, in which mutual inductance is zero, and mutual capacitance unbalance approximately zero, are discussed.

Telephone Relays

Telephone Relays Used by the French Administration (Les relais téléphoniques employés par l'Administration française). Revue Générale de l'Electricité, vol. 5, no. 4, Jan. 25, 1919, pp. 151-152, 4 figs. Apparatus deviced by Latour. From Annales des Postes, Télégraphes et Téléphones, vol. 7, Sept. 1918, p. 403, 4 figs.

Telephones, Automatic

Automatic Telephone Systems. J. N. Wallace. New Zealand Jl. Sci. & Technology, vol. 1, no. 6, Nov. 1918, pp. 331-340, 6 figs. Development and operation.

Telephony, Radio

Magnetic Modulating System for Wireless Telephony. Wireless Age, vol. 6, no. 5, Feb. 1919, pp. 20-21, 3 figs. Modulation effected by subjecting magnetic core to relatively weak and rapidly alternating cross magnetization.

Radio Telephony. E. B. Craft and E. H. Colpitts. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 3, Mar. 1919, pp. 337-375, 43 figs. Development of systems of generation, modulation, transmission and reception of radio telephone systems; work of producing radio telephone and allied apparatus for Army and Navy in late war.

Tone Frequencies

The Production of Tone Frequencies. Wireless Age, vol. 16, no. 5, Feb. 1919, pp. 18-20, 6 figs. Oscar Roos methods of operating wireless system over wide range of tone frequencies.

Vacuum Tubes

War-Time Development of Vacuum Tubes, Ralph Brown. Elec. World, vol. 73, no. 8, Feb. 22, 1919, pp. 358-363, 9 figs. Most important advance in radio engineering; three stages; determining desirable characteristics; designing tubes having these characteristics and capable of being produced in quantities; specifications and test methods.

Wave-Length Standardization

The Standardization of the Wave Lengths of Electro-Magnetic Waves for Radio Engineering and the Calibration of Wave Meter (In Japanese). K. Nishizaki. Denki Gakkwai Zasshi, no. 366, Jan. 10, 1919.

Weagant Oscillation Valve

The Weagant Oscillation Valve. Wireless Age, vol. 6, no. 6, Mar. 1919, pp. 24-25, 6 figs. Reported improvement on original Fleming oscillation valve. A plate and a filament are enclosed in a vacuum chamber as usual; a metallic electrostatic control element is placed parallel to electron stream so that its field acts at right angles to latter; this position of control is said to be essential characteristic of tube.

TRANSFORMERS, CONVERTERS, FREQUENCY CHANGERS

Phase Transformers

The Engineering Evolution of Electrical Apparatus—XXXVI. Chas. F. Scott. Elec. Jl., vol. 16, no. 1, Jan. 1919, pp. 28-30, 6 figs. Development of two-phase, three-phase transformation.

The Essentials of Transformer Practice—XVIII. E. G. Reed. Elec. Jl., vol. 16, no. 1, Jan. 1919 pp. 31-32, 9 figs. Transformer connections for phase transformations.

Voltages, Abnormal

Abnormal Voltages Within Transformers, L. F. Blume and A. Boyajian. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 2, Feb. 1919, pp. 211-248, 21 figs. Mathematical analysis of rectangular wave impinging upon a transformer winding and quantitative values of resulting internal voltage stresses in terms of transformer constants; partial applicability of conclusions to abrupt impulses; difference between operating transformer with isolated and grounded neutral; comparison of theoretical results with impulse and high-frequency tests made in laboratory.

TRANSMISSION, DISTRIBUTION, CONTROL

High-Tension Transmission

For High Tension Transmission Service. Power Plant Eng., vol. 23, no. 4, Feb. 15, 1919, pp. 179-183, 5 figs. Description of new Dixon station of Illinois Northern Utilities Co.; modern coal-handling equipment; novel arrangement of intake prevents dirty screens.

Line Tests

Line Tests in Medium-Sized and Small Offices (Essais de lignes dans les bureaux de moyenne et de petite importance), M. Poirier. Annales des Postes, Télégraphes et Téléphones, vol. 7, no. 4, Dec. 1918, pp. 625-627, 2 figs. How to make simple tests with voltmeter.

Phase-Displacement and Power Rates

Phase-Displacement and Its Relation to Methods of Charging for Power. H. Bussmann. Elecn., vol. 82, no. 2122, Jan. 17, 1919, pp. 101-102, 3 figs. Abstract of article in Elektrotechnische Zeitschrift, no. 10, 1918.

Pole Guying

Examples of Pole Guying from Other Fields. Charles Rufus Harte. Elec. Ry. Jl., vol. 53, no. 7, Feb. 15, 1919, pp. 321-324, 5 figs. Deals especially with protection against strains due to storms; refers to subject of pole preservation.

Rectifiers

Connection in Parallel and Voltage Regulation of Mercury-Arc Rectifiers (Marche en parallèle et réglage de la tension des redresseurs de courant à vapeur de mercure). Revue Générale de l'Electricité, vol. 5, no. 6, Feb. 8, 1919, pp. 230-233, 10 figs. Concerning operation of several rectifiers connected in parallel in preference to one single high-power apparatus, where demands call for large supply of power. From Electrotechnische Zeitschrift, vol. 39, Aug. 15, 1918, pp. 321-324.

Substations

A Well-Lighted and Well-Ventilated Substation, S. H. Granten. Elec. Ry. Jl., vol. 53, no. 7, Feb. 15, 1919, pp. 326-327, 4 figs. Description of new substation of Kansas City Rys.

Suspension, Aerial

New Charts for Aerial Suspensions, Joseph N. Le Conte. Jl. Electricity, vol. 42, no. 3, Feb. 1, 1919, pp. 120-122, 4 figs. Graphical representation of relationship of constants involved in suspension design. From paper before San Francisco Section, Am. Inst. Elec. Engrs.

Transmission-Line Computations

Transmission-Line Computations, A. E. Kennelly. Elec. World, vol. 73, no. 8, Feb. 22, 1919, pp. 356-357, 4 figs. Use of hyperbolic functions favored in comparison with alternative methods for calculation of voltage, current and power on long uniform transmission lines.

Wire Sizes

Calculation and Design of Direct Current Circuits, Terrell Croft. Nat. Engr., vol. 23, no. 2, Feb. 1919, pp. 72-75, 3 figs. Determining sizes of wire for distribution of electrical energy; voltage variations for incandescent lamps; apportionment of voltage drop; wiring calculations.

WIRING

Interior Wiring

Approved Interior Wiring Methods, John H. Mayer. Telegraph & Telephone Age, vol. 37, no. 4, Feb. 16, 1919, pp. 83-84. Suggestions in regard to wiring offices for electric light so work will pass inspection.

Civil Engineering

BRIDGES

Franklin-Orleans Bridge

The Franklin-Orleans Bridge. Eng. World, vol. 14, no. 2, Jan. 15, 1919, pp. 16-18, 7 figs. Plans and details of double-leaf trunnion bascule structure over Chicago river.

Howe Truss Spans

Strengthening Howe Truss Spans. Ry. Maintenance Engr., vol. 15, no. 2, Feb. 1919, pp. 45-46, 3 figs. Designs prepared by Northern Pacific.

Inspection

Periodic Inspection of Bridges. Eng. & Contracting, vol. 51, no. 9, Feb. 26, 1919, pp. 212-216. From a paper by Herbert C. Keith before the Brooklyn Engineers' Club.

Masonry Bridges

Reconstruction of Masonry Bridges Destroyed During the War (La reconstruction des ponts en maçonnerie détruits au cours des hostilités), M. Lutton. Génie Civil, vol. 74, no. 2, Jan. 11, 1919, pp. 24-26, 4 figs. Suggests building of arched reinforced-concrete segments capable of being conveniently suspended and put in place without necessitating building of heavy falsework.

BUILDING AND CONSTRUCTION

Architects

Post-War Committee on Architectural Practice. Jl. Am. Architects, vol. 7, no. 1, Jan. 1919, pp. 6-8. Announcement of preliminary program for inquiry into status of architect.

The New Architectural Education. Am. Architect, vol. 115, no. 2249, Jan. 29, 1919, pp. 157-160. Report of Sub-Committee on Education of Reconstruction Committee of Illinois Chapter. Am. Inst. Architects and Ill. Soc. Architects.

Booms

Simple Method for Designing Booms, Arthur Raymond. Eng. & Contracting, vol. 51, no. 9, Feb. 26, 1919, pp. 209, 1 fig. Presents method and solves illustrative problem.

Flat-Slab Construction

Design of Exterior Panels in Flat Slab Construction, Albert M. Wolf. Eng. World, vol. 14, no. 2, Jan. 15, 1919, pp. 27-30, 2 figs. Survey of requirements and rulings by various institutions.

Floors

Test of a Flat Slab Floor, Western Newspaper Union Building at Chicago, U. S. A., Arthur N. Talbot and Harrison F. Gonnerman. Contract Rec., vol. 33, no. 7, Feb. 13, 1919, pp. 127-131, 5 figs. Abstract from bul. 106, Univ. of Ill.

Girders

New and Little-Known Methods of Calculation of Girders, Beams and Arches, James S. Martin. Pro. Engrs.' Soc. of Western Pennsylvania, vol. 34, no. 9, Dec. 1918, pp. 579-633 and (discussion) pp. 634-639, 22 figs. Survey of literature; graphic determination of rivet pitch in flanges of riveted girders; principles of graphic integration applied to beams and arches; graphic integration applied to elastic arches.

Long Girders and High Columns Designed as Rigid Frame, A. E. Wynn. Eng. News-Rec., vol. 82, no. 7, Feb. 13, 1919, pp. 340-342, 4 figs. Gymnasium requiring 52-foot span and 20-foot clearance in height carried as third story of building.

The Patterns for Crane Girders, Joseph Horner. Mech. World, vol. 65, nos. 1670 and 1672, Jan. 3 and 17, 1919, pp. 7-8 and 31, 12 figs. Details of girders by which main checks of girders are connected. First and second installments. (To be continued.)

Roofs

Reinforced Concrete Roof for Craneways in Buildings, Albert M. Wolf. Eng. World, vol. 14, no. 4, Feb. 15, 1919, pp. 18-19, 1 fig. Description of reinforced-concrete trusses used to span craneway and shipping court in Ford Motor Co. service building in Chicago.

Roof Construction for Factories with Excessive Moisture, Frederick J. Hoxie. Am. Architect, vol. 115, no. 2249, Jan. 29, 1919, pp. 181-187, 20 figs. Varieties of wood-destroying fungi; examples of rot formation and destruction of beams; reduction of relative humidity by designing for increased temperature, putting more heating pipes near roof or preventing escape of heat through poorly insulated roof planks.

School Buildings

Construction and Equipment of Portable School Buildings, John Howatt and Samuel R. Lewis. Heat. & Ventilating Mag., vol. 16, no. 2, February, 1919, pp. 24-32, 7 figs. Experiences with the use of this type of building with suggestions for its heating and ventilating.

Tanks

Tank Construction, Ernest G. Beck. Mech. World, vol. 65, no. 1671, Jan. 10, 1919, pp. 18-19, 6 figs. Side walls of rectangular tanks. Twenty-fourth installment. (Continuation of serial.)

Trestles

Reinforced Concrete Trestles at North Toronto. Ry. Gaz., vol. 30, no. 1, Jan. 3, 1919, pp. 15-16, 3 figs. Details of structure involving 13,500 cu. yd. of concrete and 670 tons of reinforcing steel.

Viaducts

Design and Construction of Reinforced Concrete Viaducts, at Mileages 0.9 and 1.8 North Toronto Subdivision, of the Canadian Pacific Railway, B. O. Eriksen and H. S. Deubelbeiss. Jl. Eng. Inst. Can., vol. 2, no. 2, Feb. 1919, pp. 93-101, 20 figs. Slabs 36 ft. long were premolded and bulk of concrete cast in forms on the ground.

Walls

Conditions for Economy in Reinforced Concrete Wall Design, George Paaswell. Eng. & Contracting, vol. 51, no. 9, Feb. 26, 1919, pp. 226-227, 1 fig. Develops a method of comparing an "L" or "T" shaped wall with a counterforted wall to determine the height at which the latter becomes the more economical.

Wharves

Construction of the St. Louis Municipal Wharf. Ry. Rev., vol. 64, no. 8, Feb. 22, 1919, pp. 275-279, 8 figs. Description of engineering features of construction, with drawings and photographs of details of work in progress.

CEMENT AND CONCRETE

Cement Production

The Production of Cement, Lime, Clay Products, Stone, and Other Structural Materials in Canada During the Calendar Year 1917. Can. Dept. of Mines, no. 500, 44 pp. Report of Chief of Mineral Resources and Statistics.

Gravity Concreting

Placing Concrete by Gravity in Block-Frames (La mise en place du béton par gravité dans les chantiers de constructions civiles ou de travaux publics). Génie Civil, vol. 74, no. 2, Jan. 11, 1919, pp. 21-24, 13 figs. Details of falsework and auxiliary machinery. Schemes of various American builders.

Pneumatic Concreting

The Pneumatic Method of Concreting. H. B. Kirkland. Jl. Western Soc. Engrs., vol. 23, no. 5, May 1918, pp. 319-349 and (discussion) pp. 349-355, 27 figs. Method consists in blowing batches of concrete through a pipe from a central point of supplies to their place in concrete forms; materials for a batch of concrete (1-2 cu: yd.) are proportioned in a measuring device and dropped into the pneumatic mixer without previous mixture.

Progress in 1918

Concrete and Cement. Times Eng. Supp., year 15, no. 531, Jan. 1919, p. 27. New applications given to concrete and reinforced concrete in 1918.

Slag Concrete

Blast Furnace Slag in Concrete and Reinforced Concrete, J. E. Stead. Eng. World, vol. 14, no. 4, Feb. 15, 1919, pp. 36-38. Laboratory tests to determine whether blast-furnace slag has any corrosive action on iron and steel placed in contact with it. (To be continued.) From Lond. Eng.

Solubility of Cement

The Solubility of Portland Cement and Its Relation to Theories of Hydration, J. C. Witt and F. D. Reyes. Philippine Jl. Sci., vol. 13, sec. A, no. 4, July 1918, pp. 147-161, 1 fig. It is reported as result of experiments that when cement is shaken with water in a closed vessel large amounts of calcium with relatively small amounts of most other elements present go into solution, and that the factors that effect results are (1) absence of carbon dioxide, (2) method of agitation, (3) fineness of grain, (4) volume of water, and (5) time.

Wasteful Construction

Useless Waste in Concrete Construction Due to Legal Requirements. W. Stuart Tait. Am. Architect, vol. 115, no. 2249, Jan. 29, 1919, pp. 187-189, 1 fig. Criticism of basing design methods on strength for 1-2-4 concrete at 28 days of 2,000 lb. per sq. in. (Continuation of serial.)

See also MINING ENGINEERING, Mines and Mining (Cement Gun).

HARBORS

Seattle

Seattle Starts Large Expansion of Her Public Port Facilities, Frank Carleton Teck. Marine News, vol. 5, no. 9, Feb. 1919, pp. 98-99, 1 fig. Type and equipment of proposed additional pier 2,700 ft. long.

The Port of Seattle, W. A. Scott. Eng. World, vol. 14, no. 2, Jan. 15, 1919, pp. 61-63, 4 figs. Freight-handling equipment.

Shore Protection

Coastal and Shore Protection, H. Colin Campbell. Eng World, vol. 14, no. 4, Feb. 15, 1919 pp. 11-17, 7 figs. Breakwaters, sea walls, and revetment work in various locations and under various conditions.

IRRIGATION AND RECLAMATION

Arid Lands

Post War Reclamation of Arid Lands, S. O. Andros. Eng World, vol. 14, no. 2, Jan. 15, 1919, pp. 19-22, 8 figs. Butte project, other Government projects and private projects.

Irrigation Project

Preliminary Project for Irrigating the Chancay Pampas (Proyecto preliminar de irrigación de las pampas de Chancay), Carlos W. Sutton and Juan N. Portocarrero y C. Boletin del Cuerpo de Ingenieros de Minas del Peru, no. 94, 1918, 24 pp. 2 figs. Involves irrigation of 15,000 hectares.

Irrigation Prospects

Some Financial, Agricultural and Engineering Aspects of Irrigation, Charles Kirby Fox. Mun. & County Eng., vol. 56, no. 1, Jan. 1919, pp. 30-31. Statistics in United States; question of transportation; outlook of future developments.

Preliminary Work

Preparing Six Hundred Acres of Land for Irrigation, F. W. Herron. Eng. News-Rec., vol. 82, no. 7, Feb. 13, 1919, pp. 337-339, 2 figs. Soil studies, surveys, supply and drainage ditches; land leveling and ditch construction operations.

Swamp Lands

Reclamation of Swamp Lands in Dane County, Wisconsin, W. G. Kirchoffer. Mun. & County Eng., vol. 56, no. 2 Feb. 1919, pp. 65-66. Work in straightening and deepening main drainage line of marsh and in providing a main outlet; 129,349 acres drained since 1908.

MUNICIPAL ENGINEERING

Town Planning

Town Planning, Thomas Adams. Can. Engr., vol. 36, no. 7, Feb. 13, 1919, pp. 215-216. Concerning town development in Quebec. From South Shore Board of Trade Rev.

ROADS AND PAVEMENTS

Brick Paving

Latest Seattle Specifications for Brick Paving Are for the Monolithic Type, W. H. Tiedeman. Mun. & County Eng., vol. 56, no. 1, Jan. 1919, pp. 13-14. Writer prefers cement-grout filler and believes sand-cement "cushion" fails.

The Brick Highways of Ashtabula County, Ohio, Ray N. Case. Mun. & County Eng., vol. 56, no. 2, Feb. 1919, pp. 53-57, 17 figs. County engineer believes slag bed desirable to give stability and gives account of developments and results.

Canada

Federal Aid for Highways, J. D. Reid. Can. Engr., vol. 36, no. 7, Feb. 13, 1919, pp. 223-224. Plans of the Dominion Government.

Good Roads in Lanark County, C. J. Foy. Contract Rec., vol. 33, no. 7, Feb. 12, 1919, pp. 141-144, 2 figs. Account of developments. Before convention of Eastern Ontario Good Roads Assn.

Construction

Arching an Underground Roadway With Concrete Blocks, W. Ross. Iron & Coal Trades Rev., vol. 98, no. 2657, Jan. 31, 1919, p. 141, 4 figs. Method to conduct excavating and building simultaneously, the packing being done as material is produced at face.

Road Contractor Successfully Employs Portable Charging Bins to Eliminate Dumping and Wheeling on Subgrade in Concrete Road Construction, George A. Burley. Mun. & County Eng., vol. 56, no. 1, Jan. 1919, pp. 11-12, 2 figs. Comparison of bin method and dumping on subgrade.

Utilizing More Mechanical Devices on Road Construction, Frank F. Rogers. Mun. & County Eng., vol. 56, no. 1, Jan. 1919, pp. 18-20. Reports of various county engineers of Michigan.

Earth Roads

Can Earth Roads Be Made Satisfactory? H. S. Carpenter. Jl. Eng. Inst Can., vol. 2, no 2, Feb. 1919, pp. 102-104. Suggestions in regard to selection of material, placing it on roadbed and estimates of cost of earth, sand-clay, gravel and macadam roads.

Financing

How the Successful Campaign for the $60,000,000 Good Roads Bond Issue was Conducted in Illinois, S. E. Bradt. Mun. & County Eng., vol. 56, no. 1, Jan. 1919, pp. 3-5, 1 fig. Organization chart of workers.

Florida

Lessons Taught by Road Building Experience in Florida, G. Robert Ramsey. Mun. & County Eng., vol. 56, no. 2, Feb. 1919, pp. 73-74. Influence of distance from manufacturing centers, productive area, assessed valuations, etc.

Foundations

Engineers Must Study Road Foundations. Eng. World, vol. 14, no. 4, Feb. 15, 1919, pp. 31-35. Suggests that foundations be constructed with a view to bearing the greatest possible load under all conditions.

Good-Roads Movement

National Highways and Good Roads, J. A. Duchastel de Montrogue. Jl. Eng. Inst. Can., vol. 2, no. 2, Feb. 1919, pp. 91-92. Comparison of situations in U. S. and Canada with reference to act, passed by U. S. Congress, destined to aid several states in road construction.

The Federal Aid Road Law; Experience to Date and Suggestions for Better Co-operation, Logan Waller Page. Mun. & County Eng., vol. 56, no. 1, Jan. 1919, pp. 20-23, 10 figs. Various federal aid road projects; amendments to law. Written for presentation before Am. Assn. State Highway Officials.

Twenty-Five State Highway Engineers Report Their Plans for 1919. Mun. & County Eng., vol. 56, no. 2, Feb. 1919, pp. 46-51. Letters state funds available and plans in detail.

Highway Pavements

City Pavements for State Highway in Connecticut, Charles J. Bennett. Mun. & County Eng., vol. 56, no. 2, Feb. 1919, pp. 62-63. Sheet asphalt on concrete base.

New York

Highway Work in Four New York Boroughs, Good Roads, vol. 17, no. 8, Feb. 22, 1919, pp. 69-71 and 84, 4 figs. Résumé of outstanding features of road and street work in Brooklyn, Bronx, Queens and Richmond.

Roads of New York, E. A. Bonney. Good Roads, vol. 17, no. 8, Feb. 22, 1919, pp. 73-76 and 84, 8 figs. Historical sketch of development of N. Y. State Highway Department, with review of its organization and accomplishments.

Street Work in Manhattan. Good Roads, vol. 17, no. 8, Feb. 22, 1919, pp. 67-68 and 78, 3 figs. Historical sketch of development of highway operations.

Sand-Clay Roads

Experience with Sand Clay Road Surfacing in Nebraska, George E. Johnson. Mun. & County Eng., vol. 56, no. 1. Jan. 1919, pp. 9-11, 3 figs. Location of materials and their properties.

Snow Removal

Snow Removal from New York State Highways, Edwin Duffey. Mun. & County Eng., vol. 56, no. 1, Jan. 1919, pp. 23-24. Concerning snow-removal legislation.

Wood-Block Paving, Base for

Method Employed in Minneapolis in Constructing Smooth Surfaced Concrete Base for Wood Block Paving, Ellis R. Dutton. Mun. & County Eng., vol. 56, no. 2, Feb. 1919, pp. 51-52, 2 figs. Concrete surface smoothed over with small roller on templets.

SANITARY ENGINEERING

Drain Pipe

Aligning Drain Pipe, Harry Gardner. Eng. World, vol. 14, no. 4, Feb. 15, 1919, pp. 45-46, 1 fig. Method of giving grade and line for pipe sewer construction.

Latrines

A Mine Latrine, William W. Cort. Min. & Sci. Press, vol. 118, no. 5, Feb. 1, 1919, pp. 155-157, 3 figs. Details of latrine and sanitary arrangements connected with it. From bul. 28 of Cal. State Board of Health, Sanitation in Mines for the Prevention and Eradication of Hookworm.

Sanitation

Sanitation in Emergency Shipyards, W. L. Stevenson. Mun. & County Eng., vol. 56, no. 2, Feb. 1919, pp. 70-71, 2 figs. Methods of distributing drinking water; collection and disposal of wastes; fly and mosquito extermination.

Sewage Disposal

Sewage Disposal in Kansas, F. M. Veatch, H. P. Evans and L. E. Jackson. Bul. Univ. Kan., vol. 18, no. 18, Dec. 1, 1917, 40 figs. Discussion of practice in certain municipalities, together with instructions to plant operators.

Sewage Disposal at Manchester. Can. Engr., vol. 36, no. 7, Feb. 13, 1919, pp. 222-223. Results of operation and activitated sludge investigations at Withington and Davyhulme works. From Surveyor, London.

Sewage Disposal Works in Reconstruction Period, Harrison P. Eddy. Mun. & County Eng., vol. 56, no. 2, Feb. 1919, pp. 60-62. Data relating to cost of certain sewage disposal projects built under ante-war conditions, and proportion of budget likely to be required to meet annual charges.

Sewers

Some Design and Constructional Features of the Rideau River Intercepting Sewer, Ottawa, Canada, L. McLaren Hunter. Mun. & County Eng., vol. 56, no. 2, Feb. 1919, pp. 63-65, 4 figs. Sewer is 17,900 ft. long, with 400-ft. tunnel section under railway tracks.

The Selection of the Value of the Factor "n" in Sewer Design, Paul E. Green. Mun. & County Eng., vol. 56, no. 2, Feb. 1919, pp. 52-53. Attempt to demonstrate that *n* (in Kutter formula) has wrongly been recommended by experimenters as varying between 0.013 and 0.015 for vitrified-tile pipe sewers. Writer believes construction conditions determine value of *n*.

-endurance
Endurance means long life —hence economy
If you want a hack saw to endure—use one made for your particular cutting requirement.
Starrett Hack Saws
are made to endure—to last long and are truly economical because there is a saw for any job.
Our Hack Saw Chart
will tell you quickly which is the proper saw to use for every metal. Keep it before you. Write today also asking for Catalog No. 21 LD on Starrett fine precision tools.
The L. S. Starrett Company
The World's Greatest Tool Makers. Manufacturers of Hack Saws Unexcelled.
Athol, Mass.
42-897
STARRETT TOOLS

Swimming Pools

Keeping Swimming Pools Pure and Wholesome—IV. Metal Worker, vol. 91, no. 3, Jan. 17, 1919, pp. 86-87, 1 fig. Installation of ozoning apparatus. (Concluded.)

SURVEYING

Chains

Metallic Chains Used in Geodic Surveys (Fili e nastri metallici nella misura delle basi geodetiche), G. Cicconetti. Il Nuovo Cimento, vol. 15, nos. 5-6, May-June 1918, pp. 180-190. Remarks on Jadering's method for obtaining accurate base measurements.

See also AERONAUTICS, Applications (Surveying and Mapping).

WATER SUPPLY

Conservancy

Water Works Conservancy, Arthur A. Reimer. Mun. & County Eng., vol. 56, no. 1, Jan. 1919, pp. 24-29. Economical utilization and salvaging undertakings.

Electrical Control

Automatic Electrical Control at the Deer Trail, L. Brandenburger. Salt Lake Min. Rev., vol. 20, no. 21, Feb. 15, 1919, pp. 25-26, 3 figs. Diagrammatical sketch. Plant supplies 30,000 gal. water per day to flotation and cyanide mill.

Filter Plant

Need of Certain Investigations for Increasing the Efficiency of Water Filter Plant Design and Operation, James W. Armstrong. Mun. & County Eng., vol. 56, no. 1, Jan. 1919, pp. 5-6. Most efficient mix with least loss of head; time and intensity of agitating; coagulation-basin design.

Hardness

Advantages and Disadvantages of Hard City Water. (Vorteile und Nachteile der Wasserhaerte) Dr. Carl Opitz. Journal fuer Gasbeleuchtung und Wasser-Versorgung, vol. 61, no. 41, Oct. 12, 1918, pp. 482-485. Reviews the relative effects of the water supplied upon the physical condition of 87,617 school children in 158 towns in Germany and finds that the harder the water, the better preserved are the teeth, nervousness and other ills are also diminished.

Purification

Features of Present-Day Water Purification Practice, Milton F. Stein. Mun. & County Eng., vol. 56, no. 2, Feb. 1919, pp. 57-60, 4 figs. Non-technical review written for municipal officials.

Notes on Chlorine Treatment of London, England, Water Supply, A. C. Houston. Mun. & Coun. Eng., vol. 56, no. 1, Jan. 1919, pp. 29-30. From report of Director of Water Examination.

Chlorination of Chicago's Water Supply, John Ericson. Mun. & County Eng., vol. 56, no. 1, Jan. 1919, pp. 68, 2 figs. Diagram indicating operation of Miller aeriostat.

Reservoirs

The Water Supply for Montevideo. Eng. World, vol. 14, no. 2, Jan. 15, 1919, pp. 23-26, 16 figs. Design and construction of concrete reservoir at Uruguay capital.

An Interesting Nile Scheme. Elec. Times, vol. 55, no. 1422, Jan. 16, 1919, pp. 35-37, 1 fig. Reservoir project in Sudd region. Paper before Sultanieh Geographical Soc., Cairo.

Waterworks Operation: Reservoir Maintenance. Mun. Jl., vol. 46, no. 4, Jan. 25, 1919, pp. 65-67. Methods, costs, figures and results.

Water-Works Operation

Effect of War Conditions on the Operation and Maintenance of Water Works. Mun. & County Eng., vol. 56, no. 1, Jan. 1919, pp. 16-17. Cost of principal materials and supplies, 1914-1918; unskilled labor prices per hour.

WATERWAYS

Hudson River

Government Work on Hudson River. Eng. World, vol. 14, no. 2, Jan. 15, 1919, pp. 11-15, 7 figs. Removal of old works and construction work involved in erection of dam in N. Y. State barge canal at Troy.

Niagara

Mapping Niagara at the Brink. Eng. World, vol. 14, no. 4, Feb. 15, 1919, pp. 39-40, 2 figs. Apparatus used in sounding river just above fall.

Saone River

The Navigable System of the Saone River (Le réseau navigable de la Saone). Génie Civil, vol. 73, no. 24 Dec. 14, 1918, pp. 466-468, 1 fig. System consists of five routes disposed in fan shape. Data are given on organization, arrangement and operation.

Mining Engineering

BASE MATERIALS

Bauxite

Bauxite (La bauxite), Ed. Decamps. Métaux, Alliages et Machines, vol. 12, no. 1, Jan. 1919, pp. 3-8. Patented processes of precipitating aluminum from bauxite, manufacturing artificial emery (crystallized aluminum) and making refractory products.

Black Sand

Notes on the Black Sand Deposits of Southern and Northern California, R. R. Hornor. Department of Interior, Bur. of Mines, tech. paper 196, 42 pp. 14 figs. Investigation conducted by Bur. of Mines in order to determine whether any of deposits are large enough to be profitably exploited, and also possibility of commercial utilization of base minerals.

Clays

Microscopic Examination of Clays, R. E. Somers. Jl. Wash. Acad. Sci., vol. 9, no. 5, Mar. 4, 1919, pp. 113-126. Report of microscopic examinations undertaken in order to determine minerals contained in clays, and study of thin sections of burned samples.

Magnesite

Magnesite and Dolomite in Australia and New Zealand, P. G. Morgan. New Zealand Jl. Sci. & Technology, vol. 1, no. 6, Nov. 1918, pp. 359-372. Reports of mines departments of Australian states concerning supply of magnesite or dolomite; New Zealand occurrences.

Magnesite, Its Occurrence and Uses, T. Crok. Min. Mag., vol. 20, no. 2, Feb. 1919, pp. 115-120. Historical account of magnesite applications and utilization in smelting industry. (To be continued.) Paper before Swansea meeting of Ceramic Soc.

Rock Quarries

Maori Rock-Quarries on D'Urville Island, J. Allan Thomson. New Zealand Jl. Sci. & Technology, vol. 1, no. 6, Nov. 1918, pp. 321-322, 1 fig. Quarries consist mainly of serpentine, associated in some parts with amphibolites derived from doleritic or gabbroid rocks.

COAL AND COKE

Breakers and Cleaners

Bradford Coal Breakers and Preliminary Mechanical Cleaner. Coal Age, vol. 15, no. 8, Feb. 20, 1919, pp. 352-355, 2 figs. Construction and operation; account of results obtained at various commercial plants.

Canada

Coal Production in Canada—Its National Significance, F. W. Gray. Can. Min. Jl., vol. 40, no. 5, Feb. 5, 1919, pp. 73-74. Urges that mining industry be represented in federal parliament.

The Production of Coal and Coke in Canada During the Calendar Year 1917, John McLeish. Can. Dept. of Mines, no. 501, 39 pp. Report of chief of Division of Mineral Resources and Statistics.

Coke Ovens

Some Economic Considerations in Coke-Oven Practice, W. Colquhoun. Trans. Instn. Min. Engrs., vol. 56, part 2, Dec. 1918, pp. 61-79 and (discussion) pp. 79-90, 6 figs. Claims that process of coking cannot be called economically perfect until some inventor devices a more direct application of the heat necessary to distill the coal.

Costs, Mining

Anthracite Mining Costs, R. V. Norris. Bul. Am. Inst. Min. Engrs., no. 146, Feb. 1919, pp. 249-262, 5 figs. Adjustments of cost from a reported to a price-fixing basis; charts showing cost of production; accounting suggestions. Based on cost reports for 6-months' period, Dec. 1917 to May 1918, as compiled by Federal Trade Commission.

Great Britain, 1918

Coal-mining. Times Eng. Supp., year 15, no. 531, Jan. 1919, p. 21. Conditions in United Kingdom in 1918 and comparison with conditions in previous years.

Impurities

Impurities in Raw Coal and Their Removal, T. J. Drakely. Colliery Guardian, vol. 117, no. 3031, Jan. 31, 1919, p. 245. Three methods of separating impurities from coal: hand picking; mechanical shale pickers; coal washers. Also in Iron & Coal Trades Rev., vol. 98, no. 2657, Jan. 31, 1919, p. 131.

Water Supply

Water Supply at Coal Mines, Carl Scholz. Coal Age, vol. 15, no. 9, Feb. 27, 1919, p. 391, 1 fig. Location of well and pipe line at Valier Coal Co.'s mine.

Western Europe

Coal Resources of the Western Front, II. H. Stock. Black Diamond, vol. 61, no. 26, vol. 62, no. 1, Dec. 28, 1918, Jan. 4, 1919, pp. 576-578 and 5-7, 10 figs. Maps and statistics of coal and iron fields in Northern France (including Alsace-Lorraine) Belgium and Western Germany.

Lens—The Coal Field of France, Frank Haas. Coal Age, vol. 15, no. 9, Feb. 27, 1919, pp. 392-394, 11 figs. How French coal mining at Lens was conducted before German invasion.

COPPER

Copper Industry

The Position of Copper Analyzed. Min. & Sci. Press, vol. 18, no. 8, Feb. 22, 1919, pp. 243-244. Official statement of Federal Government.

World Production and Consumption of Copper (La production et la consommation mondiales du cuivre). Métaux, Alliages et Machines, vol. 12, no. 1, Jan. 1919, pp. 12-13.

Michigan

The Porphyry Intrusions of the Michigan Copper District, Thomas S. Woods. Eng. & Min. Jl., vol. 107, no. 7, Feb. 15, 1919, pp. 299-302, 3 figs. Relation of fine-grained volcanics to mineralization of Michigan copper-bearing formations.

EXPLOSIVES

Explosives

Explosives, Robert S. Lewis. Min. & Sci. Press, vol. 118, no. 8, Feb. 22, 1919, pp. 245-253, 14 figs. Compilation of data, tables and manufacturing methods. From various Bur. of Mines bulletins.

GEOLOGY AND MINERALOGY

Chile

The Veins of Chanarcillo, Chile, W. L. Whitehead. Economic Geol., vol. 14, no. 1, Jan.-Feb. 1919, pp. 1-45, 6 figs. Based upon tests of ores in laboratories of Mass. Inst. Technology and supplemented with geological studies of district. Ores contain silver and copper.

Copper Silicates

Plancheite and Shattuckite, Copper Silicates, are not the same Mineral, Waldemar T. Schaller. Jl. Wash. Acad. Sci., vol. 9, no. 5, Mar. 4, 1919, pp. 131-134. Results of investigation of United States Geological Survey.

Earth Structure

On the Internal Structure of the Earth, J. T. Morrison. South African Jl. Sci., vol. 15, no. 2, Sept. 1918, pp. 31-44, 3 figs. Discussed from viewpoint of geophysics. Curves of earth-wave paths, longitudinal vibrations, and transverse vibrations.

Haiti

A Geological Reconnaissance in Haiti. A Contribution to Antillean Geology, William F. Jones. Jl. Geol., vol. 26, no. 8, Nov.-Dec. 1918, pp. 728-752, 10 figs.

Volcanoes

Sancy Volcano: Its Secondary Volcanoes and Lavas (Le Volcan du Sancy. Ses volcans secondaires et ses laves), Ph. Glangeaud. Comptes rendus des séances de l'Académie des Sciences, vol. 167, no. 27, Dec. 30, 1918, pp. 1076-1078, 1 fig. Geological characteristics.

Volcano Model (Un modèle de volcan), Robert W. Sayles. Revue Générale des Sciences, vol. 29, no. 23, Dec. 15, 1918, pp. 661-666, 6 figs. Construction of 12-ft. model of Kilauea volcano in Hawaii.

IRON

Arizona

Magnetic Iron Ore in Arizona, Sydney H. Ball and T. M. Broderick. Eng. & Min. Jl., vol. 107, no. 8, Feb. 22, 1919, pp. 353-354, 2 figs. Geological characteristics of gabbro differentiates in Eureka district.

Goodman Shortwall Machines

Virginia Iron, Coal and Coke Company and Its Goodman Shortwall Machines. Elec. Min., vol. 16, no. 1, Jan. 1919, pp. 3-22, 50 figs. Details of mining operation and electric power house.

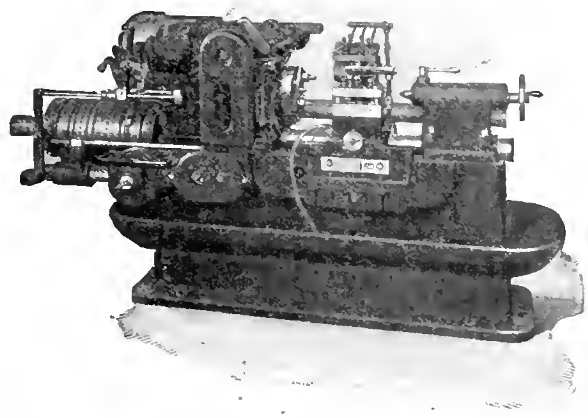
Magnetic Concentration

The Magnetic Concentration of Iron Minerals at Mineville, United States (La concentration magnétique des minerais de fer à Mineville [E.-U.]). Génie Civil, vol. 73, no. 25, Dec. 21, 1919, pp. 495-496, 3 figs. Equipment of Barton Hill mine.

Statistics

Iron Ore Production for 1918 Decreased. Iron Trade Rev., vol. 64, no. 8, Feb. 20, 1919, p. 514. 72,192,000 tons in 1918; 75,573,207 tons in 1917.

The Fay Automatic Lathe



The Fay Automatic Lathe is a real lathe, with nine-speed, all-steel geared headstock with three automatic speed changes, tailstock, carriage and bed. It differs from the engine lathe in the details of its mechanism, which fit it especially for the particular work it is designed to do. There is also the added mechanism required to make it automatic in all its motions.

FIELD: The Fay Lathe is designed for the automatic turning of work held on centers. It is thus adapted to work which is itself centered, or to work which is mounted on an arbor.

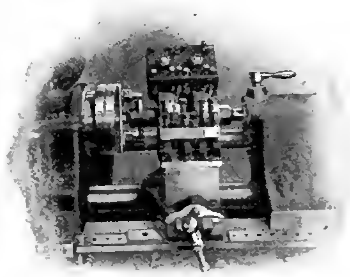
In the class of *centered work* are included such standard parts as steering knuckles for automobiles, pinion shafts for transmissions, forgings in general of such shape as to be turned rather than chucked, and many miscellaneous castings of the same type.

In the class of *work done on arbors* is included the large variety of parts which in ordinary practice is turned in the engine lathe by this means, as pulleys either straight-faced or crowned, gear blanks, flanges, disks, hubs, and a thousand and one other pieces of the kind used in textile machinery, automobiles, machine tools, electrical work and machine building in general.

Second operation work is the legitimate field of the Fay Lathe.

Furthermore, it has a large field of usefulness in the accurate finishing of parts roughed out on other and less accurate automatic machines.

On the work described above the Fay Lathe will do straight turning, taper turning, form turning, straight facing, bevel facing, recessing, singly or in combination, with roughing or finishing cuts. It will do everything of this sort except threading, for which it is not adapted.



Profitable Work for the Automatic Lathe

Advantages of the Fay Automatic

1. Ease of setting.
2. Rapidity of changing work.
3. Two pieces at a time.
4. Multiple tooling.
5. Taper turning and bevel facing.
6. Form turning.
7. Turned surfaces free from scoring on the return movement.
8. Flexibility of mechanism.
9. Facing and turning simultaneously.
10. One operator runs two machines.

JONES & LAMSON MACHINE COMPANY

SPRINGFIELD, VERMONT, U. S. A.

109 Queen Victoria Street, London, E. C.

France, Spain and Belgium: F. Auberty & Co., 91 Rue de Maubeuge, Paris
Holland: Spliethoff, Beeuwkes & Co., Rotterdam

SEE OUR DATA IN 1918 A.S.M.E. CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT

LEAD

Burma

Operations of the Burma Mines, Ltd., A. B. Parsons. Eng. & Min. Jl., vol. 107, no. 6, Feb. 8, 1919, pp. 257-262, 2 figs. Lead-silver-zinc mining in Namtu, Northern Shan States, Upper Burma.

Missouri-Kansas-Oklahoma

Mining and Milling of Lead and Zinc Ores in the Missouri-Kansas-Oklahoma Zinc District, Clarence A. Wright. Department of Interior, Bur. of Mines, bul. 154, 134 pp., 30 figs. Methods used and indication of conditions that affect their efficiency.

MAJOR INDUSTRIAL MATERIALS

Manganese

Manganese Ore Deposits in Cuba, Ernest F. Burchard. Bul. Am. Inst. Min. Engrs., no. 147, Mar. 1919, pp. 591-595. Location, character, quantity, and availability of manganese- and chrome-ore deposits.

Manganese Ore in Uruguay. Min. & Sci. Press, vol. 118, no. 8, Feb. 22, 1919, p. 253. U. S. Consular report from Montevideo.

Problems Involved in Concentration and Utilization of Domestic Low-Grade Manganese Ore, Edmund Newton. Bul. Am. Inst. Min. Engrs., no. 146, Feb. 1919, pp. 379-389. Manganese deposits in U. S.; metallurgical requirements of steel industry; concentration of domestic low-grade manganese ores; characteristics of ore affecting beneficiation.

Manganese and Chromium

Manganese and Chromium in California, Walter W. Bradley, Emile Huguenin, C. A. Logan, W. Burling Tucker and Clarence A. Waring. Cal. State Min. Bur. bul. 76, Aug. 1918, 248 pp., 56 figs. Characteristics of deposits, classification and description of mines, and report on economical conditions of mining these two minerals.

MINES AND MINING

Africa

The Mineral Industry of the Union of South Africa and Its Future, P. A. Wagner. South African Jl. Sci., vol. 15, no. 2, Sept. 1918, pp. 45-78. Survey of resources; statistics of production; expected future developments.

The Mineral Resources of Rhodesia, F. P. Mennell. S. A. Jl. Industries, vol. 1, no. 15, Nov. 1918, pp. 1411-1417. Asbestos; coal; arsenic; barites; diamonds and other precious stones; corundum; graphite; magnesite; mica; salt; soda; talc. (Second article.)

Canada

Mining Development in Northern Manitoba, R. C. Wallace. Bul. Can. Min. Inst., no. 83, Mar. 1919, pp. 287-296. Proposes building of railway along mineral belt.

Caps, Steel

The Crushing of Steel Caps, A. C. Stoddard. Min. & Sci. Press, vol. 118, no. 8, Feb. 22, 1919, pp. 258-259, 3 figs. Operations in rearrangement of haulage drifts at Inspiration Consolidated Copper Co.

Cement Gun

Use of the Cement Gun in a Bituminous Coal Mine, M. S. Sloman. Eng. World, vol. 14, no. 4, Feb. 15, 1919, pp. 56-57, 1 fig. Figures showing costs on length of 900 ft. of slope; results obtained.

Coöperation

Coöperation Among Small Mines with a View to Increasing Efficiency of Operation, R. W. Brigstocke. Bul. Can. Min. Inst., no. 83, Mar. 1919, pp. 283-286. Its value in permitting employment of staff of specialists.

Development

Examining and Developing the Mine Prospect, Harry T. Curran. Eng. & Min. Jl., vol. 107, no. 8, Feb. 22, 1919, pp. 343-348. Writer's views concerning what should constitute sufficient information to justify development of a prospect.

Dredging Areas

Topography and Geology of Dredging Areas III, Charles Janin. Min. & Sci. Press, vol. 118, no. 4, Jan. 25, 1919, pp. 122-123, 4 figs. Dredgings areas in Colo., Mont., Idaho and Oregon. Abstract from bul. 127, U. S. Bur. of Mines.

Financial Problems

The Banker and Mining Frank B. Anderson. Min. & Sci. Press, vol. 118, no. 8, Feb. 22, 1919, pp. 254-256. National economy as a solution of financial problems created by war. Claims mere increase of metal will not suffice. Address delivered before Cal. chapter, Am. Min. Congress.

Health Control

Prevention of Illness Among Employees in Mines, A. J. Lanza. Bul. Am. Inst. Min. Engrs., no. 146, Feb. 1919, pp. 435-437. Points out advisability of securing for underground work employees who are free from organic and anatomical defects and of maintaining working conditions underground on a high plane of sanitation and efficiency.

Humidity

Humidity of Deep Mines, Sydney F. Walker. Eng. World, vol. 14, no. 4, Feb. 15, 1919, pp. 43-44. Suggests that each mine be treated in same manner as cold-storage plants.

Laws

Abstracts of Current Decisions on Mines and Mining, J. W. Thompson. Dept. of Int., Bur. of Mines, bul. 172, law serial 16, 160 pp. Minerals and mineral lands; eminent domain; mining terms; mining corporations and partnerships; mining claims; statutes relating to mining operations; leases and properties; quarry operations; damages for injuries to miners; publications relating to mining lands.

Discharging Water from Mining Plants, Chesla C. Sherlock. Eng. & Min. Jl., vol. 107, no. 7, Feb. 15, 1919, pp. 311-312. Legal aspect of pollution of streams by mining operations. Reference is made to similar discussion in Eng. & Min. Jl. Nov. 16, 1918, p. 861.

Mining Law and Economics—V, David Bowen. Colliery Guardian, vol. 117, no. 3029, Jan. 17, 1919, p. 133. Ownership of minerals in British colonies and other countries.

Longwall

Regarding Longwall, F. A. Pocock. Coal Age, vol. 15, no. 9, Feb. 27, 1919, pp. 395-396, 1 fig. Proposes five-entry system of mining, employing longwall faces both advancing and retreating.

Prospecting

Concreting Prospect Drill Holes, Roy H. Poston. Eng. & Min. Jl., vol. 107, no. 7, Feb. 15, 1919, pp. 309-311, 4 figs. Plugging with concrete exploratory drill penetrations through strata in order to prevent formation of Channels for underground water.

Safety Devices

Safety Lamp Gauzes, T. J. Thomas, pts. II and III. Colliery Guardian, vol. 117, nos. 3029 and 3031, Jan. 17 and 31, 1919, pp. 134-135 and p. 246, 1 fig. Jan. 17: Survey of tests with Davy lamps Jan. 31: Statements from report of Royal Commission on Accidents in Mines.

The Eudiogrisoumeter Gas Tester, E. Hauser. Colliery Guardian, vol. 117, no. 3031, Jan. 31, 1919, p. 247, 3 figs. Researches to simplify volumetric determination, by combustion, of quantity of inflammable gas contained in a gaseous mixture.

Savoy

The Ore Minerals of Savoy, J. Morrow Campbell. Min. Mag., vol. 20, no. 2, Feb. 1919, pp. 76-88 and (discussion) pp. 88-89, 2 figs. Occurrence; source and method of segregation; origin of veins and how they are filled; order in which minerals developed in wing; decomposition of wolfram.

Shaft Pillars

Removal of a Vertical Shaft Pillar. Eng. World, vol. 14, no. 4, Feb. 15, 1919, pp. 50-52, 1 fig. Account of collapse of shaft pillar and work done to remove it, at Village Main Reef Gold Mine, Witwatersrand.

Shoveling

A Study of Shoveling as Applied to Mining, G. Townsend Harley. Coal Age, vol. 15, nos. 7 and 8, Feb. 13 and 20, 1919, pp. 314-322 and 356-364, 36 figs. Series of tests to determine under what condition a laborer would handle greatest tonnage of muck in a given time, both underground and on the surface.

Statistics

A General Summary of the Mineral Production of Canada During the Calendar Year 1917, John McLeish. Can. Dept. of Mines, no. 499, 27 pp. Report of Chief of Division of Mineral Resources and Statistics.

Metal Production for 1918 in Some of the Western States. Min. & Oil Bul., vol. 5, no. 2, Jan. 1919, pp. 87-88. Ariz., Utah, New Mexico and Oregon. From estimates prepared by U. S. Geol. Survey.

Taxation

Principles of Mining Taxation, Thos. W. Gibson. Bul. Can. Min. Inst., no. 83, Mar. 1919, pp. 273-282. Discussion of methods of evaluating mines and of plans of establishing tax rates. Before joint session Am. Inst. Min. Engrs. and Can. Min. Inst.

Timber Handling

Economical Timber Handling Plant at an Anthracite Mine, Ralph A. Smith. Coal Age, vol. 15, no. 8, Feb. 20, 1919, pp. 350-351, 8 figs. Timber shipped in to plant from a distance is unloaded by haulage transfer system, and cut into lengths suitable to use as props.

Timbering

Inclined Shaft Timbering and a Method of Alignment, Arthur Neustaedter. Eng. & Min. Jl., vol. 107, no. 8, Feb. 22, 1919, pp. 349-351, 1 fig. Method of inclined-shaft instrumental alignment.

Timbering in English Mines. Coal Age, vol. 15, no. 9, Feb. 27, 1919, pp. 400-403, 8 figs. Methods of timbering in longwall workings. Steel and concrete are used as substitutes in roof support.

Transportation

Linking Up Isolated Mineral Districts by the Loco.-Tractor Transport System, Frank Dutton. Eng. & Min. Jl., vol. 107, no. 7, Feb. 15, 1919, pp. 313-314, 1 fig. System uses trucks running wholly on light rails. From South African Jl. of Industries.

Tunnels

The Tintic Drain Tunnel and Its Objects, E. E. Grimes. Salt Lake Min. Rev., vol. 20, no. 21, Feb. 15, 1919, pp. 21-23, 4 figs. Tunnel provides drainage for deeper levels of Tintic mining district and double-track haulage facilities.

Tunnel Driving at Copper Mountain, B. C., Oscar Lachmund. Bul. Am. Inst. Min. Engrs., no. 147, Mar. 1919, pp. 579-583, 1 fig. Details of straight adit 2,900 ft. long.

Ventilation

Effect of the Velocity of Ventilating Current Upon Mine Explosions, G. S. Rice and W. L. Egy. Coal Age, vol. 15, no. 7, Feb. 13, 1919, pp. 308-309, 1 fig. Experiments carried on at experimental mine of Bur. of Mines are reported to disprove theory that ventilation should be reduced during firing.

MINOR INDUSTRIAL MATERIALS

Barium

Future of the Barium Industry, William H. Rollin. Chem. & Metallurgical Eng., vol. 20, no. 4, Feb. 15, 1919, pp. 163-164. How industry would be affected by action of Government in raising a protective tariff. Before Am. Inst. Chem. Engrs.

The Barite Deposits of Missouri, W. A. Tarr. Economic Geol., vol. 14, no. 1, Jan.-Feb. 1919, pp. 46-67, 4 figs. Writer advances theory that barite has been deposited by rising thermal solutions which derived their barium and other mineral content from deep-seated igneous rocks.

Electric Power

Oil Production Increased by the Electric Motor. Min. & Oil Bul., vol. 5, no. 2, Jan. 1919, pp. 77-79 and 91, 2 figs. Installation of variable speed 15-30 hp. oil well motor with controller and equipment, used for pumping, swabbing, pulling and cleaning oil wells.

Geology

Magnetic Disturbances and Oil Pools, Hamilton E. Anderson. Oil & Gas Jl., vol. 17, no. 37, Feb. 14, 1919, pp. 52 and 56, 1 fig. Survey of researches undertaken and available data concerning petroleum geology. Work done with a magnetic declinometer of writer's invention.

Graphite

The Graphite Industry, Charles Spearman. Can. Min. Jl., vol. 40, no. 6, Feb. 12, 1919, pp. 87-88. Flotation process of concentration.

Molybdenum

Standard Minerals Molybdenum Mine and Mill. Min. & Oil Bul., vol. 5, no. 2, Jan. 1919, pp. 73-74 and 102, 4 figs. Operations and flow sheet of Standard Minerals Co., Ariz.

Nickel

Nickel in South Africa, T. G. Trevor. Min. Mag., vol. 20, no. 2, Feb. 1919, pp. 120-122. Deposits and their possibilities.

Nickel, T. G. Trevor. S. A. Jl. Industries, vol. 1, no. 15, Nov. 1918, pp. 1385-1394. Occurrences of nickel in Union of South Africa; description of deposits.

Nitrates

The Chilean Nitrate Industry During 1918, Donald F. Irvin. Eng. & Min. Jl., vol. 107, no. 6, Feb. 8, 1919, pp. 265-267. Processes of mining; forecasts of future development.

Tungsten

Experiments Relating to the Enrichment of Tungsten Ores, R. W. Gannett. Economic Geol., vol. 14, no. 1, Jan.-Feb. 1919, pp. 68-78. Data obtained from leaching of tungsten minerals (scheelite, ferberite, wolframite, and hübnerite); data obtained from precipitating tungsten from solution; writer's interpretations of data.

Production and Import of Tungsten Ores. Automotive Industries, vol. 40, no. 5, Jan. 30, 1919, p. 252. Statistics show slight falling off as compared with two preceding years.

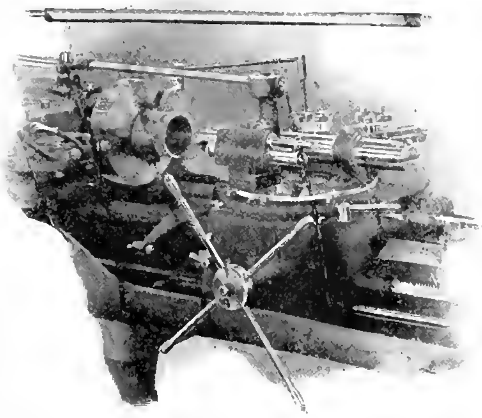
Wolfram Mining in Bolivia, G. F. J. Preumont. Instn. Min. & Metallurgy, bul. 173, Feb. 13, 1919, 9 pp. Occurrences and system of mining.

OIL

Maps and Oil Location

Map Making, R. T. Wells. Natural Gas & Gasoline Jl., vol. 13, no. 2, Feb. 1919, pp. 53-56, 6 figs. Value of maps in oil location and production.

Hartness Automatic Chasing Attachment



The Hartness Chasing Attachment is here shown applied to the Flat Turret Lathe.

This attachment is automatic. The carriage is locked to the bed and the attachment clutched with its positive drive from the work spindle. The threading tool feeds forward at cutting depth under lead screw control until the tool bar strikes a stop. The tool is then withdrawn to clear the work and returned at high speed to the starting point, where it is again fed in to cutting depth and engaged with the lead screw. The work spindle revolves continuously. The only motion required of the operator is that of adjusting the cross sliding head forward a slight amount during the return of the cutter to feed the tool in for the new cut. There is no possibility of overrunning and gouging into a shoulder, no matter how fast the machine is run.

The advantage of this attachment is that it gives engine lathe accuracy to turret lathe threading—and it gives much more than engine lathe speed.

Hartness Automatic Die

Wide Range :: Few Dies :: High Accuracy :: Small Expense

No. 1 Die: Range for standard threads, from $\frac{3}{32}$ inch to $\frac{9}{16}$ inch diameter, any length. Particularly adapted for small hand or automatic screw machine work.

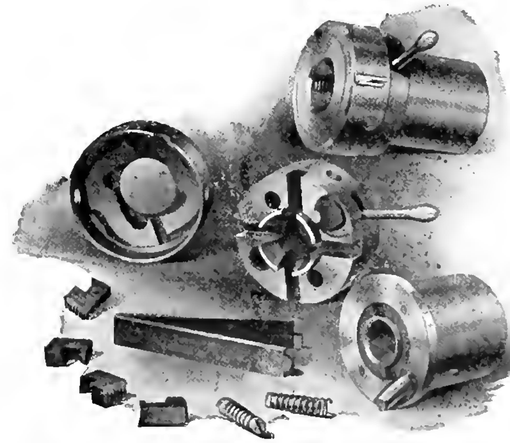
No. 4 Die: Range, $\frac{1}{4}$ inch to $1\frac{1}{4}$ inches diameter. This die is suitable for general turret lathe and screw machine use. It is especially adapted for use in automatic screw machines, owing to the compactness of its design.

No. 6 Die: Range, $\frac{3}{4}$ inch to 2 inches diameter This die is adapted for medium to large work on screw machines and turret lathes, and for the larger sizes of automatic screw machines.

No. 9 Die: Range, $1\frac{3}{4}$ inches to 3 inches diameter. This die is designed for the heaviest turret lathe work. It is provided with six chasers, and has a special double roughing attachment which adapts it particularly to large diameters or coarse pitches.

Any of these dies, even the large No. 9, will thread pitches as fine as 32 per inch on its largest diameter without danger of stripping.

The lead-controlling feature is exclusive with this die. You can cut long threads more accurate in pitch than you will get from the ordinary engine lathe.



The No. 4 Hartness Automatic Die and Its Parts

JONES & LAMSON MACHINE COMPANY

SPRINGFIELD, VERMONT, U. S. A.

109 Queen Victoria Street, London, E. C.

France, Spain and Belgium: F. Auberty & Co., 91 Rue de Maubeuge, Paris
Holland: Spliethoff, Beeuwkes & Co., Rotterdam

SEE OUR DATA IN 1918 A.S.M.E. CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT

Mexico

Mexico as Source of Petroleum and Its Products, R. De Golyer. Automotive Industries, vol. 40, no. 8, Feb. 20, 1919, pp. 420-422. Development of Mexican oil fields since 1910.

Oil Refinery

Sidelights on Oil Refinery Practice, E. W. Dean. Automotive Industries, vol. 40, no. 6, Feb. 6, 1919, pp. 315-316. Discussion of four methods of increasing supply of fuels available for use in present types of automotive engines. Paper before Soc. Automotive Engrs. Also in Natural Gas & Gasoline Jl., vol. 13, no. 2, Feb. 1919, pp. 63-64.

Determination of Gasoline in Gas, W. P. Dykema and Roy O. Neal. Chem. Engr., vol. 27, no. 1, Jan. 1919, pp. 5-7. Method of testing natural gas for its gasoline content, evolved at Bartlesville Experimental Station of Bur. of Mines.

United States

Oil in Peace and War, Van H. Manning. Natural Gas & Gasoline Jl., vol. 13, no. 2, Feb. 1919, pp. 73-74. U. S. position in regard to world petroleum situation.

The Unmined Supply of Petroleum in the United States, David White. Automotive Industries, vol. 40, no. 7, Feb. 13, 1919, pp. 361, 376, and 385. Estimates vary from 5,763,000,000 to 24,500,000,000 bbl.

PRECIOUS MINERALS

Australia

Gold Mining in Western Australia—IV. Thomas Butement. Chem. Eng. & Min. Rev., vol. 10, no. 120, Sept. 1918, pp. 364-368, 2 figs. Present position and outlook of Kalgoorlie mines.

Dredging

Possibilities of Dredging in the Oroville District, California, Charles H. Thurman. Min. & Sci. Press, vol. 118, no. 8, Feb. 22, 1919, pp. 257-258. Reasons why earlier type of dredge did not recover all of the gold.

Gold Ores

Larder Lake Gold Area, Percy E. Hopkins. Can. Min. Jl., vol. 40, no. 5, Feb. 5, 1919, pp. 68-71, 3 figs. Brief history and geological summary of camp.

Lightning River Gold Area and a Remarkable Series of Lava Flows, A. G. Burrows and C. W. Knight. Can. Min. Jl., vol. 40, no. 6, Feb. 12, 1919, pp. 83-86, 3 figs. Account of gold deposits and general geology of district.

Gold Precipitation

Gold Precipitation on Charcoal with an Accelerator, G. D. Reid. Chem. Eng. & Min. Rev., vol. 10, no. 120, Sept. 1918, pp. 374-375, 2 figs. Describes type of box for charcoal preciptation.

Platinum

The Source of Placer Platinum in the Tulameen District of British Columbia, R. M. Macauly. Eng. & Min. Jl., vol. 107, no. 7, Feb. 15, 1919, pp. 303-306, 1 fig. Claims that origin of Tulameen platinum is due to magmatic differentiation in peridotile and declares commercial extraction of platinum is doubtful.

Silver Ores

The Smelting and Refining of Cobalt Silver Ore, Sydney B. Wright. Eng. & Min. Jl., vol. 107, no. 6, Feb. 8, 1919, pp. 263-264. Operation at Deloro Reduction Co.'s works of high- and low-grade silver-cobalt ore in lump form, jig and table concentrate, and ore residues.

Statistics

Graphics of Gold and Silver, M. W. von Bernewitz. Min. & Sci. Press, vol. 118, no. 7, Feb. 15, 1919, p. 223. Production of world from 1889-1918.

Gold Production in the British Dominions, William Frecheville. Min. & Sci. Press, vol. 118, no. 7, Feb. 15, 1919, pp. 220-222. Appendix to Incheape Commission's Report on status of gold.

Mineral Production of British Columbia for 1918 Eng. & Min. Jl., vol. 107, no. 7, Feb. 15, 1919, pp. 320-322. Official report of gold commissioners and resident engineers of the province.

The Mining and Metallurgy of Cobalt Silver-Ores, R. W. Leonard. Jl. Eng. Inst. Can., vol. 2, no. 2, Feb. 1919, pp. 86-90. Ore treatment in districts of Temiskaming & Northern Ontario Ry.

The Production of Copper, Gold, Lead, Nickel, Silver, Zinc, and Other Metals in Canada During the Calendar Year 1917. Can. Dept. of Mines, no. 497, 71 pp. Report of Chief of Mineral Resources and Statistics.

RARE MINERALS

Rare Metals

Some of the Rarer Metals. Brass World, vol. 15, no. 2, Feb. 1919, pp. 58-59, 1 fig. Characteristics and properties of barium, bismuth, cadmium, calsium, cerium, cobalt, gallium, glucinum, iridium, lanthanum, lithium, osmium and palladium. (To be concluded.)

TIN

Concentration

The Comparison of Concentration Results with Special Reference to the Cornish Method of Concentrating Cassiterite, Edwin Edser. Instn. Min. & Metallurgy, bul. 173, Feb. 13, 1919, 17 pp., 5 figs. Mathematical analysis of ratio of assay of tailings increment to assay of concentrate; tests to determine variation of fractional loss of cassiterite or tin in terms of enrichment ratio.

Slime Treatment

Slime Treatment on Cornish Frames: Supplements, S. J. Truscott. Instn. Min. & Metallurgy, bul. 173, Feb. 13, 1919, 31 pp., 5 figs. Further experiments to determine circumstances in which plane and fluted surfaces were respectively better, the one than the other; and to try policy of rapid enrichment against more usual practice of continued retreatment of concentrate; also, results on fine grinding of both sand residue and original ore.

Tasmania

The Giblin Tin Lode of Tasmania, Cyril W. Gudgeon. Instn. Min. & Metallurgy, bul. 173, Feb. 13, 1919, 12 pp., 2 figs. Situation, early history, and description of deposits.

Metallurgy

ALUMINUM

Aluminum Alloys

Aluminum and Its Alloys (L'aluminium et ses alliages), Walter Rosenhain. Metallurgie, vol. 50, no. 52, Dec. 25, 1918, pp. 1877 and 1879. Their future after the war. Résumé of conference before Roy. Soc. at Exposition of British Scientific Products.

BLAST FURNACES

Bosh Tuyeres

A Few Notes on Bosh Tuyeres, J. Hollings. Iron & Steel Can., vol. 2, no. 1, Feb. 1919, pp. 11-13, 2 figs. Writer's experience in use of bosh tuyeres. Table and sketch illustrate English practice in number, size and position. Paper presented before Iron & Steel Inst.

Blast-Furnace Production

Ferromanganese in Blast Furnace, P. H. Royster. Iron Trade Rev., vol. 64, nos. 6 and 7, Feb. 6 and 13, 1919, pp. 405-407 and 439-443, 3 figs. From Bur. of Mines' report on investigation of 18 blast furnaces producing ferromanganese.

Bung

Furnace Bung Distributes Blast Evenly. Iron Trade Rev., vol. 64, no. 7, Feb. 13, 1919, pp. 446-447, 2 figs. Bung frame is provided with an air cylinder that is cast the full length of the top of the bung; cylinder is closed entirely at one end, but at opposite end an opening is provided for air blast.

Chinese Methods

Chinese Blast Furnace Iron Conversion, C. T. Huang. Blast Furnace, vol. 7, no. 3, Mar. 1919, pp. 125-126. Smelting of native white iron into foundry pig iron.

Design

Progress in Blast Furnace Design, J. G. West. Iron Trade Rev., vol. 64, no. 8, Feb. 20, 1919, pp. 499-505, 12 figs. Changes in adaptation of mechanical construction; modifications in detail of blast-furnace lines. Abstract of paper presented before Am. Iron & Steel Inst.

Slag Action

Influence of Temperance Upon the Action of Slag Upon Refractory Materials, Raymond M. Howe. Chem. & Metallurgical Eng., vol. 20, no. 4, Feb. 15, 1919, pp. 167-168. Experimental data.

COPPER

Bronze

Manganese Bronze, P. E. McKinney. Bul. Am. Inst. Min. Engrs., no. 146, Feb. 1919, pp. 421-425. Possibilities of producing manganese bronze without resorting to use of high-grade virgin materials.

Copper-Aluminum Alloys

Constitution and Hardness of Copper-Aluminum Alloys Having High Percentage of Copper (Constitution et dureté des alliages cuivre-aluminium riches en cuivre). Metallurgie, vol. 50, no. 52, Dec. 25, 1918, p. 1881, 1 fig. General type of graphs showing percentage of aluminum against Brinell hardness. (Continuation of serial.)

Copper Melting

Volatilization of Cuprous Chloride on Melting Copper Containing Chlorine, S. Skowronski and K. W. McComas. Bul. Am. Inst. Min. Engrs., no. 146, Feb. 1919, pp. 169-179, 1 fig. Experiments are said to have proved that volatilization of cuprous chloride on melting cathode copper takes place almost in its molecular ratio, and that under present copper-refining practice any cuprous chloride present in or on the cathode can be considered for all practical purposes as completely volatilized on melting, and may be the cause of a serious metallurgical loss of copper.

Leaching

First Year of Leaching by the New Cornelia Copper Co., Henry A. Tobelmann and James A. Potter. Bul. Am. Inst. Min. Engrs., no. 146, Feb. 1919, pp. 449-495, 7 figs. Process adopted consisted of leaching crushed ore 8 days by counter-current system and upward circulation, using sulphuric acid and ferric sulphate; reduction by sulphur-dioxide gas of ferric iron in neutral solutions from leaching tanks; electrolytic deposition of copper from reduced solution; and recovery of copper from discharged neutral solution as cement copper precipitated on iron. Numerical results are quoted.

Lead in Brass

Notes on the Rapid Estimation of Lead in Brass and Alloys, G. H. Hodgson. Chem. News, vol. 118, no. 3067, Jan. 24, 1919, pp. 37-38. Two methods are given, one gravimetric and one volumetric.

FERROALLOYS

Ferroalloys

Ferro-Metallic Alloys (Les alliages ferro-métalliques), Jean Escard. Revue Générale des Sciences, vol. 29, no. 23, Dec. 15, 1918, pp. 673-680, 3 figs. Manufacture of ferrochromium, ferrosilicon and ferromanganese. (To be continued.)

Production of Ferromanganese in the Blast Furnace, P. H. Royster. Bul. Am. Inst. Min. Engrs., no. 146, Feb. 1919, pp. 367-378, 3 figs. Operating data in ferromanganese practice; average practice for ferromanganese furnace and for iron furnace; calculated slag loss; stack loss. From report of research under joint auspices of U. S. Bur. of Mines and Nat. Research Council.

FLOTATION

Galena

The Flotation of Galena at the Central Mine, Broken Hill, R. J. Harvey. Min. & Sci. Press, vol. 118, no. 5, Feb. 1, 1919, pp. 149-154, 7 figs. Selective flotation of complex silver-lead-zinc sulphide associated in the main with quartz, rhodonite, rhodochrosite, and some garnet-sandstone. Paper before Instn. Min. & Metallurgy.

Lead Ores

Flotation of Oxidized Ores of Lead, Glenn L. Allen. Chem. & Metallurgical Eng., vol. 20, no. 4, Feb. 15, 1919, pp. 169-175, 1 fig. Process of sulphidizing ores such as cerussite, wulfenite and cerargyrite.

IRON AND STEEL

Aging Break

A Volute Aging Break, Henry M. Howe and Edward C. Groesbeck. Bul. Am. Inst. Min. Engrs., no. 146, Feb. 1919, pp. 181-182, 2 figs. Views of volute which developed spontaneously in a hardened and tempered steel helmet between 19 and 38 days after it had been tested ballistically.

Bessemer Process, Acid

Present American Acid Bessemer Process, Richard S. McCaffery. Blast Furnace, vol. 7, no. 3, Mar. 1919, pp. 140-142. Reversibility of manganese oxidation reaction; eliminating "spitting" by temperature control during blow.

Blast Furnaces

See preceding column.

Bluing Steel

Bluing Steel, W. B. Greenleaf. Mech. World, vol. 64, no. 1668, Dec. 20, 1918, pp. 291-292, 2 figs. Saltpeter process.

Converter Casting

Converter Steel Casting Practice, Charles M. Campbell. Proc. Steel Treating Research Soc., vol. 1, no. 10, July 1918, pp. 7-20, 15 figs. Description of steel foundry equipped with two cupolas, three 2-ton converters and producing an average of 12 heats per day. Suggestions in regard to molding, casting annealing and heat-treating.

Electric Smelting

Electric Smelting of Iron Ores in British Columbia, Alfred Stansfield. Iron & Steel Can., vol. 2, no. 1, Feb. 1919, pp. 4-10. Report of investigation to determine commercial

possibility. Swedish type of furnace is recommended as most economical for permanent plant, and open pit furnace is suggested as best for temporary plant.

Dr. Stansfield's Report on Electric Smelting of B. C. Iron Ores. Can. Min. Jl., vol. 40, no. 4, Jan. 29, 1919, pp. 54-56. Finds that while process is metallurgically feasible, nevertheless, under present conditions and prices for electric energy, its application would not be practical.

Electric Smelting of Domestic Manganese Ores, H. W. Gillett and C. E. Williams. Dept. of Interior, Bur. of Mines, War Minerals Investigations Series, no. 10, Dec. 1918, 48 pp. Tests to investigate whether electric smelting of manganiferous slags and low grade domestic ores is likely to be profitable at times of normal costs and prices are said to have demonstrated that such smelting is metallurgically possible but practicable only in times of high prices.

Electric Steel

Making Electric Steel for Ball Bearings, Arthur V. Farr. Iron Trade Rev., vol. 44, no. 3, Jan. 16, 1919, pp. 211-215, 12 figs. Reviews method of manufacture and calls attention to qualities of steel produced in electric furnace.

The Metallurgy of Electric Furnace Steel Processes, L. B. Lindemuth. Jl. Engrs. Club, Phila., vol. 35-12, no. 169, Dec. 1918, pp. 544-549. History; crucible process; open hearth; electric furnace; duplex and triplex processes; comparison between metallurgical features of electric-furnace process and those of the open-hearth and crucible processes.

Flaky Steel

Microstructural Features of Flaky Steel, Henry S. Rawdon. Bul. Am. Inst. Min. Engrs., no. 146, Feb. 1919, pp. 183-201, 27 figs. Summarizes characteristic features of defective steel of flaky type as found from laboratory study of numerous specimens, and aims to show conditions within metal that are favorable to occurrence of this type of defect.

Ingot-Production Statistics

Production of Ingots and Rolled Products. Iron Age, vol. 103, no. 8, Feb. 20, 1919, pp. 497-500. Statistics prepared by American Iron and Steel Institute show new record for steel and some finished forms in 1917.

Iron and Steel Trades

Iron and Steel. Times Eng. Supp., year 15, no. 531, Jan. 1919, p. 17. How iron and steel trades have emerged from war.

Production of Steel Ingots and Castings, Finished Rolled Iron and Steel in 1917. Iron Trade Rev., vol. 64, no. 8, Feb. 20, 1919, pp. 520-521. Statistical tables.

The Production of Iron and Steel in Canada During the Calendar Year 1917, John McLelsh. Can. Dept. of Mines, no. 498, 32 pp. Report of Chief of Division of Mineral Resources and Statistics.

Iron-Carbon-Chromium Alloys

On the Structure of Iron-Carbon-Chromium Alloys, Takejirô Murakami. Sci. Reports Tôhoku Imperial Univ., First Series, vol. 7, no. 3, Dec. 1918, pp. 217-276, 124 figs. Report of experimental investigation of alloys containing different amounts of iron, carbon, and chromium with particular reference to structural constitution, changes during heating and cooling, and self-hardening properties. Materials tested were Swedish iron, four different steels, white cast iron, ferrochromium and metallic chromium.

Japanese Iron Industry

The Japanese Iron & Steel Industry. Blast Furnace, vol. 7, no. 2, Feb. 1919, pp. 89-95. Report upon conditions in Manchuria and Korea and upon possibility of Japanese future independence in production of iron and steel.

Manganese Alloys

Manganese Alloys in Open Hearth Practice, Samuel L. Hoyt. Blast Furnace, vol. 7, no. 3, Mar. 1919, pp. 142-146. Recommendations for utilization of domestic alloys; molten spiegel mixture practice; use of manganese-silicon alloys in acid practice; electric furnace practice.

Open-Hearth Furnaces

Principles of Open Hearth Furnace Design—III, Charles H. F. Bagley. Blast Furnace, vol. 7, no. 2, Feb. 1919, pp. 111-113, 1 fig. Further considerations of furnace dimensions based on gas port area and hearth area per ton of steel capacity.

Use of Manganese Alloys in Open-Hearth Practice, Samuel L. Hoyt. Bul. Am. Inst. Min. Engrs., no. 146, Feb. 1919, pp. 277-289. It is advanced that there are three practices for utilizing our domestic alloys in open-hearth practice: Use of molten spiegel mixture for deoxidation and recarburation; practice of melting and refining steel bath so as to secure 0.3 per cent manganese alloys containing silicon; use of manganese alloys containing silicon. From report of research under joint auspices of U. S. Bur. of Mines and Nat. Research Council.

Water-Cooled Equipment for Open-Hearth Steel Furnaces, Wm. C. Coffin. Bul. Am. Inst. Min. Engrs., no. 146, Feb. 1919, pp. 497-515, 12 figs. Suggests that water-cooling devices for open-hearth steel furnaces should follow lines used in iron blast furnaces; several devices are illustrated.

Refractories

See Refractories, under Mechanical Engineering.

Rolling Mills

See Mechanical Processes (Rolling Mills), under Mechanical Engineering.

Tool Steel

New Tool Steel Developed by Research. Iron Trade Rev., vol. 64, no. 9, Feb. 27, 1919, pp. 576-577, 4 figs. Made of alloys and arranged within critical zones in order to make martensite predominant structure. Said not to diminish in efficiency by overheating.

Transformations in Steel

Effect of Rate of Temperature Change on Transformations in an Alloy Steel, H. Scott. Bul. Am. Inst. Min. Engrs., no. 146, Feb. 1919, pp. 157-167, 7 figs. Previous investigators have laid particular stress on variation of maximum temperature, rate remaining constant, while variation of rate, maximum temperature remaining constant has received little attention. Writer has applied latter method to investigation of an alloy steel and attempts to correlate results of that method with those of the former and to establish relations of several phenomena observed.

See also MINING ENGINEERING, Major Industrial Materials (Manganese); ELECTRICAL ENGINEERING, Furnaces (Steel Furnaces).

NON-FERROUS METALS

Non-Ferrous Metals

Non-Ferrous Metals. Times Eng. Supp., year 15, no. 531, Jan. 1919, p. 18. Advances made in their manufacture during recent years.

OCCLUDED GASES

Steel

Investigation of Gases Occluded in Steel, Thomas Baker. Blast Furnace, vol. 7, no. 3, Mar. 1919, pp. 156-157 and 163. Experiments to determine composition and volume of occluded gases and their effect upon physical properties of metal, relation between temperature at evolution of gas and electrical point.

ZINC, LEAD AND TIN

Conservation

Metallurgical Work of Bureau of Standards, G. K. Burgess. Blast Furnace, vol. 7, no. 3, Mar. 1919, pp. 130-131, 2 figs. Review of research work concerning welding and tin conservation. (To be continued.)

Electric Furnace for Tin

Electrometallurgy of Tin in Electric Furnace (L'électrométallurgie de l'étain au four électrique), Jean Escard. Industrie Electrique, vol. 27, no. 635, Dec. 10, 1918, pp. 444-448. Treatment of minerals; furnaces; recovery of lead; extraction of tin from industrial waste.

Zinc

Zinc Smelting in India, T. R. Wynne. Eng. & Min. Jl., vol. 107, no. 8, Feb. 22, 1919, pp. 356-358. Possibilities of zinc smelting in India; investigation of Burma ores; industrial development in India. Report of chairman at general meeting of Burma Corporation.

HYDROMETALLURGY

Terminology

Defining "Tailings" and "Residues," A. W. Allen. Eng. & Min. Jl., vol. 107, no. 7, Feb. 15, 1919, p. 317. Submits definitions. Third article of series on standardization of terms used in hydrometallurgical operations.

Aeronautics

AEROPLANE PARTS

Cooling System

The Loomis Cooling System for Aircraft. Mech. Eng., vol. 41, no. 3, Mar. 1919, pp. 255-256, 3 figs. System embodies nose radiator, adjustable booster and expansion tank with positive ejection.

Radiators

The Aeronautical Radiator, S. R. Swenson. Aerial Age, vol. 8, no. 25, Mar. 3, 1919, pp. 1256-1261 and 1286, 14 figs. Types and designs in general. Study of coefficients; the nose radiator.

AEROSTATICS

Airship Operations

British Airship Development and Operations. Aviation, vol. 5, no. 12, Jan. 15, 1919, pp. 758-759, 1 fig. Figures relative to man power required for operating airships, casualties per flight mileage, and non-flying days.

Commercial Airships

Airships for Commercial Purposes. Flight, vol. 11, no. 5, Jan. 30, 1919, pp. 144-148. Relative advantages of airships and aeroplanes; development and potentialities of rigid airships and aeroplanes; commercial considerations relating to airships. Officially issued by Air Ministry.

The report of the Civil Aerial Transport Committee. Flight, vol. 11, no. 4, Jan. 23, 1919, pp. 119-125. Main or terminal aerodrome; intermediate landing grounded; airship for commercial purposes; correspondence relating to fog on the Newfoundland coast. (Continued from p. 27.)

Dirigibles for Transport

Value of Dirigibles for Aerial Transport, Henry Woodhouse. Flying, vol. 8, no. 2, Mar. 1919, pp. 137-143, 7 figs. Relative advantages of airships and airplanes; progress in heavier-than-air and lighter-than-air machines 1914-1918; technical advantages in designs of airships. From report of Civil Aerial Transport Committee.

Military Balloons

Military Aerostatics, H. K. Black. Aerial Age, vol. 8, no. 24, Feb. 24, 1919, pp. 1166-1167, 4 figs. Free ballooning. (Continuation of serial.)

AIRCRAFT PERSONNEL

Flying Sickness

Flying Sickness, Martin Flack. Aeronautics, vol. 16, no. 272, Jan. 1, 1919, pp. 21-22, 1 fig. Record of experiences of aviators and tests.

Tests for Flyers

Medical Aspects of Aviation, L. E. Stamm. Aeronautics, vol. 16, no. 275, Jan. 22, 1919, pp. 111-113, 3 figs. Physical and mental requisites for aviation work. (To be continued.) Paper before Roy. Aeronautical Soc.

The Wear and Tear of Flying, T. S. Rippon. Flight, vol. 11, no. 4, Jan. 23, 1919, pp. 108-109. Methods used by French physicians in examining pilots; American tests.

APPLICATIONS

Aerial Ports

Organization of Aerial Ports, Gino Bastoji. Aviation, vol. 6, no. 1, Feb. 1, 1919, p. 35. Future developments. From Rivista del Transporti Aerei.

Commercial Aviation

Commercial Aviation in the Light of War Experience, F. H. Sykes. Aeronautics, vol. 16, no. 274, Jan. 15, 1919, pp. 81-83. Concerning safety, base and repair facilities, operation of flying roads, meteorology and aerodrome management. Abstract of lecture before Lond. Chamber of Commerce. Also in Flight, vol. 11, no. 3, Jan. 16, 1919, pp. 84-88.

Mail Service

Aerial Mail in the United States and Abroad, Otto Praeger. Flying, vol. 8, no. 2, Mar. 1919, pp. 144-147 and 174-177, 5 figs. Programs proposed and in operation; equipment; coöperation in Post Office Dept. and U. S. Army.

The World's Aerial Mail and Passenger Services. Aviation, vol. 5, no. 12, Jan. 15, 1919, p. 755. Operating and projected services.

Passenger Traffic

Aerial Travel for Reconstruction, G. Holt Thomas. Aeronautics, vol. 16, no. 272, Jan. 1, 1919, p. 12. Visualization of transaction of business through instrumentality of aerial navigation.

Patrol Work, Forest

Use of Airplanes in Forest Patrol Work, Henry S. Graves. Aviation, vol. 5, no. 12, Jan. 15, 1919, pp. 754-755. Present service.

Regulation

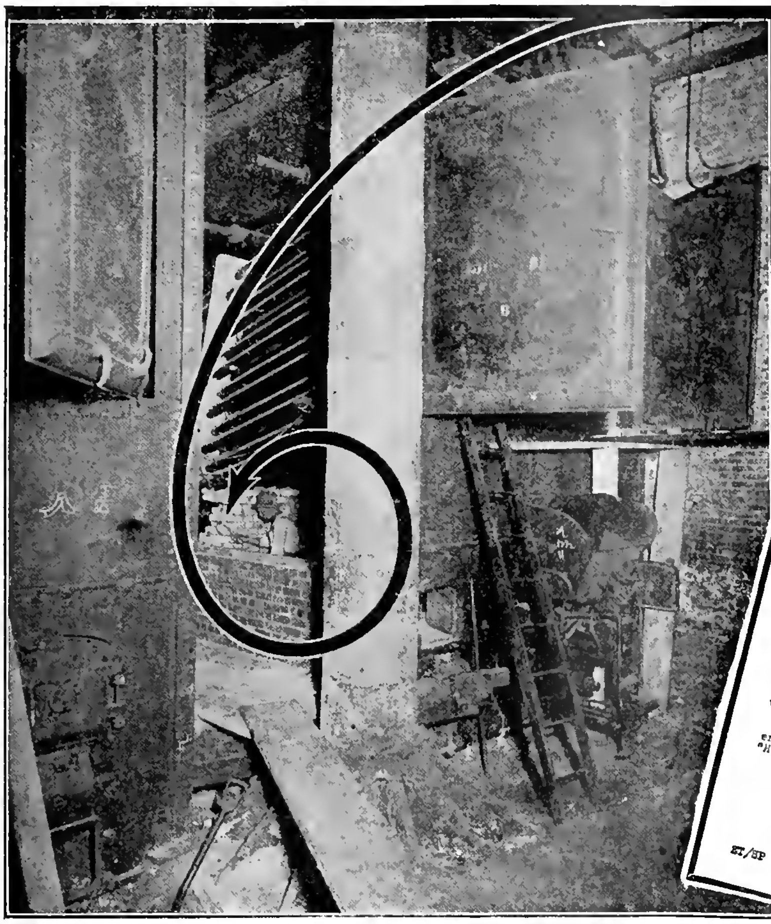
Future Air Traffic and Necessary Regulations to Govern Same, Alan R. Hawley. Flying, vol. 8, no. 2, Mar. 1919, pp. 149-154, 6 figs. Problem of utilizing military airplanes and employing demobilized aviators.

To Regulate Aerial Navigation, Henry Woodhouse. Flying, vol. 8, no. 1, Feb. 1919, pp. 33-42, 70 and 72, 15 figs. Study by British Aerial Transport Committee and Act this committee has drafted for regulation of aerial navigation.

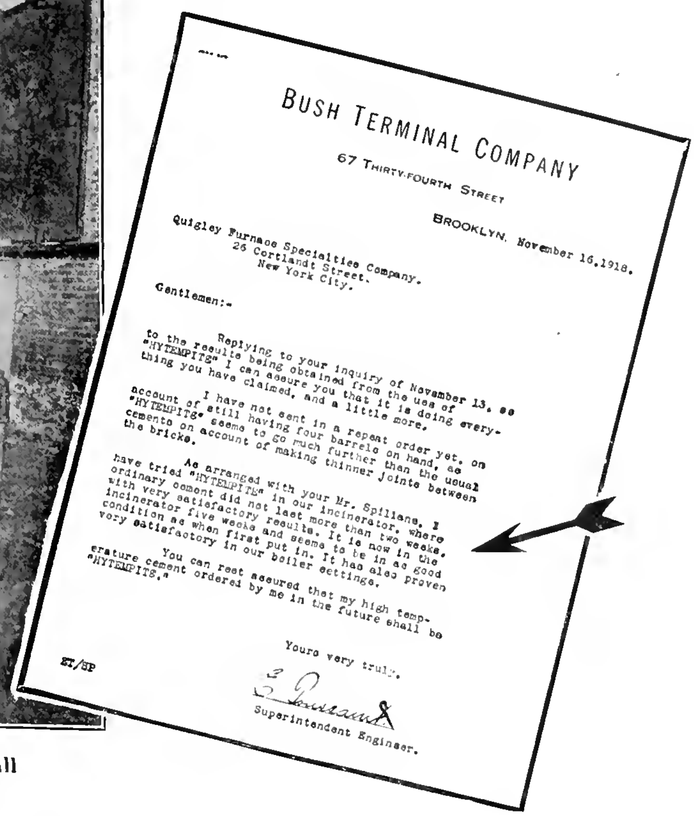
Safety

The Reliability of Aircraft Travel, Mervyn O'Gorman. Aeronautics, vol. 16, no. 272, Jan.

Deep in the Vitals of your Boiler Settings or Furnaces is where you need a strong, thin joint to bond your fire brick; a joint that is as strong as the brick itself and has the same coefficient of expansion.



Stoker-Fired Boiler Setting—Bonding the Bridge Wall



BUSH TERMINAL COMPANY

67 THIRTY-FOURTH STREET

BROOKLYN, November 16, 1918.

Quigley Furnace Specialties Company,
26 Cortlandt Street,
New York City.

Gentlemen:-

Replying to your inquiry of November 13, as to the results being obtained from the use of "HYTEMPITE" I can assure you that it is doing everything you have claimed, and a little more.

I have not sent in a repeat order yet, on account of still having four barrels on hand, as "HYTEMPITE" seems to go much further than the usual cements on account of making thinner joints between the bricks.

As arranged with your Mr. Spillane, I have tried "HYTEMPITE" in our incinerator, where ordinary cement did not last more than two weeks, with very satisfactory results. It is now in the incinerator five weeks and seems to be in as good condition as when first put in. It has also proven very satisfactory in our boiler settings.

You can rest assured that my high temperature cement ordered by me in the future shall be "HYTEMPITE."

Yours very truly,

Superintendent Engineer.

ET/SP

This mason is using

HYTEMPITE

Reg U. S. Pat. Off.

HIGH TEMPERATURE FIRE BRICK CEMENT

Because

HYTEMPITE makes the walls gas and air tight. It does not disintegrate, and prevents gases of combustion from entering the joints or leakage of air through the wall.

HYTEMPITE does not depend on heat for its adhesive qualities. It will air-set and the bond will retain its strength under all temperature conditions encountered.

HYTEMPITE will increase the life of boiler settings:—vouched for by hundreds of testimonials.

QUIGLEY FURNACE SPECIALTIES CO.

26 CORTLANDT STREET
NEW YORK

IMMEDIATE DELIVERY FROM STOCK AT

Baltimore, Benton Harbor, Birmingham, Chicago, Cincinnati, Cleveland, Detroit, Denver, El Paso, Houston, Indianapolis, Los Angeles, Montreal, New York, Niagara Falls, Oakland, Pittsburgh, Portland (Ore.), Richmond, St. Louis, Salt Lake City, Scranton, Seattle, Toronto, Vancouver, Winnipeg, Tokio, Japan

1, 1919, pp. 5-7, 1 fig. Statistics of accidents; question of reliability of engines.

The Report of the Civil Aerial Transport Committee. Flight, vol. 11, no. 5, Jan. 30, 1919, pp. 150-155. Memorandum of research in regard to meteorology; summary of work, prior to war, of Public Safety and Accidents Investigation Committee of Roy. Aero Club & Aeronautical Soc. (Continued from p. 125.)

Surveying and Mapping

The Aero Radio Surveying and Mapping, John Hays Hammond. Flying, vol. 8, no. 2, Mar. 1919, pp. 160-161, 3 figs. Writer's system of aerial radio survey.

Topographic Surveying by Aerial Photography, Arthur Brock, Jr., and L. J. R. Holst. Aviation, ol. 6, no. 2, Feb. 15, 1919, pp. 75-78, 9 figs. Use of aerial photography to making contour maps. Inspection of aerial negatives and interpretation of direction by means of them.

Transcontinental Flight

Aerial Transportation, Evan J. David. Flying, vol. 8, no. 1, Feb. 1919, pp. 64, 66, 75-76, and 78, 2 figs. Review of progress. Squadron of four Army training planes is reported to have completed transcontinental flight.

DESIGN

Aeroplane Design

Aeroplane and Seaplane Engineering, H. C. Richardson. Aerial Age, vol. 8, no. 24, Feb. 24, 1919, pp. 1171-1173, 1180 and 1182-1183, 2 figs. Paper presented before Soc. Automotive Engrs.

Report of the U. S. National Advisory Committee for Aeronautics. Aeronautics, vol. 16, no. 275, Jan. 22, 1919, pp. 116-117. Activities of Committee between Oct. 4, 1917, and Oct. 10, 1918. (To be continued.)

German Design

Trend of German Airplane Design. Automotive Industries, vol. 40, no. 5, Jan. 30, 1919, pp. 262-265, 3 figs. Summary of features of captured enemy machines. Issued by Technical Department, Aircraft Production, Ministry of Munitions.

Incidence Wires

Incidence Wires in the Strength Calculations of Wing Structures, John Case. Aeronautics, vol. 16, no. 273, Jan. 8, 1919, pp. 46-51, 4 figs. Discusses accuracy of method outlined in preceding installment. (Continued from vol. 15, p. 607.)

Inspection

Some Avoidable Dangers in Airplane Construction, Walter O. Adams. Am. Mach., vol. 50, no. 8, Feb. 20, 1919, pp. 365-366. Points out some avoidable dangers and suggests standardized inspection for elimination of defective small parts.

Research

Full Scale Aeroplane Experiments, W. S. Farren. Aeronautics, vol. 16, nos. 273 and 274, Jan. 8 and 15, pp. 53-56 and 84-86. Scope of experimental research undertaken by Roy. Aircraft establishment. Abstract of paper before Roy. Aeronautical Soc.

Rigging

Rigging, F. W. Halliwell. Flight, vol. 11, nos. 4, 5 and 6, Jan. 23 and 30, Feb. 6, 1919, pp. 107, 132-134 and 176-179, 18 figs. Manufacturing particulars in construction and erection.

Struts

Design of Airplane Struts, W. H. Barling and H. A. Webb. Aviation, vol. 6, no. 2, Feb. 15, 1919, pp. 79 and 82-83, 6 figs. Effect of tapering on strength. Paper before Roy. Aeronautical Soc.

The Spacing of Interplane Struts, John Case. Aeronautics, vol. 16, no. 272, Jan. 1, 1919, pp. 18-20, 15 figs. Computations for various types and cases.

Wing Spar Stresses

Wing Spar Stresses, H. A. Webb and H. H. Thorne. Aeronautics, vol. 16, no. 272, Jan. 1, 1919, pp. 8-11, 8 figs. Formulæ and bending-moment diagrams.

ENGINES

Aeromarine Engine

The Aeromarine Type L 6-Cylinder Aero Motor. Aerial Age, vol. 8, no. 24, Feb. 24, 1919, pp. 1164-1165, 4 figs. Describes motor designed for training and sporting machines.

American Engines

American Aero Engines, G. Douglas Wardrop. Aerial Age, vol. 8, no. 25, Mar. 3, 1919, pp. 1242-1251 and 1283, 10 figs. General data of Liberty 12, King-Bugatti, Curtis K-6 and K-12, Hispano-Suiza, Duesenberg model H, Lawrence 60-hp. air-cooled engine, Union 6-cylinder aeromotor, Knox 12, Hall-Scott A-8, and 80-hp. Le Rhone.

Carburetors

A New Principle in Carburation. Aerial Age, vol. 8, no. 25, Mar. 3, 1919, p. 1223, 2 figs. Brown carburetor said to operate automatically at all speeds.

Characteristics

Characteristics of Leading Aero Engines. Aerial Age, vol. 8, no. 25, Mar. 3, 1919, pp. 1252-1254. Tables of dimensions and data.

Curtiss

The Curtiss Model K-6 Aircraft Engine. Aviation, vol. 6, no. 2, Feb. 15, 1919, pp. 83-84, 1 fig. General design.

The Curtiss Model K-6 and K-12 Aero Motors. Aerial Age, vol. 8, no. 21, Feb. 3, 1919, pp. 1030-1034, 10 figs. Form of construction adopted gives minimum center distance between cylinders, together with placing of accessories and accessibility of various parts for inspection or overhauling.

Design

The Design of Aeroplane Engines—XV, John Wallace. Aeronautics, vol. 16, no. 274, Jan. 15, 1919, pp. 77-80, 6 figs. Cam design; choice of cam; calculations for profile; process of laying out cam; valve-lift diagram; gas velocity; cams for radial engines. (Continuation of serial.)

Duesenberg

Duesenberg Sixteen-cylinder Aircraft Engine. Automotive Industries, vol. 40, no. 4, Jan. 23, pp. 214-218, 13 figs. Weight 1250 lb.; 700 hp. on direct drive and 800 on geared. Said to be the largest aeroplane engine produced in U. S.

Liberty

Liberty Engine Tests. Mech. Eng., vol. 41, no. 3, Mar. 1919, pp. 249-253 and 295, 8 figs. Authentic data on performance tests of the standard high-compression army-type 12-cylinder Liberty engine.

The Liberty Aircraft Engine, J. G. Vincent. Automotive Industries, vol. 40, nos. 6 and 7, Feb. 6 and 13, 1919, pp. 323-327 and 378-385, 8 figs. Feb. 6: Chronological history of development, with remarks on incidents and military requirements that affected its design. Paper before Soc. Automotive Engineers. Feb. 13: Discussion of various features of design, with reasons for their adoption; performance of planes equipped with engine.

Magnetos

Standardized Magnetos for Aircraft Engines. Aviation, vol. 6, no. 1, Feb. 1, 1919, p. 37, 1 fig. Features of Dixie types.

Napier

Napier "Lion" Aero Engine, G. Douglas Wardrop. Aerial Age, vol. 8, no. 25, Mar. 3, 1919, pp. 1262-1264, 7 figs. English 12-cylinder model used by Capt. Lang in establishing world's altitude record of 30,500 ft.

Rotary

The 80-hp. Le Rhone Airplane Engine. Aviation, vol. 6, no. 2, Feb. 15, 1919, pp. 70-73, 8 figs. Principles of rotary engine; features of design; performance graph; specifications.

Stresses

The Design of Aeroplane Engines—XVI, John Wallace. Aeronautics, vol. 16, no. 275, Jan. 22, 1919, pp. 102-105, 10 figs. Inertia forces; loads on cam and tappet; stresses in camshaft; torsion of camshaft.

Thermal Efficiency

Importance of High Thermal Efficiency in Aeroplane Engine Design and Construction, Charles W. Burrage. Aerial Age, vol. 8, no. 24, Feb. 24, 1919, pp. 1168-1170, 3 figs. Graph showing difference in characteristics of various aeroplane power plants.

Valves

Valve Dispositions in High-Speed Aircraft Engines, John Wallace. Aeronautics, vol. 16, no. 272, Jan. 1, 1919, pp. 34-36, 5 figs. Computations of valve areas in theoretical engine under assumed conditions.

INSTRUMENTS

Ignition Interrupter

Douglas Automatic Airplane Ignition Interrupter. Automotive Industries, vol. 40, no. 7, Feb. 13, 1919, pp. 372-373, 2 figs. Safety device for stopping engine when propeller breaks or other breakage occurs.

MATERIALS OF CONSTRUCTION

Coatings for Boats

Tests of Moisture and Water Resistance of Various Coatings on Small Boat Construction, Henry A. Gardner. Inst. Indus. Research, Washington, D. C., 10 pp., 3 figs. Following coatings conforming to aeronautical specifications of Navy Dept. were tested: Raw linseed oil; acetate dope; oil graphite; spar varnish; and enamel.

Fabrics

Properties of Aeroplane Fabrics, E. Dean Walen. Aeronautics, vol. 16, no. 274, Jan. 15, 1919, pp. 87-90, 8 figs. Methods used by Bur. of Standards in developing a cotton fabric as a substitute for linen for aeroplane wing coverings.

MILITARY AIRCRAFT

Airships, British

The Role of British Airships in the War, W. Lockwood Marsh. Aeronautics, vol. 16, no. 272, Jan. 1, 1919, pp. 13-17, 8 figs. Various types and their uses; war incidents.

War Department, U. S.

Aeronautics, George O. Squier. Eng. World, vol. 14, no. 2, Jan. 15, 1919, pp. 33-35. Information on work done by Aeronautics Branch of War Dept.

MODELS

Air Screw

Model Aeroplanes—XX, F. J. Camm. Aeronautics, vol. 16, no. 275, Jan. 22, 1919, p. 109, 4 figs. Designing the air screw.

Motor

Model Aeroplane Building as a Step to Aeronautical Engineering. Aerial Age, vol. 8, no. 24, Feb. 24, 1919, p. 1177, 2 figs. Illustrations of redesigned Ford motor.

Performance

Model Aeroplane Building as a Step to Aeronautical Engineering. Aerial Age, vol. 8, no. 21, Feb. 3, 1919, p. 1045, 1 fig. Checking possible performance of machine. (Continuation of serial.)

Power

Model Aeroplane Building as a Step to Aeronautical Engineering. Aerial Age, vol. 8, no. 25, Mar. 3, 1919, p. 1269, 2 figs. Minimum power required for flying.

PLANES

Armored Planes

Armored Aeroplanes, H. A. Webb. Aeronautics, vol. 16, no. 274, Jan. 15, 1919, pp. 74-76, 6 figs. Comparison of vulnerabilities of square and round bodies.

The Fokkers-Junkers Armored Biplane. Aviation, vol. 6, no. 1, Feb. 1, 1919, p. 36, 1 fig. Wing construction.

Bristol

The "Bristol" Machines. Flight, vol. 11, no. 4, Jan. 23, 1919, pp. 100-105, 25 figs. Types developed of monoplane, biplane and triplane design.

Curtiss

The Curtiss Type 18-2 Triplane. Aviation, vol. 6, no. 2, Feb. 15, 1919, pp. 74-75, 2 figs. Dimensions and weights.

De Haviland

The De Haviland, or "Airco," Machines. Flight, vol. 11, no. 2, Jan. 9, 1919, pp. 36-45, 40 figs. Development of this type and features of ten models designed.

The Enclosed D. H. 4. Flight, vol. 11, no. 4, Jan. 23, 1919, p. 111, 2 figs. Views of totally enclosed two-passenger aerial limousine.

Helicopters

The Helicopter, M. A. S. Riach. Aeronautics, vol. 16, no. 272, Jan. 1, 1919, pp. 23-25. Problem of direct-lift flying machine in light of modern airscrew analysis.

Loening

Description of the Loening Monoplane. Aviation, vol. 5, no. 12, Jan. 15, 1919, pp. 759-762, 5 figs. Construction, engine installation and performance.

Martin

The Martin K-III. Scout. Aeronautics, vol. 16, no. 275, Jan. 22, 1919, pp. 106-108, 4 figs. Details and performance. From Aerial Age. Biplane has wing span of 18 ft., weighs 350 lb. and is equipped with 40-hp. A.B.C. engine.

Sopwith

The Sopwith Machines. Flight, vol. 11, no. 6, Feb. 6, 1919, pp. 163-174, 56 figs. Stages in evolution; classification, dimensions, weights of the 21 types produced.

Standard

The Standard Model E-4 Mail Aeroplane. Aerial Age, vol. 8, no. 21, Feb. 3, 1919, pp. 1036-1037 and 1034, 7 figs. General dimensions, weights and details.

Sundstedt

Airplanes for the Transatlantic Flight. Sci. Am., vol. 120, no. 9, Mar. 1, 1919, pp. 202 and 215, 4 figs. Sundstedt biplane. Upper plane has a spread of 100 ft., lower plane 71½ ft.; equipped with 2 Hall-Scott engines rated at 220 hp. each; weight 10,000 lb.; estimated speed 80 mi. per hr.

Rex Steel Roller Chain of the Chabelco type used for carrying the baskets of Rex Traveling Water Screens.

You can secure Standard Rex Sprocket Chain of any size or type, either through distributors or direct, for every transmission and conveyor need.

Numerous Rex Traveling Water Screen installations have proven to many American power plants that intake troubles need not be accepted as necessary evils.

Clean water and continuous operation can be assured at a very low cost per year by Rex Traveling Water Screens.

Send For This Rex Catalog

Our catalog No. 85 describes and pictures the details of design and operation of the standardized type of Rex Traveling Water Screens.

Every factory, plant and mill superintendent and engineer can gain by a study of its pages.

Send for it today.

It presents in detail the connection between your intake and your production.

If your problems are those of public utilities companies, you can learn what others have done to solve them.

If you are in a steel mill, it will pay you especially to send for this booklet today.

Many of the shut-downs still accepted as necessary evils in steel plants can be prevented by a proper solution of the intake problem.

The best protection to bosh plates and tuyere openings is an adequate supply of *clean* water.

Particularly those plants, whatever their product, whose water supply is endangered in winter by slush-ice and in spring by floods should write for Catalog 85 of Rex Traveling Water Screens.

CHAIN BELT COMPANY, MILWAUKEE

734 PARK STREET

New York Chicago Philadelphia Pittsburgh

REX TRAVELING WATER SCREENS

Rex Chains, Rex Concrete Mixers,
Rex Sprockets, Rex Elevators and Conveyors

The Sundstedt-Hannevig Seaplane. Aerial Age, vol. 8, no. 24, Feb. 24, 1919, pp. 1162-1163 and 1183, 5 figs. Designed for long-distance flying over sea.

PRODUCTION

Le Pere

Production of Le Père Planes Was Well Started, J. Edward Schipper. Automotive Industries, vol. 40, no. 6, Feb. 6, 1919, pp. 303-304, 4 figs. Manufacturing details.

See also ORGANIZATION AND MANAGEMENT, *Education (Training Department, Aircraft Factory).*

PROPELLERS

Calculator for Propellers

A Convenient Calculator for Propellers, E. P. Klog. Aeronautics, vol. 16, no. 272, Jan. 1, 1919, pp. 31-33, 3 figs. Chart intended to simplify theoretical work on propeller performance by blade-element method.

Torque

Propeller Torque, J. Morris. Aeronautics, vol. 16, no. 273, Jan. 8, 1919, p. 52, 1 fig. How it arises and its action in the case of both geared and ungeared engines.

SPECIFICATIONS, AEROPLANE

Seaplanes

Navy Issues Seaplane Specifications. Aviation, vol. 6, no. 2, Feb. 15, 1919, pp. 73-74. Schedule for furnishing plans, supervisory assistance and construction of seaplanes.

TRANSATLANTIC FLIGHT

Airship vs. Aeroplane

Possibilities of an Atlantic Air Line. Eng. World, vol. 14, no. 4, Feb. 15, 1919, pp. 41-42. Airships versus airplanes.

VARIA

Metric System

The Metric System and the Aeronautical Industry, David Scott. Aeronautics, vol. 16, no. 272, Jan. 1, 1919, pp. 26-27. Plea for adoption of metric system by Great Britain.

National Advisory Committee

National Advisory Committee Report. Aviation, vol. 5, no. 12, Jan. 15, 1919, pp. 750-753. Recommendations regarding future development of American aeronautics; power plants for aircraft; materials for aircraft.

Progress in 1918

Aeronautics. Times Eng. Supp., year 15, no. 531, Jan. 1919, pp. 14-15. Survey of developments in 1918.

Aeronautics in the United States, 1918, George O. Squier. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 2, Feb. 1919, pp. 53-114, 17 figs. Review of development of military aeronautics in United States up to date of armistice.

Wind Velocity, Determination of

Determination of Wind Velocity and Direction by Means of Sound Waves (Sur une méthode de détermination de la vitesse et de la direction des vents, par temps couvert, à l'aide de sondages par le son), M. Bourgeois. Comptes rendus des séances de l'Académie des Sciences, vol. 167, no. 22, Nov. 25, 1918, pp. 769-772. Balloon carries fireworks timed to explode at regular intervals; motion of balloon is recorded at each explosion, which serves to compute height.

Marine Engineering

AUXILIARY MACHINERY

Lifting Gear

Marine Steam Turbine Lifting Gear. Mech. World, vol. 65, nos. 1671 and 1673, Jan. 10 and 24, 1919, pp. 18-19 and 43, 5 figs. Brief outline and discussion of various types, giving general method of calculating proportions of principal parts. First and second installments. (To be continued.)

Oil Filter

An Efficient Oil Filter for Marine Installations. Pacific Marine Rev., vol. 16, no. 1, Jan. 1919, pp. 130-131, 3 figs. Combination batch and continuous oil filter of Paterson marine type.

SHIPS

American Types

American Shipbuilding Practice. Shipbuilding & Shipping Rec., vol. 13, no. 3, Jan. 16, 1919, pp. 63-66, 2 figs. Types of vessels adopted by Submarine Boat Corporation; organization and operation of Hog Island and arrangement of the yards.

American Shipbuilding

The Early History of American Shipbuilding, W. A. Dobson. Jl. Engrs. Club Phila., vol. 35-10, no. 167, Oct. 1918, pp. 455-466, 9 figs. Review of history and practice of shipbuilding in U. S. prior to 1880 as compiled from memoirs of C. M. Cramp, the report by Henry Hall, and the writer's personal experience.

Concrete Ships

Concrete Ships VI. Times Eng. Supp., year 15, no. 531, Jan. 1919, p. 38. Notes on yards at Thornaby-on-Tees, Amble, Whitby, Sunderlan, Granton and Faversham, where concrete ships are being built.

A Composite System of Reinforced Concrete Ship Construction, A. S. Holmes. Pacific Marine Rev., vol. 16, no. 1, Jan. 1919, pp. 116-117, 2 figs. System employs a combination of timber, concrete and reinforcing metal.

Ireland's First Concrete Ship. Shipbuilding & Shipping Rec., vol. 13, no. 2, Jan. 9, 1919, p. 42, 1 fig. Account of her launching; general dimensions.

Efficiency

The Economic Efficiency of Merchant Ships, Alexander Urwin. Shipbuilding & Shipping Rec., vol. 13, no. 3, Jan. 16, 1919, pp. 72-74. Table showing factors in a deadweight cargo carrier which operate upon each other and decide efficiency of vessel.

European Shipbuilding

European Marine Notes. Pacific Marine Rev., vol. 16, no. 1, Jan. 1919, pp. 114-115. Model British fabricated ship; concrete barges; German shipping in the war.

Fabricated Vessels

The "N" or Fabricated Vessels, Engineering, vol. 107, no. 2768, Jan. 17, 1919, pp. 69-71, 6 figs. Discussion of "National" standard vessels built according to "d'Eyncourt-Graham" system.

Ford Methods

Ford Methods in Ship Manufacture, Fred E. Rogers. Indus. Man., vol. 57, no. 3, March 1919, pp. 190-197, 10 figs. Division and subdivision of the erecting operations. Third article.

Freighter

SS. "Westerner." Shipbuilding & Shipping Rec., vol. 13, no. 1, Jan. 2, 1919, pp. 8-9, 2 figs. Principal dimensions, plans and details of cargo steamer of 8800 tons d.w. on 24 ft. 1 in. draft. Built by Emergency Fleet Corporation.

Machinery and Pipe Arrangement

Machinery and Pipe Arrangement, C. C. Pounder. Mech. World, vols. 64 and 65, nos. 1668, 1672 and 1674, Dec. 20, 1918, Jan. 17 and 31, 1919, pp. 295, 30 and 55, 11 figs. Typical location in vessels built to Board of Trade requirements. Tenth to twelfth installments. (Continuation of serial.)

Motorships

Motor-Driven Tanker "Hamlet." Shipbuilding & Shipping Rec., vol. 13, no. 2, Jan. 9, 1919, pp. 36-41, 8 figs. 10,055 tons d.w. on 24 ft. 7 in. draft. Propelling machinery consists of two Polar Diesel engines.

Splendid Record of Wooden Motorship. Pacific Marine Rev., vol. 16, no. 1, Jan. 1919, pp. 94-95, 2 figs. Account of travel of "Libby Maine" in voyage through arctic waters.

Propelling Machinery

Notes on Trial Trips, S. H. Cornell. Jl. Am. Soc. Marine Draftsmen, vol. 6, no. 3, Oct. 1918, pp. 41-43, 1 fig. Review of important fundamental theories governing economical operation of boilers and propelling engines; diagram showing approximate temperature for burning fuel oil.

Propelling Power

Economy in Ocean Transportation, A. W. Robinson. Jl. Eng. Inst. Can., vol. 2, no. 2, Feb. 1919, pp. 104-108. Remarks of conservation of fuel, economy in generation and use of propelling power; question of ocean transportation as viewed by a commission appointed by British Government to study relations of Dominions to Empire and to each other.

Standardization

Standardization of Ship Steel. Pacific Marine Rev., vol. 16, no. 1, Jan. 1919, pp. 101-103. Investigation conducted by representative of U. S. Shipping Board Emergency Fleet Corporation; table of structural shapes recommended for ships.

Stresses

Stresses in Ships, Sydney V. James. Jl. Western Soc. Engrs., pp. 356-376, 8 figs. Discussion of kinds of stresses, and of methods of determining principal longitudinal stresses; results of application of such methods to study of ships of well-known type; question of shearing stresses and of situation relative to transverse-stress calculations.

Terminology

Displacement Deadweight Gross and Tonnage, T. H. Fenner. Mar. Eng. Can., vol. 8, no. 12, Dec. 1918, pp. 303-304, 4 figs. Definitions of terms used in ship's measurements.

Train Ferries

Description of the New C.N.R. Car Ferry "Canora." Mar. Eng. Can., vol. 8, no. 12, Dec. 1918, pp. 301-302, 3 figs. General design and accommodations. Main propelling machinery consists of a four-cylinder triple-expansion surface-condensing engine balanced on Yarrow, Schlick & Tweedy system.

The English Channel Train Ferry. Ry. Age, vol. 66, no. 9, Feb. 28, 1919, pp. 509-510, 3 figs. Brief notice of the Richborough ferry.

Warships

New British Warships, Engineer, vol. 127, no. 3291, Jan. 24, 1919, pp. 71-72, 9 figs. General description of recent British craft, such as Repulse, Renown, Furious, Courageous, Glorious, Ramillies, Warspite, Erin, and Argincourt.

Water Ballast

Improvements in the Construction of Ships, E. F. Spanner. Shipbuilding & Shipping Rec., vol. 13, no. 2, Jan. 9, 1919, pp. 44-46, 3 figs. System of dealing with water ballast by means of a duct keel. Abstract of paper before Instn. Engrs. & Shipbuilders in Scotland.

Wooden Ship

A Successful Type of Wooden Ship, J. B. C. Lockwood. Pacific Marine Rev., vol. 16, no. 1, Jan. 1919, pp. 86-88, 4 figs. Survey of objections against wooden ships and comparison of various designs built by different companies.

YARDS

British Production

Shipbuilding and Engineering Output. Shipbuilding & Shipping Rec., vol. 13, no. 1, Jan. 2, 1919, pp. 15-16. Records of vessels launched at British yards during 1918.

Equipment

Time Saving in Steel Ship Construction, J. H. Anderson. Jl. Engrs. Club Phila., vol. 35-10, no. 167, Oct. 1918, pp. 467-471, 29 figs. Interests affected by application, status of spot-welding in reference to shipbuilding equipment and distribution systems. Third discussion under auspices U. S. Shipping Board Emergency Fleet Corporation.

Fabricating Plants

Inland Ship-Steel Fabricating Plants of the Emergency Fleet Corporation, Leyburn G. Fishbach. Eng. News-Rec., vol. 82, no. 7, Feb. 13, 1919, pp. 332-336, 6 figs. Shops at Pottstown and Leetsdale for fabricating Hog Island material, designed to produce 10,000 tons per month each.

Launching

Novel Method of Building and Launching, J. H. Rogers. Mar. Eng. Can., vol. 8, no. 12, Dec. 1918, pp. 305-307, 4 figs. Arrangement of transfer tables and launching trucks at Can. Car & Foundry Co. whose launching dock is 1400 ft. from building ways.

Planning Control

Planning Control—Applied to the Building of Duplicated Steel Vessels, D. V. Stratton. Pacific Marine Rev., vol. 6, no. 1, Jan. 1919, pp. 107-110, 1 fig. Development work along management lines of Todd Dry Dock & Construction Corporation, Tacoma, Wash.

Steel Castings

Steel Castings Used in Ship Construction, Ben Shaw and James Edgar. Can. Foundryman, vol. 10, no. 2, Feb. 1919, pp. 34-38, 26 figs. Pattern making, moulding and pouring of steel castings intended to replace forgings in construction of ships.

Terminal Sheds

The Marine Terminal Shed, H. McL. Harding. Pacific Marine Rev., vol. 16, no. 1, Jan. 1919, pp. 123-124, 1 fig. Suggestions in regard to construction and equipment.

Thornycroft Works

Messrs. Thornycrofts' Basingstoke Works. Engineering, vol. 107, no. 2768, Jan. 17, 1919, pp. 76-79, 10 figs. Illustrated description of works and equipment.

Welding

The Difficulties of Welding Steel by the Oxy-Acetylene Process, B. K. Smith. Mech. World, vol. 64, no. 1668, Dec. 20, 1918, pp. 297-298. Abstract of paper before North-Western Welding Assn.

The Application of Electric Welding to Ship Construction. Shipbuilding & Shipping Rec., vol. 13, no. 1, Jan. 2, 1919, pp. 5-6. Method adopted by British Admiralty in electric welding of watertight joints for ship structures and oil tanks subjected to heavy stresses.

Welding as a Process in Ship Construction, S. V. Goodall. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 3, Mar. 1919, pp. 329-335. Review of what has been done in substituting welding for riveting in shipbuilding. Writer's opinion concerning general adoption of welding.

Organization and Management

ACCOUNTING

Graphical Analysis

Graphical Analysis of Accounting, Walter E. Gaby. Min. & Sci. Press, vol. 118, no. 8, Feb. 22, 1919, p. 260, 1 fig. Proposes scheme of representing in form of flow sheet the elements of double-entry bookkeeping.

See also ORGANIZATION AND MANAGEMENT, Finance and Cost (Cost Accounting).

EDUCATION

Crippled Workmen

Cut Metal Trade's Disability Costs, Douglas C. McMurtrie. Iron Trade Rev., vol. 64, no. 7, Feb. 13, 1919, pp. 445-446. Work of Red Cross Inst. for reëducation of crippled and disabled men, New York City.

Re-education vs. Disability Compensation, Douglas C. McMurtrie. Am. Mach., vol. 50, no. 9, Feb. 27, 1919, pp. 405-406. A plea for the re-education of the disabled worker rather than the pension and his neglect.

Disabled Soldiers and Sailors, Douglas C. McMurtrie. Salt Lake Min. Rev., vol. 20, no. 21, Feb. 15, 1919, pp. 29-30. Work of reëducation at Red Cross Inst. for Crippled and Disabled Men, New York City.

L'Hôtel des Invalides, at Avignon, Jules Véran. Am. Jl. Care for Cripples, vol. 7, no. 2, pp. 139-141. Discusses establishment of institution for war cripples. Translated from Revue Interallieé pour l'Etude des Questions intéressant les Mutilés de la Guerre, vol. 1, pp. 285-289.

Placement of Disabled American Soldiers and Sailors; Agreement Between Federal Board for Vocational Education and United States Employment Service. Am. Jl. of Care for Cripples, vol. 7, no. 2, 1918, pp. 154-156.

The Problem of the Discharged Disabled Man, H. H. C. Baird. Am. Jl. of Care for Cripples, vol. 7, no. 7, 1918, pp. 117-125. Insufficiency of present means of readaptation; conditions resulting from public indifference. From Outlook.

A Record of Practical Experience in Retraining Crippled Ex-Service Men, A. G. Baker. Am. Jl. of Care for Cripples, vol. 7, no. 7, 1918, pp. 109-111. Notes of the Superintendent, Pavilion Military Hospital, Brighton, England.

Re-Education from the Point of View of the Disabled Soldier, Grace S. Harper. Am. Jl. of Care for Cripples, vol. 7, no. 2, 1918, pp. 85-87. Translated from Revue Interalliée pour l'Etude des Questions interessant les Mutilés de la Guerre, vol. 1, 1918, pp. 254-258.

Should Disabled Men be Re-Educated in Special Schools? L. Alleman. Am. Jl. of Care for Cripples, vol. 7, no. 7, 1918, pp. 100-104 Translated from French address to Inter-Allied Conference on the After-Care of Disabled Men. (Reports pp. 171-178.)

Social Responsibilities in the Rehabilitation of Disabled Soldiers and Sailors, Douglas C. McMurtrie. Am. Jl. of Care for Cripples, vol. 7, no. 7, 1918, pp. 126-132. Duties of the family, of the employer, and of the general public. From Medical Rev.

So Comes the Sacred Work, John Galsworthy. Am. Jl. of Care for Cripples, vol. 7, no. 7, 1918, pp. 88-91. Extent of reëducation work the nations will have to undertake.

The Training of the Disabled South African Soldier and Its Lesson, E. N. Thornton. Am. Jl. of Care for Cripples, vol. 7, no. 7, 1918, pp. 105-108, 4 figs. Paper at Inter-Allied Conference on Disablement Problems Arising out of the War.

The Vocational Rehabilitation Act. Am. Jl. of Care for Cripples, vol. 7, no. 2, 1918, pp. 142-144 Text of measure as signed by President Wilson.

The Vocational School for Disabled Soldiers at Nantes, France, Emmanuel Chastand. Am. Jl. of Care for Cripples, vol. 7, no. 7, 1918, pp. 92-99, 8 figs. Claims that experience has shown that reëducational school which comprises shops, classrooms, dormitories, and dining rooms is best agency for refitting for work disabled soldiers; training in private shop is considered as ineffective.

What the Employers of America Can Do for the Disabled Soldiers and Sailors. Jl. Acetylene Welding, vol. 2, no. 8, Feb. 1919, pp. 381-384 and 398. Coöperation the oxy-acetylene industry can offer. Vocational rehabilitation series no. 3 of Federal Board for Vocational Education.

Education and Democracy

Industry, Democracy and Education, C. V. Corless. Bul. Can. Min. Inst., no. 83, Mar. 1919, pp. 257-272. Address at joint session Am. Inst. Min. Engrs. and Can. Min. Inst.

Navy Machinists

How the Navy Trains its Machinists Ashore, Willard Connely. Am. Mach., vol. 50, no. 9, Feb. 27, 1919, pp. 397-400, 6 figs. Training comprises courses in machine work, pattern making, molding, blacksmithing, sheet-metal working, oxyacetylene welding, boat building and gasoline-engine construction and repair.

Research Work by Students

Reforms in the Technical Engineering Education (Ideas sobre la reforma de la ensenanza tecnica), Ramon Salas Edwards. Anales del Instituto de Ingenieros de Chile, vol. 18, no. 9, Sept. 1918, pp. 388-395. Concerning personal research work by engineering students.

Students in Coal Mining

The Training of Students in Coal Mining, Engineering Training Organization, F. W. Hardwick. Tran. Instn. Min. Engrs., vol. 56, part 2, Dec. 1918, pp. 94-100, and (discussion) pp. 119-126. Lays emphasis on practical training of students at collieries.

Training Department, Aircraft Factory

Installing a Training Department, James W. Russell. Indus. Man., vol. 57, no. 3, March, 1919, pp. 177-182, 10 figs. Descriptive of the school for training 400 women weekly for a variety of positions, including clerical, metal-working, wood-working and drafting occupations at the Buffalo factory of the Curtiss Aeroplane & Motor Corporation.

EXPORT

Foreign Plant Construction

Americans Build Foreign Plants, V. G. Iden. Iron Trade Rev., vol. 64, no. 8, Feb. 20, 1919, pp. 509-513. Discusses opportunities for American enterprises and capital.

FACTORY MANAGEMENT

Department Heads

Executive Common Sense in the Workshop, Abe Winters. Can. Machy., vol. 21, no. 7, Feb. 13, 1919, pp. 157-159. Circular letter to department heads of Standard Oil Co. Also in Can. Foundryman, vol. 10, no. 2, Feb. 1919, pp. 46-48.

Employment Management

Handbook on Employment Management in the Shipyard. Bulletin II. The Employment Building. U. S. Shipping Board Emergency Fleet Corporation, Employment Management Branch, Oct. 1918, 29 pp. 4 figs. General requirement of employment building; recommended plans for employment buildings.

Hiring Methods

Selecting Employees. Natural Gas & Gasoline Jl., vol. 13, no. 2, Feb. 1919, pp. 65-68. Method of Laclede Gas Light Co. Applicant appears separately before five examiners who test him and draw reports on appearance, mentality, native ability, mental alertness and past record, respectively.

Industrial Laws

Managing for Maximum Production, L. V. Estes. Indus. Man., vol. 57, no. 3, March 1, 1919, pp. 169-175, 5 figs. Principles and laws in industry. First of a series of articles.

Labor Saving

Plant for War and Peace. Times Eng. Supp., year 15, no. 531, Jan. 1919, pp. 2-3. Concerning saving of labor.

Labor-Saving Devices

Labor-Saving Devices, George Frederick Zimmer. Eng. Rev., vol. 32, no. 7, Jan. 15, 1919, pp. 189-191. Relative advantages and possibilities of mechanical means for handling.

Management of Employees

Developing Ambition and Confidence in Employees, George Wehrle. Gas Age, vol. 43, no. 3, Feb. 1, 1919, pp. 129-131. Suggestions to general managers of gas works.

Mental Tests

Mental Tests in Industry, Robert M. Yerkes. Bul. Am. Inst. Min. Engrs., no. 146, Feb. 1919, pp. 405-419, 16 figs. Brief account of methods for measuring intelligence prepared for use in U. S. Army, of typical results, and of their practical applications.

Office-Building Management

Building Manager and Chief Engineer, Edward H. Kearney. Nat. Engr., vol. 23, no. 2, Feb. 1919, pp. 57-59. Incidents in daily routine of managing an office building; importance of engineering and cleaning departments.

Purchasing

Method of Purchase Expediting, Harry M. Sutton. Indus. Man., vol. 57, no. 3, March 1919, pp. 230-231, 2 figs. Chart intended to eliminate delay.

Standardization of Methods

The Control of Methods, Processes and Materials in a Manufacturing Plant, H. L. Campbell. Proc. Steel Treating Research Soc., vol. 2, no. 2, 1919, pp. 20-31, 2 figs. Way in which a research department assisted in improvement and standardization of methods, processes and material used in a manufacturing plant.

Stock Room

The Storage of Electric Supplies. Jl. Electricity, vol. 42, no. 4, Feb. 15, 1919, pp. 161-162, 3 figs. General description of office and warehouse of wholesale firm.

Toolroom Organization

Modern Tool Room Organization. Machinery, vol. 13, no. 331, Jan. 30, 1919, pp. 477-479, 7 figs. Scheme for recording and costing jigs and fixtures.

See also MECHANICAL ENGINEERING, Handling of Materials.

FINANCE AND COST

Cost Accounting

Cost Accounting to Aid Production, G. Charter Harrison. Indus. Man., vol. 57, no. 3, March 1919, pp. 218-224, 3 figs. Importance of deliberation in introducing changes.

Equipment and Maintenance Factors in Cost Accounting During Transition Period, L. W. Alwyn-Schmidt. Am. Mach., vol. 50, no. 8, Feb. 20, 1919, pp. 366-368. Book value of equipment; readjustment equipment for new work; revaluation of all equipment recommended; charges for depreciation; how can each job be apportioned?

Fundamentals of a Uniform Cost Accounting System, G. A. Schonlau. Eng. World, vol. 14, no. 4, Feb. 15, 1919, pp. 58-60. General remarks on standardization and discussion of accounting method for manufacturers of concrete pipe and tile. From Proc. Am. Concrete Pipe Assn.

Costing

Accurate Costing in Engineering. Eng. Rev., vol. 32, no. 7, Jan. 15, 1919, pp. 187-188. Selection of proper standard of value is given as first step in scheme for preparing standard cost system.

Costing and Labor

The Workers' Interest in Costing, M. Webster Jenkinson. Iron & Coal Trades Rev., vol. 98, no. 2657, Jan. 31, 1919, pp. 127-130. Attainment of efficiency and progress through taking workers in confidence of management. From paper before Conference of Indus. Reconstruction Council.

INSPECTION

See Design (Inspection) under AERONAUTICS.

LABOR

Contract and Bonus Systems

Day Labor, Force Account Work and Bonuses on Highway Construction, Charles M. Upham. Mun. & County Eng., vol. 56, no. 1, Jan. 1919, pp. 31-33. Pronounces contract system more economical than day labor and discusses advantages of bonus system.

Contract vs. Day Labor

Performing Municipal Construction Work by Day Labor in Flint, Michigan, Ezra C. Showcraft. Mun. & County Eng., vol. 56, no. 2, Feb. 1919, pp. 66-67. Volume of day labor; contract vs. day-labor system; opinion as to success.

Construction Projects

City and County Engineers Write of Construction Projects Planned to Provide Buffer Employment for Labor During Readjustment Period. Mun. & County Eng., vol. 56, no. 2, Feb. 1919, pp. 37-46. Reports from 57 engineers.

Distribution of Labor

Distribution of Labor. Times Eng. Supp., year 15, 531, Jan. 1919, pp. 3-4. Discussed from viewpoints of work, skill and direction

Employee Representation

Steel Plant Industrial Relations Studied Blast Furnace, vol. 7, no. 2, Feb. 1919, pp 101-104 and 118. Plan developed and in us by a company, whereby elected employee rep resentatives meet and discuss problems o management and welfare.

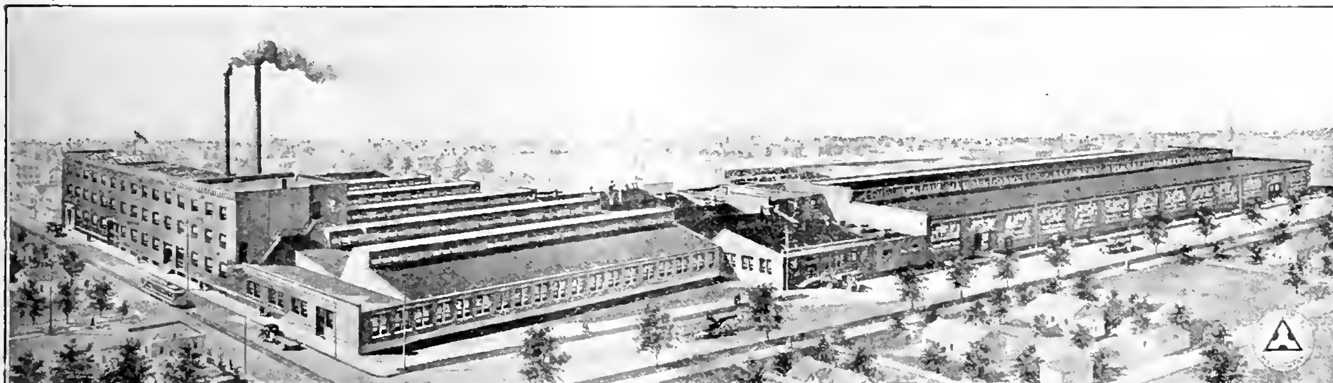
Let Us Do Your Special Work

All Firms have Work that they are not Prepared to Handle

Special and Experimental Work that must be done with speed and accuracy; but lack of room, limited time and the purchase of extra equipment make this class of work troublesome and profitless.

Quantity Production Work means additional equipment, and additional equipment means added space and extra help. Our adequate facilities for this work will reduce your costs and increase your profits.

Save time and money by letting S. A. S. Laboratories, an organization of experts and modern methods, do this work for you.



SLOCUM, AVRAM & SLOCUM LABORATORIES, INC.
NEWARK, N. J.

The Plant That is Ready to Serve You

The Slocum, Avram & Slocum plant, now in its fourth year, has earned its notable position by a successfully maintained policy of accuracy and high quality at a fair price. It has attained a foremost standing in its field, by superior workmanship, by excellence of mechanical design, and by certainty of delivery. A modern plant with up-to-the-minute equipment—every employee a specialist—backed by an unusually wide experience in special work.

It will pay you to try us on your special requirements —to learn what we can do for you—to get our prices

This is the first of a series of advertisements that will show you our plant, our methods and he work we do. Watch for them.

LET US BUILD YOUR SPECIAL MACHINES

SLOCUM, AVRAM & SLOCUM LABORATORIES, Inc.

Factory
NEWARK, N. J.

New York Office
30 PINE ST., N. Y.

SLOCUM-AVRAM-SLOCUM MANAGEMENT

IT WILL BE RIGHT IF WE BUILD IT

Hours of Work

The Eight Hour Day Defined. Nat. Indus. Conference Board, Research report no. 11, Nov. 1918, 9 pp. Comparison and analysis of different senses in which word is used and of principles on which demands for each type of a so-called 8-hr. day are based. Also in Eng. & Min. Jl., vol. 107, no. 6, Feb. 8, 1919, pp. 271-273.

Hours of Work as Related to Output and Health of Workers. Wool Manufacturing. Nat. Indus. Conference Board, Research Report no. 12, Dec. 1918, 69 pp. Based upon data gathered by means of schedules of inquiries addressed to members of Nat. Assn. Wool Mfrs., and to other wool manufacturers, and by field investigation.

Shorter Hours. Times Eng. Supp., year 15, no. 531, Jan. 1919, pp. 5 and 7. Expected effects on output.

Housing

The Group House—Its Advantages and Possibilities, Richard Henry Dana. Am. Architect, vol. 115, no. 2249, Jan. 29, 1919, pp. 163-165. Address delivered at Annual Conference of Housings in America.

Housing Construction at Craddock. Mun. Jl., vol. 46, no. 4, Jan. 25, 1919, pp. 61-63, 4 figs. Project to provide homes for 5,000 workers. Central concrete plant serving entire project.

Industrial Fatigue

Reducing Industrial Fatigue. Automotive Industries, vol. 40, no. 4, Jan. 23, 1919, pp. 219-221. Suggestions of Divisional Committee on Industrial Fatigue of Division of Scientific Research, U. S. Public Health Service.

Industrial Relations

Improving Relations of Employer and Employee, Elec. Wld., vol. 73, no. 9, March 1, 1919, pp. 418-419. Discussion by Richard H. Rice of ways to bring about a closer and better relationship between employees and the industry.

Labor Agreements

The 47-Hour Week and 8-Hour Day. Ry. Gaz., vol. 30, no. 2, Jan. 19, 1919, p. 40. Terms of understanding arrived at between representatives of Engineering and Nat. Employers' Federations, Shipbuilding Employers' Federation, and Amalgamated Soc. Engrs. and Unions Affiliated to Eng. and Shipbuilding Trades and Federations.

Labor Conditions in 1917

Labour Conditions in 1917. S. A. Jl. Industries, vol. 1, no. 15, Nov. 1918, pp. 1426-1433. Abstract of annual report for 1917 of superintendent and chief inspector of white labor union of South Africa.

Labor Conditions in 1918

A Review of the Labor Conditions of 1918. Ry. Maintenance Engr., vol. 15, no. 2, Feb. 1919, pp. 63-65. Measures introduced to secure help on account of shortage of employees.

Labor Market

The Labor Market. New York State Indus. Commission Bul., vol. 4, no. 5, Feb. 1919, pp. 98-99. Employment in N. Y. State factories in Jan. 1919; wages and cost of living in Dec. 1918.

Labor Outlook

The Labor Outlook for the Coming Year, Hugh Reid. Ry. Maintenance Engr., vol. 15, no. 2, Feb. 1919, pp. 43-45. Past and present conditions in relation to future prospects; influence of federal supervision.

Outlook for Labor Generally Improved. Ry. Maintenance Engr., vol. 15, no. 2, Feb. 1919, pp. 68-70. Review of situation in various parts of the country during 1918, and discussion of 1919 prospects.

Productivity of Labor

The Principles of Employing Labor, E. H. Fish. Indus. Man., vol. 57, no. 3, March 1919, pp. 203-207. The author points out two ways of increasing the amount of labor effort in industry; bring out labor that has retired; increase the productive work of each individual employed.

Profit Sharing

How Valuable Are Profit-Sharing Plans? Harry Tipper. Automotive Industries, vol. 40, no. 4, Jan. 23, 1919, pp. 209-210. Claims that any system which attempts to satisfy the physical necessities of the worker without increasing his responsibility must fail.

Rest Periods

Rest Periods for Industrial Workers. Safety Eng., vol. 37, no. 2, Feb. 1919, pp. 77-78. Investigation by Nat. Indus. Conference Board.

Social Surroundings of Labor

Social Surroundings Have Important Bearing on All Labor Questions, Harry Tipper. Automotive Industries, vol. 40, no. 7, Feb. 13, 1919, pp. 366-367. Points out that comfort and home life of worker will modify extent and acuteness of unrest and migration.

Soldier Apprentices

Soldier Apprentices. Times Eng. Supp., year 15, no. 531, Jan. 1919, p. 9. Scheme of state assistance.

Trade Unions

Trade Unions and Production. Times Eng. Supp., year 15, no. 531, Jan. 1919, pp. 4-5. Reports engineers express view that trade unions have not helped production in past and are not likely to help it in future.

Unemployment Statistics

Unemployment Figures Mere Guess. Iron Trade Rev., vol. 64, no. 9, Feb. 27, 1919, pp. 580-584, 1 fig. Claims figures of Federal Employment Service on unemployment are inaccurate.

Wages and Cost of Living

Salaries and the High Cost of Living (Les salaries et la vie chère). Revue Générale de l'Electricité, vol. 5, no. 6, Feb. 8, 1919, pp. 235-236. Proposes increase of salaries on pro rata basis of percentage of increase in price of principal commodities. From Moniteur des Intérêts matériels, Jan. 8, 1919.

Welfare Work

Welfare Work Among Maintenance Men. Ry. Maintenance Engr., vol. 15, no. 2, Feb. 1919, pp. 40-42, 6 figs. Pennsylvania Railroad's educational courses and camps.

Women

Employment of Women Workers in Our Industries. Gas Age, vol. 43, no. 3, Feb. 1, 1919, pp. 123-128, 7 figs. Standards for employment of women issued by U. S. Dept. of Labor; costumes in England and America; experiences of gas companies.

What Women Earn at Work. New York State Indus. Commission Bul., vol. 4, no. 5, Feb. 1919, p. 83. Data and figures compiled by Bureau of Statistics.

Women Can Handle Exacting Work, J. Edward Schipper. Automotive Industries, vol. 40, no. 5, Jan. 30, 1919, pp. 266-267, 2 figs. Experiences of some manufacturers concerning adaptability of female labor.

Women in Electrical Industry. Safety Eng., vol. 37, no. 2, Feb. 1919, pp. 67-73, 12 figs. Working conditions at Westinghouse plant where 4000 women are employed.

Organization and Management

Women in Industry, Their Work and Their Health, Samuel Semple. Safety Eng., vol. 37, no. 1, Jan. 1919, pp. 17-19. Social effects of employment of women. From Proc. Seventh Annual Safety Congress.

Working Conditions

Works Life. Times Eng. Supp., year 15, no. 531, Jan. 1919, pp. 7-8. Discusses influences affecting workers personally.

Workmen's Compensation

Workmen's Compensation Legislation of the United States and Foreign Countries, 1917 and 1918. U. S. Dept. of Labor, Bur. of Labor Statistics, Workmen's Insurance and Compensation Series, no. 243, Sept. 1918, 477 pp. Enactments, new and amendatory, made by the State legislatures during 1917 and up to July 1918. Some changes in foreign legislation are also noted.

LEGAL

Compensation Acts

The "Coverage" of the Compensation Acts, Chesla C. Sherlock, Am. Mach., vol. 50, nos. 7 and 8, Feb. 13 and Feb. 20, 1919, pp. 319-321 and pp. 354-356. Second and third article. Second article establishes who are employees and when they are entitled to compensation, with an incursion into question of dependents and when they come under protection of compensation laws. Third article makes distinction between accidents occurring "out of" and "in course of" employment and at other times technically construed by citations from American and English courts.

Joint Sales Agencies

Legality of Joint Sales Agencies, A. L. H. Street. Coal Age, vol. 15, no. 9, Feb. 27, 1919, pp. 404-405. Court decisions concerning propriety of forming a pool for sale of members' products. Coal and fuel companies have been involved in cases quoted.

Tools, Laws on Use of

The Law Relating to the Use of Tools, Chesla C. Sherlock. Iron Age, vol. 103, no. 7, Feb. 13, 1919, pp. 427-428. Rule of simple tool and its application; employer's duty of inspection limited; important exceptions.

LIGHTING

Economic Aspects

Economic Aspects of Industrial Lighting, C. E. Clewell. Elec. World, vol. 73, no. 8, Feb. 22, 1919, pp. 371-374, 7 figs. Cost vs. wages; increased production and greater accuracy in workmanship; less eye strain; stimulating effect; comfort of workmen; more neatness.

Office

Modern Office Lighting, A. L. Powell. Elec. World, vol. 73, no. 7, Feb. 15, 1919, pp. 316-320, 4 figs. Lighting system for new office building of Edison Lamp Works was designed by illuminating engineers in advance of construction period; extensive tests indicate importance of careful maintenance of fixtures and walls.

PUBLIC REGULATION

Price Regulation

Gas Coke Price Escapes Regulation in Germany. Gas Age, vol. 43, no. 3, Feb. 1, 1919, pp. 140-142. Upon profiteering under wartime conditions. From Journal für Gasbeleuchtung.

Railways, Electric

The Trend of Regulation. Aera, vol. 7, no. 7, Feb. 1919, pp. 677-684. Discussions and opinions of courts and commissions concerning electric railways.

Rates

Rate Adjustment, Valuations, and Some of the Problems Incident Thereto, G. M. Garland. Mun. & County Eng., vol. 56, no. 2, Feb. 1919, pp. 74-76. Situation likely to arise in operation and management of public utilities by reason of general opinion.

Utility Valuation

Need of a Revised Principle of Utility Valuation, Robert L. Hale. Gas Age, vol. 43, no. 3, Feb. 1, 1919, pp. 137-139. Discusses decisions of Wis. R. R. Commission.

Water Power, Canada

Water-Power Administration in Canada, H. W. Grunsky. Can. Engr., vol. 36, no. 7, Feb. 13, 1919, pp. 209-211. Summary of existing laws, regulations and practices in Quebec, Ontario, Prairies Provinces and Territories, and British Columbia.

See also AERONAUTICS, *Applications (Regulation).*

RECONSTRUCTION

Automotive Industry, England

European Expansion Under War Pressure—I and II, David Beecroft. Automotive Industries, vol. 40, nos. 7 and 8, Feb. 13 and Feb. 20, 1919, pp. 345-348 and 403-406. Developments in factory enlargement, features of electric starting and lighting. Problem of reorganization of industry on peace basis.

British Views

The Return to Civil Industry. Problems of Engineering Production. Times Eng. Supp., year 15, no. 531, Jan. 1919, pp. 1-2. Views of leading manufacturers.

Canadian Organization

Canada Organizing for Vast Trade. Iron Trade Rev., vol. 64, no. 7, Feb. 13, 1919, p. 453. List of commodities for which there is an immediate market in Belgium, prepared by Can. Mfrs.' Assn.

Cooperation

Coöperation Vital in Reconstruction. Iron Trade Rev., vol. 64, no. 6, Feb. 6, 1919, pp. 381-382. British business leaders declared, at London meeting held jointly with American business paper editors, that new tasks cannot be accomplished unless capital and labor continue teamwork as during war.

Peace Problems Demand Coöperation, G. W. Thompson. Chem. Engr., vol. 27, no. 2, Feb. 1919, pp. 43-44 and 48. Suggests that chemical industries, by means of Webb law, open price associations and through greater coöperation prepare themselves to meet foreign competition and internal conditions.

Engineering Forecast

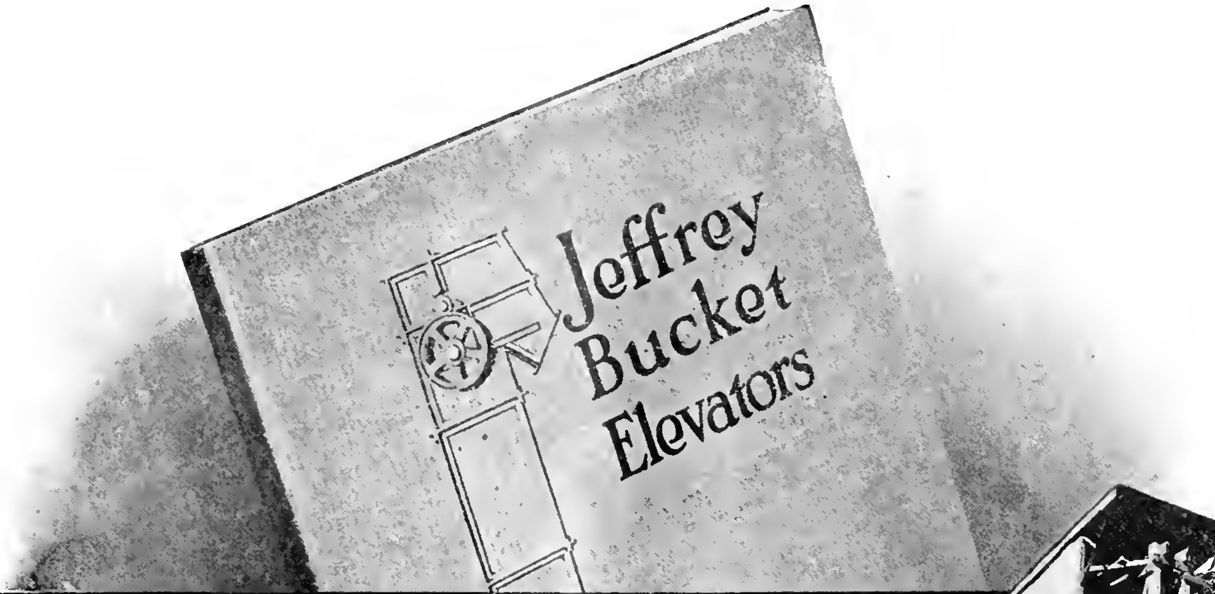
Engineering and Industrial Forecast, W. T. Christine. Eng. World, vol. 14, no. 2, Jan. 15, 1919, pp. 55-57. Writer's opinion concerning opportunities for profitable business.

France

Economic Organization of the Country After the War (L'organisation économique du pays après la guerre). Echo des Mines et de la Metallurgie, vol. 47, no. 2613, Feb. 16, 1919, pp. 108-110. Report of commission appointed by French senate.

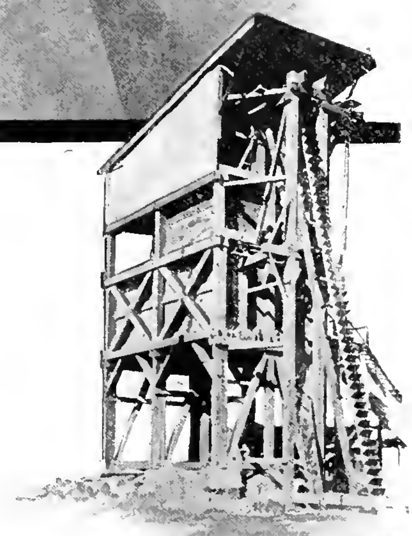
Engineering conditions in France. Mech. Eng., vol. 41, no. 3, Mar. 1919, pp. 262-264. Expressions from American engineer-delegates to conference with French engineers on reconstruction problems.

The Rebuilding of Devastated France, John V. Schaefer. Eng. World, vol. 14, no. 2,



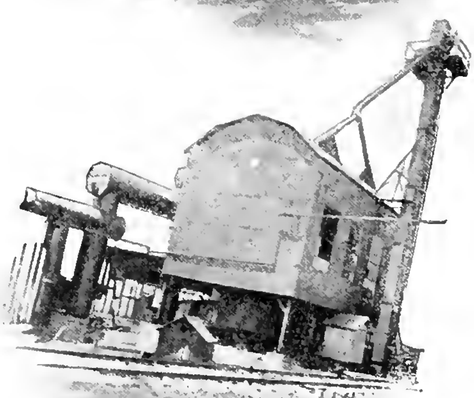
A Valuable Book for

Engineers — Contractors Manufacturers



The outstanding feature of the new Jeffrey Catalog is the ease with which a Jeffrey Standard Elevator can be selected from the 40 pages of complete layouts, and specifications to exactly meet your requirements.

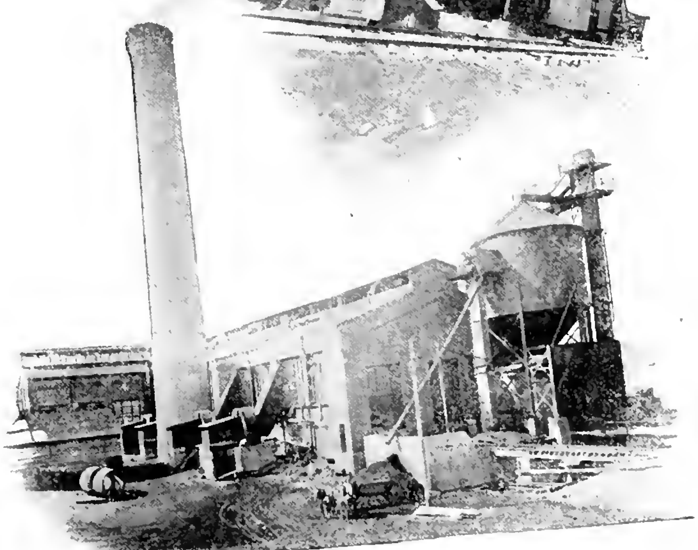
In addition to saving the expense of layouts and drawings, the purchaser is benefited by a quicker delivery made possible by the placing of Jeffrey Standard Elevators upon a manufacturing basis.



Some of the Examples and Subjects Outlined in this Book

Capacity of Jeffrey Standard Elevators
How to select a Jeffrey Standard Elevator
Jeffrey Standard Steel Casings
General arrangement of Standard Trackhoppers with line drawings giving dimensions
Suggestions for installation of Jeffrey Standard Elevators with line drawings

Write TODAY for copy of Catalog No. 244-F.



The Jeffrey Mfg. Co.

904 North Fourth Street
Columbus, Ohio

Handle it Mechanically

Jan. 15, 1919, pp. 56-58. Exposition of suggestions that have been offered in regard to the coöperation of U. S. Government with French Government.

Government Sales Plan

Government's Sales Plan Outlined. Iron Trade Rev., vol. 64, no. 6, Feb. 6, 1919, p. 389. Disposal of surplus war products to be effected through coöperation between War Dept.'s sales division and U. S. Chamber of Commerce.

Philadelphia

Reconstruction in Philadelphia After the War, Albert N. Hogg. Jl. Engrs.' Club Phila., vol. 35-12, no. 169, Dec. 1918, pp. 553,554. Declares need for a better knowledge of business methods on the part of engineers.

Public Utilities

Maintenance of Public Utility Plants, Robert J. Thomas. Mun. & County Eng., vol. 56, no. 1, Jan. 1919, pp. 14-15. Effect of war conditions.

Selling Prices

Business Dividend on Redfield Plan. Iron Trade Rev., vol. 64, no. 8, Feb. 20, 1919, pp. 495-496. Opinions concerning practicability of plans suggesting prices for basic commodities.

Proper Joint Plan to Lower Prices. Iron Trade Rev., vol. 64, no. 7, Feb. 13, 1919, pp. 456-457. Secretary Redfield's plan to determine fair selling prices in basic industries without lowering wages.

SAFETY ENGINEERING

Cooperation in Accident Prevention

Pull Together to Decrease Accidents, E. B. Van Doren. Elec. World, vol. 73, no. 8, Feb. 22, 1919, pp. 368-369, 3 figs. Coöperation between employer and employee to increase production and efficiency and reduce accidents; safety welfare committees should encourage suggestions.

Education of Workers

Foundry Management from Standpoint of Accident Prevention, G. A. Hart. Safety Eng., vol. 37, no. 1, Jan. 1919, pp. 12-13. Remarks on education of workers concerning safety methods and precautions. From Proc. Seventh Annual Safety Congress.

Employment

Scientific Employment and Its Relation to Accident Prevention, R. W. Immel. Safety Eng., vol. 37, no. 2, Feb. 1919, pp. 75-76. Suggests character analysis and allocation of individuals to work which they can adequately and safely perform.

Fire-Alarm Systems

Central Fire Alarm Station of San Francisco. Elec. Rev., vol. 74, no. 8, Feb. 22, 1919, pp. 291-294, 7 figs. Unusually complete equipment; special provision to insure reliability of power supply and interchangeability of circuits; method of operating.

Fire Prevention and Fighting

Extinguishing and Preventing Oil and Gas Fires, C. P. Bowie. Dept. of Interior, Bur. of Mine, bul. 170, Petroleum Technology 48, 50 pp., 4 figs. Points out what has been done by operators in the past, and describes various fire-prevention methods and fire-fighting apparatus.

Safety Organization

Safety, Sanitation and Welfare. Safety Eng., vol. 37, no. 2, Feb. 1919, pp. 53-58, 2 figs. Safety organization of U. S. Steel Corporation.

Shipyard Sanitation

Sanitation in Emergency Shipyards, W. L. Stevenson, vol. 6, no. 1, Jan. 1919, pp. 1-18, 8 figs. Work of Department of Health and Sanitation of U. S. Shipping Board.

See also MINING ENGINEERING, Mines and Mining (Health Control), (Safety Devices); MECHANICAL ENGINEERING, Power Plants (Safety); RAILROAD ENGINEERING, Shops (Safety Devices).

SALVAGE

Creamery Wastes

Treatment and Disposal of Creamery Wastes, Earle B. Phelps. Mun. Jl., vol. 46, no. 4, Jan. 25, 1919, pp. 68-70, 1 figs. Settling tank and sand bed designed and tested by U. S. Public Health Service. From Public Health Reports.

Metal-Waste Reclamation

Reclamation of Waste to Be Extended. Iron Trade Rev., vol. 44, no. 3, Jan. 16, 1919, pp. 220-221. Estimates on reclamation of metals by new division of Dept. of Commerce on waste reclamation service.

Salvage Organization

Scientific Salvage, H. N. Sessions. Jl. Electricity, vol. 42, no. 3, Feb. 1, 1919, pp. 105-107, 2 figs. How the Southern Cal. Edison Co. directs its salvage work.

Scrap Business

Huge Loss of Steel Brings Problem, G. H. Manlove. Iron Trade Rev., vol. 64, no. 6, Feb. 6, 1919, pp. 371-375, 6 figs. Claims that obliteration of millions of tons of American material on foreign battlefields disrupts normal cycle of scrap recovery.

Waste Prevention

Conservation of Material by the Store Department, J. G. Stuart. Ry. Age, vol. 66, no. 9, Feb. 1919, pp. 497-500. Care in ordering and handling to prevent waste; systematic methods needed in reclamation. From a paper before the Railway Storekeepers' Association, January, 1919.

Waste Utilization

Instructive Examples of Utilizing Industrial Wastes, H. E. Howe. Indus. Man., vol. 57, no. 3, March, 1919, pp. 225-229. To illustrate the importance of reclaiming and utilizing wastes in industries article quotes a number of examples.

Salvaging Miscellaneous Wastes, W. R. Conover. Gen. Elec. Rev., vol. 22, no. 2, Feb. 1919, pp. 127-133. Deals with such wastes as cables, slings, belting, paper, lumber by-products, oils, power, heat and light.

TRANSPORTATION

Coal Transportation, India

The Carriage of Coal by Rail in India, H. Kelway-Bamber. Jl. Royal Soc. of Arts, vol. 67, no. 3454, Jan. 1919, pp. 150-161 and (discussion) pp. 161-164, 6 figs. Review of past development in the Indian coal output; forecast of future coal consumption; suggestions for reducing cost of coal transportation.

Transatlantic Rates

West Blocked on Orient Shipments. Iron Trade Rev., vol. 64, no. 7, Feb. 13, 1919, p. 455. Claims that transatlantic rail rates leave advantage with Atlantic ports by canal route.

See also MINING ENGINEERING, Mines and Mining (Transportation).

VARIA

Economic Duties of Engineers

The Economic Duties of the Engineer, W. R. Ingalls. Eng. & Contracting, vol. 51, no. 8, Feb. 19, 1919, pp. 193-194. From presidential address before Mining and Metallurgical Soc. of America, Jan. 1919.

Filing Systems

Uniform Filing System, C. C. Hogan. Jl. Electricity, vol. 42, no. 4, Feb. 15, 1919, pp. 170-172. Based on Dewey decimal system.

Hand for Cripples

A Compressed Air Actuated Hand for Crippled Soldiers (Die Pressluft-Hand fuer Kriegsbeschaedigte Industrie Arbeiter), W. Dahlheim. Zeitschrift fuer Komprimierte und Fluessige Gase, vol. 19, no. 2, 1917, pp. 18-19, 1 fig. Togglejoint actuated by compressed air piston, to replace the natural hand, enabling the workman to perform practically all machine shop operations, including filing. Light, simple, inexpensive.

Land Settlement

The Present Status of Land Settlement Activities for Ex-Service Men in Great Britain. Hilda A. Fox. Am. Jl. of Care for Cripples, vol. 7, no. 2, 1918, pp. 133-138. List and activities of a number of organizations, voluntary and otherwise, working for this object.

Occupational Therapy

Occupational Therapy in Military Hospitals, James E. Russell. Am. Jl. of Care for Cripples, vol. 7, no. 7, 1918, pp. 112-116. Situation at War Department. Address before Nat. Soc. for Promotion of Occupational Therapy.

Telephone Credit-Check System

Telephone System of Credit Checks, Clotilde Grunski. Jl. Electricity, vol. 42, no. 4, Feb. 15, 1919, pp. 152-153, 2 figs. Department-store credit system; uses a central telephone exchange and various stations in different parts of store.

Industrial Technology

Alcohol

Future and Sources of Industrial Alcohol. Can. Foundryman, vol. 10, no. 2, Feb. 1919, pp. 41-42. Manufacture from grain and potatoes; synthetic processes; utilization of wood waste; comparative yields.

Ammonia

Ammonia Plant at the Stockholm Gas Works. Gas Age, vol. 43, no. 3, Feb. 1, 1919, pp. 132-134, 5 figs. Plant was designed to furnish both ammonium sulphate and aqueous ammonia. From Journal für Gasbeleuchtung.

Cements for Chemical Work

Cements for Various Purposes, J. B. Barnitt. Mech. World, vol. 65, no. 1672, Jan. 17, 1919, p. 29. Joints and similar uses in chemical work. From Gen. Chem. Bul.

Charcoal

Manufacture of Charcoal as an Economic Measure, Helge Sylven. Sci. Am. Supp., vol. 87, no. 2251, Feb. 22, 1919, pp. 124-126, 5 figs. By-product made from lumber-mill waste.

Chlorine

Future Possibilities of Electrolytic Chlorine, A. H. Hoker. Chem. Engr., vol. 27, no. 1, Jan. 1919, pp. 3-4. Evolution of Mond and Deacon processes; chlorine in refining.

Coloration, Metal

Chemical Metal Coloration, Emil Haas. Brass World, vol. 15, no. 2, Feb. 1919, pp. 45-46. Describes various processes.

Cyanogen Products

The Manufacture of Hydrocyanic Acid, H. A. Pelton and M. W. Schwarz. Chem. & Metallurgical Eng., vol. 20, no. 4, Feb. 15, 1919, pp. 165-166, 2 figs. Description of semi-industrial apparatus and plans for large scale operations.

Use of Cyanogen and Its Derivatives During the War (L'emploi du cyanogene et de ses dérivés à la guerre), Nicolas Flamel. Génie Civil, vol. 74, no. 5, Feb. 1, 1919, pp. 89-92. Preparation of these chemicals; their toxic effects.

Dust Precipitation

Checking Up on Cottrell Process, N. H. Gellert. Iron Trade Rev., vol. 64, no. 7, Feb. 13, 1919, pp. 448-450, 2 figs. Results obtained in electrical precipitation of impurities from blast-furnace gases; method said to be adaptable to spiegeleisen and ferromanganese furnaces.

Electrodeposition

Electrolytic Deposition of Zinc, H. E. Broughton. Chem. & Metallurgical Eng., vol. 20, no. 4, Feb. 15, 1919, pp. 155-162, 13 figs. Preparation of cell liquor from fumes collected as sludge in acid chambers; details of theoretical and applied electrochemistry involved; charts and data.

Muriatic Acid in Nickel Solutions, E. W. Heil. Brass World, vol. 15, no. 2, Feb. 1919, pp. 39-40. Discusses advisability of adding muriatic acid to a nickel solution and the chemical phenomena resulting therefrom.

Filtration

Utilization of Waste Paper in Filtration, S. L. Jodidi and H. G. Higgins. Chem. Engr., vol. 27, no. 2, Feb. 1919, pp. 45-48, 1 fig. Method of preparing waste and low-grade paper pulp for making filters like those used in quantitative analysis; results obtained.

Galvanizing

Modern Processes of Galvanizing Sheet Steel (Procédés modernes de galvanisation des tôles d'acier). Métallurgie, vol. 51, no. 7, Feb. 12, 1919, pp. 334-335, 1 fig. English type of galvanizing machine. (Continuation of serial.)

Gas Manufacture

Steaming Vertical Retorts, L. J. Willien. Gas Rec., vol. 15, no. 4, Feb. 26, 1919, pp. 115-116. Report of tests showing increased gas and ammonia yield, and less formation of carbon in retorts. Paper before N. E. Gas Assn.

Gas Engineering. Times Eng. Supp., year 15, no. 531, Jan. 1919, pp. 22-23. Progress of gas industry in 1918.

Install Improved Apparatus, J. Arnold Norcross. Gas Rec., vol. 15, no. 4, Feb. 26, 1919, pp. 125-128. Recommendation to reduce cost of producing gas by adopting improvements likely to reduce expenses and save labor. Presidential address before N. E. Gas Assn.

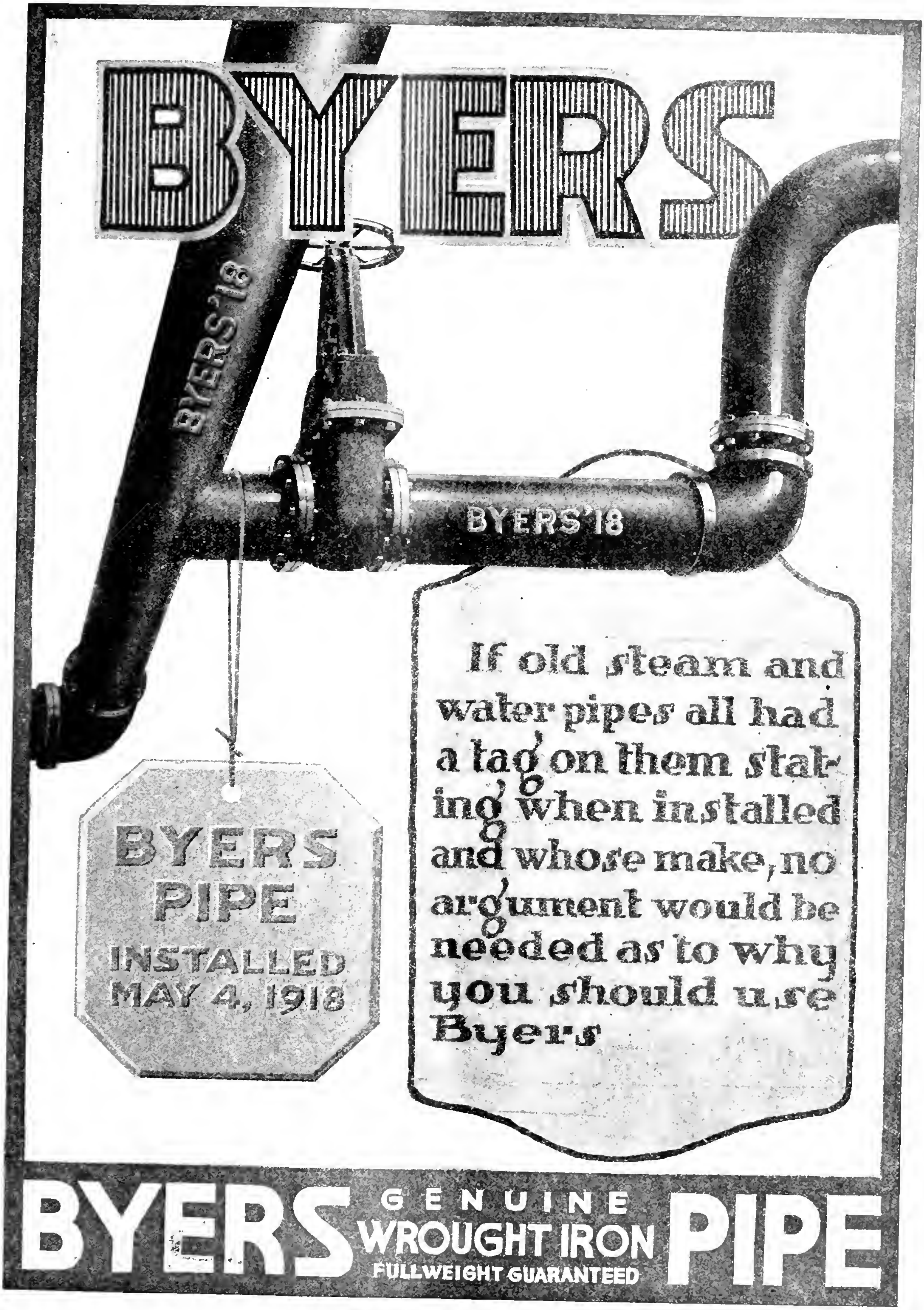
Gasoline

Gasoline from Natural Gas, G. A. Burrell. Gas Rec., vol. 15, no. 4, Feb. 26, 1919, pp. 105-108. Discussion of various types of plants available and some of essential points in their operation.

Gasoline Recovery, E. A. Spencer. Natural Gas & Gasoline Jl., vol. 13, no. 2, Feb. 1919, pp. 51-52, 1 fig. Absorption process described and illustrated.

Glass

Laboratory Glassware in England (La verrerie de laboratoire en Angleterre), A. Livache. Bulletin de la Société d'Encouragement, vol. 130, no. 6, Nov.-Dec. 1918, pp. 411-424. Experimental research of the action of chemical reagents on glass surfaces; comparison


BYERS
BYERS '18
BYERS '18
BYERS PIPE
INSTALLED MAY 4, 1918
If old steam and water pipes all had a tag on them stating when installed and whose make, no argument would be needed as to why you should use Byers
BYERS GENUINE WROUGHT IRON PIPE
FULLWEIGHT GUARANTEED

of the various types of laboratory glassware. From Jl. Soc. Glass Technology, vol. 1, 1917, p. 153.

The Condition of Arsenic in Glass and Its Role in Glass-Making. E. T. Allen and E. G. Zies. Jl. Am. Ceramic Soc., vol. 1, no. 11, Nov. 1918, pp. 787-790. Writers claim that in all glasses they have tested, both plate and optical glasses, major part of arsenic present exists in pentavalent state and a portion in trivalent state.

Some Aspects of the Scientific Glassware Industry, F. W. Branson. Jl. Soc. Chem. Indus., vol. 37, no. 24, Dec. 31, 1918, pp. 337T-339T and (discussion) pp. 339T-340T. Suggests standardization of hollow scientific glassware.

Graphite Crucibles

Preparation of Crucible Graphite, George D. Dub. Dept. of Interior, Bur. of Mines, War Minerals Investigation Series, no. c., Dec. 1918, 27 pp., 10 figs. Survey of present mining, milling, refining, sampling, and analyzing methods; experimental work on concentration and refining undertaken for the purpose of improving present practice; investigations of crucible manufacture to determine properties of domestic flake and maximum proportions that might be used without impairing quality of crucibles.

Hydrogen

The British Admiralty Hydrogen Gas Plant. Engineering, vol. 107, no. 2769, Jan. 24, 1919, pp. 102-103, 7 figs. Description of the process and the plant constructed by the Société L'Oxylithe, Paris.

Hydrogenation of Oils

Hydrogenation of Oils (L'hydrogénation des huiles), A. Mailhe. Journal des Usines à Gaz, vol. 43, no. 3, Feb. 5, 1919, pp. 33-36. Survey of patents; choice of nickel, cobalt, iron and copper as catalyzer. (Concluded.)

Nitrogen

The Production of Nitrogen Compounds, Jack P. Montgomery. Chem. Engr., vol. 27, no. 2, Feb. 1919, pp. 35-39. Review of sources of nitrogen compounds and processes of utilizing them with special reference to methods employed to meet waste of nitrogenous material.

Pickling

Removing Oxide Scale by Pickling, E. E. Corbett. Iron Trade Rev., vol. 64, no. 9, Feb. 27, 1919, pp. 564-568. Comparison of steel-cleaning liquors made of nitre cake and sulphuric acid; mode of working solutions and chemical and mechanical reactions which take place in pickling process.

Radium

The Radium Industry and Reconstruction. John S. MacArthur. Min. Jl., vol. 124, no. 4352, Jan. 18, 1919, pp. 39-40. Points out some possible uses of low-grade radium residues.

Rubber

The Ageing of Vulcanized Plantation Rubber II, Henry P. Stevens. Jl. Soc. Chem. Ind., vol. 37, no. 24, Dec. 31, 1918, pp. 340T-342T, 8 figs. Experiments are said to have proved that vulcanized rubber commences to change in physical properties from the moment vulcanization process is completed.

Silicon Products

Metallic Silicides (Les silicinres métalliques), Jean Escard. Métaux, Alliages et Machines, vol. 12, no. 1, Jan. 1919, pp. 8-10. Preparation in electric furnace of silicon alloys; their industrial utilization. (To be continued.)

Water Gas

Control of Water Gas Sets, H. Vittinghoff. Gas Rec., vol. 15, no. 4, Feb. 26, 1919, pp. 109-112, 1 fig. Essentials in operation of small plants. Paper before N. E. Gas Assn.

Providence Water Gas Plant, W. M. Russell. Gas Rec., vol. 15, no. 4, Feb. 26, 1919, pp. 119-123. Construction and operation of sets recently installed. Paper before N. E. Gas Assn.

Railroad Engineering

ELECTRIC RAILWAYS

Center-Rail Traction

Center-Rail Traction for Mountain Railways, C. Noble Fell. Ry. Engr., vol. 40, no. 468, Jan. 1919, pp. 12-14, 5 figs. Electric center-rail permanent way (Fell system.)

Freight Handling

Freight Transportation by Local Electric Railways (Le transport des merchandises sur les voies ferrées électriques d'interêt local), Lucien Pahin. Revue Générale de l'Electricité, vol. 5, no. 3, Jan. 18, 1919, pp. 114-117. Survey of developments in United States, England and France by congestion of railroads.

Locomotive

An Electric Rail Locomotive. Motor Traction, vol. 28, no. 723, Jan. 8, 1919, p. 26, 1 fig. Equipped with battery of 120 cells of Edison G11 type; ampere-hour capacity, 275.

ELECTRIFICATION

French Railways

Consequences of the Electrification of French Railways from the Viewpoint of the Exploitation of the Telegraph and Telephone Lines (L'électrification des chemins de fer français; ses conséquences au point de vue de l'exploitation des lignes télégraphiques et téléphoniques), A. Mauduit. Annales des Postes, Télégraphes et Téléphones, vol. 7, no. 4, Dec. 1918, pp. 499-525. Investigations of the Compagnie du Midi lead writer to establish that in electrified lines with small traffic and where current does not exceed 100 amp., usual protective devices will permit successful operation of telegraph and telephone lines running parallel to track; not so, however, when rail current exceeds 100 amp.-km., in which case soil return is not judged advisable in telephone or telegraph line.

Partial Electrification of a Great Railway System (Electrification partielle d'un grand réseau de chemins de fer), Victor Sabouret. Bulletin de la Société d'Encouragement pour l'Industrie Nationale, vol. 130, no. 6, Nov.-Dec. 1918, pp. 344-363. Project of Compagnie d'Orleans comprising electrification of 3000 km. of railway.

New Zealand

The Electrification of Railways in New Zealand, E. Parry. New Zealand Jl. Sci. & Technology, vol. 1, no. 6, Nov. 1918, pp. 323-328. Relative merits of steam and electric haulage; importance of a comprehensive system of electric-power supply in its bearing upon railway electrification; evolutional process of main-line electrification in New Zealand.

EUROPEAN

Ambulance Trains

British Railways Under War Conditions. Engineer, vol. 127, no. 3291, Jan. 24, 1919, pp. 73-75, 11 figs. Ambulance trains. Fifteenth article.

British

Railways. Times Eng. Supp., year 15, no. 531, Jan. 1919, p. 30. Services given to Government by British railways during war; progress in standardization: rolling-stock construction.

LABOR

Camps

Some Modern Camps for Maintenance Men. Ry. Maintenance Engr., vol. 15, no. 2, Feb. 1919, pp. 49-53, 13 figs. Buildings provided by four of the roads in Chicago district.

LOCOMOTIVES

Australian Locomotives

Locomotive Built by Australian Government, J. O'Toole. Boiler Maker, vol. 19, no. 2, Feb. 1919, pp. 40-41, 2 figs. Type 2-8-0. Total heating surface, 2421 sq. ft.; Walschaerts valve gear and Robinson superheater used.

Coal Consumption

The Economical Use of Coal in Locomotives. Ry. Gaz., vol. 30, no. 2, Jan. 10, 1919, pp. 63-64, 2 figs. Abstract of report issued by engineering staff, Univ. of Ill.

Firebox, Thermic-Syphon

New Type of Locomotive Firebox. Ry. Mech. Eng., vol. 93, no. 2, Feb. 1919, pp. 71-73, 2 figs. By introduction of thermic syphons evaporating efficiency of boiler is materially increased.

Pennsylvania 2-10-2

Pennsylvania Lines 2-10-2 Locomotive. Ry. Mech. Eng., vol. 93, no. 2, Feb. 1919, pp. 74-76, 5 figs. General description, drawings and principal data.

Powdered-Fuel Engines

Locomotives. Times Eng. Supp., year 15, no. 531, Jan. 1919, p. 30. Designs developed in 1918, particularly the powdered-fuel engine.

Standard

Standard 2-6-6-2 Type Locomotive. Ry. Mech. Eng., vol. 93, no. 2, Feb. 1919, pp. 74-77, 6 figs. General description, drawings and principal data.

The Standard Heavy Santa Fe Type Locomotive. Ry. Age., vol. 66, no. 7, Feb. 14, 1919, pp. 389-392, 6 figs. General description, principal data and drawings.

Stokers

The Elvin Mechanical Stoker. Ry. Mech. Eng., vol. 93, no. 2, Feb. 1919, pp. 103-106, 4 figs. Description of stoker for locomotives made by Elvin Mechanical Stoker Co., New York.

Superheaters

Modern Locomotive Engine Design and Construction—XLIV. Ry. Engr., vol. 40, no. 468, Jan. 1919, pp. 3-12, 24 figs. Considerations relative to design and construction of different types of superheaters for any working temperature. (Continuation of serial.)

Three-Cylinder Engine

Great Northern Railway Locomotive Performance. Ry. Gaz., vol. 30, no. 3, Jan. 17, 1919, pp. 89-98, 18 figs. Haulage of 1300-ton coal trains between Peterborough and London by a three-cylinder engine.

See also MECHANICAL ENGINEERING, Power Plants (Firebox).

OPERATION AND MANAGEMENT

Fuel Conservation

Recent Papers on Fuel Conservation. Ry. Mech. Eng., vol. 93, no. 2, Feb. 1919, pp. 66-69. Abstracts of several railway club papers prepared by fuel experts and describing methods of saving coal.

Government Ownership

State Ownership and Operation of Railways. Ry. Gaz., vol. 30, nos. 1, 2 and 3, Jan. 3, 10 and 17, 1919, pp. 11-14, 48-51 and 86-88. Digest of evidence given before commission of inquiry in South Africa concerning advantages and disadvantages of state control of railways.

The National Railroad Question of To-Day, Francis Lee Stuart. Proc. Am. Soc. Civil Engrs., Papers & Discussions, vol. 45, no. 2, Feb. 1919, pp. 53-60. Facts which led up to Federal control; competition and Government ownership.

To-Day's Railroad Problem in the States, Theodore P. Shonts. Ry. Gaz., vol. 30, no. 2, Jan. 10, 1919, pp. 57-58. Claims that most economical operation can be attained under private ownership.

Loading, Maximum

Maximum Car Loading, William H. McClymonds. Proc. Pacific Ry Club, vol. 2, no. 10, Jan. 1919, pp. 16-22. Economics of loading a car to its utmost safe carrying capacity.

Speeds, European

European Train Speeds. Ry. Gaz., vol. 30, no. 3, Jan. 17, 1919, pp. 80-85. Survey of highest, longest and fastest non-stop runs, speed of trains between two places and geographical distribution of principal service. (To be continued.)

Stores, Handling

Handling of Stores on the Santa Fé, Charles E. Parks. Ry. Gaz., vol. 30, no. 2, Jan. 10, 1919, pp. 59-61. Organization to look after waste material.

Train Dispatching

Getting Trains Over the Road, J. A. Shockey. Proc. Pacific Ry. Club, vol. 2, no. 10, Jan. 1919, pp. 10-16. Duties and responsibility of a train dispatcher.

Organization of a Train Dispatcher's Office and Duties of the Chief Dispatcher, C. E. Norton. Proc. Pacific Ry. Club, vol. 2, no. 10, Jan. 1919, pp. 6-10.

See also MECHANICAL ENGINEERING, Handling of Materials (Cooling Stations).

PERMANENT WAY AND BUILDINGS

Ballast

Maintenance of Railway Roadbed by Cleaning the Ballast (L'entretien des voies ferrées par le soufflage du ballast). Génie Civil, vol. 74, no. 5, Feb. 1, 1919, p. 94, 1 fig. Methods based on maintaining solidity of supporting parts of ballast by removing vegetation, etc., by air jet, to insure percolation of water into roadbed and trenches.

Track Support, Concrete

Concrete Railway Track-Support. Eng. World, vol. 14, no. 2, Jan. 15, 1919, pp. 58-60, 2 figs. Details of proposed continuous concrete slab support.

ROLLING STOCK

Automobile Cars

Forty-Foot Automobile Cars for Illinois Central. Ry. Age, vol. 66, no. 8, Feb. 21, 1919, pp. 440-443, 4 figs. Single-sheathed type with steel end, especially designed for carrying various types of lading; general description and principal data.

Axles

Notes on Railway High Capacity Wagon Wheel Axles, H. Kelway-Bamber. Jl. & Tran. Soc. Engrs., vol. 9, no. 12, Dec. 1918, pp. 189-204 and (discussion) pp. 204-214, 9 figs. British 10-ton wagon axle; methods of ascertaining stresses; method of calculating dimensions, etc.; specifications for axle steel; factors of safety.

Lumber for Car Construction

Lumber for Car Construction, Hermann von Schrenk. Ry. Mech. Eng., vol. 93, no. 2, 1919, pp. 85-88, 3 figs. Selecting proper grades to secure strength and lasting power, increasing service by preservatives.

Standard Cars, U. S.

Standard Cars for the United States Railways. Ry. Gaz., vol. 30, no. 3, Jan. 17, 1919, pp. 101-102, 6 figs. Standard design for 70-ton hopper wagon.

Standards for Freight Equipment

Standards for the Maintenance of Freight Equipment, H. L. Shipman. Ry. Age, vol. 66, no. 9, Feb. 28, 1919, pp. 495-497. Keeping up the condition of cars to meet demands of traffic; uniform classification of repairs. From a paper before the Western Railway Club.

SAFETY AND SIGNALING SYSTEMS

Alternating-Current Signaling

Alternating Current Signaling. Ry. Engr., vol. 40, no. 468, Jan. 1919, pp. 15-17, 7 figs. How system was developed, how it operates, and results that have been obtained. (To be continued.)

Automatic Signaling

Automatic Signals Expedite Freight Movement. Ry. Signal Engr., vol. 12, no. 1, Jan. 1919, pp. 4-7. Study of conditions of Northern Pacific; table showing information.

Many New Conditions Affected Signaling Last Year. Ry. Signal Engr., vol. 12, no. 1, Jan. 1919, pp. 11-23. Review of progress made in automatic block and interlocking construction developments and personnel of signal field.

Signal Lamps, Focusing

A Method of Focusing Signal Lamps, S. C. Hofmann. Ry. Signal Engr., vol. 12, no. 1, Jan. 1919, pp. 30, 1 fig. Details of focus tube for focusing R. S. A. semaphore lamps, claimed to have given satisfactory service.

Ties, Zinc-Treated, and Current Leakage

Influence of Zinc Treated Ties on Signal Operation. Ry. Maintenance Engr., vol. 15, no. 2, Feb. 1919, pp. 65-66. Experiences of various engineers. Discussion at convention Ry. Signal Assn.

SHOPS

Boiler Shops

Among Railroad Boiler Shops—VI, James F. Hobart. Boiler Maker, vol. 19, no. 2, Feb. 1919, pp. 49-50 & 60, 5 figs. Devices developed for special work; front-end staging, handling locomotive tenders and special tools.

Canal Zone Shops

Our Canal Zone Dry Docks and Repair Shops, R. D. Gatewood. Am. Mach., vol. 50, no. 8, Feb. 20, 1919, pp. 336-339. General description of Balboa facilities.

Roundhouse, Concrete

An Unusual Concrete Roundhouse at Proctor, Minn., Wm. E. Hawley. Ry. Age, vol. 66, no. 8, Feb. 21, 1919, pp. 428-430, 5 figs. Saw-tooth roof applied to circular building; cantilever beams support walls over entrance doors.

Safety Devices

Safeguards in Railway Shops, Frank A. Stanley. Ry. Mech. Eng., vol. 93, no. 2, Feb. 1919, pp. 93-96, 9 figs. Description of certain safety devices used at various shops of Southern Pacific.

Welding

The Oxy-Acetylene Process in Railroad Shops, W. L. Bean. N. E. R. R. Club, Jan. 14, 1919, pp. 247-261. Development; notes on apparatus selection; accessories; instruction of welders.

TERMINALS

Richborough

The Richborough Transportation Depot and Train Ferry Terminus. Engineer, vol. 127, no. 3291, Jan. 24, 1919, pp. 76-79, 15 figs. The new wharf. Third article.

Richmond, Va.

A New Passenger Station Completed at Richmond, Va. Ry. Age, vol. 66, no. 7, Feb. 14, 1919, pp. 401-406, 9 figs. Project involves terminal with facilities for two roads and improved main line. Also in Ry. Rev., vol. 64, no. 7, Feb. 15, 1919, pp. 239-242, 9 figs. Description of three-million-dollar structure.

Terminal Sheds

Marine Terminal Shed, H. McL. Harding. Eng. World, vol. 14, no. 2, Jan. 15, 1919, pp. 47-48, 1 fig. Comparison of one-story and two-story sheds in regard to cost and speed of operation.

Yards, London

Willesden Gravity and Marshalling Yards. Ry. Gaz., vol. 30, no. 1, Jan. 3, 1919, pp. 17-24, 11 figs. and chart. Freight and coal traffic in London district of London & Western Ry.

Munitions and Military Engineering

Army Bases

Brooklyn Army Base Is Largest Port Terminal. Eng. News-Rec., vol. 82, no. 7, Feb. 13, 1919, pp. 317-323, 15 figs. Description of freight-handling unit designed for overseas service. It has 138 acres of pier and warehouse floor and track space for 1,300 cars.

Camps

The Operation of the Utilities at Camp Devens, Mass., Edward W. Briggs. Jl. Boston Soc. Civ. Engrs., vol. 6, no. 2, Feb. 1919, pp. 25-60, 4 figs. Organization and operation of various departments. Entire reservation contains 10,000 acres, of which 2,000 are occupied by camp proper.

Construction Work, U. S.

Government War Construction Work in the United States, R. C. Marshall. Proc. Am. Soc. Civil Engrs., vol. 45, no. 2, Feb. 1919, pp. 164-171. Outline of work done by Construction Division of the Army.

Coast Defense

Notes on the Use of the Aeroplane in Coast Defense, John Hays Hammond. Jl. U. S. Artillery, vol. 49, no. 4, Sept.-Dec. 1918, pp. 286-291. Functions of different types of aircraft in coast defense; problems of winter flying; twin-motored aeroplanes in coast-defense work.

Depth-Bomb Throwers

Thornycroft Depth Charge Throwers. Engineer, vol. 127, no. 3291, Jan. 24, 1919, pp. 86-88, 5 figs. Description.

Fire Control

Radio Apparatus for Artillery Fire Control, G. Francis Gray and John W. Reed. Elec. Wld., vol. 73, no. 9, Mar. 1, 1919, pp. 408-412, 6 figs. Development; description of transmission apparatus and air-driven generator.

Artillery Co-Ordinate Computation Charts, S. H. Simpson. Jl. U. S. Artillery, vol. 49, no. 4, Sept.-Dec. 1918, pp. 274-279, 2 figs. Intended to simplify computations involved in trigonometric solutions of triangles.

Probability Chart, George E. Shipway. Jl. U. S. Artillery, vol. 49, no. 4, Sept.-Dec. 1918, pp. 280-285, 1 fig. Devised for determining number of rounds to be provided to destroy target under given conditions of range and gun and also hits that may be expected if a certain number of rounds are fired.

Gas Warfare

Chemical Warfare—A New Weapon, Ellwood Hendrick. Chem. & Metallurgical Eng., vol. 20, no. 4, Feb. 15, 1919, pp. 152-154. Discusses "humanity" and effectiveness of gas warfare.

Mustard Gas. Natural Gas & Gasoline Jl., vol. 13, no. 2, Feb. 1919, pp. 61-62. Part of annual report of Director of Bur. of Mines dealing with this substance.

Gun Forgings

Flaky and Woody Fractures in Nickel-Steel Gun Forgings, Charles Y. Clayton, Francis B. Foley and Francis B. Laney. Bul. Am. Inst. Min. Engrs., no. 146, Feb. 1919, pp. 203-237, 59 figs. Information concerning their nature, their effect, and some of the conditions that favor their development, obtained from metallographic examinations undertaken coöperatively by Ordnance Dept., U. S. A., U. S. Bur. of Mines, and U. S. Geol. Survey. Material studied was from different steel plants throughout the country and consisted both of forgings that had been accepted by Ordnance Dept. and those that had failed to pass specified physical tests.

Howitzers

How the 155-Mm. Howitzer Is Made, J. V. Hunter. Am. Mach., vol. 50, no. 7, Feb. 13, 1919, pp. 303-306, 22 figs. Operations on breech-block carrier. Sixth article.

Inspection

How Ordnance Is Inspected, Fred H. Colvin. Am. Mach., vol. 50, no. 7, Feb. 13, 1919, pp. 311-316, 7 figs. Work of small-arms group. Second article.

Machine-Shop Trucks

Machine Shop Trucks Reclaim Guns. Iron Trade Rev., vol. 64, no. 6, Feb. 6, 1919, pp. 376-380, 9 figs. Shops mounted on trucks for repairing of artillery in field. Designed by Ordnance Dept.

Railway Gun Mounts

Railway Gun Mounts, G. M. Barnes. Am. Mach., vol. 50, no. 8, Feb. 20, 1919, pp. 329-325, 14 figs. Description of railway mounts for 8-in. guns, 12-in. sliding mount, 12-in. mortar, 16-in. howitzer and ammuntion cars and locomotives.

Submarines

The Submarine Situation, C. H. Clandy. Sci. Am., vol. 120, no. 9, Mar. 1, 1919, pp. 198-199, 5 figs. British types of submarines, one 340 ft. in length mounting three 4-in. guns and one mounting a 12-in. 50-ton gun.

Transportation

What Our Railway Forces Did in France. Ry. Maintenance Engr., vol. 15, no. 2, Feb. 1919, pp. 55-59, 6 figs. Account of transportation organization and scope of its activities.

See also AERONAUTICS, Aerostatics (Military Balloons), Military Aircraft.

General Science

CHEMISTRY

Antimony Analysis

A Bibliography on the Analysis of Antimony, Elton R. Darling. Chem. Engr., vol. 27, no. 1, Jan. 1919, pp. 11-12 and 21. Articles which have appeared in scientific periodicals arranged alphabetically by authors' names. (Part I, from A to Ke.)

Argon

Specific Weight of Argon (Ueber das specifische Gewicht des Argons), Dr. Hugo Schultze. Zeitschrift fuer Komprimierte und fluessige Gase, vol. 19, no. 1, 1917, pp. 1-3. Mean specific weight for the pure gas, 0.00178371 at 735 m.m. mercury, or 0.001783 at 760 m.m. Coefficient of compressibility between 0 and 760 m.m., 0.00091 at 0 deg. C. Molecular weight referred to 32 for oxygen —39.945. Communication from the Physikalisch-Technische Reichsanstalt.

Colloids

Metals and Alloys from a Colloid-Chemical Viewpoint, Jerome Alexander. Bul. Am. Inst. Min. Engrs., no. 146, Feb. 1919, pp. 427-430. Regards them as sponge-like structures, the viscosity or stiffness of which at ordinary temperatures is exceedingly great.

Crucibles, Corrosion of

Action of Alkalies on Crucibles of Platinum and Gold Alloys (Action des alcalis sur les creusets en alliages de platine et d'or), Paul Niclardot and Claude Chatelot. Bulletin de la Société Chimique de France, vols. 25-26, no. 1, Jan. 1919, pp. 4-9. Experiments to determine influence of age on resistance of platinum to alkaline attack, also effect of presence of iridium and similar other metals; tests were extended to gold, silver and palladium alloys.

Glass Analysis

A Contribution to the Methods of Glass Analysis, with Special Reference to Boric Acid and the two Oxides of Arsenic, E. T. Allen and E. G. Zies. Jl. Am. Ceramic Soc., vol. 1, no. 11, Nov. 1918, pp. 739-786, 1 fig. Separation of trivalent and pentavalent arsenic in glasses depends on volatilization of trivial arsenic as A_sF_3 when glass is heated with hydrofluoric and sulphuric acids, while pentavalent arsenic remains in residue. For determination of boric acid Chapin's method is recommended as reliable and accurate.

Radiation

Ionization and Excitation of Radiation by Electron Impact in Nitrogen, Bergen Davis and F. S. Goucher. Phys. Rev., vol. 13, no. 1, Jan. 1919, pp. 1-5, 5 figs. From experiments it is found that radiation can be stimulated in nitrogen molecules by electron bombardment without ionizing them up to about 18 volts when ionization sets in.

Structure of Matter

The Conception of the Chemical Element as Enlarged by the Study of Radio-Active Change. Jl. Soc. Chem. Indus., vol. 38, no. 2, Jan. 31, 1919, pp. 19R-20R. Significance of disintegration and the discovery of elements which differ in their radioactive properties but are chemically identical.

Ultra-Violet Light

Ultra Violet Light in the Chemical Arts, Carleton Ellis and A. A. Wells. Chem. Engr., vol. 27, no. 1, Jan. 1919, pp. 19-20 and 11 ad. Conclusions regarding absorption spectra of

some aromatic compounds; conflicting views concerning spectra of nitro compounds. (Continuation of serial.)

MATHEMATICS

Algebraic Surfaces

On Surfaces Containing a System of Cubics that do not Constitute a Pencil, C. H. Sisam. Am. Jl. Math., vol. 41, no. 1, Jan. 1919, pp. 49-59. Classifies types of algebraic surfaces generated by an algebraic system of given cubic curves so that two generic curves of given system intersect in *x* variable points.

The Classification of Plane Involutions of Order (3). Anna Mamye Howe. Am. Jl. Math., vol. 41, no. 1, Jan. 1919, pp. 25-48. Discusses the different algebraic (1.3) point correspondences between two planes.

On Plane Algebraic Curves with a Given System of Foci, Arnold Emch. Bul. Am. Math. Soc., vol. 25, no. 4, Jan. 1919, pp. 157-161. Suggests method for finding foci of an *n*-ic and illustrates it by applying it to a circular cubic.

Continuous Functions

Continuous Sets that Have No Continuous Sets of Condensation, R. L. Moore. Bul. Am. Math. Soc., vol. 25, no. 4, Jan. 1919, pp. 174-176. Establishes theorem: every bounded continuous set of points that has no continuous set of condensation is a continuous curve.

Derivitiveless Continuous Functions, M. B. Porter. Bul. Am Math. Soc., vol. 25, no. 4, Jan. 1919, pp. 176-180. Proposes simplification of treatment of Weirstrass's and similar functions.

Isoperimetric Problem

An Isoperimetric Problem with Variable End-Points, Archibald Shepard Merrill. Am. Jl. Math., vol. 41, no. 1, Jan. 1919, pp. 60-78, 3 figs. Discusses necessary and sufficient conditions for a maximum (minimum) for a type of problems in the calculus of variations which are related to usual isoperimetric problems, and in which both end-points are allowed to vary along a given fixed curve.

Non-Euclidean Geometry

Quadratic Systems of Circles in Non-Euclidean Geometry, D. M. Y. Sommerville. Bul. Am. Math. Soc., vol. 25, no. 4, Jan. 1919, pp. 161-173. Study of general form $(ph^2+2\,q\,h\,-\gamma) - (h+B)\xi = 0$, where a and b represent distinct fixed lines, and *p*, *q*, *r* are given consonants.

Parabolic Arcs

Comparison of Formulas for Computing Parabolic Arcs, Robert C. Strachan. Eng. News-Rec., vol. 82, no. 7, Feb. 13, 1919, pp. 25, 326, 2 figs. Studies limit of applicability of common formula.

Poincare Surfaces

On Poincaré Surfaces of the Sixth Order (Sur les surfaces de Poincaré d'ordre 6), Pierre Humbert. Comptes rendus des Séances de l'Académie des Sciences, vol. 167, no. 22, Nov. 25, 1918, pp. 776-778. Comment on Liapounov's researches on possible number of Poincaré surfaces in vicinity of critical Jacobian.

Spectral Determination of Functions

Spectral Determination of Functions (Détermination spectrale de fonctions), Michael Petrovitch. Comptes rendus des séances de l'Académie des Sciences, vol. 167, no. 22, Nov. 25, 1918, pp. 774-776. Determination of $f(z)$ a region of *Z*-plane by one numerical datum.

Volterra's Functions

On Function of Lines and a Set of Curves, Sôichi Kakeya. Sci Reports Tôhoku Imperial Univ., First Series, vol. 7, no. 3, Dec. 1918, pp. 177-196. Discussion of Volterra's functions depending on lines represented by form $y = f(x)$, $\alpha < x < \beta$. Writer attempts to show method of representing function depending on general line.

Weierstrass Formula

On the Evaluation of the Elliptic Transcendents η_1 and η'_2, Harris Hancock. Bul. Am. Math. Soc., vol. 25, no. 4, Jan. 1919, pp. 150-157. Discusses value of Weierstrassian formulæ when applications of general theory are involved or whenever any kind of numerical computation is derived.

PHYSICS

Air

Some Recent Contributions to the Physics of the Air, W. T. Humphreys. Science, vol. 44, nos. 1259 and 1260, Feb. 14 and 21, 1919, pp. 155-163 and 182-188, 6 figs. Feb. 14: Temperatures of air at different elevations; isothermal state of upper air; relation of temperatures to barometric pressures both in summer and in winter; law of wind increase with elevation. Feb. 21: Barometric fluctuations; atmospheric electrical phenomena.

Black Body

A New Experimental Determination of the Brightness of a Black Body, and of the Mechanical Equivalent of Light, Edward P. Hyde, W. E. Forsythe and F. E. Cady. Phys. Rev., vol. 13, no. 1, Jan. 1919, pp. 45-48, 4 figs. Set of values of brightness of black body from 1,700 to 2,600 deg. *K* given on assumption of temperature scale based upon Planck's equation, taking gold point as 1336 deg. *K* and C_2 as 14350 μ deg.; 70_2 candles per cm.² as brightness of black body at 2077 deg. *K* is proposed as absolute standard of light; mechanical equivalent of light for wave length of maximum visibility $\lambda = 0.566\ \mu$ is computed to be 0.00150+0.00005 watts per lumen.

Corbino Effect

Double Induction Balance to Study the Corbino Effect (Doppia bilancia di induzione per lo studio dell' effetto Corbino), Luizi Puccianti. Il Nuovo Cimento, vol. 15, nos. 5-6, May-June 1918, pp. 249-257, 1 fig. Suggests explanation for electro-magnetic effect in a magnetic field.

Crystals

An Apparatus for Growing Crystals under Controlled Conditions, J. C. Hastetter. Jl. Wash. Acad. Sci., vol. 9, no. 4, Feb. 19, 1919, pp. 85-94, 2 figs. Consists essentially of two thermostats, — saturator and crystallizer; saturator is maintained at a temperature slightly higher than crystallizer and is about one-third filled with crystals which keep solution saturated; liquid is pumped from saturator into crystallizer where excess material is deposited into crystals, after which solution is returned to saturator.

Prevention of Columnar Crystallization by Rotation During Solidification, Henry M. Howe and E. C. Groesbeck. Bul. Am. Inst. Min. Engrs., no. 146, Feb. 1919, pp. 361-365, 6 figs. Theory of mechanism of solidification; experiments with strong hot solution of ammonia alum both with quiescent and with rotating solidification.

Reply to Dr. Fulton's Discussion of the Assignment of Crystals to Symmetry Classes, Edgar T. Wherry. Jl. Wash. Acad. Sci., vol. 9, no. 4, Feb. 19, 1919, pp. 99-102.

Sulfur Crystal, F. Russell Bichowsky. Jl. Wash. Acad. Sci., vol. 9, no. 5, March 4, 1919, pp. 126-131, 2 figs. Obtained by mixing a hot alcoholic solution of ammonium polysulfide with a mixture of benzonitrile, hydroxylamine hydrochloride and ether.

X-Ray Analysis and the Assignment of Crystals to Symmetry Classes, Alfred E. H. Tutton. Jl. Wash. Acad. Sci., vol. 9, no. 4, Feb. 19, 1919, pp. 94-99. Criticism of Edgar T. Wherry's memoir on above subject in Jl. Wash. Acad. Sci., vol. 8, 1918, p. 480.

Cyclones

On Travelling Atmospheric Disturbances, Harold Jeffreys. Lond., Edinburgh & Dublin Phil. Mag., vol. 37, no. 217, Jan. 1919, pp. 1-8. Mathematical study of propagation of a cyclone and specially of the conditions which produce the circularity of its isobars.

Diffracting Apertures

On the Radiation of Light from the Boundaries of Diffracting Apertures, Sudhansukumar Banerji. Lond., Edinburgh & Dublin Phil. Mag., vol. 37, no. 217, Jan. 1919, pp. 112-128, 6 figs. Experimental and theoretical analysis of problem. Finds that in all cases in which apertures in focal plane through which rays pass are symmetrically disposed about center of field, this latter being excluded, image of boundary of diffracting surface appears as a perfectly black line surrounded on either side by luminous bands.

On the Theory of Superposed Diffraction—Fringes, Chandi Prasad. Phys. Rev., vol. 13, no. 1, Jan. 1919, pp. 27-33, 4 figs. Shows how principle of superposition suggested by C. F. Brush (Proc. Am. Phil. Soc., 1913, pp. 276-282) may be formulated mathematically and its validity tested in experiment.

Doppler Effect

Experimental Demonstration of the Constancy of Velocity of the Light Emitted by a Moving Source, Q. Majorana. Lond., Edinburgh & Dublin Phil. Mag., vol. 37, no. 217, Jan. 1919, pp. 145-150, 1 fig. Experimental verification of Doppler effect with artificial movement of common luminous source.

Elastic Solids

Deformation Resulting from the Contact of Two Elastic Solids (Sulla deformazione conseguente al contatto di due solidi elastici), Elena Mannei. Il Nuovo Cimento, vol. 15, nos. 5-6, May-June 1918, pp. 171-179. Study of Hertz' discussion of problem. (Gesammeldte Werke, vol. 1, pp. 154-169.)

Elastostatics

A Problem in the Elastostatics of a Semi-Infinite Solid, Kwan-ichi Terazawa. Sci. Reports Tôhoku Imperial Univ., First Series, vol. 7, no. 3, Dec. 1918, pp. 205-215, 7 figs. Distribution of normal pressure on boundary of a semi-infinite elastic solid.

Electromotive Forces

Reciprocal Relations Following from Kirchhoff's Laws (Relations de réciprocité découlant des lois de Kirchoff), J. B. Pomey. Revue Générale de l'Electricité, vol. 5, no. 3, Jan. 18, 1919, pp. 83-87, 4 figs. Mathematical equations establishing relations between electrical, mechanical and kinetic magnitudes in network of conductors. Derived for various arrangements and distributions. Supplementary to writer's study of electromotive forces in branches of network. (See R. G. E. vol. 4, Aug. 3, 1918, pp. 131-132.)

Electrons

On the Mechanical and Electrodynamical Properties of the Electron, Megh Nad Saha. Phys. Rev., vol. 13, no. 1, Jan. 1919, pp. 34-44. Investigation of scalor and vector potentials of moving electron, electric and magnetic fields due to a moving electron, Maxwell's stresses, law of attraction between two moving electrons and equations of motion of the electron, by Minkowski's method of four-dimensional analysis.

Gas Equations

Molecular Attraction and Attraction of Mass, and Some New Gas Equations, James Kam. Lond., Edinburgh & Dublin Phil. Mag., vol. 37, no. 217, Jan. 1919, pp. 65-97, 2 figs. Deviations from gaseous laws lead to establishing that cohesive forces are proportional to the square of molecular weight and obey inverse square law; thus an analytical value is derived for the tensile strength of iron which is of same order as experimental value.

The Laws of Perfect Gases in Relation to the Theory of Heat (Sulle leggi dei gas perfetti in relazione alla teoria del calore), M. Ascoli. Il Nuovo Cimento, vol. 15, nos. 5-6, May-June 1918, pp. 212-220, 1 fig. Derivation of general differential of thermodynamic changes from the gas equation and also from the first thermodynamic law.

Hydrodynamics

Integral Invariant of Hydrodynamics and Its Application to the Theory of General Relativity (Sur un invariant intégral de l'Hydrodynamique et sur son application à la théorie de la relativité générale), E. Vessiot. Comptes rendus des séances de l'Académie des Sciences, vol. 167, no. 27, Dec. 30, 1918, pp. 1065-1068. Concerning Einstein's hypothesis on nature of fluids.

Induction Coils

The Optimum Secondary Capacity of an Induction Coil, E. Taylor Jones. Elecn., vol. 82, no. 2122, Jan. 17, 1919, pp. 99-101. A mathematical article.

Interferential Contact Lever

Interferential Contact Lever Experiments Relating to the Elastics of Small Bodies, Carl Barus. Proc. Nat. Acad. Sci., vol. 5, no. 2, Feb. 1919, pp. 44-49, 9 figs. Apparatus designed by writer in which interferential contact lever measures strain corresponding to stress imparted by pushing springs.

Mercury-Vapor Light

The Light From Mercury Vapor, C. D. Child. Lond., Edinburgh & Dublin Phil. Mag., vol. 37, no. 217, Jan. 1919, pp. 61-64, 1 fig. Comparison of writer's experiments with similar experiments by Strutt (Proc. Roy. Soc., 1917, A. 94, p. 88) on the luminous vapor coming from discharge through gases at low pressure.

Thermal Conductivities

Thermal Conductivity of Various Materials, T. S. Taylor. Phys. Rev., vol. 13, no. 2, Feb. 1919, pp. 150-151. Table of values for hard rubber, white fiber, various species of wood, solid and powdered graphite and lamp black.

Tuning Forks

A Method of Comparing Tuning Forks of Low Frequency and of Determining their Damping Decrements, Albert Campbell. Proc. Phys. Soc., Lond., vol. 31, part 2, Feb. 15, 1919, pp. 87-89. Method consists in putting windings of maintaining magnets in series with each other and with a sensitive vibration galvanometer; beats are shown by pulsations of band of light on scale.

Welsbach Mantle

Physical Study of the Welsbach Mantle. Engineer, vol. 107, no. 2769, Jan. 24, 1919, pp. 100-103. Develops the physical theory of the Welsbach mantle.

X-Rays

Energy of the Characteristic X-Ray Emission from Molybdenum and Palladium as a Function of Applied Voltage, Benhamin Allen Wooten. Phys. Rev., vol. 13, no. 1, Jan. 1919, pp. 71-86, 5 figs. It was found that in molybdenum α and β radiation appeared at 19.2 kv. and in palladium at 24 kv.; ratio of intensity of α line to that of β line was found to become constant as voltage increased for each metal; absorption coefficients for wave lengths of α and β lines of molybdenum and palladium in glass and in molybdenum and palladium respectively were determined.

The Right Man in the Right Place in the Army

By LT.-COL. JOHN J. SWAN,[1] U. S. A., WASHINGTON, D. C.

The Committee on Classification of Personnel in the Army, Adjutant General's Department, Washington, D. C., has recently arranged an exhibit to show how the army brings the job and the man together, and how the methods thus employed can be applied with profit to industrial management. The exhibit, which consists chiefly of charts and photographs, has already visited a number of cities, and has been received with great enthusiasm. The address abstracted below was delivered at a meeting of the New York Section of The American Society of Mechanical Engineers, on February 24, 1919, and will afford those who have not been able to visit the exhibit an opportunity to acquaint themselves with this interesting and important phase of the Army's work.

THE organization of a modern army covers nearly every field of human endeavor, and one is therefore not surprised to learn that even now vague ideas exist regarding the purpose and duties of many of the Government's war-time departments. In order that the work of the Personnel Department of the Army might be properly understood and appreciated, the Committee on Classification of Personnel, under the Adjutant General and with his authority, has prepared a special exhibit, which is arranged to acqnaint one with the various steps involved in "making a soldier," from his arrival at the camp to the time when he begins training; and again through the steps of assignment, transfer, and shipment from the camp to service overseas. The magnitude of this work can perhaps be judged from the statement that approximately 3,700,000 men had to be interviewed, enrolled, equipped and assigned.

The men coming into the camps represented every conceivable type—men with special technical education, skilled tradesmen, and workers of all degrees of ability. The necessity for conserving the skilled workmen early became apparent to the Personnel Department, for it was found that many specialists and skilled tradesmen of certain types were rare. Of 425,000 men received in the draft up to December 15, 1917, reduced to the basis of 10,000 white and averaged over the entire country, it was found that there were only 50 bakers, 90 blacksmiths, 8 bridge carpenters, 90 butchers, 190 cooks, 150 electricians, 8 farriers and a small representation of the other trades essential to the operation of the Army. These figures are based on the statements of the men themselves as interviewed by the Personnel Officers, but when the men claiming these trade abilities were examined or tested by the system employed by the Personnel Department it was found that only 6 per cent were experts, while 24 per cent were journeymen, 40 per cent apprentices, and 30 per cent without any experience whatsoever.

These figures thus bring out very forcefully the vital necessity of the system employed in the Army to detect such skilled men and place them in organizations where their skill was required. Without this system skilled men of all kinds would have been consumed in the early days and none left for subsequent Army extension; industry would also have been robbed, and to such an extent that the flow of munitions could not have been maintained.

Methods of Classification

The process of "making a soldier" is illustrated diagrammatically in Fig. 1. This is a routing diagram showing the stages in enrolling the recruits and transforming them into fully equipped soldiers. The black line is the path of all the men. The first step is the receiving and checking of draft papers, and the ne t an interview to obtain the recruit's record for his Qualification Card. This card, shown in Fig. 2, was made out for every man in the Army. The third step is the Oral Trade Test to check the statements of those claiming trade ability, and this is followed by the checking and sterilizing of clothing for storage, pending final acceptance or rejection, and a shower bath as preparation for the medical examination. The civilian clothing of men accepted was sent home or given to the Red Cross, in accordance with the desires of the man, and the clothing of those discharged was transferred to the Discharge Section of the building, to be ready for the men as they passed out at the far end.

The actual medical examination requires several rooms, the first being for dental and orthopedic examinations, and also for obtaining the height and the weight; and the next for examinations for skin afflictions, mobility of joints and other details. A third room is necessary for psychiatric examinations or those to check the mental alertness or intelligence; then follow in order the genito-urinary, primary tuberculosis, heart and circulation, nose, ear and throat, and eye examinations.

In the medical examinations up to this point, men with varying degrees of perfection have been found, and on leaving the eye room the stream is split, those having been found physically fit for any class of military service continuing along the path of the heavy line, and those giving evidence of any fundamental defects following the path of the light line for a secondary review. After this second examination these men are placed in one of two classes, Class B, those who have "remediable defects" requiring hospital treatment, and those known as Class D men, who are unquestionably unfit for any class of military service. These two classes follow the light line through the Development Battalion Review Board room and the Discharge Section, through the dressing room where they receive back their civilian clothes, and finally they are given any pay to which they may be entitled, and transportation.

Men classified by the Camp Surgeon as Class C-1 and C-2 men, and illiterates, are also passed through the Development Battalion Review Board room where a special group of medical and personnel experts give each case careful consideration, and then they go back into the line of accepted men, indicated, however, as men for "limited service" only, and for assignment to Development Battalions. All men then pass through the finger-print, scars and body-mark room, and next to the Quartermaster Section, where they are measured for clothing and shoes; then along the counter where they receive underclothing, outer clothing and other equipment and are permitted to dress. Next they pass forward to the record room where the equipment issued to them is recorded, and then on through the mustering-in room where they are interviewed for service records. In the next section applications and instructions with regard to insurance and allotments are prepared, and this is followed by an inspection of all the various papers accumulated by each man in his passage through the system, to see that they are correct and complete. Finally the men are vaccinated and inoculated and then definitely assigned to a company or organization as soldiers ready to begin military training.

As already mentioned, Fig. 2 illustrates the front and reverse side of the soldier's Qualification Card used in registering information in regard to enlisted men. This card was one of the credentials of every man, and moved with him wherever he went. The card gives the essential facts in connection with each man; his occupation, trade skill, previous experience, former employer, nativity, citizenship, schooling, linguistic ability, mental capacity, physical capacity, leadership ability, military experience, and kind of service preferred, together with subsequent military assignments. These cards are not filled out by the recruits themselves but by an interviewer who obtains from each man the information required. The card is also used to classify the men under certain standard trade-name headings or occupations essential or desirable within the Army, as it records the man's prime occupation, secondary and tertiary occupations, and length of time engaged in each.

[1] Personnel Branch of Operations Division, General Staff. Mem. Am. Soc. M. E.

When the card is completely filled out the interviewer places a tab on the top of the card above the line of numbers. These numbers indicate the line in which the man can be classed. If he is "skilled" they are marked by green tabs, and if "partially skilled" or apprentice, by an orange tab.

The cards thus tabbed enable a quick selection of men of special ability, and also permit a rapid compilation of data for

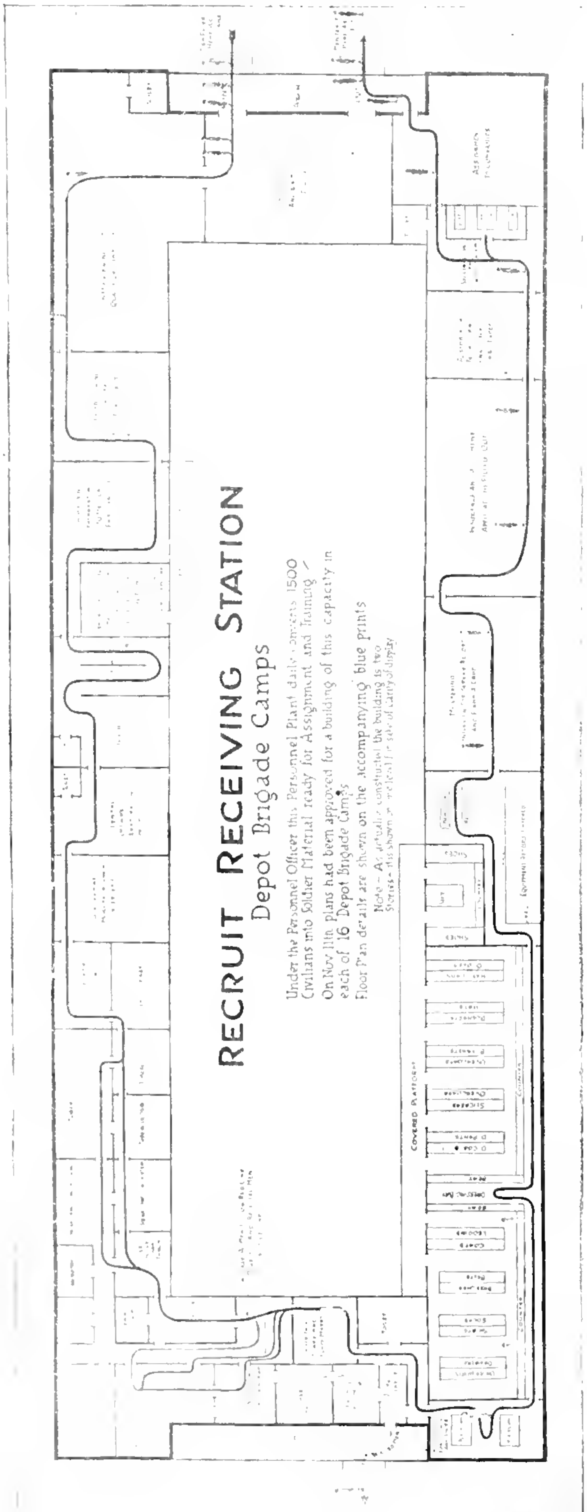


Fig. 1 Recruit Receiving Station

reports to the Central Office in Washington regarding the total numbers of men of various trade or professional ability within the camp, and available for transfer to other units or organizations.

At regular intervals a detailed tally of the cards of all unassigned drafted recruits in the camp was made and a report of totals of men under the standard occupational headings, and whether journeymen or apprentice, was forwarded to the Central Personnel Office in Washington.

Fig. 3 is a page from the Army Trade Specifications, and shows three of the 714 occupations in the Army classification system. The preparation of this list involved a very thorough detailed study of all of the organizations within the entire Army and an analysis of all of the trades or types of men required in such organizations. It represents the standard which was employed throughout the Army to designate trades and occupations. In other words, the mere statement that a man is a blacksmith is not sufficient, as the meaning of this term differs in different localities and in different industries. In the Army system, the general heading "Blacksmith" is required as a group heading and it is subdivided to cover various types of blacksmiths, and each of these types has a special name and a symbol. By the use of these specifications it is possible for any one desiring to requisition tradesmen to determine just what type of man is desired by examination of the specifications and then call for such man, using the standard name and symbol. The occupational list and trade specifications thus form the common language employed throughout the entire Army organization, and were the basis of the personnel classification employed.

The Clearance or Allotment Section of the Central Personnel Office was in Washington, and each week this office received an Occupational Report from all camps or draft receiving depots. The data on these separate reports were posted or consolidated in what were known as Supply Books under the headings of locations and trades. The Supply Books, therefore, gave the total supply of skilled men of all kinds in the camps and depots of the country.

The demand for skilled men came from the technical staff corps and the divisions being formed, and upon the receipt of a requisition by the Allotment Section the requirements stated thereon were examined with regard to the nearest camps or available supply of men as shown by the Supply Books, and an Allotment Sheet made out in which was stated the camps from which the supply was to be filled, and the number and kinds of men to come from each. From this Allotment Sheet a series of formal orders was made out, one for each camp or depot. With the completion of the Unit Allotment Sheet, which is presumed to cover all details of the requisition, separate Adjutant General orders were made out for each of the camps from which men were to be drawn. The Personnel Officer at the camps receiving "through channels" the regular order for transfer proceeded to issue the necessary camp orders and made out a "report of transfer," a copy of which was returned to the Allotment Section, so that actual shipment could be checked against its order.

All of the foregoing sounds exceedingly simple, but it requires great care and accuracy in order that mistakes be avoided and it is in this connection, and particularly because of the close coöperation between the Central Personnel Office in Washington and the Personnel Organization in the various camps, that it was possible to reduce the time of organization of a division from the nine months required in the early stages to three months toward the end, and also to effect more thorough organization in the shorter time.

Approximately 3,700,000 men of all sorts were thus carded and classified and requisitions were received and orders issued for the disposal of approximately 1,200,000 men, distributed as follows:

General Service	865,058
General Service—Colored	180,412
Limited Service—White	59,294
Army Schools, White and Colored	89,058
Special Draft (P. M. G.)	56,009
Induction Authorized	161,663

The method of recording information with regard to officers was, broadly speaking, exactly the same as in the case of enlisted men. When it is considered that there were approximately 195,000 officers in the Army at the close of the war, some slight idea can be gained of the necessity of being able instantly to locate or select officers of various experiences and abilities in

order to organize or reorganize infantry or technical units. In the case of officers, however, inasmuch as considerable additional information was required over that for enlisted men, the card was made larger. On these cards were recorded in a systematic manner and uniformly, history, education, experience and all other data to afford a clear picture of each individual officer. The original card was filed with headquarters of the particular unit with which the officer was connected. A duplicate card was filed in the Central Personnel Office at Washington or at headquarters overseas, and as officers were ordered overseas copies of the cards went with them in order that the system might operate efficiently with the fighting forces.

Rating of Officers

In the past, officers were selected or promoted by seniority or on the basis of personal judgment of some superior. When the Army was small and there were relatively few officers, this system, though not ideal, was used with a fair degree of satisfaction. However, with the rapid inflow of new material necessary to meet the tremendous expansion of the Army, it was impossible to employ such a system, and it became evident that some standard method must be devised which would insure accuracy of results and impartial treatment to all.

To meet this condition the Central Personnel Organization at Washington put into effect a Rating System devised by Walter Dill Scott, Director of the Committee on Classification of Personnel in the Army. Starting with the Officers' Training Schools, this system was put into effect step by step until now it covers the entire Army and is the standard system employed for selecting and promoting officers here and overseas.

Briefly, the system is based on giving to each officer a rating which is made by his immediate superior and which rating is determined quarterly so that the improvement or change in the officer's work or ability can be credited at frequent intervals.

The system consists of each rating officer preparing for himself a scale of measurement in accordance with a simple yet effective method which can be understood by all and is universally applicable. This scale considers separately the essential qualifications of the officer, such as physical qualities, intelligence, leadership, personal qualities and general value to the service, and the rating officer considers such officer whom he has to rate in the light of these qualifications one by one as contrasted with the officer on his scale.

In preparing his scale for rating any group of officers under his command, he thinks of the purely physical qualities of all officers of his own rank with whom he is acquainted and visualizes the physique, bearing, neatness, voice, and endurance of each, irrespective of any other qualities. Among all those he has in mind, some one will stand out preëminently and he writes down the name of this particular officer as highest. Another one will rank slightly lower, still another about average, another low, and finally one will be visualized as being lowest in the quality named.

In a like manner he then selects five officers on the basis of their intelligence, another five for their leadership, others for their personal qualities, and finally those whom he believes to be of value to the service.

The rating officer then has a scale under five general headings with five names under each heading ranged from highest to the lowest with purely arbitrary factors of value opposite each name. It should be noticed that in the preparation of this scale it makes no difference whether a general or first lieutenant has worked it out, for in the preparation of the scale any conscientious officer can do this who has considered essential qualities and has made up his scale ranging from highest to lowest of men of his own rank with whom he is personally familiar.

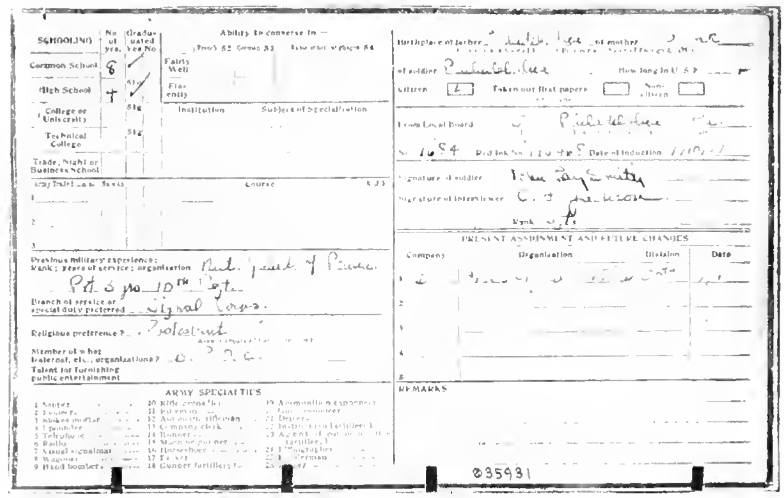


Fig. 2b Details of Soldiers' Qualification Card (Back)

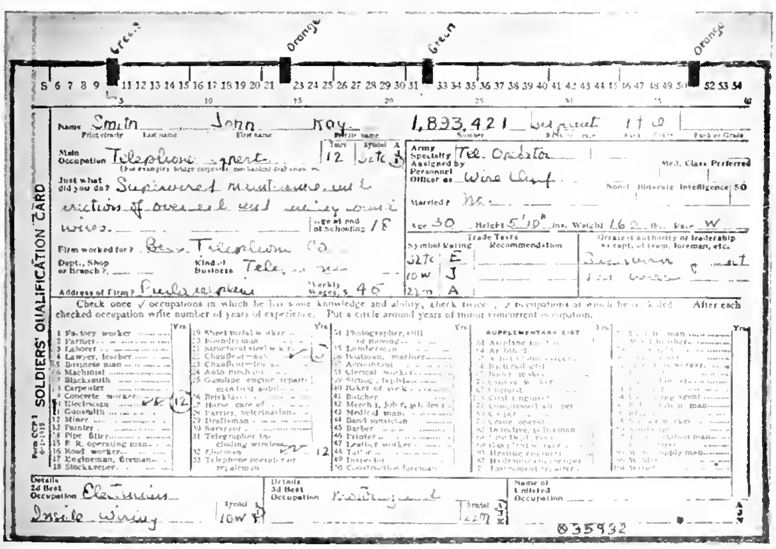


Fig. 2a Details of Soldiers' Qualification Card (Front)

In the application of the scale the reverse process is followed. If, say, a captain has to rate a number of lieutenants, he proceeds to take each and analyze him quality by quality, for the moment forgetful of all other elements of his make-up. For instance, he considers first his physical qualities, he compares him one by one with the various individuals whom he has listed in his scale. If he has the quality of the highest in the physical class, he credits that lieutenant with the highest factor; if comparable with the average man of the scale, he gives him the average factor; if lowest, the lowest factor. Having done this, he forgets completely the physical qualities and takes those of the next quality named in the scale and compares him one by one with the scale names.

In this way all officers are rated on the fine points in an orderly, logical and systematic manner, and as far as humanly possible prejudice or preference has been eliminated and the rating given each is comparable to officers of like rank no matter where or by whom rated. However, as a further safeguard the details and final rating in each case are checked by each rating officer's immediate superior.

The results obtained for October 1918 in the case of a number of large camps show that the rating officers have given average ratings of from 58 to 62, and this experience has shown to be about correct.

Psychological Tests

The results obtained through the use of various psychological tests adopted in the Army to check the intelligence or mental

alertness of men, both commissioned and enlisted, are most interesting and valuable. Some of these are shown in Fig. 4.

At the upper left side of the figure is shown a chart indicating the average intelligence of officers in the various arms of the service, the plain white indicating A and B intelligence rating, the shaded portion C+, and the black section those below C+. The chart is ranked in order of degree of A and B rating, C+, and below C+. It will be noticed that it grades Engineers at the top, with practically all A and B intelligence ratings, and a very small proportion of C+, increasing in the lower rating rather gradually, with the veterinary group at the bottom. In the latter the tests developed that of those tested about one-half were of A and B intelligence rating and one-half of C+ and below.

The lower chart on the left-hand side shows results obtained in testing the intelligence rating of men undergoing training in the Fourth Group of Officers' Training Corps. These are placed in order of highest intelligence, with Camp Lewis leading and Camp Wheeler at the bottom of the list at the time these tests were made.

The chart at the lower left center illustrates the utility of intelligence tests as applied to a group of Officers' Training Camps and Non-Commissioned Officers' Schools, the upper diagram being the summary of 1375 officer candidates. It will be noticed that the heavy vertical lines A, B, and C+ are practically all above the horizontal line, but indicate that almost without exception officer candidates having intelligence ratings of A, B, and C+ prove successful. In almost as nearly striking manner the lines C, C– and D, indicating men of lower intelligence ratings, extend below the horizontal one into the region of those who proved failures.

This chart indicates in a general way that, barring a few exceptions in a neutral zone, it would have been possible in the first instance to select candidates by some form of intelligence test, and thereby practically double the capacity of the training camps. The diagram in the lower half of the chart indicates in like manner the result obtained with the 1458 non-commissioned officers, and in this the same argument holds.

The chart at the lower right center indicates results of intelligence tests in connection with special groups, the upper diagram showing 465 promotions of various sorts, indicating that where men were "recommended for promotion" they were, to a very large extent, men of higher intelligence. The "assignment to special duty" in the case of 785 men tested, shows a similar result, although in this case the percentage of men of high intelligence is not so large. The lower line covers the test of 491 men who had been subjected to discipline for one reason or another. Here is strikingly shown the fact that low intelligence is a very serious factor; conversely, it would be assumed that with the increase of intelligence the number of disciplinary cases would decrease.

The chart at the upper right-hand side very clearly indicates the wide difference in the average intelligence of various companies making up the 319th Infantry Regiment. The height of the line for each company above the horizontal line varies from 3 to 30 per cent of men of A and B intelligence rating. The percentage of illiterates or foreigners below the line varies from 9 to 60 per cent. It will be noticed in Company A, the percentages of intelligence and illiteracy nearly balance. In Company C, however, there are only 3 per cent of the men of a high intelligence rating and 38 per cent low. It is seen from this that if a definite schedule for training had been prepared, calling for certain work to be accomplished in a definite period of time, and assuming company commanders to be of equal ability, it would be impossible for Company C to develop as far as Company E. The chart shows the importance of endeavoring to equalize the various companies in any organization, at least in the first instance. It is appreciated that when an organization gets into actual combat service, exigencies will arise which prevent carrying out any ideal system, but in the first instance, when organizations are being formed or built up and trained, such matters can receive attention.

The chart at the lower right-hand side affords a comparison of the enlisted personnel of the various arms in the 34th Division. In this division the Sanitary Detachment was first in the matter of intelligence, the Engineers being found further down the line.

B

FAMEK 7-fm **FORGING MACHINE OPERATOR**

DUTIES
1. Operation of standard types and various kinds and sizes of forging machines, such as bulldozes and hydraulic presses on general work.

QUALIFICATIONS
2. Should have thorough knowledge of rivet and bolt forging machines, screw, toggle and hydraulic presses for heading staybolts, forms, and all classes of press forgings of various materials.
Should have a practical knowledge of coal, gas, and oil types of forge furnace, and the proper heating of various material for forgings.
Must be able to set and adjust dies and maintain same and be able to turn out uniformly dimensioned product.

SUBSTITUTE OCCUPATIONS
3. Drop forge operator, press operator, heavy forge blacksmith, blacksmith. 55

HADGA 7-he **HEAT TREATER**

DUTIES
1. Heat treatment in general of steel forgings, finished parts and castings.

QUALIFICATIONS
2. Must be thoroughly experienced in the heating and oil treatment of various grades of steel for annealing or toughening for any kind of work. Must be capable of annealing, quenching and drawing of all kinds of steel forgings and castings, either rough or after being machined. Must be capable of judging temperature by the eye, and familiar with the use of pyrometers.
Must thoroughly understand the construction and operation of standard types of coke, oil, gas or electric furnace equipment, and quenching tanks, and have a working knowledge of the metallurgy of steel, at least sufficient to know how it should be heated, treated and cooled, under instruction or by test.
Should have had similar experience in forge shop of any industrial plant.

SUBSTITUTE OCCUPATIONS
3. Annealer, heater, forge heater. 56

HAEWS 7-h **HORSESHOER**

DUTIES
1. Shoeing horses and mules.

QUALIFICATIONS
2. Must be a practical horseshoer, capable of forging, shaping and punching horse or mule shoes from standard stock or bar material. Capable of removing shoes, paring and dressing hoofs, welding caulks, shaping shoes for correction of diseased or malformed feet.
Should have some veterinary knowledge, enabling him to care for and correct hoof troubles.
Must be able to handle and shoe unbroken horses under rough field conditions, and handle heavy horses and mules.
Should have some knowledge of blacksmithing and be able to make welds and do light blacksmith work.
Experienced as commercial horseshoer or as horseshoer in construction camp, or employee of company having considerable stock.

SUBSTITUTE OCCUPATIONS
3. Farrier, country blacksmith, blacksmith. 35928 57

Fig. 3 Page of Army Trade Specifications

Trade Tests

In describing the Recruit Receiving Station, mention was made of Trade Tests to check the verbal statements of men claiming trade ability. A very interesting and important side of Personnel Work in the Army has been the development and introduction of these tests into the camps and depots receiving draft men. Owing to the diversity and number of trades encountered, a very thorough study was required in determining whether tests could be applied and if so what character of tests were necessary.

As a result three forms of Trade Tests were developed, sometimes applied singly and again two or all three used. The first of these is the "oral trade test," in which the candidate or recruit is asked a series of standardized questions which have been prepared with the greatest care to eliminate ambiguity and localisms or catch features. A trained interviewer or tester asks the questions exactly as printed and in accordance with simple but very definite rules, and the recruit answers to the best of his

ability. For the benefit of the tester, the correct answer, or several answers if more than one is possible, are given under the questions. If the recruit answers correctly he is given a maximum score. If his answer is partially correct in accordance with a definite schedule, he is given a partial score. After all of the questions have been answered and scored by the tester, the total is taken and compared with the rating scale, which scale gives the terms Novice, Apprentice, Journeyman and Expert within certain numerical limits. In other words, in the case of the tailor's test, a score of from 18 to 37, inclusive, would give the recruit a rating of Apprentice; 42 to 56, inclusive, Journeyman; and 59 and above, Expert.

The second form of the test is known as the "picture test," and employs pictures of certain essential tools or devices of the trade with which a man who has or can perform in the trade must be familiar. In this test a sheet of numbered pictures is given to the recruit and the tester holds a corresponding question sheet with questions and answers corresponding to the numbered pictures. The recruit must name the various tools or appliances and the tester scores up and gives a rating as in the former case.

Post 3 round a curve. The scorer then tells him to back up to Post 2. This little preliminary run indicates whether the recruit can drive a car at all, and gives evidence of sufficient ability to proceed with the remainder of the test. It also gives the man a familiarity with the throttle and gearing and "feel" of the particular machine to be tested. The scorer then instructs him to drive on to Post 4 and turn to the left and enter the S or reverse-curve section outlined by vertical post or stakes. He is instructed to drive through this S at whatever speed he regards as best and must not stop nor drive in a jerky, irregular manner, and he must not knock down any stakes. In emerging from the reverse curve to the large square he is required to drive close up and with his hood at the center of the board at station 5. The scorer then instructs him to back away and around the semi-circle section to the second square and continue backing until the tailboard is close up to and in the center of the board 6, which is supposed to represent a loading platform. He is then told to run forward close to Post 7, where he stops on the grade, and then start and run up to the top of the grade, turning around with no more than one backing and without stalling engine or grinding gears,

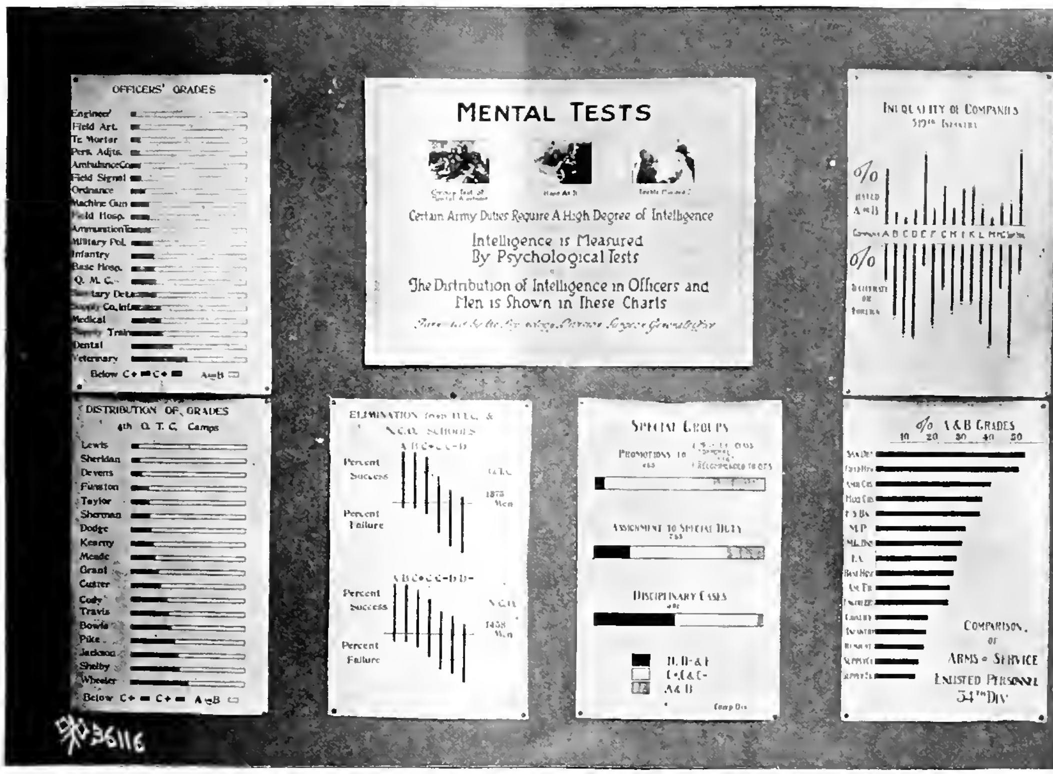


Fig. 4 Results of Psychological Tests

The third and last test consisted of an actual demonstration of the recruit's abilities. In the case of truck or auto drivers a course was laid out and each candidate was required to perform certain definite operations in a definite sequence and under identical conditions. If in doing this work he fails to perform all of the operations or does certain other things against which he is warned, he receives less than a perfect score. As in the former cases, totaling the scores gives a figure which enables the man to be rated as a Novice, Apprentice, Journeyman, or Expert.

In operation, the system is as follows: A recruit having claimed more or less ability as a truck driver when being interviewed in the first instance, is given an oral Trade Test, and provided he is classed by the interviewer as an apprentice, journeyman or expert in this, he is ordered to present himself at the performance-testing station at a definite time. On arrival at the testing station or truck course he takes command of a standard truck with a tester or scorer on the driver's seat with him to give instructions and score him for results.

The scorer instructs him to drive up to Post 1, which is the start of the test. He is then told to drive to Post 2 and on to

and then to run down the incline to the starting point. Careful instructions are given and all candidates are treated alike. It will be seen that the conditions of this test are very exacting, and it has been found that any man who gets a score of Journeyman or Expert in the test can subsequently make good under any conditions of service.

In accordance with the plans 92,550 truck drivers, 36,000 motorcycle drivers and 30,000 automobile drivers were needed overseas. These tests effected an enormous saving in maintenance and repairs because valuable transportation equipment was not turned over to inexperienced or incompetent men to be wrecked in a few hours, but was put in the hands of men proved to be skillful both in operation and care of their equipment.

The motorcyclist's test and the auto driver's test are in principle the same with varying details, inasmuch as conditions of practical operation vary somewhat from the truck driver's. It is interesting to note that these tests are at least in principle the rebirth of a system employed by the French in the very early days when automobiles were just beginning to appear in France, which was really the pioneer in automobile use. The municipal

authorities in Paris, and later in other continental cities, and still later in a few instances in the United States, employ practical tests of this sort before issuing licenses to drivers.

Carpenters were in great demand and to obtain these men the following test was employed: The recruit receives a blueprint or working drawing with dimensions and full instructions as to what is required in the finished piece. The material and tools are standard throughout and wherever the tests are conducted. The work to be performed consists in ripsawing a slab from one side of a 2-ft. piece of 2 x 4 rough scantling, in chopping with a carpenter's hatchet on one edge, planing of one face and edge and chiseling a smooth dovetail mortise at one end of the piece, all in accordance with the dimensions in the instruction print. The particular job has been prepared after extensive study with an idea of requiring a minimum amount of material and reasonable time, and yet to permit the fundamental operations required of a general carpenter, such as ripsawing, chopping, planing, chiseling, squaring, working to dimensions from a drawing or blue print, etc.

The tester is provided with a definite system of marking, scoring or crediting, so that each man is judged on what he has done in accordance with the standard system. This would give him the same rating regardless of where he performed his work, or by whom he was judged. In other words, in this test, and all of the trade tests, the fundamental criterion has been that the method of administering the test, scoring, and rating would be such that a man tested at any of the trade-test points and receiving a rating would have received exactly the same test at any of the other testing points.

Tests were also devised for linemen, patternmakers, inside house wiremen and blacksmiths, and since these trade tests were instituted about 250,000 soldiers have been tested.

These tests also emphasize the fact that it is not possible to accept a man's statement of his trade ability, for while the majority of men endeavor to tell the truth, each man's judgment of his own ability is nevertheless not comparable with any definite standard.

Briefly, the steps necessary in giving trade tests are:

1 The procurement of the necessary information
2 The preparation of questions on the basis of this information
3 The test of data and the revision of such questions or tasks
4 The second revision
5 The practical tryout to insure the value of the various questions for checking trade ability
6 A further analysis and check
7 The preparation of the tests in final form for practical use
8 The accumulation of further information bearing on results of the tests with the idea of improving them if it is thought necessary.

The foregoing is but a brief review of the general work which has been conducted by the Committee on Classification of Personnel in the Army. It is hoped that it will in some small way afford a clear and logical picture of classification as employed in the Army at the time the armistice was signed. It is sincerely hoped that this work, which was in a large degree responsible for the rapid and efficient organization of the Army, will not be permitted to lapse, but will be further perfected and carried forward, and as time goes on become a complete and permanent part of the Army Establishment.

Peat and Its Uses

Attention is called by the Department of the Interior, in a recent bulletin, to the vast undeveloped peat deposits in the United States, and to the many possible uses of peat. In northern Europe it is used for fuel and as the basis for many manufacturing industries. Gas, charcoal, coke, and a number of valuable by-products are produced from it. Owing to the scarcity of raw materials in Europe, peat and peat moss are also employed as substitutes for absorbent cotton in the preparation of surgical dressings, for wood, and for cotton and woolen cloth. In the United States peat is utilized chiefly as fertilizer and fertilizer filler, as stable litter, and as an absorbent for the uncrystallized residues of beet- and cane-sugar refineries in the manufacture of stock feed. The shortage of coal in the Eastern and Central States that began toward the end of 1917, however, has stimulated a wide interest in the potentialities of peat as a source of auxiliary fuel.

The following information concerning the features of peat as fuel has been gathered and published by the United States Geological Survey:

Peat in an undrained bog contains about 90 per cent of water, which must be reduced to 30 per cent before the peat can be used for fuel. By thoroughly draining the deposit, approximately 10 per cent of the original water contained in the peat may be eliminated, but the remainder which is held in the microscopic plant cells and minute intercellular spaces, cannot be reduced below 70 per cent without drying in the open air or in a heated chamber. No process of artificial drying has been developed as yet which can be considered as in any way one that is commercially feasible.

The value of a given deposit of peat as a source of fuel is dependent upon many factors, most important of which are degree of decomposition, heating value, and ash content. The maximum quantity of ash that is usually considered allowable in peat for commercial use has been placed at between 20 and 25 per cent, but if it exceeds 20 per cent of the total dry weight the peat is not considered worth the labor of production.

The comparative calorific value of peat and other fuels is given by the following figures:

	B.t.u.
Wood	5760
Air-dried cut peat	6840
Air-dried machine peat	7290
Lignite	7500
Bituminous coal	14000
Anthracite	13000

Cut peat is bulky, is easily crushed, and burns rapidly with considerable waste; it is superior to wood in heating value but is unfitted for commercial use. Machine peat is suitable for both domestic and industrial use. Powdered peat is well adapted for use under steam boilers with forced draft; for open grates this fuel is nearly ideal, and peat may be burned in the same stoves as coal and wood.

The machinery for the preparation of machine peat consists essentially of an excavator and a macerator. In principle and form the latest types of peat machines are similar to the pug mill or grinding machine for plastic clay. After being thoroughly macerated the peat is shaped into compact blocks as it comes from the machine. Machine peat which is allowed to dry slowly contracts into a dense mass covered by a gelatinous, skinlike substance called hydrocellulose. After the moisture has been reduced to about 25 per cent, this coating renders the machine peat impervious to water, even when immersed.

Powdered peat is prepared by reducing the moisture content to about 25 per cent and pulverizing the resulting material. It is said that when powdered peat is blown with compressed air into the furnace, ignition is almost instantaneous, the peat forming a gas which gives a uniform fire throughout the entire combustion chamber.

The value of peat, however, lies in its distillation rather than its combustion, and on these lines it could supersede wood in the production of acetic acid, methylated spirits of ammonia and tar. In the process of distillation peat requires larger retorts than coal, and of a design which facilitates the transmission of heat from the surface toward the center. Experiments have shown that revolving retorts produce the best results; the rotary movement of the retorts insures uniform carbonization in a short time and at a relatively low temperature.

To enable the gas arising from the carbonized peat to pass out of the retorts, the hollow shaft of each is perforated so as to provide a passage from the inside of the retort to a collecting chamber in the axis of the pivot and thence to the stills for fractional distillation. The distillation takes about forty minutes for retorts holding a ton of peat and making six revolutions per minute.

Electrical Measurement of Fluid Flow in Pipes

Theory and Development of a Device Embodying an Ammeter and Watt-hour Meter and in Which the Electric Current Flowing is Proportional to the Quantity of Fluid Passing Through the Pipe

By JACOB M. SPITZGLASS,[1] CHICAGO, ILL.

DESPITE the fact that the science of mechanical engineering is much older than that of electrical engineering, its methods of measurement are nevertheless in many respects much behind those afforded by the latter. A striking example of this is found in a comparison of the methods of measuring fluid motion in pipes and the flow of an electric current. The instrument used for the electric current is simple and direct-reading, and while there have been many excellent devices adopted for measuring the flow of fluids in pipes, it has been quite generally agreed that an instrument similar to the ammeter or wattmeter would be of great value.

Recently the writer had the privilege of experimenting with a flow-measuring device in which these instruments are applied. Measurement is accomplished by means of an electric current which is so regulated by the differential pressure of the flow that it represents the amount of fluid passing through the pipe.

The main features of the device are shown diagramatically in Fig. 1. The U-tube, partly filled with mercury, is made to balance the impact pressure of the flow in the pipe by the rise of mercury in the low-pressure side of the tube. The mercury column also forms a part of the electric circuit, as shown in the figure. This electric circuit contains a fixed external resistance R_1 in series with a variable internal resistance R_2, a constant electromotive force E, an ammeter A and a watt-hour meter W. In the contact chamber C, which forms the low-pressure side of the U-tube, there are a number of conductors of varying length placed above the mercury column, and as the mercury rises it makes contact with one conductor after another. The variable resistance R_2 is subdivided by these conductors into resistance steps corresponding to the varying length of the conductors, so that the rise and fall of the mercury column varies the amount of resistance and thereby regulates the amount of current passing through the circuit.

The basic principle of the device accordingly involves the laws governing the flow of fluids through pipes along with those governing the flow of an electric current. The problem of establishing the theoretical relation between these fundamental laws offered little difficulty because of the similarity between the units of flow measurement, such as pressure and velocity, and the units of electric measurement, such as voltage and current. On the other hand, the attempts to apply the theory to a working model were beset with numerous difficulties, and the obstacles that were overcome during the long period of experimental work presented many problems which are briefly dealt with in later paragraphs.

Units of Flow Measurement

The relation between the pressure and velocity of fluids in its simplest form is represented by the well-known equation

$$\frac{v^2}{2g}\delta = P_2 - P_1 = hw$$

or

$$v = \sqrt{\frac{2g(P_2 - P_1)}{\delta}} = \sqrt{2gw}\sqrt{\frac{h}{\delta}} \quad \text{. . . . . [1]}$$

where v and δ represent the velocity and density of the fluid; $(P_2 - P_1)$ the equivalent differential pressure; h the height and w the density of the liquid column balancing the differential pressure of the flow.

This differential pressure hw may be obtained, as shown in Fig. 2, either directly by balancing the difference between the dynamic and static sides of a pitot tube inserted in the line, or indirectly by balancing the difference between the high- and low-pressure sides of a venturi tube, nozzle tube or orifice plate. In the case of the pitot tube, the differential column in the U-tube represents the flow or motion existing at the given section of the line, but in the venturi tube, nozzle or orifice, the column obtained represents the *change* of motion produced by the artificial obstruction of the passage at the given section of the pipe.

In any case, however, the relation between the differential column thus obtained and the velocity of the fluid in the pipe may be represented by Equation [1], provided there is introduced

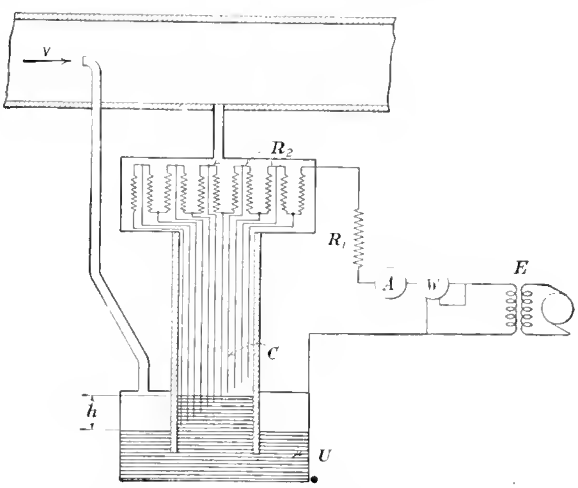


Fig. 1 Diagrammatic Sketch of Author's Electrical Device for Measuring Flow of Fluids in Pipes

the experimental coefficient derived for the given tube or orifice. Thus in general,

$$v = C\sqrt{2gw}\sqrt{\frac{h}{\delta}} \quad \text{. . . . . [2]}$$

The volume of the fluid Q passing per unit of time through an area A is given by the equation

$$Q = Av = AC\sqrt{2gw}\sqrt{\frac{h}{\delta}} \quad \text{. . . . . [3]}$$

the corresponding weight G per unit of time is

$$G = Q\delta = (A\sqrt{2gw})C\sqrt{h\delta} = KC\sqrt{h\delta} \quad \text{. . . . . [4]}$$

and the total weight S for a given period of time t is

$$S = Gt = KCt\sqrt{h\delta} \quad \text{. . . . . [5]}$$

Units of Electric Measurement

Having adopted the foregoing general equations for the flow of fluids, the corresponding electric measurements may be covered by the following definitions:

I = current in amperes flowing through the electric circuit of the measuring device. The instrument was designed so as to have one ampere represent the maximum capacity of the meter

E = electromotive force of the circuit. A uniform pressure of 40 volts was selected to represent the average density of the fluid measured

Wt = amount of electric energy expended in the circuit of the device in a period of time t

R = total resistance of the circuit in ohms.

For presentation at the Spring Meeting, Detroit, Mich., June 16 to 19, 1919, of The American Society of Mechanical Engineers. All papers are subject to revision.

[1] Vice-President and Consulting Engineer, Republic Flow Meters Co., Mem.Am.Soc.M.E.

F = rate of flow in the pipe corresponding to the electric current in the circuit, or the ratio of G to I. F is the "indicating factor" of the flow meter.

T = total amount of flow or weight of fluid corresponding to the electric energy passed through the circuit. T is the ratio of S to W, and is designated as the "totalizing factor" of the flow meter.

Since by definition $FI = G$ and from Equation [5] $G = KC \sqrt{\delta}\sqrt{h}$, therefore $FI = KC\sqrt{\delta}\sqrt{h}$, or

$$I = \frac{KC}{F}\sqrt{\delta}\sqrt{h} \quad \text{[6]}$$

The value of K is constant for any given set of conditions as determined from Equation [4]. The value of C, depending upon the particular design of the tube or orifice, is also constant for any given case.

To find the value of F, let $I_{max.}$ be the current in amperes corresponding to the maximum capacity of the meter, $G_{max.}$, which in turn corresponds to the maximum differential column $h_{max.}$ From Equation [6]:

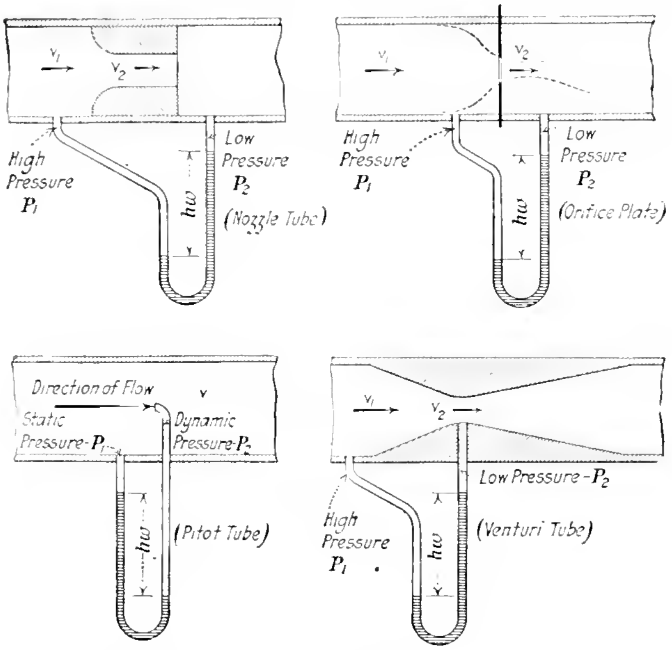


FIG. 2 METHODS OF DETERMINING VELOCITY PRESSURE

$$I_{max.} = \frac{KC}{F}\sqrt{\delta}\sqrt{h_{max.}} \quad \text{[7]}$$

whence

$$F = KC\sqrt{\delta}\frac{\sqrt{h_{max.}}}{I_{max.}} \quad \text{[8]}$$

and since $I_{max.}$ is equal to unity,

$$F = KC\sqrt{\delta}\sqrt{h_{max.}} \quad \text{[9]}$$

The quantity $\sqrt{h_{max.}}$ is called the characteristic or the scale of the given meter and it determines the capacity of the meter, depending upon the amount of differential column $h_{max.}$ which the meter is able to develop and record.

Combining Equations [6] and [9],

$$I = \sqrt{\frac{h}{h_{max.}}} \quad \text{[10]}$$

It is interesting to note that $h/h_{max.}$ represents the relative value of the differential column for a given rate of flow, and $100\ h/h_{max.}$ is the percentage variation of the head in any given meter. From Equation [10] it follows that in order to represent the amount of flow, the current I should be numerically equal to the square root of the relative height of the mercury column in the U-tube of the meter. From the same equation,

$$h = I^2 h_{max.} \quad \text{[11]}$$

That is, the height of the column for a given flow is numerically equal to the constant $h_{max.}$ times the square of the current flowing through the circuit.

From Ohm's law ($E = IR$) we obtain by substitution

$$R = E\sqrt{\frac{h_{max.}}{h}} \quad \text{[12]}$$

That is, the resistance R in the circuit should be numerically equal to the voltage divided by the square root of the relative height of the differential column.

It remains to determine the value of T, the "totalizing factor" of the instrument, or the ratio of S to W. Since $Wt = EIt$ and by definition $TWt = S = Gt = FIt$, therefore

$$T = \frac{F}{E} \quad \text{[13]}$$

That is, the totalizing factor of the meter is equal to the indicating factor divided by the voltage in the circuit.

Fig. 3 shows diagrammatically the relation of the units involved in the electric measurement of the flow. The parabolic curve to the right shows the variation of the current in the electric circuit representing the capacity of the flow and corresponding to the percentage variation in the differential column balancing the velocity pressure of the flow. This curve represents the solution of Equation [11]. The hyperbolic curve to the left of the diagram shows the relation between the current and the corresponding resistance at the given voltage of the electric circuit. The solution of Equation [12], or the relation of R to h, is obtained indirectly by following from a given value of R on the resistance curve to the corresponding value of h on the current-and-capacity curve.

It will be observed that the diagram does not include the first 10 per cent of the flow capacity inasmuch as this represents only 1 per cent of the differential column, which is as low as a practical device is able to measure with any degree of accuracy. This disadvantage, however, is offset by the fact that the scale of the flow meter can be so chosen that the desired measurements will fall within the active part of the scale.

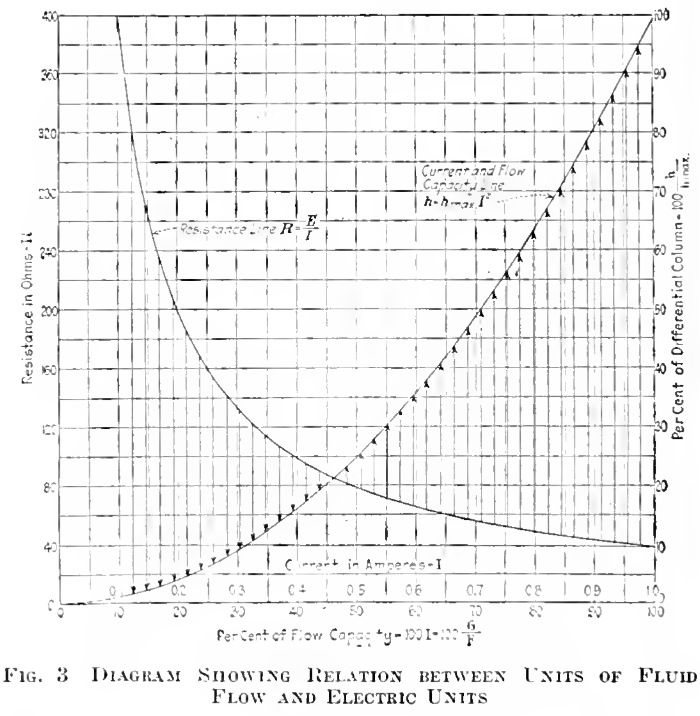


FIG. 3 DIAGRAM SHOWING RELATION BETWEEN UNITS OF FLUID FLOW AND ELECTRIC UNITS

PRACTICAL APPLICATION

After the relations between the various factors had been determined, the problem reduced itself to the construction of a resistance which would be regulated by the differential column of the flow according to the solution of Equation [12]. The first attempt in this direction was made by inserting a continuous

resistance coil in a water manometer where the height of the water column would reduce the amount of resistance in the coil by short-circuiting the part immersed in the water. The first trials were made with direct current, and while it was anticipated that electrolytic action would be set up between the metal conductors and the water, it was nevertheless expected that this action would not take place when alternating current was used.

There was little information available on the subject and it was therefore necessary to determine experimentally the amount of resistance needed. After obtaining some idea of the amount required and being hindered by the accumulation of deposit in the container, which was at first attributed to the electrolytic action of the direct current, provisions were made to continue the experiments with alternating current. It was discouraging, however, to note that practically the same action took place between the metal conductors and the water when alternating current was used. Repeated analyses of samples of the deposit disclosed that it was a formation of oxide, due to the corrosion of the metal conductors in contact with the water.

Besides the formation of deposits, there were other disadvantages in short-circuiting the metallic resistance by a water column. On one hand the conductivity of the water varied with its hardness, thus introducing a variable resistance in the part of

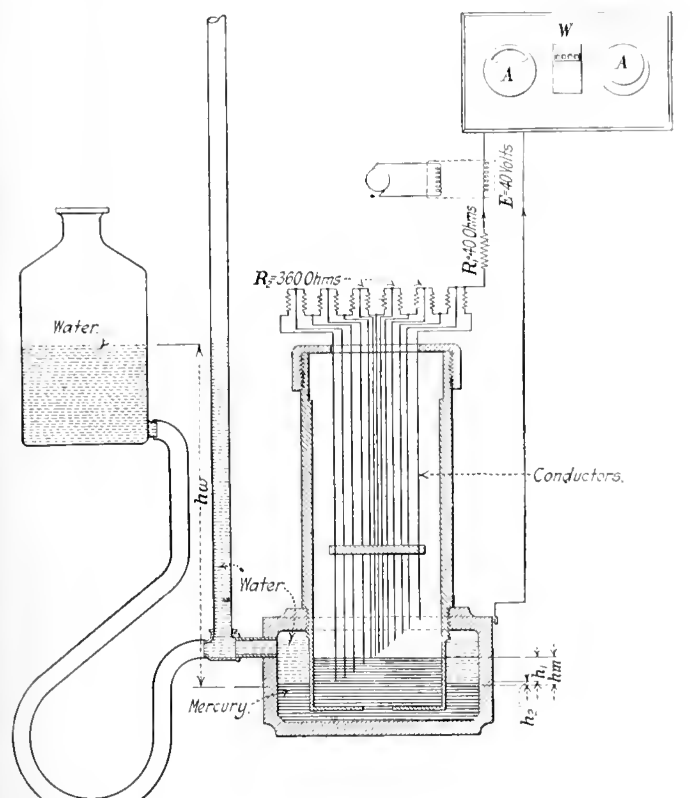


FIG. 4 DEVICE IN WHICH RISE OF MERCURY COLUMN REGULATES AMOUNT OF CURRENT

the column which was covered by water, and on the other the vapors formed over the surface of the water had a tendency to short-circuit the resistance coils, again introducing a similar variable in the portion of the column above the level of the water. When repeated attempts to eliminate these defects had failed it was decided to adapt mercury instead of water for the regulating column of the instrument. The use of mercury, however, necessitated radical changes in the form of the device. The effective column of mercury for the average velocity pressure would be too small to cover the continuous resistance coil and produce the desired regulation of the resistance. It was therefore found necessary to regulate the resistance by steps through conductors coming in contact with the top of the mercury column. Fig. 4 shows the elementary form of experimental device adapted for this purpose.

In this elementary device the successive conductors were divided into steps of equal height from the zero level of the mercury column. The electromotive force of the circuit was maintained constant at 40 volts. The resistance of the circuit, which amounted in all to 400 ohms, was subdivided by the contact rods into 40 consecutive steps, and the amount of resistance provided for each step was determined from Equation [12]. Using these values the maximum current of 1 ampere corresponded to the minimum resistance of 40 ohms, while the minimum current of 0.1 ampere corresponded to the maximum resistance of 400 ohms.

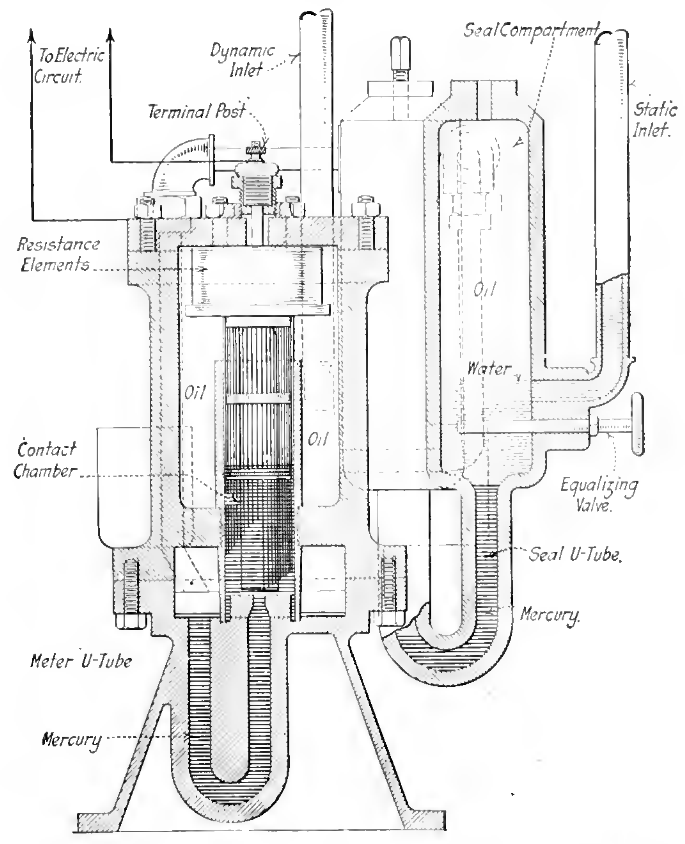


FIG. 5 LATEST TYPE OF AUTHOR'S FLOW METER WITH MERCURY SEAL

Between these limits the rise and fall of the mercury column produced by the variation of the head on the high-pressure side of the U-tube would vary the amount of resistance in the circuit in accordance with the hyperbolic curve shown on the left of Fig. 3, thereby regulating the amount of current passing through the circuit in accordance with the parabolic curve on the right of the figure.

The operation of the elementary device was successful from the very start, but only as long as the contact chamber was kept free from water did the regulation of the current correspond with the variation of the head or the height of the mercury column. On the other hand, the instrument when equipped with an oil seal and connected to a pitot tube in the steam line could not be made to operate properly. When left under pressure the oil would leak through the fiber plug and allow water to get into the contact chamber, which would immediately put the instrument out of order.

To overcome this action the body of the instrument was extended to include also the resistance coils attached to the contact rods and the circuit completed through a plug connecting the internal and external resistances together. This change eliminated the leakage of oil from the instrument, but still the water could not be kept out of the chamber for any length of time. In some cases the water would blow through the mercury as soon as the pressure was admitted to the instrument. It was thought at that time that a bypass valve connecting the static and dynamic tubes when the pressure is admitted to the instrument would eliminate this trouble. After many changes in the original design an instrument

was made which for a short period of time was used as a steam-flow meter. In this instrument, besides the equalizing valve, an additional overflow chamber was provided to keep the water from reaching the conductors over the surface of the mercury. A terminal post replaced the connecting spark plug, thus allowing an adjustment of the position of the conductors with respect to the level of the mercury column. These additions, however, did not entirely eliminate the possibility of water coming in contact with the resistance elements of the device. With a uniform flow in the pipe the operation of the instrument would continue for some time, but when a slight disturbance of pressure occurred in the line it would cause the water to blow through the mercury into the contact chamber and this would immediately discontinue its operation.

Notwithstanding this objectionable feature, the convenience of the electric measurement of the flow and the fact that the instrument would function as long as there was no water in the contact

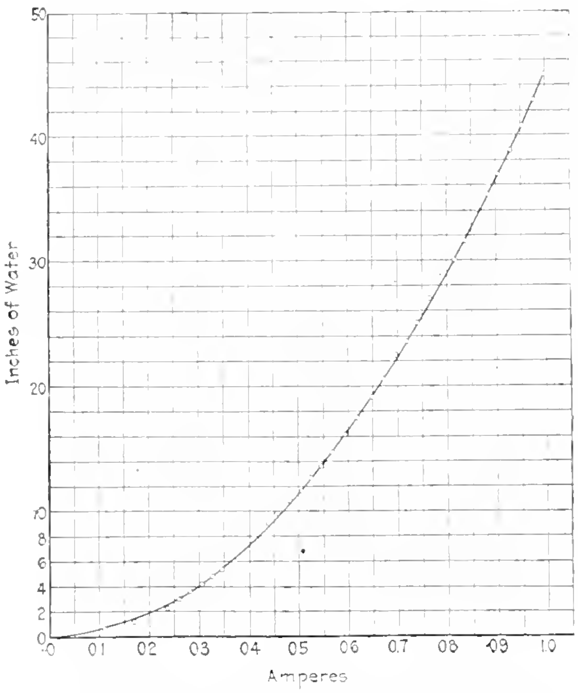


Fig. 6 Comparison of Curve Obtained from Equation [11] with Data Plotted from Table 1

chamber, have encouraged further experimenting for the elimination of defects. The problem was finally solved in the fall of 1917 by the addition of a mercury seal connected in parallel with the working base of the instrument. The function of the mercury seal in this case is quite similar to that of a fuse plug in an electric circuit, with the added advantage that it is self-replacing. The principle of its operation is illustrated in Fig. 5, which shows a section of the meter body and seal chambers. It can be seen that the U-tube joining the two compartments of the seal will contain a column of mercury about one-half the height of the column in the meter body. Under normal operation the mercury column in the seal acts in unison with the mercury column in the meter body and does not interfere with the proper transmission of the differential pressure in the meter. When, however, some disturbance of pressure occurs in the line sufficient to break the seal, the mercury spreads over the larger area of the compartment, equalizes the pressure in the two compartments in the same manner as would an automatic opening of a bypass valve, and thus prevents the breaking of the higher column in the U-tube. As soon as the abnormal differential pressure is released, the mercury drops back into its place and reëstablishes the necessary seal between the two compartments. In this model a large quantity of oil is trapped in the two compartments of the seal and in the meter body, eliminating the possibility of water blowing through the mercury and coming in contact with the resistance elements of the meter.

In the latest type of the flow-measuring device the contact rods were changed from their former equal spacing above the zero level to spaces varying in height so as to give at each step equal increments of current representing equal amounts of flow. This was accomplished by gaging the length of the contact rods to follow the parabolic curve shown at the right in Fig. 3, which represents the solution of the equation $h = I^2 h_{\max}$. In the actual gaging of the contact rods $h_{\max.}$ is taken as the distance between the zero level of the mercury and the end of the contact rod showing the maximum flow. The successive heights of the rods for the given equal increments of current are determined more conveniently by differentiating Equation [11], $h = I^2 h_{\max}$. The first differential, or $dh = h_{\max.}\ (2IdI + dI^2)$, represents the respective increments of h corresponding to the given increments of I. The second differential, or $d^2h = 2h_{\max.}dI^2$, represents the respective difference in the successive increments of h, from which it is noted that the distance between the successive contact rods is increased uniformly by the constant quantity $2h_{\max.}dI^2$.

Testing for Accuracy

The accuracy of a flow-measuring device is necessarily made up of two factors. One is the accuracy with which the device registers the differential pressure equivalent to the flow in the pipe, and the other is the accuracy with which it will indicate or record this differential pressure or the equivalent units of flow. In the usual application of the flow meters, where the pitot tube, the venturi tube, or the orifice plate is used for obtaining the differential pressure of the flow, the efficiencies of these devices have been determined by numerous tests and are at present well known. Their nature is such that a given flow will always produce the same effect under the same conditions, since they do not possess any working parts to vary the relative effectiveness of their operation. On the other hand, the indicating or the recording elements of such devices may vary from time to time depending upon the condition of the moving parts in these elements. It is necessary, therefore, to have convenient means for testing them in order to ascertain their accuracy at frequent intervals.

Table 1 gives the data of a typical test on the resistance element of the flow-measuring device, showing the relation between the differential column and the corresponding readings of the electric current.

TABLE 1 DATA OBTAINED FROM TEST OF AUTHOR'S ELECTRIC FLOW-MEASURING DEVICE

(E_1 = 112 volts)

h in. water	E_2 volts	I amperes	h in water	E_2 volts	I amperes
0.45	40.15	0.110	16.12	39.45	0.592
1.06	40.15	0.170	17.43	39.45	0.618
2.06	40.15	0.235	19.44	39.35	0.642
2.81	40.05	0.260	21.00	39.25	0.666
3.56	40.05	0.280	22.75	39.25	0.689
4.00	39.95	0.305	24.00	39.25	0.713
4.56	39.95	0.326	25.25	39.25	0.740
5.125	39.85	0.347	27.00	39.25	0.765
5.875	39.85	0.370	29.125	39.15	0.790
7.00	39.75	0.392	30.00	39.05	0.814
7.56	39.65	0.418	31.625	39.05	0.838
9.125	39.75	0.434	34.06	39.05	0.860
9.875	39.75	0.458	35.37	39.05	0.882
10.812	39.65	0.480	37.00	39.00	0.905
11.25	39.55	0.505	38.75	38.90	0.930
12.50	39.65	0.523	40.75	38.80	0.953
13.56	39.55	0.542	42.875	38.70	0.978
14.87	39.55	0.566	44.75	38.45	1.000

In Fig. 6 the points obtained from the test are indicated by the small circles, and for comparison a curve is shown giving the theoretical relations according to the equation $h = I^2 h_{\max}$. In this test the differential pressure was obtained by varying the height of a water column connected to the dynamic side of the meter. The electric current was supplied to the indicating instrument through a transformer, and the primary or line voltage was kept

(Concluded on page 487)

The Design of Riveted Butt Joints

Simple General Equations for Use in Design, Derived from Schwedler's Graphical Method

By ALPHONSE A. ADLER,[1] BROOKLYN, N. Y.

In this paper Schwedler's graphical method of designing riveted joints is analytically treated by the author, who states the fundamental assumptions employed and submits brief evidence for their justification.

A general equation is derived to determine the pitch in any row, and another to determine the efficiency in ideal cases. The design of cover plates is also considered.

Actual joints are calculated, using commercial dimensions, and the close agreement found between the ideal and calculated efficiencies seems to indicate that the scheme of analysis is consistent. The design of a quadruple-riveted joint furnishes the data for the single-, double- and triple-riveted joints by simply omitting the extra rows of rivets.

In the design of riveted joints certain assumptions are made the justification of which is ascertained from their agreement with the results of experiments. Among the more important of these assumptions are the following:

a The tensile resistance of the joint is directly proportional to the net area under stress

b The shearing resistance of the joint is directly proportional to the total cross-sectional area of the driven size of rivets

c The bearing resistance of the joint is directly proportional to the total projected area of the driven size of rivets

d There is no bending stress in the rivets

e The frictional resistance of the joint is independent of the strength.

Of the foregoing, the first assumption is perhaps the one which involves the greatest discrepancy. This subject was studied by Coker[2] by means of an optical method. A perforated plate of xylonite was placed between the polarizer and analyzer of a pair of Nicol prisms. By this means Coker showed the intensity of stress around the rivet hole. An analytical treatment of this problem was given by Suyehiro[3] and his results show fair agreement with those obtained experimentally by Coker. Suyehiro further shows that if the hole in a plate is plugged, the resultant stress around the rivet hole is very much less. In the latter case it corresponds to a riveted joint when the rivets are driven, as only in this case can the plate be loaded. The stress intensity between the rivet holes, nevertheless, is not uniform.

Assumptions *b* and *c* are common in structural and machine design and are dealt with at length in the more important texts on strength of materials.

Assumption *d* is also common in structural design. Since the rivet completely fills the hole and the plates are comparatively rigid, there is little chance for bending and hence the bending stress is negligible.

The last assumption forms the basis of another method of designing joints the advantages of which are pointed out by Bach[4]. Briefly stated, joints in this country are designed for strength and checked for tightness, while in the method proposed by Bach the procedure is reversed and quite different from that in the former case.

After all, if actual joints are riveted up and tested to destruction, the data so obtained yield the maximum values of the stresses in tension, shear and bearing. If these values are then used in actual designs the process becomes reversible and errors made originally in the assumptions are automatically canceled. Indeed, this is the general plan followed in structural design today. For the limited sizes of plate and rivets used in boiler joints it should give results sufficiently reliable to inspire confidence. However, additional experimental data will always be useful.

Analytical Treatment

As is customary in riveted-joint design, the shearing resistance of a rivet is equated to the crushing resistance in order to find the smallest permissible diameter of rivet. Hence if d is the diameter of the rivet in inches, f_s' the shearing resistance in lb. per sq. in. per single surface in double shear, f_c' the crushing (or bearing) resistance in lb. per sq. in. in double-shear bearing, and t the thickness of the plates connected in inches,

$$\frac{\pi d^2}{2} f_s' = dtf_c' \qquad [1]$$

from which

$$d = \frac{2tf_c'}{\pi f_s'} \qquad [2]$$

In other words, if d is chosen in accordance with Eq. [2] the rivet is equally likely to fail in shear or crushing because of the condition imposed in equating the shearing and bearing resistances.

For reasons to follow, assume a strip of plate of width w inches to be bent around the rivet somewhat like the link of a chain but of rectangular cross-section. If the resistance of this link under tension is equal to either the shearing or the crushing resistance of the rivet and if R denote this resistance,

$$R = 2wtf_t$$

or

$$w = \frac{R}{2tf_t} \qquad [3]$$

where f_t is the tensile resistance of the plate in lb. per sq. in.

The idea of conceiving a plate to be divided into hypothetical tension strips the resistance of each of which is equal to the strength of a rivet, first occurred to Schwedler,[1] who used it as the basis of a graphical method. Unwin[2] has applied this method to boiler joints, but it is cumbersome and does not lend itself to slight changes in the assumed data without entailing a comparatively large amount of effort. An attempt to avoid this led to an analytical treatment which was published by the writer in 1916.[3] It was found later that the steps in this analysis could be concisely expressed by simple general equations, and these are the subject of this paper. A sufficient part of the article referred to is repeated here in order to insure continuity of treatment.

Fig. 1 shows a single-riveted joint in which the cover plate nearest the observer has been removed for convenience. The tension strips are shown around the rivet. The portion between the tension strips (shown shaded) could be cut out of the plate without impairing its strength. Of course in an actual boiler this could not be done, since this metal is required to enclose the contents.

Fig. 2 shows a commercial quadruple-riveted joint with the distance between the rivet rows greatly exaggerated and in which the rivets are not staggered. The tension strips are numbered for convenience. It will be found that, starting below with any strip, it may be traced around a rivet and back again, thus showing that each strip has a particular rivet the resistance of

For presentation at the Spring Meeting, Detroit, Mich., June 16 to 19, 1919, of The American Society of Mechanical Engineers. All papers are subject to revision.

[1] Assistant Professor of Mechanical Drawing and Design, Polytechnic Institute of Brooklyn. Mem.Am.Soc.M.E.

[2] *Engineering* (London), March 28, 1913, p. 439.

[3] *Engineering* (London), August 14, 1914, p. 231.

[4] Bach, Die Maschinen-Elemente, chapter on Nietverbindungen.

[1] Ueber Nietverbindungen. Lecture by J. W. Schwedler before the Architekten Verein zu Berlin; reprinted in their Wochenblatt, Nov. 22, 1867, et seq., pp. 451, 461 and 472.

[2] Machine Design, vol. 1.

[3] *Power*, August 1, 1916.

which it adds to the total resistance of the joint. The problem therefore rests on finding the maximum resultant strength.

If w is the width of a strip and d is the diameter of the rivet, then from Fig. 1 the most economical pitch for the first row of rivets occurs when the tension strips just touch each other. Denoting this pitch by p_1,

$$p_1 = 2w + d \;\ldots\ldots\ldots\ldots\ldots\ldots [4]$$

The shaded area is metal available for rivets in subsequent rows. Thus in each pitch there is available a strip of width d. If m_1 represents the available metal per inch, then

$$m_1 = \frac{d}{p_1}$$

But since the amount of metal required to insert extra rivets in

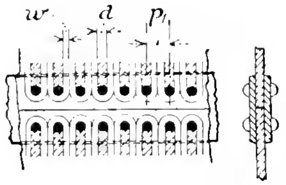


FIG. 1 SINGLE-RIVETED BUTT JOINT

a second row is a strip of width $(2w + d)$, the pitch of the second row is

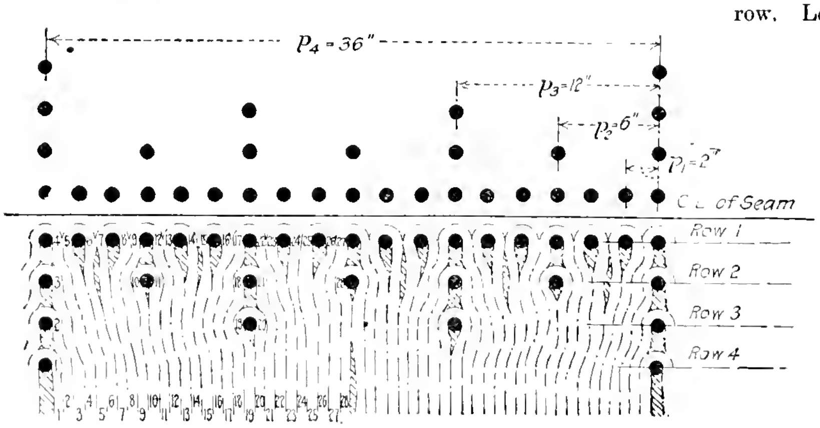


FIG. 2 LAYOUT OF A QUADRUPLE-RIVETED BUTT JOINT

$$p_2 = \frac{2w + d}{m_1}$$

Since, however, from Eq. [4] $p_1 = 2w + d$ and $m_1 = \dfrac{d}{p_1}$, the pitch p_2 may be written

$$p_2 = \frac{p_1}{d \div p_1} = \frac{p_1^2}{d} \;\ldots\ldots\ldots\ldots\ldots\ldots [5]$$

Similarly, there is available for rivets in a third row a width of metal d in each distance p_2, or the width of available metal m_2 from the second row per inch of width of seam is

$$m_2 = \frac{d}{p_2}$$

Hence the pitch of the third row is

$$p_3 = \frac{2w + d}{m_2}$$

and replacing the values of numerator and denominator as before,

$$p_3 = \frac{p_1}{d \div p_2}$$

But since p_2 is given in terms of p_1 by Eq. [5], this substitution results in

$$p_3 = p_1 \div \frac{d}{p_2}$$

$$= p_1 \div \frac{d}{p_1^2 \div d}$$

or

$$p_3 = \frac{p_1^3}{d^2} \;\ldots\ldots\ldots\ldots\ldots\ldots [6]$$

In the same manner

$$m_3 = \frac{d}{p_3}$$

$$p_4 = \frac{2w + d}{m_3}$$

$$= p_1 \div \frac{d}{p_3}$$

$$= p_1 \div \frac{d}{p_1^3 \div d^2}$$

or

$$p_4 = \frac{p_1^4}{d^3} \;\ldots\ldots\ldots\ldots\ldots\ldots [7]$$

Therefore it will be seen in Eqs. [4], [5], [6] and [7] that the subscript of p in the left-hand member is the same as the exponent of the numerator p_1 in the right-hand member and is one greater than the exponent of d in the denominator. For a general equation, let n signify the number of the row; then it follows that

$$p_n = \frac{p_1^n}{d^{n-1}} \;\ldots\ldots\ldots\ldots\ldots\ldots [8]$$

To try a simple check, the equation should hold for the first row. Let therefore

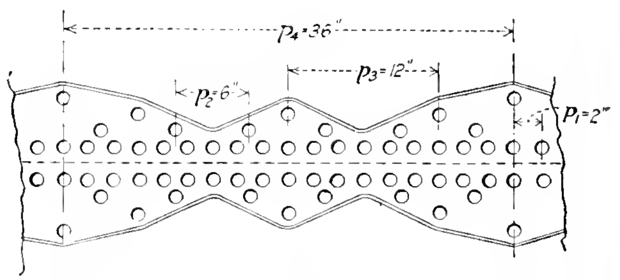


FIG. 3 SCALLOPED COVER PLATE FOR QUADRUPLE-RIVETED JOINT

$$p_1 = \frac{p_1^1}{d^0}$$

or

$$p_1 = p_1$$

which as it stands conveys little information; but recourse to Eq. [4] shows it to be equal to $2w + d$.

A general equation for the efficiency of a Schwedler joint is also possible. Thus, in an ideal joint all manners of failure are equally likely. Choosing the most convenient form for the equation, take the case for the efficiency in tension of the last row, namely:

$$e_n = \frac{(p_n - d)\,tf_t}{p_n t f_t}$$

$$= \frac{p_n - d}{p_n}$$

$$= 1 - \frac{d}{p_n} \;\ldots\ldots\ldots\ldots\ldots\ldots [9]$$

As p_n becomes very large by increasing the number of rows, the efficiency approaches unity or 100 per cent.

A slightly different form might be obtained for the general equation of the efficiency. Since p_n in Eq. [9] may be replaced by its value from Eq. [8],

$$e_n = 1 - \frac{d}{p_1^n \div d^{n-1}}$$

$$= 1 - \frac{d^n}{p_1^n}$$

$$= 1 - \left(\frac{d}{p_1}\right)^n \;\ldots\ldots\ldots\ldots\ldots\ldots [10]$$

This equation expresses the same result as Eq. [9]. For example, the ratio d/p_1 is always less than unity, and the fraction raised to any positive power will approach zero as n becomes large. Again, the efficiency approaches 100 per cent as the number of rows is increased.

For high-efficiency joints the cover plates must be designed from fundamental principles rather than from the empirical rules given in certain textbooks. On the plate the tension strips must all pass through the last row of rivets. On the cover plates the condition is just the reverse, that is, the strips all pass through the first row of rivets. Since the pitch and tensile stress are fixed, the required area of metal may be obtained by suitably determining the thickness.

The total load on a strip of plate of width p_1 is

$$\frac{p_1 t f_t e}{100}$$

where e is the actual efficiency of the joint in per cent. The resistance of two cover plates is

$$2\ (p_1 - d)\ t_c f_t$$

where t_c is the thickness in inches of one cover plate. For equal strength these must be equated; hence

$$2\ (p_1 - d)\ t_c f_t = \frac{p_1 t f_t e}{100}$$

from which

$$t_c = \frac{p_1 t e}{200\ (p_1 - d)} \quad \ldots\ldots\ldots\ldots\ldots\ldots [11]$$

Application of the Method

Assume a plate ½ in. thick. Let f_t = 60,000 lb. per sq. in., f_s' = 45,000 lb. per sq. in., and f_c' = 100,000 lb. per sq. in. From Eq. [2],

$$d = \frac{2 \times \tfrac{1}{2} \times 100{,}000}{\pi \times 45{,}000} = 0.707 \text{ in.}$$

The value of R in Eq. [3] is obtained from the shearing or bearing resistance in Eq. [1]. Thus for shear,

$$R = \frac{\pi \times (0.707)^2 \times 45{,}000}{2} = 35{,}300 \text{ lb.}$$

From Eq. [3]

$$w = \frac{35{,}000}{2 \times \tfrac{1}{2} \times 60{,}000} = 0.588 \text{ in.}$$

Then from Eqs. [4], [5], [6] and [7]

$$p_1 = (2 \times 0.588) + 0.707 = 1.883 \text{ in.}$$

$$p_2 = \frac{(1.883)^2}{0.707} = 5.03 \text{ in}$$

$$p_3 = \frac{(1.883)^3}{(0.707)^2} = 13.4 \text{ in.}$$

$$p_4 = \frac{(1.883)^4}{(0.707)^3} = 35.7 \text{ in.}$$

The corresponding efficiencies for these ideal joints are, from either Eqs. [9] or [10],

$$e_1 = 1 - \frac{0.707}{1.883} = 62.5 \text{ per cent (Single-riveted)}$$

$$e_2 = 1 - \frac{0.707}{5.03} = 85.9 \text{ per cent (Double-riveted)}$$

$$e_3 = 1 - \frac{0.707}{13.4} = 94.7 \text{ per cent (Triple-riveted)}$$

$$e_4 = 1 - \frac{0.707}{35.7} = 98.0 \text{ per cent (Quadruple-riveted)}$$

To design commercial joints from the foregoing, choose, say, d = 0.75 in., p_1 = 2 in., p_2 = 6 in., p_3 = 12 in., p_4 = 36 in., as shown in Fig. 2. This will afford a joint having simple ratios of rivet pitches from row to row. The calculated efficiencies for commercial riveted joints are found in the usual way. A simple calculation will show that R = 37,500 lb. in bearing. Hence no rivets will fail in shear since the shearing resistance is 39,000 lb. Thus, for a quadruple-riveted joint where the unit pitch is 36 in., it is necessary to consider—

a Bearing resistance of all rivets in a 36-in. strip
b Tensile resistance of row 4
c Tensile resistance of row 3 plus bearing resistance of row 4
d Tensile resistance of row 2 plus bearing resistance of rows 3 and 4
e Tensile resistance of row 1 plus bearing resistance of rows 2, 3 and 4.

The values of these resistances are as follows:

a 28 × 37,500 = 1,050,000 lb.
b 35.25 × 60,000 × ½ = 1,057,500 lb.
c (33.75 × 60,000 × ½) + (1 × 37,500) = 1,050,000 lb.
d (31.50 × 60,000 × ½) + (4 × 37,500) = 1,095,000 lb.
e (22.5 × 60,000 × ½) + (10 × 37,500) = 1,050,000 lb.

It will be seen that the liability of rupture will occur under items *a*, *c* or *e*. The resistance of an unperforated strip 36 in. wide is 36 × 60,000 × ½ = 1,080,000 lb. The efficiency is consequently

$$e = \frac{1{,}050{,}000}{1{,}080{,}000} \times 100 = 97.2 \text{ per cent}$$

The thickness of the cover plates is, from Eq. [11], approximately,

$$t_c = \frac{2 \times \tfrac{1}{2} \times 97.2}{200 \times 1.25} = \frac{25}{64} \text{ in.}$$

To make a triple-riveted joint, omit the rivets in row 4 of Fig. 2. A similar set of calculations will show that in a 12-in. strip failure is likely to occur through—

a Bearing resistance of all rivets in a 12-in. strip
b Tensile resistance of row 3
c Tensile resistance of row 2 plus bearing resistance of row 3
d Tensile resistance of row 1 plus bearing resistance of rows 2 and 3.

These resistances have respectively the following values:

a 9 × 37,500 = 337,500 lb.
b 11.25 × 60,000 × ½ = 337,500 lb.
c (10.5 × 60,000 × ½) + (1 × 37,500) = 352,500 lb.
d (7.5 × 60,000 × ½) + (3 × 37,500) = 337,500 lb.

The lowest resistance of the joint is for items *a*, *b* or *d*. The initial strength of the plate is 12 × 60,000 × ½ = 360,000 lb., hence the efficiency is

$$e = \frac{337{,}500}{360{,}000} \times 100 = 93.7 \text{ per cent}$$

The thickness of the cover plates is approximately

$$t_c = \frac{2 \times \tfrac{1}{2} \times 93.7}{200 \times 1.25} = \tfrac{3}{8} \text{ in.}$$

For a double-riveted joint omit rows 3 and 4 of the quadruple joint and the unit strip becomes 6 in. wide. In this case failure may occur through—

a Bearing resistance of all rivets in a 6-in. strip
b Tensile resistance of row 2
c Tensile resistance of row 1 plus bearing resistance of row 2.

Numerically these become

a 4 × 37,500 = 150,000 lb.
b 5.25 × 60,000 × ½ = 157,500 lb.
c (3.75 × 60,000 × ½) + (1 × 37,500) = 150,000 lb.

The strength of the original plate is 6 × 60,000 × ½ = 180,000 lb., hence the efficiency is

$$e = \frac{150{,}000}{180{,}000} \times 100 = 83.3 \text{ per cent}$$

The thickness of the cover plates is about

$$t_c = \frac{2 \times \tfrac{1}{2} \times 83.3}{200 \times 1.25} = \frac{11}{32} \text{ in.}$$

Finally, for a single-riveted joint omit rows 2, 3 and 4. The results for bearing and tension can be put down immediately as

a 1 × 37,500 = 37,500 lb.
b 1.25 × 60,000 × ½ = 37,500 lb.

The original strength of a strip 2 in. wide is $2 \times 60{,}000 \times \frac{1}{2} = 60{,}000$ lb., from which the efficiency is

$$e = \frac{37{,}500}{60{,}000} \times 100 = 62.5 \text{ per cent}$$

The thickness of the cover plates is

$$t_c = \frac{2 \times \frac{1}{2} \times 62.5}{200 \times 1.25} = \frac{1}{4} \text{ in.}$$

The efficiencies just calculated are compared in Table 1 with those obtained by using Eq. [9] or [10].

TABLE 1 IDEAL AND CALCULATED EFFICIENCIES OF DOUBLE-STRAPPED BUTT JOINTS

Type of double-strapped butt joint	Efficiencies, Per Cent	
	Ideal	Calculated
Single-riveted	62.5	62.5
Double-riveted	85.9	83.3
Triple-riveted	94.7	93.7
Quadruple-riveted	98.0	97.2

There are two things worthy of note in the method that has been presented. One is, that the design of a quadruple-riveted joint presupposes the design of the triple-, double- and single-riveted joints. Thus there is symmetry existing in all of these joints and manufacturers will find it easy to standardize them should it be found advisable to do so. The other follows from a discussion of the equations of bearing and tension on the plate. Equating these,

$$dtf_c' = (p_1 - d)\, tf_t$$

from which

$$p_1 f_t = df_c' + df_t$$

so that the expression for the pitch becomes

$$p_1 = d\left(1 + \frac{f_c'}{f_t}\right)$$

Since f_c' and f_t are properties of the materials used and therefore constants, the last equation might be written in the form

$$\frac{d}{p_1} = \text{constant}$$

This ratio appears in the equation for efficiency, Eq. [10], and due to the linear relation between p_1 and d the same efficiency might be obtained with an infinite number of values of d. For instance, if d is doubled then p_1 must be doubled, and so on. There is a certain minimum value that d might have in any joint and that value has been found in Eq. [2], where a smaller value will cause the rivet to fail by shear. Hence no ambiguity arises in this case. Commercial considerations require the smallest rivet in general, while for very thin plates where the rivet sizes are very small it is desirable to know that, even with these, good efficiencies may be obtained by increasing the pitch in the same ratio as the rivet diameter.

In connection with assumptions b and c at the beginning of the paper, the supposition is made that the shear and bearing are uniformly distributed among the rivets of a given joint. To prevent too serious a deviation from this premise, the cover plates might be designed in the following way: Let it be assumed at the start that each rivet is properly driven, then, in an ideal case, the same metal-to-metal contact exists among all the rivets. For this condition to prevail after loading requires that the same stress exist in the cover plate as exists in the connected plate. Under these conditions the deformation under load will be the same for both cover plates and connected plate. In commercial joints, departures from the ideal case arise which may be somewhat obviated by scalloping the cover plates for triple- and quadruple-riveted joints, as shown in Fig. 3. This will decrease the rigidity of the cover plate and to some extent prevent the rivets of the outer rows from taking an undue share of the whole load.

EXTINGUISHING AND PREVENTING OIL AND GAS FIRES

For the past three years the Bureau of Mines has been conducting investigations to determine the nature and the specific causes of oil and gas fires, with a view to suggesting means whereby they may be successfully combated, and even eliminated, if possible. In a bulletin recently issued by the Bureau, C. P. Bowie points out what has been done by operators in the past, and describes various fire-prevention methods and fire-fighting apparatus which are being used or adopted by many of the larger oil companies. These methods and apparatus, it is stated, if universally employed by operators, will largely decrease the present enormous annual losses, of which some idea may be found by quoting from the statistics of the Bureau that during the period of ten years from January 1, 1908, to January 1, 1918, approximately 12,850,000 bbl. of oil and 5,024,506,000 cu. ft. of gas were destroyed by fire in the United States.

Oil and gas fires are caused principally by lighting and frictional electricity, and to a lesser extent by carelessness. Static

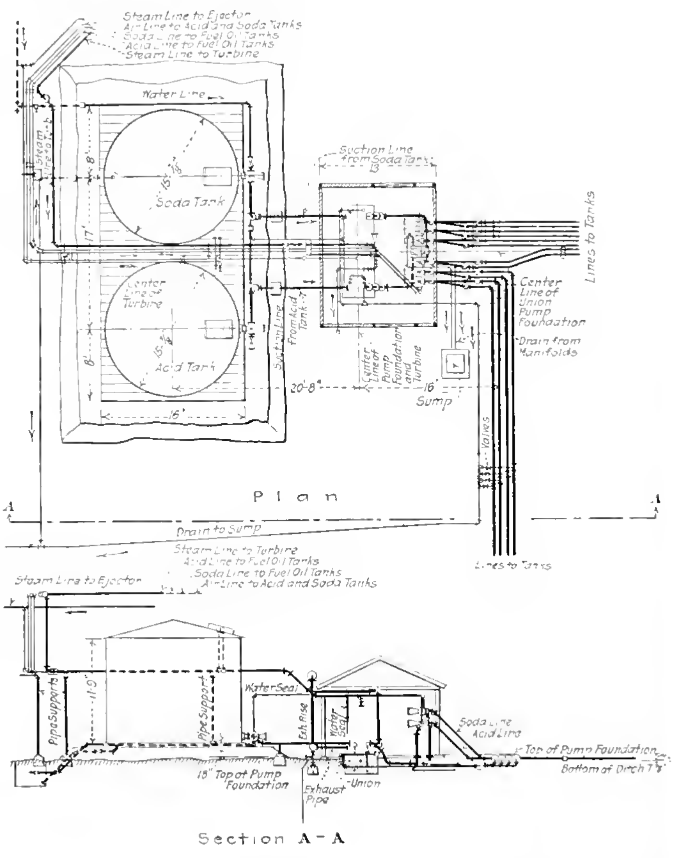


FIG. 1 GENERAL ARRANGEMENT OF SUCTION AND DISCHARGE PIPING AT PUMPS, FROTHY-MIXTURE SYSTEM

electricity accounts for the origin of a number of seemingly mysterious fires. An unpublished report of the chemist for the Massachusetts District Police to the chief of the Boston Fire Department mentions the following instances:

A chauffeur desiring to fill a large limousine, which was standing on the cement floor of a garage, took an ordinary 50-gal. can having a wooden handle on the bail, and hung it by this wooden handle on the hook of a self-measuring gasoline pump connected with an underground tank in the yard outside. He had drawn about a gallon when he heard a snapping noise, and the can was in flames. . . .

At another garage an employee filled a 5-gal. can with gasoline from a pump and took it to the running board of a car. He had an ordinary metal funnel across which was stretched a piece of chamois skin, and, to make the funnel sit upright on the car tank, he had attached a thin piece of wood, with a hole in it, for the funnel spout. He stood on the running board and held the pouring can quite near the edge of the funnel, but not touching it, when he saw a spark jump from the funnel to the can. It ignited the gasoline.

The explanation of the first fire is that the friction of the flow-

ing gasoline against the bottom and sides of the can generated electricity that charged the can: when the potential of the charge became too great, the discharge took place between the metal of the bail and the pump. The second case cited presented practically the same phenomenon. The funnel was insulated from the tank by the board at its base, and the funnel became charged with the electricity developed by friction of the gasoline flowing through the chamois skin.

Fires in oil tanks are successfully extinguished by the so-called frothy-mixture system. Essentially this system provides for bringing together two chemical solutions and for feeding into the top of burning oil tanks the thick, tenacious foam resulting from their combination, thereby excluding air and extinguishing the flame. The apparatus required in practice comprises two tanks—one for each chemical solution—a suitable pump, pipe lines to carry the solution to the oil tanks or reservoirs, mixing chambers where the chemicals can combine, and a means for properly distributing the foam.

The solutions for producing the foam may be any two compounds that on coming together form an abundance of relatively tough bubbles inflated with a non-inflammable gas. The chemicals must be fairly cheap; also they must not deposit any appreciable amount of sediment after having been in solution for a considerable time. The proportion of froth to solution should be about 6 or 8 to 1, that is, combining 50 cc. of each solution should produce 600 to 800 cc. of foam.

The installation put in by the Associated Pipe Line Co. at Coalinga, Cal., and shown in Fig. 1, was designed to protect four 55,000-bbl. oil tanks each 114 ft. 6 in. in diameter, one 30,000-bbl. tank 86 ft. in diameter, and two fuel-oil tanks each about 8 ft. in diameter. The solutions used at this station have the following composition:

Solution A	Parts by weight	Solution B	Parts by weight
Water	100	Water	100
Aluminum sulphate (crystal)	10	Ground glue	$1\frac{1}{4}$
Sulphuric acid, 66 deg. B.	$\frac{1}{2}$	Glucose	$\frac{1}{2}$
		Sodium bicarbonate	$7\frac{1}{2}$
		Arsenious oxide	1–52

Other formulæ are:

FORMULA 1

Solution A	Parts by weight	Solution B	Parts by weight
Water	100	Water	100
Aluminum sulphate (crystal)	14	Sodium bicarbonate	$9\frac{1}{4}$
Extract of licorice (powdered)	3		

FORMULA 2

Water	100	Water	100
Aluminum sulphate (crystal)	12	Sodium bicarbonate	10
Acetic acid	$\frac{1}{2}$	Ground glue	1
Ground glue	1	Glucose	$\frac{1}{4}$
Glucose	$\frac{1}{4}$		

The capacities of the solution tanks depend on the number of square feet of oil surface to be covered. On an estimate that 1 gal. of mixture ($\frac{1}{2}$ gal. of each solution) will produce 7 gal., or 1617 cu. in. of foam, to cover the oil in a 55,000-bbl. tank with 6 in. of foam would require about 2800 gal. of each solution. This quantity, of course, should be increased by using a reasonable safety factor.

Fires at gas wells, except at wells producing large volumes of gas, are, as a rule, not particularly difficult to overcome if the gas can be confined in one stream, because if the flow can be cut off for an instant the flame will be extinguished. When the gas flow has been confined in one stream the flame, unless it is very small, will always be some distance above the casing. The greater the pressure of the gas the longer this column of unburned gas will be. If enough steam or water can be directed against this part of the gas column to interrupt the stream of ascending gases momentarily, even the largest fire will be put out. In putting out gas-well fires with steam, the usual practice is to set up portable field boilers in the vicinity and surround the burning well with steam pipes terminated in goosenecks, which throw a fan-shaped spray of steam against the gas column. Steam is turned on from all boilers simultaneously; if the volume is sufficient, a blanket or cloud of steam will be formed and momentarily interrupt the gas stream just above the head of the casing, and the fire will be extinguished.

H. O. Ballard, of the Empire Gas & Fuel Co., has adapted the snuffer principle to a portable extinguisher. The device consists of a hood mounted on wheels and terminating in a valve to which is attached a piece of 14-in. pipe about 20 ft. long. The pipe can be extended to any desired length by screwing on more joints. On either side of the hood, midway of its height, is a short piece of 10-in. pipe also containing a valve. The hood is taken to the side of the burning well and upended over the fire, with the large valve opened and the two small valves closed. When the hood has reached its vertical position, the lower valves are opened and the large one closed, thereby cutting off the flame. If the flow of gas is so strong that the discharge from the 10-in. pipes may reach the top of the stack and ignite before the large valve can be closed, the 10-in. pipes are extended to a safe distance from the well before the valves are manipulated.

Oil-well fires are often much more difficult to overcome than gas-well fires, because the well may be producing in such large quantities that the oil is not all consumed in one tapering flame as with gas. Also, the burning oil soon heats the ground around the well so hot that, no matter how often the fire may be extinguished, it will immediately reignite. Consequently, no definite rules can be given for combating fire at oil wells, as each burning well presents a problem of its own. Special precautions should be taken against fires in oil wells, as the process of extinguishing them is always laborious and difficult. The practice of having a fire inside of the derrick has been the cause of many fires about drilling wells. Gas fires about oil wells being drilled are, in most instances, wholly inexcusable, as permitting gas to escape unchecked from the well is a wasteful and, as a rule, unnecessary procedure. All bearings about the machinery, especially the bull-wheel, calf-wheel and sheave-wheel bearings, should be kept thoroughly oiled. Static electricity generated by the band-wheel belt or other moving parts of the machinery has often caused fires; danger from this source can be prevented by grounding all machinery parts and providing belts with properly constructed copper brushes attached to a grounded pipe. Numerous other precautionary measures have been devised for cases where there is danger of the oil coming in contact with a flame or a spark.

The recent developments of wireless telegraphy have required the use of more powerful Hertzian waves than had been sent out by any station up to the time of the war. There are present, therefore, in the ether permeating and surrounding the atmosphere, numerous trains of waves traveling in all directions. It is altogether possible that one of these sets or a set resulting from a combination of several of them should come in contact with a number of conducting bodies so arranged in a casual manner as to form a Hertzian resonator of the required inductance, capacity and resistance to respond to the passing train. There would then be an ether wave excited in the system, a spark would be produced and a fire probably caused as the result of the passage of the wave.

Mr. George A. Le Roy has presented to the Académie des Sciences a note on the possibilities of a fire being produced in this manner. He conducted a laboratory investigation by means of an apparatus which he terms "inflammatory-resonator." It consists of a globular glass flask provided with four openings, two lateral, one at the top and one at the bottom. Through the lateral openings two electrodes are introduced and kept at the desired distance apart by an adjusting mechanism; they constitute the terminals of a Hertzian resonator. The bottom opening permits placing under the electrodes a plate which carries the inflammable substances; there is also at the bottom a connection for exhausting air with a pump, or introducing gases into the globe. Through the top are located the required measuring instruments.

Hertzian waves of relatively low intensity, generated by means of an ordinary Ruhmkorff coil, were sent through the instrument.

Mr. Le Roy asserts that iron electrodes facilitated the inflammation of cotton, amadou, paper, tow, etc. He, therefore, concludes that a condition may be produced in such a case as the piling of a number of cotton bales, when by the breaking of one of the iron bracings an open resonator is virtually formed.

THE HEAVY-OIL ENGINE

In line with the prevailing tendency of engineers of related branches to forgather and discuss their mutual problems, the New York Section of The American Society of Mechanical Engineers and the Metropolitan Section of the Society of Automotive Engineers held a well-attended joint meeting at the Automobile Club of America, on the evening of April 9, at which various topics connected with the development of the heavy-oil engine were dealt with in brief addresses. Dr. Charles E. Lucke, Dean of the School of Mechanical Engineering, Columbia University, and late Director of the U. S. Naval Gas Engine School, presided over the meeting.

J. H. Smootz, of the U. S. Bureau of Mines, Petroleum Division, spoke on the methods employed in refining petroleum, and in obtaining lighter oils from the heavier fractions by the cracking process, as well as on the general properties of the various products. From the 13-odd billion gallons of petroleum annually produced in the United States, 1.8 billion gallons of kerosene were obtained and twice as much gasoline; the remainder being gas oil, distillate and light and heavy residuals, which latter were convertible into distillate. Costs of treatment were low and selling prices of the various products were purely dependent on the demand. Kerosene was relatively scarce and in his opinion not a fuel that would affect the situation to any considerable degree.

Dr. Lucke, in discussing the adaptation of the engine to the fuel, called attention to the necessity of heated vaporizing appliances when heavy gas oils and kerosene were used as engine fuels, and to the advantages of late injection. The heaviest, unvaporizible oils if injected in a fine enough spray, well scattered and homogeneously mixed with air, would explode as if gaseous. There was no question but that the engineers could adapt the engine to the fuel, and the chemists would see to it that cheap fuels were supplied. The important problem ahead was to adapt the engine to its various uses, and the interchange of ideas at meetings like the one in session would contribute largely to bringing this about.

J. M. Hunt, of the Dayton Engineering Laboratories Company, told of the possibilities of adapting automobile engines to fuels heavier than motor gasoline, and of experimental work he had carried on in this direction, particularly with kerosene. One car had been run 14 months on this fuel, covering 12,000 miles and without engine trouble developing. Preheated air was used and the mixture heated to 220 deg. and then compressed. Another way to avoid the difficulties of starting with a cold engine was to use two fuels, one highly volatile, to warm up the engine, but this involved needle-valve troubles. In regard to the kerosene "knock," experiments at Dayton had shown this to be due, not to preignition, as many supposed, but to abnormal pressures—three to five times the normal explosion pressure—developed probably through the detonation of some product of combustion. The introduction of water or cool exhaust gas had been suggested as remedies for knocking, but manifestly this was not a final solution. The problem ahead was to design engines to use fuel and gas oils, for the limits of the gasoline and kerosene supply were already in sight.

A short paper by A. H. Goldingham, of the De La Vergne Machine Co., on the heated-metal type of heavy-oil engine, was read in the author's absence by the chairman. The desiderata in an engine of this type, it was stated, were reliability, first cost and economy. As to reliability, engines would run six months continuously, using any fuel, and with an odorless and practically invisible exhaust. This had been accomplished by thorough atomization and aeration of the oil sprayed in under 4000 to 5000 lb. pressure; improved construction of vaporizing chamber; and by the use of forced-feed lubrication, an automatic air starting valve and an improved vaporizer heating lamp or electric heating coil. Four-cycle engines up to 400 hp. running at 900 ft. per min. piston speed cost today $120 per hp. as against $55 in 1913, and weighed 425 lb. per b.hp. They operated regularly on 0.4 lb. fuel per b.hp., and at 6 cents per gal., $1000 would buy the fuel for a 100-hp. engine for a year.

Mr. Hansen, of the Skandia Pacific Oil Engine Co., told of his experience on the Pacific Coast in connection with the installation of Werkspoor engines in the wooden ships built by the Emergency Fleet Corporation. These ships had been constructed of green timber, with the result that there were many bedplate breakages due to shrinkage and warping of foundations, but charged nevertheless against the engines. Large hot-bulb engines required care, but it had been impossible to train properly the large number of engineers needed in the time available.

T. O. Lisle, editor of *Motorship,* said that the new type of motorship developed by the United States during the war—the wooden auxiliary—had been unsuccessful, as in addition to being constructed of green timber, they had been equipped with insufficient sail power so that the auxiliary engines were forced to the limit, and it had furthermore been necessary to operate them by untrained engineers. A 5000-ton boat had been provided with an engine of only 700 hp. In his opinion steel hulls should be adopted for such vessels and the powering raised, to range from 500 hp. for a 2000-ton boat up to 1100 hp. for a 5000-ton vessel. Stationary Diesel engines had been so developed that six-cylinder 4000-hp. engines were now being built and 5000 hp. was possible. A 20,000-ton 16-knot boat equipped with large power units would require space for but 14 tons of oil per 24 hours, and but 20 men in the engine room. He believed it would have been much better if the Emergency Fleet had consisted entirely of motorships. Eighty-six concerns were now building Diesel engines—50 on a large scale, and 150 concerns semi-Diesels. As to reliability in service, he would cite the *Zeelandia,* a vessel of 7500 tons built in 1912 and with engines of 2750 i.hp., which had sailed a total of 327,000 nautical miles at an average speed of 10.4 knots and had consumed 11,667 tons of fuel oil in her 31,600 hours at sea.

In the brief discussion which followed, referring to the matter of reliability, J. H. Norris stated he had been told that a motorship had never had to be towed into port.

H. C. Verhey, of the engineering staff of the Emergency Fleet Corporation, who had had twelve years' experience with Diesel engines and was familiar with European conditions, said that the materials of construction available in the United States were of superior quality and it was not necessary now to go abroad for designs, engineering talent or workmanship. Moreover, facilities here were better and our castings could not be surpassed in excellence by anything in Europe.

Harte Cooke, of the McIntosh & Seymour Corp., in discussing Diesels for stationary use, said that with the lighter fuels, if the fuel valve was too hot, the oil would crack and clog the burner plates. Careful cooling of the fuel valve would do away with this, but it was better to use a heavier grade of fuel. All oil fuels available could be successfully burned, even those carrying sulphur. With the latter, however, it was best to run a short time with sulphur-free oil before shutting down. This would carry the SO_2 out of the system and prevent the piping from being attacked.

Preceding the meeting, dinner was served in the grill room of the Automobile Club. The arrangements were in the hands of W. W. Macon, Chairman of the A.S.M.E. New York Section, and A. M. Wolf, Secretary of the S.A.E. Metropolitan Section. Before the speakers of the evening were introduced, Mr. Macon stated that the gathering was but one of a series of special meetings planned to secure closer coöperation among the various local organizations of engineers.

Raw Material, heretofore issued as *The Metal Record and Electroplater,* made its initial appearance under the new name with the March 1919 issue. This journal has recently been acquired by the Gage Publishing Company, well known as the publishers of the *Electrical Record* and *Electrical Export,* and it is planned to considerably widen the field of *Raw Material.* The new editor in chief is R. L. Herrick, formerly western editor of *Mines and Minerals,* later of the staff of the *Engineering and Mining Journal,* and until recently assistant publicity manager of the Ingersoll-Rand Company, of New York.

Electric Welding as Applied to Ship Construction

By H. Jasper Cox,[1] New York, N. Y.

Few subjects offer as great inducements for experimental research as that of the application of electric welding to shipbuilding, and it is doubtful whether in the whole range of applied science intimately concerned with practical developments in both industries greater potentiality is open than under the various headings in which the subject of electric welding naturally divides itself.

Although electric welding, and especially arc welding, has been used for a long time to great economical advantage in ship-repair work and marine engineering, it has been but little understood, and it is not overstating the case to say that it is only within recent months that any serious attempt has been made to analyze the elements of the art and determine the underlying scientific principles involved.

The chief investigator in this field was the General Engineering Committee of the Council of National Defense, which has made a very careful study of the application of spot welding to ship construction. In January 1919, however, this committee was dissolved and the Electric Welding Committee of the United States Shipping Board, Emergency Fleet Corporation, was appointed to investigate the whole field of electric welding and to advise the Emergency Fleet Corporation as to how the shipbuilding program might be speeded up and work economized by a wider adoption of the process.

The committee is composed of shipbuilders, electrical engineers, many prominent physicists and metallurgists, and of representatives of the Emergency Fleet Corporation, Classification Societies and Bureau of Standards, with Prof. Comfort A. Adams, of the Massachusetts Institute of Technology and President of the American Institute of Electrical Engineers, as Chairman.[2]

Much useful work has already been accomplished by the committee, data collected, investigations and research work carried out and important facts established. In the meantime similar investigations and research work were being conducted abroad, particularly in Great Britain, where an exhaustive series of practical experiments has recently been completed by the Technical Committee of Lloyd's Register of Shipping.

The results of these investigations have been not only encouraging, but have led to the conclusion that under certain prescribed conditions an electrically welded joint may with reasonable safety be applied to the main structure of a vessel.

Methods of Welding

The methods of electric welding applicable to ship construction can be considered under two main headings, resistance welding and arc welding.

Resistance Welding. As the term implies, it is the resistance offered to the flow of electric current through the material and contact surfaces to be united which causes the metal in the path of the current to heat up to the necessary temperature. Welding is then accomplished by the application of pressure. There are two distinct kinds of resistance welding—spot welding and butt welding.

Spot welding has been extensively used for jointures of thin metal such as ventilators, lifeboats and railway cars, and with considerable success, but it is only recently that its application to sheet plates and bars of the thickness required in ship construction has been investigated.

The two or more pieces to be welded are overlapped or superposed to form the joint and clamped between two copper electrodes; then current is passed through and pressure applied. In order to insure a successful weld the pressure should be sufficient to cause the metal to "flow" at the weld and to extrude all oxides, slag, etc., which may form. The pressure is maintained for a short time after the current is cut off, and the operation is then repeated at the next spot. Small buttons or disks of metal are sometimes placed under one or both of the electrodes, and when of proper thickness are completely submerged in the plate metal during the operation of forming the weld.

Intensive research work is now being conducted along these lines by the General Electric Company, who have built a heavy spot-welding machine, shown in Fig. 1, with a capacity of 100,000 amperes at 20 volts and a hydraulic pressure of 36 tons at the electrodes. A careful series of experiments is being carried out with this machine, using plates of from ¼ in. to 3 in. in total thickness, and it has already been demonstrated that satisfactory spot welds can be made within this range. It has also been found that an appreciable range is permissible in the variables of current, pressure and time without seriously impairing the efficiency of the weld for a given thickness of material.

Where considerable tensile pull is anticipated in an overlap joint, it is considered desirable to have a double row of spots to prevent the tendency to bend and tear out the spots in the same manner as the countersunk heads of rivets are sometimes torn through the holes in a single-riveted overlap.

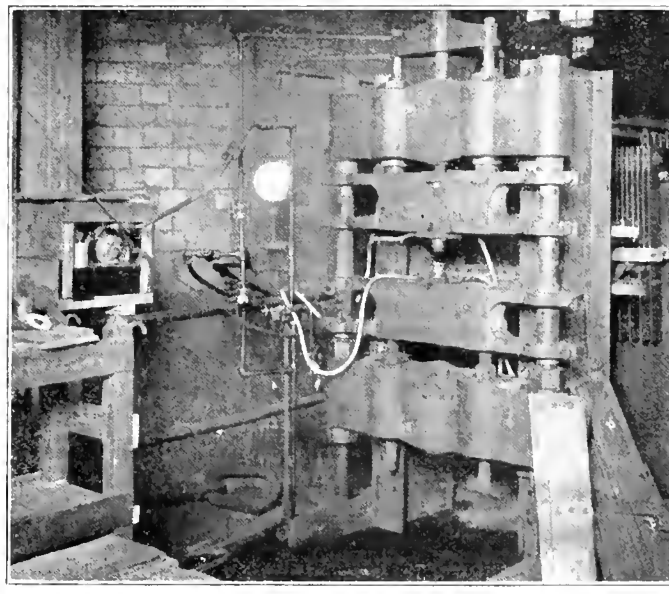


Fig. 1 Spot-Welding Machine made by General Electric Co. Current Capacity, 100,000 amperes; Pressure, 36 tons

Figs. 2 and 3 show some joints made during these experiments, which at the time of writing are still proceeding, and will no doubt shortly yield definite and comprehensive data. Although this method of welding has not yet reached the stage of development which might warrant its practical application to ship construction, it offers every prospect of doing so within the very near future. Obvious developments with this system are multiple spot and continuous or seam welding, both of which will tend toward great saving in time. In general, spot welding is much more rapid than arc welding and requires less labor, but more power and a much heavier and more expensive machine.

Butt welding is especially applicable to bars of uniform section and will probably have a broad future in jointing the reinforcements in ferro-concrete construction. The bars to be welded are brought together, end on, clamped and a low-pressure current passed through until a welding heat is obtained. Then end pressure is applied until the metal at the joint shows signs of squeezing

Abstract of paper presented at the Annual Meeting of the Society of Naval Architects and Marine Engineers, Philadelphia, on November 14 and 15, 1918.

[1] Lloyd's Register of Shipping.

[2] Representatives of the gas-welding industry have recently been added to this committee, and the title changed to The Welding Committee.

out. A machine for this type of welding has been ordered by the Emergency Fleet Corporation and will be tried out during the construction of a 3500-ton (dead weight) reinforced-concrete steamer now being built by the Fougner Concrete Shipbuilding Company.

Arc Welding. In this method of welding the electrode and the material to be welded are connected in a simple electric circuit and an arc is struck by bringing the electrode in contact with the work at the point where the weld is to be made, then withdrawing it slightly to obtain the desired length of arc. The two principal methods of applying this process are by means of the carbon arc and the metallic arc.

In the former a carbon electrode is used and the heat from the arc produced brings the metal to a fusion heat. When welding with the carbon arc additional metal is introduced into the arc and fused into and with the parent metal at the joint. Its main field of application, however, is in rough cutting in foundries and steel mills and for the repair or building-up of imperfect castings. It has not been advocated for use in ship construction generally and there are a number of reasons which make it doubtful whether it ever will be.

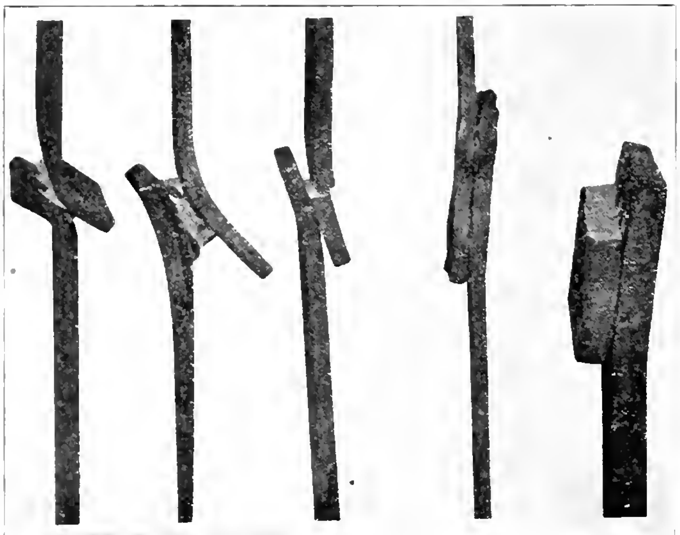


Fig. 2 Electrically Welded Steel Plates After Being Tested in Tension

In metallic-arc welding a metal electrode is used of approximately similar material to that being welded, the electrode itself is fused by the arc, and molten particles are carried over the arc into the fused portion of the parent metal, thus gradually building up the joint.

The actual operation, however, is not quite so simple as this sounds, as there are a large number of variables, any one or any combination of which may affect the efficiency of the result to a greater or less extent. These variables may be enumerated as follows:

1 The type of electrode, i.e., bare metal or covered
2 Chemical composition of the electrode
3 Chemical composition of metal being welded
4 Size of electrode
5 Kind of current, i.e., alternating or direct
6 Amperage and voltage
7 Skill of the operator
8 Method of preparing and building up the joint.

Training of Welders

Of these the skill of the operator is still the most vital factor, and it is probably because of this that arc welding is known as an art rather than a science. A skilled and properly trained welder knows instantly whether or not he is making a good weld. He can tell this by the smoothness of the flow of metal, the uniformity of the sound and light of the arc, and by the lack of "spattering" or deposition of "beads." When his arc is not welding he should immediately cease work, remedy the cause, whether it be unsuitable current control or faulty electrode, and, before proceeding again, should chip out the bad work and especially where the arc was broken. It will be seen, therefore, that the welder should possess some knowledge of the elements of electricity, how it is generated, conducted and controlled, the melting point of the metals employed, and the properties of the particular electrode in use. In ship work he should understand the correct methods of preparing the various joints and their relative importance, together with the best methods of building them up. It is therefore a *sine qua non* of welding the main structure of a vessel that only skilled operators be used. Recognizing this, the Emergency Fleet Corporation has established a separate training and education department for electric welding and has opened schools for the training of operators and instructors in New York, Newport News, and the Great Lakes district.

Lloyd's Experiments on Electrically Welded Joints

When the development of electric arc welding had reached a stage at which its application to the main structure of a vessel, with all the attendant possibilities, appeared a feasible proposition, the Technical Committee of Lloyd's Register of Shipping, in accord with its traditions, immediately embarked upon an exhaustive investigation in order to determine at first hand the suitability of electrically welded joints for such work. A series of experimental tests was accordingly devised and carried out under the direction of the society's technical staff in England, extending over a period of many months.

It is commonly accepted that the tests imposed on manufactured material do not in any way represent the strains which may be experienced in practice. Such tests are rather based on simple means for determining the average reliability of the material.

Fig. 3 Samples of Electric Spot Welding

Thus, also, in this case no one particular test is likely to determine whether the welding process under trial is sufficient for the work it is likely to have to do. It is therefore necessary to approach the problem rather on the basis of circumstantial evidence and to decide from a number of different types of experiments whether, on the whole, the performance is satisfactory.

The investigations were undertaken to determine the possibilities of the application of electric arc welding to shipbuilding, and, as it was desired to obtain as good a knowledge as possible of the physical properties of the combination of rolled and welded material, only highly skilled operators were employed. It must therefore be realized that the results of the experiments which have been made represent skilled practice, and that in general such performance can only be equaled with good workmanship and efficient supervision. The "Quasi Arc" process of electric arc welding was used throughout the experiments.

NATURE AND DESCRIPTION OF EXPERIMENTS

The general scope of the experiments included:

1 Determination of modulus of elasticity and approximate elastic limit

2 Determination of ultimate strength and ultimate elongation

3 Application of alternating stresses with (*a*) rotating specimens, (*b*) stationary test pieces

4 Minor tests, such as (*a*) cold bending of welds, (*b*) impact tests of welded specimens

5 Chemical and microscopic analysis

6 Strength of welds.

Tests were carried out on specimens as large as possible, particularly in respect to the static determinations of elasticity, ultimate strength and elongation, some of the test specimens being designed for a total load of just under 300 tons. The advantage of these large specimens was that the effect of workmanship was better averaged and the results were more comparable to the actual work likely to be met with in ship construction.

Fig. 4 illustrates the method adopted to measure the modulus of elasticity by means of a strainmeter designed by Dr. James Montgomerie, principal surveyor for Lloyd's Register in Scotland. The illustration shows the holders which were specially designed with a view to securing, as far as practicable, an even pull across the breadth of the plate. Readings were taken in way of the weld and at various points on the plate itself, both adjacent to and well clear of the weld, and the points at which these observations were taken are clearly shown in Fig. 5.

Typical results, illustrating the extensions as measured along the line *C*, are shown in Fig. 6, from which it would appear that the extensions in way of the weld do not show any marked difference from those at various points in the plain plate, the lines showing extensions in way of the weld lying among the others without disclosing any distinctive features. Measurements were also taken with the strainmeter set at right angles to the line of pull, the readings in this case, of course, representing contractions.

With a view to confirming this result a set of specimens of smaller size was prepared and tested. The curves obtained exhibit the same general characteristics as those of the large specimen and would appear to justify the inference that there is very little difference between the modulus of elasticity of the welded samples and that of the plain plate.

With alternating stresses the specimens were relatively of small size. For the rotating test pieces, circular rods, machined from a welded plate, were used, the diameters selected being 1 in. and ¾ in. These bars, about 3 ft. in length, were attached to a lathe headstock, and a pure bending moment in one plane was applied by means of two ball races to which known weights were attached. The material of the bar was thus exposed alternately to maximum tension and to equal maximum compression once in each revolution. The machine was run at about 1060 r.p.m.

Bars of identical material were tried in pairs, one specimen welded and the other unwelded, and the number of revolutions before the specimens parted was observed for various ranges of stresses varying from ± 15 tons to ± 6 tons per sq. in. Fig. 7 clearly shows the stresses at which the welded and unwelded bars will withstand a very large number of repetitions of stress.

In the second series of alternating-stress experiments flat plates were used of three thicknesses, viz., ¼ in., ⅜ in. and ½ in. These specimens were tried in groups of four, each group consisting of one plain, one butt-welded, one lap-welded and one lap-riveted plate. The specimens, which were about 14 in. long and 5 in. broad, were clamped along the short edges, so that the distance between the fixed lines was 12 in. Each plate was also clamped, near the middle, to the end of a pillar, which by means of a crank arm was caused to oscillate and to bend the specimen equally up and down by adjustable amounts (the maximum total movement in any of the experiments tried was 5/16 in). The machine was run at various revolutions (not exceeding 9 per min.), and the number of repetitions at which the specimen parted was observed. Typical results obtained are illustrated in Fig. 8, in which the ordinates represent total displacement from normal position, i. e., 2/16 in. means 1/16 in. up and 1/16 in. down.

The experiments on bending consisted of doubling the welded plate over a circular bar of diameter equal to three times the plate thickness and comparing the results with those of the plate of the same material, but unwelded. Fig. 9 shows the results obtained from the bending tests, and it will be noticed that the angle at which fracture occurs decreases rapidly with increased thickness of plate.

In the impact tests heavy weights were dropped from various heights on to the welded portion of a plate 5 ft. long and 2 ft. 6 in. in breadth, the weld being across the plate, parallel to the shorter edge. The deflections were noted and the condition of the weld was examined after each blow.

Other tests to determine the relative value of welding and calking under tension and the relative bearing value of a riveted or welded lug attachment are shown in Figs. 10 and 11. In the former, two plates are attached at right angles by an angle lug with closely spaced rivets and the angle calked on both edges, similar to the boundary angles of a watertight or oiltight bulkhead. The object of the test was primarily to ascertain at what stress the "tightness" of the attachment was destroyed as compared with that of the welded attachment. The results indicated

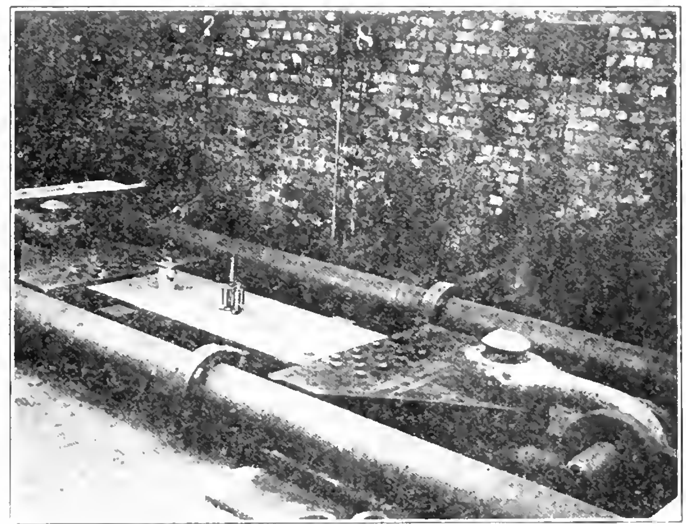


FIG. 4 LLOYD'S METHOD OF MEASURING MODULUS OF ELASTICITY

are very striking. The test shown in Fig. 11, in which a direct shearing force was applied to the lug attachment, indicates the relative values as between riveting and welding a lug attachment for such work as bracket connections. It will be observed that the welded lug is notched out at its mid-length and the welding applied only at the ends and in way of the notch.

The chemical and micrographical examination followed the ordinary practice.

SUMMARY OF EXPERIMENTAL RESULTS

1 *Modulus of Elasticity and Approximate Elastic Limit*

a In a welded plate the extensions in the region of the weld are sensibly the same as for more distant portions of the unwelded plate.

b With small welded specimens containing an appreciable proportion of welded material in the cross-sectional area, the relation between extension and stress is practically the same, up to the elastic limit, as for similar unwelded material.

c The elastic limit (or the limiting stress beyond which extension is not approximately directly proportional to stress) appears to be slightly higher in welded than in unwelded material.

d The modulus of elasticity of a small test piece, entirely composed of material of the weld, was about 11,700 tons per sq. in. as compared with about 13,500 tons for mild steel and about 12,500 tons for wrought iron.

2 *Ultimate Strength and Ultimate Elongation*

a The ultimate strength of welded material with small specimens was over 100 per cent of the strength of the unwelded steel

plate for thicknesses of ½ in., and averaged 90 per cent for plates of ¾ in. and 1 in. in thickness.

b Up to the point of fracture the extensions of the welded specimens are not sensibly different from those of similar unwelded material.

c At stresses greater than the elastic limit, the welded material is less ductile than mild steel, and the ultimate elongation of a welded specimen when measured on a length of 8 in. only averages about 10 per cent as compared with 25 to 30 per cent for mild steel.

3 *Alternating Stresses*

a Rotating Specimens (round bar). Unwelded turned bars will withstand a very large number of repetitions of stress (exceeding, say 5 millions) when the range of stress is not greater than from 10½ tons per sq. in. tension to 10½ tons per sq. in. compression. Welded bars similarly tested will fail at about the same number of repetitions when the range of stress exceeds 6½ tons per sq. in.

b Stationary Test Pieces (flat plate). Butt-welded specimens will withstand about 70 per cent of the number of repetitions

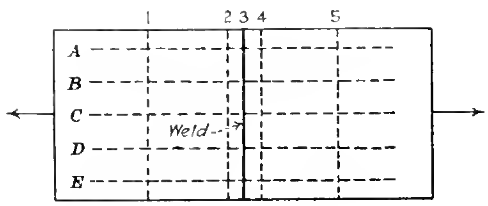


FIG. 5 POSITION OF READINGS, LLOYD'S METHOD

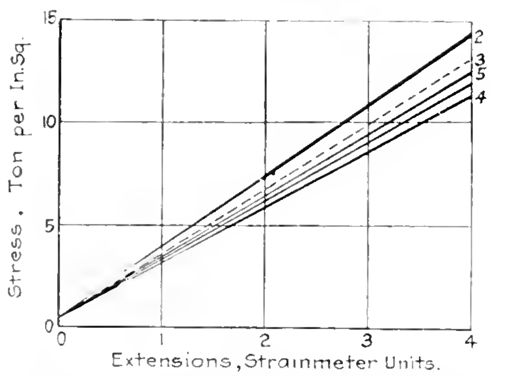


FIG. 6 EXTENSIONS IN DIRECTION OF PULL, READING ALONG LINE C OF FIG. 5

which can be borne by an unwelded plate. Lap-welded plates can endure over 60 per cent of the number of repetitions necessary to fracture a lap riveted specimen.

4 *Minor Tests*

a Welded specimens are not capable of being bent (without fracture) over the prescribed radius to more than about 80 deg. with ¼-in. plate, reducing to some 20 deg. where the thickness is 1 in. Unwelded material under the same conditions can be bent through 180 deg.

b Welded plates can withstand impact with a considerable degree of success; a ½-in. plate of dimensions already quoted sustained two successive blows of 4 cwt. dropped through 12 ft., giving a deflection of 12 in. on a length of about 4 ft. 6 in. without any signs of fracture in the weld.

5 *Chemical and Microscopic Analysis*

a Chemical Analysis. The electrode was practically identical with mild steel, but there was a greater percentage of silicon. The material of the weld after deposition was ascertained to be practically pure iron, the various other contents being carbon, 0.03; silicon, 0.02; phosphorus, 0.02; and manganese, 0.04 per cent, respectively.

b Microscopic Examination. The material of the weld is practically pure iron. The local effect of heat does not appear to largely affect the surrounding material, the structure not being much disturbed at about 1/16 in. from the edge of the weld. The amount of disturbance is still less in thin plates. The weld bears little evidence, if any, of the occurrence of oxidation. With welds made as for these experiments, i. e., with flat horizontal welding, a sound junction is obtained between the plate and the welding material.

6 *Strength of Welds*

a Butt welds have a tensile strength varying from 90 to 95 per cent of the tensile strength of the unwelded plate.

b Lap welds with full fillets on both edges have an ultimate strength in tension varying from 70 to 80 per cent of that of the

TABLE 1 COMPARATIVE STRENGTH OF RIVETS AND WELDED JOINTS

Thickness, in.	Diameter of rivet, in.	Breaking stress unperforated plate, lb. per sq. in.	Strength of plain plate, lb. per sq. in.	Percentage strength o joint
TRIPLE-RIVETED LAP JOINTS				
0.49	⅞	42,400	61,400	69.0
0.53	¾	38,300	54,700	62.5
LAP WELD—FULL FILLET—BOTH EDGES				
0.514	10.02[1]	45,300	63,600	71.0
0.730	8.76[1]	40,330	59,600	68.0
BUTT WELD—NOT STRAPPED				
0.505	10.66[1]	61,000	63,600	96.0
0.760	9.88[1]	54,680	59,600	91.5

[1]Total sectional area, square inches.

unwelded material. With a full fillet on one edge and a single run of weld on the other edge the results are very little inferior to those where a full fillet is provided for both edges.

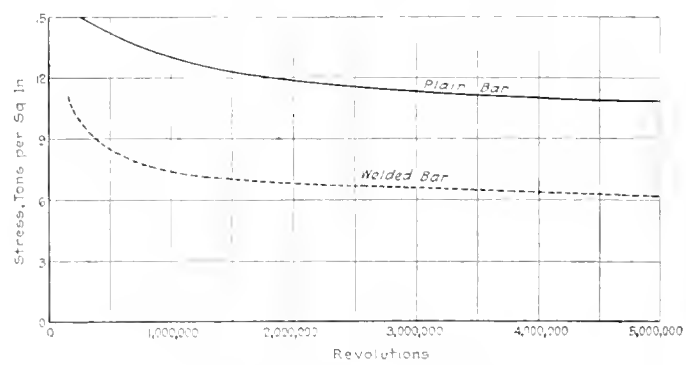


FIG. 7 ALTERNATING-STRESS TESTS ON ROTATING BARS

c Riveted Lap Joints. For plates of about ½ in. in thickness, the specimens averaged about 65 to 70 per cent of the strength of the unperforated plate. Typical examples of the statical strength of large specimens of riveted and welded joints are given in Table 1.

OBSERVATIONS ON EXPERIMENTAL RESULTS

1 *Static Elasticity.* It will be observed that the statical tests made to determine the elasticity indicate that, in general, the combination of welded and unwelded material behaves practically homogeneously up to at least the elastic limit. Moreover, the experiments show that the process of welding is such that the stress

is distributed practically uniformly over the weld and also transmitted uniformly to the adjacent plates.

The material of the weld is practically pure iron, and from the tests made on a specimen composed entirely of the deposited material of a weld, it will be seen that for a given stress the weld stretches slightly more than mild steel. This property will enable any undue occurrence of load being transferred in a proper manner to adjacent portions of the structure. When, however, the stress exceeds the elastic limit and is so great that the extension grows continuously without increase of load, the welded material fails sooner than mild steel. But this disadvantage is of little practical importance in shipbuilding and may be regarded as negligible in the particular problem under consideration.

2 *Dynamic Elasticity.* In a structure, such as a ship, which is exposed to variations and reversal of stresses, it is extremely important to know whether the material to be used is likely to break down rapidly under such alternations and ranges of stress as are likely to be experienced. The modified Wöhler tests employed in the experiments certainly indicate, if considered solely by themselves, that whereas for a given number of alterations mild steel would withstand a range of stress of, say ± 10½ tons, the welded material might be expected to fail at about ± 6½ tons, a figure which is more nearly experienced in ordinary ship construction.

As already stated, the material in the weld appeared to be nearly pure iron, and experiments of repetitive stress show that wrought iron bars are likely to fail under a range of stress of perhaps ± 7 to 8 tons as compared with mild steel at ± 10 to 11 tons. The weld has to be deposited electrically and is subject to

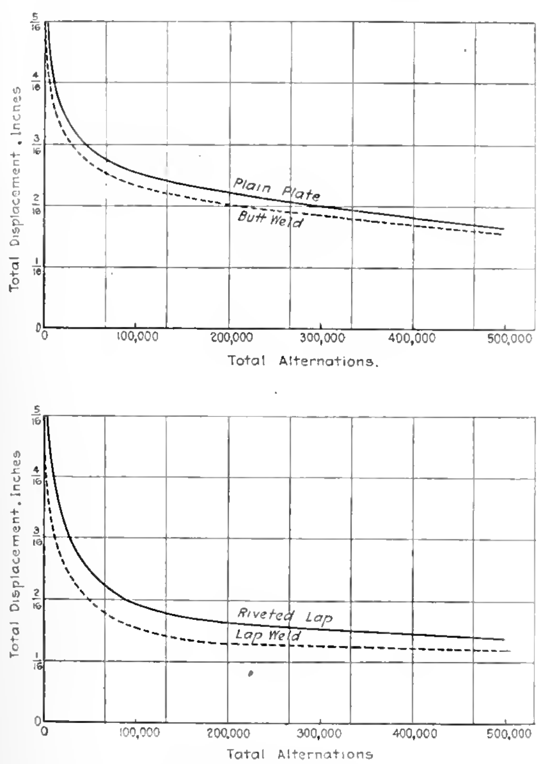


Fig. 8 Alternating-Stress Tests on Flat Stationary Plates

variations in workmanship; it would consequently be considered satisfactory if the material could withstand a range of stress of say ± 6½ tons. It would appear to be necessary to design the welded joints in such a manner that the amount of work likely to be thrown on the joint is as small as possible, and to meet such a condition a welded joint must be either lapped or strapped.

Lloyd's Rules for Electrically Welded Ships

In view of the satisfactory results of these tests, the Committee of Lloyd's Register of Shipping has decided that, under certain conditions, electric arc welding may be used in the main structure of a vessel and have adopted as a tentative measure, the following provisional rules for classification in Lloyd's Register Book of vessels electrically welded, subject to the notations "Experimental" and "Electrically Welded."

Tentative Regulations for the Application of Electric Arc Welding to Ship Construction

A—System of Welding and Workmanship

1 The system of welding proposed to be used must be approved and must comply with the regulations and tests laid down by the committee.

2 The process of manufacture of the electrodes must be such as to ensure reliability and uniformity in the finished article.

3 Specimens of the finished electrodes, together with specifications of the nature of the electrodes, must be supplied to the committee for purposes of record.

4 The committee's officers shall have access to the works where the electrodes are manufactured, and will investigate, from time to time

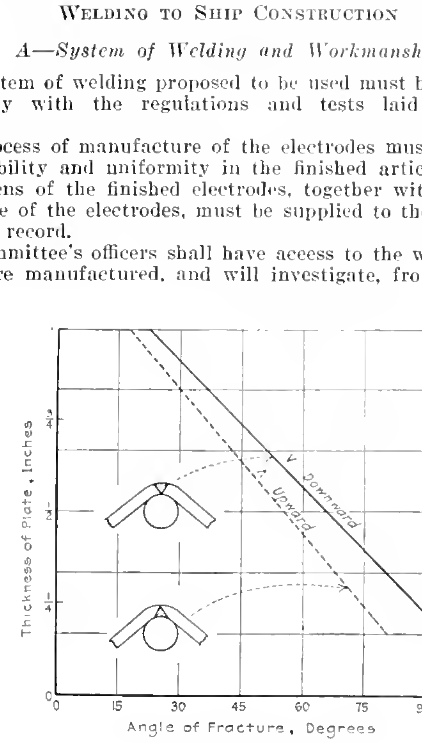


Fig. 9 Bending Tests

as may be necessary, the process of manufacture to insure that the electrodes are identical with the approved specimens.

5 Alterations from the process approved for the manufacture of electrodes shall not be made without the consent of the committee.

6 The regulations for the voltage and amperage to be used with each size of electrode, and for the size of electrode to be employed with different thicknesses of material to be joined, are to be approved by the committee.

7 The committee must be satisfied that the operators engaged are specially trained, and are experienced and efficient in the use of the welding system proposed to be employed.

8 Efficient supervisors of proved ability must be provided, and the proportion of supervisors to welders must be submitted for approval.

B—Details of Construction

9 The details of construction of the vessel and of the welds are to be submitted for approval.

10 Before welding, the surfaces to be joined must be fitted close to each other and the methods to be adopted for this purpose are to be approved.

11 All butt and edge connections are to be lapped or strapped.

12 With lapped connections the breadths of overlaps of butts and seams and the profiles of the welds are to be in accordance with the following table:

Thickness of plate, in.	*Width of overlay seam and butt, in.*	*Throat thickness, in.*
0.40 and under................	2¼	0.28
0.60 and under................	2½	0.38
0.80 and under................	2¾	0.48
1.00 and under................	3	0.50

Intermediate values may be obtained by direct interpolation, and for thicknesses below 0.40 in. the throat thickness is to be about 70 per cent of the thickness of the plate.

13 A "full weld" extends from the edge of a plate for a distance equal to the thickness of plate to be attached, and the minimum measurement from the inner edge of plate to the surface of weld is the throat thickness given in the table above.

14 A "light closing weld" is a single run of light welding worked continuously along the edge of the plate. Such a weld may, however, be interrupted where it crosses the connection of another member of the structure.

15 An "intermittent or tack weld" has short lengths of weld which are spaced three times the length of the weld from center to center of each short length of weld. Such tack welding may vary in amount of weld between a "full weld" and a "light closing weld."

16 The general character of welds is to be in accordance with the following table:

	Inside edge	*Outside edge*
a Butts of shell, deck and inner bottom plating .... *b* Butts of longitudinal girders and hatch coamings	Full Weld	Full Weld
c Edges of shell, deck and inner bottom plating .... *d* Butts and edges of bulkhead plating..	Light Weld	Full Weld
	Toe	Heel
e Frames to shell, reverse frames to frames and floors....... *f* Beams to decks....... *g* Longitudinal continuous angles....... *h* Side girders, bars to shell, intercostal plates, floors and inner bottom..... *i* Bulkhead stiffeners	Tack Weld	Light Weld

17 All bars required to be watertight are to have continuous welding on both flanges with tack welding at heel of bar.

18 The welded connections of beam, frame and other brackets are to be submitted for special consideration.

19 The committee may require, when considered necessary, additional attachment beyond that specified above, and the welding of all other parts is to be to their approval.

The rules are necessarily of a tentative nature and general in character and will be modified as further experience demands. It will be observed, however, that considerable importance is attached to the system of welding, type and process of manufacture of electrode, and to the employment of specially trained operators under supervisors of proved ability.

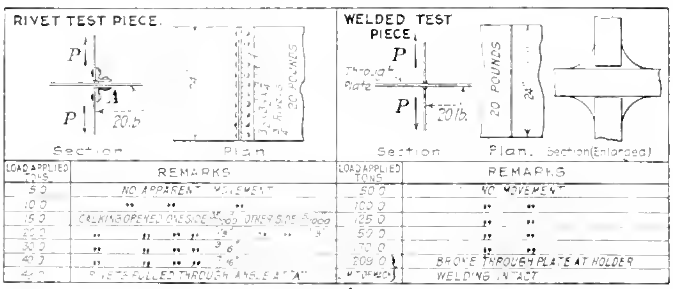


FIG. 10 COMPARATIVE TESTS ON BEARING STRENGTH OF WELDED AND RIVETED LUG ATTACHMENT

ELECTRICALLY WELDED VESSELS

The first vessel to be electrically welded so far as the writer is aware was the *Dorothea M. Geary*, a small launch 42 ft. long and of 11 ft. beam, built by the Geary Boiler Works at Ashtabula Harbor, Ohio, in 1915. The shell, which is of 8-lb. plating, is electrically welded throughout, the joints being butted and metallic-arc bare electrode used. The frames and bar keel are riveted to the shell. This little boat has been in service in the harbor since her completion, and no signs of distress or leakage have yet been noticed in any of the welded joints.

The barge recently completed at Richborough on the southeast coast of England, and referred to in the daily press as "the first rivetless ship," has attracted widespread attention. The construction of this barge was the sequence to a long series of successful tests on electrically welded joints carried out in England at the Admiralty dockyards and elsewhere, and will doubtless prove to be the stepping stone between the laboratory test stage and an actual full-powered ocean-going steamer yet to be built.

The barge in question is a non-propelled standard cross-channel transport barge 125 ft. between perpendiculars and 16 ft. beam, with a displacement of 275 tons. It differs in no way from the standard riveted type with lapped joints excepting that the seams of shell plating are arranged clinker fashion and joggled to permit of horizontal downward welding as much as possible. The hull is rectangular in section amidship with only the bilge plates curved. The shell plates are $\frac{1}{4}$ in. and 5/16 in. thick. It was erected in the ordinary manner with service bolts spaced from 10 in. to 15 in. apart, and after the joints were welded the bolts were removed and pins driven into the holes and welded up as it was desired to complete the structure entirely without rivets.

Five welders of considerable experience were employed on the work, using the "Quasi Arc" process with flux-covered electrodes. After a few initial difficulties had been overcome, an average speed of welding of 7 ft. per hr. was maintained, including overhead work which averaged from 3 to 6 ft. per hr. Altogether there were some 7000 linear ft. of welding and 3066 holes to be filled. The total cost of welding, which was £300 ($1500), was made up as follows: Electrodes, £178; current, £60; labor, £62. It is anticipated that the large proportion of this amount represented by cost of electrodes could be reduced by some 60 per cent with an increased output.

Careful check was kept of the total cost and the total man-hours of work involved, but a comparison with that of a similar riveted barge would be misleading, since the welded vessel was purely an experimental demonstration and no attempt was made to save material or to economize by the substitution of rivets in parts where this might have been cheaper or quicker than welding. Nevertheless it is estimated that 246 man-hours were saved over the riveted barge.

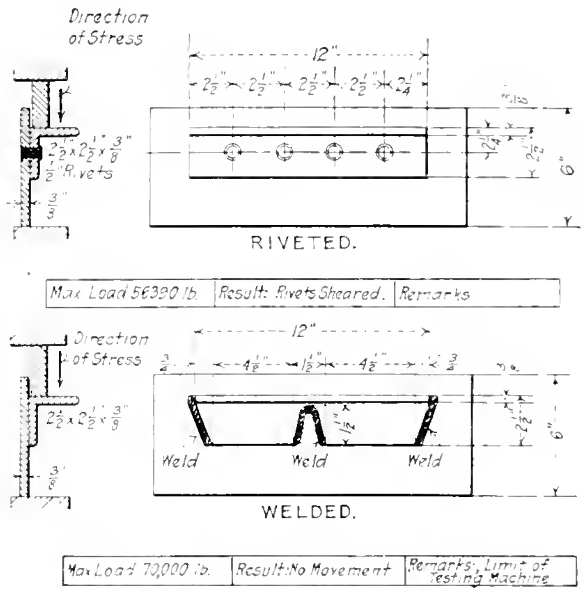


FIG. 11 RESULTS OF TESTS SHOWING RELATIVE VALUE OF CALKING AND WELDING

Since her completion she has been engaged in cross-channel service and with a full cargo of ammunition has experienced some exceptionally heavy weather, but has so far shown no signs of failure in the electrically welded joints.

WELDING AS AN OCCUPATION FOR DISABLED FIGHTERS

Apart from its importance to the shipbuilding and engineering professions, there is an impelling reason why the subject of this paper should at least command the sympathetic attention of all interested in the future of those men who in the defense of civilization have sacrificed their physical fitness to return to their former means of livelihood.

In the application of electric welding to ship construction a vast field of useful and honorable employment is opened up for temporarily or permanently disabled men on their discharge from the service or hospitals. We have seen that welding is not an arduous task; a man maimed by the loss of an arm or a leg can weld as well as the physical giant; it may be that he will weld better, for such work demands the conscientious application usually found among those whose occupations are limited as a result of physical impairment. In developing the welded ship, with all its economical possibilities, we may therefore be helped not a little by the consciousness of directly assisting in the solution of this greater problem of our national industrial economics in particular and of humanity in general.

Some Twentieth-Century Problems

By WILLIAM B. DICKSON,[1] NEW YORK, N. Y.

THE one clearly defined issue which seems to run through all history, is the eternal, irrepressible conflict between autocracy and democracy. And now America, the hope of a world grown weary with the ancient strife between democracy and autocracy, is facing anew the problem of the ages. How will she answer it? This is the theme to which I wish to direct your thoughts this evening, and I desire to say to you frankly in advance that I expect to raise some questions to which I have not been able to find completely satisfactory answers.

Let me read a recent poem by E. E. Miller:

The Question of All Time

Beside the road of time the gaunt Sphinx lay
  Half buried in the dust of cities dead.
  A mighty nation came with ringing tread;
The monster rose; the traveler stood at bay
And heard the riddle: "What is there to say
  When idlers feast and toilers lack for bread?"
  No answer came; a struggling gasp instead

Told that the Sphinx had clutched another prey
Empire on empire fell, the question still
  Unanswered, and today our young land hears
It asked. She hears; her lips half apart with will
  To speak; yet she is silent and appears
To halt in sudden doubt 'twixt two replies.
Still closer draws the Sphinx with baleful eyes.

My grandfather landed in Philadelphia in the autumn of 1830. He had come, in advance of his family, to see if America really was the promised land of which he had heard. He rode horseback to Pittsburgh, the journey requiring fourteen days. After spending some months in the Ohio Valley, he started back to Philadelphia on horseback in the depths of winter and suffered severe hardships in the crossing of the unbridged streams.

Not long ago, while thinking over some of the problems we are discussing this evening, I tried to picture what he would have thought if he could have foreseen the changed conditions in which his grandson would live. Let us suppose that he could have foreseen that in these latter days the journey from Philadelphia to Pittsburgh, which he made with such toil in fourteen days, would then be made in ten hours in luxurious ease. That instead of the single furrow turned by the oxteam, the food of the nation would be grown on farms where great tractors would drag a dozen plows and plow up an acre in seven minutes; and that, when the grain was ripe, it would be reaped, bound, threshed, and sacked by mechanical power, so that one man's labor would be equal to that of fifty men of his time. That instead of the slow hand process of carding, spinning, and weaving of cotton, wool and flax, great mills would be filled with power machinery that would multiply the product of man's labor a hundred fold. That all of the crude appliances of this time had been superseded by the marvelous labor-saving devices with which we are so familiar.

What would have been his conclusions as to the state of society in which his grandson would be privileged to live? Would he not have been justified in looking upon it as a golden age—an age in which the curse of poverty had been finally overcome? An age in which no honest man, willing to do his share in the community life, need ever have any apprehension of want for himself or his family? Has such a state been realized? If not, why?

Justin McCarthy, in his History of Our Own Times, tells of the horrible conditions under which women labored in English coal mines, when the seam of coal was so thin that they had to crawl on all fours for fourteen to sixteen hours a day, dragging after them the trucks loaded with coal. And this condition existed in the enlightened reign of good Queen Victoria.

I remember on my first visit to London, looking out of my hotel window early one morning in May, I saw a crowd of outcasts waiting for the park gates to be opened so that they could get in and throw their exhausted bodies on the damp grass. They had wandered the streets all night, and this was their only place of rest. I was informed that in London, on one night, as many as 35,000 homeless men, women and children had walked the streets —of whom it could be said, as was said of another outcast,—"He had not where to lay his head." And this condition was in the reign of good King Edward, and in the richest capital in the world.

Four years ago, in February 1915, as I sat down to breakfast, I opened the New York *Sun* and saw two headlines on the front page which made a lasting impression on my mind. At the upper left-hand corner was the announcement that a well-known American business man had bought four pictures for $250,000 each, or $1,000,000 in all. At the upper right-hand corner on the same page was the announcement that about 2000 men, women and children had stood in line the previous night in the cold rain to receive from the hand of charity a roll and cup of coffee, to keep them alive till morning. And these were not vicious men and women outcasts from society, but working people unable to obtain employment.

You will recall that this situation was so serious that Mayor Mitchel appointed a committee of prominent New York citizens to deal with this question of unemployment, of which Judge Gary was chairman.

As Louis F. Post says in his Ethics of Democracy—

> Though wealth is abundant, and wealth-producing power emulates Omnipotence, degrading poverty, and the more degrading fear of poverty, are distinguishing characteristics of civilized life. Instead of lifting all to better conditions of opportunity, man's triumphs over the forces of nature enormously enrich a few at the expense of the many.
>
> They have done little to increase the comforts of the toiling masses, even absolutely, but much to diminish their comforts relatively; and industrial liberty they have almost destroyed.
>
> The gulf between riches and poverty has not been filled in; it has been widened and deepened and made more of a hell than ever. So dreadful is the poverty of our time felt to be that it has inspired us all with a fear of it—a fear so terrifying that many more good people than would like to acknowledge their weakness, look upon the exchange of one's immortal soul for a fortune, as very like a bargain.

The Declaration of Independence proclaims as the inalienable birthright of every human being, the right to "life, liberty and the pursuit of happiness." I would like to amend the last expression to read: "the attainment of happiness," or, at least, a reasonable opportunity for its attainment.

James Mackaye has said: "Everywhere we are taught that life is sacred, that liberty is sacred, but where are we taught that happiness is sacred?" And yet, it is only because of their relation to happiness that these other things have a trace of sacredness.

You may be surprised to have me name as one of the causes of social unrest in our day the modern factory system, which we are accustomed to hear extolled to the skies as one of the most notable evidences of our progress toward a higher civilization. I confess approaching this subject with a good deal of hesitation, because it is not easy to reason this problem to a satisfactory conclusion. It is my earnest belief, however, that the man who, day after day, for the best years of his life, is a mere cog in the complex organizations which go to make up our modern factory system, is bound, in spite of himself, to be stunted mentally, morally and physically by the dreadful monotony of his task.

I have in mind such operations as wire-nail factories, where, amid the ceaseless deafening din, a man stands tending automatic machines pouring out an endless stream of nails. How much pride of achievement can be associated with such a task; or, even worse, the workers in the dust-laden, lung-destroying cement, acid, and fertilizer works?

The village blacksmith of our fathers' days who would shoe a horse in the morning and make a chain or build a wagon in the afternoon, was a better all-round citizen than the man who stands

[1] Vice-President Midvale Steel and Ordnance Company, 14 Wall St.

Address delivered before the Philadelphia Section of The American Society of Mechanical Engineers, January 28, 1919.

all day shut out from sunlight and fresh air, feeding some automatic machine, in the product of which he can have little pride. And this is not because the old-fashioned blacksmith was inherently a better man, but because of the inevitably narrowing effect of modern factory work.

I believe this very thing of which we are so proud is full of menace to our civilization, and that there was more of the joy of living among the rural population of 100 years ago than there is among a large proportion of the factory operatives today. The most important raw material of our factories is never mentioned in their system of accounting, namely, human lives and characters, but the finished product is made up of these elements just as really as of wood or steel or cotton. Cheap factory products would seem to be a vital necessity to our civilization, but if in producing them we are debasing our manhood and womanhood,—yes, and oh, the pity of it! that we must include our child workers also,—we are paying a fearful price for them.

In the mechanical arts, the world has progressed more in the past century than in all previous recorded history. If George Washington could have invited the Pharaoh of the Exodus to visit his plantation at Mount Vernon, he could not have shown him any advance in the art of agriculture over his own time, and with the exception of gunpowder, printing and the telescope, he could have shown him little or no advance in the mechanical arts. The steam engine, the cotton gin, the spinning jenny, the power loom, have revolutionized human life since then.

Most of the marvellous advances in applied science have been made in the memory of men still living,—such as the sewing machine, telegraph, telephone, phonograph, electricity in all its branches, internal-combustion engines, dynamite, airplanes and submarines.

In view of this wonderful acceleration in material progress, we should not be surprised to find a tendency toward a similar progress in the domain of human relationship, which, in some of its aspects, is as startling as were some of the inventions I have mentioned.

It is the tendency of the average business man to mistake mere inertia for true conservatism, and it is a sad comment on the power of inertia in human affairs that great advances in the science of human relationship seldom are achieved as the result of calm reasoning, but usually under the pressure of dire necessity or public danger. An English statesman once said that the British Parliament had enacted many just laws; but that it had enacted very few because they were just.

Many wonder at the social unrest which is so much in evidence, but as I contemplate recent history such as I have mentioned, my wonder is—not that men have become aroused, but that they were able so long to remain quiescent under such conditions.

In a completely natural society, every man, by reason of close and continuous contact with land and other natural resources would be an independent, self-sustaining unit. When a man has left this natural condition, whether voluntarily or otherwise, and has become the servant of another man, or other men, he has given up a natural right, and his employer has assumed an equivalent obligation. The fact that neither the employer nor the employee has been conscious of this exchange, and that both may have acted from purely selfish motives, does not alter the elemental fact, which, in the great national aggregate, constitutes the great unanswered problem of modern times: the elemental fact that is at the base of all social unrest.

The saying, "Taxation without representation is tyranny," epitomized the sentiment back of the American Revolution. Whether money is taken from a man by unjust taxation, or withheld from him by an unfair wage system, the principle remains the same. Lincoln, in one of his famous debates with Douglas said: "A house divided against itself cannot stand; this nation cannot continue to exist half slave and half free."

Political thinking has advanced with tremendous strides since then, so that as a result of the war with Germany, the nations seem ready to say: "This world cannot continue to exist half democratic and half autocratic." And while this is true in the domain of politics, it is no less so in industry. Our past history is full of instances where men in control of large aggregations of capital have been guilty of grave abuses against the public welfare and against the most elementary principles of morality. These autocrats of capital have been partly balanced (whether as an effect or a cause, would depend upon your point of view) by equally autocratic and irresponsible labor leaders, who have not hesitated to use force in its vilest forms in order to win their ends.

I do not unreservedly denounce the use of force, as to do so I would have to include in such a sweeping condemnation some of the noblest of mankind, who, as a last resort, and to redress just grievances, have not hesitated to use it. But this, which should be reserved for the holiest uses, has been prostituted by labor demagogues to achieve the most trivial ends. The only way out of this senseless conflict between capital and labor is for employers to realize that the day of industrial democracy has dawned, and that "The establishment of wage rates and other conditions of employment without representation is tyranny" also.

Much has been done by benevolent employers to improve working conditions, but however conditions may be improved, the right of the workmen to collective bargaining must be recognized as a legitimate outgrowth of American ideals. The individual workman, dependent on his own strength and resources, cannot hope to bargain on equal terms with the corporation. If he cannot do so, and is debarred from association with his fellow-workmen, he is no longer a free man but a serf: and the serf has no place in the future of America.

Many years ago a noted steel man was asked which was the most important factor in his business, labor, capital, or management. His reply was in the form of a question: "Which is the most important leg on a three-legged stool?" While the above conclusion as to the equality and interdependence of these three factors has been generally accepted as a theory, in very few instances has it been given practical effect.

I believe that the greatest task to which American employers must address themselves is the devising of practical ways in which labor can be given the full recognition to which, as an equal partner, it is entitled. I make this statement with absolute confidence in the fair-mindedness of the American workingman when he is fully informed and is entirely free to act. If I did not have this confidence, I would despair of the future of our free institutions. I believe that one of the first steps necessary to inspire the workmen with confidence in the sincerity of the employers' recognition of the proper status of labor is the adoption of a fair system of collective bargaining. I am glad to say that the company with which I am connected has recognized this right, and has established what I believe to be the most democratic system of collective bargaining which has ever been devised.

Some of you may ask what is to become of the sacred freedom of contract under such a system? I answer—The same thing which has happened to many other seeming natural rights which the individual has sacrificed for the common good.

Consider for a moment the natural rights which you have resigned as compared with the residents of Philadelphia only two or three generations back. Can you imagine some doughty individualist of those days submitting suddenly and gracefully to all of the laws and ordinances of the municipality, the state, and the Federal Government, to which you give not only obedience, but also assent? Would your great-grandfather have tamely submitted to compulsory vaccination, to restricted child labor, to the haughty traffic policemen and your one-way streets; to all of the restrictions on your personal liberty which you recognize as essential to the common good? None of these questions can be answered separate and apart from the problems of our complex civilization.

I also believe that as a further natural development of democratic ideals, systems of profit sharing with employees must be worked out and adopted. One of the earliest records we have of the employment of one man by another for wages, is that of an Arabian sheik who employed a young man to care for his flocks. It is interesting to note that while at first he was a mere hireling, the relationship eventually changed into one of profit sharing. I refer to the story of Laban and Jacob as recorded in the thirtieth chapter of Genesis. If you look this up and find that the em-

ployee "put one over" on his employer, I hope you will not on that account condemn the principle.

No system could be devised which would be applicable to every industry, but this basic principle would be common to all. Capital can, with reasonable care, be invested so as to return, say, 5 per cent, with little or no risk to the principal. Where it is invested in a business where risk of depreciation or loss of the principal is a constant factor, as it is in most industries, it should have the first call on the profits to an amount in excess of 5 per cent to fully cover this risk. This percentage would, of course, differ widely from that of national bank stock up to the manufacture of explosives. If I were asked to suggest a tentative plan for the average well-established steel company, I would first give the stockholders 10 per cent on their stock and divide the surplus over this amount equally between the stockholders and the employees, including the management.

In other words, capital, management and labor are each entitled to wages at current rates, and to a sufficient share of the profits to insure permanency. Capital, under the example cited, would receive 5 per cent as wages and an additional 5 per cent as insurance. Management would receive salaries which, presumably, would be large enough to enable each person to avail himself of modern life, accident and health insurance. Labor would receive wages at current rates and would be insured by the workmen's compensation law, maintained by taxation of industries. After the payment of these wages and insurance, the remaining profit should be divided equally between capital on one hand and management and labor on the other.

And now, in conclusion, in what spirit shall we deal with these problems—that of class consciousness, or in that broader spirit of human brotherhood which is so gloriously set forth in the writings of the loving-hearted Lincoln—"With malice toward none—with charity for all"?

Herr Ballin, one of the wisest of the former counselors of the Kaiser, in a recently published letter ridiculed the idea that Americans as a nation were mammon worshippers, and expressed the opinion, based on long years of close business association, that we were, on the contrary, above everything a nation of idealists. To prove that this has been true in the past, we need only to point to the Civil War, waged for the great ideal of human freedom; the part we played in the Boxer Rebellion, in returning to China our share of the indemnity exacted from her; the Spanish War, to end the intolerable conditions in Cuba and to establish her as a self-governing nation; and lastly, our part in this great war in the defense of civilization, in which we engaged technically, perhaps, because our legal rights were violated, but in fact because we recognized that it was a death struggle between autocracy and democracy, and one in which the leading democracy must play a noble part or be forever put to shame.

And in this holy war, in which the ideals for which America stands have been so gloriously triumphant, the sons of employers and workmen have marched shoulder to shoulder, and many of them sleep together today in the same patriotic graves in the soil of France, hallowed by their sacrifices. Let us, in the same spirit of brotherhood, grapple with the problems of peace and help to usher in the dawn of an industrial democracy which will give fuller recognition to the thought expressed by Burns:

> The rank is but the guinea stamp,
> A man's a man for a' that.

The speaker prefaced his address with a brief statement of his experience in order to show that he had at least had the opportunity to study certain present-day social problems at close range. Starting when a boy as a manual worker in the Homestead Steel Works, he had been fortunate in receiving rapid and continuous promotion, and eighteen years later had become one of the junior Carnegie partners. He had been vice-president of the U. S. Steel Corporation for the first ten years of its existence. In 1915, after a brief retirement, he had returned to active business life as an officer of the Midvale Steel and Ordnance Company.

He had been reproached for his attitude on social questions by his friends and associates, and had at one time or another been called a socialist, an anarchist, a Bolshevik, a radical. He was glad to be termed the latter, however, provided that Gladstone's definition was accepted:

Conservatism—Distrust of the people, tempered by fear.
Liberalism—Trust of the people, tempered by prudence.
A Radical—A Liberal in earnest.

He wanted to disclaim being a mere sentimentalist. He had had to deal with hard facts all his life, and he believed that he was able to keep his feet on the ground, even if his head might seem to be in the clouds.

Readjustment of Labor

The Readjustment Committee of the Merchants and Manufacturers' Association of Baltimore has rendered a report on the labor conditions in Maryland. A brief summary of their remarks and suggestions, which were classified under 11 different headings, is as follows:

1 *Right kind of man can get a job.* Employers now are not driven to the extremity of submitting to any kind of labor as during the war, and they can expect in return for a high wage an equal measure of productiveness.

2 *No use to look for war wages in normal shops.* Times are normal again and workers cannot in reason expect the excessively high wages of munition and other war plants.

3 *Must beat down the high cost of living.* Alliance of capital and labor is absolutely essential to bring about a reduction in food prices.

4 *How about the soldier laborer? How could he be handled?* Proximity of military places to Baltimore causes many of the discharged soldiers to pass through the city on their way home. They plunge into pleasures and accompanying excesses and find themselves stranded. Then they look for work under conditions to their disadvantage. This demoralizes the labor market.

5 *Must reëmploy resident returning soldiers.* It is suggested that the public, through some community committee, should be apprised of all those employers who turn their backs upon the men who responded to the call of their country.

6 *What to do to take care of the unemployed.* If unemployment becomes ominous, it becomes a community problem, and the state, the city and the counties should work out plans for public improvements and should offer work to those who might otherwise suffer.

7 *Women workers who do not have to work for a living.* If these women were induced solely by patriotic motives to take jobs during the war, why will not the same lofty patriotism, in times of peace, induce them to surrender the jobs in favor of men and other women whose families will go hungry if employment is not found?

8 *Returning munitions and shipbuilding laborers vs. out-of-town soldiers.* During the urgent days of the war great patriotic drives were made all over the country to make workmen understand that it was their primary duty to give up all else in order to promote rapid making of munitions and the speedy building of ships. That being true, the munition worker or shipbuilder who seeks a return to his old employment under terms and conditions commensurate with the peace situation is entitled to consideration ahead of the out-of-town man in uniform.

9 *Not fair to fill the places of local labor with soldiers who belong elsewhere.* The committee is of opinion that when a nonresident soldier makes application for employment to a local United States Employment Service, that Service should endeavor to place him at work in the city or state from whence he came.

10 *Industry should not drive labor into the arms of dangerous allies.* Only a genuine coöperative relationship between industrial employers and labor can prevent a closer alliance of the Non-Partisan League, an organization of radical agriculturists, with industrial labor. Narrow-minded policies of American employers will precipitate the spread of the socialistic tendencies that have gripped North Dakota.

11 *How to make high wages certain.* Employers are willing to pay an average wage to an average worker, but why should not the worker be allowed to progress in the range of his wage earnings in proportion to his individual productive powers?

The Engineer as a Citizen

A Symposium on His Civic Responsibility and Relation to Legislation, to Administration, to Public Opinion and to Production and Distribution

A WELL-ATTENDED meeting of engineers of the metropolitan district was held on the evening of March 26 at the Engineering Societies Building, New York City, the purpose of the gathering being the discussion of the place and duty of the engineer in the community. The meeting was held under the general auspices of the New York sections of the national mining, mechanical and automotive engineers' societies, and the members of fifteen other engineering and chemical societies were invited to attend and take part in the discussion. Gano Dunn presided and introductory addresses were made by Philip N. Moore, Calvert Townley, Nelson P. Lewis, Spencer Miller and Comfort A. Adams. An active and extended discussion followed, one important result of which was that resolutions were adopted looking to the organization of a New York local engineering society composed of the local sections of the national societies and of other local engineering organizations. Abstracts of the addresses and the discussion which followed their presentation are given below.

The Civic Responsibility of the Engineer

PHILIP N. MOORE

The engineer, waking from long sleep of indifference and self-content, satisfied with himself in his professionad successes, has suddenly waked to the fact that he is not politically potent. He has not counted as a class politically because he has not served politically; he has not, save in rare cases, developed in himself the political sense. In the professional heart-searching, momently the dominant mood, he seeks the reason.

Broadly speaking, the answer is plain. He has not cared enough to exert himself personally or professionally to attain an end which now at last seems to him worth while and vital.

Given like heredity and culture, there is no inherent reason why an engineer should react differently from any other citizen to the patriotic call or civic responsibility. But, unfortunately, things have combined to leave him too often unwanted and uncalled. What are these things?

First, lack of local attachments. With few exceptions, the engineer's tasks are scattered countrywide, or worldwide, and mostly are those of construction, which, completed, he goes his way to build again. He works under strain, he has little time to forgather with his fellows, or to think in terms of political or national interest and service, save as great emergencies come, like that of the late war. And without local responsibilities a man feels little sense of civic duty and finds less opportunity for participation in national questions.

Second, a large proportion of the total body of engineers serve the great business consolidations, many of which have interests adverse to the public, or by their very size induce criticism and political attack, and in self-defense they think they must hold their staffs to strict neutrality on all public questions.

Third, the engineer's training has failed to teach that the greatest task of all is the ability to persuade men, and unwillingness or incapacity to enter public discussions, either through modesty or lack of readiness, have held him back. False professional pride, and the same indifference which holds back many high-class men through unwillingness to mingle with and rub shoulders against the great majority, have also deterred him.

Fourth, the past habits of the great organizations which the engineer forms (and which voice his profession) to hold themselves aloof from political affairs as collectively unethical.

What shall be the remedy for the engineer's isolation? It is within himself. He must realize that the duty is in him first and then in his society. By virtue of his exact knowledge of the things which build so large a share of civic affairs, for so much is engineering, he is particularly fitted to render expert advice and service.

We need fearless men who in the market place and from the housetop shall proclaim to the world: That since the beginning of history brains have ruled brawn; that the brain deserves, and in the ultimate will inevitably receive, greater reward than the hand; and that any proposed condition which puts brawn over brains plans the pyramid on its apex and necessarily is one of unstable equilibrium.

These are a few of the things we can preach, and because we fear no political backfire. We have no fences to mend. We can stand in the open and say everlasting truths, and the time will come when some men may believe them.

The Relation of the Engineer to Legislation

CALVERT TOWNLEY

What the attitude of the engineer should be toward legislation is a question that has been debated with considerable vigor for many years. Opinions differ widely, and range all the way from that of the ultra-conservative, who believes that the engineer should have nothing whatever to do with legislation or politics, to that of the ultra-radical, who thinks that he should direct all legislation—in fact, that no government function should be exercised except under his direction.

It may help us to visualize the present situation if we examine briefly one or two of the ways in which engineers have attempted to influence legislation heretofore. In 1911 the American Institute of Electrical Engineers, on invitation from the National Waterways Commission, sent a committee to Washington to appear before the Commission. The committee was assisted by a special advisory committee, and held several meetings before proceeding to Washington in order to determine just what should be their policy and what sort of a presentment they should make. It was decided that the committee should confine itself strictly to a statement of engineering and allied facts which engineers were peculiarly competent to testify and which were beyond the field of controversy. They were instructed to refrain from expressing views as to the wording of any legislation or to give opinions regarding legal matters.

In 1911 a bill was introduced in the New York state legislature to license engineers and which aroused the alarm and stirred up the strenuous opposition of the four national engineering societies. A joint committee was appointed from these societies, and from the Institute of Naval Architects and Marine Engineers as well. This committee sent a strong representation to Albany, which appeared before the Legislative Committee and vigorously opposed and assisted in defeating this attempted legislation. It was found desirable to take somewhat similar action again in 1913. Feeling that it would be advantageous to have some means of coöperation among the national engineering societies, this committee was continued under the title of a Joint National Committee of Engineering Societies and continued to serve for several years, its activities, however, not by any means being confined to legislative matters. One of its functions was to serve with respect to the National Engineering Congress held in California in 1915, and out of it grew the discussion which finally resulted in the organization of the Engineering Council.

The Engineering Council has been in existence since May 1917. It has been in receipt of many requests to favor or oppose legislation, and this legislation is by no means confined to questions of engineering, but covers every sort of subject from the fixing of a minimum wage for labor up to the organization of the Army for the conduct of war.

The Engineering Council was created to speak for its constit-

uent societies on matters of common concern to engineers and to afford a means for joint action when desirable. Its by-laws give it wide latitude, and there have been no limiting instructions issued to its delegates by the appointing bodies. The Council has therefore had to determine upon its own line of action, and it is by no means certain what that should be with respect to legislation.

It has been my lot to have to do with this question for a number of years, and while I have earnestly sought to get the opinions of my engineering friends and to act upon them, I confess that I do not know what engineers want, and therefore what our policy should actually be. Of course, we believe in ourselves. We believe that an engineer's training, designed as it is to make him think clearly, to deal with essential facts and to arrive at logical conclusions regardless of outside influence, peculiarly qualifies him to express opinions on legislative as on other subjects, but we shall have to choose which of two places to occupy. Shall we be a united body of technical men, speaking only with deliberation and a certain amount of proper dignity regarding subjects which the public recognizes us as qualified to speak upon, or shall we be as a body of somewhere from 30,000 to 100,000 citizens who have a common interest and desire to exert political pressure by reason of our numbers?

I would like to think that we could combine these two positions, but my logic tells me that we cannot. Personally I believe we should not try to influence legislation which concerns us only as citizens, but if we undertake the task at all, we should concentrate our efforts on certain specific lines and thereby stand a better chance of having them prove effective.

The Relation of the Engineer to Administration

Nelson P. Lewis

Heads of great industrial enterprises, transportation companies, and all other public-service activities, are required to perform functions which are largely administrative. Such places were once almost always filled by business men or lawyers; later by men who had come up from the ranks, hard-headed men who had begun as boys and passed through the various branches or divisions of the work and had demonstrated qualities of men, leadership and executive capacity, but seldom were they of technical education. During recent years, however, we have seen such places more frequently filled by men who knew the science as well as the art of the business, keeping in mind the old distinction between the two, namely, that science teaches us to know and art to do. There have been many conspicuous instances where spectacular success has been achieved by young men of this type, a success which would only have been gained under the former system through long service, beginning at the very bottom and slowly mastering the details.

But the term "administration," as commonly used and understood, relates more particularly to public business; business of the city, state and nation. From this type of administration the engineer has been more completely excluded than in the case of industrial concerns or public-service corporations. In this exclusion the engineer himself has appeared to acquiesce. He has been so long accustomed to doing things when he is told, as he is told, and because he is told by those whose function he has thought it to be to determine general plans and policies that he is in no small degree responsible for the idea which has been generally prevalent, that the duty of the engineer is simply to carry out the ideas and policies of others. But if it be admitted, as it must, that what is commonly called the administration of public business is largely the formulation and execution of engineering projects, why should not engineers themselves take a conspicuous part in their formulation as well as their execution?

The machinery of municipal administration, as prescribed by city charters, has usually been very cumbersome and ill adapted to meet emergent conditions. In 1900 the city of Galveston was practically wrecked by a violent storm and tidal wave. The city was already in a bad financial condition and the municipal government was unable to cope with the situation. In order to meet existing conditions, a form of commission government was adopted under which the entire management of the city's affairs was placed in the hands of five men. So successful was the plan that within a dozen years it had been adopted by about four hundred cities and towns within the United States.

In 1913 the city of Dayton went a step further and adopted what is known as the commission-manager plan. This also consisted of a commission of five citizens, elected at large, who constituted the governing body, but they appoint a chief administrative officer, designated as the city manager. It will be noted that these two forward steps in municipal government were taken by cities which had suffered great disasters.

Thus was developed a public office which the engineer with executive capacity is especially well qualified to fill, and that this opinion is held by those responsible for the selection of the managing executives is evidenced by an examination of the list of city managers who have been appointed. Of the 124 cities now operating under some form of the city-manager plan, the speaker has been able to secure information as to the previous experience and training of 88 of the managers, the classification being as follows:

50 professional engineers
9 merchants
6 minor city officials
5 general business
3 superintendents of construction
2 journalists
13 miscellaneous (these including one each of contractor, railroad president, railroad purchasing agent, public-utility manager, professor of government, training school for public service, office manager, league secretary, real estate, lawyer, physician, broker and plumber).

But what about the training of the engineer to fit him for such positions? Business sense is certainly an essential qualification for success in such work as the management of a city, a public-service corporation or an industrial enterprise. Are the courses given in our engineering schools calculated to fit him for these most attractive fields of activity? We will be told that all of the time of the student is required to enable him to cover the strictly technical curriculum, and that if such things as culture and business courses are to be added, the period of training will have to be lengthened or some of the technical courses will have to be curtailed or omitted. Perhaps this would not be as serious a loss as professional educators imagine, while it would broaden the student and might account for the difference between success and failure in administrative positions.

The Relation of the Engineer to Public Opinion

Spencer Miller

The engineer is assuming an ever larger position in public life, and in spite of himself he is at the very center of life. The more we realize this great truth, the more seriously do we contemplate our responsibilities. This thought fills some with pride and others with humility. Eliminate the engineer from the world and civilization would soon pass through other Dark Ages comparable with savagery and barbarism. It is clear, therefore, that we, individually and collectively, should make every possible effort to mold public opinion in the right direction, especially at present to counteract the propaganda of those stirring up class hatred. Even today the engineer stands, with all law-abiding citizens, facing the dark cloud of Bolshevism—not timidly, not indifferently, but in full strength, courage and faith that Bolshevism cannot survive in America because it stands squarely against the code of morals upon which our civilization was founded.

We observe that the engineer is successful in public life because of his technical training and his upright character. But who may say that a well-trained lawyer with upright character to his credit would not make an equally good public servant? Is it not evident that both engineer and lawyer are needed in public and political life and are any comparisons advantageous?

A Congress half lawyer and half engineer surely would be superior to one all lawyer or all engineer. Do we not also recognize

that experienced business men, manufacturers and farmers of upright character are also required to serve the nation in Senate and Congress?

What is the relative importance of the training of an engineer as one element and his upright character as the remaining element? Let us look for an answer in the recent struggle to find that element which President Wilson so aptly called "the very stuff of victory."

The program for the United States involved billions upon billions of money. Ships by the thousands, airplanes by the thousands, guns by the hundreds of thousands, shells by the millions, tanks in hundred thousand lots, and several million men besides. A small fraction of these materials of war ever arrived in France, and yet both France and England frankly acknowledge that our troops turned the scales against Germany. What, then, is the answer? Who won the war? What won the war? The answer to the riddle is the same that Napoleon announced one hundred years ago: "The relation of morale to materials of war is as three to one." And Marshall Foch only last week said, "Faith won the war." Both faith and morale are things of the spirit. If the stuff of victory at arms is largely a thing of spirit, why is it not also true of any victory in engineering. Are not the greatest engineering victories due more to perseverance, industry, good habits, courage, pluck, steadfastness than to simple engineering training? Is it not the spirit, after all, that wins all victories?

If the engineer finds that in the complete fulfillment of his life work about one-quarter is material and the remainder spiritual, should not engineering societies make adequate recognition of this important fact? Is not morale as important to the engineer as to the soldier? Is it not as important to an engineering association as it is to a military division? If these facts are conceded, then can we refuse to give the fullest and most complete consideration to the development of these traits among engineers?

The Relation of the Engineer to Production and Distribution

Comfort A. Adams

Two of three of the speakers have spoken of engineering education, and the last speaker spoke of matters of character and spirit. I have long been concerned with engineering education, and certain things have been impressed very vigorously on my mind, and one of them is that it is not the curriculum and the subjects that are taught that count; it is absolutely and solely the way in which they are taught. That is really a conviction so strong in my mind that I am not concerned with the subjects that are taught, but vastly concerned with the men who teach them.

Coming now to the subject assigned to me on the program, let me say that the civilized world is today facing a crisis second to none within the memory of this generation or of many preceding generations. Discontent is rampant throughout the proletariat in many European countries, and is spreading rapidly in our own.

The situation may be stated roughly as follows: Labor feels that in the past it has not had its fair share of the wealth it has helped to create; it wants, is beginning to demand, and in some instances is getting so much, that the balance will soon be a minus quantity.

What are we going to do about it? Shall we sit tight, and because we are comfortable satisfy ourselves by criticizing vociferously the discontented because of their unreasonable demands, or shall we use our brains and training and at least to try to remove the cause, and to meet the situation intelligently? We are engineers, and the machinery of production and distribution is largely of our making and largely in our hands; is it not possible that this machinery can be so improved as to increase the productivity of labor and thus make possible a really living wage and still have a fair return for capital?

"But," I hear you say, "that is our normal job—we are doing that all the time, and as rapidly as possible; moreover, the United States already leads the world in that direction."

In answer may I point out a few facts: First, our industrial success has been due in considerable part to our enormous natural resources, the cream of which we have been squandering in prodigal fashion, and also in part to our exploitation of cheap foreign labor, for which exploitation we may have to pay a very high price, as it is in that group that most of the active discontent is found.

Second, in many of our old established industries there still remain many grossly inefficient, almost traditional, processes which we accept without thinking, because "it has always been done that way."

Third, and this is my chief point, there still remains an almost untouched field of possibilities in the elimination of our present excessively expensive system of competition.

One instance of this wastefulness which has come under my close observation during the past year is in the field of electric welding. Here a dozen or fifteen manufacturers were each found selling welding apparatus under claims relating solely to the characteristics of the electric machine which supplied the current. The claims were so conflicting that no ordinary purchaser or customer could possibly come to any sane conclusion as to the best apparatus to purchase. And, as a matter of fact, even of all the factors which go to make up a good weld, the characteristics of the electric machine are practically of the least importance.

I can cite specific instances in this field where the cost of accomplishing a certain result was two or three times as great as the reasonable cost might well have been, and others in which the whole expense involved was practically thrown away; and although the problem of the electric weld is not a simple one, still information was available and knowledge was available of the art which, if collected together, under any reasonable coöperative system, would have largely eliminated the wastefulness mentioned. In other words, the answer to this problem is well covered by the one word "coöperation"—coöperation in research, in standardization, and even in some cases in design.

The chief obstacles to this are traditional fears as to the loss of independence and initiative, and the distrust of our competitors. I only wish that I might by some telepathic process convey to you my firm conviction after some experience, much thought and study, that these fears are largely ungrounded, that the result of such thorough-going coöperation as here urged is sure to be a gain to all concerned, and that under such a system real merit would prevail even more than now.

Finally, may I add a plea that we engineers, whose normal work is so much concerned with organization in industry, accept as a part of our responsibility as citizens the broader problems relating to the organization of society, that we face the facts fairly and prepare to take an intelligent step forward, rather than wait until the great tank of discontent has gained momentum enough to crush us and all that we represent.

DISCUSSION

S. N. Castle, who opened the discussion, said that the speakers had truly voiced the feeling instinctive to the engineer—the desire to serve. But to enable him to serve others, he must first serve himself. At present a hedonist in his individualism, he must learn to present, as an engineer, a single and united front.

This must undoubtedly come through organization; but how? what? Highly differentiated though the engineer might be, the lawyer was far more so; yet he spoke as with one voice—as a lawyer, and with and through his bar association. Soo, too, did the merchant who also had his associations and chambers of commerce. The engineer, however, still talked confusedly, with many tongues.

The problem, he believed, was susceptible of four general solutions: (1) A merger of the existing societies into a single national organization (with such local sections as appear desirable) capable of serving equally all technicians, whether artisans, mathematical engineers, applied scientists, or research scientists; in other words, create definitely an Institute of Industrial Sciences; (2) a New York engineering society or metropolitan association of engineers, comprising the New York section of the national societies and local engineering societies; (3) a joint engineering council, to be composed of definite delegates from

the New York sections or local societies; and (4) interlocking committees in the national societies.

Daniel Turner, in discussing Mr. Castle's recommendations, urged that no new organization be formed, inasmuch as a suitable organization already was in existence.

"Why not let the American Association of Engineers become the standard bearer of the affiliated and united engineering societies?" he said. "Why not help to establish its destinies? Why start another organization, which means more differentiation and still further dispersion of our energies? Service is one thing, being servants in the situation is quite another thing. The logic of the situation points inevitably in one direction—there is only one answer: In squads, all of our efforts, just as in the past, are doomed to fail; as a great army of engineers we would be irresistible."

Frank Skinner believed that the national and local methods proposed by Mr. Castle could be combined. There were already several hundred different organizations for the 50,000-odd accredited engineers of the country, and he urged a federation of these rather than the formation of a new body in which the rivalries and just pride of the now existing societies would be lost. The engineer was he who actually carried to successful fruition the work of the designer, the mathemetician and the pure scientist, and the Association of General Contractors of America, recently formed in Chicago, he believed was better adapted to deal with their necessities than any precedent organization.

J. E. Johnson, Jr., made a plea for a change in the curricula of the engineering schools in order that more attention might be paid to the human side of engineering and to the subject of finance. In the matter of organization he believed that both the national and local societies had their proper place in the scheme of things. The Engineering Council was an associated activity that should be endowed with greater power, made more national in its scope and composed of men who would do their full share of the work.

H. A. Pratt told of the effective work carried on by local associations of engineers of all branches in San Francisco, Cleveland and Philadelphia, and urged strongly a similar organization for New York City.

Lieut. George S. Van Gilder expressed the opinion that the whole situation could be analyzed as a feeling of unrest. No doubt, he said, the engineer had occupied a very insular position toward society, and the crisis of the past two or three years having gone by, he was now confronted with a new crisis which he feels intensively, but is hardly able to express.

The unemployment problem might easily become a menace, and his suggestion was that each engineering society organize a unit for the purpose of studying sociological questions from an engineering standpoint, and that a council of these units be formed for the discussion of the problems arising at the different local branches.

In order that some definite action might be taken as a result of the meeting, C. F. Scott offered the following resolution, which was later adopted:

Whereas, All engineers, as citizens, should invite the fullest coöperation; and

Whereas, Complete coördination of the engineering profession, as a whole, is essential for the best interests of the community; and

Whereas, It is the sense of this meeting that some program be formulated whereby closer coöperation between engineers may be obtained; therefore, be it

Resolved, that the Secretary of this meeting be and is hereby directed to so notify the secretaries of the several societies or local sections of the societies here represented tonight with the request that the several secretaries transmit this resolution to their respective local membership, together with an invitation to said local membership to appoint a delegate to attend a joint conference, with a view to organizing so as to obtain closer coöperation between engineers, particularly between the engineers resident in the Metropolitan District, whereby they may become more potent in fulfilling their responsibilities as citizens.

C. A. Doremus, a member of the Société de Chimie Industrielle and the Society of Chemical Industry, while not officially representing these societies, was nevertheless of the opinion that they would coöperate in any movement to make the engineering professions and scientific pursuits of more weight and greater influence.

Jesse M. Smith, one of the charter members of the American Institute of Electrical Engineers and a past-president and one of the earlier members of The American Society of Mechanical Engineers, spoke of the constantly increasing coöperation of the four national societies brought together in close relations through the United Engineering Society. Up to the present time this society had been scarcely more than a holding corporation, but its constitution was such that engineers of all branches might come together under its organization. A single society for the engineering profession seemed to him inevitable.

At the request of the chair a letter from H. H. Vaughan, of Montreal, Canada, was read, which briefly outlined the organization of the Engineering Institute of Canada. This society is composed of engineers belonging to all branches of the profession, and is the only national engineering society in Canada. Its organization is such that the society can represent the engineers with equal ease in city, town or province, or, if necessary, all the engineers in the Dominion.

Farley Osgood thought that the principal reason why engineers were not more generally accorded recognition was their own individual lack of interest in outside things. This was particularly true of young engineers, and he believed if educators were to teach them as much of a curriculum as was necessary, and also find out what the minds of the various young men might be adapted to other than engineering, that they would help them broaden themselves along these lines also, so that when they started out in the practice of their profession they would carry in parallel with it some civic work, some outside interest.

As an indication that the subject of the evening was one receiving nation-wide consideration, Philip N. Moore called attention to the work of the National Service Committee of the Engineering Council. "This Committee," he said, "has taken as its first task one which is unanimously welcomed by the engineers of the country as a great public need, namely, the establishment of a National Department of Public Works, where under one head the different engineering functions of the United States can be correlated and which today are scattered under twenty-two bureaus and six cabinet officers. In undertaking that task, the National Service Committee has called a meeting of delegates from all the engineering societies of the United States of which they can learn the existence, and requested them to send delegates to a meeting in Chicago, April 23 to 25, prepared to discuss a concrete, definite plan for the establishment of a National Department of Public Works. Through one of the secretaries of one of the organizations a questionnaire has been issued to all of the organizations interested on which they request organization action.

"Further, I happened to learn in Washington that the idea itself will be more than gladly welcomed. That meeting of engineers in Chicago will probably be the most representative meeting of engineers ever gathered together in this country. From it your speaker personally feels that there will come great good, and it is a great deal of pleasure for him to tell you of it in advance of the public statement of the meeting, because it may have some influence on your decision in the matters now here before you."

Louis C. Marburg, Chairman of the A.S.M.E. Committee on Aims and Organization, said that the problems under discussion were so great that the four national societies had appointed committees on development and on aims and organization to secure, if possible, a crystallization of opinion as to what the ideals of the engineering profession and the ideals of the engineering societies should be. There were hundreds of engineering societies in the country and an utter lack of coördination between them as to their efforts along lines of public service and public uplift. The discussion of the evening should be spread everywhere, it should be taken up by all the national engineering societies and by all the local engineering societies. The crystallization of ideas as to what the purposes and aims are to be must be secured before the machinery for carrying them out can be proposed. To this end he offered the following statement and resolutions:

Around us is a world on which, during the past two generations,

(*Concluded on page 496*)

ELECTRIC ARC WELDING

By F. A. ANDERSON,[1] SAN FRANCISCO, CAL.

It is only a few years ago that the subject of electric arc welding would have aroused but little interest, and yet today the art is engaging the attention of many men standing high in the engineering profession.

At the present time electric welding may be divided into two general classes, resistance welding and arc welding. The former had its inception some thirty years ago, and has been practiced more or less continuously ever since, gaining in popularity as its many applications have proved themselves valuable.

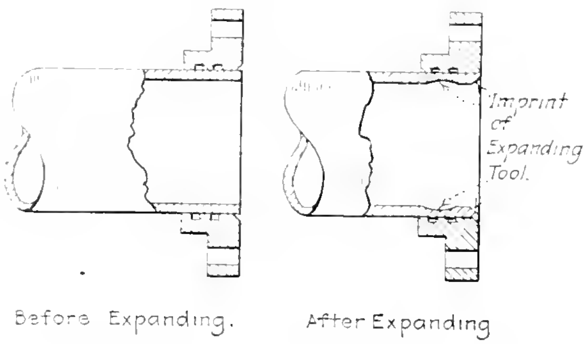


Fig. 1 Method of Expanding Pipe into Flange

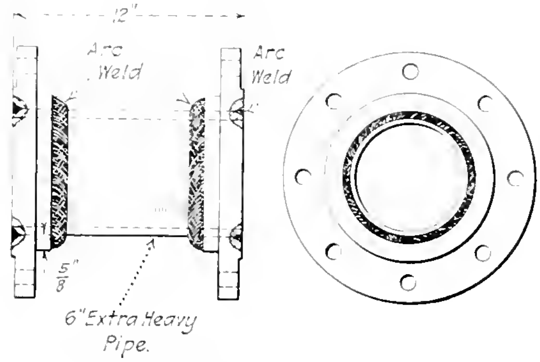


Fig. 2 Welding Required on 6-in. Steel Flange

In this process the necessary heat is produced by current flow through the high resistance of metals in contact, and when the proper heat is obtained the completion of the weld is accomplished by the application of pressure sufficient to unite the molten masses into one. This is the fundamental principle of the many spot- and butt-welding processes in use today.

Arc welding is about twenty years old and was probably first introduced by Zerener, who devised the means of holding two carbons of opposite polarity in a V form and employing an electric magnet for forcing the arc toward the work. The desired heat was thus obtained directly on the metal to be welded, and welding wire was fed into the arc, filling the void and completing the work. This early process resembled that of the acetylene torch and is rarely used today.

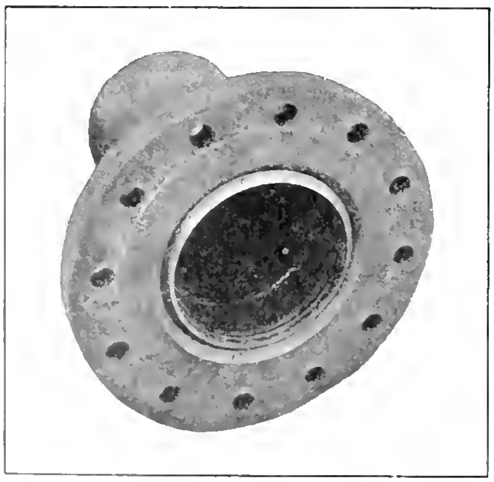


Fig. 3 Pipe End and Flange, Ready for Welding

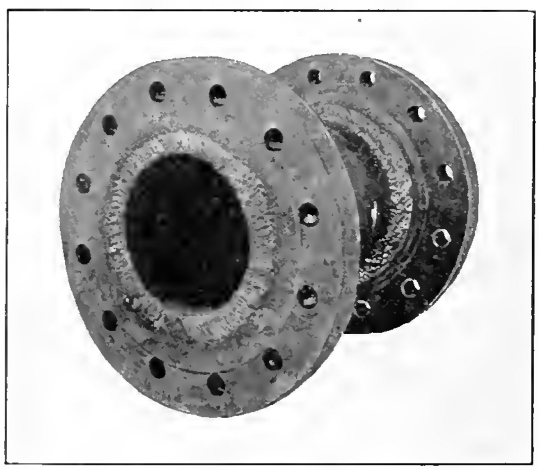


Fig. 4 Pipe and Flange with Weld Complete

The next improvement in the art was due to Bernardos, who dispensed with the electromagnet and one carbon, using instead the work as one side of the circuit and a carbon as the other. The arc was struck directly on the work, immediately producing the desired heat, and at the same time the welding wire was fed into the work. This process is still extensively used and lends itself most advantageously to many phases of modern practice. It is generally referred to as carbon welding.

A further development was made by Slavianoff who introduced the method of using the welding wire for both striking the arc and feeding it into the work. As a result the welding wire became known as the electrode, and the process as metal-electrode welding. It is one of the most generally used today and whenever discussing it the term "electrode" refers to the metal added in the operation and the term "parent metal" to the metal to be welded. In recent years the term "arc welding" has been understood to mean metal-electrode welding, and it is generally customary to qualify the phrase when referring to carbon welding.

In the past a great many failures of welds have been largely due to the operator, who did not manipulate the electrode so as to bring the parent metal to a molten state. This resulted in the electrode being deposited on but not uniting with the parent metal, since no pressure is added to complete the union.

As an example of one such failure, the following may be of interest. A short time ago the writer was connected with ar enterprise where difficulty had been experienced in successfully expanding 6-in. extra heavy pipe into steel flanges. Fig. 1 show a section through a flange, with the pipe in place before an after expanding.

This method, however, proved unsatisfactory. Both th screwed flange and the Van Stone or flanged joint had also bee

Abstract of a paper presented at a meeting of the San Francisco Section of The American Society of Mechanical Engineers, February 13, 1919.

[1] Electric Inspector, U. S. Shipping Board

disapproved, and when arc welding was suggested the writer was asked to make a sample for test.

Fig. 2 shows the welding required and Fig. 3 the pipe with one flange in place and the end of pipe beveled to form half the V for the arc-welding operation, the other half of the V being formed by the original bevel provided on the flange for the intended expanding process. Fig. 4 shows the welding operation completed. It will be noticed that the operator has overfilled

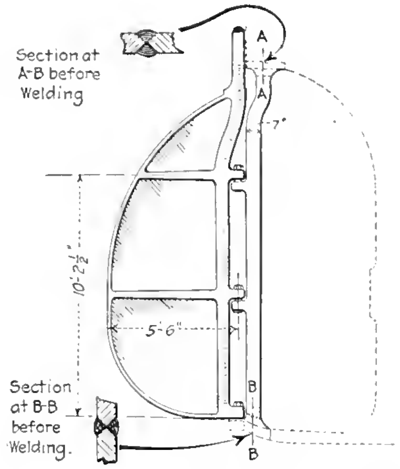


Fig. 5 Rudder Post Repaired by Welding

the V on the face of the flange, thus making it necessary to machine the fitting.

It is still generally believed that the metal in passing through the arc loses all its ductility and elasticity and assumes characteristics wholly those of cast iron or steel. The turnings of this weld, however, presented an appearance similar to good machine steel, and when analyzed showed the following: Silicon, a trace; sulphur, 0.075; manganese, 0.23; phosphorus, 0.0018; carbon, 0.25.

While it was essential that this weld be able to stand a steam pressure of 200 lb., the sample was tested first at 500 lb., then at 800 lb., next at 1000 lb., and finally the pressure allowed to go the available limit of 1400 lb.

This test was witnessed by a number of interested parties, but one skeptical member asked that the specimen be given a hammer blow with the full pressure on. This was readily agreed to, and, since the workmen refused to strike the blow, the writer secured a 14-lb. hammer and struck twelve blows on the face of the flange, after which examination was made and no damage whatsoever was apparent. Six blows in the reverse direction were also given without producing any failure of the weld.

Fig. 6 Engine Frame in Course of Repair by Welding

The weld was then tested. It was believed the weld was not more than 25 per cent efficient, for the operator had not given his best efforts to the work, and as the welding material was only of about 50,000 lb. tensile strength the effective area of welded material would probably show about 250,000 lb. This, however, was greater than the strength of the twelve ¾-in. flange bolts, which was perhaps 150,000 lb. The weld was then pulled in an ordinary testing machine at 119,000 lb.

Although the test had proved the weld capable of sustaining a strain greater than ever likely to be met in service, it was completed by breaking the weld. To do this the flanges were enlarged, and when the piece was again pulled, the weld gave way at 208,000 lb., but before this the flange on each end had dished about ½ in.

The results of these tests, while showing that such a weld might be serviceable, nevertheless justify the statement that the weld was a failure, for the broken specimen showed that only about 1/5 of the welded material united with the pipe and flange. This was most apparent from the specimen itself, which thus justified the previous estimate, since 208,000 lb. is practically 20 per cent of the amount which it was assumed the weld would hold when figuring the 25 per cent weld at 250,000 lb.

In passing, it is of interest to note that in one of the large manufacturing plants near Philadelphia, Pa., there is a 2000-lb. hydraulic pipe system installed, every joint of which is arc-

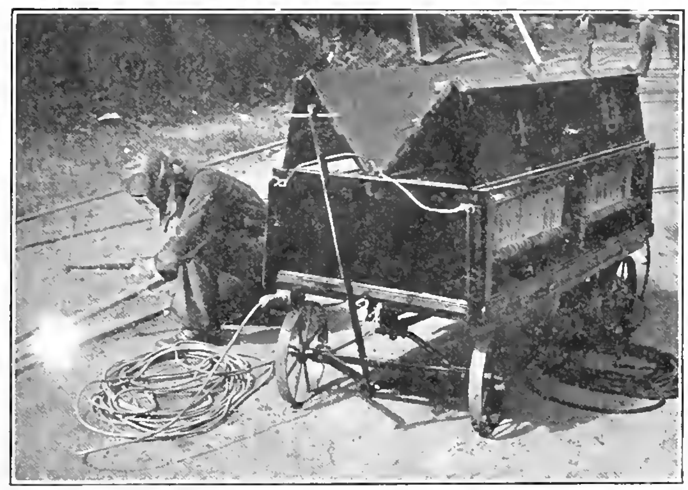


Fig. 7 550-Volt Railway Arc-Welding Set

welded, and although it has been in service a year and a half no joint has developed a leak or given any trouble. There are a number of firms today who are using electric arc welding for securing flanges to pipes and making T and other connections on steam lines, and their excellent records testify to the ability of arc welding to withstand the many strains of time and service.

Many other examples could be presented. The following is one of particular interest, as it shows the service to be expected under severe conditions.

On the large 16-wheel articulated locomotive it is necessary to have a ball joint in the steam pipe between the two trucks, and one manufacturer has, for about six years, used the arc welding process to fasten in place the ball of this joint. This weld must stand vibration from the jar of the locomotive over track and joints, tension and compression from the forward and backward movement of the train, reverse strain as the curves from right to left are made, and an internal steam pressure of about 100 lb. Six years' service has brought no reports of failure.

As an illustration of the saving in time and money often resulting from arc welding, the following incidents are typical. The Italian ship *Titania* had a badly damaged rudder, but it was successfully repaired by arc welding at a saving of $10,000 and 4 months 2 weeks of time. One part of the weld was completely through the 6-in. by 9-in. rudder post. This vessel was repaired in August 1916 and has since seen constant service.

Another case of a broken rudder successfully repaired is

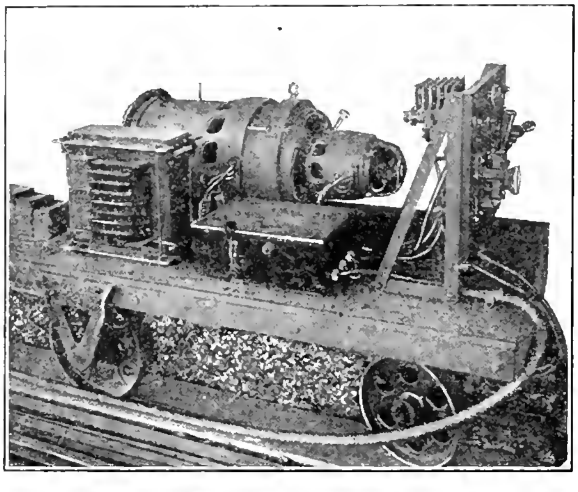


FIG. 8 PORTABLE MOTOR-GENERATOR ARC-WELDING SET

shown in Fig. 5. Here the rudder post was welded into place, the sketch clearly showing the operation. This work was done in May 1916, and if installed in the usual manner would have occasioned a delay of at least 6 months, with the necessity of using a dry dock. Instead, arc welding saved 10 per cent in cost and restored the vessel to service 5 months sooner.

An illustration of the use of arc welding in railroad practice is shown in Fig. 6. This is an engine frame broken at a place most inconvenient to weld. In this case, however, the repairs are being made with the frame still in place. Notice the V groove filled by arc welding, also the ingenious method used by the operator to obtain the desired fillet. He has used the half of an old brass lining to which the welding material will not readily adhere.

A report of the electrical engineer of one of the great middle-western railroad systems accredits to arc welding a saving of about $200,000 in one year. This saving was computed from economy in this method over others previously used on the same class of work, and also from the saving effected by the restoration to service of otherwise useless apparatus. Since that report this road has increased its number of welding units about 300 per cent.

Developments in welding equipment are shown in Figs. 7 and 8. Fig. 7 is a resistance grid for use on a 550-volt railway circuit, and it is a type in present-day service. For welding with a ¼-in. electrode it requires an approximate imput of 200 amperes at 550 volts or 110 kw. to produce 200 amperes at about 18 volts or 3.6 kw. at the weld, resulting in a total loss in wasted energy of 106.4 kw.

This type of apparatus is chiefly used for street-railway work, and the process has proved so successful that even the high cost of wasted electrical energy has failed to eliminate it as a most profitable and satisfactory investment.

A motor-generator of the type shown in Fig. 8 would accomplish the same result with an input of 6 kw., or 11 amperes at 550 volts. The weight of this unit and portable truck is about 1800 lb.

Among the great lessons which the recent war has taught us are economy and the conservation of our time, energy and raw material, and arc welding presents a veritable storehouse of opportunities ready for the engineer who will adapt them to his own requirements.

In the course of the discussion which followed Mr. Anderson's paper the following interesting facts were brought out. Since 1906, the Pelton Water Wheel Co. has used arc welding for very heavy work, in building up large steel castings. In making these castings the shrinkage stresses are so severe that the reinforcing ribs are often pulled apart and ruined. The reinforcing ribs are therefore cut to allow for this shrinkage and then welded.

In discussing the relative merits of alternating and direct current the consensus of opinion seemed to be that direct current is the more suitable for arc welding. Alternating current can of course be used, but it takes a more experienced man to maintain the arc, and in practice there are very few that are able to weld with any degree of satisfaction.

In discussing the question, What, in general, is the effect of the weld on the character of the metal? it was brought out that metallurgists and chemists are trying to arrive at some standard for electrodes. It must be remembered, however, that the parent metal has certain constituents that become molten. The electrode also becomes molten and it has certain constituents. These two commingle and form other elements which disappear in the heat of the arc, are carried off in the oxide, and sometimes, strange to say, form a new composition. The advocates of the covered electrodes claim one thing, others use fluxes, and still others metals in various proportions, and every one is claiming certain results for the particular method he uses.

Classical Education for Engineers

Dean Mortimer E. Cooley, in two articles published by the *Evening Sun* of New York, April 14 and 15, advocates the broadening of engineering courses by teaching young engineers three or four years of Latin and Greek, some political economy, considerable history, philosophy, a good knowledge of English and a speaking knowledge of at least one foreign language, preferably Spanish. He said that "the one great need today from our educational institutions is training for responsible citizenship" and rather than give our youth "a smattering of this and that so-called practical thing as a preparation for college" it were better to prepare them "to be of maximum use to themselves and their fellowmen."

The study of Latin and Greek, Dean Cooley remarked, sets forth before the mind the civilization and wars of early times and the characteristics of the people who developed that degree of culture which even in this time of tremendous achievements surprises us for its advancement.

He further emphasized the necessity for broadening the technical man by citing "the relation of the engineer, in the different branches of his science, to the worker . . . who typifies the constructive half of our civilization known as 'Labor,' and his equal and important intimacy with the other, the provisioning and directing half, usually termed 'Capital.'" Thus it is that the engineer being the connecting link between capital and labor, "there is one phase of the engineering profession . . . which is of even broader value to the nation than that of material advancement." And yet in spite of the "need of engineering skill in the direction of executive matters of state and national problems," engineers are unwilling to enter political life, precisely because "our technical institutions are specializing too much" and "vision, background, knowledge of life and the 'humanities' suffer at the expense of an almost selfish concentration on laboratory methods."

A new system is being set up in the world, continued Dean Cooley, and "our international leadership in industry, commerce and political idealism demands superior training for the young men who are to continue the administration of our affairs," because "no longer is government simply the administration of a system of statutes, the collection of taxes and duties and the maintenance of a military system," but "it is a complicated machine by which the citizens themselves drive forward the great industrial, social, commercial, aesthetic and idealistic entity of the State." And so it is that "our future engineers should stand head and shoulders above the present professional man of today to fulfill their full duties to the nation and to themselves as citizens."

Dean Cooley concluded with an exposition of the forces which inevitably led the German military machine to its complete destruction. The German war diplomacy "could not grasp the psychology and spirit of other peoples" and "the specialist . . . without his schedule, prepared and learned by rote, was nonplussed and conquered when his carefully built plan went wrong and found unexpected obstacles."

Relative Corrosion of Wrought-Iron and Steel Pipe

AT the last Annual Meeting of this Society a paper was presented by Dr. William P. Gerhard of New York on the Relative Corrosion of Cast Iron, Wrought Iron and Steel Pipe in House Drainage Systems. The paper was based on the examination of the pipe-drainage systems in 78 tall buildings of New York City along the line of Broadway, beginning at Bowling Green and ending at Forty-second Street, a distance of approximately four miles. Numerous illustrations were given, taken from photographs of roof pipes which had corroded, in order to illustrate the effect of corrosion and to show its relative effect on different kinds of material.

There were also tables in which were tabulated in very complete form the data relative to the various installations and with respect to the observed conditions. Dr. Gerhard's conclusions with regard to welded steel pipe and welded genuine wrought iron pipe, a report upon which constituted the main part of his paper, were as follows:

Welded Steel Pipe. The investigation showed conclusively that *steel pipe* is *much inferior* to both *cast-iron* and *wrought-iron pipe* when exposed to corrosive action. In many cases the black steel vents showed scaling to a considerable depth after only ten years' use. Generally speaking, galvanizing was observed to be somewhat less of a protection against corrosion on steel pipes than on wrought-iron pipes. It appears that the galvanized coating does not adhere so firmly to the smooth surface of steel pipes as to the comparatively rougher surface of wrought-iron pipes. The galvanizing on steel pipes showed signs of disappearing within 10 to 20 years, after which time the life of such pipe may be assumed to be merely equal to that of ordinary black steel pipe.

Welded Genuine Wrought-Iron Pipe. The investigation has furnished an almost overwhelming evidence *in favor of genuine wrought-iron pipe* and *against steel.* To mention only one example, contrast the black wrought-iron vent pipes of the Mail and Express Building, installed 27 years ago, with the black steel vents in the Townsend Building, put in 22 years ago. It was also found that the galvanized coating lasts a little longer on the wrought-iron than on the steel pipes, but that ultimately the rust resistance of the base metal is of far greater importance than that of the coating.

Conclusions were also drawn with regard to the use and durability of cast-iron pipe having calked joints and screw-jointed pipe systems. Concerning these, it is stated that while it is freely admitted that cast-iron pipe, as such, is a satisfactory material for house-drainage purposes, and that many of the cast-iron roof vents inspected showed a much better condition as regards corrosion than anticipated, the objections to a cast-iron system, well-known heretofore and corroborated by this investigation, are the unsafety and unreliability of the calked joint. A calked joint can never be considered a permanent one as long as expansion and contraction cannot be eliminated.

An abstract of the paper was published in The Journal of the Society for November 1918, and the paper in complete form has been issued as a pamphlet.[1]

The discussion upon this paper was extended, and the account which follows is in abstracted form with duplicate matter omitted and the whole condensed in so far as possible without changing the intent of the writers.

Discussion

GEORGE SCHUHMANN. The discussion of the relative corrosion of wrought iron and steel started about twelve years ago, and to those who have kept informed on the subject the question has undoubtedly been decided in favor of wrought iron when used under ordinary working conditions. Unfortunately, the matter has been much befogged by the investigations of many experimenters who have based their conclusions on so-called accelerated corrosion tests such as acid tests, etc.

I made the same error a number of years ago after some steel pipe had been in use for a few years and the practical evidence pointed in the direction of a more rapid corrosion of steel pipe than of wrought-iron pipe. I found, by testing with diluted sulphuric acid, that while the steel pipe had been somewhat reduced in thickness, the immersed portion of the wrought-iron pipe had been completely ruined. Many other similar experiments were tried with practically the same results; but as the evidence of both wrought-iron and steel pipes that had been in use many years showed decidedly in the opposite direction, it led to further investigations in relation to the structure of the metal itself.

Chemical analysis did not lead to any practical results, as there is really not much difference between the chemical composition of wrought iron and low-carbon steel. There is, however, a decided difference in their physical structures, due to the great difference in their methods of manufacture.

The temperature in the puddling furnace in which pig iron is converted into wrought iron is about 2300 deg. fahr., not enough to melt wrought iron. After the pig iron is melted, the stirring up of the molten mass under the influence of the flame and the material composing the lining of the furnace causes the pure iron to separate from the impurities and solidify because the temperature of the furnace is not high enough to keep the purified iron liquid. The carbon in the pig iron is burned out and the other impurities form a liquid cinder in which the pure-iron globules float around like sugar crystals in molasses in a vacuum pan. When this spongy mass is removed from the furnace and compressed by squeezing, hammering and rolling, much of this fluid cinder is expelled, but a thin coating of each globule remains, and when the mass is rolled out the iron fibers become coated with minute capsules of cinder. This cinder consists principally of silicate of iron, and because silicate of iron resists ordinary corrosion much better than pure iron, the presence of the silicate in wrought iron causes it to resist corrosion better than steel.

Steel, on the other hand, is made at a much higher temperature, which keeps the whole mass liquid, and the cinder generally floats to the top, where it is removed. After the steel melter has finished his work the metal is still in a liquid state—too hot for rolling—and it must be allowed to cool, during which process soft impurities which remain flock together in a liquid mass by what is technically known as "segregation."

While silicate of iron resists corrosion due to ordinary exposure much better than pure iron, it readily dissolves in a strong acid, which explains the results obtained by means of the accelerated corrosion tests. Further evidence that cinder or slag with which wrought iron is impregnated affords resistance against slow corrosion has been demonstrated by observations upon the durability of sheet-iron roofing reported by Mr. R. C. McBride, of Youngstown, Ohio.[1]

Another important factor to which I will call attention is that corrosion acts very capriciously, sometimes concentrating itself on certain spots (pitting), while at other times and under apparently the same conditions it will diffuse itself over larger areas. Several years ago, in the Indiana gas belt, two parallel pipe lines were taken up on account of the gas giving out. Each line was 25 miles long, and the two lines had been laid side by side in practically the same soil and had transported the same kind of gas. The wrought-iron pipe was 8 in. in diameter and had been in service 18 years, while the steel pipe was 6 in. in diameter and had been in service only 11 years. While 24¾ miles (over 99 per cent) of the wrought-iron pipe was still in good condition after being taken up, 1200 ft. (nearly 1 per cent) was corroded so as to make it unfit for further use. On the other hand, 14 miles (56 per cent) of the steel pipe was thrown aside for the above reason, 11 miles, or 44 per cent, being still in good condition.

WM. W. WALKER[2] expressed the opinion that the author's investigation was too fragmentary to warrant his broad generaliza-

[1] The Relative Corrosion of Cast-Iron, Wrought-Iron and Steel Pipe in House-Drainage Systems, Wm. Paul Gerhard. Price, 15 cents to members, 30 cents to non-members.

[1] Corrosion Tests, *Engineering Record*, May 20, 1911.

[2] Professor of Chemical Engineering, Mass. Inst. of Technology, Cambridge, Mass.

tion as to the superiority of genuine wrought-iron pipe over steel pipe. He further said:

In Par. 48 the author speaks of his investigation as having afforded . . . "an excellent comparison of the life of wrought-iron and steel pipe under equal conditions to service." . . . Inasmuch as in no single case were samples of wrought iron and steel taken from the same continuous structure, I can state from my experience that the conditions of comparison were very inadequate and the results can be entirely misleading. The factors which control speed of corrosion are so many and so difficult of determination that unless two pieces of metal have been subjected to *identically the same conditions* a comparison as to durability is worthless.

The broad statement that genuine wrought-iron pipe "has shown itself in actual service and under a variety of conditions. . . to be much more resistant to corrosion than steel pipe," I must most emphatically deny. I can state with conviction that whether the wrought iron outlasts the steel, or the steel outlasts the wrought iron, depends upon whether one is dealing with good steel and poor wrought iron, or good wrought iron and poor steel.

JOHN L. ROBBINS[1]. The author's conclusion that genuine wrought-iron pipe is far more durable than steel pipe for house drainage purposes does not seem to me to be proved at all. Most of the tests, the results of which showed the wrought-iron pipe to be in better condition than the steel, were made on piping which was installed when wrought-iron pipe was at its best and steel pipe was at its worst. The author's conclusions are based on the inference that the pipe of today is of the same standard as that used in most of his tests, and make no reference to the great improvement in the steel pipe of recent years. In buildings erected eight or nine years ago, such as the Fifth Avenue Building and the Martine, the steel pipe in the author's tables shows up as "as apparently good," or as "good as new."

A. E. HANSEN[2] devoted considerable attention to a discussion of the merits of the screw-pipe system of wrought iron or steel pipe, and of the use of cast-iron pipe with lead-calked joints for drainage and vent pipes.

Much controversy has existed among engineers about the relative value of cast iron compared to wrought iron or steel pipe in house-drainage systems, but it has been heretofore generally conceded, and Dr. Gerhard also concludes that the life of extra heavy cast-iron soil pipe is fully as great as that of genuine wrought-iron pipe. Mr. Hansen's own observation was that the life of cast-iron pipe for drainage systems has been proved for about 60 to 70 years, whereas proof exists that wrought iron has outlived a period of but 30 to 35 years in drainage systems. The criticisms against the use of cast-iron pipe consist of the alleged weakness of lead-calked joints; the possible existence of sand or blow holes; and the greater number of joints required.

He said that while the weakness of the calked joints as pointed out by the author is true to some extent, the very fact of possible expansion and contraction of cast-iron soil-pipe systems at their leaded joints is a distinct advantage, especially in tall buildings.

One of the chief objections to the use of screw pipes is the combination of screw pipe with galvanized cast-iron fittings. The galvanizing hides serious defects and the fittings are easily cracked by the expansion and contraction of the rigidly connected screw pipes. He considered other objections to be a reduction of the thickness of the metal at the threaded ends; the peeling off of the galvanizing at the ends where the threads are cut; the difficulty of making repairs; the use of steel-pipe nipples which, if it is admitted that steel pipe itself is unsatisfactory, are still less desirable because of the cutting away of the metal in threading; and obstruction to flow in the pipes due to neglect on the part of the workman in reaming the ends or in allowing red lead to enter the pipe when making the joints, where it hardens.

As to the question of the higher cost of completed wrought-iron drainage systems over completed extra heavy cast-iron soil pipe, the author secured comparative estimates of cost of a genuine wrought-iron galvanized Byers pipe stack, 100 ft. long, with a galvanized cast-iron drainage branch fitting every 10 ft., and a similar extra heavy cast-iron soil-pipe stack. The quotations furnished cover stacks, 2 in., 3 in., 4 in., 5 in. and 6 in. in diameter. The excess cost of galvanized wrought-iron stacks is as follows:

Stack diam., in.	2	3	4	5	6
Excess cost, per cent:					
W. G. Cornell & Co.	0	25	55	70	85
Lasette & Murphy	23	65	74	97	119

Referring specifically to the question of corrosion in the discussion in the author's paper, Mr. Hansen said:

"I believe that the opinion of engineers who are competent to judge, favors the use of wrought iron for plumbing water-supply pipes even though its cost is somewhat in excess of steel pipe."

Engineers, architects and contractors have frequently questioned the wisdom of using genuine wrought-iron pipe because of this additional expense. No specific proof had been brought which would warrant them in spending their clients' money in this manner. It is of the greatest interest, therefore, to find that Dr. Gerhard draws the conclusion from his investigations covering an inspection of the pipe drainage systems in 78 tall buildings, that genuine wrought-iron pipe is far more durable for house-drainage purposes than a steel pipe. A careful study of his detailed report indicates that this conclusion is correct.

It should be understood, however, that the author's investigation did not cover main and branch vent pipes in the building, which, of course, are difficult of access. Roof vents are exposed to the corrosive action of both the atmosphere and rain water, and the oxidizing agents which they contain, as well as to the corrosive influences of the sewer air.

W. H. KENERSON.[1] The paper is interesting because of the very definite conclusion reached as a result of the author's investigations. For a great many years I have followed the discussion of this subject with much interest and have made many investigations myself but without being able to arrive at any such positive conclusion as the author. Prior to ten or fifteen years ago, before steel pipe was made as well as it is today, it was rather easy to find many examples where wrought iron was distinctly superior to steel, but of late years this condition has changed. Evidence collected at random is so very contradictory that it would not be at all difficult, by properly choosing data, to "prove" that either wrought iron is superior to steel or that steel is superior to wrought iron, whichever seems desirable for the moment.

Sometime ago I was asked by the National Tube Company to secure various kinds of iron and steel pipe and determine their relative corrosion in a hot-water line in one of the dormitories at the University. I installed two series of pipes of identical size and length, including genuine wrought iron, black "wrought," black copper alloy, galvanized "wrought," and galvanized copper alloy. After about a year of use all of the pieces were in such poor condition that they were practically useless. No very great difference existed between them. The tests indicated the slight superiority of the black "wrought" or steel pipe over the others, but it might not be unlikely that another similar series of tests would reverse the conclusion.

For many years I investigated personally, or caused to be investigated, the relative corrosion of pipe lines of various kinds, and it is my experience that with modern steel pipe and well-made wrought-iron pipe there is very little if any difference in behavior under corrosive influence. One of the most convincing evidences to me is the fact that while practically all pipe lines, both steel and iron, include wrought-iron couplings, I never have seen myself nor has anybody reported to me any difference in the condition of the couplings and pipe in any given line. I have found many individual cases where wrought iron appeared superior to steel, and many cases where the reverse is true. I am inclined to believe that Mr. Gerhard's positive "proof" of superiority of wrought iron over steel may hold for the cases he instances, but is not completely convincing as a general proof.

[1] Robbins, Gamwell & Co., Pittsfield, Mass.
[2] Hydraulic and Sanitary Engineer, 2 Rector St., New York.

[1] Professor of Mechanical Engineering, Brown University, Providence R. I.

J. O. HANDY.[1] The author's investigation, to have been conclusive, should have included every precaution to avoid errors in distinguishing wrought iron from steel. A qualitative test for manganese, such as was used, is not sufficient to distinguish between wrought iron and steel, particularly when the amount of metal used varies to an unknown degree. The manganese content of wrought iron is known to be very variable, and that in steel of the kind used for pipe is by no means constant.

In our own practice, we do not consider that we have proved pipe to be steel or iron until we have determined carbon, manganese and silicon *quantitatively*, and also made a microscopic examination.

A second source of error was not taken into account by the author, viz., that small percentages of copper, such as are sometimes found in wrought iron, cause it to be very resistant to corrosion by atmospheric influences. Extended tests have shown that wrought iron free from copper is no more durable than steel. On the other hand, when both the wrought iron and steel contain the same amount of copper, they are equally durable.

I have personally taken part in a number of very thorough tests of wrought-iron and steel pipe under the most severe service conditions in hot-water systems. For the purpose of securing results in a shorter time, ungalvanized wrought-iron pipes were purchased in the open market, cut to the same lengths, and exposed in the same hot-water line with steel pipes. After 14 months the line was taken down and it was found that the pitting of the wrought-iron pipe and of the steel pipe had been equally deep and extensive. The amount of roll scale adhering to the pipe was the controlling factor in determining the degree of pitting. Steel pipe free from scale did not pit, and the corrosion in general was much less. A detailed report of Part 1 of the corrosion test of steel pipe to which I have just alluded may be found in the Journal of the American Society of Heating and Ventilating Engineers, page 159, volume for 1917. The tests showed that genuine wrought-iron pipe of the two best-known brands was no more durable than steel pipe having the usual roll-scale covering. On the other hand, steel pipe freed from scale by a special process of rolling was far more durable than either of the kinds of pipe just mentioned.

Bearing on the relative durability of steel and iron containing small percentages of copper are the following references:

D. M. Buck: Keystone Copper Bearing Steel. A Discussion on Corrosion, July 1914. (Jl. Am. Iron & Steel Inst., May, 1915.)

D. M. Buck and J. O. Handy: Research on the Corrosion Resistance of Copper Steel. (Jl. Ind. & Eng. Chem., 1916, p. 200.)

The author's conclusions, which are based on insufficient evidence as to the composition of drainage pipe which failed, are not convincing to one who has taken part in scientifically conducted researches in the corrosion field. His observations upon vent pipe also are not dependable, because the identity and composition of the pipes were not established beyond question.

[Mr. Handy transmitted with his discussion a copy of a report upon tests made by the Pittsburgh Testing Laboratory to determine the comparative resistance to corrosion of wrought-iron and steel pipe when used in a system supplying hot water to shower baths. The tests were made upon ungalvanized pipe in a hot-water system during a period of 14 months. No significant differences were discovered in the depth or extent of the pitting as between the steel or wrought-iron pipe. Both had corroded rapidly. The main factor in its influence upon corrosion appeared to be the roll scale. Where this was removed by mechanical processes the rate of corrosion was diminished to about 20 per cent of the rate for pipes carrying the usual covering of roll scale. Inasmuch as Dr. Gerhard specifically states in his paper that his "investigation was restricted to the drainage and vent system, and the hot- and cold-water pipes were excluded from consideration," the report will not be given here in detail.—EDITOR.]

F. N. SPELLER.[2] The author's statement that "Steel pipe is vastly inferior to genuine wrought iron pipe" is based, as he says, on inspection of roof vents, the relative condition of the drains (the important part) being mainly based on the assumption:

1. That all vents examined were subject to the same kind of service.
2. That his observations of corrosion in vents were representative of wrought iron and steel as a class and that the same conditions of corrosion prevailed in the drains as in the vents.
3. That material in the drain pipe which failed is the same as the vents or other pipes in the system.

No evidence is given to warrant the first of these assumptions, but granting this for the present, the investigation on the vents is interesting only as a comparison of metals under atmospheric corrosion—the air evidently being the most important factor, as the corrosion of these vents is always more pronounced near the top.

The results would be more valuable if the method of identification had been more conclusive and had the copper and other elements been determined. Those who have gone into this subject are now almost unanimously agreed that in atmospheric corrosion certain elements, particularly copper, have a controlling influence regardless of whether iron is made in a puddling furnace or in the bessemer converter. Some steels are so low in manganese as to pass as wrought iron under the rough qualitative test used in this investigation unless fracture or etching tests are also applied. Several references are given below, containing general information on the influence of copper in iron under atmospheric corrosion.[1]

It has been proved by tests in service to destruction that 0.1 per cent to 0.3 per cent copper (or even less) has a very marked effect in prolonging the life of iron in air, so much so that bessemer copper steel has been found to be practically as good as new after reworked wrought iron and ordinary steel had been entirely destroyed.[2]

"As further evidence of the influence of copper content, we have lately taken down some tests which were started seven years ago with a view to determining the effect of small additions of copper to pipe steel exposed to impure air. The results are shown in Fig. 1. After some consideration it seems that this should offer a solution and a remedy for the trouble experienced with vent lines and drains, although it should be understood that it is not suggested as a remedy for corrosion in water pipes and under other conditions as the copper does not seem to have much influence except under gaseous corrosion. We have found that iron pipe is protected by a small percentage of copper steel, so that it is quite probable that if Dr. Gerhard had made a complete analysis of the iron pipe and determined the copper he would have found a relation between the copper content and the corrosion.

"The sulphur and silicon contents should also be considered, so that one should be careful in concluding from the data presented in the paper that vent lines of wrought iron are necessarily superior to steel. Moreover, the size and thickness of these vents are not given nor how each one is used. Condensation in the upper portion above the roof is obviously responsible for the greater corrosion of these vents near the top and this would depend largely on what kind of fixture the vent is attached to. Also, no information is given as to the relative corrosion inside and outside nor how often these vents were painted."

"As direct evidence on genuine wrought iron and steel under severe atmospheric corrosion, the following is submitted:

"Portions of a pipe fence on a river wall at McKeesport, Pa., were constructed alternately of 2-in. black wrought-iron (puddled without steel scrap) and bessemer-steel pipe. This was erected October, 1906, and removed August, 1917, after nearly eleven years. The arrangement of test, condition of the wrought iron and steel and analyses of pipe are shown in Fig. 2 and in Table 1 which follow. The depth of pitting and general condition

[1] Director of Department of Chemistry, Metallurgy and Mining, Pittsburgh Testing Laboratory, Pittsburgh, Pa.

[2] Metallurgical Engineer, National Tube Co., Pittsburgh, Pa.

[1] Burgess and Aston: Influence of Various Elements on the Corrodibility of Iron and Steel, Journal of Industrial and Engineering Chemistry, June, 1913.
D. M. Buck and J. O. Handy: Research on Resistance to Corrosion of Copper Steels, Journal of Industrial and Engineering Chemistry, 1916.
O. W. Storey: Corrosion of Fence Wire, Transactions of American Electrochemical Society, 1917.
Report of Committee A-5: American Society for Testing Materials, 1918 Proceedings.

[2] Figs. 4 and 5, paper by D. M. Buck, "Recent Progress in Corrosion Resistance," American Iron and Steel Institute, May, 1915.

was practically the same on both materials when the fence was removed. Some pieces of each material had corroded through at the posts. It will be noticed that the worst corrosion on the steel is in the bottom row, as would be expected. The bottom row of wrought iron, however, does not show this increase, probably due to the copper contents. This fence was given one coat of black paint after erection, with no further attention."

In the course of his discussion Mr. Speller called attention to a number of the author's comments which he contended were inconclusive or misleading. One of these, typical of three or four others, states that two main drainage lines in the Home Life

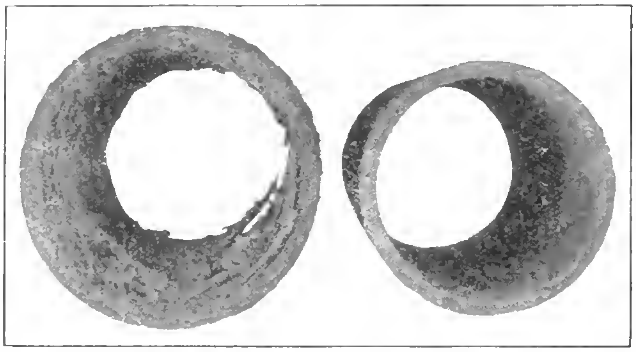


Fig. 1 Corrosion of Steel Pipe Exposed to Moist Mill Atmosphere for Seven Years. First View, Pipe without Copper Content; Second View, Pipe with Copper Content

Building failed after 25 years and that "*these were probably steel because other lines in the cellar were tested and found to be steel.*" He considered such evidence to be inconclusive, particularly in view of the fact that nearly all piping in buildings constructed during the past 30 years has consisted of mixed steel and wrought-iron construction, as confirmed by the author's investigations. Another objection, he said, is that "*relative* corrosion varies with conditions especially as between gases and liquids, so that any conclusion as to corrosion in the drains should be based on a direct

TABLE 1—HARBOR WALL RAILING

Section Used for Experimental Purposes—Post, 4½-in. Pipe; Railing, 2 in. Pipe. Erected October, 1906. Removed August 9, 1917.

STEEL PIPE

	Serial No.	S	P	Mn	C	Average depth of pits, in.	Deepest pit, in.
		Percentage Analysis					
Top Row......	1	.073	.111	.46	.08	.030	.055
	2	.085	.104	.32	.08	.031	.065
	4	.052	.136	.34	.07	.028	.043
	5	.042	.140	.38	.06	.027	.035
	6	.067	.114	.47	.07	.056	.073
	7	.039	.124	.54	.07	.029	.038
Middle Row...	8	.090	.113	.39	.07	.019	.025
	9	.066	.100	.43	.08	.031	.038
	10	.070	.113	.44	.08	.037	.045
	11	.065	.103	.38	.07	.054	.063
Bottom Row...	15	.054	.107	.35	.07	.033	.040
	16	.067	.105	.40	.07	.060	.071
	17	.062	.108	.37	.07	.061	.073
	18	.088	.106	.35	.07	.064	.073

IRON PIPE[4]

	Serial No.	S	P	Mn	O	Average depth of pits, in.	Deepest pit, in.
Top Row......	3	.024	.129	.11	2.20	.032	.045
Middle Row....	12	.022	.137	.12	1.78	.043	.053
	13	.022	.139	.11	1.97	.030	.035
	14	.022	.131	.11	2.00	.038	.047
Bottom Row... (Copper steel)	19[1]	.032	.110	.09	2.60	.041	.050
	20[2]	.026	.130	.09	2.07	.046	.054
	21[3]	.028	.105	.11	2.33	.053	.062

[1] Copper, 0.10 per cent. [2] Copper, 0.06 per cent. [3] Copper, 0.08 per cent.
[4] Analyses of iron pipe below all showed a trace of carbon.

"Of course it would have been more desirable had there been more evidence of this kind and especially from more pipe from the drains of the same buildings. However, the data given certainly do not support the author's conclusion as to the inferiority of steel pipe for drains, but on the contrary indicate surprisingly little trouble, and what there is, according to the data, is at least equally divided between wrought iron and steel.

"Most of the steel pipe included in this report was made over 10 years ago before 'Full weight' became standard, and before improvements in the manufacture of modern steel pipe had been developed and put into practice. Much of the drain and vent pipe in use at that time was light merchant weight with no protective coating."

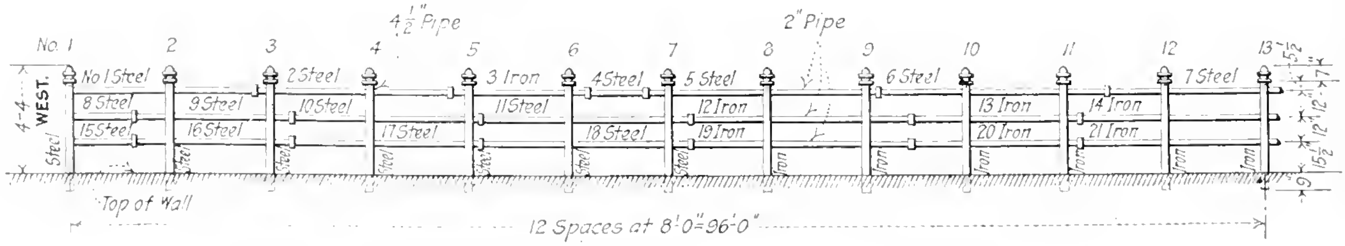


Fig. 2 Harbor Wall Pipe Fence Subjected to Corrosive Action for Eleven Years

examination of these drain pipes and not by assumption and inference from material exposed mainly to atmospheric corrosion.

"However, taking all the results of examination of drainage pipes, as reported in Table 1, as the basis of comparison, but eliminating such cases as No. 58 where the house drains are reported as 'Wrought iron; could not inspect; no trouble,' as incompetent and immaterial, and including in the first place only those buildings where the author was able to examine the pipe which had failed or where there had been no trouble, and it had been possible to make tests on the drains, we find from the author's notes, Table 1:

Pipe material and service given, as reported in Table 1	Investigation in which replaced pipe was examined and tested or where no trouble had been experienced with drains, the kind of pipe determined from tests on drains.		Including additional cases where the kind of pipe is inferred from examination of other pipe in building.	
Wrought iron, good	11, 12, 17, 67,	4	22, 43, 52, 65,	8
Steel, good	16, 19, 20, 28, 71, 73,	6	50,	7
Wrought iron and steel, good	5, 6, 7, 9, 42,	5	38,	6
Wrought iron, failed	63,	1	64, 77,	3
Steel failed	46,	1	31, 40,	3
Wrought iron and steel, failed	2, 37,	2		2
	Total	19	Final total	29

Note.—Nos. 58 and 61, in which report apparently favors wrought iron, and 62 and 70, apparently favoring steel, were left out for lack of any evidence as to material involved.

James Aston, in comment on the four references given by Mr. Speller, and as joint author of one of them (Burgess and Aston), sent the following analysis of these investigations:

The work of Burgess and Aston covered tests upon small samples only, and was not a test to destruction but solely upon the weight lost in a one-year interval. Again, it did not refer to comparative tests of steel and wrought iron but dealt entirely with the influence of different alloying ingredients upon the corrosion loss in the atmosphere; among these was copper-bearing material. Wrought iron played no part in the test or in the discussion of results.

The paper of Storey covered an examination of old barbed-wire fence, and he noted that where the steel wire was in good condition it carried copper, whereas wires which had been destroyed were free from copper. While practically all of the samples were steel, it is significant that there were a few wrought-iron samples; these were in as good condition as the copper-bearing steel and they contained no copper.

The tests of the American Society for Testing Materials deal with sheets exposed to the weather. Among these are all classes of steel and some wrought iron sheets with and without copper. While some of the steel sheets, especially bessemer steel, have failed, the tests have not progressed far enough to be conclusive,

particularly with regard to the relative durability of wrought iron and copper-bearing steel.

The paper of Buck and Handy cites only steel and ingot iron products, the tests including full-size sheets exposed to the weather, and accompanying exposure of small samples 2 in. by 4 in. in size for record of loss of weight. No mention is made of wrought iron.

Author's Closure

Mr. Hansen refers in his discussion to the question of the relative merits of steel and genuine wrought iron pipes for water supply lines. As this is a subject by itself, which was not involved in the author's investigation, no reference need be made here. But further on Mr. Hansen agrees with the author "beyond the shadow of a doubt" that for house drainage purposes genuine wrought-iron pipes are far more durable than steel pipes.

The question raised, as to whether atmosphere and rainwater or the sewer air produced the larger percentage of corrosion, appears to the author to be one of small significance in view of the fact that *all* vent pipes examined and tested were subject to identical conditions of service, regardless of whether they were of steel, wrought iron, or cast iron.

As regards cast iron pipe, Mr. Hansen concedes the weakness of the calked joint, which was the principal point brought up by the author against the use of cast iron in house drainage.

As to the higher cost of screw-jointed pipe systems, this is, to some extent, conceded, especially for small installations. In large installations, however (both in tall buildings and in extensive groups of low buildings), contracting firms equipped with the required pipe-cutting machinery have frequently made but a slight difference, and sometimes none at all, between the cost of a cast-iron calked and a welded screw-joint pipe system. I prefer disregarding the comparative estimates of cost submitted by Mr. Hansen, which I understand to be recent figures, and not figures based upon "pre-war" conditions. Prices of material and cost of labor or both, at the present time are factors of considerable uncertainty, and no definite or important conclusions should be based on them.

Mr. Schuhmann maintains that the question of relative corrosion of wrought iron and steel pipe has "undoubtedly been decided in favor of wrought iron pipe, when used under ordinary working conditions." The author's investigation was based solely upon roof vents in use under ordinary or normal conditions, and no accelerated corrosion tests were considered.

In preparing his paper, the author was not unaware of the fact given by Mr. Schuhmann that some of the discussions before the American Society for Testing Materials, and many experiments made by individuals, confirm the superiority of wrought-iron pipe.

In reply to Professor Walker's statements, it is to be regretted that he could not bring himself to look upon the author's investigation as more than a "fragmentary" investigation and "a statement based upon inadequate data." Professor Walker indicates his belief that there is practically no difference in the corrosion of steel and wrought iron; the author is convinced, nevertheless, that if he had had Professor Walker's assistance or company in his examination of these numerous New York roof vents, he could hardly have escaped changing his opinion.

It would be useless to try to refute Professor Walker's assertion that the data gathered were "inadequate."

Professor Walker is obviously in error when he says that "in no single case were samples of wrought iron and steel taken from the same continuous structure (!)" What fairer proceeding could there be than to take samples and record conditions of corrosion from both wrought-iron and steel pipe standing alongside of each other, *on the same roof, under equal conditions, serving the same class of fixtures, and of equal length of service,* as was done at every opportunity?

In view of this, Professor Walker's contention that the conditions of service were not identical and therefore that no comparisons as to durability can be made is quite incomprehensible.

From his knowledge of the manufacture of wrought iron pipe, the author contends that Mr. Robbins is mistaken when he asserts that wrought-iron pipe made twenty or thirty years ago was a better article than it is to-day, nor does the author believe that there has been in recent years such "a great improvement in the manufacture of steel pipe" as he claims. Five years of service is apparently not a sufficient exposure to corrosive conditions for vent pipes, and for this reason, neither wrought-iron nor steel pipe of such limited age of service was taken into consideration in this investigation.

Professor Kenerson intimates that some of the data on roof vents may have been "properly chosen" to prove that wrought iron is superior to steel. The facts, however, are these: The investigation was begun at the lower end of Broadway and extended to 42d Street, taking in the buildings on both sides of the street in consecutive order, omitting only those which were of very recent date, and buildings of minor importance. In not one case, on entering the buildings and proceeding to make the examination, did the investigators know what kind of pipes they would encounter on the roofs, or in the cellars. The author neither collected his evidence "at random" nor did he aim to chose only data to prove wrought iron superior to steel.

Mr. Handy claims that the qualitative manganese test is not sufficient to distinguish between wrought iron and steel. It is distinctly stated in the paper that fracture tests were made in a number of cases; and where any doubt existed, larger samples of the pipes were submitted for further physical test and qualitative analysis to the metallurgical and chemical departments of Columbia University.

But it must be obvious that where so many hundreds of pipes were under investigation, it would have been both too expensive and too slow a process to have a complete quantitative analysis made of every single pipe. Mr. Handy is, to my knowledge, the only person broadly claiming that the so-called "manganese test" is insufficient and unreliable.

As to the claim that the "copper content" of wrought iron causes this to be very resistant to corrosion, I will refer to the tests of a harbor wall railing, introduced in the discussion by Mr. Speller. The deepest pits, according to these tests, were found in wrought iron pipe, having respectively 0.10%, 0.06% and 0.08% of copper, and where the wrought iron pipe contained no copper the deepest pits were less in extent according to this very table. The further contention that "where wrought iron and steel contain the same amount of copper they are equally durable" is in exact contradiction of what Mr. Speller shows in his table, as evidence that steel pipe without copper content is more durable than wrought-iron pipe with copper.

In Mr. Speller's discussion there are certain inconsistencies and inaccuracies to which attention should be called.

The main purpose of the writer's investigation was to find if commercial wrought-iron pipe purchased in the open market and installed in house drainage systems is superior in rust resistance to steel pipe obtained and used in the same way. Neither steel nor wrought iron pipe has ever been marketed according to their copper content, hence this and other questions as to complete analysis, brought up by Mr. Speller, are not of interest. Moreover, a careful perusal of reports and other literature on *pipe corrosion* fails to reveal the slightest mention of copper content in pipe. Assuming, however, that copper does retard corrosion, about which point metallurgists do not seem to be agreed, it seems absurd to the author to assume that all the iron pipes of this investigation contained copper, and that all the steel pipes were free from it.

Mr. Speller's arguments as to copper content in the wrought-iron pipes having a marked effect in the prolonging of the life of iron in air, are inconsistent and unconvincing, for the very table which he introduces to prove that copper content reduces liability to corrosion shows that wrought-iron pipes with copper content showed a deeper average pitting (0.053) or corrosion than those which did not contain copper (0.045). If this is quoted to prove anything at all, the author's interpretation would be that *copper-bearing wrought iron* is *inferior* to wrought iron without it.

Furthermore, it seems ridiculous to assume, as Mr. Speller apparently does, that among the hundreds of vent pipes tested, all of these of steel should happen to have been installed so as to be subject to severe corrosive conditions, whereas all the wrought

iron ones, in many cases interspersed at random, should have been so placed as to be shielded from corrosive attack.

The fact is, these hundreds of pipes inspected were all installed, practically in the same manner, in the same kind of service, in the same locality, hence the operation of the *law of averages* applies, and minor differences as to composition, original thickness, service conditions, etc., can be disregarded. It is not an *assumption*, as claimed by Mr. Speller, but a *fact* that all the roof vents examined and tested were subject to the same kind of service, for such *roof extensions of soil, waste as well as vent lines are always intended for the removal of sewer gases from the house drainage systems, and all of them without exception are subject to the corrosive action of not only sewer air, but also of the outdoor atmosphere and at times of rain water.*

Mr. Speller expresses a doubt as to the validity of the methods of identification of the pipes, contending that some steel pipe has such a low manganese content as to pass as wrought iron, whereas the author distinctly stated that in many cases the chemical tests were supplemented by fracture tests, also that in *doubtful* cases larger pipe samples were referred to the metallurgical and chemical departments of Columbia University for chemical and microscopical determination.

Mr. Speller further contends that the author's conclusions as to the drains were based on the condition of the roof vents, whereas the author distinctly stated that "the information as to corrosion of drains *is not supported by direct evidence* as in the case of the roof vents," because it was found impossible except in the few isolated cases mentioned to obtain samples of drain pipes which had been removed on account of having corroded through. Yet the fact remains that in those cases of drain failures, where information could be obtained, the evidence, even though circumstantial, pointed to the fact that the corroded pipes were of steel.

The author agrees with Mr. Speller that it would have been desirable if more evidence had been obtained from the drains of such buildings, but he found this either impossible or impracticable. It is to be hoped that when Mr. Speller continues his research on drain pipe he may have better luck.

In making a plea for the better quality of steel pipe made in recent years, Mr. Speller states that formerly the steel pipe manufacturers were in the habit of delivering light, i.e., short-weight pipe, but is not this likewise true of some of the wrought-iron pipe formerly made? And if true, wherein lies the difference?

In spite of Mr. Speller's conclusion that the condition of the steel pipes indicated "surprisingly little trouble," the author believes that one cannot carefully examine the photographs accompanying his paper without becoming strongly impressed with the great difference in the corrosion of wrought-iron and steel pipe, and without noting the fact so clearly brought out, of the *vastly better average condition* of the wrought iron pipes as compared with that of the steel pipes.

Airship Development

In 1910, the average endurance of the German rigid airship at a cruising speed was under one day, and the maximum speed about 50 miles an hour. In 1918, with the German L70 class of 2,195,000 cu. ft. capacity, the endurance at 45 miles an hour rose to 177.5 hours, and the speed to 77 miles per hour. The British R38 class, a contemporary of the German L70, has a capacity of 2,720,000 cu. ft., and an estimated cruising endurance, at 45 miles per hour, of 211 hours. In a note on the possibilities of the commercial airships, issued recently by the British Air Ministry, it is predicted that future airships will have a capacity of 10,000,000 cu. ft., a propelling apparatus of 6000 hp., and a maximum speed of 85 miles per hour. These ships would be 1000 ft. in length, 150 ft. in overall height, possess a range of 20,000 miles, and could stay aloft for three weeks without requiring refilling. The crew would consist of three officers and 26 men, and the freight capacity would be 200 tons. The cost of a 10,000,000-cu. ft. airship is estimated at between \$1,000,000 and \$1,500,000. From *Aviation*, February 1, 1919.

WORK OF THE BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York City.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation in the form of a reply is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in Mechanical Engineering, The Journal of the Society, in order that any one interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee in Cases Nos. 215-227, inclusive, as formulated at the meeting of April 1, 1919, and approved by the Council. In this report, as previously, the names of inquirers have been omitted.

Case No. 215

Inquiry: Is it permissible under the requirements of Par. 257 of the Boiler Code to remove the caulking edges of plates, butt straps and heads by burning them off by the oxy-acetylene process instead of planing, milling or chipping,

Reply: Removing the calking edges of plates, butt straps and heads by the oxy-acetylene burning process will not be in compliance with the intent of the Boiler Code in Par. 257.

Case No. 216

Inquiry: An interpretation is requested of the relation between Section *A* of Par. 275 of the Boiler Code and Sections *B* and *C*. Section *A* would appear to allow 12 per cent additional relieving capacity to a valve than either Section *B* and *C*.

Reply: The Committee purposely limited the requirements for rating of safety valves to 3 per cent increase over that at which the valve is set to blow, that is, one-half the maximum allowable increase in pressure of 6 per cent, so that a margin of safety represented by the difference between 6 per cent and 3 per cent would be provided.

Case No. 217
(Annulled)

Case No. 218

Inquiry: For material to be used as headers and manifolds of superheaters, does that of the open-hearth, extra-heavy, lap-welded steel pipe meet the requirements of Par. 11 and the material specifications of the Boiler Code? It is found that the average analyses of such lap-welded pipe appear to meet the physical and chemical requirements of either the boiler plate steel specifications, or the specifications for steel castings of Class B Grade, although they do not conform fully to either one separately.

Reply: It is the opinion of the Committee that, under the requirements of Pars. 9 and 11, headers and manifolds of superheaters must be constructed from material which in its initial form of plate or skelp, conforms to one or the other of the specifications given in the Boiler Code for wrought steel, or they may be constructed of cast steel of the Class B Grade. See reply in Case No. 208.

Case No. 219

Inquiry: *a* Is the intention under Par. 184*c* of the Boiler Code

to deduct the rivet holes when figuring "the full strength of the plate corresponding to the thickness at the joint"?

b An interpretation is requested of Par. 201, as regards the constant in the formula for staybolts. This paragraph requires that "the spacing of the rivets over the supported surface shall be in conformity with that specified for staybolts," but we fail to find a constant which seems to fit the case.

c An interpretation is requested of the last sentence in the last paragraph in Par. 299 of the Boiler Code which is not quite clear.

Reply: *a* It is not the intention under Par. 184*c* of the Boiler Code to deduct the rivet holes when figuring "the full strength of the plate corresponding to the thickness at the joint."

b The constant *C* used in the formula for rivets shall be that given in Par. 199 for stays screwed through the plates with the ends riveted over. This means that *C* shall be 112 or 120 depending on the thickness of the plate.

c The sentence referred to is intended to convey the idea that fittings on pipe connections or in other fittings that are used between the main steam nozzle of the boiler and the boiler itself need not conform to the dimensions given in Tables 16 and 17.

CASE NO. 220

(In the hands of the Committee)

CASE NO. 221

Inquiry: Is it necessary under the requirements of the Boiler Code that small vertical tubular boilers such as are used for clothes-pressing, vulcanizing and laundry service, shall be fitted with gage cocks when a water gage glass is attached?

Reply: It is the opinion of the Committee that a boiler of this type that is operated with a fixed water level, should be fitted with both water gage glass and gage cocks; or two gage glasses as indicated in Par. 294.

CASE NO. 222

Inquiry: What is the application of the limitation of length of staybolts given in Par. 200 of the Boiler Code, that must be drilled with tell-tale holes in their outside ends? Does this length of staybolt apply to inside distance between plates stayed, or to the outside length of the bolt over all?

Reply: Par. 200 of the Code specifies that "staybolts used in waterlegs of water-tube boilers shall be hollow or drilled at both ends irrespective of their length." Par. 220*d* specifies that "the length of a stay between supports shall be measured from the inner face of the stayed plates."

CASE NO. 223

Inquiry: Is it necessary under the requirements of the Boiler Code to provide staying in a single flue boiler 19½ in. in diameter by 43 in. high, having a 16½ in. furnace, crown sheet of which is connected to the top head of the boiler by a 6-in. flue?

Reply: Inasmuch as the diameter of the furnace is less than 18 in., it is evident that under the requirements of Par. 239, the furnace will not require staying. There remains, therefore, only the crown sheet, top head of the boiler and the flue to be considered. Par. 203*d* or the latter part of Par. 216 are applicable to the crown sheet and top head, if formed from flat sheets. If, on the other hand, the crown sheet and top head are dished, the maximum allowable working pressure is calculated from Par. 195. Par. 241 applies to the flue.

CASE NO. 224

Inquiry: Is it necessary that fire-box steel of lower tensile strength than specified in Par. 28*a*, the use of which is sanctioned in Par. 28*c*, shall have a minimum carbon limit of 0.12 per cent as specified for fire-box steel in Par. 25?

Reply: The minimum carbon limit of 0.12 per cent given in Par. 25 applies to fire-box steel having a tensile range of 55,000 to 65,000 lb. per sq. in. and does not apply to steel of a lower tensile strength, the use of which is sanctioned in Par. 28*c*.

CASE NO. 225

Inquiry: Is it necessary under the requirement of Par. 185 of the Boiler Code to plane down to ½ in. the thickness of the shell plate and heads at head seams, or does this requirement apply to girth seams in shell plates only?

Reply: It is the intent of the Code that Par. 184 shall apply to the plates at all circumferential joints on the shell of a horizontal return tubular boiler where exposed to the fire or products of combustion. It therefore applies to a joint between the shell and the head where the joint in the shell is exposed to the products of combustion, in which case the plate is reduced in thickness if over 9/16 in. in thickness, but the flange of the head is not so reduced.

CASE NO. 226

Inquiry: Is not the basis of determination of the relieving capacity of pop safety valves given in Par. 274 of the new edition of the Boiler Code a misprint? The bases of 6 lb., 5 lb., and 3 lb., of steam per hour per sq. ft. of boiler heating surface for the different types of boilers, do not seem to be in line with the other data given in the Boiler Code and not in line with good practice.

Reply: The decision to base the required minimum capacity of safety valves on heating surface was made by the Committee as a result of investigation of general average of operating duty for boilers in practice, it having been found that water-tube boilers rarely exceed a condition of forcing which will evaporate more than 6 lb. of steam per hour per sq. ft. of boiler heating surface, whereas 5 lb. per hour seems to be the limit for high pressure boilers of any other type; similarly practice with boilers operated at pressures of 100 lb. and under, indicated that 3 lb. of steam per hour was a reasonably high figure. These relieving rates were therefore adopted; the provision of Par. 270 limiting the rise of pressure to 6 per cent above the maximum allowable working pressure, being ample for protection against any boiler emergency, as in case the evaporation is over the figure specified additional safety valve capacity must be added to meet this requirement.

CASE NO. 227

Inquiry: *a* Is Par. 12 of the Boiler Code intended to prohibit the use of cast iron on boiler nozzles, flanges and supporting lugs for any temperature or pressure?

b How far from the boiler are the Rules of the Boiler Code intended to apply? That is, do they cover beyond the second stop valve and do they extend indefinitely along the header and steam pipe?

Reply: *a* Par. 12 is not intended to prohibit the use of cast iron for supporting lugs or for boiler nozzles or flanges, provided such nozzles or flanges are not attached directly to the boiler, or used for temperatures in excess of 450 deg. fahr.

b The rules are intended to apply to the boiler structure only as far as and including the nozzles or flanges attached directly to the boiler and to the various accessories and appliances as specified. In Par. 305 of the Code, provisions are made to allow for expansion and contraction of steam mains and for the use of steam reservoirs on the steam mains in case there are pulsations of the steam currents that might cause vibration of the boiler shell plates. This paragraph is included for the protection of the boiler and is not intended to have a bearing on the general subject of design of steam mains.

Circular 79, issued by the Bureau of Standards and prepared by G. W. Vinal and H. D. Holler, summarizes the available information on dry cells as to materials and methods of construction, and presents an elementary theory of their operation.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Departments of MECHANICAL ENGINEERING by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in this journal, or brief articles of current interest to mechanical engineers.

Pumping Machinery Used by Service of Supply of American Expeditionary Forces in France

TO THE EDITOR:

On the writer's return to America you asked for a statement regarding the nature of the work upon which he was engaged in connection with water-supply problems in France. The following account is therefore sent for your consideration:

The Water Supply office of the Headquarters Lines of Communication was first located in Paris, where it continued until January 13, 1918, when it was removed to Tours. There were changes in nomenclature during the war and finally the office was under the Headquarters Service of Supply, Service of Utilities, Department of Construction and Forestry.

The work included all the water-supply problems except those at the front, which were under another closely coöperating office at the Headquarters of the Chief of Engineers, A. E. F.

I was assigned to duty in the Water Supply office late in October, 1917, shortly after arriving in Paris, and continued the work until the end of the year 1918, when I left Tours en route to the United States. During this time I was largely responsible for the general policy regarding pumping machinery. The following information on the scope of the work is based on a report submitted by an assistant, Oscar G. Goldman, First Lieutenant of Engineers:

On the entry of the United States into the world war and on the dispatch of troops to France, the question of the water supply became of great importance. This included the supplying of camps and hospitals, as well as the railroads, in many cases necessitating the development of new supplies, in some, increasing the already existing French supply, while in others, simply assuring the French supply.

The necessity for the immediate delivery of the water to the point in question meant the development of the nearest supply, either by the sinking of deep wells or by developing the supply from the nearest stream or canal.

This required the use of pumps, the type depending upon the supply utilized and the elevation to which the water had to be delivered. Another feature affecting the pump installation was the size of discharge main available, it being necessary in many cases to install two discharge mains in default of the proper size of pipe for a single line.

Pumps which were expected to be used were estimated in a general way in regard to type, quantity of water to be pumped per minute, and head against which they were to operate. These pumps were tabulated and placed on order in the United States and supplied on monthly priorities, the number requested being estimated according to expected use.

The pumps were placed in two main classes, centrifugal and piston. Several other types were also ordered such as deep-well, steam, and air-lift pumps. The following was the general list of pumps placed on order in America:

CENTRIFUGAL PUMPS		PISTON PUMPS	
Gal. per min.	Head, ft.	Gal. per min.	Head, ft.
200	40	50	150
100	75	60	175
200	75	100	200
100	150	40	460
200	150	175	460
350	250	...	...

Pending deliveries from America, orders were placed with several French manufacturers for pumps for immediate use. Also, where special pumps were required, it was intended to obtain them from French sources.

With the French manufacturers were placed orders for the following centrifugal pumps:

Capacity, gal per min.	Head, ft.	Capacity, gal per min.	Head, ft.
100	50	200	250
100	100	350	50
100	150	350	100
100	200	350	150
200	50	350	200
200	100	350	250
200	150	350	300
200	200	...	...

Piston pumps were also ordered with capacities of 25 gal. per min. (260 ft. head) and 44 gal. per min. (60, 100 and 130 ft. head, respectively).

At the beginning of the war, the pumping machinery used by the American Army was either sent to the depot at Gievres or to Is-sur-Tille and from there shipped to the various jobs. Later it was decided to concentrate all this material at Gievres for distribution.

Nearly all requisitions for pumps were handled by the Water Supply Section of the Division of Construction and Forestry, and as each one was filled a card index was kept showing the type of pumps shipped and also the conditions under which they were to be operated. The pumps thus sent out were later tabulated and in this way a fairly good estimate was arrived at showing the pumps needed or which would be required, as well as the number of each such type, assuming of course that the future demands would be similar to those of the past. It was found that 25 piston pumps and 50 centrifugal pumps were required per month, in the following quantities and sizes:

CENTRIFUGAL PUMPS			PISTON PUMPS		
No.	Gal. per min.	Head, ft.	No.	Gal. per min.	Head, ft.
15	150	100	15	60	175
7	225	100	4	25	300
15	225	150	3	50	300
13	150	200	4	100	300

Of the thirteen 150-gal. centrifugal pumps, three were used in series with another pump, thereby requiring it to be of the reinforced type. The ordinary French pump was built to stand a static pressure of 200 ft. while in the reinforced type castings were made for a static head of 500 ft.

Not many steam pumps were used for water-supply work as it was almost impossible to obtain boilers. Those of the smaller capacities were used by the Forestry Section for boiler feed pumps as a standby to injectors in the operation of the sawmills, and practically all of these were of American make. In several cases triplex pumps were used as boiler-feed standbys when steam pumps were not available.

In several of the deep wells, air-lift installations were made, in many cases of the ordinary type. In some cases a special air-working cylinder was installed, known as the Weber subterranean pump, thereby making it possible to force the water directly into the supply tank, located a considerable distance and at a higher elevation from the well. Direct-connected, straight-line, gas-driven compressors were used, mounted on wheels, with a capacity of 90 cu. ft. of free air per min., against a head of 100 lb. per sq. in.

The majority of the pump installations were belt-driven. At first fiber belting was furnished, but due to the high belt velocities it was found very difficult to keep the lacings from cutting through the holes. Later, leather belting was furnished and no further trouble was experienced.

Belt velocities on French installations usually varied between 4100 and 4500 ft. per min., with a few cases as high as 4875 ft. per min. These velocities are not considered high by the French manufacturers and it was stated by the Rateau Company that they usually signed for velocities of between 4900 and 5700 ft.

Wherever electric power was available, it was desirable to install electric-motor-driven pumps. This was not always possible, as electric motors and apparatus were very difficult to obtain in

France and those from the United States had not been received until late. When American motors were available it was not always possible to use them, due to their lower speeds. Many of the French motors supplied ran at 2850 r.p.m., full-load speed, while others were rated at 1425 r.p.m. The electric motors obtained from America had a speed of about 1000 r.p.m. and with the difficulty of obtaining pulleys it was almost impossible to use them with the French pumps.

For railroad water supply the usual installations consisted of gasoline-engine, belt-driven pumping units. In most cases these plants consisted of two or more units, an extra unit being installed as a standby, all units being of the same capacity, so that should one unit have need of repairs, the plant could still supply the needed amount of water. Where electric power was available but found to be unreliable, gas-engine standby units were installed, not of the total capacity of the entire plant, but of such capacity as to have a certain percentage of water available.

The gas engines used for most of the installations were of the high-speed automobile type. The French engines had a range of speed of from 1200 to 1500 r.p.m., while those of the stationary type had a range of 600 to 1000 r.p.m.

The French manufacturers claimed these high-speed engines had been in continuous service, being used by the armies of England and France throughout the period of the war, and had given good service, yet whenever possible the heavy-duty, or low-speed, American-made gas engines were used.

Having thus far discussed in general terms the type of pumps and power used by the American Army along the lines of communication, a few special installations will now be explained.

The number of trains, including freight and troop, passing over the roads having increased many times that before America entered the war, it became necessary to increase the railroad water supply, and in some cases install new watering points.

One of these pumping stations was located at Foecy, Department of Cher. This plant contained two centrifugal pumps made by the Rateau Company, Paris, of the PFP-28-R type, belt-driven by a Chapuis-Dornier automobile-type 15-hp. gas engine, with 4-in. single-ply leather belting, rawhide lacing being used. The amount of water required was 140 gal. per min. against a total head of 150 ft., the discharge being two 4-in. cast-iron pipe lines with a length of about 4300 ft. The water was discharged into a 50,000-gal. railroad water tank, and supplied to the locomotives through two 10-in. standpipes.

The centrifugal pumps were single-stage, diffuser type, running for the condition mentioned above at 1890 r.p.m. and requiring about 10.5 hp. at the shaft.

At Perigueux, Department of Dordogne, the pumping station located on the Dronne River consisted of two Dumont centrifugal pumps direct-connected to 15-hp. Chapuis-Dornier gas engines. Each pumping set really consisted of two pumps bolted together on the same shaft, with special fittings, so that they could either be operated in series or parallel. Operating in series at 1300 r.p.m. each pump would supply 264 gal. per min. against a head of 98 ft., while in parallel the pumps would deliver 528 gal. per min. against a head of 49 ft. In this station these pumps were operated in series. The water was supplied to a 100,000-gal. concrete reservoir through a 6-in. discharge line about 700 ft. in length and then through a 10-in. line of about 1000 feet to the reservoir. This 10-in. line was also used as the supply line to two 10-in. standpipes for supplying water to the locomotives.

For hospital supply, the pumping station usually contained more pumping units than that installed for railroad purposes. Several of the larger stations will be hereafter described.

At Allerey, Department of Saone et Loire, the maximum amount of water needed was figured at 460,000 gal. per day, the hospital being one of 10,000 beds with a crisis expansion to 20,000. Test wells were sunk in a gravel pit located about 8500 ft. from the extreme end of the hospital and it was at first expected to get all the water from this location by sinking an additional well about 200 ft. from the first. Two centrifugal pumps of the PFP-28 type, single-stage, made by Rateau Company, Paris, rated at 189 gal. per min. against a head of 207 ft., running at 2100 r.p.m., belt-driven by 20-hp. Charron automobile-type gasoline engines, were installed. Later it was determined that the needed amount of water could not be obtained from the two wells, and it was decided to install another station on the Saone River about 2200 ft. from the wells. In this station two Rateau centrifugal pumps of the PFP 28-R single-stage type were installed, rated at 150 gal. per min. against a head of 200 ft., running at 2160 r.p.m., belt-driven by a 30-hp. Bignan automobile-type gasoline engine.

The water was pumped to a 100,000-gal. concrete reservoir through a 6-in. cast-iron main as far as the hospital and from there on through an 8-in. main, which was part of the hospital distributing system, with a length of 5500 ft. In each station the pumps were to be operated so as to give 190 gal. per min. against a head of 200 ft. This necessitated speeding up the pumps of the station located on the river to about 2300 r.p.m.

At Joue-les-Tours, Department of Indre et Loire, a 2000-bed hospital was erected. Here the water was pumped from an 8-in. well about 600 ft. deep by means of compressed air to a 11,000-gal. storage tank at about 85 ft. above the top of the well, a Weber subterranean cylinder being used. The amount of water delivered was about 100 gal. per min., through a 4-in. main about 300 ft. long, the compressor used being one of the Chicago straightline 15-hp. gas-engine-driven type, rated at 90 cu. ft. of free air per min. at 100 lb. per sq. in. The cylinder was set at about 265 ft. from the top of the well. When the well was not operating the water stood at about 25 ft., but as soon as the pump was started the water level receded to about 50 ft. from the surface of the ground. The starting pressure was about 125 lb. per sq. in. at the well, while the running pressure dropped to about 108 lb.

In another deep well, driven about 25 ft. from the other to a depth of about 500 ft., an ordinary nozzle-type air lift was installed with a 2-in. discharge and a $\frac{1}{2}$-in. air line. The air was supplied from a gasoline-engine belt-driven Worthington compressor rated at 30 cu. ft. of free air per min. against a pressure of 100 lb. per sq. in. A rough test showed that about 20 gal. per min. could be obtained at the tank, and it was proposed to use this installation as a standby.

Bassens, located near Bordeaux, was one of the ports developed by the American Army. The work there consisted in building new wharves, railroad yards, camp sites, as well as a large refrigerating plant.

The supply for the docks, railroad yards and camps was supplied from two artesian wells. At the first well, two direct-connected electric-driven 26-hp. centrifugal pumps of the PFP-28-S type were installed for 395 gal. per min. against a head of 130 ft., running at 1430 r.p.m. The "S" type pumps are two single-stage pumps bolted together on the same shaft.

At the second well two PHP-20 direct-connected, electric-driven, single-stage centrifugal pumps were installed, rated at 395 gal. per min. against a head of 130 ft. at 2800 r.p.m.

The distributing system consists of 8-in. and 6-in. Universal cast-iron pipe. The first station was located almost 8000 ft. from the docks, the discharge main being 8 in. in diameter, while the second was about 5000 ft. distant, the discharge main consisting of 6-in. pipe.

For the refrigerating plant the pumping station was situated on the banks of the Garonne River, and consisted of three direct-connected, electric-driven, single-stage centrifugal pumps of the PFP-36 type, rated at 500 gal. per min. against a head of 160 ft., running at 1430 r.p.m., the motor being one of 36 hp. The discharge line was of 12-in. cast-iron bell-and-spigot pipe with a length of about 3000 ft.

The elevation of the water level varies about 21.5 ft. between extreme high and low water, and it was therefore necessary to set the pump in a concrete pit about 9.5 ft. deep, so that at extreme low water the suction lift would be about 13 ft.

The pumps used at Bassens were among a large number especially designed for each condition by the Rateau Company of Paris.

W. B. GREGORY,
Major of Engineers.

New Orleans, La.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A. S. M. E.

The Thermal Testing Plant of The Engineering Experiment Station, The Pennsylvania State College

THE Thermal Testing Plant of The Pennsylvania State College is one of the best-equipped plants of its kind. It consists of two buildings, the generating plant and the calorimeter building.

The generating plant is a brick building 50 ft. by 18 ft. Its equipment consists of a complete 3-ton experimental refrigerating system of the compression type, and a variable-speed circulating pump for carrying the brine to the calorimeter building. The installation is such that the plant can be driven either by electricity or by steam. The observer's bench is located in this building and contains the necessary voltmeters, ammeters, rheostats, etc., for measuring the electrical heat supplied to the test box and switches and a wheatstone bridge for measuring the temperatures registered by the resistance thermometers in the calorimeter building. In addition to the apparatus listed there are two experimental house-heating boilers located in this building.

The calorimeter building is a brick building 32 ft. by 32 ft. and contains, centrally located, an outside calorimeter room of corkboard construction, 20 ft. by 20 ft. by 10 ft. high. This room is fitted with 550 ft. of 1¼-in. brine coils distributed over three sides of the room and the brine flow can be regulated by means of the circulating pump in the generating plant, to hold the temperature to within a variation of about 1 deg. fahr. The test box which has been used in the room is a 5-ft. cube of 3-in. cork board, with one side removable. Within this calorimeter room a second calorimeter room 10 ft. by 7 ft. by 10 ft. high has recently been built and since its completion it has been used for all the testing work. It is of somewhat similar construction and is fitted with 690 ft. of 1½-in. brine coils located on the four side walls and the ceiling. This inner room is so located that space is afforded in the large room for experimenting with large test boxes. This small calorimeter room is fitted with a Tagliabue thermostat which so regulates the flow of brine that the room temperature can be held within 5 deg. fahr. and in several cases no difficulty has been experienced in maintaining a temperature which has not varied a tenth of one degree for as long as three hours. The thermostat can be adjusted from the outside of this room, so as to regulate at any desired predetermined temperature. The compressed air necessary for the operation of this instrument is supplied from an adjoining engineering building. To avoid as much as possible the evaporation of the condensed moisture from the brine coils, drip pans and drain pipes have been suspended under the various coils. The test box being used at the present time is one of wood and felt construction 32 in. by 32 in. by 16 in. It has removable blanks 2 ft. square for which similar-sized blanks of the material to be tested can be substituted. The electrical heat is furnished to the inside of the box by means of a coil of manganin resistance wire which is located near the bottom of the box. A very small electric fan is used for circulating the air inside of the box. A "sandwich" heating element is also available and can be substituted for the one now in use. It consists of coils of manganin wire placed between two perforated asbestos boards 2 ft. square, and is designed to be set vertically in the center of the box and to be used without the circulating fan. Another test box is available. The heating element of this box is an asbestos cube whose six faces are mounted with manganin resistance wire, the cube being encased in a tight-fitting galvanized-iron box. Over this heating element a casing of the material to be tested is constructed, the cube being entirely encased in the "unknown" material.

Both live current and storage-battery current are available for heating the various resistance coils. Temperature measurements are taken by means of specially designed electrical resistance thermometers. Flat nickel spirals (about 1/50 in. thick and 1¾ in. in diameter) are used for temperatures near and on surfaces, and small nickel coils encased in cylindrical cases of polished metal are used for all other temperatures. These thermometers are connected to the wheatstone bridge in the generating building.

For determining the humidity in the calorimeter room a wet-and-dry-bulb thermometer is available, and so located that readings can be taken through a triple-sash glass window, and to have the readings compare with those of a sling psychrometer a current of air is blown over the bulbs by means of an electric fan until the readings become constant, a period of about three minutes being sufficient. If it is desired to determine the effect of air velocity, electric fans are available for forcing air against the surfaces of the test box.

In heat-transmission studies the method of testing finally adopted as combining rapidity and accuracy in such degree as to be consistent with the limitation of the apparatus is to raise the temperature of the test box as quickly as possible to several degrees above the required equilibrium temperature as predetermined by an approximate calculation for a given wattage. The current is then lowered and adjusted to give the required input of heat and when the temperature drops no faster than 2 deg. fahr. per reading (20 min.) the voltage is dropped about 10 per cent for one interval and then raised to the required voltage. The current from the storage battery being subsituted for the 110-volt d.c. current at this time to maintain a constant heat input. If the temperature drops slightly and then rises and practically holds its former value, there is reason to believe that the box is "saturated" and that the equilibrium value has been reached. The test is then continued for about two hours, further testing being unnecessary. Voltage, amperage and temperature observations are made every twenty minutes and humidity and brine observations every hour.

The Engineering Experiment Station of The Pennsylvania State College will be glad to coöperate in the testing work incident to the development of new insulating materials and methods and the more efficient use of those already available.

Results of tests performed in the Thermal Testing Plant of The Pennsylvania State College appear in the following publications:

Preliminary Report from the Thermal Testing Plant of The Pennsylvania State College, by J. A. Moyer, at the Third International Congress of Refrigeration. 1913.

The Effect of Velocity and Humidity of Air on Heat Transmission Through Building Materials, by J. A. Moyer, J. P. Calderwood and M. P. Helman, Bulletin 16, The Engineering Experiment Station, Pennsylvania State College; also *A. S. R. E. Journal*, November 1915.

Determining Heat Transmission of Compound Walls with Tests on Insulated Steel Car Sections, by A. J. Wood, *A. S. R. E. Journal*, January 1917.

Report on A Study of Surface Resistance with Glass as the Transmission Medium, by H. R. Hammond and C. W. Holmberg, at the annual meeting of the A. S. M. E., December 1917.

Some Recent Studies in Heat Transmission, by J. A. Wood and R. B. Fehr, *A. S. R. E. Journal*, March 1918.

Report on The Thermal Testing Plant, by R. B. Fehr, Bulletin No. 24, Engineering Experiment Station, Pennsylvania State College.

The present work of the Thermal Plant concerns a study of the comparative insulating values of the various building materials and of air spaces. The future plans include a further study of this work and a study of the insulating values of various numbers and sizes of air spaces.

Steel Research Laboratory Planned for the Carnegie Institute of Technology

Contributed by Thomas S. Barker

THE decision of a number of officials of the leading steel and engineering companies manufacturing rolling-mill machinery, to install an experimental rolling mill and Bureau of Rolling Mill Research under the auspices of the Carnegie Institute of Technology at Pittsburgh, marks not only the beginning of a radical advance in the art of rolling steel and other metals in this country, but an equal advance in the spirit of coöperation among American manufacturers which the industrial leaders have long strived to obtain, and which they recognize as absolutely necessary if this country is to retain its industrial supremacy during the coming period of reconstruction. This Bureau of Rolling Mill Research will have four distinct functions:

1 To investigate and study the physical and mechanical changes taking place in steel and other metals, and the power consumed, during the process of being rolled at various temperatures and speeds.

2 To distribute the information obtained by means of these experiments among the coöperating firms in order that they may put it into commercial use.

3 To provide laboratory facilities in which the contributing companies may conduct experiments and investigate designs of rolls for the production of new sections which they wish to place on the market.

4 To offer courses of instruction to students employed by the contributing interests and to those students who are to specialize in this field and are registered at the Carnegie Institute.

As planned at present the mill will consist of three stands of three-high rolls driven by a 500-hp. variable-speed electric motor. The drive and change-speed gears will be so arranged that any number of revolutions between 4 r.p.m. and 1000 r.p.m. may be obtained. This wide range of speeds will enable a careful study to be made of the effects of speed on power consumed, and physical properties of the steel when rolled and treated under varying conditions.

Both the mill and the drive will be equipped with a complete set of automatic recording instruments and changes in their reading under the varying conditions of rolling mill be recorded. The special stand for measuring the spreading force on rolls is to be equipped with hydraulic cylinders so arranged that the work done to overcome friction at the roll is automatically separated from the work done in rolling the steel.

Another feature of the mill will be a quick-action stop clutch. By means of this clutch the mill may be instantly stopped while a bar is passing through the rolls.

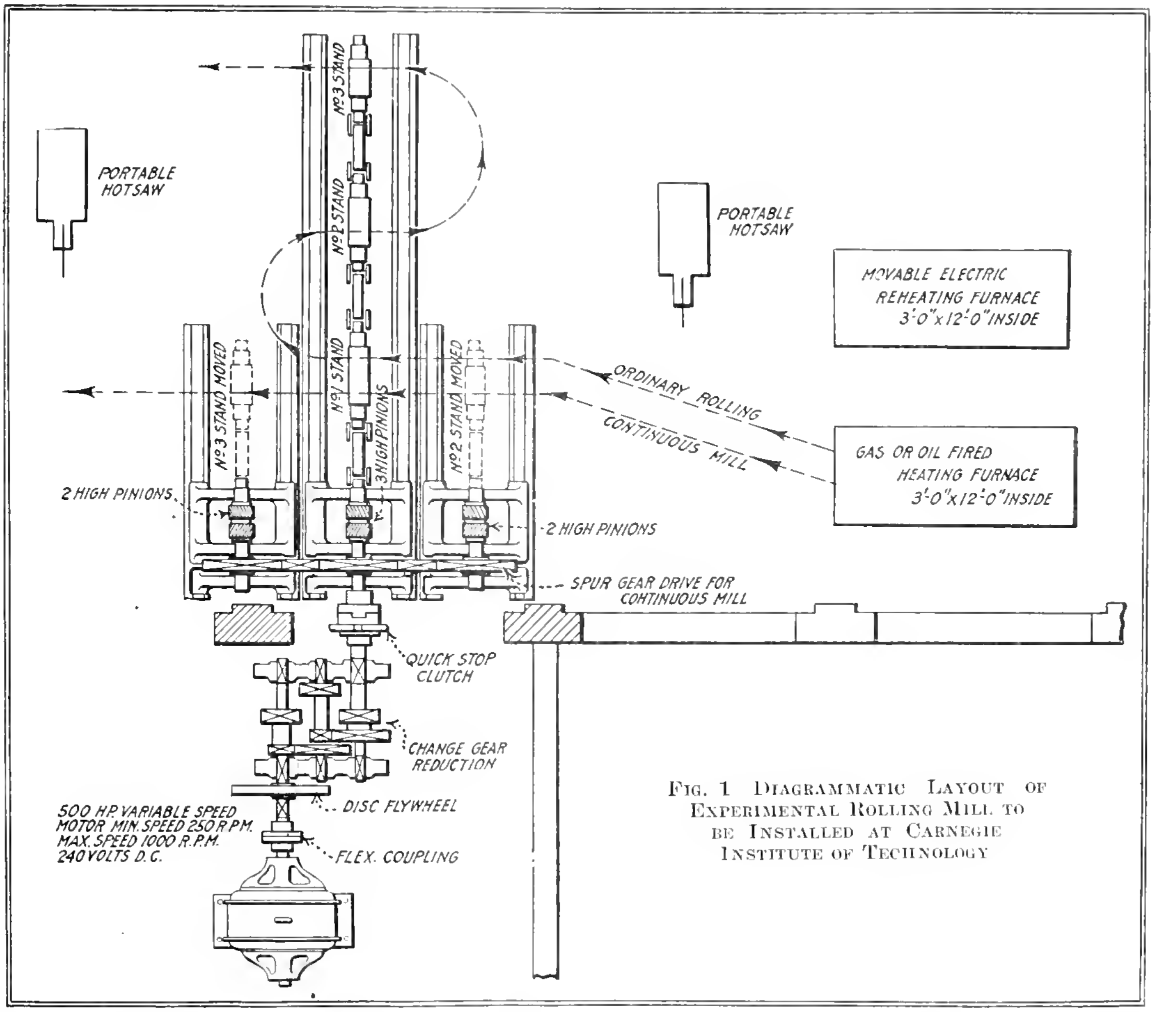


Fig. 1 Diagrammatic Layout of Experimental Rolling Mill to be Installed at Carnegie Institute of Technology

In practical mill work a roller often has to wait days and sometimes weeks before he can catch this condition, as he could not consider the stopping of production while he made a cobble in some particular roll pass that was giving him trouble, and it is mainly by studying the cobbles that the action of the steel can be observed and studied.

By stopping the mill and catching a bar in the rolls the exact action or flow of the steel in that particular pass and with the particular set of conditions under which the mill is operating, will be permanently recorded in the section of bar being pinched by the rolls.

The rolls will then be opened and the bar withdrawn and studied. By this means a student can gain more experience in the rolling of steel and knowledge of the flow of steel during rolling in one year on the experimental mill than could possibly be gained in many years' work on a commercial mill.

Fig. 1 shows a diagrammatic layout of the mill and drive. As will be seen, the three stands may be mounted on one shoe and used as a Belgian train with No. 1 as a rougher, No. 2 stand as

strand or leaders, and No. 3 stand as finishers; or No. 2 and No. 3 stands may be moved as indicated in dotted lines so that all three housings are placed in tandem and the mill will operate as a continuous mill.

When operating in this manner only the upper two rolls would be used, the lower ones being left out and the space for their neck bearings filled up. In order to drive the continuous mill a train of gears is located just outside the pinion housings, the large driving gears being mounted on an extension of one of the pinion necks. Idle gears between are carried by separate adjustable bearings.

By means of a spur gear instead of the usual bevel-gear drive used on continuous mills, the reduction ratio between the stands may be altered by changing only one gear instead of two.

In this manner it is hoped that the actual conditions existing in the mills of the contributing members of the Bureau may be easily duplicated in the laboratory, thus enabling any member to experiment on problems arising in his business under conditions which duplicate those in his mills, without excessive expense or without the losses incident to tying up a producing department.

The Bureau will be under the control of a Research Committee who will be composed of members appointed by the contributing interests, and representatives of the Carnegie Institute of Technology. This Research Committee will lay out and oversee all work and transact all business in connection with the Bureau. The entire Department is to be operated on a no-profit basis and all funds subscribed for this work and not used, will be returned to the subscribers.

Among the many problems where research work can be done and on which the information is badly needed by rolling-mill engineers, are

a Separating forces acting on rolls and housings
b Influence of speed on separating forces and on roll-train resistance
c Ratio of roll-neck friction to total roll-train resistance
d Influence of roll diameter, steel temperature, roll velocity and form of projected contact area on spreading
e Greatest deformation which plastic material can undergo without injury while being rolled.

It is planned to demonstrate to students who are studying rolling-mill engineering and roll-pass design the following phenomena:

1 Effect of separating or closing the rolls
2 Effects of "crossing" the rolls
3 Metallurgical effects of many light passes
4 Metallurgical effects of a few heavy passes
5 Rolling of shapes and merchant material
6 Study of plastic deformation and lines of flow
7 Forward slippage in rolling.

Reports Upon Research

A—Research Results

Apparatus and Instruments A1-19 Thermometers for Aeroplane Use. Describes types of construction, design, nature and amount of errors. Aeronautic Instrument Circular No. 39. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Apparatus and Instruments A2-19 Aeronautic Instruments. A complete mathematical theory on elastic fatigue. Circular No. 39. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Apparatus and Instruments A3-19 Altitude Tables. Tables for determining altitude corresponding to various atmospheric pressures, giving results in millibars and other units. Aeronautic Instrument Circular No. 3 Supplement. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Apparatus and Instruments A4-19 Standard cement samples for standardizing 200 mesh sieves. 180-gram containers will give enough material for three tests. These may be purchased at 25 cents each. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

B—Research in Progress

Properties of Engineering Materials A1-19 Concrete Molds of Paper. Tests of 1:2:4 concrete made in steel molds and paper molds. Comparative tests gave similar results, showing that paper mold can be used for test samples. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Air B2-19 Coefficient of Friction in Air Ducts. University of Michigan, Ann Arbor, Mich. Address Dean M. E. Cooley.

Apparatus and Instruments B1-19. Profile projecting lantern with short screen distance for magnification. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Apparatus and Instruments B2-19 Thread-angle measurements by three-wire method. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Automotive Vehicles and Equipment B2-19 Car Performance Curves. The determination of values, curves of acceleration, fuel economy at various speeds and speed ranges in accordance with specifications of the Research Division of S. A. E. University of Michigan, Ann Arbor, Mich. Address Dean M. E. Cooley.

Cement and Other Building Materials B1-19 Marble. Permanent increase in dimensions due to alternate heating and cooling. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Cement and Other Building Materials B2-19 Plaster "Popping." A study to determine the cause of "popping" in plaster. The investigation includes the use of overburned lime, underburned lime, improperly hydrated lime and unclean sand. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Cement and Other Building Materials B3-19 Sand-Lime Bricks. An investigation of the time of curing of sand-lime bricks. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Heat B3-19 Thermal Expansion of Glass, Dental Alloys, Cements, Human Teeth and Johannsen Gages by Interference Methods. Permitting measurements within 0.06 micron (about 2 millionths of an inch). Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Heating B1-19 Radiators, Hot-Water. Test of hot-water radiators. University of Michigan, Ann Arbor, Mich. Address Dean M. E. Cooley.

Heating B2-19 Radiators. Heating Effect as Influenced by Type, Style and Location. University of Michigan, Ann Arbor, Mich. Address Dean M. E. Cooley.

Insulation B1-19 Magnesia Heat Insulation. A continuation of the work reported at the December meeting of The American Society of Mechanical Engineers, 1918. Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa. Address Director R. F. Bacon.

Internal-Combustion Motors B2-19 Combustion Efficiency of Automobile Engines. University of Kansas, Lawrence, Kan. Address Dean P. F. Walker.

Internal-Combustion Motors B3-19 Delivery of Power from Multi-Cylinder Engines. University of Kansas, Lawrence, Kan. Address Dean P. F. Walker.

Properties of Engineering Materials B2-19 Concrete Floor Surfaces. A test of 31 slabs subjected to actual traffic for five months, testing out magnesium fluosilicate, varnishes and paints, waxes and three other hardeners. To date the greater part of the slabs are almost free from dust and those treated with magnesium fluosilicate compounds are very hard. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Properties of Engineering Materials B3-19 Bearing Metals. Ex-

perimental study has been planned and submitted to manufacturers for consideration and suggestions. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Textile Manufacture and Clothing B1-19 Asbestos Textiles. An investigation for the purpose of standardizing specifications for asbestos textiles. Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa. Address Director R. F. Bacon.

Textile Manufacture and Clothing B2-19 Investigation of Tautness of Airplane Fabrics by Means of Special Meter. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Transmission B4-19 Universal Joints. A study of problems of the universal joint used in automobile transmissions. University of Kansas, Lawrence, Kan. Address Dean P. F. Walker.

C—Research Problems

Apparatus and Instruments C1-19 Study of Gaging Systems in Manufacturing Plants. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Apparatus and Instruments C2-19 Heat Treatment and Chemical Composition of Steel for Gages. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Apparatus and Instruments C3-19 Screw-Thread Gages. Possible errors in screw-thread gages and discrepancies in fit of plug and ring thread gages. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Apparatus and Instruments C4-19 Gages. Utility of flush-pin gages and built-up snap gages. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Apparatus and Instruments C5-19 Gage Marking. The proper method of etching lines on gages for correctness and distinctness. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Apparatus and Instruments C6-19 Indicators for Machine Work. The design of indicators more sensitive and constant than those in present use. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Apparatus and Instruments C7-19 Gage Salvaging. The possibility of salvaging gages by electrically nickel plating gage surfaces. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Metal Manufactures C1-19 Lapping. A Study of Lapping Compounds to Determine Suitability for Certain Purposes. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Metal Manufactures C2-19 Cutting Oils. The effect of different lubricants on cutting quality of taps. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Metal Manufactures C3-19 Thread Grinding. The correct principles of thread grinding. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Metal Manufactures C4-19 Rusting of Small Steel Parts. A method to prevent rust in small steel parts, as those in a watch, without destroying the finish. Elgin National Watch Co., Elgin, Ill. Address G. E. Hunter, Gen. Supt.

D—Research Equipment

Air D1-19 Compressed-Air Plant. Large air compressor equipped for study of air through orifices and nozzles and under cooling. Johns Hopkins University, Baltimore, Md. Address Prof. A. G. Christie.

Air D2-19 Vacuum Cleaners. Equipment to test one type of vacuum cleaning machine for power, air handled and vacuum required for vacuum cleaning. University of Illinois, Urbana, Ill. Address Dean C. R. Richards.

Air D3-19 Air Compressor for Studying Problems in Air Compression. University of Illinois, Urbana, Ill. Address Dean C. R. Richards.

Apparatus and Instruments D3-19 Devices and Instruments for Measuring Radii of Profile Gages. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Apparatus and Instruments D4-19 Balanced Micrometer Holder for Making Diameter Measurements of Thread Gages. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Apparatus and Instruments D5-19 The Hoke Precision Gage Disks. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Carnegie Institute of Technology D1-19. Steel Research Laboratory. See Mechanical Engineering for May, 1919. Carnegie Institute of Technology, Pittsburgh, Pa. Address Thomas S. Baker.

Fuels—Gas, Tar and Coke D1-19 Gas By-Products Laboratory. Complete laboratory for studying gas production and by-products. Equipped to study all kinds of problems arising in ovens, such as low temperature, distillation of coal, coking properties, by-products and gas-forming capacities of various coals and lignites. Johns Hopkins University, Baltimore, Md. Address Prof. A. G. Christie.

Heat D1-19 Heat Transmission Through Building Materials. Cube 6 ft. on one side equipped with heating elements and thermocouples to determine heat transfer. University of Illinois, Urbana, Ill. Address Dean C. R. Richards.

Heating D1-19 Direct and Indirect Radiators with Fans, Air Washers and Thermostats. Instruments for studying problems of heating and ventilation. University of Illinois, Urbana, Ill. Address Dean C. R. Richards.

Heating D2-19 Warm-Air-Furnace Testing Plant. University of Illinois, Urbana, Ill. Address Dean C. R. Richards.

Heating D3-19 House-Heating Boilers. Several types of sectional heating boilers equipped to study problems in heating water and generating steam. University of Illinois, Urbana, Ill. Address Dean C. R. Richards.

Heating D4-19 Thermal Testing Plant. Pennsylvania State College. See Mechanical Engineering for May, 1919, page 464. Pennsylvania State College, State College, Pa. Address Prof. A. J. Wood.

Internal-Combustion Motors D1-19 Diesel Engine of 80 Hp. For investigation with different types of oil-spray nozzles and other devices for injecting fuel. Johns Hopkins University, Baltimore, Md. Address Prof. A. G. Christie.

Internal-Combustion Motors D2-19 Plant for Testing Gas Engines, Producers Using Bituminous Coal, Automobile Engines and Other Problems of Such Motors. University of Illinois, Urbana, Ill. Address Dean C. R. Richards.

Internal-Combustion Motors D3-19 Four-Cylinder Gas-Engine Direct-Connected to 75-Hp. Sprague Electric Dynamometer. Complete equipment. Apparatus arranged for testing motor fuels. Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa. Address Director R. F. Bacon.

Johns Hopkins University D1-19 Mechanical Engineering Laboratory Equipment.

1 Gas by-products laboratory equipped to study problems in gas manufacture and the by-products thereof.
2 Spray Pond. Apparatus to study cooling of water.
3 Compressed-Air Plant. Equipment to study flow of air through orifices and nozzles.
4 Refrigeration. Fifteen-ton refrigerating system with provisions for measuring fluids.
5 Buckeyemobile. A 75-hp. buckeyemobile unit for heat-transfer tests.
6 Diesel Engine. An 80-hp. Diesel engine for studying fuel oils. Address Prof. A. G. Christie, Johns Hopkins University, Baltimore, Md.

Mellon Institute D1-19 Unit Plants. The Mellon Institute has installed small-scale complete equipments to study process development by the construction of unit plants in which the process was carried out commercially, although of smaller size than the final commercial installation. Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa. Address Director R. F. Bacon.

Metallurgy and Metallography D1-19 Furnaces, ovens, grinders, crushers, vacuum dryers and filter presses. Mellon Institute of Industrial Research. University of Pittsburgh, Pittsburgh, Pa. Address Director R. F. Bacon.

Metallurgy and Metallography D2-19 Steel Research Laboratory, Carnegie Institute of Technology. See Mechanical Engineering for May 1919, page 465. Address Thomas S. Baker, Secretary, Carnegie Institute of Technology, Pittsburgh, Pa.

Pennsylvania State College D1-19 The Thermal Testing Plant of the Engineering Experiment Station. See Mechanical Engineering for May, 1919, page 464. Pennsylvania State College, State College, Pa. Address Prof. A. J. Wood.

Refrigeration D1-19 Refrigerating Plant for Accurate Determination of Ammonia and Brine Used in Refrigeration. Fifteen-ton refrigerating system equipped for weighing ammonia and measuring brine. Johns Hopkins University, Baltimore, Md. Address Prof. A. G. Christie.

Refrigeration D2-19 Compression and Absorption Apparatus for Experimental Work. University of Illinois, Urbana, Ill. Address Dean C. R. Richards.

Steam Power D1-19 Spray Ponds. Spray pond equipped with nozzle to determine the laws of cooling water by such means. Johns Hopkins University, Baltimore, Md. Address Prof. A. G. Christie.

Steam Power D2-19 Buckeyemobile of 75 Hp. for Heat-Transfer Tests. Johns Hopkins University, Baltimore, Md. Address Prof. A. G. Christie.

Steam Power D3-19. Engines and Turbines for Use with Saturated and Superheated Steam. University of Illinois, Urbana, Ill. Address Dean C. R. Richards. See University of Illinois, *D1-19.*

Steam Power D4-19 Boiler Experimental Work. Water-tube boiler equipped with chain-grate stoker with independent superheater and economizer for experimental work. University of Illinois, Urbana, Ill. Address Dean C. R. Richards.

Textile Manufacture and Clothing D1-19 Machinery for Wool Manufacturing, Including Spinning and Weaving. Installed for experimental purposes at the Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Transmission D1-19 Belt-Testing Apparatus. Two Sprague electric dynamometers of 100 hp. each. Mellon Institute of Industrial Research, Pittsburgh, Pa. Director R. F. Bacon.

E—Research Personal Notes

Apparatus and Instruments E1-19 Gage Section—Bureau of Standards.

During the last few months the Gage Section of the Bureau of Standards has developed several new methods of making measurements of gages and gaging instruments. These include:

1 Simple methods of measuring effective pitch diameters of taper pipe-thread gages using three wires.

2 The use of light-wave interference methods for making length comparisons and for testing flatness and parallelism of surface of flat end standards.

3 Application of sliding taper parallel for measuring snap gages.

4 The use of mechanical indicator for testing plain ring gages. Address S. W. Stratton, Bureau of Standards, Washington, D. C.

Apparatus and Instruments E2-19 Gage Section—Bureau of Standards.

The Gage Section of the Bureau of Standards has made several communications which may be had under certain conditions by application to the Bureau. For the information of those interested, the following list is given:

B462—Test of Micrometer Calipers. (To be revised before distribution.)

B466—Procedure of Tests and Explanation of Reports of Munition Limit Gages by Bureau of Standards.

B467—Gage Tolerances Used by Ordnance Department, U. S. A.

B500—Inspection of Pipe Thread Gages in the Fields. (To be revised before distribution.)

B503—Course of Instructions Covering Measurement and Use of Munition Limit Gages. (Obsolete but available.)

B505—Questionnaire for Information on the Standardization of Screw Threads.

B506—Important Screw-Thread Systems.

B507—Dimensions of Briggs Standard Pipe Gages.

B511—Reminders Regarding Microscopes. (Not intended for general distribution, but obtainable on request.)

B513—Service Available at the Bureau of Standards Gage Laboratories.

B515—Formula for Determining Effective Diameter of Buttress Threads. (Not ready for distribution.)

B516—Tables of Dimensions of Foreign Threads. (Not ready for distribution.)

B517—Thread Form and Clearance of U. S. Standard Thread Gages. (Not ready for distribution.)

Address Director S. W. Stratton, Bureau of Standards, Washington, D. C.

Cement and Other Building Materials E1-19 Concrete Shear Tests.

The Editor of *Engineering News-Record* calls attention to the fact that the question of shear in concrete is in a most unsatisfactory state in spite of the number of tests which have been made on this subject. He calls attention to a series of tests described in the *News-Record* for Feb. 27, 1919, by Slater, and states that these investigations should be carried further. The Bureau of Standards is willing to carry on this work if funds may be provided for the work, and those interested might take up this matter with members of Congress for support.

General E3-19 Steel Treating Research Society.

The Steel Treating Research Society, with headquarters at Detroit, Mich., W. P. Woodsie, President, and H. G. Kiefer, Chairman of the Detroit Section, is desirous of coöperating with the Research Committee. The work of the Society is outlined from its By-Laws relative to its Standards Committee as follows:

> The duties of the Standards Committee shall be to adopt as standard, steels having the composition of the Society of Automotive Engineers Standard Steels, and to compile in suitable form all existing data regarding the physical properties and heat treatment of the same, or by the supervision of original research work, to establish as standard the heat treatment for the above steels. It shall also be the duties of the Standards Committee to collect all information regarding methods of manipulation and heat treatment and equipment with which to conduct heat treatment, and to adopt as standard the most uniform and desirable methods to obtain the standard physical properties. The work of standardization is not to be limited to automotive steels entirely, but in time may be extended to cover all types of steels and their heat treatment which are known to the art.

Heating E1-19 Heating Researches.

The American Society of Heating and Ventilating Engineers has just begun a comprehensive program of research costing $20,000 per year. Most of the work will be done in connection with the laboratories of the Bureau of Mines at Pittsburgh. No definite information has been received by the Committee on the plans for this research, but as soon as information is received it will be communicated to the Society.

University of Michigan E1-19.

The research personnel of the mechanical engineering department includes Prof. J. E. Emswiler, H. E. Keeler and H. J. Watson in general mechanical engineering and Prof. W. E. Fishleigh and W. E. Lay in automobile truck and tractor investigations.

F—Bibliographies

Petroleum, Asphalt and Wood Products F1-19 Distillation of Oils and Latent Heat of Vaporization. Short bibliography. Address Library, United Engineering Society, 29 West 39th St., New York City.

ENGINEERING SURVEY

A Review of Progress and Attainment in Mechanical Engineering and Related Fields, as Gathered from Current Technical Periodicals and Other Sources

AERONAUTICS (See Internal-Combustion Engineering)

BUREAU OF STANDARDS

Physical and Chemical Tests of the Commercial Marbles of the United States, D. W. Kessler. This paper is the first report of the Bureau of Standards in connection with an extensive coöperative program for investigating the building stones of the United States. The other Government departments participating in the work on different phases of the investigation are the U. S. Geological Survey, Bureau of Mines, and Office of Public Roads.

The paper comprises the results of strength tests, water absorption, porosity, specific-gravity, freezing, thermal-expansion, electrical-conductivity and chemical tests on 52 different types of marbles produced in this country. The purpose of the work is to determine the relative value of the different types for building purposes and other special uses.

Compressive-strength tests were made on specimens in the original condition and on specimens after being soaked in water for two weeks. The dry specimens have strength values ranging from 7,850 to 50,205 lb. per sq. in. As a rule the soaked specimens gave lower compressive strengths than the dry, and in a few cases the loss due to soaking was over 25 per cent.

Transverse- and tensile-strength tests are included and show the strength of the specimens when broken perpendicular and parallel to the bedding planes.

The freezing tests made for this report consisted in determining the loss in weight and strength due to 30 freezings and thawings. While these losses were considerable in most cases, some samples showed practically no loss and occasionally a gain in strength was indicated. Hence it was decided that 30 freezings were not enough to give a trustworthy indication of the durability of such materials. An apparatus has been installed which automatically shifts the specimens back and forth between a cold chamber and warm chamber at certain intervals. With the use of this apparatus it is possible to make a great number of freezings which will correspond to several years of exposure to the weather. It is proposed to make extensive weathering tests with this apparatus to determine more definitely the relative effect of frost action on the different marbles as well as other types of building stones.

Electrical-resistivity tests were made on a number of different types to determine their relative value as insulators and resistivity under different conditions of moisture. The results show a considerable range of values, indicating that there is a choice of marble for use in switchboards and allied purposes.

Measurements of the thermal expansion made on a few samples of marble in this investigation show that this material does not expand at a uniform rate even at ordinary temperatures. As the temperature is increased the rate of expansion increases, hence it is not possible to state a coefficient of expansion for marble that will hold good for any very great range of temperatures. Another peculiarity brought out by these tests was the fact that marble when expanded by heating does not contract to its original dimensions as the temperature is lowered, but retains a part of the increase permanently. A number of successive heatings show the same effect, each adding an increment of length to the specimen.

A few cases of warped marble slabs are illustrated and a discussion is made of the causes which may be instrumental in bringing about this warping. (Abstract from Bureau of Standards Technologic Paper No. 123.)

The Viscosity of Gasoline. The short-tube viscosimeters which are in ordinary use for determining the viscosity of lubricating oils cannot be used with gasoline, for which it is necessary to employ an instrument with a much longer outlet tube. The Ubbelohde viscosimeter, primarily designed for kerosenes, appeared suited to the purpose and two instruments of this type were used in determining the relation between time of discharge and viscosity in poises. By a large number of runs with water and ethyl alcohol solutions, liquids of known viscosity, it was found that:

$$\text{Kinetic viscosity} = \frac{\text{viscosity in poises}}{\text{density, g. per cc.}} = 0.0000887\ t - \frac{1.438}{T}$$

where t is the time of discharge in seconds. The published standard dimensions of the instrument give 0.125 cm. as the inside diameter of the outlet tube, and this was found to be 0.129 in the instruments tested. The time of discharge for 100 cc. of water at 20 deg. cent. (68 deg. fahr.) was found to be very close to the specified value of 200 sec. It is therefore suggested that 200 sec. should be retained as standard, but that the diameter of the outlet tube should be changed to 0.129 cm.

In dealing with highly fluid liquids such as gasoline, it is convenient to use the fluidity, or reciprocal of the viscosity in poises, in place of the viscosity. The temperature-fluidity curve is very much more nearly a straight line than is the temperature-viscosity curve. Fluidities were found for thirteen samples of gasoline and one kerosene over a temperature range from 5 deg. to 55 deg. cent. (41 deg. to 131 deg. fahr.). These tests showed that kerosenes have a lower fluidity or higher viscosity than water, while gasolines, though varying greatly among themselves are all more fluid than water. This is in agreement with the published data in regard to kerosene; the available information in regard to the viscosity of gasolines is very meager.

It is generally recognized that the gravity test is an uncertain guide to the quality of kerosene or gasoline, if taken by itself without information as to the source of crude oil. This was confirmed by the tests on gasolines, their order when arranged according to densities being quite different than when arranged according to fluidities. A fractional distillation is often used as a substitute or supplement to the gravity test, and this gives valuable information. It requires, however, more complicated

apparatus and greater skill than needed to test fluidity. Furthermore, the close relation between fluidity and vapor pressure, to which attention has been called by E. C. Bingham, points to the conclusion that fluidity may be an extremely good criterion for volatility.

Bingham gives tables for fluidities of various pure chemical compounds over a wide range of temperatures, and these tables were used to compare the fluidities of the thirteen gasolines with those of the aliphatic hydrocarbons. It was found that ordinary commercial gasoline, as now sold for use in automobiles, has a fluidity slightly less than octane. Most of the special gasolines, intended for use in airplane motors, have a fluidity between that of heptane and hexane. The temperature-fluidity curves of these gasolines were nearly straight and parallel, so that the order of the different gasolines, arranged according to fluidity, would be nearly independent of the temperature considered. It is suggested that the specification of fluidity at two temperatures might serve to define a desired grade of gasoline. (Abstract from Bureau of Standards Technologic Paper No. 125)

The Constitution and Microstructure of Silica Brick and Changes Involved Through Repeated Burnings at High Temperatures, R. Insley. With the coöperation of many of the principal American manufacturers of silica brick, petrographic and microscopic studies were made of the raw quartzite, the finished brick, and brick which had received repeated burns by actual use in kilns, coke ovens, etc., for the purpose of determining the original constitution and also components of silica brick stable under conditions of repeated burning such as it would undergo in the industries. Test cubes were also prepared in the laboratory of the Bureau of Standards according to a standard commercial mix and burned at 50-deg. intervals from 1200 deg. to 1500 deg. cent. in order to trace out the mineralogical structure changes with increasing temperature.

Quartz, critobalite, tridymite, pseudo-wollastonite (α — $CaO.SiO_2$), and glass are found to be present in silica brick. Pseudo-wollastonite and glass are never present in anything but small amounts. The proportions of the other constituents vary according to the heat treatment undergone.

Microscopical quantitative analyses of the relative proportions of the three predominant minerals were made of each brick examined. These analyses show that the longer a brick is burned at high temperatures but below 1470 deg. cent., the greater will be the amount of tridymite present.

Silica brick are usually found to have a porphyritic-like structure made up of phenocrysts and groundmass. This structure is not due to any chemical or physical action which takes place during the heating or cooling of the brick but is caused by the method of grinding the raw material, the phenocrysts being the coarsely ground pieces while the ground mass is made up of finely ground material and rock flour.

Microscopic examination shows that the first inversion is from quartz to cristobalite and begins in the groundmass. The material which is broken up in the phenocrysts by shattering due to expansion on heating is then transformed into cristobalite and rims of cristobalite form around the phenocrysts similar in appearance to the reaction rims seen around minerals in natural rocks. After long heating tridymite begins to appear in the groundmass. The crystals are at first very small and rather poorly developed but increase in size with successive burnings. Tridymite is usually present at wedge-shaped and more complicated interpenetration twins. In reburned brick the quartz phenocrysts are occasionally entirely transformed to cristobalite and sometimes even tridymite crystallites begin to appear in the phenocrysts.

The lime added in the grinding of the raw materials does not appear to aid in the bonding of the brick by the compounds which it forms but rather by hastening the inversion of the silica through its fluxing action. Most of the bonding action seems to be due to the interlocking of the cristobalite and tridymite crystals. Any glass present aids but little in the bonding.

Permanent expansion is caused by the inversion of quartz to cristobalite and tridymite. A large proportion of tridymite is desirable in silica brick since it has the larger permanent expansion and subsequent buckling of the furnace walls is reduced to a minimum.

The investigation has verified the prediction of Fenner: that with a comparatively small amount of flux quartz inverts to cristobalite, then to tridymite at temperatures where cristobalite is the unstable and tridymite is the stable modification. In the case of every brick examined cristobalite was the first inversion product to form, whether the conditions had been such as to promote much or little inversion. Moreover, the final inversion product reached after many reburnings to the temperature range where it was the stable modification, resulted invariably in the formation of tridymite. (Extended abstract from Bureau of Standards Technologic Paper No. 124)

The Ultra-Violet and Visible Transmission of Eye-Protective Glasses, K. S. Gibson and H. J. McNicholas. Many glasses are on the market and extensively advertised to protect the eyes from injurious radiant energy. Unfortunately, but little authoritative information concerning the properties of these glasses has been available. The public and even oculists and physicians have had little to guide them in selecting such glasses except the claims of makers and agents. One purpose of such glasses is to absorb the injurious radiant energy which is emitted along with the light from certain lamps as well as from welding arcs and industrial furnaces, while transmitting sufficient light for vision. They thus act as filters. Another purpose in certain cases may be to absorb part of the light so as to reduce a blinding brilliance. Glasses of different types are required for different needs. The degree to which these glasses actually fulfill their avowed purpose can only be determined by measurements of their "transmission" (i.e., the ratio of transmitted energy to the energy falling on them) for the various forms of radiant energy in question. The Bureau of Standards has made such measurements on a great number of glasses now on the American market and the results are published in this paper. (Abstract from Technologic Papers of the Bureau of Standards, No. 119)

ENGINEERING MATERIALS

Fiber. Fiber was originally developed as an insulating material and as such was widely adopted in electrical work. Since then, however, it has also found wide applications in other fields, both of mechanical equipment and such non-mechanical uses as baskets, barrels, boxes, etc.

It possesses most of the properties of the flexible and semi-flexible materials and at the same time some of the desirable qualities of hard materials and metals, and as a material of construction may be considered as an intermediate between the two groups.

There are three kinds of fiber in general use, viz., two kind of vulcanized fiber—known as hard and flexible, and horn fiber. Vulcanized fiber is made by treating specially prepared vegetable fiber (usually cotton) with strong chemical reagents, afte which it is manipulated with heavy machinery to produce th two commercial forms. During the passage of the so-calle paper through the chemical bath the cellulose base is hydrolize and the surface is gelatinized to such an extent that on bein passed through the laminating machines a homogeneous produ is produced. Horn fiber is somewhat similar to vulcaniz fiber but has hemp twine (instead of cotton as in vulcanized fibe as its base is not chemically treated. The hydrating effect pr duced by chemical action in the case of vulcanized fiber is a proximated in the case of horn fiber by prolonged heating. is not quite as hard and can not be made as thick as vulcaniz fiber and has, therefore, a more limited field of application.

Vulcanized fiber is made in two forms, hard and flexible; latter being restricted to such uses as pump valves, washers a gaskets. Fiber should be clearly distinguished from such insul ing materials as bakelite, condensite and others which have ma properties similar to those of fiber but are not fiber.

Vulcanized fiber possesses great strength, elasticity and du bility. Its tensile strength varies from 10,000 to 20,000 lb. per sq. in. (as compared with 3000 to 6000 lb. for leather). Its

resistance to compression varies from 40,000 to 60,000 lb. per sq. in. (for wood it varies from 3000 to 11,000 lb.). Its resistance to shearing varies from 9000 to 13,000 lb. per sq. in. (compared to wood, with the grain, 225 to 906 lb., to aluminum casting 12,000 and to aluminum forgings 16,000 lb.). There is no clearly defined elastic limit, but it approximates 4000 lb., and there is no permanent set even at rupture point. The specific gravity is about 1.3, varying from 1.2 to 1.5 (sp. g. of pure aluminum in a cast state is 2.58; of cork, 0.24; of wood, 0.35 to 1.33). It possesses the strength and density of a metal, yet is elastic and nearly as light as hardwood. A square foot of 1/8-in. fiber weighs about 7/8 lb., and the same area of 1-in. stock about 7 lb.; i.e., about 20 cu. in. to the pound. Fiber is usually sold by weight and the present article gives the average weights of standard sheets.

Vulcanized fiber is insoluble in all the ordinary solvents and is not affected by immersion in alcohol, ammonia, benzine or any of the animal, vegetable or mineral oils. It absorbs water freely and swells when wet but is not otherwise injured.

When heated, fiber does not melt or soften, but at a high temperature it chars and loses its elasticity. Vulcanized fiber is not brittle and will stand a great amount of pounding and rough usage. It can be machined and will take a fine polish but cannot be molded.

The original article describes and illustrates many applications (mechanical and electrical) of this material. (*Raw Material*, vol. 1, no. 1, new series, March 1919, pp. 115-120, illustrated, *d*)

New Methods of Etching Show Hitherto Undiscovered Characteristics of Rail Steel

Rail Steel. Abstract of a report of an investigation carried out under the direction of the Rail Committee of the American Railway Engineering Association, the following points of which are of special interest:

The discovery of the value of deep etching with strong acid is bringing out hitherto unrecognized defects in the interior of the rail head. The Altoona Laboratory of the Pennsylvania Railroad has for some time suspected that chemical analyses of samples from different parts of the cross-section of the rail do not give sufficient information as to its quality. Further, the usual micrographic etching solutions employed have proved unsatisfactory and definite results have been secured only when the specimens were etched for two hours in a mixture consisting of nine parts hydrochloric acid, three parts sulphuric acid and one part water, kept at 200 deg. fahr. This brought out a remarkable number of longitudinal, transverse and irregular marks or depressions, and these marks, representing streaks of more soluble materials, proved the existence of serious non-homogeneity, which hitherto could not be discovered otherwise.

In a rail that had never been in service the deep etching with strong mineral acid mixtures brought out indications of irregularity of structure, whereas picric acid etching has failed to develop anything unusual. In this connection an observation is reported by J. B. Young, chemist of the Philadelphia and Reading Railroad, whose tests indicate the likelihood that flaws and cracks may exist in new rails which have been subjected to no strains except those developed in the rolling.

The second point brought out by the research of the Rail Committee is that statistics prove that about all transverse fissures occur in rails rolled directly from the ingot, while rails from reheated blooms virtually never fail in this way. If true, this would prove that defects of the ingot rather than excessive stresses are responsible for transverse fissures. As an editorial in *Engineering News-Record* (March 27, 1919, p. 599) remarks, it may be deduced from these data that there seems to be more promise in metallurgical studies of rail steel and examination of furnace and mill conditions than in the study of track service.

Tests of rails by a magnetic tester to detect internal flaws were made by Dr. P. H. Dudley of the New York Central Lines. He gives no details as to results obtained, but states that the leakage curves of rails obtained with this apparatus furnish much information about the physical properties in rails and about the disturbance of the metal by the gag press employed in straightening it.

For acceptance tests on the Pennsylvania Railroad rails are subjected to a press bending test in addition to the regular drop test. The press is in a hydraulic machine operated by an intensifier standing alongside, and capable of exerting a pressure of 378 tons. The main ram is 16 in. in diameter and has a 12-in. stroke. The machine weighs 11 tons. The supports for the rail, under the pressure ram, may be set at various spacings; tests have been made with supports 24 in. to 51 in. apart. A hydraulic pressure indicator records on a drum turned by a connection with the main ram, so that an autographic diagram is produced.

Deflections at ultimate load of rail specimens bent in this machine are found to be an indication of the ductility of the material, just as well as is the elongation in the drop test of the rail. It is also believed that the deflection is in a measure an indication of the toughness of the rail, or rather its capacity to resist shock.

Tests made up with the head down (in tension) gave more satisfactory and uniform results than those made with the head up. In the former, breaks were obtained in nearly all cases, while with the head up the breaks were apt to be branching or irregular. Furthermore, the tests made with different lengths of span of the rail showed closer agreement between the test results and theoretical curves, for the tests with head down than those with head up.

One of the striking results of tests with the bending machine brought out in a report on the subject submitted by W. C. Cushing, chairman of the subcommittee on the quick-bend tests, is the distinct superiority in quality of the rails produced by one mill as compared with those of another. A large number of tests of 130-lb. rails from three mills, plotted to show elastic limit as ordinates and ultimate deflection as abscissæ, placed the rails from one of the three mills in a group distinctly above and to the right of the groups representing the other two mills. This comparison shows greater ductility and strength, on the average, for the rails of the first mill, though all were rolled to the same specification and the same section and weight.

In another experiment, a rail that failed in the bend test at a small deflection—in other words, was brittle—was retested after annealing, and the deflection was increased more than four times, indicating a curing of the brittleness by the heat treatment. (*Engineering News-Record*, vol. 82, no. 13, March 27, 1919, pp. 610-611, *eA*)

FOUNDRY

Necessary Properties of Molding Sand and Their Determination

The Practical Analysis of Molding Sand, P. Albert Hayes. The paper discusses sieve tests and the methods of selecting sand, and attempts to give a definition of the best usable sand. Molding sand must satisfy the three major requirements of rigidity, permeability and refractoriness, which the author further subdivides as follows:

Rigidity:

a Bond of clay; *b* Size, and shape of grain.

Permeability:

a Porosity; *b* Quantity of clay; *c* Size and shape of grain.

Refractoriness:

a Quality of clay; *b* Quantity of clay; *c* Size of grain.

Rigidity and Bond. The ability of molding sand to resist strain after forming is dependent on the shape of the sand grains and also bears a very close relation to the bond of the sand. Sharp, angular and flat-sided grains interlock and form a stronger mold than rounded grains; but, on the other hand, such interlocking reduces the freedom of escape of gases and also gives a less evenly packed mold than do round grains. Hence rigidity should be secured by the bond of the clay rather than by dependence on sharp sand.

The power of clay to keep the grains of sand together depends on its content of fatty or sticky clay. The necessity of sufficient bond in worked floor sand is often neglected. The fatness of

the clay is destroyed by contact with the hot iron in the molds and care should be exercised in shaking out the castings to see that the minimum of burned sand is returned to the pile.

Porosity and Permeability. The proper venting of sand depends both on the porosity and permeability of the sand, the former referring to the spaces existing between individual grains of sand and the latter to the shortest linear distance through the pore spaces between the grains from one side of a unit volume of sand to the other. In this connection the tempering water and amount of clay are important since a large clay content will tend to fill the pore spaces and diminish the venting qualities, while water tends to reduce the permeability. Experiments indicate that 4 per cent of water is the average requirement to give maximum strength, and increasing the tempering water 50 per cent decreases the strength 35 per cent. In this connection, the original article cites tests made from several floors on which the very much lower temperatures and thereby form fluxing materials. As a result such alkali silicates may reduce the fusing point of the mixture so that cutting of the mold takes place with excessive loss of sand and poor casting surfaces. It may also cause sintering and sticking of the material to the mold. A good check on this factor is the determination of the amount of sand used per ton of castings of a given classification. This figure varies a great deal in foundries showing that either the sand is deficient or the practice is poor.

The grain size of the sand bears a relation to the size of the casting poured, a small casting taking a finer sand than a large one.

The writer recommends the use of the so-called rational analysis which would cover the percentage of clay, quartz and feldspar, and the relative fatness or bond of the clay together with a sizing test (cp. Table 1).

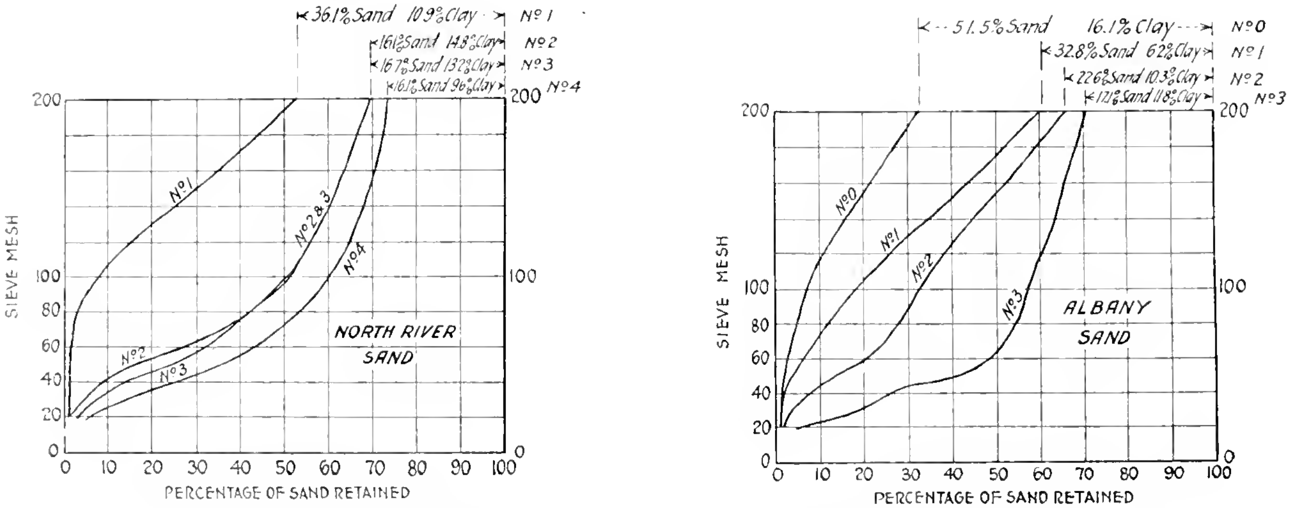


FIG. 1 GRAPHICAL STUDY OF THE RELATIVE GRAIN SIZE OF VARIOUS SANDS WHICH FACILITATES THE SELECTION OF FOUNDRY MOLDING SAND FOR THE PARTICULAR WORK IN HAND

same sand was used and the same general class of work was molded. All the sand was mixed by a sand cutter, but each individual molder tempered his own sand. The results have shown that the water content was very irregular.

Refractoriness. Refractoriness affects the ease with which the mold is broken down after use and the damaged sand is reclaimed.

TABLE 1 ANALYSIS OF SANDS, DRY BASIS

Name	North River				Albany			
	No. 1	No. 2	No. 3	No. 4	No. 0	No. 1	No. 2	No. 3
Chemical Analysis.								
Clay...	10.9	14.8	13.2	9.6	16.1	6.2	10.3	11.8
Quartz	69.5	60.4	58.4	72.4	71.9	77.6	72.3	70.9
Feldspar	19.5	21.8	28.4	18.0	12.0	16.0	17.1	17.4
Iron oxide	6.7	8.5	9.8	6.2	4.1	5.5	6.0	6.0
Alumina	2.1	3.0	3.4	2.6	2.3	3.5	3.0	2.4
Physical Test								
20 mesh	0.2	1.0	3.7	5.2	0.4	0.4	1.0	4.9
40 mesh	0.6	6.5	9.9	19.1	0.8	1.3	6.5	22.0
60 mesh	0.6	22.2	16.6	23.1	1.4	5.0	12.7	22.1
80 mesh	1.9	10.7	14.1	8.5	2.6	7.1	8.0	5.8
100 mesh	3.1	8.0	6.0	4.9	1.9	5.7	5.3	2.4
200 mesh...	46.6	20.6	19.8	13.5	25.3	41.5	32.6	13.9
200 mesh	36.1	16.1	16.7	16.1	51.5	32.8	23.6	17.1
Bonding value	81.0	77.0	64.0	46.0	77.0	92.0	24.0	42.0
Moisture as received.	10.5	6.5	9.1	7.3	8.6	8.2	7.8	10.0

The molding material consists of silica sand which is practically infusible, while fat clay and aluminum silicate are unchanged by the heat of molten iron except at the inner mold surface, and residual mica and silicates of the alkalies fuse at

The sieve test indicates the size of the casting for which the sand is suitable, while the other data will show the sand that will give the most rigid mold with greatest permeability and ability to stand the cutting action of the hot iron.

The accompanying curves (Fig. 1) are found by plotting the percentage of sand that will be retained by a given mesh. The perfect sand would be a straight sand parallel with the abscissa, and the nearer this condition is approached, the better the sand. Practically a sand never gains the ideal, but the graph affords very ready comparison. Many founders can grade sand to a certain extent by feel, but the writer has seen many instances of false judgment on the part of experienced men. For instance, the same sample of sand presented at two different times was graded as 1 and 2. Reference to the curves gives explanation, as the No. 1 and No. 2 sands are very similar; but the decision as rendered determined the use on certain floors. (*The Iron Age*, vol. 103, no. 12, March 20, 1919, pp. 739-741, 1 fig., *p*)

FUELS AND FIRING

STOKERS TO BURN COKE BREEZE. Description of mechanical stokers designed to burn coke breeze. These stokers contain a nonsifting grate which the designer (Joseph Harrington, Mem.Am. Soc.M.E.) emphasizes as a feature fundamentally new.

The stoker consists of cast-iron side frames carrying the driving gear, hopper, front shaft and feed gate. The grate bars overlap, giving a tortuous air passage and preventing the falling of fine fuel into the air compartment below. The bars are made of gray iron and the overlapping is secured by causing one bar to project under the overhanging part of another.

The following conditions were considered as necessary to be met before forced draft could be successfully used with coke breeze:

1 The stoker must allow the fuel to remain quiet during the

combustion period in order to avoid the formation of clinkers that cause any disturbance of the fuel bed when the ash content is in a plastic condition.

2 To avoid the accumulation of refuse in the furnace and consequent fouling of the grate surface, it must be discharged as formed, so that the ash remaining on any unit section of the grate is that which results from the burning of a single unit of fuel.

3 There must be no air spaces that are not periodically and completely cleaned by the automatic operation of the adjacent parts and disengagement of clinker which may have entered the air spaces during the previous passage through the furnace.

4 Inasmuch as the fuel bed does not require the same volume or pressure of air throughout its extent, the stoker of the future must be divided into compartments in such a manner that the air pressure and volume in each compartment are suited to the requirements of the fuel passing over the compartment.

5 To avoid the wasteful use of steam-driven auxiliaries, the stoker must be readily converted to the natural draft type during the low-load periods.

6 Parts subjected to the heat and fusing action of direct fuel contact must be readily replaceable and subjected to no mechanical stress other than its own support and the support of its portion of the fuel bed. (*Iron Age*, vol. 103, no. 13, March 27, 1919, pp. 816-817, 3 figs., *d*)

New Fuel Developed by Submarine Defense Association

Colloidal Fuel. Two articles describing experiments on colloidal fuels developed under the auspices of the Submarine Defense Association. This association was organized in June 1917 by companies representing the shipping and marine insurance interests of this and other countries to assist in developing effective anti-submarine measures and had its offices at 141 Broadway, New York City.

According to the report pulverized coal can be successfully held in suspension in fuel oil so that the colloidal liquid flows freely through pipes, preheaters and burners equipped to burn fuel oil. Months after mixing the composites showed little or no deposit. A "fixateur" which comprises about 1 per cent or 20 lb. per ton acts to stabilize the particles of pulverized coal in the oil. The fixateur and fixated oil are readily made and may be shipped anywhere. On burning, the combustion is so complete that with fair coal there is no slag and very little ash left.

Regarding the saving of cost involved in the use of this fuel, the report of the association states that, for example, with coal at $4 per ton and oil at $4 per 50-gal. bbl. the saving is $2 per ton. With coal at $5 per ton and oil at $7 per bbl. the saving is close to $6 per ton.

An interesting feature of the new development is that plants and railroads may buy from refineries any grade of colloidal fuel they desire to the prescription wanted, or they may obtain the appropriate fixated oil and make a final composition themselves. No change in oil-storage or burning equipment is required.

Another development is represented by colloidal fuel made with pressure-still residuals which hitherto have been quite neglected. From these residuals a fuel is prepared so low in sulphur that it is expected to command a premium for making higher-grade alloy steels.

A further research was started in blending petroleum oils and coal tars to see if it was practicable to stabilize the mixture so that free coke and asphaltic substances would not settle out but would produce a stable liquid fuel that could be shipped, piped and stored. The quest was well worth while because could it succeed one might so create annually here and in England up to 20,000,000 bbl. of superior liquid fuel without an increase in oil-well production. Success is now confirmed. Thus countries without oil like Australia, France, Italy and England may themselves produce over half of the substances to make liquid fuel, and as the gas-house and coke-oven tars are usually cheaper than fuel oil they will average down the cost of oil in the composite.

The experiments in making colloidal fuel were conducted at the Brooklyn plant of the Standard Oil Company. No information is given as to the nature of the fixateur besides saying that it is a heavy, black, pasty substance of the consistency of axle grease.

The fixateur, to the amount of 1 per cent of the finished product, is placed on the top screen of four horizontal screens which extend through the entire diameter of a tank, about 20 ft. high and 12 ft. diameter. The oil is entered through the top of the tank and seeps through the fixateur. The lower screens catch that part of it which oozes through the first screen, thereby holding it up where more oil can encompass it. When the oil has thus been fixated, it is introduced by pumps into the mill, which is a cylindrical tank about 2 ft. high and 3 ft. in diameter, inside of which are the mixers, consisting of arms with balls upon the ends. After the fixated oil and coal dust have been thoroughly compounded, the new mixture is pumped into storage tanks, ready to be forced into the burners.

Different grades of coal have been experimented with, ranging in ash content up to 25 per cent. An especially good carbon material has proved to be a coke containing, it is stated, 98 per cent carbon, no ash and no sulphur. The mobile paste, which is about half oil and half coal, is said to develop the largest number of heat units per unit volume of any proportion. With higher coal percentage the total B.t.u. content per gallon diminishes gradually.

Though the first experiments were conducted for marine purposes during the submarine menace, it is believed that varied uses will be found on land as well as sea in many peace-time pursuits. It is thought that colloidal fuel will be the fourth major fuel, on a par with existing solid, liquid and gaseous burning substances. Experiments are soon to be conducted in steel plants. One advantage claimed is that waste coal will be utilized with profit by the new process. (*Iron Age*, vol. 103, no. 13, March 27, 1919, p. 824, *eA*)

HOISTING MACHINERY

Gearless Tractor Elevator and Its Safety Appliances

Gearless Tractor Elevator, R. H. Whitehead. Description of an installation using the 1:1 gearless tractor-type elevator machine.

The particular feature that characterizes this type of installation is that the driving sheave and brake wheel are pressed directly on the armature shaft of the motor and hence rotate at the motor speed. The motor, therefore, must be built for very slow speeds and generally has six or eight poles wound with shunt field only. The armature is series-wound with rectangular conductors to get the largest amount of copper into the armature slots. The result is that the dimensions of the motor are several times larger than those of a machine of the same power built for a greater speed.

The matter of slippage is taken care of in the following way. The counterweight, which includes the counterweight buffer, is adjusted so that it equals the total weight of the car and sling, plus 40 per cent of the car load. Thus, for a duty of 2500 lb. the counterweight would weigh 1000 lb. more than the car and sling. With compensation as obtained by compensating ropes (Figs. 2 and 3), the maximum difference between the tension on the counterweight and the car side of the hoisting rope is 1500 lb. As the total load on both sides exceeds 16,000 lb. and as slippage does not occur until the load on one side is twice that on the other, the traction is positive; in fact, as positive as if the ropes were wound on a spirally grooved drum, which in this case would be impossible on account of the large amount of rope required due to the high rise.

The hoisting ropes are so adjusted that if the car should overrun the bottom landing the counterweights will not run into the overhead work. If either the car or the counterweight bottoms in the pit, the traction between the driving sheaves and ropes is lost, so that even if the machine continues to run, neither the car nor counterweights can be drawn into overhead work. This makes this type of machine very safe.

Compensating ropes compensate for the variation in the net load on the driving sheaves due to the shifting of the weight of the hoisting ropes from one side to the other which occurs during motion of the car up and down the hoistway. The weight of the

compensating ropes must be such per foot that they will with the electric cables leading to the car compensate for the net shifting of the load due to the weight of the hoisting ropes regardless of the position of the car in the hoistway. In addition to this a special oilspring buffer (discussed in detail and illustrated in the original article) is placed in the hoistway under the car and counterweights to assist in bringing them to rest in case the car overtravels the top or bottom landings.

An elaborate system of safety devices is provided, summed up in the following manner in the original article:

1 Automatic return of the car switch to an off position.

2 The automatic stopping switch gradually brings the car to a stop as the top or bottom landings are approached.

3 The hatchway limit switches operate if the car continues to move after the automatic stopping switch opens the reversing switches.

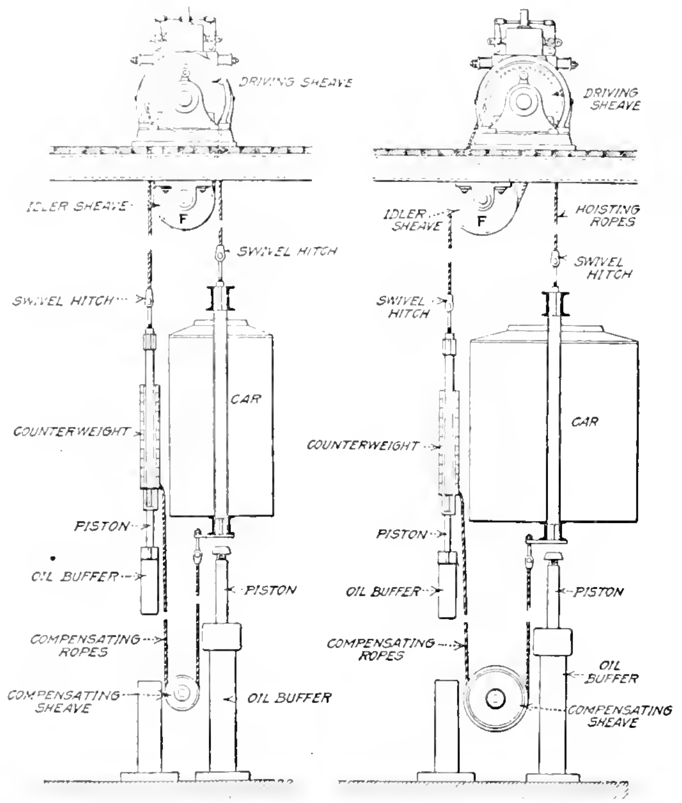


Fig. 2 Installation where Driving Sheave Spans Half the Car Width

Fig. 3 Installation where Driving Sheave does not Span Half the Car Width

4 The switch operated by the centrifugal governor stops the car in case of overspeeding, by causing a light retarding force to be applied between the car-safety jaws and rails and opening the main potential switch.

5 The oil buffers are capable of stopping the car or counterweight at 50 per cent excess speed without discomfort to passengers.

6 After the car or counterweight strikes the bumpers, the traction between the hoisting cables and driving sheave is either lost or greatly reduced.

7 Overtravel beyond the top terminal landing lifts the compensating sheaves and housing, and this in turn helps to decrease the traction and also operates a switch to stop the motor.

8 Opening of the car-safety switch stops the motor and applies a light retarding force between the car-safety jaws and rails, thus stopping the car.

9 For high-lift elevators a mechanical retarding and latching device is provided to stop the car from overrun beyond the top-terminal landing.

10 Breaking of the hoisting ropes causes the application of a heavy retarding force on the car and counterweight safeties. (*Power*, vol. 49, no. 13, April 1, 1919, pp. 474-478, 9 figs., *d*)

HYDRAULICS

Values of n in Kutter's Formula for Different Channel Conditions, C. E. Ramser. Experiments were made to determine the value of n in Kutter's formula on five courses of the South Forked Deer River, between Jackson and Roberts, Tenn.

The channel along these courses varied from one newly dredged and in excellent condition to a very crooked course of the old river in very bad condition, and Table 2 gives the values of n obtained for each of the courses for stages ranging from low to high.

The lowest values of n were obtained for the course of channel near Roberts (Table 2) where they were taken at periods from

TABLE 2 VALUES OF n IN KUTTER'S FORMULA FOR DIFFERENT CHANNEL CONDITIONS

Name or type of channel	Minimum value of n	Maximum value of n
Roberts Channel (straight)..........	0.0240	0.0255
Jackson Channel (straight)..........	0.0310	0.0420
Irregular Dredged Channel	0.0367	0.0455
Old Straight River Channel	0.0500	0.0620
Old Crooked River Channel.........	0.1400	0.1620

four to six months after the dredging of the channel has been completed. These low values may be attributed to the comparatively smooth and regular side slopes and bottom, the uniformity of cross-section and the freedom from curve or obstructions in the channel.

The effect of roughness and irregularities is revealed in the results obtained for the course near Jackson. Although the channel was practically free from vegetation or obstructions of any sort, yet the values of n are considerably higher than those obtained for the course near Roberts. The irregularities in the lower portion of this channel were left at the time of construction, the bottom and sides of the channel never having been smoothed properly.

Still higher figures are obtained on the old straight river channel where the course is fairly straight but the cross-section variable, side slopes irregular, bottom irregular with deep holes and, what is most important, the sides are covered with trees, roots and vines and subject to caving. Here the value of n is roughly three times as high as in the section of channel near Roberts.

Finally the highest values for n were obtained in the old crooked river channel where the side slopes are very irregular, the bottom likewise very irregular and full of holes. There are many roots, trees and bushes on side slopes and many logs, large trees and other drift on bottom, in addition to which trees are continually falling into the channel due to caving banks. Furthermore, the course of the channel itself is very crooked and is made up of four distinct curves.

A comparison between the figures for the old straight river channel and the old crooked river channel is particularly instructive, since the conditions of flow except for the difference in shape of channel are rather similar and the difference in values of n is apparently due to this difference in the character of the course of the channel. (*Engineering News-Record*, vol. 82, no. 11, March 13, 1919, pp. 522-523, 5 figs., *et*)

INTERNAL-COMBUSTION ENGINEERING

Port Design for Two-Cycle Oil Engines. Discussion of a subject on which comparatively little has been published in the English language. The writer mainly considers the so-called semi-Diesel type of crude-oil engines.

The article, which is not suitable for abstracting, discusses the design of the inlet port, transfer port, and exhaust port, and gives formulæ therefor.

The writer calls attention to the fact that the designer of semi-Diesel engines should fully appreciate the necessity of getting int

the cylinder for scavenging purposes the largest amount of air possible. Not all of the incoming air remains in the cylinder and a portion of it may be driven out through the exhaust ports, allowing a corresponding amount of exhaust gas to remain in the cylinder. This loss may be taken care of in some manner and, for example, in the marine Diesel engines where scavenging air is furnished by a separate pump the displacement of the pump piston is made approximately $1\frac{1}{2}$ times that of the power piston. The design of the deflector on the end of the piston is very important in getting this air into the cylinder with the least possible loss. By a mere change in the shape of this deflector the writer claims to have seen the developed horsepower increased 10 to 20 per cent. Indicator cards of various engines are given with interesting comments on their showing. (*The Gas Engine,* vol. 21, no. 2, Feb. 1919, pp. 37-42, 5 figs., *et*)

New British Carburetor with Modified Venturi Tube

Cox "Atmos" Carburetor. Description of a new carburetor of British manufacture. The commanding feature of the device is a special construction of what has come to be known as the venturi tube, well illustrated in Fig. 4. It is claimed that in the usual venturi tube as the speed of the engine and hence of the air increases, the depression about the jet also increases, with the result that a relatively greater portion of gasoline than is necessary flows through the jet and the mixture becomes too rich unless special measures are provided to correct this fault.

The following explains how this difficulty is handled in the Cox carburetor. If air be drawn through the venturi tube, there comes into play at the walls of the narrow throat a fall in pressure, as at 1 in Fig. 4. The depression in this region is believed to be in strict proportion to the volume of fluid passing through the venturi. If, therefore, the jet of a carburetor be placed in a small choke tube entering the narrow throat of a venturi, then as the volume of air passing through is increased so will the depression on the jet increase in proportion. In other words, it is claimed that with such an arrangement if the mixture be set right at one point, it will remain correct over the usable range of variation in volume per unit of time demanded by the different speeds of the engine. It should be borne in mind, however, that the conditions described held good only so long as the venturi preserves its shape, or, in effect, so long as the barrel throttle is wide open.

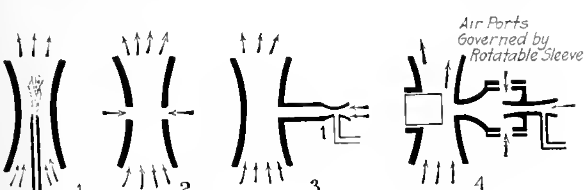


Fig. 4 Diagrams Illustrating the Principle of the Cox Carburetor

At the walls of the throat of a venturi tube there is also a region of depression, and if holes be drilled at this point (2, Fig. 4) a flow will be induced through the apertures, as indicated by the horizontal arrows. No. 3 a diagram of the carburetor at full throttle opening is shown at 3, Fig. 4. From the throat of the main venturi a pipe runs to a small subsidiary choke tube surrounding the jet. The operation with partly open throttle is shown at 4, Fig. 4. Air ports open as the throttle closes in order to prevent too great a fall of air pressure around the jet. For the sake of simplicity a piston throttle is shown in place of the barrel-type throttle actually employed.

In the Cox carburetor (Fig. 5) the middle portion of the main venturi tube is formed in the throttle barrel itself, and with partly closed throttle, therefore, the conditions of the perfect venturi tube no longer obtain, the flow of the air becoming distorted. In consequence of this, with the partly closed throttle there is a reduction of pressure in the region of the branch choke tube and the jet will be forced to deliver a disproportionately great amount of gasoline, so that the mixture will become too rich. This difficulty is overcome by the introduction of air ports in the subsidiary choke tube on the engine side of the jet. These ports are gradually opened and closed by a sleeve attached to the throttle barrel in such a way that closing the throttle opens the air ports.

Attention is called also to the consideration of the float chamber (Fig. 5). The float rises and falls upon a fixed central guide. It is separated from the needle valve and, therefore, vibration is less likely to temporarily upset the gasoline level. The needle valve is carried within a separate cylindrical duct and is operated by a single fork-ended balance-weighted lever.

A particularly important feature of the float-chamber design is the provision made to trap dirt or water. The delivery from the needle-valve duct is high up in the chamber, and the gasoline has to rise to the top of the gauze filter cylinder before it can overflow to the float chamber. At the bottom of the needle-valve duct is a passage leading to a trap chamber beneath the main float chamber. Any water or grit issuing past the needle valve falls by

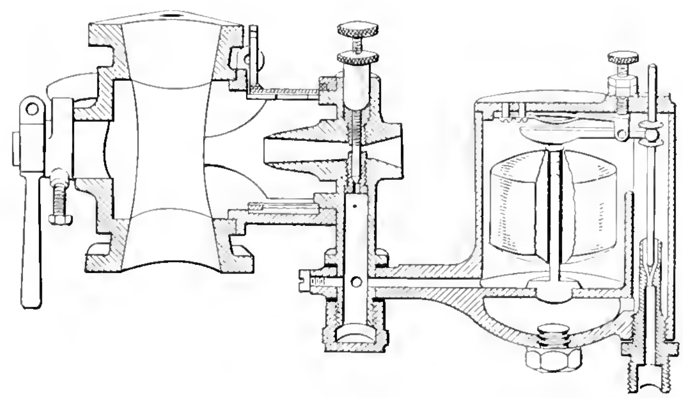


Fig. 5 Section in Perspective of the Cox Carburetor

reason of its greater specific gravity into this trap chamber, whence it can be drawn out from time to time through the orifice of a detachable plug. (*The Autocar,* vol. 62, no. 1221, March 15, 1919, pp. 358-360, 4 figs., *d*)

Striking Results of Tests on Liberty-12 Engine

Outlet Water Temperatures and Engine Efficiency. Data of tests (hitherto confidential) on a standard Liberty-12 engine, model A, the purpose of which was to determine how the various outlet water temperatures affect the power curve of the engine. In general, it was found that the power increases as the cooling-water temperature decreases to a point of about 100 deg. fahr. It will be noted, however, that at 90 deg. the power again begins to drop off slightly at the higher speeds. Also, the power decreases considerably with an extreme increase in temperature. At about 200 deg. fahr. the power is only 417 hp., while at 90 deg. fahr. it is 436 hp.

TABLE 3 GASOLINE CONSUMPTION OF LIBERTY-12 ENGINE AT VARIOUS OUTLET WATER TEMPERATURES

Outlet water temperature, deg. fahr.	200	170	150	130	110	90
Rev. per. min.	1600	1600	1600	1600	1600	1600
Average hp	382	387	388	397	400	403
Lb. per hour	197.5	200	204.5	206	205.5	197.5
Gal. per hour	33.5	33.9	34.7	34.9	34.8	33.5
Lb. per hp-hr	0.518	0.518	0.527	0.520	0.516	0.490

This is well illustrated in the curves in Fig. 6. Because of the fact that the actual data of the tests are reported only in a publication not generally available, those in Table 3 are reprinted here. No information is available as to the other features of operation of the plant. Thus, for example, it is not stated whether preigni-

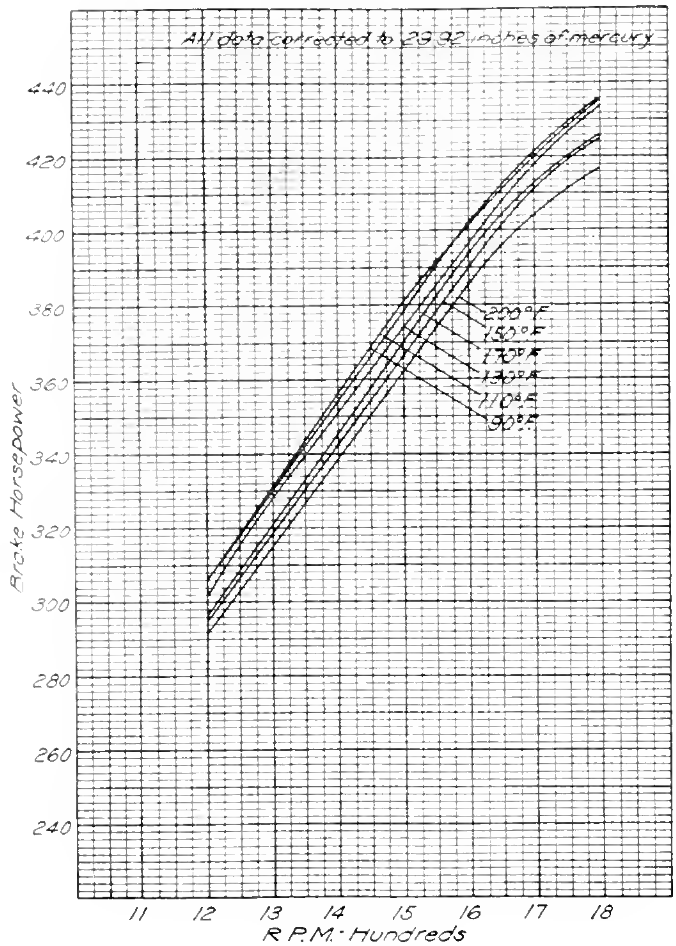


FIG. 6 POWER CURVES OF STANDARD LIBERTY-12 AT VARIOUS OUTLET WATER TEMPERATURES

tion occurred at the higher outlet water temperatures. (*Technical Orders, Technical Division, Air Service*, no. 4, Jan. 1919, pp. 15-17, *e*. Secret publication, present abstract being made by special courtesy of the War Department, Air Service Engineering Division.)

Means for Increasing Power Output of Aircraft Engines at High Altitudes

MAINTAINING CONSTANT PRESSURE BETWEEN THE CARBURETORS OF AIR ENGINES REGARDLESS OF THE ALTITUDE, Leslie V. Spencer. It is well known that at high altitudes the power developed by the ordinary internal-combustion engine decreases materially because of the decrease of the oxygen content in the cylinder charge. The Bureau of Standards curve between the pressure and altitude at a temperature of 50 deg. fahr. shown in Fig. 7 illustrates this fact very well. From it, it appears that at 20,000 ft. an engine operates with an intake pressure of approximately half that at ground level, which affects both the proportion of the mixture and the fuel delivery through the nozzle.

In order to overcome this difficulty in the operation engineers have turned to the idea of supercompressing the air sent to the carburetor so as to maintain as nearly as possible the ground-level pressure regardless of the height. Such supercompression has been given various names, of which the present writer recommends the term "supercharging." The function of a supercharging device is, however, not to increase the normal ground-level power up to the limit in altitude for which the supercharger is designed.

In Europe the method apparently most widely used is the turbo-supercompression, a good example of which is represented by the Rateau scheme developed by Professor Rateau in France.

The rotary compressor has been tried in competition with the centrifugal type of compressor by the British at the Royal Aircraft Establishment and has been discarded in favor of the latter. The centrifugal form of compressor, however, has proved the most desirable through having a minimum of working parts, being very compact for a given capacity and being capable of operating satisfactorily at top speed over long periods of time.

As to the methods of driving the compressor, there are three possibilities. It can be direct-connected with the engine just as a magneto, possibly with a gear train to step up the speed of the compressor rotor as shown in Fig. 8.

Also the compressor might be driven by a small steam turbine, the steam being produced by the exhaust-gas heat. The third alternative is to drive the compressor impeller by means of an exhaust-gas turbine receiving its energy directly from the engine exhaust gas.

In England and Italy direct-connected means of drive through an intermediate gear train have been tried, but great difficulty was experienced in coping with the severe stresses developed in the rapidly operating mechanism due to sudden fluctuations in the speed of the engine.

Steam-turbine drive has not been seriously considered because of the obvious complications and it is the exhaust-gas drive that has found the best favor. The exhaust-gas turbine can be connected directly with the exhaust ports of the engine through special manifolds replacing the standard manifolds, so that all the

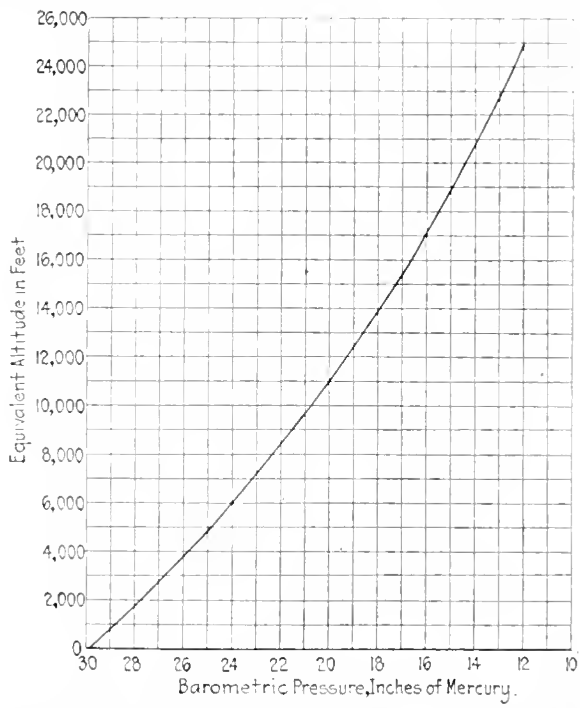


FIG. 7 BUREAU OF STANDARDS CURVE BETWEEN PRESSURE AND ALTITUDE AT TEMPERATURE OF 50 DEG. FAHR.

exhaust must pass through the turbine nozzles and give up its energy to the turbine rotor before being allowed to escape into the atmosphere through the turbine discharge passages.

In the designs which have been experimented with thus far, the turbine rotor and the impeller of the centrifugal compressor are mounted on the same shaft so that the two are in one unit.

The general design of the Rateau supercharger can be seen from Fig. 10. The only difficulty that has been encountered is that of coping with the high temperatures of the exhaust gases, but even this difficulty seems to be close to satisfactory solution.

Around the turbine rotor there is atmospheric pressure while the supercharged engine exhausts at a normal pressure of about 30 in. of mercury corresponding to a normal atmospheric pressure of 15 lb. per sq. in. at sea level. The expansion of the gases from this pressure to that of the atmosphere is sufficient to operate the turbine at high speeds and ordinarily the turbine rotor speeds run up to 25,000 or 30,000 r.p.m.

Experiments with this system indicate that of the energy of combustion the engine and turbo-compressor utilize about 33 per

cent, whereas approximately 45 per cent is lost in the exhaust which finally escapes from the discharge ports of the turbine.

In addition to the work of Professor Rateau and other foreign experimenters a certain amount has been done in America, where at the request of the Government, E. H. Sherbondy and Dr. Sanford A. Moss, Mem.Am.Soc.M.E., have taken up the same problem. The designs evolved in this country will be described in an early issue of MECHANICAL ENGINEERING. (*Aerial Age Weekly*, vol. 9, no. 5, April 14, 1919, pp. 244-246 and 264, 6 figs., *d*)

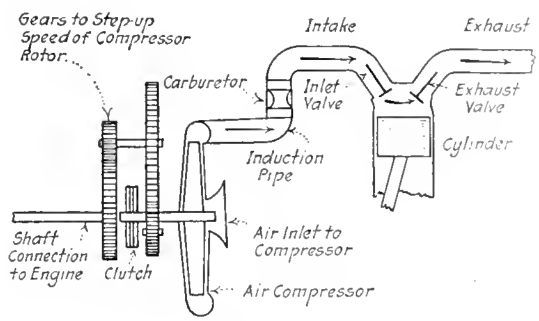


FIG. 8 DIAGRAM OF GEAR-DRIVEN COMPRESSOR FOR SUPERCHARGING

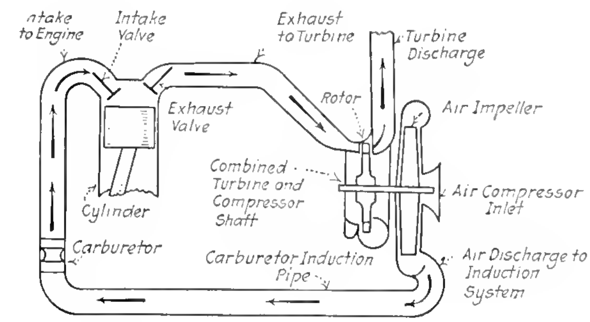


FIG. 9 THE CYCLE OF THE EXHAUST-TURBINE SUPERCHARGING SYSTEM

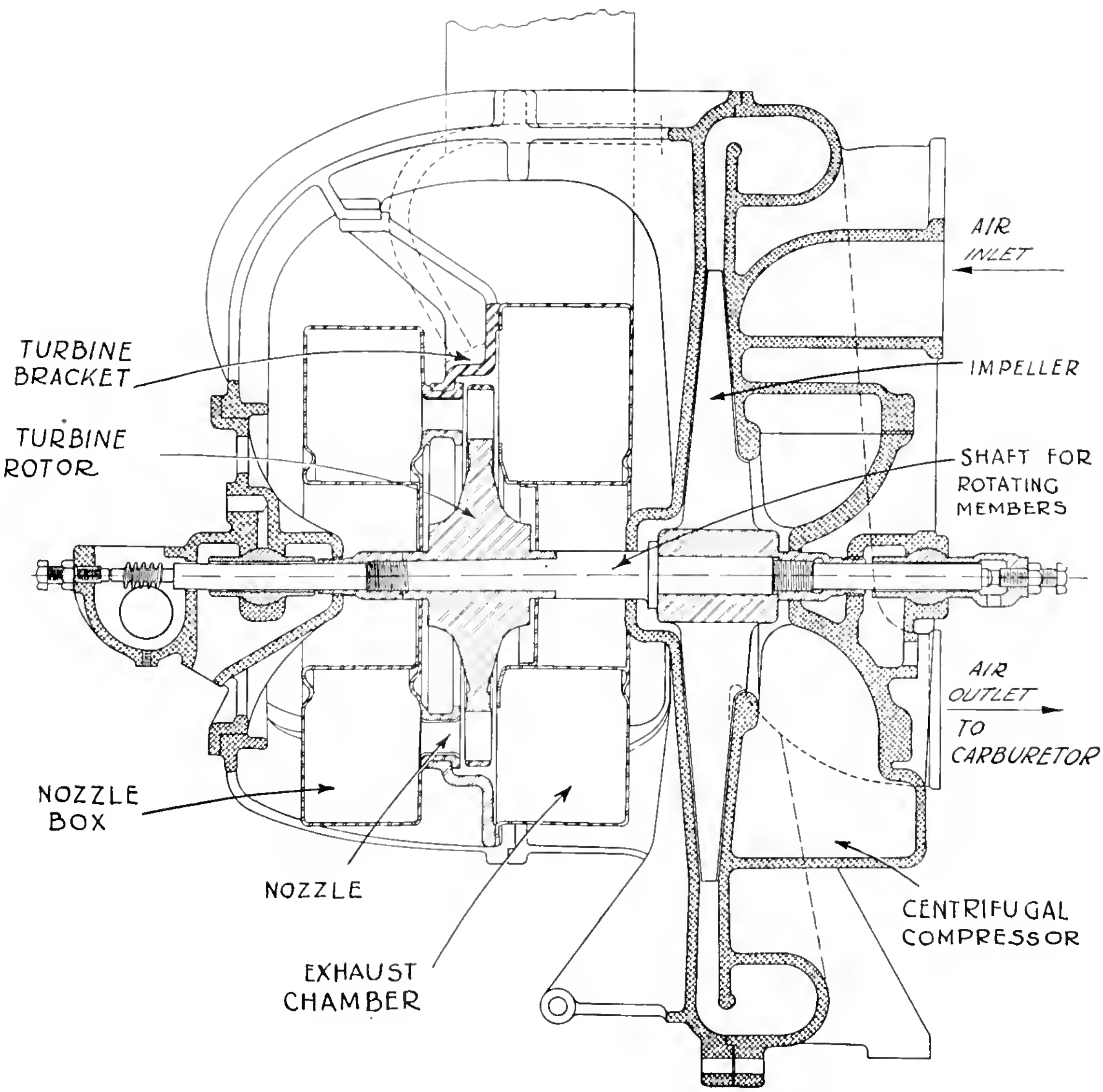


FIG. 10 CROSS-SECTION OF AN EXHAUST-TURBINE-DRIVEN SUPERCHARGER DESIGNED BY PROFESSOR RATEAU

MATHEMATICS

THE BESSEL-CLIFFORD FUNCTION, G. Greenhill. Writers on stability, statical and dynamical, as of a beam, strut or whirling shaft, are compelled to introduce the Bessel function, to give a complete solution, and the ordinary function is then employed as given in the textbook.

But attention should be directed to a forgotten posthumous note by Clifford, in his Mathematical Papers, 1882, page 346, where

he makes a start with a function, which we may denote after him by $C(x)$, obtained as the sum of all the positive integral k powers of $-x$, $(-x)^k$, divided by the square of the fractorial k, Πk, and thus

$$C(x) = \Sigma(-x)^k.(\Pi k)^2$$

but the exponential function

$$e^{-x} = \Sigma\ (-x)^k\ \Pi k$$

But there is this important difference, that whereas the exponential function never vanishes, the equation $C(x) = 0$ has an infinite number of positive roots.

The nth derivative of $C(x)$ is Clifford's

$$C_n(x) = \Sigma\ (-x)^k/\Pi k\Pi\ (n+k)$$

and the nth integral,

$$\Sigma\ (-x)^{n+k}/\Pi k\Pi\ (n+k)$$

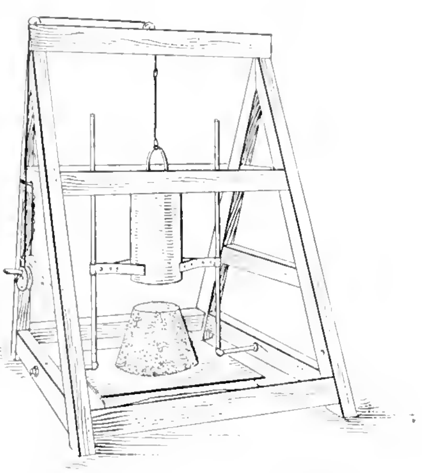


FIG. 11 CONCRETE CONSISTENCY TESTING MACHINE (SHOWING RESULTING CONE FOR CONCRETE WHICH CAN BE SUCCESSFULLY USED IN PRACTICALLY ALL ORDINARY REINFORCED-CONCRETE WORK)

is denoted by $C_{-n}(x)$, so that $C_{-n}(x) = x^n C_n(x)$

Thence the differential equations

(1) $d_x{}^{2n} x^n C_n(x) = C_n(x)$, and

(2) $d_x\,[x^{n+1} d_x C_n(x)] = x^n C_n(x)$

or $x d^2 C_n/dx^2 + (n+1)dC_n/dx - C_n = 0$;

and (3) $J_n(2\sqrt{x}) = x^{0.5n} C_{-n}(x) = x^{0.5n} C_n(x) =$
$x^{0.5n} d^n C(x)/dx^n,\ J_0(2\sqrt{x}) = C(x)$

Take the problem of the uniform chain, hanging vertically and vibrating slightly, investigated on the first page of Bessel Functions, by Gray and Matthews, and again at the end of the book, where the density is taken to vary as the nth power of x the height above the lower end. To realize the experiment it is easier to revolve the chain by hand, bodily in steady motion, and to investigate the permanent shape. When the deviation from the vertical is small, it is proportional to $C(x/l)$, or $C_n(n+1)x/l$, where l is the height of the equivalent conical pendulum, and is the length of the subtangent at the lowest point, the free end of the chain. The plane vibration will be shown in the shadow of the revolving chain thrown on a vertical wall.

In the linear differential equation of the second order, reduced to the canonical form

$$\frac{1}{y}\cdot\frac{d^2y}{dz^2} + \mathrm{I} = 0,$$

where I is called its differential invariant, the solution is given by the Bessel or Clifford function when $\mathrm{I} = kz^m$; or writing it

$$z^2\frac{d^2y}{dz^2} + kz^p y = 0,\ p = m+2,$$

and changing to the variable $x = kz^p/p^2$, the differential equation changes to the (2) above for $C_n(x)$, with $n = -1/p$, as in *Engineering*, page 99, January 24, by Arthur Morley. This is the differential equation required in the investigation of the vertical stability of a mast or tree, and with $m = 1$, $p = 3$, for a vertical wire or uniform rod. Here n is fractional, and in Clifford's definition Πn must be taken to mean $\Gamma(n+1)$, in Gauss' notation. Thus when n is half an odd integer, the Clifford functions are the derivations or integrals of $\sin\ (2\sqrt{x}+a)$.

The Bessel function of real or imaginary argument, denoted by $(b\ e\ r)$ and $(b\ e\ i)$ in Kelvin's notation, are distinguished here by a mere change of sign in the argument x of the Clifford function.

To utilize the elaborate tables computed of the Bessel function, say of argument x, all that is required is a new column alongside of $x = 2\sqrt{z}$, as argument x of the corresponding Clifford function.

If writers on these questions of practical stability, which require the old Bessel function, will introduce these methods of Clifford and his function, they will notice a considerable simplification in their formulæ, and they will give to the writer of the theoretical textbook a lead he will be compelled to follow. (*Engineering*, vol. 107, no. 2776, March 14, 1919, p. 334, *t*)

MEASUREMENTS AND MEASURING APPARATUS

METHOD FOR MEASURING THE CONSISTENCY OF CONCRETE, Herbert A. Davis. Description of a field instrument developed by the Concrete Ship Section, Emergency Fleet Corporation.

The apparatus consists essentially of a metal cylinder (Fig. 11) whose inside surface is perfectly smooth, mounted on metal slides that direct the movement of the cylinder so as to be truly vertical. The cylinder rests on a smooth glass plate supported horizontally and independent of the supports of the cylinder.

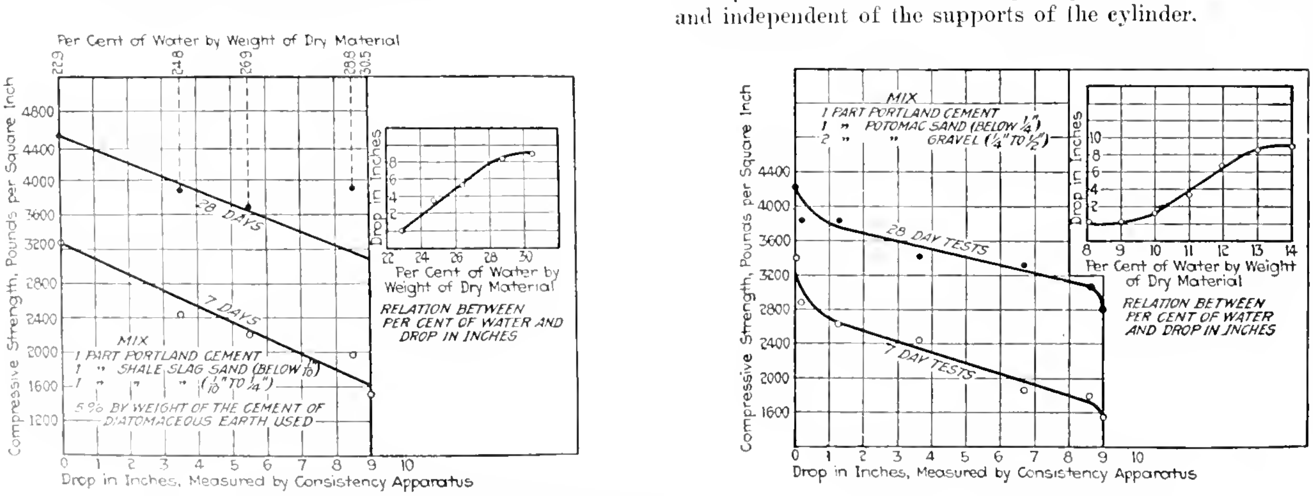


FIG. 12 EFFECT OF WATER ON CONCRETE CONSISTENCY AND DROP AS SHOWN IN TESTING MACHINE

To operate this apparatus the cylinder resting on the glass plate is filled as a mold with the concrete, the top surface is struck off level and the metal cylinder is slowly raised, leaving the concrete unsupported. It was found that this unsupported concrete took various shapes, dependent on the amount of water used in gaging the concrete. Furthermore, over a considerable range it was noted

that the loss in height of the concrete cylinder and the removal of the metal cylinder bore a definite relation to the amount of water used in gaging the concrete.

The diameter of the resulting cone was found to be fairly reliable as a measure of consistency. Typical curves (Fig. 12) showing the relation between compressive strength, the amount of water used and the loss in height of the unsupported concrete cylinder as determined by this apparatus by two different concretes are given in the article, along with certain practical instructions as to the handling of the apparatus. (*Engineering News-Record*, vol. 82, no. 13, March 27, 1919, pp. 603-605, 6 figs, *de*)

MECHANICAL PROCESSES

Manufacture of Pre-Cast Reinforced-Concrete Members for Structural Purposes

Concrete-Molding Plant of the Pennsylvania Railroad Company. Description of a plant, the purpose of which is to manufacture pre-cast reinforced-concrete members for the erection of buildings and construction of bridges, as well as such items (fence posts, telegraph poles, etc.) as lend themselves to production in quantities at a central point. Information is also given on the erection of engine houses involving the use of elements constructed at the plant.

The fundamental idea underlying the erection of this plant is that the building of engine houses and other construction work could be facilitated by concentrating the casting of reinforced-concrete columns, roof girders, beams and similar apparatus at a central point. The site chosen was at Morrisville, Pa., just across the Delaware River from Trenton, N. J. While not exactly at the center of the road requirements for pre-cast concrete products, this site had the advantage of possessing an unlimited supply of sand and gravel peculiarly adapted to the purpose of concrete construction.

The article describes and illustrates the layout of the plant and the method of handling materials, which is of great importance in a plant of this character.

The casting operations proper are carried on in the following manner: The forms are first located on the casting platform and a shed is pushed into position to protect the work. On top of each shed are two tent houses or cupolas over bins into which concrete is deposited from the distributing tower. Leading from these beams to the forms in the building underneath are flexible delivery spouts, each capable of reaching all points within its half of the structure. A gateman stationed in each cupola through which material is being poured, operates valves to the distributing spout as may be required by the operatives on the platform and as is indicated by a system of gong signals.

A very interesting and important feature of these portable casting sheds is the heating system which has been installed in each. These consist of boiler plants located on floors suspended from the roof structure in the corner of each building, and each involving the use of a 20-hp. vertical boiler and a 150-gal. capacity water storage tank. The latter is filled by means of a hose connection to an adjacent hydrant and is of such capacity as to contain about five days' supply at each filling. The radiating coils are mounted on the side and end frames of the building and below the level of the boiler. In order to bring the returns from the heating system back to the boiler plant automatically, steam traps are used in tandem, there being about 20 lb. pressure on the line. The first of these traps collects the condensation and returns it to a point above the level of the boiler from which point the second trap returns the water to its source.

The practice is to protect the work from freezing for a period of 24 hours after pouring. By way of further protection, both from extremes of cold and excessive rates of evaporation in dry weather, large hay-filled mats are placed over newly filled forms until seasoning has advanced to the desired stage.

The articles illustrate the manner in which the various reinforced-concrete elements of construction are cast and assembled. At the outset an attempt was made to cast the roof beams and slabs in complete units, but this was found objectionable because of the unwieldiness of the completed slabs and also because their size precluded the loading of more than three on a single car. This scheme has therefore been abandoned and the plan involving individual roof beams substituted.

The erection of engine houses constructed essentially of pre-cast reinforced members is described in detail. This represents an interesting departure from what might be called standard practice, and the experience that the Pennsylvania Railroad has had is said to be such as to completely justify the experiment. In fact, the first three stalls which the road undertook to erect were set up without a hitch, as have been those since undertaken.

By virtue of the facilities described and the system of engine-house erection that has been adopted, the Pennsylvania Railroad is now in position to complete its program of enlarged engine-house facilities at a rate to which the usual method of casting columns, girders, beams, roof, slabs, etc., in place can bear no comparison; likewise a uniformly dependable quality of construction is insured and is made available at a total cost that not only justifies the plant and facilities that have been provided, but will yield a constantly increasing profit as the road continues to meet the rapidly enlarging demand for concrete structures of whatever type. (*Railway Review*, vol. 64, no. 12, March 22, 1919, pp. 425-432, illustrated, *dA*)

POWER PLANTS

New Patents Concerning Steam-Boiler Firing (Pradel, *Zeitschrift für Dampfkessel und Maschinenbetrieb*, Jan. 17, 1919). This article is the conclusion of a quarterly summary of patents relating to the firing of steam boilers. Descriptions and illustrations of the patents are given.

In the event of failure in the boiler feed pumps, the attendant must close all the boiler dampers. As information regarding pump breakdowns may often take some time to reach the boiler attendant in a large works, and as the closing of all the dampers may take a considerable time, there is a good deal of risk of an explosion occurring. To counteract this a patent (D.R.P. No. 307,490) has been taken out for an arrangement by means of which all the dampers are closed automatically as soon as for any reason the pressure in the feedpipe falls below the normal boiler pressure. Also when the maximum safe pressure is exceeded through failure of the safety valve, the dampers are closed through the pressure in the feedpipe.

Draft-regulating links for steam boiler heating must be occasionally adjusted to the steam pressure. It is also necesary to close the damper when opening the fire door so that no cooling off of the heating surface occurs. The adjustment of the regulating links to the steam pressure in the boiler, which again depends on the steam consumption, is often done mechanically. An innovation (D.R.P. No. 287,194) provides that besides the constant effect on the damper of the steam pressure, it is automatically closed when the fire door is opened, and opened fully again when the fire door is closed.

A suction smoke exhauster and cleaning device is patented (D. R.P. No. 306,668), consisting of rotating water and guide wheels and means by which the dust and gases are intimately mixed with the water.

A new apparatus for delivering and distributing the fuel on the grate is patented (D.R.P. No. 308,037), which works with a shuttle movement.

An improvement (D.R.P. No. 309,727) on a previous patent (D.R.P. No. 303,646) consists of a steam-jet tube cleaner for cleaning out locomotive boiler tubes while making a journey.

Two special spraying burners for liquid fuel are mentioned. The first is (D.R.P. No. 306,788) a further improvement of the burner, and (D.R.P. No. 296,485) has a ceramic nozzle and steel needle. The second is a revolving sprayer (patent number not given). The fuel as it leaves the nozzle is thrown sideways as much as possible, and forms a conical circle which insures the correct mixture with air being obtained. The atomized fuel and air intermingle completely, whereas in other systems on the same principle the mixture is not perfect and combustion suffers accordingly.

The last patent described (D.R.P. No. 309,345) consists of an automatic control, by means of which the liquid fuel is shut off if the boiler-feedwater supply fails. (*Technical Supplement to the Review of the Foreign Press*, vol. 3, no. 6, March 18, 1919, p. 182-183, no. 4478. *d*)

SPECIAL MACHINERY

Continuous Centrifugal Separation Machines. Description of the continuous centrifugal separator built by a South African firm. As shown in Fig. 13, it consists essentially of two vertical cylinders or bottomless buckets *A* revolving rapidly in a frame *B* around an upright spindle *C*. Each of the two buckets has an independent revolution on its own axis. The pulp or slime to be separated is fed into each bucket by a chute *D* against the outer wall, i.e., at the point farthest from the central spindle. The centrifugal force packs the solid matter of the pulp against the wall of the bucket, the fluid flowing over the upper rim and carrying the colloids with it. If desired, by lengthening the time of separation, both crystalline and colloidal solid matter may be packed against the side of the bucket and only a clear liquid is

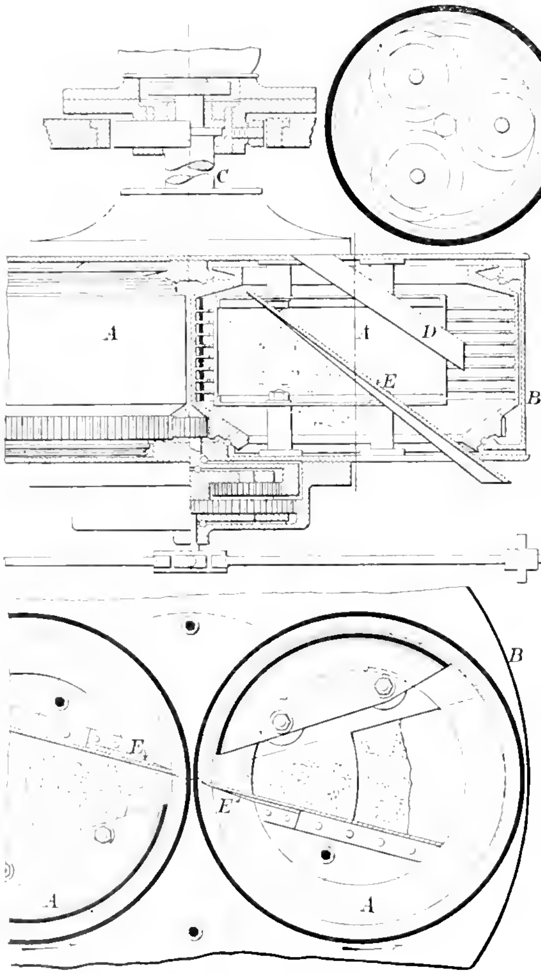


Fig. 13. Continuous Centrifugal Separator

then discharged over the rim. The slow revolution of the bucket continually carries away the clean and dry solids packed against the wall from the point of feed, so that a fresh face is constantly exposed to the feed flow. The packed solids are carried around in the bucket until they arrive at the inner wall or at the point next to the central spindle. Here the centrifugal force, which at first packed them against the wall, exercises a reverse effect and disengages them with the aid of a plow *E*, so that they fall down and out into a proper receptacle. The revolving bar of the machine is 3 ft. 6 in. in diameter. The machine is capable of treating over 25 tons of dried material per 24 hours.

It is claimed that this machine is capable of handling silver, copper, and even tin slime, of which the latter has been hitherto particularly difficult to handle. Another type of the same machine is also described in the original article. (*Engineering*, vol. 107, no. 2776, March 14, 1919, pp. 354-355, 7 figs., *d*)

New Puddling Mill at Dover, N. J. In the last few decades there has been practically no expansion of the merchant-bar-iron industry, the existing plants working mainly along the old lines. In view of this situation the erection of a new and modern puddling mill by the Ulster Iron Works, of Dover, N. J., may be considered as a very important development in the progress of this industry in the East.

The new plant now contains eleven complete double puddling furnaces and space is provided for a second similar group. The furnaces themselves are of the standard type. They burn bituminous coal under forced draft and each furnace is surmounted by a waste-heat boiler for generating steam required in the operation of the rolls and pumps and generation of electric current.

For rolling the puddle balls into blooms there is a squeezer of the rotary type. In addition an alligator squeezer was installed for upsetting the blooms. The puddle bars are rolled in an 18-in. three-high puddle train. Further refining and rolling of the puddle bars is to be carried out at the company's old plant where the equipment includes a 20-in. bar mill and other apparatus. A modern feature in the new plant is the extensive use of labor-saving devices. For delivering the puddling balls to the squeezer the old-fashioned handcar has been replaced by a monorail system. Blooms are transferred automatically from the squeezer to the puddle train. The raw materials are handled by two overhead conveyors which also remove ashes and cinder from the building.

On the other hand, however, side by side with these most modern devices is to be found the actual process of making the iron, which is the same as that discovered in 1830 by Joseph Hall, the only difference being the use of the double puddling furnace instead of the old pig-boiling process. (*The Iron Trade Review*, vol. 64, no. 11, March 13, 1919, pp. 699-701 7 figs., *d*)

RAILROAD ENGINEERING (See Also Engineering Materials)

Large Consolidation-Type Locomotives for the Philadelphia and Reading Railroad. These locomotives are notable for their weight and hauling capacity and also because they are the only engines built to a railroad company's design to be included in the 1430 locomotives ordered last year by the Railroad Administration.

They are designed for heavy drag service and are in many respects similar to the Mikado-type locomotives which preceded them. On the other hand, there are a great many differences.

TABLE 4 COMPARISON OF P. & R. CONSOLIDATION AND MIKADO TYPE LOCOMOTIVES

Type	2–8–0	2–8–2
Tractive effort, lb.	61,260	57,320
Total weight, lb.	281,100	329,300
Weight on drivers, lb.	250,800	246,600
Diameter of drivers, in.	55½	61½
Cylinders, diameter and stroke, in.	25 x 32	24 x 32
Steam pressure, lb. per sq. in.	200	225
Heating surface, total evaporation, sq. ft.	2655	4224
Heating surface, equivalent, sq. ft.	3518	5264
Grate area, sq. ft.	94.9	108
Tractive effort × diam. drivers ÷ equivalent heating surface	966.5	699 7
Firebox heating surface ÷ equiv. heating surface, per cent	8.4	6.2
Grate area ÷ vol. cylinders	5.2	6.4

As shown in Table 4, the new locomotives have smaller driving wheels and lower boiler pressure than the Mikado, but the cylinders are 1 in. larger in diameter and the starting tractive effort almost 4000 lb. greater than in the Mikado. There is also a

considerable sacrifice in heating surface, as there are eight less superheater units and 20 less tubes than in the Mikado type, and the tubes themselves are 4 ft. 2 in. shorter. For heavy drag service, however, high tractive effort at slow speeds is more important than high sustained horsepower capacity.

Because of the relatively smaller diameter of the wheels a firebox of sufficient depth can be placed above the rear drivers without raising the boiler center to an excessive height, in this instance 9 ft. $7\frac{1}{2}$ in. above the rails.

The smokebox is comparatively short, and is equipped with the Economy front and arrangement, patented by I. A. Seiders, superintendent of motive power and rolling equipment of the railroad. A special feature of this arrangement is a breaker plate, which consists of a slotted plate fitted with deflecting vanes. This plate is placed under the superheater damper and in front of the tubes, and is very effective in breaking up the large sparks before they strike the netting. The netting frames are most substantial in construction, and the device has proved effective in preventing the setting of fires due to escaping sparks. (*Railway Age*, vol. 66, no. 12, March 21, 1919, pp. 760-762, 2 gfs., *d*)

GONDOLA CAR OF REINFORCED-CONCRETE CONSTRUCTION. Description of a reinforced-concrete car of the gondola type, comprising steel center sills with concrete floor, sides and ends. (See Fig. 14).

The steel skeleton body is mounted upon the standard center sills and bolsters of the United States Railroad Administration 40-ft., 50-ton gondola car. Concrete walls and floors are contained within the skeleton steel frame, and together with the reinforcement in the floor, are connected to the underframe in such a manner that the buffing and pulling stresses are distributed throughout the car body. The unit stresses in the steel were limited to 16,000 lb. per sq. in. and in the concrete to 1000 lb. per sq. in.

FIG. 14 REINFORCED-CONCRETE GONDOLA CAR

The car has an overall length of 41 ft. $6\frac{1}{2}$ in. and overall width of 10 ft. $2\frac{7}{8}$ in., with sides 4 ft. $10\frac{1}{2}$ in. high. The concrete work on this car represents the first commercial application of a light-weight aggregate known as Haydite. It is stated that this material was developed by Stephen J. Hayde of Kansas City, Mo., but no information as to the process is given. *Railway Age*, vol. 66, no. 12, March 21, 1919, pp. 776-777, 3 figs., *d*)

A NEW METHOD OF PRESERVING RAILWAY TIES. The method described by the author consists first in drying the ties and sealing them against moisture.

Essentially, an attempt was made to use the same process that nature does but faster than nature unassisted can accomplish the work. An effort was made to dissolve, neutralize or wash out the sap or other liquids or semi-liquids which obstruct and close the pores, and to do this warm vapor, or, in other words, warm saturated air with moisture is circulated among the ties. This opens and cleans the pores in the wood. Further, the liquid components of the saps and resins filling the vesicles expand with the heat and force their way out to be diluted and carried away by the warm vapor. After some hours of this treatment the amount of moisture is reduced by very slow degrees until at the end it is practically dry and the timber is removed with not more than 5 per cent of moisture left in it. Care is taken not to let the temperature of the kiln get above 160 deg. fahr. so that no injury may be done to the fiber of the wood.

The author believes that so long as the timber so treated is kept dry, it is indestructible except by fire. The elements of decay being entirely removed from the inside, all that is necessary is to keep them from entering from the outside and to do this some waterproofing coating, preferably a cheap one, is desirable.

In the experiments conducted a heavy oil tar was found which is an almost worthless by-product of refineries. The ties were merely dipped in a hot bath of this material for a few minutes and on coming out were sanded by a sand blast to absorb any superfluous stickiness and make them easier to handle.

One of the prospects opened up by this new process is the possibility of using for ties, timbers which cannot be used now. For instance, the northern birch is a strong, reliable and hard wood which cannot be used for ties or bridge timbers on account of its superabundant sap and consequent tendency to rot rapidly. Poplar and balsam belong to the same category. All of these and other similar timbers, it is claimed, can be employed when treated by the process described here. (*Railway Age*, vol. 66, no. 13, March 28, 1919, pp. 849-850, *eA*)

VARIA

ZIRCONIUM AND OTHER STEELS. In an interesting editorial *The Iron Age* calls attention to the fact that steel containing zirconium promises to play an important role in the future metallurgy of the steel industry.

Information has been published recently in France regarding some of the properties of zirconium steel. From this it appears that such steel not only possesses a very high tensile strength and an elastic ratio of over 85 per cent, but also in toughness surpasses any other steel hitherto made.

The chief difficulty in this connection had evidently been, and still is, the production of uniform ferrozirconium, one containing definite amounts of the metal and correspondingly regular amounts of other ingredients or the absence of them, and it is evident that until such ferrozirconium is secured definite scientific progress will be impossible.

Considerable concern is reported as to the future supply of vanadium. In view of the rapid exhaustion of present resources it may be necessary to find a substitute for this important alloying metal. It is hoped that this may not be the case, for the value of vanadium has been eminently demonstrated. However, should the need come, it may develop that zirconium or titanium can take the place of vanadium to a greater or less degree. Already the interest in titanium as an alloy in steel has been active and unusual results are reported from its value as an alloy in steels and not simply as a cleanser.

The zirconium steel which has given the best results in France is stated to have the following composition and physical properties:

Carbon	0.42 per cent
Manganese	1.00 per cent
Silicon	1.50 per cent
Nickel	3.00 per cent
Zirconium	0.34 per cent

Tensile strength....198 kg. per sq. mm. (281,560 lb. per sq. in.)

Elastic limit....169 kg. per sq. mm. (240,320 lb. per sq. in.)

Brinell hardness....470 (weight of 10-kg. ball making an impression 2.8 mm.)

(*The Iron Age*, April 17, 1919, p. 1030, *g*)

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer.

MECHANICAL ENGINEERING
THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Published Monthly by the Society at
29 West Thirty-ninth Street, New York

M. E. Cooley, *President*
William H. Wiley, *Treasurer* Calvin W. Rice, *Secretary*

PUBLICATION COMMITTEE:
George A. Orrok, *Chairman* J. W. Roe
H. H. Esselstyn George J. Foran
Ralph E. Flanders

PUBLICATION STAFF:
Lester G. French, *Editor and Manager*
Leon Cammen, C. M. Sames, *Associate Editors*
W. E. Bullock, *Assistant Secretary Editor Society Affairs*
Frederick Lask, *Advertising Manager*
Walter B. Snow, *Circulation Manager*
136 Federal St., Boston

Yearly subscription $3.00, single copies 35 cents. Postage to Canada, 50 cents additional; to foreign countries **$1.00 additional.**
Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

Members of the Society who participated in the enjoyable trip to England in 1910, and who remember with the greatest pleasure the hospitality extended by Capt. A. E. S. Hambelton of the SS. *Celtic* who conducted the party across, will regret to learn of the Captain's serious injury as a result of having been struck by an auto truck. Captain Hambelton is in Bellevue hospital where he has been confined for ten weeks, but is making a good recovery and hopes to be about again soon, although as yet he is still incapacitated.

Reunion of "Eighty-niners"

American Society of Civil Engineers
American Institute of Mining Engineers
American Society of Mechanical Engineers
American Institute of Electrical Engineers

Thirty years ago a party of American engineers, with members of their families, belonging to the four national engineering societies, sailed for Europe visiting England and the Paris Exposition of 1889, and being the recipients of many high courtesies, official, professional and individual.

Plans have been made for a Reunion Dinner, to be held in New York City, about May 26, at which it is hoped that all the survivors, ladies as well as men, of that memorable trip may meet again.

While the records of the various societies furnish an approximately complete list of the party, it is possible that some have been overlooked, or that addresses require correction.

It is therefore urgently requested that any one who was of that party communicate immediately with the Secretary of the Committee, Mr. Jesse M. Smith, Engineers' Club, 32 West 40th Street, New York, N. Y. This information is desired from every member of the party, whether attendance at the function is possible or not; those who cannot come will be heartily remembered when their letters are read.

It is hoped that the response to this request will be immediate and complete; the time is brief and the information required important.

Announcement of the precise date and place, and full details, will be sent to every individual who can be reached. Send in your name now and resolve to come to meet your traveling companions of thirty years ago.

Henry R. Towne, *Chairman.*
Jesse M. Smith, *Secretary.*

April 15, 1919.

Federal Board of Vocational Training

The great difficulty encountered by the Government in re-educating disabled soldiers and sailors is to acquaint them with the opportunities available. The ignorance of the average man regarding the Government and what it stands ready to do for him is most amazing. There are many men now in civil life, badly handicapped by injuries received in the war, but nevertheless endeavoring to work. In the hope that the condition of these men may be somewhat alleviated the Federal Board for Vocational Training has issued a notice giving full particulars regarding vocational training which is supplied free of cost, and with compensation during training based on the amount to which a man would be entitled under the War Risk Insurance Act. Further information is given regarding the supplying of artificial limbs or other appliances, and, if needed, medical treatment.

All disabled soldiers and sailors who desire aid should address their communications either to the Federal Board of Vocational Training at Washington, D. C., or to the District Offices located in Boston, New York, Philadelphia, Washington, Atlanta, New Orleans, Cincinnati, Chicago, St. Louis, Minneapolis, Denver, San Francisco, Seattle and Dallas.

Sir Robert Hadfield Prize

Sir Robert Hadfield, D.Sc., F.R.S., has placed in the hands of the British Institution of Mechanical Engineers the sum of £200, the income from which is to be awarded at the discretion of the Council of the Institution as a prize or prizes for the description of a new and accurate method of determining the hardness of metals, especially of a high degree of hardness. Ordinary tests are described in the Report of the Hardness Tests Research Committee (Proceedings of the Institution of Mechanical Engineers, 1916, pp. 677 to 778) and should be consulted by all competitors. Any tests offered should be a description of a method suitable for metallurgical work, and which can be used to determine accurately the degree of hardness in cases where present methods fail. The offer will be withdrawn January, 1922, and communications prior to that time should be addressed to the Secretary, The Institution of Mechanical Engineers, 11 Great George St., Westminster, London, S. W. 1.

Screw Thread Commission

The Screw Thread Commission, which has been extended until March 21, 1920, by an act of Congress passed February 28, has recently circulated a questionnaire relative to Acme threads. Information is desired regarding the sizes and extent of use of Acme threads in order that a tentative standard may be prepared. The standard is to include a series of pitches and diameters, and manufacturers and others interested can be of great service in this connection by answering promptly the questions below.

Replies should be forwarded to the Gage Section, Bureau of Standards, Washington, D. C., giving name, position, name of firm or organization, nature of product manufactured, street address and city.

1 To what extent do you produce or use Acme screw threads in your manufactured product? Give details as to the nature of your requirements for Acme threads.

2 Have you adopted, or are you using, any standards with reference to specified pitches corresponding to fixed diameters? If so, state sizes and pitches.

3 If you have no established standard, what sizes (diameters and pitches) would suit your regular needs? This information can be transmitted by detailed blueprints.

4 To what extent would a standard series of Acme threads benefit your manufacturing conditions?

5 To what accuracy is it necessary to produce Acme threads meeting your requirements? If you are working to definite tolerances on pitch diameter, lead, and angle, it is requested that details of this information be furnished.

SPRING MEETING OF THE A. S. M. E.

As previously announced, the Spring Meeting this year to be held at Detroit, June 16 to 19, inclusive, begins on Monday of the week of the convention instead of on Tuesday, the usual day for the opening session. Both the Committee on Meetings and Program, which has general charge of the convention and arranges the professional program, and the Detroit Local Committee, have plans well matured which are of such a character as to awaken the greatest interest and enthusiasm on the part of the membership. The attendance is sure to be large and every member who can do so is urged to take advantage of this unusual opportunity to meet so large a number of the engineers of the country and to enjoy and profit by the attractive features which the Detroit Committee are arranging for their guests.

Hotel Statler, Headquarters of the A. S. M. E. Spring Meeting, June 16-19

Rooms Should Be Reserved at Once

The headquarters for the meeting will be at the Hotel Statler where reservations should be made as early as possible. For the convenience of guests the following rates are given by the Hotel Committee, both for the Statler and the other leading hotels of the city:

Hotel Statler: \$2.00 to \$2.50 (limited in number)
3.00 (a few available)
3.50 (plenty available)
5.50 and up, rooms with double beds (plenty available)

Hotel Pontchartrain: \$2.00 up (rooms getting scarce for June)
Hotel Tuller: \$1.75 up (rooms scarce for June)

General Arrangements

The General Committee at Detroit having in charge the local arrangements is headed by H. H. Esselstyn, Commissioner of Public Works, with whom are coöperating Ralph Collamore, Vice-Chairman, Fred H. Mason, Secretary and Treasurer, and other members comprising this Committee, besides sub-committees on Reception, Hotels, Transportation, Finance, Entertainment, Printing, etc., and the Women's Committee, of which Mrs. F. G. Ray is Chairman.

A feature of the meeting will be a session in charge of the regular Detroit Local Committee, of which Mr. E. C. Fisher is Chairman. Papers will also be contributed by the Local Sections at Chicago, Cincinnati, Cleveland, Atlanta and possibly by others.

The Research Committee of the Society which is now so active in collecting and publishing in Mechanical Engineering research data regarding the work of the various laboratories of the country, will have charge of one session and the Gas Power Committee of another, taking up the subject of oil engines. A general session of interest to every member regardless of his specialty of engineering will be devoted to Industrial Relations, at which there will be addresses by prominent men in the industrial field discussing the relations existing between employers and employees under the present conditions and what must be done in order to preserve industrial peace.

As announced more fully in Section 2 of this number, plans are being made for a very attractive excursion, partly by boat and partly by rail, for those going to Detroit from the East. A blank is provided with this announcement which all who contemplate going on this excursion are requested to fill in.

Among the many social functions contemplated by the Detroit Committee are two of unusual interest in which all will wish to participate. One of these is an afternoon and evening on the Lake, which occurs on Wednesday, June 18, with a trip across Lake St. Clair and the St. Clair Flats—the "Venice of America" —on the boat *Britannia*. There will be music and dancing, and dinner will be served.

On Tuesday evening a social evening is planned, preceded by a lecture of popular interest, after which there will be music, dancing and refreshments. The ladies will be invited to enjoy a visit to Belle Isle, Detroit's beautiful playground, to participate in automobile trips, a visit to the Country Club, etc.

A Glimpse of Detroit's Fine Office Buildings Near Headquarters at Hotel Statler

Outline of Program.

Monday, June 16: Opening of headquarters and registration. Business meeting in the afternoon, followed by a general meeting at which the Committee on Aims and Organization

will make a preliminary report. This will cover one of the most important matters which has yet come before the Society, in that it involves a discussion of the aims and purposes of the Society and its work. In the evening there will be an informal reception at the hotel.

Tuesday, June 17: Research Session in the morning and Industrial Relations Session in the afternoon. Social evening with lecture, music and dancing. Should it be necessary, the professional sessions on this day will be paralleled by others at which papers offered by the Local Sections or by individual members will be presented.

Wednesday, June 18: In the morning, a session in charge of the Detroit Local Committee and Miscellaneous Session. Afternoon and evening, boat trip and dinner on the Lake.

Thursday, June 19: In the morning, Gas Power Session and Miscellaneous Session. Excursions in the afternoon.

For particulars regarding the proposed excursion to Detroit from the East, by boat and rail, with return blank for those to fill out who expect to go on this excursion, see inside front cover of Section Two of this number. Special cars will leave Eastern cities on Friday evening, June 13. Entertainment and short excursions will be provided both in Buffalo and Cleveland for those arriving in those cities on Saturday, and on Sunday both contingents will meet and continue by boat to Detroit.

Manufacture of Precision Gage Blocks at the Bureau of Standards

REFERENCE was made in the March number of MECHANICAL ENGINEERING (p. 289) to the sets of precision gages completed at the Bureau of Standards with an accuracy of a few millionths of an inch. H. L. Van Keuren, Chief of Gage Section of the Bureau, has published in *American Machinist* of April 3, an account of the process for manufacturing these gages, which are the invention of Maj. William E. Hoke.

One of the first problems was the selection of a material which would combine a suitable coefficient of expansion with permanency, wearing qualities, resistance to corrosion, susceptibility to high polish, ease of machining and uniformity of structure. Many possibilities such as agate, fused quartz, stellite, invar, pack-hardened machine steel and tool steel were given very careful consideration; but as in practically every case these precision gages are used for verifying other gages which are of steel or pieces and parts made of steel, the convenience of avoiding the corrections due to different coefficients of expansion when the measurements are not performed at the standard temperature determined on the adoption of a steel having a carbon content of 1.00 to 1.25 per cent (the regular tool-steel carbon content) and from 1.00 to 1.50 per cent of chromium to prevent corrosion.

The various operations required for finishing the gages are as follows:

Number of Operation	Description of Operation	Number of Operation	Description of Operation
1	Stock	9	Finish grind radius on edges
2	Turn, drill, ream, countersink one side, cut off	10	Rough lap
3	Rough grind the cut-off side	11	Inspect
4	Countersink the cut-off side	12	Lap countersink, both sides
5	Mark size	13	Finish outside diameter
6	Heat treat	14	Finish lap faces
7	Rough grind faces	15	Final inspection and measurement
8	Season	16	Assemble in sets
		17	Pack and ship

In the hardening operation, No. 6, the gages are preheated slowly to a temperature of from 800 to 1000 deg. fahr. They are then placed in a lead pot and heated to from 1550 to 1569 deg. fahr. It is said that quenching from this temperature into water through oil results in gages which have a hardness ranging from 90 to 95 scleroscope scale, and the number of cracked gages is reduced to a minimum.

In operation No. 8 the gages are given a seasoning treatment which consists of immersing them alternately in boiling and ice water about 30 times and holding them there just long enough to attain the temperature of the liquid.

The finish-lapping of the gages, operation No. 14, is done on the Hoke lapping machine. In this device the work is done on a lapping fixture driven by a vertical drilling machine and consisting of three plates; the lower and upper plates are lapping plates and are secured against rotation; the intermediate plate, which is the gage-block carrier, rotates and oscillates at the same time. The thickness of the blocks is equalized by transposing them diametrically and at 90 deg. at various times during the process of lapping. Another machine for lapping precision blocks is described and illustrated in *American Machinist,* March 27, p. 613.

The final inspection listed under operation No. 15 is made in the optical laboratory with the use of the light-wave interference method. The apparatus employed includes only two optical glass flats and a source of light. The process consists of wringing two glass plates on each end of the gage and determining with suitable apparatus the number of light waves between the gage planes. Inasmuch as the exact number of light waves in a length represented by the international standard meter has been determined to within an accuracy of about one part in 15 million, the length of a light wave is very definitely known and is constant. Therefore the determination of a number of light waves between the two glass planes on each end of the gage is equivalent to determining the exact length to a high degree of accuracy. The use of a source of light of one color, such as helium or a mercury-vapor lamp is not absolutely necessary, but in this case the interference bands take the form of more definite light and dark spaces, and thus the inspection is facilitated; with daylight the interference bands are made up of several colors merging into one another. The entire process of comparing gages by the light-interference method is extremely simple, and the cost of the measurement and inspection, including the determination of the standard for each size gage, is in the neighborhood of seven cents per gage.

University Teaches Naval Architecture

The University of Michigan announces the introduction of an intensive training course in Naval Architecture into its curriculum. The course begins January 6, 1919, and will run for eleven weeks.

The announcement states that applicants to be enrolled should be graduates of civil, mechanical, electrical, mining or architectural engineering courses, or should have the equivalent of such training. Men who have completed their junior year in college in any of those engineering courses will be given consideration as applicants. The tuition is $32.25 for the course, payable to the University, each student to pay his own expenses. Prof. E. M. Bragg is at the head of the course, which is designated the Department of Naval Architecture.

The Education and Training Section of the Emergency Fleet Corporation is coöperating with the University to make the course a success. While it does not guarantee the employment of men by shipbuilding companies, and will not employ such men itself on completion of the work, the Section will assist in obtaining work for men who finish the course successfully and who may be recommended by the Department. (*Emergency Fleet News,* Dec. 5, 1918, p. 5)

Interesting Figures on Munitions Production

An advance summary of certain features of the forthcoming report of the Secretary of War as Director of Munitions, was published in the New York *Times,* April 6, 1919. This summary was prepared by Col. James L. Walsh and contained the following data of engineering interest.

Before the United States entered the war a total of 50 machine

guns was the standard equipment of an infantry division. When the armistice was signed the total machine-gun equipment of a division consisted of 768 light automatic and 262 heavy machine guns—an increase of 2060 per cent.

Of shoulder rifles there were produced in the 19 months of our participation in the war over 2,500,000—France produced only 1,400,000 and England 1,970,000. Of small-arms ammunition for pistols, rifles and machine guns 2,879,148,000 rounds were produced between April 6, 1917, and November 11, 1918, a total of one complete round every 20 seconds for 1918 years. Of machine guns and automatic rifles, America produced a total (181,662) slightly greater than that of England (181,404), and slightly less than that of France (229,238); but a fairer basis of comparison—the average monthly rate of production—indicates that America was producing 27,270 per month, more than twice as many automatic rifles and machine guns per month as France (12,122), and nearly three times as many per month as England (10,947).

As to artillery ammunition, a typical instance is the 75-mm. project. Of this caliber four and a quarter million of high-explosive shells, more than a half million of gas shells and over seven and a quarter million of shrapnel had been produced complete when the armistice was signed. From January 18, 1918, when the first complete American division entered the line, until firing ceased on November 11, 1918, a total of six and a quarter million rounds of 75-mm. ammunition were e pended by American artillerymen.

Efficiency the Keynote in Shipbuilding

Holden A. Evans, president of the Baltimore Dry Docks and Ship Building Company, spoke recently on the question, What is to be done to make possible the continuance of shipbuilding in this country? His answer is that only through the removal of the various inefficiencies that now exist in the industry and by the education and training of workmen can this be done.

Before the war cargo ships were built in Great Britain at from \$30 to \$40 per deadweight ton. At the same time, some cargo ships of similar type were built in this country at from \$60 to \$70 per deadweight ton. Today contracts are being placed in Great Britain at \$100 to \$120 per deadweight ton. In this country, under present conditions, it will cost the shipbuilder from \$170 to \$180 a ton to build the same ship.

Wage schedules are today double what they were before the war and steel plates which could then be bought at \$1.10 have risen as high as \$3.25. The high cost of construction is obviously due in part to the increase in labor and materials; but principally, Mr. Evans contends, to *inefficiency*, which he classes under the following heads:

The inefficiency of a large number of unskilled men taken in the yards, due to the enormous plant expansion.

Inefficiency due to rush war methods. Speed of construction has been the only thought, which brought about extravagant methods. Old trained men are not as efficient today as they were before the war. It will take some time to bring them back to normal efficient methods.

The inefficiency due to the rapid increase in wages. The men do not work as steadily as before the war. There is much more lost time.

He adds: "The American people are thoroughly convinced of the absolute necessity of our own merchant marine, and we are going to have it. But if we are to maintain a great American-built, American-operated merchant marine, the American people must in some way or another pay for the excess cost while we are learning to build and learning to operate. In no other way will we ever get it."

NATIONAL RESEARCH COUNCIL

THE National Research Council of the National Academy of Sciences, which has been one of the potent factors in the development of scientific and research problems during the war, has now been organized on a permanent basis in order to promote research in the mathematical, physical and biological sciences and in the application of these sciences to engineering, agriculture, medicine and other useful arts.

Throughout the period of our participation in the war the National Research Council conducted a very large and successful work, largely through the foresight and active direction of its distinguished chairman, Dr. George E. Hale, director of Mt. Wilson Observatory. Doctor Hale had previously been in Europe investigating research matters and brought to the Council an intimate knowledge of accomplishments in other countries and of the requirements which the Allies of the United States had found necessary to meet in the research field. It is hoped that the Council may long have the continued service of Doctor Hale in his capacity as chairman whereby he has contributed so much of his enthusiasm and scientific knowledge to the advancement of science and the arts in America.

In this connection, it is interesting to note that the National Academy was organized at the request of President Lincoln to meet the scientific needs of the country during the Civil War; and likewise the Research Council came into existence by an executive order of President Wilson to extend the work of the Academy into a broader field of research during the recent war.

The permanent organization of the National Research Council replaces the temporary organization under which it has heretofore operated, and its membership is to be chosen with a view to forming an effective federation of the principal research agencies in the United States concerned with the field of science and technology. It is to consist of

(1) Representatives of national, scientific and technical societies.

(2) Representatives of the Government, as members and provided in the executive order.

(3) Representatives of other research organizations and other persons whose aid may advance the objects of the Council.

Organization of National Research Council

The Council is to be organized in two divisions,—one of General Relations dealing with foreign and states relations, educational relations, industrial relations, etc.; and the other of Science and Technology. The latter will include divisions of physical sciences, engineering, chemistry and chemical technology, geology and geography, medical sciences, biology and agriculture, and anthropology and psychology.

To secure the effective federation of the principal research agencies in the United States, a majority of the members of each of the divisions of science and technology are to consist of representatives of scientific and technical societies. The other members are to be nominated by the executive committee of the division, approved by the executive board of the Council, and appointed by the president of the National Academy.

The affairs of the Council are to be administered by an executive board of which the officers of the Council, the president and the home secretary of the National Academy of Sciences, the president of the American Association for the Advancement of Science, the chairman and vice-chairman of the Divisions of Science and Technology, and the chairman of the Divisions of General Relations shall be ex-officio members.

National Research Fellowships

The very large way in which the Research Council is functioning is indicated by the recent support accorded to it by the Rockefeller Foundation through an appropriation of \$500,000 to be expended within a period of five years for promoting fundamental research in physics and chemistry, primarily in educational institutions of the United States. The primary feature of the plan is the initiation and maintenance of a system of National Research fellowships to be awarded by the National Research Council to persons who have demonstrated a high order of ability in research for the purpose of enabling them to conduct investigations at educational institutions which make adequate provision for effective prosecution of research in physics or chemistry. It is expected that 15 to 20 research fellow-

ships will be available during the coming year and that the number will be increased in subsequent years. The Research Fellows will be permitted to conduct their investigations at institutions that will coöperate in meeting their need and that are amply supplied with equipment, and above all, that are conducted in the stimulating atmosphere to be found only in institutions that have brought together groups of men devoted to the advancement of science through the pursuit of research.

Applications for these fellowships should be made on the form provided for the purpose and should be sent to the secretary of the Research Fellowship Board, National Research Council, 1023 16th Street, Washington, D. C.

Representatives Abroad

Two distinguished representatives of the National Research Council have recently left for Europe on important commissions. Dr. Charles S. Howe, president of Case School of Applied Science, sailed for France on April 19, where he will assume the duties of scientific attaché to the United States Embassy in Paris. This appointment is regarded as a notable development in the American diplomatic service produced by the war and the appointment will be watched with interest, as it is expected the industries of the country will be materially assisted by authentic information on the scientific discoveries which may be made in Europe. Dr. Comfort A. Adams sailed for England on April 14, and later he will go to France to attend the conference of the International Electro-Technical Commission to be held in Paris.

ENGINEERING DELEGATES REPORT TO FRENCH CONGRESS

The American delegation of Engineers who recently went abroad to investigate reconstruction problems, rendered a preliminary report to the Congres General du Genie Civil previous to returning to this country. A summary of this report was recently presented to the Council of The American Society of Mechanical Engineers by Mr. Charles T. Main, Past-President of the Society and its representative on the delegation. The following abstract brings out some of the most interesting features of the report.

There is but one national engineering society in France, the Société des Ingénieurs Civils, which includes engineers of all branches of the profession. It was not unnatural, therefore, that when the invitation was sent to the American engineers that it should have been addressed to the American Society of Civil Engineers. Nearly all of the problems submitted to the American Delegation were problems in civil engineering, and only incidentally those which might be classed under the headings of mechanical, electrical or mining engineering.

At the time of their appointment the delegates were of the impression that the problems which were to be discussed with the French engineers were those concerning the reconstruction of devastated areas. It soon developed, however, that this was not the case, and that the problems to be considered were of a much broader scope, and those which would profoundly affect the future policy of the development of the Republic. While these problems were of broad interest and great importance, they were nevertheless not so definite and of such immediate interest as would have been those dealing directly with the subject of reconstruction.

Ports and Inland Waterways

Among the recommendations made to the French engineers were a number relating to the development of ports and inland waterways. The desirability of concentrating on the improvement of a few principal ports rather than scattering efforts over many large and smaller ones, was pointed out, and the use of modern freight-handling apparatus and close connection between railroad tracks and wharves to reduce the time of vessels spent in port, strongly urged. A more limited use of enclosed basins with locks was also suggested, and the advantages of wharves with suitable loading and unloading apparatus, and a sufficient number of dry docks and facilities for repairs, were enumerated.

The Delegation also recommended that financial accounts and statistics relating to each port should be kept separate from those of other ports, so that the relative efficiency should be determined.

Water Power

The Delegation did not feel inclined to discuss the laws relating to water power, as they were too complicated, but it did recommend that no project should be undertaken unless it could be demonstrated to be economically justified. The Government, it suggested, should encourage these enterprises and render financial aid, temporarily or permanently, in view of collateral advantages.

The necessity of standardizing the characteristics of their electric systems and the possibility of making one great connected system for the entire country was discussed, and recommendations of 50 cycles for local distribution and 25 cycles for long distance were made for careful consideration.

The Delegation also recommended that effective measures be taken to facilitate the extension of existing installations and construction of new ones where such extensions or new construction are justified. France has within her borders, in three rather widely separated regions, water-power possibilities which are probably sufficient, if developed and utilized, to obviate the necessity now existing of importing coal for power purposes. The importance and desirability of a unified system is emphasized by the study of the seasonal characteristics of the flow of the streams in the different regions. The low-water flows in these several regions do not occur simultaneously and thus combined operation will make it possible to utilize a greater amount of continuous power than could be utilized if the various groups of plants were operated independently. No insurmountable technical difficulties stand in the way of operation of such a unified system, and while the data for an exact study of the cost and results of interconnecting the several regions were not at hand, a general consideration of the situation led to the opinion that it would be amply justified. It was recommended that steam plants be connected to the general distributing system and operated in such a way as to supplement the varying amount of power which can be derived from hydraulic sources. The concentration of electric power production by steam in a small number of large, modern plants will result in a great economy of coal as compared to the amount required to produce equivalent power in a large number of small steam plants; and at high potential, such as is now in successful use in America, electric energy can be transmitted for much less than the cost of transporting the coal required to produce the same amount of energy. The use of auxiliary steam power developed in large plants properly interconnected with hydroelectric plants can be utilized advantageously in supplementary power from the latter at certain seasons of the year.

Navigable Waterways

With a few special exceptions, the experience with works of inland navigation in the United States has been disastrous. In France, however, the conditions are more favorable. The Government there has assumed the payment of interest on works of internal navigation, and also expenses of maintenance.

The four purposes of control of a river are the development of power, irrigation and domestic water supply, improvement of navigation, and regulation of floods, and these should always be considered together. No project should be undertaken which will not be economically justified when all uses are considered and all charges included.

Roads

In the past the French used broken stone for their highways but such construction is now unsuited to the traffic. The Delegation accordingly advised the use of cement concrete, bituminous and brick coatings, the preference depending on climate, trav

and cost. Brick coatings can be used in exceptional cases only: cement roads only where materials are at hand at a low price.

On account of the enormous destruction of roads during the war, considerable reconstruction is necessary, but it has been found that in most cases the existing foundations can be used. Under the present laws bonds cannot be issued for this work, but it is necessary to have appropriations made by the various territorial departments or by the communes. Some arrangements, it was suggested, might be made with private enterprises for constructing and maintaining the roads.

Agriculture

The rehabilitation and expansion of agriculture should be based on improved financial facilities, which require modifications in the banking laws of France. To this end the delegation recommended that working capital for farmers should be obtained from the sale of long-term farm bonds. It also recommended safe and convenient procedures for establishing chattel mortgages; a comprehensive system of warehouse receipts, bills of shipment or lading, acceptances of commission houses, etc., so that records of property may be accepted as collateral; and amendments to banking laws to permit loans for a period in a year or more.

The establishment of modern slaughterhouses and cold-storage plants and refrigerator cars was also urged, although this also will require modification of laws to establish effective sanitary supervision. Persistent campaigns toward better hygienic conditions among the farmers were advocated, as well as rural welfare movements to increase the comforts of farm life.

Technical Education

Many papers dealing with technical education were presented to the Congress. The question was very complex, reaching from the lowest primary to the highest technical education. However, it was recommended that agricultural schools be established; also courses in chemistry and chemical engineering; and that the field and scope of engineering should be brought to the attention of students in the secondary schools, and schools should be provided to receive all young men who are qualified and desire to pursue technical studies.

The interchange of students, professors and instructors between France and America was held to be eminently desirable, but all agreed that France must offer greater encouragement than formerly if she instead of Germany is to be the place for post-graduate work.

Franco-American Engineering Committee

Pending the completion of its formal report, the Delegation of American Engineers has submitted to the national societies which it represents the following statement:

The French Congres Général du Génie Civil, at its meeting on January 15, 1919, adopted the following resolution:

"In order to study both the possibilities and the means of coöperation which have been considered between the engineering societies represented by the members of the American Delegation and the representatives of the French Civil Engineers, it would be highly desirable to maintain the contact which has just been established.

"For this purpose the formation of a permanent Franco-American Committee should be the first result of the studies and trip of inspection which has just taken place.

"The American Delegation and the delegates of the Génie Civil unite in expressing a resolution in favor of the immediate formation of this permanent International Committee."

The members of the American Delegation were requested by the French engineers to act as the American members of the Permanent International Committee. This, however, the delegation declined to do, explaining that it represented the four national engineering societies of America, to which societies it must report, and in whose hands any permanent action must lie.

However, to meet the desire of the French engineers for the immediate creation of an International Committee, and in view of the fact that the Delegation still has some work to do in preparing reports and information for transmission to the French Committee, the members of the Delegation consented to act temporarily as the American members of the International Committee, promising to bring the matter to the immediate attention of the societies they represent, and to secure immediate action if possible. Accordingly, the American Delegation, at a meeting held January 25, 1919, unanimously passed the following resolution:

Resolved: That the Delegation bring to the immediate attention of the national societies which they represent the facts with reference to the formation of a permanent Franco-American Engineering Committee, and urge upon the societies that they take immediate action to constitute the American representatives upon such a Committee.

ELECTRICAL MEASUREMENT OF FLUID FLOW IN PIPES

(*Continued from page 432*)

constant by varying the field of the generator supplying the power, thus approximating the actual condition of an average installation. The secondary voltage varied due to the transformer regulation, but the resistance element of the instrument is designed to compensate for such regulation, so that the indicated variations of current gave a fairly accurate measurement of the differential pressure.

Conclusion

The fact that the flow of fluids can be measured electrically has made possible many important installations where no other method could be employed. In one instance a large manufacturing concern had been contemplating for a long time the adoption of a system for measuring the amount of steam, air and water used by its various departments, but was hindered by the fact that the various lines were distributed over a wide area and in some places were carried through sub-basements, where measuring devices would be inaccessible; also much time and a large force of employees would be required to read the various instruments about the plant and to integrate the recording charts. As soon as the concern discovered that flow could be measured electrically, that the indicating instruments did not have to be located where the flow was to be measured, and that the integrating device was merely a watt-hour meter which integrated the flow independently of the other instruments, a measuring system was instituted for all its products and many wasteful uses of power were thereby eliminated and an accurate distribution of costs established throughout the factory.

The adaptability of the integrating feature to the electrical measurement of flow is of great importance since the readings from the watt-hour meter are more accurate than those taken from the recording ammeter and just as accurate as the instantaneous readings of the indicator. This feature therefore eliminates the necessity of planimetering the charts and insures accurate results for any variation of flow.

When measuring the flow of steam generated by a battery of boilers the flow indicators are placed in front of each boiler, showing the momentary performance for the guidance of the fireman. At the same time, supplementary recorders connected electrically with the indicators are placed conveniently for the supervision of the chief operator.

Recently the manufacturers of water gas adopted the use of low-pressure exhaust steam for gas generation, which created an urgent demand for a measuring device to operate intermittently, varying every few minutes from zero to maximum. After many unsatisfactory trials of mechanical devices the electrical method of flow measurement was adopted, as this made it possible to measure successfully the steam required for the manufacture of water gas and resulted in a great economy.

The main advantage, however, of the electrical method of flow measurement is the accuracy with which the differential pressure is transmitted through a mercury column, which column is not hindered in its movements by any mechanism and is therefore free to attain the true level under all conditions of flow. Furthermore, the electrical instruments used to register the flow can be checked at any time without interfering with the operation or installation of the measuring device.

ENGINEERING COUNCIL

Engineering Council[1] is an Organization of National Technical Societies of America, Created to Consider Matters of Common Concern to Engineers, as Well as Those of Public Welfare in Which the Profession is Interested

Classification and Compensation of Engineers

THE make-up of the Committee on Classification and Compensation of Engineers has been completed. It comprises a main committee and three sub-committees or sections, as follows: *Main Committee:* Arthur S. Tuttle, *Chairman;* Francis Lee Stuart, John C. Hoyt, Charles Whiting Baker, M. O. Leighton. *Railroad Section:* Francis Lee Stuart, *Chairman;* Frank H. Clark, Bion J. Arnold. *Federal Government Section:* John C. Hoyt, *Chairman;* John S. Conway, Oscar C. Merrill. *Municipal* (including City, County and State): Arthur S. Tuttle, *Chairman;* M. M. O'Shaughnessy, F. W. Cappelew. The Railroad Section has been the first to get into action, its chairman, Mr. Stuart, having appeared before the Railroad Administration's Board as reported below.

Hearing on Classification and Compensation of Railroad Engineers

AT a recent hearing by the Railroad Administration's Board on Wages and Working Conditions, arguments were presented by representatives of Engineering Council, appearing for the Societies of Civil, Mining, Mechanical and Electrical Engineers, and the Society for Testing Materials; and representatives of the American Association of Engineers.

Francis Lee Stuart opened the hearing for Engineering Council, which, he said, had been advised (1) that engineers and engineering assistants of the more important classes on the railroads have been individually considered as belonging to the Officer or Supervisory Force, and certain increases of salary have been granted them by the Railroad Administration; (2) that whereas the men in subordinate positions in the civil, mechanical, electrical and signal departments have also been granted certain increases, they have not been given a classification such as the Supervisory Force has had.

He urged that it would be for the best interest both for the social and economic welfare of the railroad professional engineers of the United States that the case of these younger engineers holding subordinate positions be further considered. Before the war the compensation of these engineers was notably inadequate and the increases which have been granted the men in the subordinate positions do not seem to them sufficient. Engineering Council, through this committee, asks that the employees of the engineering departments—civil, mechanical, electrical and signal, who were not considered in the Officer or Supervisory Force, but who will, from their technical education or training, at some later date occupy the higher positions in these departments, be given a classification and the titles of these positions standardized, and a proper remuneration be given them in order that their physical welfare and mental interest may be provided for so as to insure efficient service to the public.

Mr. C. E. Drayer appeared first for the American Association of Engineers and offered a wage schedule for subordinate engineers which had been approved by Railroad Engineers' Convention, in Chicago, on March 17, 1919.

Mr. W. C. Bolin then said it had been estimated that the education required to fill an average railway engineer's place represented a capital of $10,000. At the present scale of wages, he declared it impossible for the engineer, except under unusual circumstances, to recover his $10,000 investment in education. The apprentice in the mechanical department is better off than the boy who enters school to take an engineering course. The apprentice earns money while the other boy is spending money for education, and under the existing rate scale, the former would continue to get more money throughout his career.

The full Board was present at the hearing and manifested unusual interest in the entire proceedings. It is believed that substantial increases in salaries for the junior technical engineers on railroad work are in sight and will very probably be a reality as soon as the Board can get the additional data and information required to complete its work.

NATIONAL SERVICE COMMITTEE

Engineering Legislation in the Past Congress and in Prospect

ALL engineers should understand that legislative measures in which they are most concerned do not succeed in Congress merely by reason of merit. Such bills fail to become laws, not because of adverse votes on the merits, but because of no votes. Congress is deluged with bills. In the Sixty-fifth Congress there were over 16,000 separate and distinct measures introduced into the House, and nearly 6000 into the Senate. These, together with hundreds of joint resolutions, made up a legislative program which could not possibly be digested or appraised according to merit. The Sixty-fifth Congress does not differ from preceding Congresses in this respect, nor will it differ from future ones. Under such conditions the legislation must be the result of interested work by persistent advocates.

Engineering legislation usually fails because there are no engineers in Congress to become its champions. We fail to recall a single worthy engineering measure in the past decade that did not have voting support enough to carry it through; but this was passive support—it did not contrive an opportunity to vote. The good lawyers, farmers, journalists and business men who make up the Congress have to become engineering students when they champion an engineering measure. They have to learn fundamental principles, facts and figures, all in an unfamiliar field. These men are already too busy with subjects with which they are already familiar. Here and there men are found willing to put aside the subjects familiar to them and take up engineering matters. Of course, they merely touch the high spots, and, in common with all high-spotters, they usually "fall down hard" when they get into action.

The members of Congress are not to blame. They deserve profound thanks for their efforts and accomplishments. If any engineer doubts this, let him for the moment assume that he is a member of Congress and is suddenly called upon to familiarize himself with and champion a measure based on international law or preventive medicine. Would he perform better than the lawyer does in Congress on engineering matters? Manifestly not. Therefore let us be persuaded that so long as engineers shirk participation in legislation and remain unrepresented in Congress, just so long must their legislative measures be conducted through the parliamentary maze, not by blood relatives, but by well-meaning foster parents.

To appreciate the truth of this, one needs merely to review the proceedings of the Sixty-fifth Congress. Some of the big engineering measures arrived at the point of final vote at the eleventh hour, were caught in the jam of filibuster, and died. The Water Power Bill, for example, had been on the road for several years, and a determined push by engineer members would have undoubtedly carried it through the Sixty-fifth Congress with months to spare.

An apparent exception to these general conclusions is the case of the engineering measure for the appropriation for public highways. This bill did pass, but as a rider on the Post Office appro-

[1] Officers of Engineering Council: J. Park Channing, *Chairman;* Alfred D. Flinn, *Secretary*, Engineering Societies Building, 29 West 39th Street, New York.

Washington Office in charge of M. O. Leighton, *Secretary*, National Service Committee, McLachlen Building, 10th and G Streets.

Representatives of The American Society of Mechanical Engineers on Engineering Council: Ira N. Hollis, Charles Whiting Baker, George J. Foran, Mortimer E. Cooley, David S. Jacobus.

priation bill. It was a measure easily understood, and one in which members of Congress were personally interested, and it was practically inevitable that it would be passed.

Mineral Resources

Another bill that failed in the last Congress—that was talked to death—was the long-discussed measure for opening up the mineral resources of the public lands for development. The point to be impressed in this connection is that it is possible by strict adherence to parliamentary rules and practices for one "willful man," by means of filibustering tactics, to deny for the time being an otherwise unanimous demand. It is expected that this bill will be introduced in the next Congress, where it is hoped it will be regarded in the nature of unfinished business and thus receive early consideration and passage.

The Water Power Bill

The fate of this bill was the same as that of the Mineral Lands Bill above mentioned. For at least six years the differences of opinion which have prevented the people of this country from enjoying the economic advantages of water-power development on the navigable streams and on streams in the public lands have related to matters of minor importance from the purely development standpoint. One great bone of contention has been the matter of charge or annual payment to the Federal Government for the privilege of developing water powers. This has been of only the remotest interest to public-utility companies and to investors because the charge imposed by the Federal Government must of necessity be paid by the consumer. Nevertheless, this and other points of similar purport have brought water-power development to a virtual standstill in all situations in which the Federal Government has jurisdiction. These difficulties have at last been ironed out, and the bill will again come up in the Sixty-sixth Congress.

Good Roads Legislation

Relatively few engineers have done more than to glean from the press a general idea that the Government is embarked on a road-making policy. Yet the subject is one which demands the thought of every engineer. It is the biggest and most costly internal improvement program ever known in our history. The Federal Road Act, approved July 11, 1916, provides for an appropriation of $75,000,000 during a period of five years, allotments from which, however, are to be made only as the states add equal amounts.

Further, the Post Office appropriation bill passed by the last Congress increased the statutory limit of unit cost of highways built under its provisions from $10,000 to $20,000 per mile, and appropriated in addition to the sums above mentioned a further sum of $50,000,000 for the fiscal year ending June 30, 1919, and $75,000,000 for each of the two following fiscal years. Thus we have a total of Federal and State moneys available to June 30, 1921, of $550,000,000, to which may be added an additional $10,000,000 appropriated by Congress for roads and trails in the National Forest.

The Soldiers' Land Settlement Bill

A bill of particular interest to engineers and yet one which the Congress also failed to pass is the Soldiers' Land Settlement Plan. Under this bill returned soldiers, sailors and marines would be employed on construction work in the reclamation of swamps and arid lands, and would thereafter be given preference in the selection and settlement of those lands. A new bill has now been written for introduction at the next session which, however, instead of providing for the development of new tracts, proposes an "infiltration method" of buying improved farms in established communities. The contrast of this bill to the one recommended is of vital importance to engineers, chiefly because of the broad engineering program that the latter bill proposes as against no engineering under the infiltration method.

Those who favor the new bill argue that it will cost less than the community plan; also that a greater increase in production of food would be secured from the intensive cultivation secured thereby. On the other hand, those who favor the community plan argue that the infiltration plan is impracticable because it will not eliminate the lag of cultivated area behind our increase of population. In the ten-year period subsequent to 1900, our cultivated area increased only about one-half as fast as did the population.

It is interesting to note in this connection that the infiltration and the community plans have both been tried in Australia. The latter proved a success, whereas the former was a failure. After long and careful study, Great Britain also adopted the community plan and we have come to the conclusion that the community settlement plan is best fitted to our requirements.

War Minerals Claim

One of the most important matters now under consideration at Washington is the determination of the remuneration to producers of manganese, chrome, pyrites and tungsten, who in their efforts to meet Government requirements during the war met with heavy losses. Congress has passed a bill setting aside $8,500,000 to meet such claims, and the Secretary of the Interior has been given authority to expend this sum following proper proof of claims from the producers affected.

To assist in this important work, Secretary Lane has appointed a Commission to gather and settle these claims. The work has progressed rapidly for such matters, as a test case was heard in Washington, D. C., on April 15. The claim involved the Charles T. Pyrites and Chemical Co.

At this hearing the interested company was permitted to retain counsel, and it is therefore contemplated that other claims will be permitted to do so, although it has been pointed out by the Commission that claims without attorneys will have every opportunity to get all the facts before the Commission.

Topographic Mapping

If the topographic survey of the country does not proceed more rapidly than prescribed by Congress in the past, a generation at least will have past before the work is completed. Accordingly, Engineering Council has urged the Secretary of the Interior that he recommend to the 66th Congress the importance of increasing the appropriation for that work from $350,000 to $500,000. The importance of topographic mapping hardly needs to be urged or explained to the engineering profession.

In the execution of our national road-construction program, in water-power development, in the fields of mining and geology, in the extension of railway systems, etc., a complete topographic map of the sections involved is a fundamental necessity and becomes the greatest single aid, time saver and means of economy that can be placed in the hands of the constructors.

Proposed Pan-American Conference

A Pan-American Industrial Conference fully as pretentious as was the Pan-American Scientific Congress held in 1915 is under consideration by the Pan-American Union. It is considered practically certain that such a conference will be held. American engineering has taken such an important place in Latin America that it will occupy a prominent place on the program. This will be the first conference of the kind which will be devoted exclusively to the economic features of Pan-American relationships.

Open competitive examinations are now being advertised in the New York City Record for positions in the city employ. These include Mechanical Draftsman Grades C ($1200 to $1800 per annum) and D ($1800 to $2400) for Heating and Ventilating and Electrical Draftsmen. Those desiring to take examinations should apply on or before May 7, 1919, for the proper application blanks, addressing the Municipal Civil Service Commission, 14th story, Municipal Building, New York.

NEWS OF THE ENGINEERING SOCIETIES

Reports of Annual Meetings of Mining and Electrical Engineers and Electric Railway Association —The Aims of an Engineering Society, etc.

Newly Formed American Petroleum Institute

Government officials having to do with matters pertaining to the petroleum industry are very anxious that the newly formed American Petroleum Institute establish its headquarters in Washington. With few exceptions, the important industries of the country are represented in Washington by organizations which are prepared to give immediate information concerning any phase of their activities, and committees of Congress are coming more and more to rely on these national organizations for information.

Electric Furnace Association

On the afternoon of April 3 the recently formed Electric Furnace Association held a meeting at the Chemists' Club, New York. A tentative draft of the constitution and by-laws was adopted pending such time as is necessary to secure a representative list of members from the various industries interested in the work of the association. An aggressive campaign will be undertaken at once to secure members from manufacturers of electric furnaces, electric-furnace supplies, electric-furnace products, etc. This was the second meeting of the association, which is another instance of the present tendency of manufacturers in a given line to get together for their mutual good.

Engineering Society of Western Massachusetts

A dinner and organization meeting of the Engineering Society of Western Massachusetts was held at the Hotel Kimball, Springfield, Mass., on Wednesday evening, April 16. The following officers were elected: Charles L. Newcomb, president; C. C. Chesney, vice-president; George E. Williamson, vice-president, and Winfield E. Holmes, secretary and treasurer.

The constitution and by-laws provide for four grades of members, an entrance fee of five dollars and annual dues of the same amount.

The speakers included Prof. L. P. Breckenridge, Mr. William Spencer Murray, and Dr. George Otis Smith. Over 300 persons attended the dinner and nearly 1100 applications for membership were presented.

American Welding Society

The newly-organized American Welding Society held its first meeting in the Engineering Societies' Building, 29 West 39th Street, New York, on March 28. This is an outgrowth of the Welding Committee organized by the Emergency Fleet Corporation and the Council of National Defense to develop welding methods and coördinate the welding industries during the war. The constitution and by-laws were adopted as recommended, and it was also voted to consider all those who apply for membership before April 8 as charter members of the society. Announcement was also made of the election of Comfort A. Adams as president and the appointment of W. E. Symons as treasurer and H. C. Forbes as secretary.

The first honorary member of the society is Prof. Elihu Thomson, who was characterized by President Adams as the father of electrical engineering in this country.

The main offices of the society are located at 29 West 39th Street, New York City.

Meeting of the American Chemical Society

The American Chemical Society held its spring semi-annual meeting on April 7-11 in Buffalo, N. Y. The convention was named the "Victory Meeting" in view of the new industries which the chemists of this country built during the time of the war.

The papers and discussions presented formed a complete index to American progress in the chemical arts. A few of the topics treated in the session of Industrial and Engineering Chemistry were: Corrosion Tests on Commercial Calcium Chloride Used in Automobile Anti-Freeze Solutions, by Paul Rudnick; Non-Metallic Inclusions in Steel, by E. G. Mahin; Mineral Rubber, by Gustav Egloff; and Testing Materials for Increasing the Water Resistance of Sole Leather, by H. P. Holman and F. P. Veitch. A symposium on Library Service in Industrial Laboratories was another feature of this session. Other divisional meetings dealt with the physical and inorganic, biological, organic, and pharmaceutical applications of industrial chemistry.

New Cuban Engineering Society

There was established in Havana on the evening of February 21 the Association of Members of American National Engineering Societies in Cuba. This organization restricts its membership to persons who are members of the following American national engineering societies: The American Society of Mechanical Engineers, the American Society of Civil Engineers, the American Institute of Electrical Engineers, the American Institute of Chemical Engineers, the American Society of Agricultural Engineers, the American Society of Refrigerating Engineers, the American Institute of Mining and Metallurgical Engineers, the American Institute of Architects, the American Iron and Steel Institute, and the American Chemical Society.

There will be four regular meetings each year, one of which will be the Annual Meeting, occurring on the second Friday of December. The headquarters of the Society are located at No. 17 Empedrado, Havana.

The officers for the coming year are Luther Wagoner, president; George H. Nolan, vice-president; T. Carlile Ulbricht, secretary, and Wallace R. Lee, treasurer.

American Electrochemical Society

The best-attended meetings in the history of the American Electrochemical Society were held at the Chemists' Club, New York, April 3, 4 and 5. Only two days were devoted to technical discussions, the chief topics being the products and possibilities of the electric furnace, and the work of the electrochemist during the war. Several papers were presented relative to the first of these subjects, the most timely perhaps being one by G. K. Elliott. In his paper on improving the Quality of Gray-Iron Castings by the Electric Furnace, Mr. Elliott outlined the most recent practice of employing the electric furnace in conjunction with the cupola in a foundry. Another paper of value was one on Electric Furnaces of the Resistance Type Used in the Production of Essential War Material, by T. F. Bailey, of the Electric Furnace Co., Alliance, Ohio. Following the presentation of Mr. Bailey's paper, moving pictures were shown of several of the installations described.

The Friday session was given over to papers dealing with the work of the electrochemists during the war. The use of silicon and titanium tetrachlorides in the manufacture of compounds employed in producing smoke screens was described by O. Hutchins and G. A. Richter. Compounds of these metals sprayed into moist air are broken up into silica and hydrochloric acid, and the latter in the presence of ammonia forms dense white

fumes of particularly effective screening value. Poison gases were also developed by the electrochemists and their work along these lines was described by Col. W. H. Walker, of the Chemical Warfare Service.

Government ownership of hydroelectric power developments was also discussed and a decided difference of opinion was found to exist. The report of a committee appointed to investigate this subject was made, and while a majority of its members favored private organization and operation, a report was also submitted by the minority members favoring Government control. When, however, both reports were put to vote, the Society decided in favor of private ownership.

The Society recently held its election of officers. The new President is Lieut.-Col. W. D. Bancroft, U. S. A., of the Chemical Warfare Service and professor of chemistry at Cornell University; the vice-presidents are D. U. Dorr, W. R. Whitney, and Dr. Carl Hering. B. G. Salow was reëlected treasurer and Dr. J. W. Richards again selected as secretary.

Dinner of Utah Section of A. I. M. E.

Over two hundred engineers sat down to the dinner of the Utah Section of the American Institute of Mining and Metallurgical Engineers, held at the Hotel Utah, Salt Lake City, on Monday evening, April 7. Homer V. Winchell, president of the A. I. M. E., Prof. C. K. Leith, Adviser at the Paris Peace Conference of Bernard Baruch, Prof. J. F. Kemp, Hon. Mem. A. I. M. E., and Hon. Reed Smoot, Senator from Utah, were the speakers. Calvin Rice, Secretary of the A. S. M. E., was present, together with a number of prominent engineers of the Society and also members of the Engineering Society of Utah who had previously attended an informal dinner at the University Club in honor of Mr. Rice.

The dinner of the Mining Engineers was a great success and the spirit of coöperation and get-together of all engineers of the locality strongly emphasized. Some glimpses of the tremendous part that the mineral industry plays in the affairs of the world, together with some intimations of the gigantic task before the peace conference, now adjusting the industrial and economic machinery of all nations, some expression of the responsibility that rests upon every American to do his part of the work that lies at hand, were vividly presented.

American Railway Engineers' Association

RECENT progress in rail manufacture and testing, as well as a new method of testing rail joints, was placed on record at the annual meeting of the American Railway Engineers' Association, held at Chicago during the week of March 16th. The proposed changes in the rail specifications are slight and yet exceedingly important, for they will call for a harder rail; establish a new acceptance standard, and create an entirely new form of test to be used in place of the familiar drop-test. The required percentage of manganese in open-hearth rail of all weights is raised by 0.10 per cent, making the limits read 0.70 to 1.00 per cent. For the heavy weights of open-hearth rail, 111 lb. per yd. and over, the required amount of carbon is raised by 0.05 per cent to the figures 0.67 to 0.80 per cent. A higher ductility is also demanded, the elongation in drop test being changed from 6 to 8 per cent. Acceptance is made more difficult by requiring that all three drop or bending tests representing a given heat must pass if the heat is to be accepted.

While the drop test has also been the final physical test for rails, the experience of the Pennsylvania Railroad has so clearly demonstrated the value of a bending test that it was adopted as an alternative to the drop test. The bend test is specified to be made with a 350-ton press on a 48-in. span, and autographic records of load and deflection are to be taken; the test is to be made preferably with the rail head in tension.

Rail-Joint Tests

As the result of many elaborate tests made by the Pennsylvania Railroad to determine the strength of rail joints, the Committee on Rails submitted and there were adopted new specifications for testing rail joints. These specifications demand that the test be made in a press, the rails being supported on two supports 48 in. apart and the load applied over the joint midway of the span. Measurements of deflection and set are to be made at 3000-lb. intervals of load, and from the results of the test the efficiency of the rail joint is to be computed as the ratio of the elastic limit of the rail joint to the elastic limit of the continuous rail. This efficiency is to be stated both for head up and for head down.

The Society of Industrial Engineers

THE Society of Industrial Engineers met in New York from March 18 to 21 and all who attended their conference were impressed with the fact that a new order of things is upon us. The future will see a greater service rendered by all, and not the least of the burden will fall upon the industrial engineer as he strives for a better understanding between capital and labor.

The session held on Tuesday evening was devoted to Manufacturing and Production Problems. Papers were presented by C. E. Knoeppel, president of C. E. Knoeppel & Co., Industrial Engineers; J. E. Otterson, vice-president of the Winchester Repeating Arms Co., and C. H. Scovell of Scovell, Wellington & Co. Dr. S. W. Stratton also spoke, and in discussing the work of the Bureau of Standards as related to commercial and industrial problems, illustrated his talk with stereopticon views.

The technical session on Wednesday evening was devoted to a consideration of labor problems. The speakers of the evening were Irving A. Berndt, Col. Walter Dill Scott, Magnus W. Alexander, Meyer Bloomfield and Dudley R. Kennedy. Colonel Scott discussed the personnel classification in the Army, and elsewhere in this issue will be found a paper describing in detail this important work.

Engineering Education

The afternoon session of Thursday was given over to a discussion of The Influence of Engineering Education. Dean Schneider, of the University of Cincinnati, was unable to be present and in his place Prof. D. S. Kimball of Cornell occupied the chair. The first speaker of the session was L. P. Alford, editor of *Industrial Management*. Mr. Alford discussed the engineer's place in reconstruction and pointed out that in our present complicated civilization, reconstruction must go beyond medieval ideas. We must do more, he said, than tell the people to "be good." We must show the worker the way and the means.

The chief of the training service of the Department of Labor, H. E. Miles, spoke on Training and Education of Workers. Over one-half the factory workers in the United States, he declared, are giving less than a half-day's fair production. This means a loss of approximately $170,000,000,000. Production, he insisted, must be increased and training is also needed. Mr. Miles also urged manufacturers to coöperate with the U. S. Training Service of the Department of Labor.

Executives as well as workers must be trained and educated, declared F. N. Steinmetz, Jr., president of the Western Efficiency Society. A danger, he said, rests in the possibility of industry continuing to be haphazard. The worker, the major executives and the minor executives must all be educated, and this, he believed, could best be done by the manufacturers themselves, coöperating with the various technical organizations.

The final address of the session was made by C. R. Dooley, on Standards of Engineering Education. As illustrating the work of the Government along these lines, he stated that of all the men who were drafted only 8 per cent had had a high-school education or better, and that the great majority had had no continuity of training. Furthermore, only one-half as many skilled men were found as were needed. The United States Training Service was given 90,000 men and in two months' time had graduated 7000 of them in approximately sixty different trades.

Industrial Engineering as a Profession

An informal banquet was held on Thursday evening, March 20. President L. W. Wallace presided and the topic of the evening was Industrial Education—The Profession. In discussing the subject Professor Kimball declared that the power of modern civilization rested upon the ability to produce worldly goods in enormous quantities. The capacity for production, he stated, was such that he could see no reason why we cannot feed the hungry and clothe the poor as no other people have ever done. People themselves are beginning to form convictions such as these and industry should be considered as the means of supporting human life in the best possible way, but this of course means a radical reorganization of industry if these ideas are to be carried out.

The Scope of Industrial Engineering was discussed by John R. Dunlap, and The Future of Industrial Engineering by Harrington Emerson, Director of Emerson Engineers, New York. Papers were also read by F. C. Schwedtman, vice-president of the National City Bank of New York, and Louis C. Marburg of Marburg Bros., Inc.

Labor-Saving Equipment

The final session was held on Friday afternoon, and the discussion was chiefly concerned with labor-saving equipment as related to maximum production and the elimination of fatigue. Mrs. Frank B. Gilbreth spoke on Fatigue Elimination, and referring to some recent studies by psychiatrists at Boston, emphasized the fact that their work had brought out the resemblance between patients coming to hospitals for psychopathic treatment and many employees in plants. There is, however, she declared, a marked difference between psychopathic fatigue and physical fatigue, and while a worker may not actually be fatigued in body, he may feel so mentally. Mrs. Gilbreth also declared that the psychologist had come into industry to stay and she urged a continuation of the admirable personnel work which had been accomplished by the Adjutant General's Department.

The Need for Labor-Saving Equipment was discussed by Leon I. Thomas, managing editor of *Factory*. About 25 per cent of the alien workmen in the Middle West, he said, are planning to return to their mother countries and such emigration may perhaps produce a shortage of common labor. Furthermore, a new social order is bound to arise and he predicted a great wave of education which, too, will decrease the supply of common labor. It is the duty therefore of the engineer to meet these needs.

J. M. Carmody, in discussing the industrial engineer and the future, considered that an open mind is of primary importance. Engineers, he declared, cannot afford to be behind in the new social order, and particularly industrial engineers, who have a vastly larger field than that of mere welfare work.

During the final session President Wallace announced that sections will shortly be formed at New York, Cleveland, Detroit and Chicago; and that the next conference will be held at Cleveland during the coming autumn.

For a portion of this report Mechanical Engineering is indebted to *The Iron Age*.

In its issue of March 21, *Engineering* (London) published an account of a meeting of the Diesel Engine Users' Association, and announced that, as a result of papers and discussion, the Association has approved and is now circulating among its members the following definitions of Diesel and semi-Diesel engines.

A Diesel engine is a prime mover actuated by the gases resulting from the combustion of a liquid or pulverized fuel injected in a fine state of subdivision into the engine cylinder at or about the conclusion of a compression stroke. The heat generated by the compression to a high temperature of air within the cylinder is the sole means of igniting the charge. The combustion of the charge proceeds at, or approximately at, constant pressure.

A semi-Diesel engine is a prime mover actuated by the gases resulting from the combustion of a hydrocarbon oil. A charge of oil is injected in the form of a spray into a combustion space open to the cylinder of the engine at or about the time of maximum compression in the cylinder. The heat derived from an uncooled portion of the combustion chamber, together with the heat generated by the compression of air to a moderate temperature, ignites the charge. The combustion of the charge takes place at, or approximately at, constant volume.

NECROLOGY

JAMES NISBET HAZLEHURST

Major James N. Hazlehurst, a prominent member of the engineering profession of Atlanta, Ga., died at Brussels, Belgium, February 9, 1919, at 55 years of age. Early in June, 1917 he was commissioned Major of Engineers and assigned to the staff of Major-General Wood, Commander of the Department of the Southeast, as water supply officer of that department. When in September of that year General Pershing cabled for 11 expert engineers, Major Hazlehurst was one of the number chosen to go overseas, serving as first assistant to the officer in charge of the water supply section for six months at General Headquarters, S. O. S., Toms. He was made water-supply officer for Base No. 6 in October, his territory extending from the Riviera to the Italian frontier. Late in January he was assigned to the American Commission to negotiate peace and as Director of the Division to estimate damage to buildings at Brussels, his death occurring while on this assignment.

He was author of a number of technical articles and also a book entitled Towers and Tanks. Major Hazlehurst was very active in technical affairs, taking a leading part in the organization of the Affiliated Technical Societies of Atlanta. He became a member of our Society in 1916.

JOSEPH W. HENDERSON

Joseph W. Henderson, chief of the Bureau of Smoke Regulation, Pittsburg, Pa., died on December 19, 1918. Mr. Henderson was born in Millbrook, Ontario, Canada, on February 22, 1869, and was educated in the schools of Jackson, Mich. He was formerly connected with the Griffin Wheel Co., Chicago, the Maryland Car Wheel works, Baltimore, and the Butler Car Wheel Co., Butler, Pa. He was also vice-president of the Gulick, Henderson Co., New York.

Mr. Henderson was a member of the American foundrymen's Association, the Railway Club of Pittsburg, and the Chamber of Commerce of Pittsburg. He became a member of the Society in 1916.

WILLIAM THOMAS COYLE

William T. Coyle, of the engineering department of the U. S. Naval Experimental Station, New London, Conn., died on December 18, 1918, of pneumonia.

Mr. Coyle was born in Hartford on January 11, 1887, and was educated in the public and high schools of that city. In 1905 he started work for the Sterling Blower Co., Hartford, as detailer, designer and draftsman on heating, ventilating and dust-carrying systems. From 1907 to 1909 he was connected with the Pope Manufacturing Co., Hartford, as draftsman. His next position was with the Dwight Slate Machine Co., also located in Hartford, as a designer of drill presses, gear cutters, marking machines, etc. In 1910 he became connected with the Bullard Machine Tool Co., Bridgeport, as a designer of boring mills, roughing lathes, etc.

William T. Coyle

After four years with this company he became special engineer for the Putnam Machine Co., Fitchburg, Mass., where his work dealt with the development of a new line of boring mills. From 1915 to 1917 he was with the Winchester Repeating Arms Co., New Haven, as designer of equipment and assistant chief draftsman, when he again returned to the Putnam Machine Co., until October, 1917. At that time he became associated with the Deane Machine Co., Fitchburg, as secretary and mechanical engineer. In the summer of 1918 he was called to the Naval Experimental Station.

Mr. Coyle became an associate-member of the Society in 1918.

FREDERICK LESTER LANE

Frederick L. Lane, works manager of the McCambridge Co., Philadelphia, died on March 6, 1919. Mr. Lane was born on March 6, 1856, in St. Johnsbury, Vt., and was educated in the schools of Springfield, Mass. He was formerly connected with the Chapman Valve Manufacturing Co., Springfield, as superintendent, and up to the early part of the present year held the position of mechanical superintendent with the Haines, Jones & Cadbury Co., Philadelphia. Mr. Lane became a member of the Society in 1915.

LOUIS H. MARTELL

Louis H. Martell, president of the Martell Packings Co., Elyria, Ohio, died on January 31, 1919. Mr. Martell was born in Tusket, Nova Scotia, Canada, on February 26, 1864. He was educated in Mt. Clemens, Mich., serving a three-years' apprenticeship with the Michigan Central Railroad, Jackson, Mich. He was later employed by the Boston, Revere Beach and Lynn Railroad and also served as an engineer on coast-wise steamers.

He was also connected with W. B. Merrill & Co., Boston, and under his management the Pitt Manufacturing Co. was organized. In 1908 he became associated with the Metallic Packing & Manufacturing Co. Mr. Martell became a member of the Society in 1906.

STEPHEN PAUL HOSKINS

Stephen Paul Hoskins, 319 Infantry, A. E. F., was killed in action on November 2, 1918, in one of the battles of the Argonne Forest and lies buried near the little town of Imecourt.

Lieutenant Hoskins was born on May 22, 1891, in Erie, Pa. He received his education in the grade schools of Pennsylvania and West Virginia, later attending the West Virginia Wesleyan College and the West Virginia University. He was graduated from the latter in 1914 with the degree of B. S. in mechanical engineering. The year following his graduation he was assistant in mechanical drawing in the University, and later instructor in machine design and mechanical drawing.

Lieut. Stephen P. Hoskins

He left this position to become efficiency engineer with the research division of the Westinghouse Electric & Manufacturing Co., Pittsburg, Pa., where he remained until June, 1916. An attack of inflammatory rheumatism made it necessary for him to sever temporarily his business connections and upon his recovery he entered the service at Camp Lee, Petersburg, Va., in October, 1916. He was recommended for the Third Officers' Training Camp and just before leaving for France was graduated as second lieutenant. He was later promoted to first lieutenant for bravery on the field and just prior to his death was recommended for promotion to the grade of captain and for the Distinguished Service Cross.

Lieutenant Hoskins became a junior member of the Society in 1916.

HARRY DREW EGBERT

Harry Drew Egbert was born at Bay Head, N. J., on August 24, 1886, and died of pneumonia on March 23, 1919. He was educated in the Jersey City public schools and in the Newark Academy. He entered Columbia University in 1904 as a sophomore. The year previous to his entrance he spent with his father, Prof. J. C. Egbert of Columbia, in Rome, where the latter was serving as professor of classical literature in the American School of Classical Studies.

Mr. Egbert was graduated from Columbia University in 1907. He then entered the Schools of Applied Science and spent three years in study for the degree of mechanical engineer which he received in 1910. In the summer during his scientific study he attended the course in surveying at Camp Columbia and was an apprentice in different shops where he became familiar with the practical side of his profession.

After his graduation Mr. Egbert became a member of the office force of the Guaranty Construction Co. After two years he was asked to join the staff of the Research Corporation and in connection with this organization he became an expert on electrical precipitation and was the author of many articles on this subject.

He was a member of the Phi Beta Kappa and Sigma Xi societies. He became a junior member of our Society in 1915 and was secretary of the New York Section, the Executive Committee of which on April 9, 1919, adopted the following resolution:

Resolved, That there be entered upon the minutes the sincere regret of the Committee and their appreciation of his splendid achievements as an engineer and his untiring effort to at all times advance the interest of the Profession, the Society and this Committee.

CHARLES B. RICHARDS

Charles B. Richards, scientist and inventor, for 25 years Higgins Professor of Mechanical Engineering at Yale University and for the last nine years professor emeritus, died on April 20, 1919, in his eighty-sixth year. Professor Richards was a charter member of the Society, having served as manager 1880-1882 and as vice-president, 1888-1890. A more extended biographical sketch will be published in the June issue of Mechanical Engineering.

CHARLES H. MANNING

Capt. Charles H. Manning, for many years prominent in engineering circles in New England, died at Manchester, N. H., on April 1, 1919, in his seventy-fifth year. Captain Manning became a member of the Society in 1884 and was elected to Honorary Membership in 1913, having served as manager 1892-1895 and as vice-president 1895-1897. In the June issue of Mechanical Engineering a more extended account of Captain Manning's life and activities will appear.

PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by May 15 in order to appear in the June issue.

CHANGES OF POSITION

William A. Blackburn has severed his connections with the Bryant Manufacturing Company, Chicago, Ill., as works manager, and has assumed the position of general manager of the Gray Motor Company, Detroit, Mich.

F. W. Cleveland, formerly assistant superintendent of equipment, Pratt and Whitney Company, Hartford, Conn., has accepted a position with the Illinois Watch Company, Springfield, Ill., in the capacity of equipment engineer.

Arthur C. Whatley, formerly marine draftsman, Bethlehem Shipbuilding Corporation, Bethlehem, Pa., is now in the employ of the Union Oil Company of California, Los Angeles, Cal.

W. H. Diefendorf of Syracuse, N. Y., has resigned his position as chief engineer and director of the New Process Gear Corporation, and is now with the Weeks-Hoffman Company of the same city.

John J. Eason has resigned his position as manager of the Havana Iron Works and the Havana Dry Dock Company at Havana, Cuba, and has accepted a position with the U. S. Shipping Board, Emergency Fleet Corporation, Ship Construction Division, Philadelphia, Pa.

Lewis A. Belding, who for the past two years has been assistant professor of mechanical engineering at Stevens Institute of Technology, Hoboken, N. J., is now associated with the Thomas A. Edison interests at Orange, N. J., in the power service division, as service engineer.

Charles Eisler, for about five years with the Westinghouse Lamp Company, Bloomfield, N. J., as chief designer and engineer in charge of the equipment, designing and development departments, has resigned and has become associated with the recently organized Save Electric Corporation, Brooklyn, N. Y., in the capacity of superintendent of the equipment, designing and development departments.

Kenneth Lydecker, formerly engineer with the Standard Oil Company of New Jersey, has become associated with The White Company, Cleveland, Ohio.

Alfred W. Kimmel, until recently mechanical engineer, Airplane Engineering Department, Bureau of Aircraft Production, McCook Field, Dayton, Ohio, has assumed the duties of general manager of the newly opened eastern office of the Charles M. Kelso Company, Inc., in Utica, N. Y.

Ralph B. Kennard has become affiliated with the engineering department of the New Jersey Zinc Company, Palmerton, Pa. He was until recently connected with the Niagara, Lockport and Ontario Power Company, Buffalo, N. Y., in the capacity of chief draftsman.

Louis W. Sipley, formerly with the Midvale Steel and Ordnance Company, has become affiliated with the Electric Storage Battery Company, of Philadelphia, Pa., in the capacity of sales engineer.

William L. DeBaufre has resigned from the Naval Engineering Experiment Station, Annapolis, Md., and has assumed the duties of designing engineer with the Precision Instrument Company, Detroit, Mich.

J. W. Brussel, formerly superintendent of the Wright-Martin Aircraft Corporation, Long Island City, has accepted a position as factory manager of the Dyneto Electric Corporation, Syracuse, N. Y.

Walter H. Hall has accepted the position of plant engineer with the Champion Ignition Company, Flint, Mich. He was formerly connected with the Remington Arms Union Metallic Company, Swanton, Vt., as works engineer.

E. D. Walen, until recently associate physicist, Bureau of Standards, Washington, D. C., has assumed the duties of manager of the Textile Research Company, Boston, Mass., which has recently been organized by textile manufacturers for the conduct of research or to have research conducted for them along textile lines.

William Stewart Ayars has left the employ of the U. S. Shipping Board where he had been senior performance engineer, Division of Ship Construction, Philadelphia, Pa., and has entered the employ of the Pusey and Jones Company, Wilmington, Del., as chief estimator.

Lloyd D. Gilbert has accepted the position of chief engineer with the Sandusky Cement Company, Cleveland, Ohio. He was formerly chief engineer and superintendent with the Southwestern Portland Cement Company at Victorville, Cal., and also engineered the El Paso plant for the same company.

I. Tornberg, formerly assistant chief draftsman, R. Hoe and Company, New York, has become associated with the Wood Newspaper Machinery Corporation, Plainfield, N. J., in the capacity of engineer.

ANNOUNCEMENTS

K. G. Walker has become affiliated with the Atlas Company, of Lincoln, N. J.

Capt. Philip F. Miller, Ordnance Department, U.S.A., has been discharged from the Army and has become connected with the New York sales office of the A. S. Cameron Steam Pump Works, New York.

Eugene E. Maher has resigned from the district sales managership of the Terry Steam Turbine Company, Hartford, Conn., and has opened offices in Chicago, Ill. He will handle sales and construction of lines of centrifugal, triplex and steam pumps, and engines.

Barzillai G. Worth, vice-president and general manager of Walter Kidde and Company, Inc., New York, has been elected treasurer of the Monmouth Chemical Company, which produces potassium chlorate electrolytically, using processes and apparatus developed under Mr. Worth's direction and whose manufacturing is technically supervised by Walter Kidde and Company, Inc. A contribution to the war was the development by this organization for the Monmouth Chemical Company of a special bromate free chlorate surpassing the German standard, which was adopted by the Ordnance Department to eliminate the causes for ammunition failures reported to Congress in the early stages of the war by Secretary Baker.

Reuben Hill, Major, Ordnance Department, U. S. A., has received his discharge from the service and has accepted the position of chief engineer with the Pratt and Whitney Company, Hartford, Conn.

George E. Harris, for the past year First Lieutenant, U.S.A., assigned to the Bureau of Aircraft Production, Finance Department, has become connected with the Hawkridge Brothers Company, Boston, Mass., in the capacity of director of sales. Mr. Harris has been engaged in the steel business, in both operating and selling ends, for the past 20 years.

A. L. Kershaw has accepted a position with the Electric Auto-Lite Corporation, of Toledo, Ohio.

A. B. Taggart, formerly secretary and treasurer of the Advance Machinery Company, has gone into business in Toledo, Ohio, under the firm name of Toledo Glue Appliance Company, as a designer and manufacturer of glue heaters. Mr. Taggart was connected with the Advance Machinery Company for about seven years, disposing of his interest there last July to enlist. His new company will specialize as consulting engineers in agglutinants and methods of preparing them for use.

Major C. E. Whipple has been honorably discharged from the U. S. Army and has returned to his duties as general manager and treasurer of the New York Central Iron Works Company, Hagerstown, Md.

W. H. Kniskern has become connected with the engineering division, nitrate products department, of the General Chemical Company, New York.

George L. Lubbert has resigned his position of chief operating engineer, Filtration Plant, Baltimore City Water Department, and is now engaged in the electrical and mechanical engineering and contracting business with office in Baltimore, Md.

F. J. Ryan, general manager of the American Metallurgical Corporation, Philadelphia, Pa., was elected to the position of vice-president and treasurer, also continuing as general manager.

T. W. Ransom, chief inspector for the Emergency Fleet Corporation, has resigned, and on April 1 resumed his own offices in San Francisco, as consulting engineer.

Henry M. Leps has assumed the position of general superintendent for the Kanawha Manufacturing Company, Charleston, W. Va.

Herbert M. Hill has accepted a position with the Paper Utilities Corporation, New York, in the capacity of mechanical engineer.

Carl Ehrmann has severed his connection as chief engineer of the Oklahoma Petroleum and Gasoline Company, Tulsa, Okla., and has opened offices as consulting engineer in the same city.

Dean E. Foster, Secretary of the recently organized Mid-Continent Section of the Society, on April 1 severed his connection with Cosden and Company to enter consulting practice with F. P. Peterson, under the firm name of Frank P. Peterson Company, Tulsa, Okla.

Thomas Chester has opened an office in St. Louis, Mo., in order to manage the St. Louis district office for the American Blower Company. He was until recently connected with the New York office of the company as special representative, handling the Navy business.

Lieut. F. C. Holmgren, who returned from France in February, has taken the management of the Philadelphia branch of the Trailmobile Company. Lieutenant Holmgren has been identified with the automobile and truck industry since 1905.

Clarence O. Hartman has become associated with the Atlas Portland Cement Company, Northampton, Pa. He was, until recently, connected with the Engineering Bureau of the U. S. Government at Washington, D. C.

B. J. Cline has assumed the position of factory manager of the Templar Motors Corporation, Cleveland, Ohio.

Captain Harvey S. Benson has left the Ordnance Department, U.S.A., and has assumed the duties of factory manager of the Caskey Dupree Manufacturing Company, of Marietta, Ohio.

Major Leiferts Hutton, M.C., son of the late Prof. Frederick R. Hutton, Past-President and Honorary Secretary of the Am. Soc. M.E., has been cited for exceptional energy and zeal in the performance of all duties as assistant division surgeon and for courage displayed under fire in the forward areas. This throughout the service of the division in Belgium and in France.

Leo Mayer, for nine years construction engineer for the Otis Elevator Company at New York and Cleveland, and more recently with the Bureau of Construction and Repair, Navy Department, has resigned his position with the Navy Department and has established himself as sales engineer with offices in Boston, Mass., specializing in conveying and material handling machinery. Mr. Mayer also represents the Standard Conveyor Company, of St. Paul, Minn.

John R. Battle has opened an office in Philadelphia, Pa., as consulting industrial oil and mechanical engineer. He was, until recently, mechanical engineer and Philadelphia manager of Swan and Finch Company, of New York.

Lieut. Wallace J. Cross, Engrs. U.S.A., has been discharged from service and has accepted the position of assistant mechanical engineer with the Watson Engineering Company, Cleveland, Ohio.

Major James Guthrie, U.S.A., Ordnance Engineering, has returned to Cleveland and reopened his consulting engineering office. Major Guthrie put aside his practice in order to enter active service at the beginning of the war, completing a staff assignment in Washington and serving eight months as engineering manager of the Michigan Ordnance District.

Lieut. Richard S. Austin, of Brooklyn, N. Y., a member of the 166th Aero Squadron, was cited by General Pershing for valor during the Argonne-Meuse offensive.

APPOINTMENTS

Harold J. Williams, First Lieutenant, Ordnance Department, U.S.A., who for the last 16 months has been attached to the Mobile Gun Carriage Section of the Artillery Division, Washington, D.C., has resigned his commission in the Ordnance Department to accept the appointment of engineer for the Beacon Falls Rubber Shoe Company, Beacon Falls, Conn., and associated interests. Prior to his entry into service, Mr. Williams was consulting and mechanical engineer, and was also on the teaching staff of Pratt Institute, Brooklyn, N. Y.

AUTHORS, ETC.

Miss Kate Gleason, the first woman to be elected a member of the Am. Soc. M.E., addressed the Rochester Engineering Society at its weekly meeting on March 17 at the Hotel Seneca. She described engineering features noted on her recent visit to the Orient.

Major W. B. Gregory has been appointed representative of the Louisiana Engineering Society at the conference of Engineering Societies to be held in Chicago, April 23 to 25.

LIBRARY NOTES AND BOOK REVIEWS

Aeronautical Engines. A Critical Survey of Current Practice with Special Reference to the Balancing of Inertia Forces. By Francis Jogn Kean. Second edition. Spon & Chamberlain, New York. 1918. Cloth, 5 x 8 in., 101 pp., 49 illus., 31 pl.. $2.50.

This book consists of a course of ten lectures given during 1915 to men of the Royal Naval Air Service and the Royal Flying Corps, designers and engineering students.

The Design and Construction of Dams. Including Masonry, Earth, Rock-fill, Timber and Steel Structures, also the principal types of Movable Dams. By Edward Wegmann. Sixth edition, revised and enlarged; 1918 reprint revised. John Wiley & Sons, Inc., New York, 1918. Cloth, 9 x 12 in., 529 pp., 157 pl., 24 tables, $6.

The present volume is a reprint, with revisions, of the sixth (1911) of this well-known and popular treatise. A special feature of the book is the detailed information given concerning important dams in all parts of the world.

Compressed Air Plant. By Robert Peele. Third edition. John Wiley & Sons, Inc., New York, 1919. Cloth, 6 x 9 in., 485 pp., 246 illus., 54 tables, $4.25.

This edition has undergone a thorough revising, and a number of chapters have been rewritten and several have been expanded, while old material has been condensed or omitted. The volume describes current practice in the construction and operation of compressors and discusses the applications of compressed-air drilling, pumping and hauling, with special reference to mine service.

Cotton Facts. (Edition of October, 1918.) Compilation from Official and Reliable Sources of the Crops, Receipts, Exports, Stocks, Home and Foreign Consumption, Visible Supply, Prices, and Acreage of Cotton in the United States and Other Countries for a Series of Years. Also Cotton-Mill Statistics of the United States, Europe, India, etc., the Reports of Condition of Growing Cotton Crops, issued by the U. S. Department of Agriculture and the Cotton Acreage and Yield of each State and County in the South according to the U. S. Census. Edited by Carl Geller. Shepperson Publishing Co., New York. 1918. Cloth, 4 x 7 in., 240 pp., 1 por., $1.

This volume is the forty-third annual issue. In a book of pocket size, it presents the statistics needed by cotton merchants, manufacturers and growers, as indicated in the title.

Gasoline and Kerosene Carburetors. Construction—Installation—Adjustment. A simple, comprehensive Treatise for Practical Men, explaining all principles pertaining to Carburetors for all Types of Internal-Combustion Engines intended to operate on Liquid Fuels such as Gasoline, Kerosene, Benzol and Alcohol. By Victor W. Pagè. The Norman W. Henley Publishing Co., New York, 1919. Cloth, 5 x 8 in., 219 pp., 89 illus., $1.50.

A handbook for operators of internal-combustion engines. Explains in non-technical language the principles of carburetors, the usual modern types and the method of adjusting and repairing them.

Graphic Charts for the Business Man. By Stephen Gilman. La Salle Extension University, Chicago, 1918. Paper, 6 x 9 in., 62 pp., 56 illus.

A pamphlet showing the value of charts in presenting statistical data, and describing some of the varieties used in business.

Hendrick's Commercial Register of the United States for Buyers and Sellers. With which has been incorporated The Assistant Buyer. Especially devoted to the Interests of the Electrical, Engineering, Hardware, Iron, Mechanical, Mill, Mining, Quarrying, Chemical, Railroad, Steel, Architectural, Contracting and kindred Industries. A complete and reliable annual Register of Producers, Manufacturers, Dealers and Consumers connected with the aforesaid Industries. S. E. Hendricks Co., Inc., New York, (copyright 1918). Cloth, 8 x 10 in., 2381 pp. $10.

This register of producers, manufacturers, dealers and consumers connected with the engineering and industrial activities of the country has been carefully revised and corrected. The firms included are listed alphabetically and also carefully classified. A section containing trade names and brands, with the names of manufacturers, forming a convenient ready reference list for purchasers, is a distinctive feature.

Mill and Cyanide Handbook. Comprising Tables, Formulæ, Flowsheets, and Report Forms, compiled and arranged for the use of Metallurgists, Mill-men and Cyanide Operators. By W. A. Allen. J. B. Lippincott Co., Philadelphia, 1918. Cloth, 4 x 7 in., 128 pp. $2.

The author has tabulated the physical, chemical and mechanical data needed by mill-men, in a volume of convenient size, well indexed. A glossary of mill and cyanide terms is included.

Modern Shipbuilding Terms Defined and Illustrated. Including a Series of Photographs showing the Progressive Steps of Construction, together with an Appendix on Electric Welding. By F. Forrest Pease. Lippincott Co., Philadelphia, (copyright 1918). Cloth, 5 x 8 in., 143 pp., 68 pl. $2.

This work contains a glossary of the more common words and phrases used in building a steel ship; a list of shipyard trades and the duties performed by each; a series of instruction charts on electric welding; a list of symbols used on plans and parts; a description of the Isherwood system of shipbuilding; directions for the use of acetylene, hydrogen and oxygen for cutting and welding; and a select list of books on ship construction and equipment. The plates illustrate the construction of a ship by the usual methods, the construction of the "fabricated" ship, and the tools, machines and installations.

Simplified Navigation for Ships and Aircraft. A Text Book based upon the Saint Hilaire Method. By Charles Lane Poor. The Century Co., New York, 1918. Cloth, 126 pp., 10 illus., 7 charts, 4 tab. $1.50.

This work is an attempt to explain in non-technical language and without the use of complicated mathematics the principles which form the basis of modern methods of navigation. Particular attention is given to aerial navigation.

A Study of Engineering Education. Prepared for the Joint Committee on Engineering Education of the National Engineering Societies. By Charles Riborg Mann. (Carnegie Foundation for the Advancement of Teaching, Bulletin number 11). New York, 1918. Paper, 8 x 10 in., 139 pp.

The purpose of this report is to examine the fundamental question of the right methods of teaching and of the preparation of young men for the engineering professions. In the light of the fifty years of experience of the engineering colleges of the United States, an effort has been made to suggest the pedagogic basis of the course of study intended to prepare young men for the work demanded of the engineer to-day, without losing sight of the point of view of the teacher, the engineer, the manufacturer and the employer. A limited number of typical schools were visited and studied by Professor Mann and the views of the whole engineering profession throughout the country were ascertained in the course of the investigation. It is the hope of the Committee that the report will awaken wide interest because of its applicability, and that its influence on engineering education will be beneficial.

The Silk Directory. Davison's Silk Trade. Office Edition. A Directory of the Silk Manufacturers of the United States and Canada, including Silk Dyers, Finishers and Printers; Manufacturers' Agents; City Offices and Salesrooms of Silk Mills; Dealers in Raw, Thrown, Spun and Artificial Silk; Waste; Cotton, Tinsel and Worsted Yarns; Silk Jobbers and Retailers and a Classified Directory of All Manufacturers of Silk Goods. Twenty-third annual edition. Davison Publishing Co., New York. (Copyright, 1918.) Cloth, 8 x 6 in., 778 pp. $3.50.

The directory includes dyers, finishers, printers, manufacturers' agents, city offices and salesrooms of mills, dealers, jobbers, retailers and manufacturers. These are given in lists classified primarily by occupation and secondarily by location. The lists have been carefully revised and enlarged by the addition of new establishments.

Success in the Small Shop. By John H. Van Deventer. Second edition. Published by American Machinist. (McGraw-Hill Book Co., Inc., sole selling agents), New York, 1918. 1/4 cloth, 9 x 11 in., 137 pp., illus. $1.75.

A series of articles, 50 in number, dealing with the problems of small machine shops, that appeared originally in the *American Machinist*. The articles discuss economic conditions, management, equipment, methods, etc., and are intended to be of practical help to owners and workmen.

Handbook of Chemistry and Physics. Compiled by Charles D. Hodgman, assisted by Melville F. Coolbaugh and Cornelius E. Senseman. The Chemical Rubber Co., Cleveland, Ohio, 1918. Flexible cloth, 4 x 7 in., 557 pp., $2.50.

This compilation is intended to present in one volume of convenient size a comparatively comprehensive reference book for the use of chemists and physicists. The seventh edition has been enlarged by one hundred pages, which contain a revision of a table of the physical constants of organic compounds. This table now includes about two thousand substances. Various minor additions and corrections have been made throughout the work.

Heaton's Annual. 15th Year, 1919. Published by Heaton's Agency, Toronto, Canada. Cloth, 5 x 7 in., 512 pp. (including advertisements), $1.50.

A handbook of condensed commercial and industrial information on Canada. Describes the natural and commercial resources of the provinces, and industrial opportunities in the towns and cities. Much general information of use to visitors and business men is included.

A Manuel of Chemical Nomography. By Horace G. Deming. The University Press, Champaign, Ill., 1918. In two parts, text and tables, $1.25.

The Noman (part one) is a nomographic reckoner, devised by the author for the graphic solution of various arithmetical problems. Multiplication, division, powers, roots and logarithms can be treated by the eighteen charts, with an average error of one part in four or five thousand.

The manual describes the method of using the Noman and gives specific examples of its application to the solution of chemical problems and indicates the kinds of calculations in which it is most useful.

Model Making. Including Workshop Practice, Design and Construction of Models. A Practical Treatise for the Amateur and Professional Mechanic. Gives Instructions on the Various Processes and Operations Involved in Model Making and the Actual Construction of numerous Models, including Steam Engines, Speed Boats, Guns, Locomotives, Cranes, etc. Lathe Work, Pattern Work, Electroplating, Soft and Hard Soldering, Grinding, Drilling, etc., are also included. Edited by Raymond Francis Yates. The Norman W. Henley Publishing Co., New York, 1919. Cloth, 6 x 9 in., 390 pp., 303 illus., 1 pl., $3.

The author hopes that his book will promote interest in model engineering in this country, and will also give a correct impression of its value as a recreation.

Nineteenth Year Book. Of the Rubber Association of America, Inc., New York, 1918. Paper, 6 x 9 in., 119 pp.

Contains list of members, constitution and annual report for 1918.

Public Utility Rate Fixing. Comments on Current Problems Pertaining to Public Utilities and to Rate Fixing. By C. E. Grunsky. Technical Publishing Co., San Francisco, 1918. Cloth, 6 x 9 in., 169 pp., 5 charts, 2 pl., $2.50.

A reprint of a number of articles originally contributed to the *Journal of Electricity*, written in the hope that they may prove helpful in determining fair rates for the output of public utilities and in prescribing methods of procedure when rates are to be fixed; and that they may assist in the solution of some of the economic problems which arise in the readjustment to peace conditions.

Radiation, Light and Illumination. By Charles Proteus Steinmetz. Compiled and edited by Joseph LeRoy Hayden. Third edition. McGraw-Hill Book Co., Inc., New York, 1918. Cloth, 6 x 9 in., 305 pp., 127 illus., 1 pl., 14 tables, $3.

A series of twelve experimental lectures, most of which were delivered in 1908-1909, with the exception of two lectures on Light Flux and Distribution, and Light Intensity and Illumination. The treatment is non-mathematical and discusses the subjects in plain language. This edition is apparently a reprint of the preceding ones.

The Shipbuilding Industry. By Roy Willmarth Kelly and Frederick J. Allen, with an introduction by Charles M. Schwab. Houghton Mifflin Co., Boston and New York, 1918. Cloth, 6 x 8 in., 303 pp., 61 pl. $3.

The primary purpose of this volume, as stated by the authors, is to describe and interpret for the general public, as well as for those employed in the shipyards, our war emergency shipping program and the task of the shipbuilders. It is also hoped that the book will help those who wish to prepare themselves for executive positions and those considering shipbuilding or naval architecture as a possible life calling.

Steam Engine Troubles. A Practical Treatise for the Engineer, telling how to locate and remedy troubles with a Steam Engine. Cylinders, Valves, Pistons, Frames, Pillow Blocks and other Bearings, Connecting Rods, Wristplates, Dashpots, Reachrods, Valve Gears, Governors, Piping, Throttle and Emergency Valves, Safety Stops, Flywheels, Oilers, etc., are all treated. By H. Hamkens. The Norman W. Henley Publishing Co., New York, 1919. Cloth, 5 x 8 in., 284 pp., 276 illus., $2.50.

A simple account of the troubles which may arise in steam-engine operation, the causes and the proper remedies. Intended for the power-plant engineer. Based on a series of articles published in *Power*.

THE ENGINEER AS A CITIZEN

(*Continued from page 451*)

engineers have placed a stamp more marked than any other group of men. Among the every day questions in legislation and administration are many engineering problems. The engineer's knowledge is therefore needed in the public affairs of today, and the engineering profession must recognize the duty of making available to Society its peculiar training and experience.

Public activity, to be effective, must be carried on by groups rather than by individuals. A prerequisite of any worth-while public profession or activity, therefore, is the organization of the whole engineering profession in such a manner that it may be mobilized in city, state and nation for the purpose of giving representative opinion, appointing representative individual engineers or committees and securing united action.

Even in professional activities better organization of the profession is desirable because there no longer exist clear lines of demarkation between the spheres of interest of individual groups of engineers and because many activities, like standardization and research, can be carried on effectively only if undertaken jointly. There are in this country several hundred engineering societies having in common many aims and purposes and duplicating efforts to a large degree.

Organization and coöordination of efforts is not possible without previous crystallization of aims and purposes of individual societies. Four large national engineering societies have appointed special committees for the purpose of securing such crystallization.

This meeting, attended by members of engineering and scientific societies having a total metropolitan membership of about 15,000, feels strongly that more coöperation among all groups of engineers and among all existing engineering societies is essential. It is therefore—

Resolved, that all engineering societies of this country, not yet having committees on development, be asked to appoint such committees with instructions to undertake a survey of the aims and purposes of their respective associations and to coöperate with corresponding committees of other engineering and similar societies; and it is further

Resolved, that a copy of these resolutions be sent to every engineering society in this country.

Following the passing of this resolution, the chair appointed Mr. Castle secretary of the meeting and instructed him to carry out the order of the resolution.

Before the meeting adjourned Spencer Miller offered the following resolution, which was unanimously adopted:

Resolved, that the representatives of the local sections of the various engineering bodies here present tonight recommend to their bodies that these bodies shall send a delegate to a common engineering conference for the purpose of discussing, formulating and reporting back to their respective bodies a Code for Professional Conduct, with a view of its adoption by all the engineering bodies involved as the common code for the engineering profession.

THE ENGINEERING INDEX

Published Monthly by The American Society of Mechanical Engineers

The Engineering Index was Founded in 1884 by the Association of Engineering Societies; Published from 1895 to 1919 by The Engineering Magazine Company; and Acquired January 1919 by The American Society of Mechanical Engineers

THE following pages form a descriptive Index to articles on engineering and related subjects in current periodicals. In its preparation the Society's engineering staff regularly examines all of the technical journals and society publications received by the Engineering Societies Library, which form one of the greatest and most complete collections of scientific periodicals in the world, comprising upward of 1100 distinct publications in some ten languages. Cross-references are freely introduced in the Index, and in all cases where the titles of articles are not sufficiently descriptive, explanatory sentences are appended. The main abbreviations used in the items are given at the bottom of this page.

PHOTOSTATIC COPIES OF ARTICLES LISTED

THE Society is prepared to supply photostatic copies (white printing on brown background) of any of the articles listed. Copies of the periodicals themselves, or clippings of articles, cannot be supplied.

Price of each print (up to 11 x 14 in. in size), 25 cents plus postage. A separate print is required for each page of the larger-size periodicals, but where possible two pages will be photographed together on the same print. Bill will be mailed with the prints.

Those holding coupon books for clippings formerly issued by The Engineering Magazine Company may use the coupons in payment for photostatic prints. In ordering, state plainly

(1) Page number of Index on which item appears
(2) Title of article
(3) Name of periodical.

Orders should be sent to

HARRISON W. CRAVER, *Director,*
Engineering Societies Library,
29 West 39th Street, New York City.

DIVISIONS OF THE ENGINEERING INDEX

MECHANICAL ENGINEERING

Air Machinery
Corrosion
Forging
Foundries
Fuels and Firing
Handling of Materials
Heat Treating
Heating and Ventilation
Hoisting and Conveying
Hydraulic Machinery
Internal-Combustion Engines
Lubrication
Machine Elements and Design
Machine Shop
Machinery, Metal-Working
Machinery, Special
Machinery, Woodworking
Materials of Construction and Testing of Materials
Measurements and Measuring Apparatus
Mechanical Processes
Mechanics
Motor-Car Engineering
Pipe
Power Generation
Power Plants
Power Transmission
Producer Gas
Pumps
Refractories
Refrigeration
Research
Standards and Standardization
Steam Engineering
Textiles
Thermodynamics
Welding
Varia

ORGANIZATION AND MANAGEMENT

Accounting
Education
Export
Factory Management
Finance and Cost
Inspection
Labor
Legal
Lighting
Public Regulation
Reconstruction
Safety Engineering
Salvage
Transportation
Varia

ELECTRICAL ENGINEERING

Electrochemistry
Electrodeposition
Electrophysics
Furnaces
Generating Stations
Generators and Motors
Lighting and Lamp Manufacture
Measurements and Tests
Power Applications
Standards
Telegraphy and Telephony
Transformers, Converters, Frequency Changers
Transmission, Distribution, Control
Wiring
Varia

CIVIL ENGINEERING

Bridges
Building and Construction
Cement and Concrete
Earthwork, Rock Excavation, etc.
Harbors
Materials of Construction
Municipal Engineering
Roads and Pavements
Sanitary Engineering
Water Supply
Waterways

MINING ENGINEERING

Alloys Ferrous
Base Materials
Coal and Coke
Copper
Explosives
Geology and Mineralogy
Iron
Lead
Major Industrial Materials
Mines and Mining
Minor Industrial Materials
Oil and Gas
Precious Minerals
Rare Minerals
Tin
Transportation
Varia

METALLURGY

Aluminum
Blast Furnaces
Copper
Flotation
Iron and Steel
Non-Ferrous Alloys
Occluded Gases
Waste Recuperation

AERONAUTICS

Aeroplane Parts
Aerostatics
Aircraft Production
Applications
Auxiliary Service
Design
Dynamics
Engines
Gliders
History
Instruments
Materials of Construction
Mechanics
Meteorology
Military Aircraft
Models
Planes
Propellers
Specifications, Aeroplane
Transatlantic Flight

MARINE ENGINEERING

Auxiliary Equipment
Salvage
Ships
Yards
Varia

INDUSTRIAL TECHNOLOGY

RAILROAD ENGINEERING

Electric Railroads
Electrification
Equipment
Foreign
Labor
Locomotive
Maintenance
New Construction
Operation and Management
Permanent Way and Buildings
Rails
Rolling Stock
Safety and Signaling Systems
Shops
Special Lines
Street Railways
Terminals

MUNITIONS AND MILITARY ENGINEERING

GENERAL SCIENCE

Chemistry
Mathematics
Physics

NOTE.—The abbreviations used in indexing are as follows:

Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
New York (N. Y.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

Mechanical Engineering

AIR MACHINERY

Compressors

Up-to-date Practice in Compressor Maintenance. Elec. Ry. Jl., vol. 53, no. 12, Mar. 22, 1919, pp. 569-572, 4 figs. Methods of inspection and overhauling. Details of compressor overhauling and testing bench.

Fans

Centrifugal Fans and Their Application to Gas Engineering Practice, Frank S. Townsend. Gas Jl., vol. 145, no. 2906, Jan. 21, 1919, pp. 116-118 and discussion pp. 118-119, 15 figs. Elementary theory of fan; description of two types of centrifugal fan (radial flow and mixed flow); discussion of efficiency of fan, methods of driving, and regulation; examples of recent practice in application of fan plants. Paper before Midland Junior Gas Assn.

See also MECHANICAL ENGINEERING, Lubrication (Air Compressors); MINING ENGINEERING, Mines and Mining (Dust Sampling).

FORGING

Heavy Forgings

Making and Heat-treating Heavy Forgings, Franklin D. Jones. Machy., vol. 25, no. 7, Mar. 1919, pp 583-590, 12 figs. General practice of Tacony Ordnance Corporation in production of ingots and forgings for 155- and 240-mm. guns.

Turned Forgings

Making Accurate Turned Forgings. Iron Trade Rev., vol. 64, no. 13, Mar. 27, 1919, pp. 815-818, 8 figs. Details of manufacturing operations at plant of company specializing on finished marine and machine forgings.

FURNACES

Davis "Revergen" Principle of Firing

The Davis "Revergen" Principle of Firing Furnaces with Town Gas. Metal Industry, vol. 14, no. 9, Feb. 28, 1919, pp. 169-171, 2 figs. Demonstrations made of system in annealing steel billets at 870 deg. cent.; billet heating up to 1000 deg. cent. and high-temperature test. Also in Gas Jl., vol. 145, no. 2911, Feb. 25, 1919, pp. 385-387, 2 figs.

Industrial Furnaces

Industrial Furnaces (Fours Industriels), A. Bigot. Chimie & Industrie, vol. 2, no. 1, Jan. 1, 1919, pp. 30-36, 8 figs. Classification of various types; their uses and equipment.

Oven and Muffle Furnaces

Industrial Oven and Muffle Furnaces and Their Method of Operation, C. M. Walter. Metal Industry, vol. 14, no. 10, Mar. 7, 1919, pp. 183-185. On theoretical maximum temperatures of combustion of different fuels to be obtained in economical operation of furnaces.

FOUNDRIES

Brass Foundry

Materials and Chemicals Used in Brass Foundry Practice—IV, Charles Vickers. Brass World, vol. 15, no. 3, Mar. 1919, pp. 69-71, 2 figs. History, properties, appearance, physiological action and commercial use of the substances commonly used in brass founding.

Some Principles Involved in Melting Metals—IV, Charles Vickers. Brass World, vol. 15, no. 3, Mar. 1919, pp. 73-75. Effect of heat upon metals; action of zinc and copper; casting of yellow brass.

British

British Foundries Undergo Change, H. Cole Estep. Iron Trade Rev., vol. 64, no. 13, Mar. 27, 1919, pp. 819-823, 2 figs. Survey of conditions in Great Britain, with reference to recent improvements in shop methods.

Malleable Foundry

Uses Electric Furnace in Malleable Foundry, F. L. Prentiss. Iron Age, vol. 103, no. 9, Feb. 27, 1919, pp. 537-543, 8 figs. Features of Cleveland plant of Nat. Malleable Castings Co., designed for making castings by Kranz triplex process.

Nickel Alloy Castings

Casting Nickel Silver—a Copper-Nickel-Zinc Alloy, R. V. Hutchinson. Metal Industry, vol. 14, no. 9, Feb. 28, 1919, pp. 161-162, 1 fig. Method of packing a crucible with nickel silver.

Patternmaking

Patternmaking Methods, Joseph A. Shelly. Machy., vol. 25, no. 7, Mar. 1919, pp. 631-634, 9 figs. Typical examples of pattern work and methods used in general practice. First article.

Pouring Metal

Foundry Puzzles and Their Solution, J. G. Horner. English Mechanic, vol. 109, no. 2816, Mar. 14, 1919, pp. 85-86. Remarks on static load and dynamic action at time of pouring due to inrush of molten metal.

Sand

Ferruginous and Other Bonds in Molding Sands, P. G. H. Boswell. Brass World, vol. 15, no. 3, Mar. 1919, pp. 81-84. Foundry practices followed in Great Britain, France, Belgium and Germany. Paper read before Am. Foundrymen's Assn.

The Practical Analysis of Molding Sand, U. Albert Hayes. Iron Age, vol. 103, no. 12, Mar. 20, 1919, pp. 739-741, 2 figs. Selection according to physical qualities and the nature of the work is advocated; sieve tests.

See also MECHANICAL ENGINEERING, Heating and Ventilation (Foundry Ventilation), Standards and Standardization (Brass and Brass Foundries).

FUELS AND FIRING

Absorption of Gases by Coal

Absorption of Gases by Coal, S. H. Katz. Queensland Govt. Min. Jl., vol. 20, Feb. 15, 1919, pp. 60-62. Experimental research with air and with an atmosphere of nitrogen.

Blending

The "Sandwich" System of Fuel Blending, E. W. L. Nicol. Gas Jl., vol. 145, no. 2906, Jan. 21, 1919, pp. 113-115, 3 figs. Apparatus which permits the mixing of various qualities of solid fuel as they are fed to burners. Also in Natl. Engr., vol. 23, no. 4, Apr. 1919, pp. 161-164, 2 figs.

Chart for Comparing Values of Different Sizes of Coal

Chart for Finding True Value of One Size of Coal. Black Diamond, vol. 62, no. 12, Mar. 22, 1919, p. 318, 1 fig. Gives value of one size in terms of values of other sizes.

Coal Analysis

Natural Solid Fuels (Contribution à l'étude des combustibles naturels solides, Roger Hartman. Société Industrielle de l'Est, bul. 144, Jan. 1919, pp. 7-18, 3 figs. Method of analyzing a sample of coal and calculating into its calorific value. Based on notes published by the Association Alsacienne des Propriétaires d'Appareils à vapeur.

Coal Problem

Coal and Other Fuels and Substitutes, Alexander Ross. Ry. Gaz., vol. 30, no. 6, Feb. 7, 1919, pp. 202-205. Address before Retired Ry. Officers' Soc.

Gas and Oil Fuels

See Producer Gas, page 10*a*; items under INDUSTRIAL TECHNOLOGY; and Oil, under MINING ENGINEERING.

Lignites

Combustion of Lignites and High-Moisture Fuels, T. A. Marsh. Power, vol. 49, no. 14, Apr. 8, 1919, pp. 525-527, 5 figs. Types of stoker adaptable to burning lignites containing up to 35 per cent moisture. Predrying is considered impractical. Also in Elec. World, vol. 73, no. 6, Feb. 8, 1919, pp. 265-267, 5 figs.

Notes on Lignite, Its Characteristics and Utilization, S. M. Darling. Universal Engr., vol. 29, no. 1, Jan. 1919, pp. 27-34. Concerns particularly the utilization and storage of lignite.

Peat

Peat, Lignite and Powdered Coal, F. Parkman Coffin. Steam, vol. 23, no. 3, Mar. 1919.

Powdered Fuel

Powdered Fuel for Hammersmith. Elec. Times, vol. 55, no. 1430, Mar. 13, 1919, pp. 168-169, 2 figs. Layout of Holbeck system of powdered fuel for firing boilers.

Pulverized Coal Burners Versus Stokers, Joseph T. Foster. Elec. World, vol. 73, no. 10, Mar. 8, 1919, pp. 474-475, 1 fig. Comparative freight charges on low- and high-grade fuel. Chart showing maximum amount that can be paid for pulverized coal to make it comparable with a given stoker coal.

Success in Combustion of Powdered Coal, W. G. Wilcox. Black Diamond, vol. 62, no. 12, Mar. 22, 1919, pp. 328-329. Velocity of combustion; importance of mixing with air.

Smokeless Combustion

Combustion and Smokeless Furnaces, Jos. W. Hays. Steam, vol. 23, no. 2, Feb. 1919, pp. 42-46. Points out what are termed undesirable features of the various types of smokeless furnace.

Storage

Storage of Fuel and Spontaneous Combustion, S. H. Pudney. Official Proc. Can. Ry. Club, vol. 17, no. 2, Feb. 1919, pp. 15-21 and (discussion) 22-23. Losses due to storage and causes for spontaneous combustion, verified by author's experience. Also in Contract Rec., vol. 33, no. 13, Mar. 26, 1919, pp. 291-293.

Spontaneous Combustion of Bituminous Coal in Storage (La conservation en tas des charbons bitumineux et les dangers de leur combustion spontanée), Ch. Vallet. Industrie Electique, vol. 28, no. 640, Feb. 25, 1919, pp. 73-76. Experiments, observations and recommendation. From paper before Inst. Mar. Engrs.

Deterioration in Value During Storage, H. C. Porter and F. K. Ovitz. Black Diamond, vol. 62, no. 12, Mar. 22, 1919, pp. 322-324, 10 figs. Summary of tests to determine heat-value losses from various forms of storage.

Wood

The Use of Wood for Fuel. U. S. Dept. of Agriculture, Bul. 753, Mar. 10, 1919, 40 pp., 2 figs. Suggestions as to proper use of wood resources to prevent recurrence of fuel shortage such as occurred during winter of 1917-1918.

See also MINING ENGINEERING, Coal and Coke (Ash Yield, Calorific Value); RAILROAD ENGINEERING, Locomotives (Powdered Fuel).

FURNACES

See MECHANICAL ENGINEERING, Heat Treating (Heating Furnaces), Refractories (Ovens and Kilns).

GAGES

Checking

Checking Gages, Herman L. Wittstein. Factory, vol. 22, no. 3, March 1919, pp. 456-457, 3 figs. Forms for keeping gage inspection.

Gage Systems

A Practical Ring, Plug, and Snap Gauge System. Machinery, vol. 13, no. 328, Jan. 9, 1919, pp. 400-401, 10 figs. System designed to meet requirements in interchangeable manufacture.

Profile Gages

Contour of Profile Gauges. Machinery, vol. 13, no. 337, Mar. 13, 1919, pp. 649-655, 31 figs. Principles involved and procedure followed in developing gaging systems for interchangeable manufacture, based upon experience of Pratt & Whitney Co. Third article.

Thread-Measuring Wires

The Manufacture of Standard Thread Measuring Wires, Fred. R. Daniels. Machy., vol. 25, no. 7, Mar. 1919, pp. 606-607, 4 figs. Table of values used for determining error in thread angle by the three-wire system.

HANDLING OF MATERIALS

Ash Handling

Raw Material and Ash Handling Equipment, Robert June. Brick & Clay Rec., vol. 54, no. 6, Mar. 25, 1919, pp. 507-509, 3 figs. Principles of power-plant requirements. Ninth article.

Foundry Trucking

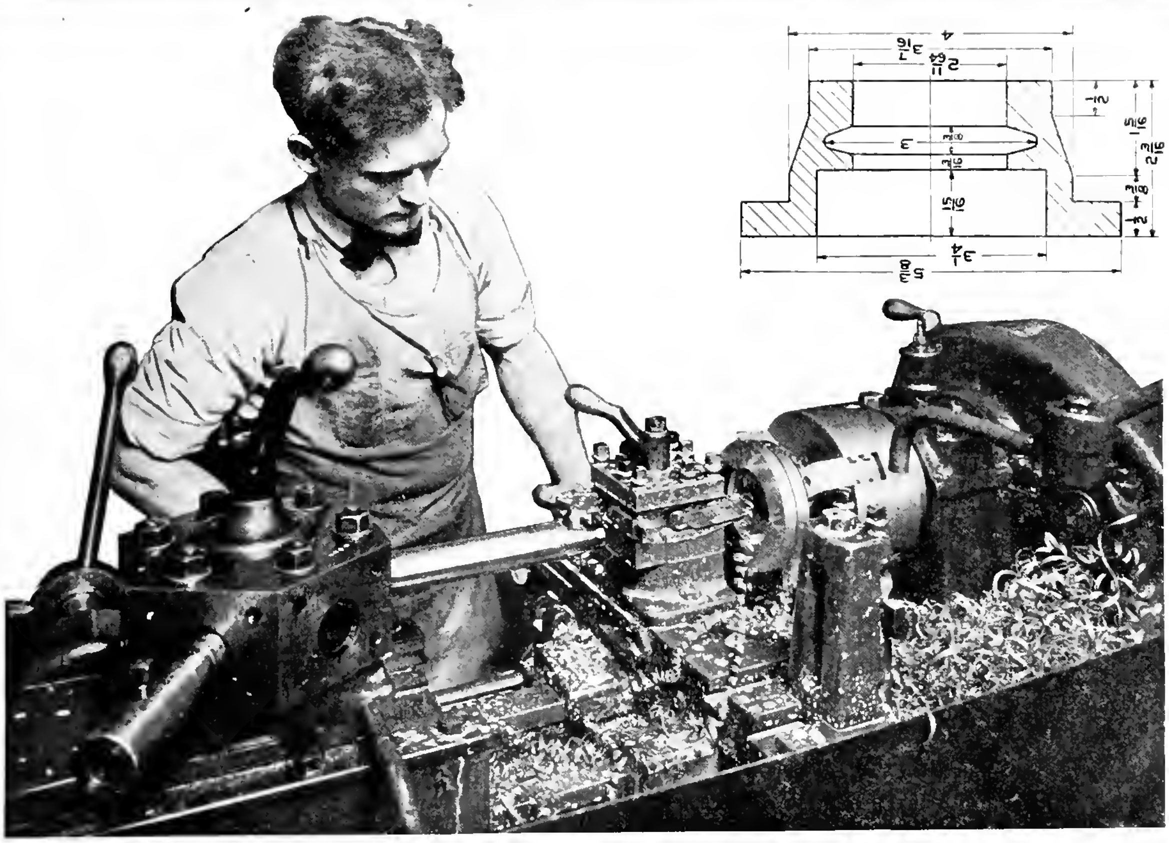
Foundry Built around a Shop Truck. Iron Age, vol. 103, no. 10, Mar. 6, 1919, pp. 603-606, 10 figs. Material-handling system at new plant of Peerless Foundry, Cincinnati.

Materials

Handling Materials, F. T. Buell and Edward R. Cole. Factory, vol. 22, no. 3, March 1919, pp. 470-471, 8 figs. Seven plans as used in two plants.

Shell Shops

Handling Devices in British Shell Shops. Eng. & Indus. Management, vol. 1, no. 5, Mar. 13, 1919, pp. 157-161, 20 figs. Handling ap-



Value of the Square Turret

THIS shows the amount of material removed and how well the many operations on these tough power sprocket clutches were finished on the No. 4 Universal Screw Machine. The hexagon turret was used only for boring. The square turret, loaded to capacity with cutters, did the rest with the aid of its eight power cross and longitudinal feeds.

For Work Too Complicated or Ordinary Screw Machines

The special features of the No. 4 Universal (in this case the unusual use for the square turret) adapt them to a wide range of work too complicated for ordinary screw machines or turret lathes.

SEND FOR DETAILS
Turret Lathes and Screw Machines
from ⅝ in. x 4 in. to 4½ in. x 44 in., Maximum Swing 21½ in.

THE WARNER & SWASEY COMPANY

CLEVELAND, OHIO, U. S. A.

NEW YORK Office—Singer Building. **Boston Office**—Oliver Building **Buffalo Office**—Iroquois Building. **Detroit Office**—Ford Building. **Chicago Office and Show Rooms**—618-622 Washington Blvd.
FOREIGN AGENTS: Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow Allied Machinery Company, Paris and Turin. Van Rietschoten & Houwens, Rotterdam. Yamatake & Co., Tokio. Benson Brothers, Sydney and Melbourne. A. Asher Smith, Sydney. A. R. Williams Machinery Co., Ltd., Toronto, St. John. Winnipeg and Vancouver. Williams & Wilson, Ltd., Montreal.

pliances for conveying objects while suspended from above. (Continuation of serial.)

See also MINING ENGINEERING, Coal and Coke (Coke Handling).

HEAT-TREATING

Engine Parts

Heat Treatment of Steel for Small Petrol Marine Engines. Engineer, vol. 127, no. 3294, Feb. 14, 1919, pp. 159-160, 1 fig. On the building of light "chasers" in America.

Gun Forgings

Electric Heat Treatment of Gun Forgings. C. E. Wright. Iron Age, vol. 103, no. 11, March 13, 1919, pp. 673-678, 12 figs. Installation at naval gun plant of Tioga Steel & Iron Co., Philadelphia. It is intended to use this plant for commercial use.

Heating Furnaces

Practical Pointers on Heating Furnaces. George J. Hagan. Am. Drop Forger, vol. 5, no. 3, Mar. 1919, pp. 142-144. Deals with heating furnaces in general for treatment of both light and heavy stock. Before Engrs. Soc. Western Pa.

Annealing and Heating Furnaces Fired by Town Gas. Engineering, vol. 107, no. 2774, Feb. 28, 1919, pp. 272-276, 8 figs. Leading feature is incorporation of regenerators for heating the air supply before it enters the furnace by means of waste gases from the furnace. Development by Technical Section of the Davis Furnace Co.

Steel

Heat Treatment of Steels (Le traitement thermique des aciers). Métallurgie, vol. 51, no. 12, Mar. 19, 1919, pp. 646-647. Its influence on the quality of products.

HEATING AND VENTILATION

Air Sampling

The Effect of Sunlight on Air. William J. Mauer. Heat & Vent. Mag., vol. 16, no. 3, Mar. 1919, pp. 27-32, 7 figs. Report on laboratory tests to determine proper technique in handling air samples.

Central-Station Combination Heating Plants

Advantage of the Combination Central Station Heating Plant. John C. White. Heat. & Vent. Mag., vol. 16, no. 3, Mar. 1919, pp. 33-37. Recommendations put forth by Bureau of Mines for combining central-station heating systems with steam-power plants.

Equivalent Temperatures, Steam-Hot Water

Equivalent Temperature of Guaranteed Steam and Hot Water Heat. Henry N. Dix. Am. Architect, vol. 115, no. 2254, Mar. 5, 1919, pp. 358-360, 6 figs. Formula and charts.

Factory Heating

Factory Heating. Alfred G. King. Domestic Eng., vol. 86, no. 11, Mar. 15, 1919, pp. 466-468, 5 figs. Hot water heating with forced circulation.

Foundry Ventilation

Foundry Ventilation. Iron Age, vol. 103, no. 10, Mar. 6, 1919, p. 610, 3 figs. Effect of roof design and heating systems on air circulation.

Hot-Water Central Heating Plant

Designing Data as Applied to a Large Hot Water Heating Plant. George E. Reed. Heat. & Vent. Mag., vol. 16, no. 3, Mar. 1919, pp. 17-26, 11 figs. Plant for high school of five buildings. "Unit" system followed in design and construction.

Industrial Buildings

The Mechanical Equipment of Industrial Buildings—II. Charles L. Hubbard. Power, vol. 49, no. 10, March 11, 1919, pp. 362-365. Remarks on selections of type of prime mover, systems of power distribution and methods of heating and ventilating.

Laws

Proposed Michigan Law on Furnace Heating. Metal Worker, no. 2360, Mar. 21, 1919, pp. 372-374. Bill to regulate and control the installation of warm-air heating plants.

Temperatures, Indoor and Outdoor

Tests for Heating Plants in Mild Weather. Henry N. Dix. Metal Worker, no. 2360, Mar. 21, 1919, pp. 365-367, 7 figs. Charts of temperature indoors with varying outdoor temperatures.

Vacuum Heating

Care of Heating and Ventilating Equipment—VIII. Harold L. Alt. Power, vol. 49, no. 9, March 4, 1919, pp. 306-308, 11 figs. Vacuum-heating systems.

See also MINING ENGINEERING, Mines and Mining (Ventilation).

HOISTING AND CONVEYING

Bucket Hoist

Bucket Carrier System (Benne preneuse continue, pour la manutention des matières pondéreuses). Génie Civil, vol. 74, no. 9, Mar. 1, 1919, pp. 171-175, 3 figs. Chain belt with buckets moves continuously over material to be handled; buckets discharge on iron channel where material descends by gravity.

Cable Breakage

Breaking of Cable in Protection Shaft. Robert Dunn. Coal Age, vol. 15, no. 11, March 13, 1919, pp. 489-491, 2 figs. Tests said to indicate that breaking of rope was due to inadequate lubrication, particularly in hemp center.

Grab Bucket, Self-Discharging

Barnard's Self-Discharging Grab. Engineering, vol. 107, no. 2772, Feb. 14, 1919, pp. 200-202, 11 figs. Improvements made in design since last description published in issue of April 17, 1914, p. 524.

See also MARINE ENGINEERING, Auxiliary Machinery (Luffing Cranes).

HYDRAULIC MACHINERY

Flow of Water

The Flow of Water in Large Pipes and Tunnels. Frederick J. Mallett and Alfred A. Barnes. Engineering, vol. 107, no. 2774, Feb. 28, 1919, pp. 288-291, 14 figs. Traces out inconsistencies met with in many of the older formulæ, and sets out the features that in practice determine the ultimate capacity of water mains. Abstracts of two papers read before Instn. Civil Engrs.

Pelton Wheels

A Pelton Wheel Driven Centrifuge. F. J. Broadbent. Engineering, vol. 107, no. 2771, Feb. 7, 1919, pp. 161-164, 10 figs. Design based on theory outlined in article entitled Static Torque Experiments on a Pelton Wheel, Eng. Sept. 11, 1914.

Tidal Power

"Blue Coal." Sci. Am. Supp., vol. 87, no. 2253, Mar. 8, 1918, pp. 156-157 and 160, 9 figs. Efforts that have been made to utilize energy of waves and tides. From Larousse Mensuel, Paris.

Wave Propagation

Determination of the Velocity of Propagation of Waves in Forced Conduits (Détermination de la vitesse de propagation des ondes dans les conduites forcées). C. Camichel. Technique Moderne, vol. 10, no. 12, Dec. 1918, pp. 537-544, 20 figs. Explains by means of de Sparre formulæ anomalies which have been pointed out by engineers in experimental determination of velocity of propagation of waves; writer believes that the apparent variations of this velocity are explicable and disappear altogether if a correct experimental method is followed.

INTERNAL-COMBUSTION ENGINES

Carburation

The Carburation Temperature of Oil Mixtures. C. A. Norman. Automotive Industries, vol. 40, no. 9, Feb. 27, 1919, pp. 490-491, 1 fig. Method of determining temperature necessary to keep in a permanent state of vaporization any oil fraction contained in a carburized mixture.

Diesel-Engine Injection

Solid Injection Versus Air-Injection. Motorship, vol. 4, no. 4, Apr. 1919, pp. 35-37, 6 figs. Technical aspect of subject in its bearing on future design and construction of high-compression marine oil engines for merchant and naval ships. Second installment.

Diesel Engines

McIntosh & Seymour Marine Diesel Engine. Power, vol. 49, no. 14, Apr. 8, 1919, pp. 528-531, 4 figs. Description of a four-stroke cycle directly reversible engine.

Hot-Bulb Engines

The British Two-stroke Motor. Engineer, vol. 127, no. 3295, Feb. 21, 1919, pp. 182-183, 3 figs. Gear of directly reversing hot-bulb engine.

Radial Engines

The Enfield-Allday Five-cylinder Radial Engine. Autocar, vol. 42, no. 1221, Mar. 15, 1919, p. 357, 1 fig. Engine in which air cooling is effected by means of aluminum fins and forced draft.

Truck and Tractor Engines

Three Hinkley Engines Built Around Class "B" Design. Automotive Industries, vol. 40, no. 11, Mar. 13, 1919, pp. 587-589, 6 figs. Models for 1 to 6-ton 1½- to 2½-ton trucks and tractors drawing 1 to 4 plows.

Valves

Small Inlet Valves Satisfactory in Overhead Valve Design—II. L. H. Pomeroy. Automotive Industries, vol. 40, no. 9, Feb. 27, 1919, pp. 471-475, 5 figs. Tests made with two engines of same size, one having a valve-in-head design and the other an L-head with valves side by side in valve pocket. Tests are said to have proven that specific fuel consumption is largely independent of r.p.m. and torque for 50 to 60 per cent of maximum hp. Paper before Instn. Automobile Engrs.

Characteristics of a High-Grade Standardized Engine. J. H. W. Kerston. Automotive Industries, vol. 40, no. 10, Mar. 6, 1919, pp. 527 and 549. Effect of increasing valve size on efficiency and smoothness of run.

See also MECHANICAL ENGINEERING, Motor-Car Engineering (Carburetor Testing, Carburetors); AERONAUTICS, Engines.

LUBRICATION

Air Compressors

Correct Lubrication of Air Compressors. H. V. Conrad. Iron Age, vol. 103, no. 12, Mar. 20, 1919, pp. 753-754, 1 fig. Cylinder temperatures and physical tests of oils given as guide for selecting lubricant. Paper prepared for Compressed Air Soc. Also in Eng. & Min. Jl., vol. 107, no. 9, Mar. 1, 1919, pp. 392-394, 1 fig.

Colloidal Phenomena

A Problem in Lubrication. W. B. Hardy. Jl. Soc. Chem. Indus., vol. 38, no. 2, Jan. 31, 1919, p. 7T. Colloidal phenomena in lubrication.

Lubricants

Lubrication and Lubricants. G. R. Rowland. Jl. Am. Soc. Naval Engrs., vol. 31, no. 1, Feb. 1919, pp. 97-138, 7 figs. Definition, classification, testing, refining and selection.

See also MECHANICAL ENGINEERING, Motor-Car Engineering (Lubrication).

MACHINE ELEMENTS AND DESIGN

Bearings

On Proportioning Engine Bearings. Otto M. Burkhardt. Automotive Industries, vol. 40, no. 12, Mar. 20, 1919, pp. 651-655, 10 figs. Analysis of crank-bearing loads in a 4-cylinder, 3-bearing truck engine under different conditions of operation.

Cams

Cam Design and Construction. Franklin de R. Furman. Am. Mach., vol. 50, no. 13, Mar. 27, 1919, pp. 581-586, 13 figs. Introduction; types of cams described. First article.

Gears

Toothed Gearing. Joseph Chilton. Times Eng. Supp., vol. 15, no. 532, Feb. 1919, p. 92. Manufacture and design of spur, helical, bevel, and worm gearing for transmitting motion between shafts the axes of which are either parallel or at right angles to each other. Paper before North-East Coast Instn. Engrs. & Shipbuilders.

Pistons

Pistons and Their Treatment. Motor Traction, vol. 28, no. 733, Mar. 19, 1919, pp. 246-248, 10 figs. Suggestions in regard to detaching the piston; testing the relative truth of pistons with connecting rods.

Springs

Minimum Number of Combined Springs (Sur le nombre minimum de spiraux associés). Jules Andrade. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 3, Jan. 20, 1919, pp. 139-141. On regulation of pendulums and balance wheels for exact chronometric work.

MACHINE SHOP

Broaches

Determining the Number of Broaches to Use. Machinery, vol. 13, no. 335, Feb. 27, 1919, p. 599, 1 fig. Chart.

FIRING THAT IS • DIFFERENT •

WITH the RILEY STOKER the coal is fed—the fire cleaned—the ash discharged, *continuously* and *automatically*. All done without waste or effort, efficiently and economically.

It is not only the things the RILEY STOKER does but the way it does them. For instance, when steam is wanted quickly and time is precious, you can get this steam instantly and economically by increasing the motion of the grates.

With the first turn of the cranks the grates start moving—the whole fuel bed is thrown into action. There is no watching nor waiting—poking nor slicing—the stoker responds instantly and in two or three minutes the boiler will be operating at 200 or 250% of rating.

It is this kind of flexibility that saves not only for the central station but for the industrial plant.

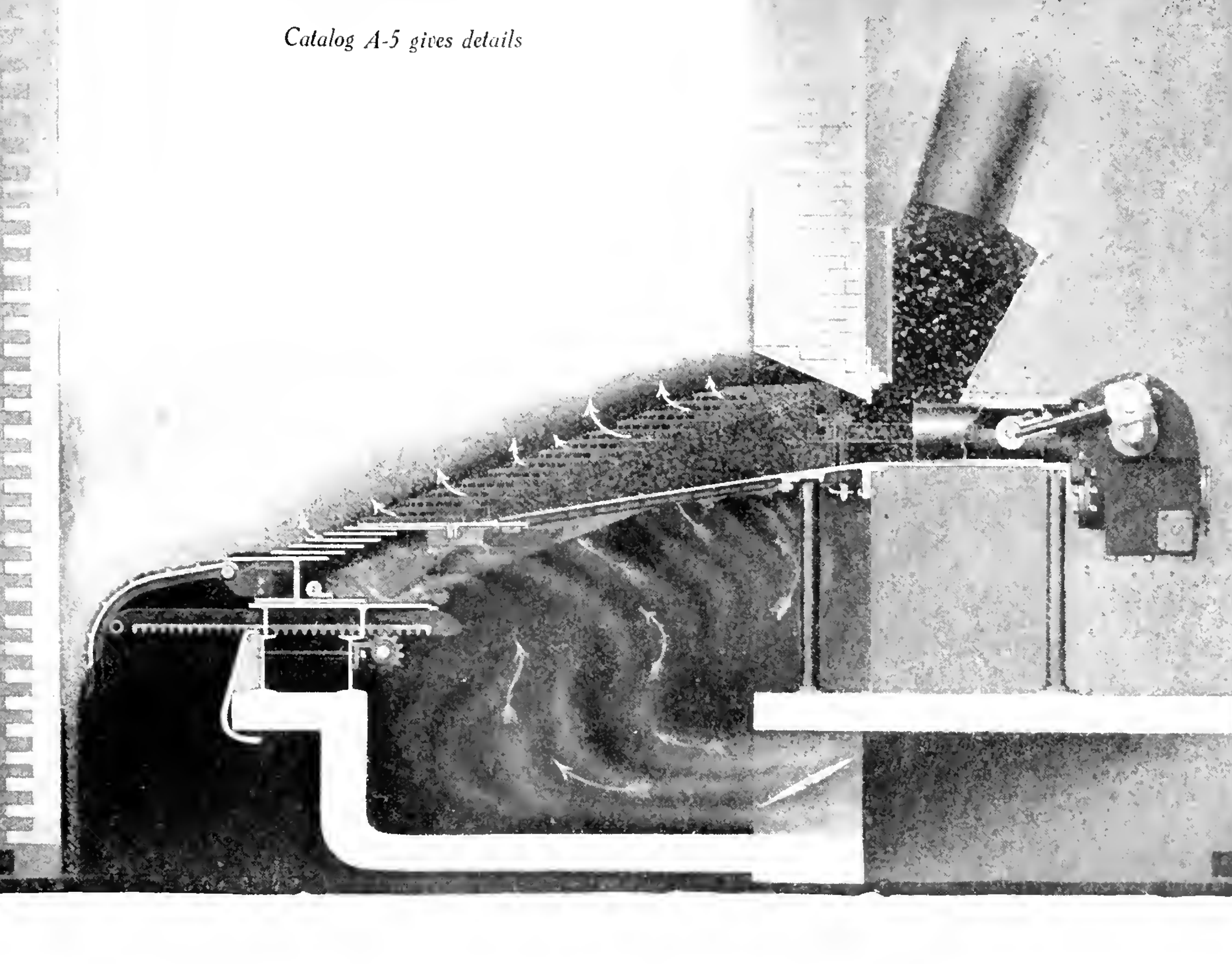
Catalog A-5 gives details

RILEY UNDERFEED STOKERS

TRADE MARK Rx REGISTERED

Sanford Riley Stoker Co.,
Worcester, Massachusetts

British Licensees: Erith's Eng. Co., Ltd., London
French Licensees: Erith, Leroy & Cie., Paris, France



Crankshaft Repairs

Recent Crankshaft Repairs. Iron Age, vol. 103, no. 13, Mar. 27, 1919, pp. 812-813, 3 figs. Six-throw crankshaft made from steel billets by thermit process.

Electric Drive

Electric Drive for Punching Shaping and Slotting Machines. C. E. Clewell. Am. Mach., vol. 50, no. 10, Mar. 6, 1919, pp. 439-444, 12 figs. Discussion on basis of machines in which duty cycle throughout given operations consists of two directions of motion.

Motor Drive as Viewed by Machine Builders and Motor Manufacturers. C. E. Clewell. Am. Mach., vol. 50, no. 11, March 13, 1919, pp. 475-478, 7 figs. Result of canvassing opinions of various machine-tool builders and electric-motor manufacturers.

Machine Tool Drives: Motors and Controllers. H. W. Tice. English Mechanic, vol. 109, no. 2816, Mar. 14, 1919, pp. 88-89, 2 figs. Service records of motors and machine tools controlled in Lehigh plant of Bethlehem Steel Co. (To be continued.)

Foundations

Foundations for Various Types of Planers. Terrell Croft. Can. Machy., vol. 21, no. 2, Jan. 9, 1919, pp. 29-34, 16 figs. Suggests use of leveling blocks and recommends concrete as best material.

Grinding and Sizing

Grinding and Sizing Diagrams. Alfred T. Fry. Min. & Sci. Press, vol. 118, no. 10, March 8, 1919, pp. 324-327, 5 figs. Suggests method of drawing curve to compare and use results obtained while making tests of grinding efficiency of a given machine under varied conditions.

Cylinder Grinding. Franklin D. Jones. Machy., vol. 25, no. 7, Mar. 1919, pp. 615-621, 12 figs. Discussion of advantages of finishing cylinder bores by grinding; machines and auxiliary equipment used; practice in different plants manufacturing engines for automobiles and airplanes. First article.

Roller Bearings

Roller Bearings for Machine Shop Equipment—III. Machinery, vol. 13, no. 335, Feb. 27, 1919, pp. 604-607, 6 figs. Combination radial and thrust roller bearings; roller bearings with staggered rollers; lubrication.

Splitting Piston Rings

Splitting Piston Rings. Jacob Young. Machy., vol. 25, no. 7, Mar. 1919, pp. 590-591, 1 fig. Chart for determining length of section to be cut from piston ring.

Swivel Machining

Machining Front Axle Swivels. A. Thomas. Automobile Engr., vol. 9, no. 124, Mar. 1919, pp. 72-74, 10 figs. Manufacturing operations on swivels made from nickel-steel drop forgings.

Templets

Templets, Jigs and Fixtures. Joseph Horner. Engineering, vol. 107, no. 2772, Feb. 14, 1919, pp. 197-199, 13 figs. Describes various types. Twentieth article.

Test-Piece Manufacture

The Rapid Production of Test Pieces. Can. Machy. vol. 21, no. 9, Feb. 27, 1919, pp. 206-207, 9 figs. Making test pieces from shell.

Workshop Practice

Modern Workshop Practice—VI. W. Wilson. Commonwealth Engr., vol. 6, no. 6, Jan. 1, 1919, pp. 173-180, 15 figs. Science of quick repetition. Deals with modifications in lathes through omission of parts not required for the particular work to be done.

See also RAILROAD ENGINEERING, Shops.

MACHINERY, METAL-WORKING

Arresting Motion for Presses

Automatic Arresting Motion for Power Presses. Engineer, vol. 127, no. 3293, Feb. 7, 1919, p. 135, 2 figs. Mechanism can be applied to type of machine in which a flywheel revolves freely on its shaft until a positive connection is established between the two parts by a convenient device.

Die-Sinking Tools

A discussion on Die Room Conditions. F. J. Rau. Am. Drop Forger, vol. 5, no. 3, Mar. 1919, pp. 126-128, 4 figs. Sketches of die-sinking tools.

Gear-Tooth Rounding Machine

Walker Automatic Gear Tooth Rounding Machine. Automotive Industries, vol. 40, no. 12, Mar. 20, 1919, pp. 648-650, 5 figs. Design to round meshing edges or to remove burrs left by cutters or hobs.

Lathe

Engine Lathes for Precision Work. Iron Trade Rev., vol. 64, no. 10, Mar. 6, 1919, pp. 633-637, 8 figs. How various lathe parts in the process of making are routed through the grinding, planing, milling, turning and assembling departments of a machine-tool plant in Cincinnati.

Niles Heavy Driving Wheel Lathe at Crewe Works, London & North Western Railway. Ry. Gaz., vol. 30, no. 7, Feb. 14, 1919, pp. 252-253, 2 figs. Turning tires of express passenger locomotives.

Milling and Gear Cutting on Lathes

Making Milling and Gear Cutting Attachment—1. Robert Mawson. Can. Machy., vol. 21, no. 3, Jan. 16, 1919, pp. 51-53 and 63, 11 figs. Attachment for lathes which performs milling and gear-cutting operations. Various tools and operations used are shown.

Square Bar for Internal Planing

Square Bar for Internal Planing, W. G. D. Machinery, vol. 13, no. 335, Feb. 27, 1919, pp. 600-601, 2 figs. Formulæ and calculations.

Thread-Milling Cutter

The Cycloid Thread-Milling Cutter. Engineer, vol. 127, no. 3294, Feb. 14, 1919, p. 159, 1 fig. Design to overcome "waves" and "flats" on work.

MACHINERY, WOODWORKING

Woodworking Machines

Apparatus for Woodworking and Their Recent Improvements (Les machines-outils pour le travail du bois et leurs récents perfectionnements). E. Gay. Technique Moderne, vol. 10, no. 12, Dec. 1918, pp. 554-563, 29 figs. French types of machines for finishing patterns. (Concluded.)

MACHINERY, SPECIAL

Clock Escapements

Clock Escapements. Engineering, vol. 107, no. 2775, Mar. 7, 1919, pp. 297-298, 2 figs. History of development of present combination. Paper before Roy. Instn.

Drill Sharpener

Drill Sharpener Speeds Up Shipbuilding. Letson Balliet. Mine & Quarry, vol. 11, no. 2, Mar. 1919, pp. 1130-1133, 14 figs. Making of drift bolts, rivets, grab-iron ends, ball stanchions, etc.

Hammer Drills

Hammer Drills—Their History, Design and Operation. Henry S. Potter. Jl. South African Instn. Engrs., vol. 17, no. 6, Jan. 1919, pp. 86-98, 5 figs. Materials of construction; pistons and valves; general features of modern jack hammers; limitations in use of hammer drills for stoping. Second and concluding installment.

Lapping Machine

A Machine for Lapping Precision Gage Blocks. Am. Mach., vol. 50, no. 13, Mar. 27, 1919, p. 613, 1 fig. Design for producing gage blocks of any contour, but having two opposite sides flat and parallel and a definite distance apart.

Routing Machine

Routing Machine of Special Design. Am. Mach., vol. 50, no. 11, Mar. 13, 1919, pp. 491-493, 5 figs. Machine uses tool which is rapidly rotated through several turns in one direction, then reversed and rotated as rapidly and for an equal number of turns in the opposite direction, this cycle of movement being continued so long as may be necessary to complete the operation.

Worm-Wheel Generator

G & E 18-In. Worm Wheel Generator. Automotive Industries, vol. 40, no. 14, Apr. 3, 1919, pp. 746-747, 3 figs. Machine designed for producing worms and worm wheels for trucks, tractors, etc., and adapted for production and experimental work.

See also MINING ENGINEERING, Coal and Coke (Coal-Washing Machinery, Roll Crushers).

MATERIALS OF CONSTRUCTION AND TESTING OF MATERIALS

Aluminum

Aluminum: Its Use in the Motor Industry in England. E. Carey Hill. Metal Indus., vol. 17, no. 3, March 1919, pp. 125-127, 2 figs. Application of aluminum in replacing steel and other metals. Second and last article.

Alternating Stresses, Steel

Premature Rupture of Steel Pieces Subjected to Repeated Stresses (Cause de la rupture prématurée des pièces d'acier soumises à des efforts répetés). Ch. Fremont, Génie Civil, vol. 74, no. 3, Jan. 18, 1919, pp. 47-52, 15 figs. Survey of experiments on formation and extension of fissures. Some deductions in Wöhler's theory are held to be inexact. Also in Comptes rendus des séances de l'Académie de Sciences, vol. 168, no. 1, Jan. 6, 1919, pp. 54-56.

Beams, Reinforced-Concrete

Tests Show High Shears in Deep Reinforced-Concrete Beams. W. A. Slater. Eng. News Rec., vol. 82, no. 9, Feb. 27, 1919, pp. 430-433, 4 figs. Preliminary studies made for Emergency Fleet Corporation's concrete ship work. Higher safety units than those now permitted are advocated.

Bearing Metals

Proper Specifications for Bearing Metals. Alfred A. Greene. Iron Age, vol. 103, no. 14, Apr. 3, 1919, pp. 874-875. Functions of a lining alloy; mixing the component metals; electrically hardened lead.

Brass, Rolled Sheet

Structural Characteristics of Rolled Sheet Brass. Metal Indus., vol. 17, no. 3, March 1919, pp. 121-124, 6 figs. Thermal equilibrium diagrams of various alloys; photomicrographs of cast and annealed brass. (To be continued.)

Brickwork

Tests Determine Strength of Brickwork. W. W. Pearse. Contract Rec., vol. 33, no. 8, Feb. 19, 1919, pp. 151-155, 10 figs. Report of tests carried out at Toronto Univ. in cooperation with City Architect's Dept.

Mortars, Cement-Lime

Compressive Strength of Cement-Lime Mortars. F. A. Kirkpatrick and W. B. Orange. Jl. Am. Ceramic Soc., vol. 2, no. 1, Jan. 1919, pp. 44-64, 9 figs. Determination of factors exerting greatest control over strength of cement-lime mortars. Manner of control expressed by mathematical formula and practical application of results indicated.

Resistance of Materials

The Resistance of Materials. G. S. Chiles and R. G. Kelly. Ry. Mech. Engr., vol. 93, no. 3, March 1919, pp. 123-126, 6 figs. Review of data relative to effect of abrupt changes of section under "static" and "dynamic" tests published by various authorities and results of experiments conducted by writers. (To be continued.)

MEASUREMENTS AND MEASURING APPARATUS

Air-Measuring Instruments

The Determination of the Efficiency of the Turbo-Alternator, S. F. Barclay and S. P. Smith. Elecn., vol. 82, no. 2128, Feb. 28, 1919, pp. 244-246, 3 figs. Suggestions in regard to measuring air volume and temperature; diagrams plotted from pitot tube readings taken at opening of temporary discharge trunk. Before Instn. Elec. Engrs.

Coal-Consumption Meter

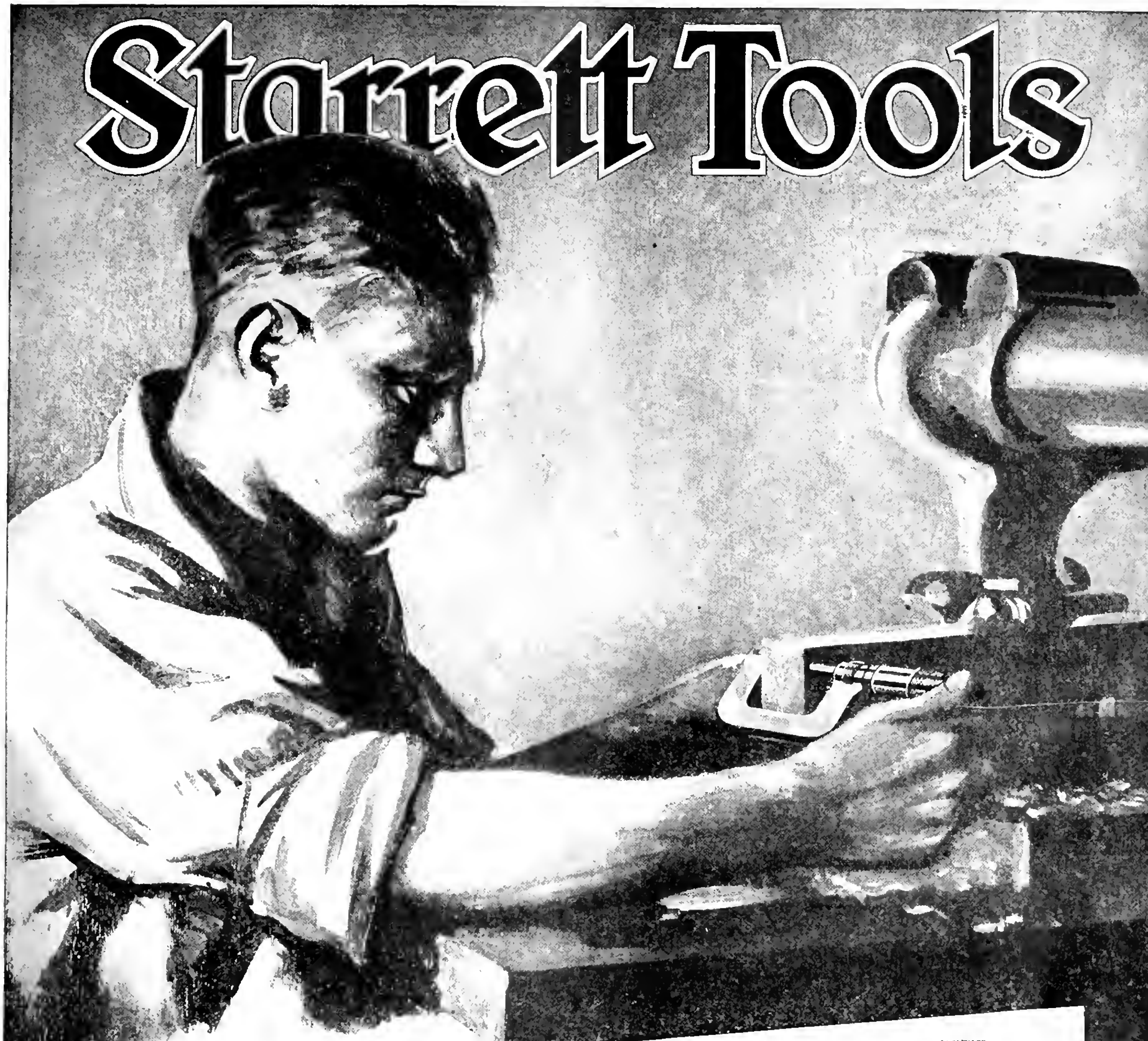
Lea Coal-Consumption Meter (Apparell indicateur-totalisateur de la consommation de charbon, système Lea). P. Letheule. Génie Civil, vol. 74, no. 6, Feb. 8, 1919, pp. 101-105, 18 figs. Registers total consumption by system of levers and pinions operated by motion of stoker and controlled by volume of coal fed into burners. Details of construction and application of apparatus to Stirling and Babcock boilers are given.

Flow Meters

An Automatic Compensating Flow Meter. G. G. Oberfell. Jl. Indus. & Eng. Chemistry, vol. 11, no. 4, Apr. 1, 1919, pp. 294-296, 1 fig. Instrument intended for accurately controlling gas concentration of gas-air mixtures.

Fluid Velocity and Pressure

The Measurement of Fluid Velocity and Pressure, J. R. Pannel. Engineering, vol. 107, nos. 2774 and 2775, Feb. 28 and Mar. 7, 1919, pp. 295-297 and 261-263, 14 figs. Robinson cup anemometer; vane anemometer and other "moving part" instruments. (Continuation of serial). Feb. 28: Pressure tube instruments.



SINCE 1880—

For two generations we have been making fine precision instruments — building them to the Starrett standard—not to a price.

Today the name Starrett is recognized the world over as standard for accuracy. Starrett Tools are helping skilled mechanics produce high-quality work.

Write for Catalog No. 21LD

You should own these books—Ask your dealer for them.

THE L. S. STARRETT COMPANY

The World's Greatest Toolmakers
Manufac urers of Hack Saws Unexcelled

Athol, Mass.

42-001

Oil-Tank Gaging

Scientific Gauges, B. C. Rinehart. Petroleum Age, vol. 6, no. 3, March, 1919, p. 30, 1 fig. Method of gaging oil tanks.

Standards of Temperature and Means of Checking Pyrometers. Am. Mach., vol. 50, no. 12, Mar. 20, 1919, pp. 541-545, 7 figs. Directions for use of standards; chart showing relation between base-metal thermocouple and net electromotive force.

Paper Tester

The Webb Paper Tester—A New Instrument for Testing Corrugated Fiber Boards, J. D. Malcolmson. Jl. Indus. & Eng. Chem., vol. 11, no. 2, Feb. 1, 1919, pp. 133-138, 6 figs. Comparison with Mullen tester decides writer to prefer Webb machine.

Pyrometers

Checking Pyrometers to Get Results. Am. Drop Forger, vol. 5, no. 3, Mar. 1919, pp. 131-137, 6 figs. Various methods are recommended for different sizes of equipment.

Thermocouples

Calibration of Base-Metal Thermocouples, G. S. Crouse. Eng. & Min. Jl., vol. 107, no. 10, March 8, 1919, pp. 442-444, 1 fig. Describes three methods of calibrating such couples.

Viscosimeters

Standardization of the Saybolt Universal Viscosimeter, Winslow H. Herschel. Department of Commerce, Tech. Papers Bur. Stand., no. 112, 25 pages, 4 figs. Equation for instruments of standard dimensions.

See also MECHANICAL ENGINEERING, Research, (Rolling Mill, Research Laboratory), Air Machinery (Compressors), Machine Shop (Test-Piece Manufacture), Power Plants (CO_2 Recorders); AERONAUTICS, Aerostatics (Schilling Apparatus for Measuring Hydrogen), Instruments; MINING ENGINEERING, Mines and Mining (Dust Sampling).

MECHANICAL PROCESSES

Bakelite Products and Dies

Making Molded Bakelite Products. Machinery, vol. 13, no. 331, Jan. 30, 1919, pp. 481-485, 9 figs. Designing and making dies with provision for heating with steam.

Boilers

Areas of Segments of Boiler Heads, Power, vol. 49, no. 11, March 18, 1919, pp. 402-404, 2 figs. Table of areas of segments of boiler heads to be stayed.

Chains, Cast-Steel

Malleable Plant Proves Versatility. Iron Trade Rev., vol. 64, no. 10, Mar. 6, 1919, pp. 623-629, 12 figs. Adaptation to manufacture of cast-steel anchor chains of plant designed and constructed for malleable foundry.

Gears

The Manufacture and Design of Toothed Gearing, Joseph Chilton. Engineering, vol. 107, no. 2772, Feb. 14, 1919, pp. 202-206, 13 figs. Gearing employed in transmission of motion between shafts whose axes are either parallel or at right angles to each other. (To be continued.) Read at North-East Coast Instn. Engrs. & Shipbuilders.

Pumps

Manufacturing Rotary Suds Pumps. Machinery, vol. 13, no. 328, Jan. 9, 1919, pp. 406-408, 11 figs. Pump manufactured by Brooke Tool Co. is presented as example of interchangeable manufacture.

Rolling Mills

Universal Mill Rolls Strip Steel. Iron Trade Rev., vol. 64, no. 11, Mar. 13, 1919, pp. 691-695. Roughing unit is of massive construction, each housing weighing 42 tons; spring of mill when rolling high-carbon steel is 0.001 in.

Rolling Concrete Reinforcements from Old Rails, W. S. Standiford. Can. Machy., vol. 21, no. 3, Jan. 16, 1919, pp. 59-61 and 65, 5 figs. Design and general layout of roughing and finishing rolls.

Large Rolling Mill Plant. Elec. Rev., vol. 84, no. 2155, Mar. 14, 1919, pp. 283-284, 4 figs. Particulars and illustrations of Siemens 19,000 hp. rolling mill motor. (To be concluded.)

The Government Rolling Mill, Southampton. Engineer, vol. 127, nos. 3296 and 3297, Feb. 28 and Mar. 7, 1919, pp. 191-193 and 217-219, [illegible]. Mill is being employed in melting of scrap metal and is turning out standard Government brass ingots of guaranteed analysis. Mar. 7: Power plant and gas-producer equipment; facilities for handling coal, coke and raw materials; foundry and rolling departments.

Rubber Goods

Railroad Rubber Goods, G. W. Alden. Official Proc. Car Foremen's Assn., Chicago, vol. 14, no. 5, Feb. 1919, pp. 36-71. Growth and properties of crude rubber; manufacture of wrapped ply hose, belting and various kinds of packings.

Sheet Metal Products

Imagination and Sheet Metal Layout Work, F. Scriber. Can. Machy., vol. 21, no. 9, Feb. 27, 1919, pp. 199-202, 10 figs. Examples of bending sheet metal into shape.

Work of Sheet Metal Man in New Industry, W. B. Metzger. Metal Worker, vol. 41, no. 10, Mar. 7, 1919, pp. 302-304, 5 figs. Making apparatus for use in distillation of volatile oils from birch and wintergreen.

Tank Links

Machine Tool Adaptations for the Manufacture of Tank Links. Engineer, vol. 127, no. 3293, Feb. 7, 1919, pp. 120-123, 12 figs. Operations performed on stamping pattern of links for moving tracks of tanks.

Tubes, Seamless

Making Seamless Tubes. Iron Trade Rev., vol. 64, no. 4, Jan. 23, 1919, pp. 259-264, 11 figs. Piercing and cold-drawing processes as followed at plant of Standard Seamless Tube Co.

Textiles

Back-Filling Process for Sheetings. Textile World Jl., vol. 55, no. 13, Mar. 29, 1919, pp. 29 and 31, 2 figs. Handling goods in finishing department; composition of mixings.

MECHANICS

Angles, Section Moduli

The Angle as a Beam, R. Fleming. Eng. News Rec., vol. 82, no. 9, Feb. 27, 1919, pp. 433-434, 5 figs. Tables comparing section moduli angles of various sizes.

Axles, Critical Velocity

Critical Velocity of High Speed Axles—II (La velocità critica degli alberi a grande velocità), Industria, vol. 33, no. 4, Feb. 28, 1919, pp. 113-114, 3 figs. On Dunkerley's theorem.

Beams

On the Beam of Uniform Strength, Taking the Weight of the Beam Into Consideration (in Japanese), Keiichi Aichi. Jl. Soc. Mech. Engrs., Tokyo, vol. 22, no. 54, Nov. 1918.

Bevel Gears, Strength of

Distribution of Load on Bevel Gear Teeth and Strength of Bevel Gear Teeth, W. G. Dunkley. Machinery, vol. 13, no. 337, Mar. 13, 1919, pp. 660-662, 4 figs. Investigation of variation of load in bevel-gear teeth; diagram illustrating deflection of teeth under load and graph showing distribution of load on teeth and their strength.

Gear Drives

Dynamics of Gear Drive, N. W. Akimoff. Jl. Am. Soc. Naval Engrs., vol. 31, no. 1, Feb. 1919, pp. 46-52, 1 fig. Designing formula.

MOTOR-CAR ENGINEERING

Carburetor Testing

Bureau of Standards Carburetor Test Plant, P. M. Heldt. Automotive Industries, vol. 40, no. 12, Mar. 20, 1919, pp. 641-644, 6 figs. Designed to determine metering qualities of different carburetors under varying conditions of atmospheric pressure and pressure drop. Fifth article.

System of Testing Fuel Jets in Zenith Carburetors. Aerial Age, vol. 9, no. 2, Mar. 24, 1919, p. 121, 4 figs. Machinery used in Zenith laboratory.

Carburetors

The Cox "Atmos" Carburetor. Autocar, vol. 42, no. 1221, Mar. 15, 1919, pp. 358-360, 7 figs. Results of tests of carburetor using only one jet and having no automatic moving parts.

Fiat

The New Fiat Light Car. Autocar, vol. 42, no. 1221, Mar. 15, 1919, pp. 355-357, 6 figs. Mechanical points in construction of engine, gear box and rear axle.

Fire Apparatus

Motor Apparatus and Equipment. Fire & Water Eng., vol. 65, no. 13, Mar. 26, 1919, pp. 649-653. Motor apparatus at Highland Park, Mich., equipped with Sewell cushion wheels.

French Cars

Automotor Design and Construction of 1919. Auto., vol. 24, no. 949, Mar. 13, 1919, pp. 250-252, 5 figs. Six-cyl. 23.9-hp. Delage type being exhibited at Lyons Fair.

A Standardized French Car. Autocar, vol. 42, no. 1221, Mar. 15, 1919, pp. 368-369, 6 figs. Details of 10-hp. 4-cyl. monobloc-engine car.

Headlights

Report of 1917-18 Committee on Automobile Headlighting Specifications. Trans. Illum. Eng. Soc., vol. 14, no. 2, Mar. 20, 1919, pp. 64-77 and (discussion) pp. 77-99, 2 figs. Specifications are based upon practical considerations and tests, and are selected in a manner to make them applicable to all devices.

Lubrication

Lubricating the Farm Tractor. Motor Age, vol. 35, no. 8, Feb. 20, 1919, pp. 28-29, 2 figs. Suggestion in regard to selection and application of lubricants.

The Lubrication of Motor Cars—II, G. W. A. Brown. Automotive Industries, vol. 40, no. 14, Apr. 3, 1919, pp. 751-754, 20 figs. Discussion of methods employed in lubrication of steering gears, drag links, rear axles, springs, spring eyes and road wheels; oil- and grease-retaining devices.

Mercury

The 10-12 hp. Mercury. Autocar, vol. 42, no. 1221, Mar. 15, 1919, pp. 583-584, 6 figs. Engine and transmission details.

Military Chassis

Military Transport Chassis—XII. Automobile Engr., vol. 9, no. 124, Mar. 1919, pp. 68-71, 5 figs. Performance under war conditions. Albion 32-hp. (3 tons) chassis.

Napier Trucks

A New Two-Tonner. Motor Traction, vol. 28, no. 733, Mar. 19, 1919, pp. 240-242, 6 figs. Designed for reliable and inexpensive operation. Napier 40-55 cwt. chassis.

Producer Gas for Tractors

Producer Gas Driven Tractors (Tracteurs à gaz pauvre). Bulletin de la Société d'Encouragement pour l'Industrie Nationale, vol. 131, no. 1, Jan.-Feb. 1919, pp. 185-187, 2 figs. Tests with Cages truck.

Talbot

A New 25-50 hp. Talbot. Autocar, vol. 42, no. 1221, Mar. 15, 1919, pp. 352-354, 3 figs. Main features are: Cylinders cast in pairs; pump water circulation; forced oil circulation; electric starting and lighting; cone clutch, with fabric on flywheel.

Tanks

The French Baby Renault Tank, W. F. Bradley. Automotive Industries, vol. 40, no. 9, Feb. 27, 1919, pp. 464-470, 12 figs. Weighs $6\frac{1}{2}$ tons with machine gun. Driving sprocket is at rear, endless band passes around pulley at front, and between these is a series of idlers and automatic tensioning apparatus.

Tractor Attachments

The Big Auto Tractor Attachment. Automotive Industries, vol. 40, no. 10, Mar. 6, 1919, pp. 528-529, 3 figs. Conversion unit for converting large touring cars of older models into farm tractors.

Tractors

An Analysis of Tractor Specifications, P. M. Heldt. Automotive Industries, vol. 40, no. 10, Mar. 6, 1919, pp. 522-524, 6 figs. Representation of different features of design on percentage basis. Charts based on count of American-built tractors.

The Austin Farm Tractor. Automotive Industries, vol. 40, no. 9, Feb. 27, 1919, p. 484. British tractor on Fordson lines.

Southern Tractor Requirements, B. M. Ikert. Motor Age, vol. 35, no. 13, Mar. 27, 1919, p. 27. Protection of working parts from dust and sand held to be of greatest importance.

Ball Bearings in Tractor Design, H. M. Trumbull. Can. Machy., vol. 21, no. 8, Feb. 20, 1919, pp. 179-183 and 187, 20 figs. Advocates using high-grade self-aligning ball bearing and illustrates its operation under various conditions of tractor service. From Tractor and Trailer.

Novel Frame in S. W. H. Tractor. Motor Age, vol. 35, no. 8, Feb. 20, 1919, pp. 46-47, 4 figs. Housing of gear set and rear axle in single casting.

Fiat Tractor Design Changes, W. F. Bradley. Automotive Industries, vol. 40, no. 10, Mar. 6, 1919, pp. 525-526, 4 figs. Secondary shaft behind axle housing; straight belt drive.

Vulcan

The Eight-Cylindered 20-25 H. P. Vulcan. Auto., vol. 24, no. 949, Mar. 13, 1919, pp. 247-250, 5 figs. Description and discussion with reference to characteristics of "eights" in general.

See also MECHANICAL ENGINEERING,

Internal Combustion Engines (Carburetion, High Speed Engines, Truck and Tractor Engines, Valves); RAILROAD ENGINEERING, Equipment (Motor Inspection, Cars).

PIPE

Corrosion

Health Board Studies Pipe Corrosion in Buildings. Eng. News Rec., vol. 82, no. 10, March 6, 1919, pp. 469-470, 6 figs. Examinations of sewer and vent-pipe systems in buildings of various ages found in the Chicago business district.

Couplings

Lead Pipe Couplings, John A. Jensen. Can. Engr., vol. 36, no. 1, Jan. 2, 1919, pp. 107-108. Results of examination of street leaks. Paper read before St. Louis Convention Am. Water Works Assn.

POWER GENERATION

Appalachian System

The Appalachian Power System, H. S. Slocum. Power, vol. 49, no. 12, Mar. 25, 1919, pp. 438-444, 12 figs. Features of hydroelectric and steam system supplying electric current to a large section of the South. Glen Lyn steam station.

Atlantic Seaboard

Power Supply for Atlantic Seaboard. Elec. World, vol. 73, no. 13, Mar. 29, 1919, pp. 638-639, 1 fig. Scope of plan of Secretary of Interior Lane for development of superpower stations in Boston-Washington district. Paper before Boston section Am. Inst. Elec. Engrs.

Australia

Water-Power Resources in Australia, Douglas Mawson. Commonwealth Engr., vol. 6, no. 6, Jan. 1, 1919, pp. 181-182. Figures gathered by writer show that a total of 13,722,000 hp. is available in Australasia; of this he believes 8,500,000 hp. is capable of development in Papua.

Hydroelectric Developments, Costs

General Factors Affecting the Cost of Constructing Hydro-Electric Development. Eng. & Contracting, vol. 51, no. 11, March 12, 1919, pp. 271-273. Investigation by Public Utilities Commission of State of Maine.

Massachusetts

Development of Massachusetts' Water Power. Elec. World, vol. 73, no. 6, Feb. 8, 1919, pp. 272-273, 1 fig. Special commission declares public ownership to be of doubtful value as a water-power policy.

Muscle Shoals

United States Nitrate Plant No. 2 at Muscle Shoals, Ala., Charles H. Bromley. Power, vol. 49, no. 12, Mar. 25, 1919, pp. 424-431, 8 figs. Data on flow and available power of Tennessee River at that point. Table of specifications of plant. First article of series.

Nationalization

Nationalization of Transport and Electricity Supply. Tramway & Ry. World, vol. 45, no. 13, Mar. 13, 1919, pp. 113-115. Scheme for unification and cheapening of communication.

Oil Engines

Place for Oil-Engine-Driven Generators. Elec. World, vol. 73, no. 11, March 15, 1919, pp. 519-520. Operating and maintenance expenses; analysis of expenses with old and new types of engines.

Solar Energy

The Utilization of Solar Energy, J. F. Heffron. Power House, vol. 12, no. 3, Mar. 1919, pp. 56-59, 5 figs. Review of attempts that have been made to utilize sun heat and indication as to what may be accomplished in future.

Sweden

The Extension of Hydro-Electric Power in Sweden. Engineering, vol. 107, no. 2775, Mar. 7, 1919, pp. 302-304. Calculations and investigations of Roy. Swedish Waterfalls Board.

Power Conditions in Europe. Power Plant Eng., vol. 23, no. 7, Apr. 1, 1919, pp. 332-334. Developments proposed in Sweden. Data supplied by Roy. Consulate of Sweden.

POWER PLANTS

Air Heaters for Boilers

Boilers Provided with Air Heaters (Les chaudières avec réchauffeurs d'air), J. R. Revue Générale de l'Electricité, vol. 5, no. 7, Feb. 15, 1919, pp. 265-269, 8 figs. Installation by Underfeed Stoker Co. in English plant. Heat contained in the chimney gases of boiler is utilized for heating air entering the furnace.

Ash Disposal

Fast Modern Methods of Ash Disposal. Black Diamond, vol. 62, no. 12, Mar. 22, 1919, pp. 332-335, 6 figs. Comparison of methods; review of book published by Am. Steam Conveyor Corp.

Central Heating Plant of the Colorado State College. Power, vol. 49, no. 10, March 11, 1919, pp. 346-348, 6 figs. Coal- and ash-handling equipment.

Power Plant Management; Coal and Ash Handling—I, Robert June. Power House, vol. 12, no. 3, Mar. 1919, pp. 60-62, 3 figs. Claims that elimination of hand labor is an important element in power-plant operation. Also in Refrig. World, vol. 54, no. 3, Mar. 1919, pp. 23-25, 3 figs.

Boiler Explosion

Boiler Explosion at Mobile. Power, vol. 49, no. 12, Mar. 25, 1919, pp. 432-436, 11 figs. Particulars of explosion of two Heine boilers at plant of Mobile Electric Co.

Boiler Interconnection

New Boiler Plant of the A. S. & R. Co. at Omaha, R. N. Robertson. Power, vol. 49, no. 14, Apr. 8, 1919, pp. 514-518, 7 figs. Main feature of this underfed stoker plant is interconnection of two boilers which are baffled to utilize radiant energy from fire; superheater is placed behind bridge wall.

Boiler-Tube Ruptures

Water-Tube Boiler Tube Ruptures, Weldon Melroy. Power, vol. 49, no. 9, March 4, 1919, pp. 302-303, 5 figs. Illustrations of ruptures from various causes.

CO_2 Recorders

Fuel Economy in the Boiler House—III, J. B. C. Kershaw. Chem. & Metallurgical Eng., vol. 20, no. 6, March 15, 1919, pp. 291-295, 8 figs. Description of German types of CO_2 recorders which depend on measurements of the physical properties of flue gas.

Coal Consumption

The Coal Consumption of Steam Power Plant, Robert H. Parsons. Elec. Rev., vol. 84, no. 2152, Feb. 21, 1919, pp. 200-202, 4 figs. Charts of coal consumption, steam consumption, coal efficiency and water efficiency.

Saving Coal in Steam Power Plants, Dept of Interior, Bur. of Mines, Technical Paper 217, 8 pp., 1 fig. Economical principles and method of applying them to power-plant operation.

Condensers

Installation and Operation of Condensers (Remarques sur l'établissement et l'exploitation des installations de condenseurs), C. Oettinger. Revue Générale de l'Electricité, vol. 5, no. 11, Mar. 15, 1919, pp. 419-422, 5 figs. Suggestions to engineer assuming direction of condensing apparatus in steel plant.

Economizers

Economizer Practice, M. E. Alone. Power Plant Eng., vol. 23, no. 7, Apr. 1, 1919, pp. 311-315, 2 figs. Saving, materials, cleaning, keeping track of performance, temperatures, gas volume, and air leakage in steam-boiler plants.

Equipment

Modern Steam Power Station Equipment, Joseph G. Worker. Blast Furnace & Steel Plant, vol. 7, no. 4, Apr. 1919, pp. 177-182, and 202, 13 figs. Review of modern steam power-plant equipment installed to meet demand of increased power facilities.

Exhaust Steam

Values of Exhaust Steam, R. L. Wales. Natl. Engr., vol. 23, no. 4, Apr. 1919, pp. 156-161, 5 figs. Discussion of factors to be considered when calculating relative values; distribution of costs between power and heat; charts for computation of comparative values.

Hand-Fired Plants

Saving Coal in Boiler Plants, Henry Kreisinger. Universal Engr., vol. 29, no. 2, Feb. 1919, pp. 45-54, 3 figs. Suggestions given to operators of hand-fired plants.

Power Costs

Saving Coal in Steam Plants, Edward J. Willis. Natl. Engr., vol. 23, no. 4, Apr. 1919, pp. 170-172. Data of costs of production.

Emergency Shop Power and Coal Conservation, C. E. Clewell. Am. Mach., vol. 50, no. 12, Mar. 20, 1919, pp. 533-536, 6 figs. Graph showing how operating costs per unit of energy delivered may vary for different values of percentage of use.

Calculation of Plant Efficiencies and Fuel Costs, J. T. Foster. Power, vol. 49, no. 9, March 4, 1919, pp. 316-318, 2 figs. Charts.

Power-House Economy

Getting Better Economy in the Power House, G. H. Kelsay. Elec. Ry. Jl., vol. 53, no. 10, Mar. 8, 1919, pp. 455-460, 9 figs. Relation of boiler load to efficiency; increase in efficiency of steam turbines and relation of coal used to available supply; curves showing progress of combustion beyond fuel bed and effect of excess air. Abstract of paper read before Central Elec. Ry. Assn.

Power Plants

Power Plants of New Gotham Hotels. Black Diamond, vol. 62, no. 12, Mar. 22, 1919, pp. 321 and 335, 4 figs. Battery of boilers of 15,000 hp.

Stokers

Erith-Riley Mechanical Stokers. Engineering, vol. 107, no. 2774, Feb. 28, 1919, pp. 268-269, 5 figs. Development of Erith-Riley stoker in conjunction with large boiler plants installed on the unit system.

Valves

Notes on the Repairing and Adjusting of Valves, W. H. Wakeman. Domestic Eng., vol. 86, no. 13, Mar. 29, 1919, pp. 556-559, 12 figs. Suggestions to steamfitters on repairing and adjusting valves of various types.

Water Softening

Water Softening, E. V. Chambers. Chem. News, vol. 118, no. 3066, Jan. 17, 1919, pp. 27-29. Treatment given in North of England to upland surface water intended for use in textile industry.

Water Softening, P. E. King. Chem. News, vol. 118, no. 3065, Jan. 10, 1919, pp. 14-16. Classification and description of methods.

See also MECHANICAL ENGINEERING, Handling of Materials (Ash Handling), Measurements and Measuring Apparatus; MARINE ENGINEERING, Auxiliary Machinery (Evaporators).

POWER TRANSMISSION

Belt Transmission

On the Power Transmission by Belt and Pulley (in Japanese), Chido Sugatani. Jl. Soc. Mech. Engrs., Tokyo, vol. 22, no. 54, Nov. 1918.

PRODUCER GAS

Operation

Gas Producers (Les gazogènes), G. Marconnet. Chimie & Industrie, vol. 2, no. 1, Jan. 1, 1919, pp. 6-14, 6 figs. Classification; operating data.

Theory

Elementary Theory of the Gas Producer, W. L. Badger. Mich. Technic, vol. 31, no. 1, Mar. 1918, pp. 13-17, 2 figs. Le Chatelier theorem.

REFRACTORIES

Graphite Ash Fusibility

Fusibility of Graphite Ash and Its Influence on the Refractoriness of Bond Clay, M. C. Booze. Jl. Am. Ceramic Soc., vol. 2, no. 1, Jan. 1919, pp. 65-68. From laboratory tests it is concluded that the softening point of a graphite ash is not a true criterion of its action in a crucible body.

Ovens and Kilns

Ovens and Kilns with a High Thermal Efficiency, A. Bigot. Gas Jl., vol. 145, no. 2905, Jan. 14, 1919, p. 71. Laboratory kiln with waste pipe surrounded by sheet-iron recuperator claimed by author to have increased by 200 deg. cent. temperature of interior of kiln. Paper before Ceramic Soc.

Research

Refractory Materials as a Field for Research, Edward W. Washburn. Jl. Am. Ceramic Soc., vol. 2, no. 1, Jan. 1919, pp. 3-31, 1 fig. Survey of scientific aspects of subject. Report drafted under auspices of Section of Indus. Research of Nat. Research Council.

REFRIGERATION

Cold Storage Abroad

Refrigeration Abroad. Ice & Refrigeration, vol. 56, no. 3, Mar. 1919, pp. 174-175. Cold storage accommodations in Great Britain, Australia, and Russia.

Compression Refrigerating Machine

The Compression Refrigerating Machine, Gardner T. Voorhees. Ice & Refrigeration, vol. 56, nos. 2 and 3, Feb. and Mar. 1919, pp. 99-100 and 149-151, 6 figs. Comparison of types; conditions of heat flow. (To be continued.)

The Ammonia Compression Refrigerating System XXXVIII, W. S. Doan. Refrig. World, vol. 54, no. 3, Mar. 1919, pp. 30-32, 4 figs. Atmospheric parallel flow type ammonia condenser; submerged condenser, shell type condenser; submerged and shell type condensers.

Fur Storage

Cold Storage of Furs, B. F. Green. Refrig. World, vol. 54, no. 3, Mar. 1919, pp. 25-26. Suggestions in regard to efficiency and safety.

Hotel Equipment

Refrigerating Equipment of the Pennsylvania Hotel. Power, vol. 49, no. 14, Apr. 8, 1919, pp. 522-524, 3 figs. Equipment has ice making capacity of 100 tons per day.

Refrigerating Plant Efficiency

Refrigerating Plant Efficiency, Victor J. Azbe. Mech. Eng., vol. 41, no. 4, Apr. 1919, pp. 362-368, 10 figs. General discussion of refrigerating plant economics. Abstract of paper read at Annual Meeting of A.S.M.E., December 1918.

PUMPS

Centrifugal Pumps

On the Combined Running of Centrifugal Pumps (in Japanese), Iwao Oki. Jl. Soc. Mech. Engrs., Tokyo, vol. 22, no. 54, Nov. 1918.

RESEARCH

Canada

The Canadian Honorary Advisory Council for Scientific and Industrial Research, A. B. Macallum. Can. Min. Jl., vol. 45, no. 2, Jan. 15, 1919, pp. 28-29. Situation which has confronted Research Council since its erection in Dec. 1916.

Chemical Warfare Service

The Research Division, Chemical Warfare Service, U. S. A., George A. Burrell. Jl. Indus. & Eng. Chem., vol. 11, no. 2, Feb. 1, 1919, pp. 93-104. Review of work done by Service, beginning with its inception before U. S. entered war, and covering development of Division, including personnel, location of various parts of work and some of the problems attacked and solved.

England

The Government and the Organisation of Scientific Research, Frank Heath. Jl. Roy. Soc. Arts, vol. 67, no. 3457, Feb. 21, 1919, pp. 206-215 and (discussion) pp. 215-219. Difficulties encountered by Department of Sci. and Industrial Research, England.

The Organization of Research in Great Britain. Science, vol. 44, no. 1262, March 7, 1919, pp. 239-241. Abstract of report of Committee of Privy Counsel for Scientific and Industrial Research.

Industrial Laboratories

Technical Direction of an Industrial Laboratory (Direction d'un laboratoire industriel au point de vue analytique), Paul Nicolardot. Chimie & Industrie, vol. 2, no. 1, Jan. 1, 1919, pp. 18-24, 5 figs. Concerning standardization of methods of analysis and relations with other laboratories.

Rolling-Mill Research Laboratory

Rolling Mill Research Laboratory Founded. Blast Furnace & Steel Plant, vol. 7, no. 4, Apr. 1919, pp. 183-185, 2 figs. Experimental rolling mill and bureau of rolling mill research, organized in Pittsburgh by leading steel and rolling-mill manufacturers under auspices of Carnegie Inst. of Technology.

See also MECHANICAL ENGINEERING, Refractories (Research); AERONAUTICS, Research.

SPECIFICATIONS

Leather Belting

Specifications for Leather Belting, Harry A. Hey. Indus. Management, vol. 57, no. 4, Apr. 1919, pp. 275-281, 2 figs. Requirements to control quality from new point of view.

Steel, High-Speed

Specifications for High Speed Steels, R. Poliakoff. Iron Age, vol. 103, no. 13, Mar. 27, 1919, pp. 827-829. Questions to take into consideration in drafting specifications, with reference to European practice.

STANDARDS AND STANDARDIZATION

Brass and Bronze Foundries

Standards for Brass and Bronze Foundries and Metal Finishing Processes, William Erskine. Metal Indus., vol. 17, no. 3, March 1919, pp. 113-117. Methods and apparatus to protect health of workers.

Marine Engines

Standardization of Marine Engines. Mar. Rev., vol. 49, no. 4, Apr. 1919, pp. 179-182, 2 figs. Composite design embodying approved features of standard types is advocated.

Standards

Standards in Engineering, R. J. Durley. Jl. Eng. Inst. Can., vol. 2, no. 3, Mar. 1919, pp. 174-182. Their importance in limiting costs of manufacture and facilitating production. Notes on attention now being given in England and U. S. to standards.

STEAM ENGINEERING

Boilers

Talbot Boilers and Engines Made in Canada. Power House, vol. 12, no. 3, Mar. 1919, pp. 66-98, 5 figs. Description of contraflow boiler and uniflow engine.

Evaporation Charts

Chart for Finding the Factor of Evaporation, G. H. Sheasley. Power, vol. 49, no. 11, March 18, 1919, p. 406, 1 fig. Chart gives required factor of any given steam-boiler performance.

Rotary Engines

Avery's Rotary Steam Engine. Natl. Engr., vol. 23, no. 4, Apr. 1919, pp. 173-174, 2 figs. Construction details and performance.

Steam-Turbine History

Steam Turbine Progress Reviewed Historically. Steam, vol. 23, nos. 2 and 3, Feb. and Mar. 1919, pp. 33-41 and 63-69, 37 figs. Review of British patent-office records. Mar. 1919: Impulse blading and blade materials. Also in Railroad Herald, vol. 23, no. 3, Feb. 1919, pp. 63-65; Universal Engr., vol. 29, no. 2, Feb. 1919, pp. 34-44, 13 figs.

Steam Turbines

The Assembly and Adjustment of Steam Turbines, J. Humphrey. Machinery, vol. 13, no. 331, Jan. 30, 1919, pp. 486-492, 14 figs. Turbines considered are those working on the Parsons principle and having large number of fixed and moving blades, calked into the casing and on the periphery of the rotor.

The Large Steam Turbine, J. F. Johnson. Mech. Eng., vol. 41, no. 4, Apr. 1919, pp. 355-361, 7 figs. Development of large units to meet modern power requirements; records of performance; notes on design and construction.

WELDING

Arc-Welding Regulations

Notes on Regulations for Arc Welding, H. M. Sayers. Can. Machy., vol. 21, no. 2, Jan. 9, 1919, pp. 39-41. Precautions to be observed for safety of operator; effects of welding load on supply mains of power station.

Blowpipe, Oxy-Acetylene

How to Choose an Oxy-Acetylene Blowpipe, C. Royer. Can. Machy., vol. 21, no. 8, Feb. 20, 1919, pp. 184-187, 1 fig. Writer considers that determining factors are character of work to be done and equipment on hand, and refers to features he estimates as of paramount importance in various classes of service.

Frog Shop

Welding in the Frog Shop, B. K. Smith. Welding Engr., vol. 4, no. 3, Mar. 1919, pp. 19-20. Reclaiming of materials.

Lead Welding

The Autogenous Welding of Lead—II, P. Rosemberg. Acetylene & Welding Jl., vol. 15, no. 178, July 1918, pp. 118-119, 6 figs. Uses of hydrogen and air blowpipe.

Rail Joints

Modern Welding and Cutting, Ethan Viall. Am. Mach., vol. 50, no. 12, Mar. 20, 1919, pp. 529-532, 11 figs. Notes on welding various types of rail joints. Sixth article.

Seam Welding, Electric

Electric Seam Welding, P. T. Van Bibber. Am. Mach., vol. 50, no. 13, Mar. 27, 1919, pp. 575-580, 14 figs. Details of welding roller head; lap-seam welding machine and Thomson machine for flange-seam welding.

Thermit Welding

Modern Welding and Cutting, Ethan Viall. Am. Mach., vol. 50, no. 11, Mar. 13, 1919, pp. 479-483, 11 figs. Thermit rail welding for electric systems. (Continuation of serial.)

Miscellaneous Thermit Repairs in the Nashville, Chattanooga & St. Louis Shops, Albert L. Seals. Reactions, First Quarter, 1919, pp. 18-20, 7 figs. Splice welded to main frame of engine; repair on a two-throw crankshaft.

Tires, Welded

Microscopic Study of Welded Tires. Acetylene & Welding Jl., vol. 16, no. 185, Feb. 1919, pp. 30-32, 30 figs. Structure of test pieces 3/16-in. from fracture, and tabulation of their characteristic differences according to position relative to fracture. (Concluded.)

Tool-Steel and Stellite Welding

Electric Welding of High-Speed Steel and Stellite in Tool Manufacture, P. T. Van Bibber. Am. Mach., vol. 50, no. 10, March 6, 1919, pp. 425-437, 80 figs. Stellite used only for vital parts is welded to shank of ordinary steel by butt-welding process. Operations, data and specifications.

WOOD

Applications

The Uses of Wood, Hu Maxwell. Am. Forestry, vol. 25, no. 303, Mar. 1919, pp. 923-930, 18 figs. Fencing materials from forests. Eleventh article.

Drying

English Methods of Lumber Drying, John Young. Wood-Worker, vol. 38, no. 1, Mar. 1919, p. 34, 1 fig. Details of English drykiln.

Seasoning

The Seasoning of Lumber, Bror L. Grondall, Sci. Am. Supp., vol. 87, no. 2253, Mar. 8, 1919, pp. 158-160. Basic facts underlying artificial drying of forest products. From West Coast Lumberman.

VARIA

Drawings, Reproduction of

Reproducing Drawings, F. G. Allen. Univ. Colo. Jl. Eng., vol. 15, no. 2, Jan. 1919, pp. 36-51. Discussion of the various methods of making duplicates of engineering drawings. Photo-chemical methods, lithographic methods, zinc etching, and half-tones, are considered.

Engineers

The Functions of the Engineer: His Education and Training, W. A. J. O'Meara. Elec. Rev., vol. 84, no. 2152, Feb. 21, 1919, pp. 219-221, 1 fig. Diagram of salaries and estimated personal qualifications.

Invention

Efficient Invention, Douglas Leechman. Automobile Engr., vol. 9, no. 124, Mar. 1919, pp. 74-79. Writer suggests that if present patent fees were suitably reduced, trade of country would be benefited by increased encouragement of invention. Particular reference to patents affected by the war. Paper presented to Instn. Automobile Engrs.

Licensing Engineers

Comparison of Various Existing and Proposed License Laws, Eng. News Rec., vol. 82, no. 9, Feb. 27, 1919, pp. 423-430. States that have laws regulating practice of engineering and those which contemplate establishing such laws.

Nomography

Nomography, M. J. Eichhorn. Natl. Engr., vol. 23, no. 4, Apr. 1919, pp. 165-169, 13 figs. Reduction tables for pressures, temperatures, etc., and graphical steam tables. (Continuation of serial.)

Semi-Logarithmic Paper

The Use of Semi-Logarithmic Paper in the Determination of Empirical Formulas, E. W. Lane. Cornell Civ. Engr., vol. 27, no. 1, Feb. 1919, pp. 3-8, 3 figs. Types of semi-logarithmic curves.

Steam-Distribution Charts

Chart of Steam Distribution (Abaque général pour l'étude des distributions de vapeur), Rodolphe Soreau. Mémoires et Compte rendu des Travaux de la Société des Ingenieurs Civils de France, vol. 71, nos. 11-12, Nov.-Dec. 1918, pp. 551-556, 2 figs. Chart is prepared to indicate any of three quantities, relative piston displacement, ratio of crank to connecting rod, and angle between crank and line of dead centers—when the other two are determined.

Organization and Management

ACCOUNTING

Cost Accounting

Uniform Cost Accounting. Ice & Refrigeration, vol. 56, no. 2, Feb. 1919, pp. 101-109, 8 figs. Forms covering cost accounting for production and distribution of ice, worked out by special committee of Nat. Assn. Ice Industries.

Cost Accounting to Aid Production—VII, G. Charter Harrison. Indus. Management, vol. 57, no. 4, Apr. 1919, pp. 314-318, 3 figs.

Expansion of application of scientific management principles. Theory illustrated by example of firm entering field of manufacturing automobile trucks.

Inventories .

Accurate Inventories Aid Output, Clifford E. Lynn. Iron Trade Rev., vol. 64, no. 13, Mar. 27, 1919, pp. 828-829, 2 figs. Form of keeping complete plant records of finished and semi-finished stocks.

Production Accounts

Systematizing Production Accounts, Ralph E. Butz. Iron Trade Rev., vol. 64, no. 12, Mar. 20, 1919, pp. 757-759. Methods for keeping records of costs in manufacturing plants. It is recommended that accounting be operated on double-entry principle.

EDUCATION

Crew Instruction at Hydroelectric Plant

Operation at Holtwood, Charles H. Bromley. Power, vol. 49, no. 12, Mar. 25, 1919, pp. 450-454, 6 figs. Methods used in instruction of crew at hydroelectric station of Pa. Water & Power Co. First article of series.

Education and Industry

Industry, Democracy, and Education, C. V. Corless. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 148, Apr. 1919, pp. 621-635. Social problems developed from moral forces which found themselves released at termination of war.

Soldiers

Soldiers Civil Re-Establishment, L. Anthes. Jl. Eng. Inst. Can., vol. 2, no. 3, Mar. 1919, pp. 185-187. Notes on responsibility for soldiers' welfare placed on those who did not share their sacrifice.

Women, Training School for

Training Women in an Airplane Plant, James W. Russell. Machy., vol. 25, no. 7, Mar. 1919, pp. 593-595, 7 figs. Experiments and results in Curtiss Aeroplane & Motor Corporation's training school.

See also MINING ENGINEERING, Coal and Coke (Training of Students).

FACTORY MANAGEMENT

Credit

Mathematics of Credit Extension, Frederick Thulin. Jl. Accountancy, vol. 27, no. 4, Apr. 1919, pp. 259-267. Question of determining point of limitation to which grant of credit can go and of determining prima facie amount of capital, if any, a business requires from its proprietorship in reference to particular request of credit under consideration.

Employment System

Employment System of Cincinnati Planer Co., A. J. Schneider. Machy., vol. 25, no. 7, Mar. 1919, pp. 622-623, 8 figs. Forms of inquiry cards, record sheets and employment pass.

The Employment Department, G. L. Hostetter. Eng. & Indus. Management, vol. 1, no. 5, Mar. 13, 1919, pp. 142-143. Discusses effect of defective organization upon minds of applicants for employment and shows how first impressions generally influence the worker in the factory.

Selecting and Training Interviewers, Roy Willmarth Kelly. Indust. Management, vol. 57, no. 4, Apr. 1919, pp. 263-270, 9 figs. Analyzes knowledge and training needed by employment interviewer and points out specific information he should secure in regard to his community.

Forge-Shop Maintenance Department

Methods of Increasing Shop Efficiency, J. D. Lannon. Am. Drop Forger, vol. 5, no. 3. Mar. 1919, pp. 117-120. Schemes for sustaining maintenance department in forge shop. First article.

Human Activities, Classification of

Human Parasitism or Service, Harrington Emerson. Indus. Management, vol. 57, no. 4, Apr. 1919, pp. 257-262, 1 fig. Classifies human activities into nine elements. Graphs for purpose of aiding each one to know where he belongs and what he is doing.

Human Factor in Efficiency

The Human Factor in Efficiency Methods, C. A. Pells. Elec. Rev., vol. 84, no. 2153, Feb. 28, 1919, p. 228. Social, economic, and hygienic conditions of worker as affecting efficiency.

Industrial Organization

Managing for Maximum Production—II, L. V. Estes. Indus. Management, vol. 57, no. 4, Apr. 1919, pp. 284-288, 5 figs. Theory of functions of industrial organizations. It is advanced that the industrial machine should be so built that routine work becomes compulsorily automatic.

Problems of Industrial Organization, Major Greenwood. Colliery Guardian, vol. 117, no. 3035, Feb. 28, 1919, p. 477. Remarks that while details of production, quantities of goods made, nature and powers of machines are matters which can be adequately described, such is not the case with efficiency of workers. Paper before Roy. Statistical Soc. Also abstracted in Eng. & Indus. Management, vol. 1, no. 5, Mar. 12, 1919, pp. 150-154.

Labor Turnover

Proper Systems Reduce Labor Turnover. Automotive Industries, vol. 40, no. 12, Mar. 20, 1919, pp. 619-621. Statistics of labor turnover and analysis of factory methods for handling it.

Labor Turnover and a Remedy, W. H. Weingar. Am. Mach., vol. 50, no. 11, Mar. 13, 1919, pp. 497-499, 5 figs. How a munition plant has handled problem.

Layout of Works

The Thornycroft Motor Works at Basingstoke. Ry. Gaz., vol. 30, no. 5, Jan. 31, 1919, pp. 168-169, 5 figs. Layout of works and views of laboratories.

The Automobile Factory—III. Automobile Engr., vol. 9, no. 124, Mar. 1919, pp. 87-94, 18 figs. Notes on layout, construction and equipment.

Library

The Organization of a Factory Library, W. Barbour. Jl. Soc. Chem. Indus., vol. 39, no. 3, Feb. 15, 1919, pp. 35R-40R. Particulars of a system of indexing books, extracts, periodicals, manuscripts, papers, reports and charts.

Limitation of Output

The Limitation of Output, Andrew Stewart. Engineering Review, vol. 32, no. 9, Mar. 15, 1919, pp. 247-250, 6 figs. Deals with problem of restriction of output of men and machines.

Machine-Tool Plant

Organization and Management of a Machine Tool Plant, Oskar Kylin and Erik Oberg. Machy., vol. 25, no. 7, Mar. 1919, pp. 608-614, 10 figs. Principles of organization and details of system used in a medium-size machine-tool manufacturing plant. First article.

Management Systems

Democracy Applied to Shop Management. Iron Age, vol. 103, no. 12, Mar. 20, 1919, pp. 743-745. Describes system adopted by Am. Multigraph Co., said to be based on American form of government.

"Efficiology," a Method of Making Profits by Universal Democracy, W. S. Rogers and Nellie M. Scott. Indus. Management, vol. 57, no. 4, Apr. 1919, pp. 299-301, 3 figs. Method of Bantam Ball Bearing Co. Charts of authority and responsibility.

Milling Calculations

Milling Calculations, Robert S. Lewis. Chem. & Metallurgical Eng., vol. 20, no. 5, March 1, 1919, pp. 224-233, 2 figs. Formulae for determining extraction of processes, efficiency of machines, density of solids, solutions and pulps; notes on methods of testing and microscopic examination; bibliography of articles dealing with calculations.

Profit Sharing

A Profit-Sharing Plan for Executives, A. P. Ball. Indus. Management, vol. 57, no. 4, Apr. 1919, pp. 296-298, 3 figs. Experiment of Square D Company.

Rotation in Jobs

What Is the Value of Rotation in Jobs? Harry Tipper. Automotive Industries, vol. 40, no. 12, Mar. 20, 1919, pp. 628-629. Discussion whether employer or employee benefits most from shifting workers frequently.

Scientific Management

Seven Common Questions Regarding Scientific Management, Carle M. Bigelow. Indus. Management, vol. 57, no. 4, Apr. 1919, pp. 281-283. Objections that must be overcome in minds of business executives before they will consider the possibility of installing scientific management in their plants.

How I Have Applied the Taylor System (Comment j'ai mis en pratique le systéme Taylor), Serge Heryngfel. Mémoires et Compte rendu des Travaux de la Société des Ingénieurs Civils de France, vol. 71, nos. 11-12, Nov.-Dec. 1918, pp. 557-559, 17 figs. Personal experiences in organization work.

Science and Industry (La science et l'industrie). Métallurgie, vol. 51, nos. 1 and 2, Jan. 1 and 8, 1919, pp. 26 and 75. Conducting industrial operations by scientific methods of organization.

Guiding the Creative Instinct, W. R. Basset. Factory, vol. 22, no. 3, March 1919, pp. 449-452. Concerning scientific management and the psychological characteristics of workers.

Shop Routing

Shop Routing System Reduces Handling Costs, F. L. Prentiss. Iron Age, vol. 103, no. 14, Apr. 3, 1919, pp. 867-870, 5 figs. Methods of Cleveland Tractor Co.

Store Room

Distribution of Materials and Supplies, B. J. Yungbluth. Elec. Ry. Jl., vol. 53, no. 10, Mar. 8, 1919, pp. 473-475. Economic aspect of methods followed in storeroom.

Keeping Track of Factory Material, J. C. Hickman. Factory, vol. 22, no. 3, March 1919, pp. 465-469, 16 figs. Remarks on specifying, receiving and inspecting purchase. First article.

Time Study

Six Fundamentals of Time Study, Samuel R. Gerber. Indus. Management, vol. 57, no. 4, Apr. 1919, pp. 308-311. How they must be handled by time-study man.

Tool Room

Modern Tool Room Organization. Machinery, vol. 13, no. 331, Jan. 30, 1919, pp. 477-479, 7 figs. Scheme of the record and costing of jigs and fixtures.

Trucks, Industrial

Conserving Labor in the Mill. Am. Miller, vol. 47, no. 4, Apr. 1, 1919, pp. 319-320, 4 figs. Suggests cutting down overhead by employing industrial truck to do work of many men.

Timken Solving Difficult Production Problem, Edward Schipper. Automotive Industries, vol. 40, nos. 13 and 14, Mar. 27 and Apr. 3, 1919, pp. 685-688 and 748-750, 13 figs. Mar. 27: Methods for scheduling work of Timken-Detroit Axle Co. Apr. 3: Practice of company in departmental communication, by using electric trucks.

Welfare

Welfare in the Factory. Times Eng. Supp., vol. 15, no. 532, Feb. 1919, p. 77. Influence of the State.

FINANCE AND COST

Prices

Civil War Price Trends Compared with Those Today, Morris Knowles. Eng. News-Rec., vol. 82, no. 9, Feb. 27, 1919, pp. 414-416, 2 figs. Writer, judging by past, believes high prices will continue.

LABOR

American Conditions

American Workmen During the War (Le travail américain pendant la guerre). Revue Générale de l'Electricité, vol. 5, no. 7, Feb. 15, 1919, pp. 275-278. Survey of organization work in United States, specially of relations between workers and employers.

Crippled Soldiers

Economic Benefit to Mining Industry Illustrated by Experience with Crippled Soldiers, Douglas C. McMurtrie. Colo. School Mines Mag., vol. 9, no. 3, Mar. 1919, pp. 55-57. Studies of Red Cross Inst. for Crippled and Disabled Men.

Dilution of Labour

Dilution of Labour. Times Eng. Supp., vol. 15, no. 532, Feb. 1919, p. 76. Progress and consequences; methods of training.

Housing

Attractive Homes for Employees, W. F. Sutherland. Can. Machy., vol. 21, no. 10, Mar. 6, 1919, pp. 234-237, 17 figs. Plan of housing development at Chippewa plant of Norton Co.

Westinghouse Village at South Philadelphia, Pa. Am. Architect, vol. 115, no. 2251, Feb. 12, 1919, pp. 223-229, 10 figs. Tract set aside for housing contains about 90 acres.

Town Housing of the Working Classes, Herbert Freyberg. Surveyor, vol. 55, no. 1409, Jan. 17, 1919, pp. 31-32. Experience of administration of part III of act of 1890. Before Soc. Architects.

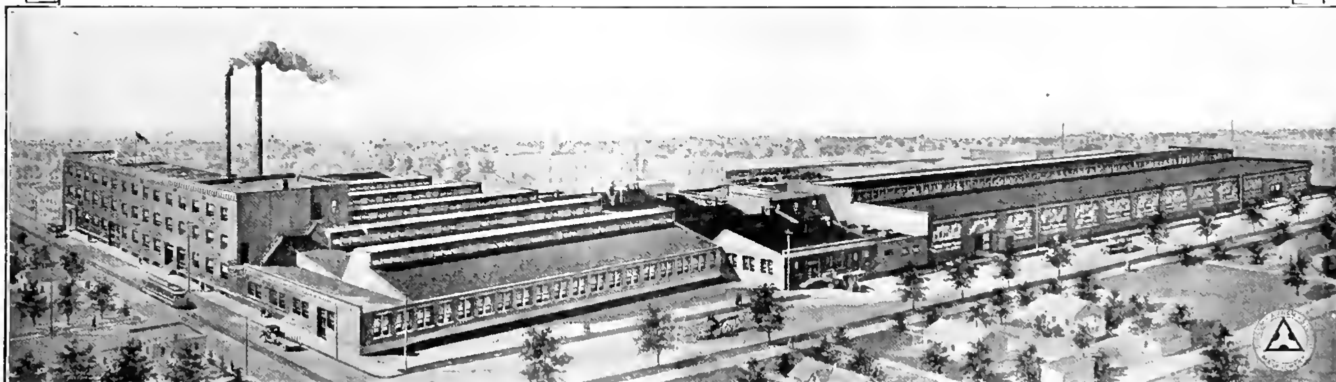
Housing from the Point of View of Economy in Planning and Construction, Henry Tanner. Jl. Roy. Sanitary Inst., vol. 39, no.

Let Us Do Your Special Work

Production Work and Special Work as you want it—and when you need it

When you give Production Work or Special Work to the S. A. S. Laboratories you can feel certain to get accuracy and fine work—the kind you have hoped for, but never expected to get. All work is done by experts, each a specialist in his line. We have more than 500 men trained to do things right and do them well—trained to produce accurate and fine work in large quantities—trained to make the last hundred as good as the sample submitted.

No organization is better equipped to handle your work, and most not as well—we were the only successful manufacturer of Schneider Sights, used on 155m and 240m Howitzers, for the United States Government as well as other extremely accurate devices.



SLOCUM, AVRAM & SLOCUM LABORATORIES, INC.
NEWARK, N. J.

A complete service is offered—

To work with you and for you—from designing to finishing—whether you need a simple part of accurate measurement or an intricate mechanical device that must work accurately—we can do it and do it right—and deliver on time.

What the S. A. S. Laboratories can and will do for you:

—cooperate with you
—design and perfect your special parts or complete machines
—build and perfect working models
—relieve you of troublesome work and make it profitable for you
—handle your production work in any quantity with speed and accuracy

This is the second of a series of advertisements showing our plant, our methods and the work we are doing. Watch for them.

Investigate today—learn just wherein our services are invaluable to you.

LET US BUILD YOUR SPECIAL MACHINES

SLOCUM, AVRAM & SLOCUM LABORATORIES, Inc.

Factory
NEWARK, N. J.

New York Office
30 PINE ST., N.Y.

IT WILL BE RIGHT IF WE BUILD IT

2, Oct. 1918, pp. 79-84. British Government view as to what is proper accommodation to be provided for workers.

The Cost and Construction of Workmen's Dwellings, Roads, Sewers, and Water Supply in Connection with Town Planning. John Parker. Jl. Roy. Sanitary Inst., vol. 39, no. 2, Oct. 1918, pp. 75-78. Conditions and legal regulations at Hereford.

Industrial Councils, Joint

Whitley Plan for Improving Labor Status. Contract Rec., vol. 33, no. 13, Mar. 26, 1919, pp. 279-280. Joint standing industrial councils recommended to provide remedy for differences between employers and employees.

The League of Labor and Capital. C. S. Robinson. Iron Age, vol. 103, no. 11, Mar. 13, 1919, pp. 683-684. Concerning coöperation in industry between employer and employee by establishing a basis for representation of workers.

Labor Representation

Labor's Representation in Plant Management the Immediate Problem. Harry Tipper. Automotive Industries, vol. 40, no. 9, Feb. 27, 1919, pp. 476-477, 2 figs. Chart illustrating representation of employees of Bethlehem Steel Corp. and subsidiary companies.

Profit Sharing

The Profit Sharing Plan of the Baker Manufacturing Co., John S. Baker. Wisconsin Engr., vol. 23, no. 6, Mar. 1919, pp. 193-201. Writer advocates plan for increased remuneration of employees with increased production, and illustrates instance of application of plan.

Psychology of Workers

The Human Machine. Arthur P. Young. Eng. & Indus. Management, vol. 1, no. 5, Mar. 13, 1919, pp. 135-137, 2 figs. Study of psychology of workers.

Unemployment

View of Unemployment from Employer's Side. Iron Age, vol. 103, no. 12, Mar. 20, 1919, pp. 747-748. Opinion of representatives of National Associations connected with metal trades.

Wage Problem

The Wage Problem in Industry. W. L. Hichens. Colliery Guardian, vol. 117, no. 3036, Mar. 7, 1919, p. 536. Suggests ways in which increase of wages may be effective in increasing production. Paper before Roy. Soc. Arts. See also Engineer, vol. 127, no. 3297, Mar. 7, 1919, pp. 231-232, and Jl. Roy. Soc. Arts, vol. 67, no. 3458, Feb. 28, 1919, pp. 224-229 and (discussion) pp. 229-233.

Probable Wages and Supply of Construction Labor During Coming Season. Eng. & Contracting, vol. 51, no. 12, Mar. 19, 1919, pp. 284-286. Committee report of Am. Road Builders' Assn.

Wage Systems (Les différents systèmes de salaires). Métallurgie, vol. 51, no. 11, Mar. 12, 1919, p. 587. Review of systems which have been put into practice in France, America, England and Germany. (To be continued.)

Problems and Formulæ for Payment of Wages (Problèmes et formules de paiement des salaires). Technique Moderne, vol. 10, no. 12, Dec. 1918, pp. 571-574, 1 fig. Includes graph for the Benedict-Stronck, Emerson, Halsey, Rowen, Taylor and Gantt systems. From Metallurgical and Chemical Eng., Mar. 1, 1918; Annales des Ponts et Chaussées, Apr.-May 1917 and previous account in Technique Moderne, vol. 10, no. 1, Jan. 1918, p. 17.

Different Wage Systems (Les différents systèmes de salaires). Métallurgie no. 12, Mar 19, 1919, pp. 649-650, 5 figs. Different wage systems; relation of wage system to effective production. (Continuation of serial.)

Women

Women in the Industry. George H. Priest. Gas Indus., vol. 19, no. 3, Mar. 1919, pp. 73-75. Results from questionnaire sent out to 28 gas works.

LEGAL

Boiler Legislation, Low-Pressure

Low Pressure Boiler Legislation. Official Bul. Heating & Piping Contractors Nat. Assn., vol. 26, no. 3, Mar. 1919, pp. 26-28. Quotes a number of bills now pending before legislatures of several states.

Building Contracts

The Building Contract of the Future. Sullivan W. Jones. Jl. Am. Inst. Architects, vol. 7, no. 3, Mar. 1919, pp. 119-122. Analysis of various forms of existing contracts and suggested changes in policy on building loans. From address before Inst. Elec. Contractors.

Disability

Disability Under the Compensation Acts I, II, III. Chesla C. Sherlock. Am. Mach., vol. 50, nos. 10, 11 and 13, Mar. 6, 13 and 27, 1919, pp. 415-418, 499-502 and 597-599. Court decisions in cases involving temporary disability.

See also MECHANICAL ENGINEERING, Heating and Ventilation (Laws).

LIGHTING

Gas Lighting

Modern Gas Lighting. Philmer Eves. Gas Indus., vol. 19, no. 3, Mar. 1919, pp. 70-72. Practice in churches, public buildings, etc.

Illumination Intensity

Industrial Illumination. Geo. K. McDougall. Jl. Eng. Inst. Can., vol. 2, no. 3, Mar. 1919, pp. 210-215, 8 figs. Review of general information on subject and data of foot candle intensity for various classes of work.

Lighting and Production

Four Conclusive Tests of Production Value of Good Factory Lighting. Elec. Rev., vol. 74, no. 12, Mar. 21, 1919, pp. 449-451, 4 figs. Details of tests conducted by Testing Department of Commonwealth Edison Company. Average increase of production ranges from 10 to 20 per cent.

RECONSTRUCTION AND EXPORT TRADE

Belgium

Reconstruction in Belgium. Times Eng. Supp., vol 15, no. 532, Feb. 1919, p. 69. Requirements in tools; disorganization of transport; problem of labor.

Coal Trade

American Opportunities in the Foreign Coal Trade. Coal Age, vol. 15, no. 11, March 13, 1919, pp. 486-488. From Colliery Guardian.

Electrical Goods

Electrical Competition in Foreign Markets. Joseph M. Goldstein. Elec. World, vol. 73, no. 10, Mar. 8, 1919, pp. 468-471, 2 figs. How the industry in the United States may compete with Allgemeine Elektrizitaets-Gesellschaft of Berlin, which, it is asserted, has dominated the world.

Electrical Goods in Japan. Jl. Electricity, vol. 42, no. 6, Mar. 15, 1919, pp. 266-267. Possibilities of American trade.

Financial Aspect of Reconstruction

The Problem of Reconstruction. Southwestern Elecn., vol. 14, no. 11, Jan. 1919, pp. 14-16. Financial aspect of problem.

France

The Problem of Rebuilding the Devastated Regions of France, Jean-Paul Alaux. Jl. Am. Inst. Architects, vol. 7, no. 3, Mar. 1919, pp. 115-117. Visualization of extent of reconstruction work to be required.

Great Britain

Reconstruction in Great Britain Following the War, H. Babington Smith. Sci. Monthly, vol. 8, no. 4, Apr. 1919, pp. 298-305. Problems of demobilization, vocational instruction of soldiers, and disposal of property in reserve for military purposes.

Latin America

Some Agencies in the Development of Closer Relations with the Countries of Central and South America. L. S. Rowe. Sci. Monthly, vol. 8, no. 4, Apr. 1919, pp. 320-322. Effectiveness of international organization based on moral and cultural ties between nations.

Market for Electrical Goods in South America—II. Philip S. Smith. Elec. World, vol. 73, no. 10, Mar. 8, 1919, pp. 479-481. Notes on Bolivia, Ecuador and British Guiana; résumé of South American conditions as a whole; list of central stations in Chile, Uruguay, Ecuador and Peru.

New Engineering Industries (England)

New Engineering Industries. Chem. News, vol. 118, no. 3070, Feb. 14, 1919, pp. 80-81. Report of Committee of Ministry of Reconstruction, appointed to compile list of articles (suitable for manufacture by those with engineering trade experience) not made in United Kingdom before war.

Railway Buying

Railway Buying and Industrial Readjustment, E. B. Leigh. Ry. Age, vol 64, no. 14, Apr. 4, 1919, pp. 879-881, 1 fig. Shows relation of railway purchases to general business conditions. Address delivered before Natl. Indus. Conference Board.

Union of International Associations

International Associations and After-War Constructions (Les associations internationales et la reconstitution de l'après-guerre), Paul Otlet. Revue Générale des Sciences, no. 4, Feb. 28, 1919, pp. 114-119. Work done by the Union of International Associations organized in 1910. Probable future relations of the Union with Science and Industry.

SAFETY ENGINEERING

Accident Prevention

The Limits of Accident Prevention. Eng. & Indus. Management, vol. 1, no. 5, Mar. 13, 1919, pp. 139-141, 3 figs. Study of accident causes in iron and steel industry based on statistical reports.

The Economics of Safety. Lew R. Palmer. Sci. Monthly, vol. 8, no. 4, Apr. 1919, pp. 350-355, 2 figs. Plant management in relation to accident prevention. As illustration organization of Safety Dept., U. S. Steel Corp., is quoted.

Elevator Accidents

Elevator Accidents and Their Causes. William J. Picard. Safety Eng., vol. 37, no. 3, Mar. 1919, pp. 117-123, 8 figs. Statistical charts and data.

Increasing Cage Safety. Thomas Price. Coal Age, vol. 15, no. 13, Mar. 27, 1919, p. 570, 2 figs. Scheme for attaching two ropes to each cage, either one of which is capable of sustaining load.

Fire Doors and Shutters

Covering Fire Doors and Shutters—I. Metal Worker, vol. 91, no. 13, Mar. 28, 1919, pp. 395-397 and 399, 16 figs. Information on size of sheets to use, method of notching and bending locks, etc., in conformance with underwriters' regulations.

Statistics of Accidents

Statistics in Accident Prevention. Evelyn M. Davis. Elec. World, vol. 73, no. 10, Mar. 8, 1919, pp. 476-477, 1 fig. Analysis of 1172 cases during two-year period, giving data on days lost and division of cost.

Industrial Accidents in the United States Iron and Steel Industry. Engineering, vol. 107, no. 2771, Feb. 7, 1919, pp. 164-167, 7 figs. Statistics giving frequency and severity of accidents.

See also MINING ENGINEERING, Coal and Coke (Fatalities), Mines and Mining (Accidents).

SALVAGE

Motor Shells

Saving Motor Shells from the Scrap Heap by Welding. Elec. Ry. Jl., vol. 53, no. 12, Mar. 22, 1919, pp. 581-586, 15 figs. Different steps in thermit method of welding motor shells as used by large electric-railway system; suggestions for relining crucibles and keeping welding tools in proper repair.

Tool-Steel Scrap

Reclaiming High-Speed Steel Scrap. Edwin F. Cone. Iron Age, vol. 103, no. 13, Mar. 27, 1919, pp. 805-808, 6 figs. Detection and sorting of steel scrap from nature of sparks from special grinding wheel.

War Material

Salvage of War Material. Times Eng. Supp., vol. 15, no. 532, Feb. 1919, p. 70. Organization and research.

Waste of Industrial Materials

Common Wastes of Industrial Materials. H. E. Howe. Indus. Management, vol. 57, no. 4, Apr. 1919, pp. 303-307. Suggestions in regard to elimination of waste.

TRANSPORTATION

Crating

Crating Automobiles for Export. J. H. Teagan. Automotive Industries, vol. 40, no. 11, Mar. 13, 1919, pp. 570-571, 4 figs. Combining security with minimum waste of space.

Light as Aid to Transportation

Light as an Aid to the Transportation of Material. A. L. Powell and R. E. Harrington. Tran. Illum. Eng. Soc., vol. 14, no. 1, Feb. 10, 1919, pp. 1-17 and (discussion) pp. 17-23. Argues that proper lighting of stations, warehouses and piers increases their capacity which depends on speed with which material moves through them.

Mine Cars

Standardized Wagon Designs. J. R. Bazin. Colliery Guardian, vol. 117, no. 3037, Mar. 14, 1919, p. 595. Buffing and drawgear; wheels and axles; axle guards; brakes; body work. Paper read before Inst. Locomotive Engrs.

Rural Transport

Rural Transport. Times Eng. Supp., vol. 15, no. 532, Feb. 1919, pp. 67-68. Suggestions being put forward to effect improvement.

Shop Haulage

Shop Haulage System of New Design. Iron Trade Rev., vol. 64, no. 12, Mar. 20, 1919, pp. 760-763, 13 figs. Geometric principle employed to enable cars to trail correctly and turn sharp corners without tracks; hauling unit is tractor capable of pulling 15 trucks.

Industrial Electric Tractors (Chariots transporteurs electriques pour manutention), Jacques Deschamps. Revue Générale de l'Electricité, vol. 5, no. 5, Feb. 1, 1919, pp. 171-174, 6 figs. Describes various types and their uses, also the Edison accumulator with which industrial tractors are usually operated.

Truck Transportation

Concrete Material for Army Base Hauled by Motor Trucks. Eng. News Rec., vol. 82, no. 8, Feb. 20, 1919, pp. 366-368, 4 figs. Analysis of truck performance and delivery cost. Equipment considered was utilized for stevedoring and haulage at South Brooklyn supply unit.

Economical Motor Transport. Iron Age, vol. 103, no. 11, Mar. 13, 1919, pp. 693-694, 1 fig. Experience in operation by large organization employing trucks in freight haulage.

Zoning

Industrial Zoning, Herbert S. Swan. Am. Architect, vol. 115, no. 2258, Apr. 2, 1919, pp. 500-503. Considers method of formulating zoning ordinance and of laying out several business and factory districts, in order to remove congestion in transportation.

Electrical Engineering

ELECTROCHEMISTRY

Electrolytes

The Effect of Some Simple Electrolytes on the Temperature of Maximum Density of Water, Robert Wright. Jl. Chem. Soc., vols. 115 and 116, no. 676, Feb. 1919, pp. 119-126, 1 fig. Reported from experiments that lowering of temperature produced by highly ionized binary electrolyte is composed of two separate, independent effects, one due to acid radical and other to basic radical of electrolyte.

Electrolytic Dissociation, S. Arrhenius. Chem. News, vol. 118, no. 3069, Feb. 7, 1919, pp. 61-64. Discussion of analytical-chemistry explanation of dissociation.

Electrolytic Conductivity in Non-Aqueous Solutions, Henry Jermain Maude Creighton. Jl. Franklin Inst., vol. 187, no. 3, March 1919, pp. 313-318. Results of measurements in 13 solvents are discussed with reference to viscosity, degree of association and dielectric constant of solvent.

Electroplating

Electro-Plating on Iron from Copper Sulphate Solution, Oliver P. Watts. Gen. Meeting Am. Electrochem. Soc., Apr. 3-5, 1919, paper 7, pp. 61-69. Arsenic, antimony, bismuth, lead and tin dipping solutions were tried. Arsenic, lead and antimony solutions said to be effective in securing a good subsequent electroplating of copper. Bismuth was electrodeposited on iron by using a preliminary arsenic or antimony dip, and nickel on aluminum by using a ferric chloride dip.

Remarkable Pitting of Electroplating, Oliver P. Watts. Gen. Meeting Am. Electrochem Soc., Apr. 3-5, 1919, paper 5, pp. 51-53, 1 fig. Study of irregular pitting in some lead platings led writer to attribute it to air dissolving in electrolyte while it was resting over night, which on cooling was expelled as minute air bubbles on work when bath was heated up by passage of current.

Storage Batteries

Chemical Phenomena in Lead Storage Batteries (Recherches sur le fonctionnement chimique de l'accumulateur au plomb), Ch. Féry. Bulletin de la Société Francaise des Electriciens, vol. 9, no. 77, Feb. 1919, pp. 85-96. Study of what are termed inconsistencies of double sulphate theory in the light of laws of electrolysis. Also in Bulletin de la Société d'Encouragement pour l'Industrie Nationale, vol. 131, no. 1, Jan-Feb. 1919, pp. 92-98.

ELECTROPHYSICS

A. C. Waves, Harmonics

Direct Harmonic Analysis of Alternating Current Waves by Mechanical or Electrical Resonance (Sur l'analyse harmonique directe de l'onde des courants alternatifs par résonance mécanique ou electrique), André Blondel Annales de Physique, series 9, vol. 10, Nov.-Dec. 1918, pp. 195-354, 47 figs. Starting out to measure current, measurement of tension is effected by branching apparatus to terminals of non inductive rheostat placed in series in circuit. Writer states that in harmonic analysis mechanical resonance of vibrating galvanometer is less subject to errors than electrical resonance method.

Arc Electrodes, Temperature of

Temperature of Arc Electrodes (Détermination de la température aux electrodes de l'arc), A. Hagenbach and K. Langbein. Archives des Sciences Physiques et Naturelles, year 124, vol. 1, Jan.-Feb. 1919, pp. 48-54. Experiments apparently show that anodes of metallic arcs (Ag, Cu, Fe, Ni, W) become heated to ebullition temperature but not the cathodes; when oxidation of metal has taken place, temperature rises to ebullition temperature of metallic oxide.

Circuits

Properties of Electrical Circuits Considered as Having No Resistance (Sur les propriétés des circuits électriques dénués de resistance), G. Lippman. Revue Générale de l'Electricité, vol. 5, no. 5, Feb. 1, 1919, pp. 163-165. Advantages of disregarding resistance in establishing general laws of electric action in long circuits. Writer concludes that the laws thus established are static laws. Before the Académie des Sciences. Also in Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 2, Jan. 13, 1919, pp. 73-78.

Electrolytic Safeguards Against Overcharge

Electric Discharge on the Surface of a Solid Electrolyte, Was. Sulejkin. Phys. Rev., vol. 13, no. 3, Mar. 1919, pp. 197-208, 5 figs. Theory of electrolytic safeguards against over tension; dependence of value of critical tension upon the concentration of the electrolyte for different solutions; photomicrographs; behavior of aluminum anode up to critical tension explained.

Overhead Lines

Electrical Constants of Overhead Lines (Costanti elettriche per il calcolo delle condutture aeree), Renzo Norsa. Elettrotecnica, vol. 5, no. 33, Nov. 25, 1919, pp. 470-477, 10 figs. Diagrams and tables showing values of resistance, impedance and reactance of various circuits.

Polyphase Currents

Theory of Polyphase Currents (Théorie des Courants polyphasés), Philippe Banneux. Société Belge des Electriciens, vol. 32, 1915-1916, 1917-1918, pp. 11-91, 8 figs. Generalization of principles involved in investigations with two-phase and three-phase currents. A trigonometric series which permits addition of sines of arcs in arithmetical progression between any two limits is introduced in computations and expressions for electrical quantities are thereby developed.

Selectivity of Circuits

Process and Device for Increasing the Selectivity of Electric Circuits (Procédé et dispositifs pour accroitre la sélectivité des circuits électriques), M. I. Pupin and E. H. Armstrong. Revue Générale de l'Electricité, vol. 5, no. 7, Feb. 15, 1919, pp. 270-274, 10 figs. No. 485533 and 20499. Object is to increase selectivity of circuits which are the seat of periodically variable electric vibrations, particularly of radio-telegraphic installations.

Wehnelt Tube

The Relation of Potential Distribution to Hysteresis Effect in the Wehnelt Tube, R. A. Porter. Phys. Rev., vol. 13, no. 3, Mar. 1919, pp. 189-196, 7 figs. Three stages in discharge of vacuum tube with CaO cathode identified and potential distribution curves for one pressure and heating current obtained for each stage.

FURNACES

Air-Tight Furnaces

English Electric Furnace Developments, F. J. Moffett. Blast Furnace & Steel Plant, vol. 7, no. 4, Apr. 1919, pp. 169-170. On high efficiency and high temperature possibilities and reduction of heat losses by air-tight furnaces.

Arc Furnaces

Development of the Electric Arc Furnace (Perfezionamenti nei forni elettrici ad arco), E. Thovez. Elettrotecnica, vol. 5, no. 33, Nov. 25, 1918, pp. 477-481, 3 figs. History of various types, particularly Héroult and Bassanese.

Steel Furnaces

Iron and Steel Electric Furnaces, J. Bibby. Electrical Review, vol. 84, no. 2150, Feb. 7, 1919, pp. 166-167, 2 figs. Writer advocates single arc for steel making. (Continuation of serial.) Before Manchester Assn. Engrs.

Temperature Uniformity

Temperature Uniformity in an Electric Furnace, John F. Ferguson. Chem. & Metal lurgical Eng., vol. 20, no. 6, March 15, 1919, pp. 283-288, 9 figs. Method of manufacturing laboratory electric furnaces producing uniform temperature from end to end of core.

See also MECHANICAL ENGINEERING, *Foundries (Malleable Foundry).*

GENERATING STATIONS

Alternators in Parallel

Operation of Alternators Connected in Parallel (Etude sur la marche en parallèle des alternateurs), M. de Marchena. Bulletin de la Société Française des Electriciens, vol. 9, no. 76, Jan. 1919, pp. 17-42, 2 figs. Study of conditions under which existing theories, specially the researches of Cornu, Blondel and Boucherot, are applicable. Also in Revue Générale de l'Electricité, vol. 5, no. 11, Mar. 15, 1919, pp. 405-415, 2 figs.

Canada

Statistical Analysis of the Central Electric Stations of Canada. Power, vol. 49, no. 9, March 4, 1919, pp. 309-310. Figures showing amounts of power, capital invested, salaries and wages paid, with data on hydroelectric power.

Central Stations in West

Data on Central Stations in the West. Jl. Electricity, vol. 42, no. 5, Mar. 1, 1919, pp. 215-216. Figures issued by Bur. of Census on central electric light and power stations in New Mexico, Oregon, Nevada and Utah.

GENERATORS AND MOTORS

Armatures

Design of Small Direct-Current Armatures, C. R. Wylie. Elec. World, vol. 73, no. 12, Mar. 22, 1919, pp. 571-575, 8 figs. Methods of designing small armatures based upon both test data and theory developed for larger machines.

Asynchronous Machines

Asynchronous Generators and Converters (Generatrici asincrone e macchine convertitrici), Luigi Lombardi. Elettrotecnica, vol. 6, no. 6, Feb. 25, 1919, pp. 110-114, 1 fig. Characteristic curves of Gadda converters. (Continued.)

Ball Bearings

The Use of Ball Bearing for Electrical Machinery, H. M. Trumbull. Can. Machy., vol. 21, no. 2, Jan. 9, 1919, pp. 35-38, 12 figs. Argues that ball bearings enable builder to use smaller air gap and enhance efficiency of machines.

Commutation

Phenomena of Commutation (Phénomènes de la commutation), J. Rezelman. Société Belge des Electriciens, vol. 31, Aug.-Dec. 1914, pp. 599-632, 14 figs. Experimental determination of impedance of section of drum armature and its mutual induction with neighboring sections and the fieldmagnets, under various conditions; oscillograms showing shape and simultaneous values of tension between sections and current under brushes, for various arrangements of brushes and under different ratios b/B.

D. C. Generators

Causes of Direct-Current Generators Failing to Build Up Their Voltage, Robin Beach. Power, vol. 49, no. 14, Apr. 8, 1919, pp. 519-521, 5 figs. Mentions various causes why a machine may fail to come up to voltage and proposes remedies.

Effect of Interpoles on Commutation of Direct-Current Machines, R. L. Witham. Power, vol. 49, no. 9 and 10, Mar. 4 and 11, 1919, pp. 303-305 and 358-360, 15 figs. Purpose of interpoles and how they operate to effect commutation. Mar. 11: Influence of interpoles on voltage of generators, and on speed of motors.

D. C. Motors

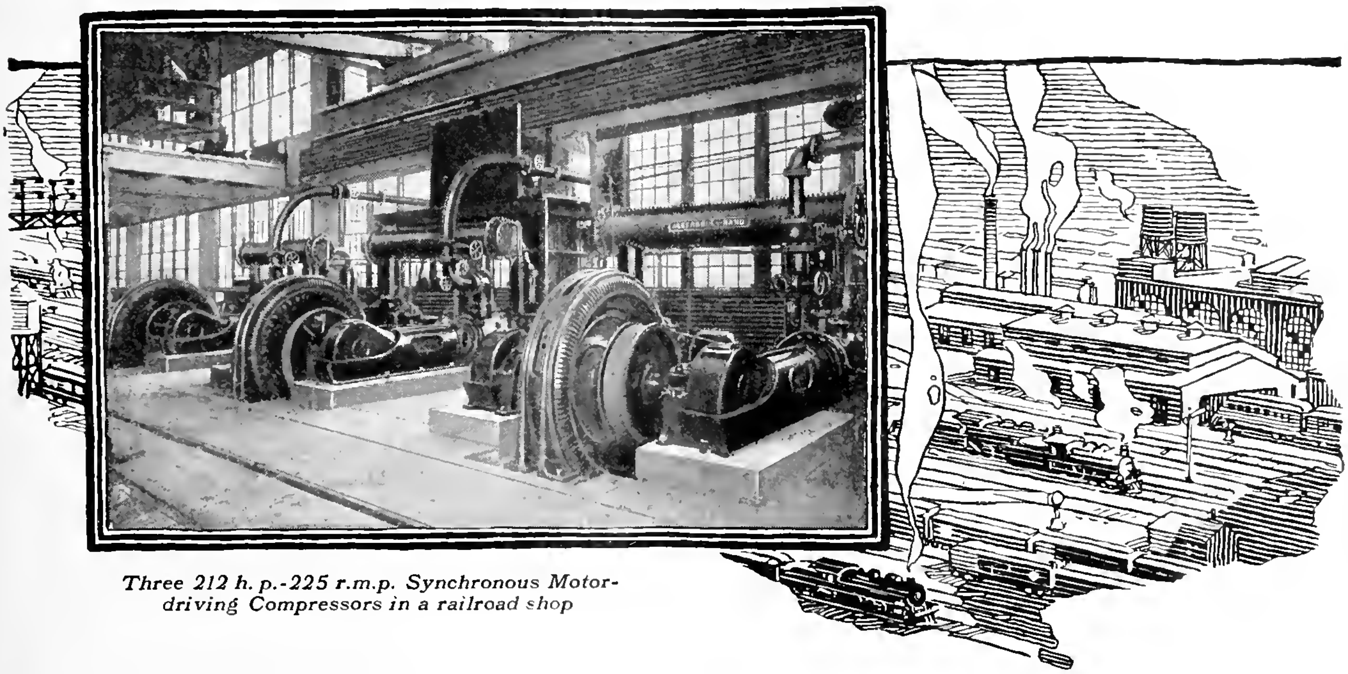
The Influence of the Distribution of Losses on the Efficiency Curves of a Continuous Current Motor, Thomas Carter. Elecn., vol. 82, nos. 9 and 10, Feb. 28 and Mar. 7, 1919, pp. 247-249 and 275-277, 8 figs. Graphs of maximum efficiency and corresponding input and output against k, with various percentages of full load efficiency. Mar. 7: Maximum output which can be got from a motor and values of input and efficiency at which it occurs. (Concluded.)

The Emeol D. C. Motors. Electrical Review, vol. 84, no. 2153, Feb. 28, 1919, pp. 250-251, 3 figs. General features, arrangement of air circulation, and temperature-rise curves of 50-hp. motor.

High Frequency Alternators

High Frequency Alternators (Les alternateurs à haute fréquence), Marius Latour. Bulletin de la Société Française des Electriciens, vol. 9, no. 77, Feb. 1919, pp. 97-114, 18 figs. Design characteristics of machines capable of furnishing directly, without supplementary transformers, the electromotive force necessary for feeding antennæ in wireless telegraphy.

The high efficiency and dependability of G-E Synchronous Motors are relied upon in many industries today.



Three 212 h.p.-225 r.m.p. Synchronous Motor-driving Compressors in a railroad shop

88,000 h.p. of synchronous motors supplied in 1918 for air compressor drive

FOR a quarter century the General Electric Company has supplied synchronous motors designed for the particular work to be done. The first ones furnished are still in continuous service requiring maximum dependability.

For industrial drives these motors are furnished from 25 to 2000 h.p. capacity with speeds from 80 to 1800 r.p.m. and are designed tc start any load met with in commercial practice without excessive current demands upon the power circuit.

The very high efficiency and dependability of these motors are due to their excellent design which is based on thorough testing of both raw materials and finished motors.

Our engineers will be pleased to supply additional information on these motors.

43-163

General Electric Company

General Office Schenectady, N.Y.

Induction Motors

Speed Regulation of Induction Motors Coupled in Cascades. (Réglage de la vitesse des moteurs d'induction par couplage en cascade), G. Darrieus. Revue Générale de l'Electricité, vol. 5, no. 7, Feb. 15, 1919, pp. 257-265, 13 figs. Survey of present designs. Suggestions to develop a more general process.

Reconnecting Induction Motors, A. M. Dudley. Power, vol. 49, no. 11, March 18, 1919, pp. 393-396, 6 figs. Summary of principles brought out in a series of thirteen articles by writer.

Mill Motors

Live Roller Motors in Steel Works, W. W. Wood. Electrician, vol. 82, no. 10, Mar. 7, 1919, pp. 269-271, 4 figs. Graphs of tests made on small mill motors without ingots on the rollers and of approximation for calculating heating effect for large mill motor. From Magnet Mag.

Large Motors for Reversing Mills. Iron & Coal Trades Rev., vol. 98, no. 2663, Mar. 14, 1919, p. 311, 2 figs. Reversing mill motors of Siemens Brothers, Dynamo Works, Ltd.; with peak load of 19,000 hp. Also in Electn. vol. 82, no. 2130, Mar. 14, 1919, pp. 302-303, 4 figs.

Nomenclature

Motors for Electric Installations (Moteurs primaires pour installations électriques). Société Belge des Electriciens, vol. 31, Aug.-Dec. 1914, pp. 636-643, 7 figs. Hydroelectric nomenclature proposed by the Commission Electrotechnique Internationale.

Turbo-Alternators

The Determination of the Efficiency of the Turbo-Alternator, S. F. Barclay, and S. P. Smith. Engineering, vol. 107, no. 2775, Mar. 7, 1919, pp. 322-326, 11 figs. Attempting to introduce method for establishing alternator efficiency based on measurement of actual losses on load. Writer shows that actual losses on load can be deduced from measurements of cooling air flowing to alternator. Paper read before Instn. Elec. Engrs.

Winding Old Armatures

Winding Coils for Old Armatures. Elec. Ry. Jl., vol. 53, no. 12, Mar. 22, 1919, pp. 578-580, 9 figs. Suggests that additional insulation is necessary at corners and between leads where clearance with core is small and large radius bends give greater flexibility for rewinding.

IGNITION APPARATUS

Ignition of Gases

The Ignition of Explosive Gases by Electric Sparks, John David Morgan. Jl. Chem. Soc., no. 675, Jan. 1919, pp. 94-104, 6 figs. Experiments with low-tension sparks under various magnetic conditions.

Plugs

Tests of Ignition Apparatus, P. M. Heldt. Automotive Industries, vol. 40, no. 11, March 13, 1919, pp. 578-579, 3 figs. Resistance to thermo-cracking and shock and gas-tightness of plugs.

Spark Gaps. Sci. Am. Supp., vol. 87, no. 2256, Mar. 29, 1919, p. 198. Suggestions concerning the construction and use of the plugs. From The Auto.

The Operation and Design of Sparking Plugs—II, H. Warren. Automobile Engr., vol. 9, no. 124, Mar. 1919, pp. 94-97, 24 figs. Details of manufacture of various types.

LIGHTING AND LAMP MANUFACTURE

Report of the Committee on Progress. Tran. Illum. Eng. Soc., vol. 13, no. 9, Dec. 30, 1919, pp. 450-511. Gas, incandescent lamps, arc lamps, lamps for projection purposes, street lighting, interior illumination, fixtures, photometry, and physical experiments.

Hotels

Illumination Notes. Hotel Rooms, W. F. Little and A. C. Dick. Tran. Illum. Eng. Soc., vol. 14, no. 1, Feb. 10, 1919, pp. 15-52, and (discussion) pp. 52-59. Survey of light intensities in rooms of Twelve New York City hotels. Data and measurements given in tabular forms.

Incandescent Lamp Manufacture

Present Status of the Industry of Incandescent Lamps (Etat actuel de l'industrie des lampes à incandescence), A. Larnaude. Houille Blanche, no. 23-24, Nov.-Dec., 1918, pp. 356-357. Abstract from communication presented before Société Internationale des Electriciens.

Legislation

Report of Committee on Lighting Legislation, L. B. Marks. Tran. Illum. Eng. Soc., vol. 13, no. 9, Dec. 30, 1919, pp. 524-527. Digest of laws on illumination.

Nomenclature

Report of the Committee on Nomenclature and Standards of the Illuminating Engineering Society for the Year 1918. Tran. Illum. Eng. Soc., vol. 13, no. 9, Dec. 30, 1919, pp. 512-523. New and revised symbols, coefficients and definitions.

Searchlights

Searchlights, Hugh M. Goody. Electrical Review, vol. 84, no. 2153, Feb. 28, 1919, pp. 227-228, 3 figs. Notes on the various designs of projector and control gear.

Spherical Candlepower

Apparatus for the Determination of the Spherical Candle-Power of a Source of Light, J. Sahulka. Elecn., vol. 82, no. 2128, Feb. 28, 1919, pp. 255-256, 2 figs. Apparatus intended to simplify usual method by obviating necessity of constructing Rousseau curve. From Elektrotechnische Zeitschrift.

Standards

Illumination and Some of Its Fundamental Considerations, H. A. Tinson. Tran. South African Instn. Elec. Engrs., vol. 9, part 11, Dec. 1918, pp. 192-198. Standards of exterior and interior illumination for various buildings, roadways, thoroughfares, etc.

Street Lighting

Street Lighting in a City of Average Size, C. D. Gray and E. Hagenlocher. Elec. World, vol. 73, no. 12, Mar. 22, 1919, pp. 575-578, 6 figs. Features of ornamental system installed at South Norwalk, Conn., said to be operated with low maintenance expense.

Tungsten Lamps

Characteristic Equations of Tungsten Lamps and Their Application to the Heterochromous Photography. (Equations caractéristiques des lampes à filament de tungstène et leur application à la photométrie hétérochrome), G. W. Middlekauff and J. F. Skogland. Revue Générale de l'Electricité, vol. 5, no. 7, Feb. 15, 1919, pp. 252-256. Investigation conducted by the Bureau of Standards concerning comparison of standards. From Scientific Papers of the Bureau of Standards.

MEASUREMENTS AND TESTS

Insulators

Photographic Study of Porcelain Insulators, Harold G. Tufty. Elec. World, vol. 73, no. 6, Feb. 8, 1919, pp. 268-271, 2 figs. Polarized light employed in examination of thin sections of insulators some of which had been properly fired, while others were underfired, and still others overfired.

Lines

Note on the Tests and Measurements of Electrical Lines (Note sur les essais et mesures relatifs aux lignes électriques), L. Monchard. Revue Générale de l'Electricité, vol. 5, no. 9, Mar. 1, 1919, p. 352, 1 fig. Arrangement suggested in L. Puget's scheme given in R. G. E. Oct. 19, 1918, pp. 563-565, to eliminate η, which is not considered in that scheme.

Magnetic Testing

Frequency of Current Reversals in Magnetic Testing, A. W. Smith. Mich. Technic, vol. 31, no. 1, Mar. 1918, pp. 18-24, 3 figs. Effect of various methods for demagnetization.

Photometry

Photometric Apparatus for Measuring the Illuminating Value of Fluctuating Sources of High Candlepower (Flares, Parachute Lights, etc.), A. P. Trotter. Illuminating Engr., vol. 11, no. 11, Nov. 1918, pp. 253-259, 3 figs. and (discussion) vol. 11, no. 12, Dec. 1918, pp. 269-276, 1 fig. Method and apparatus devised by society.

Repairmen's Testing Apparatus

Curing Electric Troubles. Motor Age, vol. 35, no. 12, Mar. 20, 1919, pp. 22-24, 11 figs. General testing apparatus for repairmen.

Transformers, Instrument

Field Testing of Instrument Transformers, H. M. Crothers. Elec. World, vol. 73, no. 11, March 15, 1919, pp. 516-519, 2 figs. Experiences with the Agnew method are said to have shown it to be valuable for tests conducted at place of installation.

POWER APPLICATIONS

Heating

Electric Heating in Houses (Le chauffage à l'électricité des maisons d'habitation), Augustin Frigon. Revue Trimestrielle Canadienne, vol. 4, no. 16, Feb. 1919, pp. 371-383, 1 fig. Efficiency and cost.

Difficulties in Electric House Heating, Joseph F. Merrill. Jl. Electricity, vol. 42, no. 5, Mar. 1, 1919, pp. 212-214. Figures showing comparative cost of central steam heating and electric heating. Writer concludes electric house heating is not a practicable load for the average power company.

Principles of Inductive Heating With High Frequency Currents, E. F. Northrup. Gen. Meeting Am. Electrochem. Soc., Apr. 3-5, 1919, paper 8, pp. 71-159, 29 figs. Theory of this method of heating and accounts of methods employed and actual results obtained in tests and experiments conducted at Palmer Phys. Lab., Princeton Univ.

Hospital

Some Electrical Features of New San Francisco Hospital. Elec. Rev., vol. 74, no. 13, Mar. 29, 1919, pp. 493-496, 5 figs. Municipal institution with power plant, silent-call signals, electric elevators, electric clocks, modern laundry and kitchen equipment, electrotherapeutic and laboratory apparatus, etc.

Loading Machinery

Electricity as Applied to Bulk Material Handling Boats. Freight Handling & Terminal Eng., vol. 5, no. 3, Mar. 1919, pp. 102-105, 10 figs. History of application of electricity to loading and unloading coal and ore. Paper read before Soc. Terminal Engrs.

Paper Making

Making Paper by Electricity. Jl. Electricity, vol. 42, no. 6, Mar. 15, 1919, pp. 260-261, 3 figs. Outline of reservoir, penstock and power plant.

Quarrying

Quarrying and Working Stone by Electricity. Stone, vol. 40, no. 3, Mar. 1919, pp. 120-122, 2 figs. Detail of Westinghouse quarry equipment.

Steel Plants

Electric Steel Plant; Features of Plant Design, W. F. Sutherland. Can. Machy., vol. 21, no. 10, Mar. 6, 1919, pp. 225-228, 8 figs. Layout of electrical apparatus in a large electric-steel plant.

See also MECHANICAL ENGINEERING, *Machine Shop (Electric Drive).*

POWER GENERATION

Hydroelectric Plants

See Power Generation, Mechanical Engineering.

STANDARDS

Lightning Rods

New Standards of the Swiss Association of Electricians (Les nouvelles normes de l'association suisse des électriciens), S. Frid. Industrie Electrique, vol. 28, no. 640, Feb. 25, 1919, pp. 72-73. Relates to installation and maintenance of lightning rods.

Polyphase Voltages

The Standardisation of Polyphase Voltages, R. Rudenberg. Elecn., vol. 82, no. 10, Mar. 7, 1919, pp. 272-273, 2 figs. Comparison of recent suggestions for standardized voltages. From Elektrotechnische Zeitschrift, Nov. 24, 1918.

TELEGRAPHY AND TELEPHONY

Amplifiers

The Use of Impedance, Capacity, and Resistance Couplings in High-Frequency Amplifiers, J. Scott-Taggart. Wireless World, vol. 6, no. 71, Feb. 1919, pp. 628-633, 8 figs. Receiving circuits without intermediary transformers or oscillatory circuits between the valves.

Vacuum-Tube Amplifiers, MacC. Batsel. Elec. World, vol. 73, no. 12, Mar. 22, 1919, pp. 568-570, 9 figs. Detection by use of vacuum-tube amplifiers of weak telegraphic ground currents and stray telephonic currents.

Antenna

Note on the Fundamental Wave and the Harmonics in a Homogenous Antenna and also a Non-Homogenous Antenna (Note sur l'onde fondamentale et les harmoniques dans une antenne homogène et dans une antenne non homogène), L. Dubar. Revue Générale de l'Electricité, vol. 5, no. 8, Feb. 22, 1919, pp. 284-289, 5 figs. Conclusions of the question derived on article R. G. E., vol. 4, no. 11, Sept. 14, 1918, p. 363.

Call Letters

International Wireless Administration. Wireless World, vol. 6, no. 71, Feb. 1919, pp. 609-610. Sugestion in regard to allocation of station call letters.

Direction Finders

Radio Direction-Finding Apparatus, A. S. Blatterman. Elec. World, vol. 73, no. 10, Mar. 8, 1919, pp. 464-467, 11 figs. Use of loop antenna in guiding airplane flight and general principles affecting design of receiving loops.

Field Stations

Recent Developments in Field Station Apparatus. Wireless World, vol. 6, no. 72, Mar. 1919, pp. 656-662, 7 figs. Technical details of damped and continuous wave transmitters and receivers.

Fires

Fires Caused by Hertzian Waves (Incendies provoqués par les ondes hertziennes), Georges Le Roy. Génie Civil, vol. 74, no. 7, Feb. 15, 1919, pp. 133-134, 1 fig., Industrie Electrique, vol. 28, no. 640, Feb. 25, 1919, pp. 78-79, and Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 4, Jan. 27, 1919, pp. 224-227, 1 fig. Specially constructed Hertzian resonator with which writer studied possibilities of fire being produced by wireless waves traversing iron bodies accidentally disposed in form of resonator.

Military Radio

Military Radio Communication, A. D. Cameron. Elec. World, vol. 73, no. 11, March 15, 1919, pp. 521-525, 3 figs. Organization of a wireless telephone and telegraph system of the signal corps.

Norwegian Stations

Great Wireless Stations of the World, Julius Galster. Wireless World, vol. 6, no. 71, Feb. 1919, pp. 591-595, 6 figs. Norwegian radio station.

Photographs

The Design and Construction of Apparatus for the Wireless Transmission of Photographs. Wireless World, vol. 6, no. 72, Mar. 1919, pp. 685-690, 16 figs. Details of the various apparatus used. (Continuation of serial.)

Poulsen System

Poulsen System of Radiotelegraphy (Il sistema di radiotelegrafia "Poulsen"), G. Pession. Elettrotecnica, vol. 6, no. 7, Mar. 5, 1919, pp. 126-134, 18 figs. System is based on property of electric arc to determine electrical oscillations in circuit comprising capacity and self-inductance.

Receivers

Super-Sensitive Receivers, Wireless World, vol. 6, no. 71, Feb. 1919, pp. 598-600, 2 figs. Types 50 and 55 evolved by Marconi Company.

Telegraphs

Ground Telegraphy in the World War, Willis L. Winter, Jl. Electricity, vol. 42, no. 5, Mar. 1, 1919, pp. 210-211, 3 figs. Principles of ground telegraphy and conditions of operation.

Telephones

The Sonority of Telegraph and Telephone Lines and a New Type of Damper (La Sonorita dei Fili telegrafici e telefonici e un nuovo tipo di sordina). Elettricista, vol. 8, no. 4, Feb. 15, 1919, pp. 25-28, 7 figs. Instrument which grips hanging wire at predetermined point in its length.

System Protecting Telephone Lines Against Trolley Wires (Los sistemas de protección contra la caida de los hilos telefónicos sobre las lineas aéreas de los tranvias eléctricos), Eng. Aigouy. Energia Eléctrica, vol. 21, no. 2, Jan. 25, 1919, pp. 17-20. Answers to questionnaire sent out to railway companies by International Union of Brussels. (To be continued.) From Electricien, Paris.

Circuits with Zero Mutual Induction, William W. Crawford. Telephony, vol. 76, no. 13, Mar. 29, 1919, pp. 15-18, 11 figs. Reduction of inductive interference in telephone circuits; forms of constructions and calculations and tentative design for greatest refinement of balance against induction. Paper before Am. Inst. Elec. Engrs.

The Multiple Interurban Telephone of Strassburg (Le multiple téléphonique interurbain de Strasbourg). Revue Générale de l'Electricité, vol. 5, no. 9, Mar. 1, 1919, pp. 335-339, 2 figs. Schemes of connections and account of construction.

Transmitters

Radio Transmitters of Synchronous Rotary Spark-Gap Type, Millard C. Spencer. Elec. Rev., vol. 74, nos. 12 and 13, Mar. 21 and 29, 1919, pp. 456-458, and 497-499, 11 figs. Theory of simple transmitter; diagram of equivalent circuit of radio transmitter; use of vector diagram for analyzing test results. First and second articles.

Undamped Oscillations

Undamped Electrical Oscillations of Short Wave Length (Oscillations électriques non amorties de courte longueur d'onde), Gutton and Touly. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 5, Feb. 3, 1919, pp. 271-274, 1 fig. and Revue Générale de l'Electricité, vol. 5, no. 11, Mar. 15, 1919, pp. 415-416, 1 fig. Apparatus developed at laboratories of military radio-telegraphy, while examining application of lamp valves with three electrodes for the generation of long waves employed in wireless telegraphy.

Vacuum Bulb

On Reading on Mr. Nozoye's "Vacuum Bulb" (in Japanese), T. Kikuchi. Denki Gakkwai Zasshi, no. 367, Feb. 10, 1919.

TRANSFORMERS, CONVERTERS, FREQUENCY CHANGERS

Rectifier

An Electro-Magnetic Alternating Current Rectifier, George F. Haller. Sci. Am. Supp., vol. 87, no. 2248, Feb. 1, 1919, pp. 76-78, 15 figs. Type designed for construction in amateur laboratory.

Transformer Connections

Transformer Connections for Power Transmission, Gordon Kribs. Power House, vol. 12, no. 3, Mar. 1919, pp. 69-73, 19 figs. Transformer connections in common use and characteristics of resulting circuits.

Transformer Mounting

Standardization of Transformer Mounting, W. C. Blackwood. Elec. World, vol. 73, no. 12, Mar. 22, 1919, pp. 578-581, 9 figs. Tables and drawings specifying methods of hanging and spacing the units mounted on poles or on consumers' premises.

TRANSMISSION, DISTRIBUTION, CONTROL

Electricity Supply

A New Era in Power Transmission, Louis Bell. Elec. World, vol. 73, no. 13, Mar. 29, 1919, pp. 631-632. Believes that development of water power, establishment of stations at mines and wider interconnection are necessary for proper industrial development of the country and for the social betterment of labor.

The Past, Present, and Future of Electricity Supply. Electrical Review, vol. 84, no. 2150, Feb. 7, 1919, pp. 163-165. Problem dealt with on a national basis. Discussion at meeting of Manchester Assn. Engrs.

Projects of Great Distribution Systems of Electrical Energy in Germany, Holland and Sweden (Les projects de création de très grands réseaux de distribution d'énergie électrique en Allemagne, Hollande et Suède). Revue Générale de l'Electricité, vol. 5, no. 9, Mar. 1, 1919, pp. 353-354. Official communication of the French Government.

Electricity Supply at Birmingham. Elec. Rev., vol. 84, no. 2154, Mar. 7, 1919, pp. 255-257, 4 figs. Installation of additional generating plant of two 5000-kw. B.T.H. turbo-alternators.

Line

Reliability of a Transmission Line (in Japanese), M. Shibuzawa. Denki Gakkwai Zasshi, no. 367, Feb. 10, 1919.

Poles

Extending the Life of Wood Poles, Charles R. Harte. Elec. Ry. Jl., vol. 53, no. 12, Mar. 22, 1919, pp. 554-559, 13 figs. Description of various methods used and discussion of their relative advantages, based on manner in which different preservatives keep out and destroy germs.

Potential Regulators

Compensated-Type Potential Regulators, Arthur H. Ford, Paul E. Mead and Guy W. Thomas. Elec. World, vol. 73, no. 13, Mar. 29, 1919, pp. 620-623, 13 figs. Connections for using compensated potential regulators for power factor and voltage correction at load; tests to determine dependence of action of regulator upon influence of line constants.

Power Circuits

Determination of Economical Power Circuits, P. O. Reyneau. Elec. World, vol. 73, no 10, Mar. 8, 1919, pp. 471-473, 3 figs. Method of deriving curves showing when two circuits become more economical than one as load increases. Fixed charges are balanced against saving of line loss when new conductors are added.

Substations

A Year of the Automatic Substation at Butte, E. J. Nash. Elec. Ry. Jl., vol, 53, no. 12, Mar. 22, 1919, pp. 565-567, 6 figs. Maintenance cost of first year.

Static Condenser Installation at the Stoughton Sub-Station of the Brockton Edison Company, W. A. Forbush. Stone & Webster Jl., vol. 24, no. 3, Mar. 1919, pp. 195-199, 3 figs. How Edison Electric Illuminating Co. solved the problem of feeding new sections in district supplied by system already loaded to capacity.

VARIA

International Electrotechnical Commission

The International Electrotechnical Commission (La comisión electrotécnica internacional), German Niebuhr. Boletin de la Asociación Argentina de Electro-Técnicos, vol. 4, no. 10, Oct. 1918, pp. 840-850, 1 fig. History, development and work. (Continuation of serial.)

Civil Engineering

BRIDGES

Concrete Arch Bridges in Canada

Concrete Arch Bridges in Canada. Contract Rec., vol. 33, no. 13, Mar. 26, 1919, pp. 275-279, 8 figs. Historical review of Canadian bridge building and reference list of reinforced-concrete arch spans.

Concrete Slab Bridge

Re-Enforced Concrete Slab Bridge Design, Based on Tests of Full-Sized Slabs, A. T. Goldbeck. Can. Engr., vol. 26, no. 10, March 6, 1919, pp. 280-281, 2 figs. Tests were conducted at Bureau of Public Roads. From Public Roads.

Design

Bridge Engineering. Surveyor, vol. 55, no. 1412, Feb. 7, 1919, pp. 129-130. On future loads and dangers of faulty design.

Erection

Cantilever Erection of Draw in Open Position While Old Draw Serves as Fixed Span. Eng. News Rec., vol. 82, no. 12, Mar. 20, 1919, pp. 567-569, 6 figs. Swing-span part of Union Pacific Bridge over Missouri at St. Joseph; old span during work carried traffic.

Bridge Substructure Construction with Concrete Caissons Sunk by Open Excavation Method, L. W. Scov. Eng. & Contracting, vol. 51, no. 13, Mar. 26, 1919, pp. 317-319, 3 figs. Experiences of Chicago, Burlington & Quincy R. R. Paper presented before Western Soc. Engrs.

Highway

Concrete and Steel Bridges, John W. Towle. Better Roads & Streets, vol. 8, no. 10, Oct. 1918, pp. 371-372. Economic advantages of good roads. Address delivered before North Carolina Good Roads Assn.

Painting

Maintenance and Painting of Highway Bridges, Charles D. Snead. Eng. & Contracting, vol. 51, no. 13, Mar. 26, 1919, pp. 306-307. Classification of structures according to structural conditions; maintenance and cost of painting.

Railway and Highway Bridge

Move Bridge Spans 136 Feet Endwise on Car Trucks. Eng. News Rec., vol. 82, no. 11, Mar. 13, 1919, pp. 530-532, 4 figs. Combined railway and highway bridge of the Union Pacific Ry.

Strengthening

Strengthening Railway Bridges, W. J. Doak. Commonwealth Engr., vol. 6, no. 6, Jan. 1, 1919, pp. 191-197, 10 figs. Details of various bridges erected throughout Queensland, Australia. Paper read before Inst. Civil Engrs.

Track-Elevation Bridge

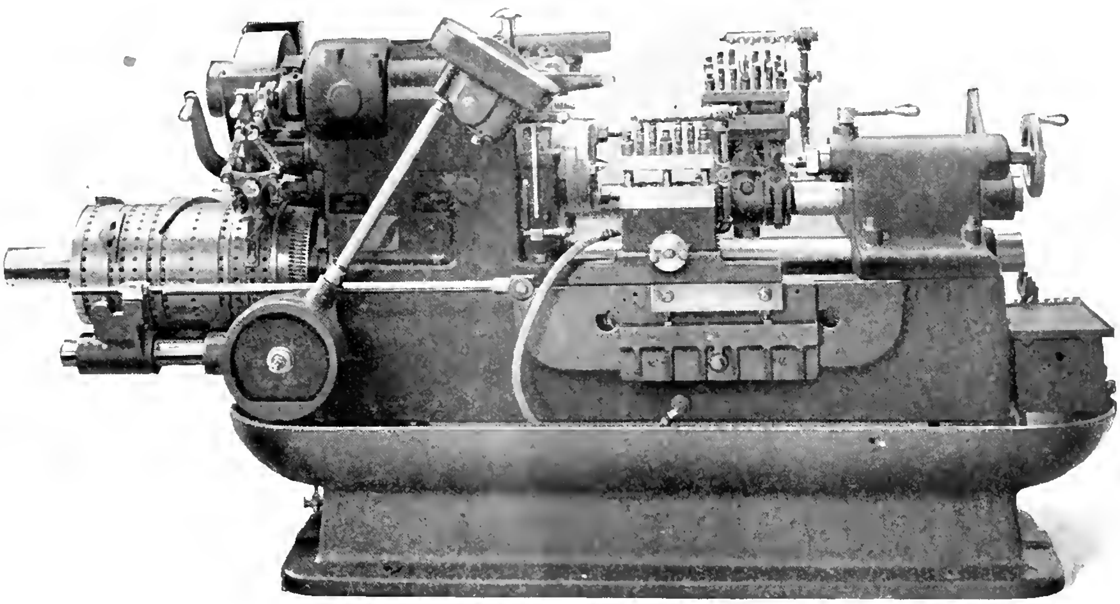
Omaha Track-Elevation Bridges Vary in Type to Meet Local Conditions. Egr. News Rec., vol. 82, no. 8, Feb. 20, 1919, pp. 380-382, 3 figs. Types of bridge superstructure and floor of Missouri Pac. R. R.

Vertical-Lift Bridge

Mechanical Features of Vertical-Lift Bridge, J. A. L. Waddell. Mech. Eng., vol. 41, no. 4, Apr. 1919, pp. 379-381, 4 figs. Details of a 260-ft. double-track lift span at Louisville, Ky.

Viaducts

Design and Construction of Reinforced Concrete Viaducts on North Toronto Subdivision,



Canadian Pacific Railway, B. O. Eriksen and H. S. Deubelbeiss. Can. Ry. & Mar. World, no. 253, March 1919, pp. 109-113, 7 figs. Dimensions, details, and method of calculating moments in towers.

BUILDING AND CONSTRUCTION

Arch Analysis

Arch Analysis by a Method Using Variable Elastic Weights, F. J. Dulude. Eng. News Rec., vol. 82, no. 10, March 6, 1919, pp. 471-473, 3 figs. Tabular form intended to simplify computation of summations required in solution of arch problem by influence lines.

Architects

Does the Architect Function as He Should? Robert D. Kohn. Am. Architect, vol. 115, no. 2253, Feb. 26, 1919, pp. 291-296. Résumé of program of Post-War Committee on Architectural Practice, Am. Inst. Architects.

Automobile Storage Structure

The New Automobile Center, Social Hall Avenue, Salt Lake City. Am. Architect, vol. 115, no. 2252, Feb. 19, 1919, pp. 281-287, 13 figs. Reinforced-concrete 3-story structure used for storage of automobiles.

Barracks

A Barracks Built in a Hurry, Parker R. Whitney. Univ. Colo. Jl. Eng., vol. 15, no. 2, Jan. 1919, pp. 11-19, 4 figs. Main barracks built for Students' Army Training Corps to accommodate 350 men.

Brick

Shallow Brick Stand Up Well on Cement-Sand Base. Eng. News Rec., vol. 82, no. 8, Feb. 20, 1919, pp. 378-379, 4 figs. Service given by patching bricks on ramps of Pa. Station, N. Y.

Dams

See Earthwork, Rock Excavation, etc., p 26a.

Dry Dock

Building a Floating Dry Dock in Well Laid Out Yard. Eng. News Rec., vol. 82, no. 1 , Mar. 20, 1919, pp. 552-554, 6 figs. Cableway assisted by whirler and derrick car keeps heavy timbers ready for carpenter crews; large b saws and cutoffs; frame handled on two-way roller system.

Elevators

Floating Pneumatic Grain Elevators. Engineer, vol. 127, no. 3296, Feb. 28, 1919, pp. 206-208, 7 figs. Elevators have a maximum capacity of about 100 tons per hour each, when working in wheat.

Chicago & North Western Ry. Co.'s Grain Elevator, W. H. Finley. Eng. World, vol. 14, no. 6, Mar. 15, 1919, pp. 15-19, 5 figs. Handling capacity is 1,766,000 bu. per day. Location permits grain to be received and shipped both by rail and water.

Engine House

A Rectangular Reinforced Concrete Engine House. Ry. Age, vol. 64, no. 14, Apr. 4, 1919 pp. 891-892, 3 figs. Design to replace old brick and timber building in location where space for expansion was restricted.

Factory

Modern Factory Construction, B. A. Williams. Aeronautics, vol. 16, no. 280, Feb. 26 1919, pp. 226-227, 3 figs. Example illustrates use of Reliance standard steel sashes.

Building a Home for an Industry. Am. Architect, vol. 115, no. 2257, Mar. 26, 1919, pp. 467-475, 15 figs. Studies and projected design of buildings of dye-manufacturing concern are presented as illustration of procedure in designing an industrial structure.

Flat-Slab Construction

Design of Exterior Panels in Flat Slab Construction, Albert M. Wolf. Eng. World, vol. 14, no. 6, Mar. 15, 1919, pp. 11-14, 5 figs. Details of spandrel strips in flat-slab floors; examples of typical interior and exterior panels in accordance with Acme design standards.

Floors

Some Pointers on How to Finish a Concrete Floor, William McGinnis. Eng. News Rec., vol. 82, no. 10, March 6, 1919, pp. 477-478. Notes on use of screens and treatment of aggregate and surface.

Foundations

Anchor Bolts for Foundations, Terrell Croft. Natl. Engr., vol. 23, no. 4, Apr. 1919, pp. 175-179, 11 figs. Dimensions and weights of materials used. (To be continued).

Hotels

The Hotel Pennsylvania, New York. Am. Architect, vol. 115, no. 2253, Feb. 26, 1919, pp. 297-306, 14 figs. Said to be largest in world.

Housing

Quantity House Production Methods, Construction Branch, Emergency Fleet Corporation. Am. Architect, vol. 115, no. 2254, Mar. 5, 1919, pp. 353-358, 20 figs. Organization of Housing Section. (To be continued).

Suggested Solution of Housing Problem. Contract Rec., vol. 33, no. 6, Feb. 5, 1919, pp. 119-121. Advanced by British Roy. Sanitary Inst.

Tilbury Housing—Present and Future. Surveyor, vol. 55, no. 1415, Feb. 28, 1919, pp. 159-161, 9 figs. Scheme providing for building workers' homes rapidly.

A Chepstow Housing Scheme, William Dunn and W. Curtis Green. Jl. Roy. Inst. British Architects, vol. 26, no. 2, Dec. 1918, pp. 25-38 and (discussion) pp. 38-43, 6 figs. Site is about 28 acres in extent. Details of layout of streets, number of houses per acre and other particulars are given.

Housing: The Architects' Contribution, Raymond Unwin. Jl. Roy. Inst. British Architects, vol. 26, no. 3, Jan. 1919, pp. 49-59 and (discussion) pp. 60-64, 13 figs. Various types of houses are examined from point of view of convenience and comfort.

Financing the Expected Boom in the Building Industry—III. Am. Architect, vol. 115, no. 2251, Feb. 12, 1919, pp. 241-243. Efforts of Government authorities to encourage building construction.

The Preparation of Housing Schemes, A. G. Wheeler. Surveyor, vol. 55, nos. 1412, 1413 and 1415, Feb. 7, 14 and 26, 1919, pp. 127-128, 144 and 162. Recommendations to municipal engineers and surveyors. (Concluded)

Mortar Under Pressure

Injecting Mortar Under Pressure (Les appareils pour l'injection du mortier sous pression), L. Biette. Génie Civil, vol. 74, no. 7, Feb. 15, 1919, pp. 121-126, 15 figs. Features and operation of various types with reference to their utilization in the construction of Paris subway.

Hotel Lincoln, Indianapolis, Ind. Am. Architect, vol. 115, no. 2251, Feb. 12, 1919, pp. 238-240, 11 figs. Situated on triangular lot measuring 150 ft. and 187 ft. street fronts.

Roofs

Zinc as a Roof Covering, William Hutton. Metal Worker, no. 2360, Mar. 21, 1919, pp. 370-371, 5 figs. Suggestions based upon practice in European countries.

School

The Scarboro-on-Hudson School, Welles Bosworth. Am. Architect, vol. 115, no. 2258, Apr. 2, 1919, pp. 477-480, 4 figs. Architectural features.

Methods, Economies and Standardization in Preparation of Plans for School Buildings, Clarence E. Dobbin. Eng. & Contracting, vol. 51, no. 13, Mar. 26, 1919, pp. 313-314, 1 fig. Plea for uniform practice. From paper presented before Mun. Engrs. of City of N. Y.

Sheet Steel

A Structural Material Made of Thin Sheet Steel. Am. Architect, vol. 115, no. 2251, Feb. 12, 1919, pp. 249-254, 12 figs. Describes joists, studs, sills and caps made of said material embedded in concrete.

Standardization

The Standardization of Building Products, Robert D. Kohn. Am. Architect, vol. 115, no. 2258, Apr. 2, 1919, pp. 498-500. Advocated as means to insure production speed in housing work.

Storage Tanks

Storage Tanks made of Reinforced Concrete, F. W. Frerichs. Chem. & Metallurgical Eng., vol. 20, no. 5, March 1, 1919, pp. 234-236, 3 figs. Details of large installation of concrete tanks; tests on permeability for water and ammoniacal liquor; drawings, construction, and costs. Before Chicago meeting, Am. Inst. Chem. Engrs.

Design and Construction Features of Concrete Oil Storage Tanks, C. W. Van Dyke. Eng. & Contracting, vol. 51, no. 13, Mar. 26, 1919, pp. 304-305, 4 figs. Particulars of 182,-000-gal. fuel-oil tank of American Brakeshoe Co.

Structures, Theory of

On a New Principle in the Theory of Structures, George F. Swain. Proc. Am. Soc. Civil Engrs., vol. 45, no. 3, Mar. 1919 (paper and discussion), pp. 75-91, 13 figs. Mathematical formula to determine angular rotation at a point, derived by a method analogous to that used for finding the deflection for any point of a structure in any given direction.

Swimming Pools

Swimming Pools for Public Schools, C. E. Dobbin. Am. Architect, vol. 115, no. 2253, Feb. 26, 1919, pp. 319-328, 8 figs. Arrangement and details.

Warehouse

Industrial Building Construction in Trafford Park. Engineer, vol. 127, no. 3292, Jan. 31, 1919, pp. 98-100, 11 figs. Warehouse with capacity of 10,000 tons of frozen produce, erected to comply with the requirements of Ministry of Food.

See also MECHANICAL ENGINEERING, Pipe (Corrosion).

CEMENT AND CONCRETE

Blended Portland Cement

An Investigation of Blended Portland Cement. School of Mines & Metallurgy, University of Missouri, vol. 4, no. 4, May, 1918, pp. 1-76, 33 figs. Study of behavior of sand-blended cement. From tests at Mo. School of Mines.

Cement Gun

Tests on Cement Gun Products, Bryan C. Collier. Contract Rec., vol. 33, no. 10, March 5, 1919, pp. 216-218. Modulus of rupture determined for slabs having various ages.

Consistency Measurement

Concrete Consistency Measured by New Device, Herbert A. Davis. Eng. News Rec., vol. 82, no. 13, Mar. 27, 1919, pp. 603-605, 6 figs. Method developed for construction of concrete ships determines amount of water to use in field operations.

Flue Dust

Double Salts of Calcium and Potassium and Their Occurrence in Leaching Cement Mill Flue Dust, E. Anderson. Jl. Indus. & Eng. Chemistry, vol. 11, no. 4, Apr. 1, 1919, pp. 327-332, 3 figs. Formation of potassium penta-calcium sulfate.

Holland

New Dutch Instructions Relative to Reinforced Concrete Construction (Les nouvelles instructions hollandaises relatives aux instructions en béton armé). Génie Civil, vol. 74, no. 9, Mar. 1, 1919, pp. 171-173, 10 figs. Regulations published by the Roy. Inst. Engrs.

Mixing

Effect of Quantity of Mixing Water and Curing Conditions on the Strength and Wear of Concrete. Eng. & Contracting, vol. 51, no. 13, Mar. 26, 1919, pp. 309-312, 9 figs. Deductions obtained from tests made at Lewis Inst., Chicago.

Pneumatic Concreting

The Pneumatic Method of Concreting, H. B. Kirkland. Jl. Western Soc. Engrs., vol. 23, no. 5, May 1918, pp. 319-349 and (discussion), pp. 349-355, 23 figs. Method consists in blowing batches of concrete through a pipe from a central point of supplies to their place in the concrete forms.

Precast Construction

Concrete Moulding Plant, Pennsylvania R. R. Ry. Rev., vol. 64, no. 12, Mar. 22, 1919, pp. 425-432, 14 figs. Facilities placed in operation for the purpose of manufacturing precast reinforced-concrete members for erection of buildings and construction of bridges, and also for turning out concrete fence posts and telegraph poles.

Quick-Hardening Cement

The Hydraulic Properties of the Calcium Aluminates, P. H. Bates. Jl. Am. Ceramic Society, vol. 1, no. 10, Oct. 1918, pp. 679-696, 5 figs. Tests are reported to have shown that it is possible to make cements giving 24 hours strengths as high as those developed by Portland Cements in 28 days. This quick-hardening cement is said to consist of calcium aluminate high in alumina (55 to 75 per cent.).

Reinforced-Concrete Structures

Theory of Reinforced-Concrete Structures (Calculo de estructuras de hormigón armado), Julio R. Castiñeiras. Universidad Nacional de la Plata, Publicaciones de la Facultad de Ciencias Fisicas, Matemáticas y Astronómicas, vol. 1, no. 35, May 1918, pp. 373-454, 55 figs. Formulæ and theorems applicable to beams under simple flexure. (Continuation of serial.)

Reinforcing Elements

New Accepted Form of Reinforcing Metal in Concrete (Sur une nouvelle forme canonique des massifs armés), Charles Rabut. Comptes rendus des séances de l'Académie de Sciences, vol. 168, no. 1, Jan. 6, 1919, pp. 50-53. Value of plates in reinforcing; claimed advantages over bars.

Slag Concrete

Blast Furnace Slag in Concrete and Reinforced Concrete, J. E. Stead. Eng. World, vol. 14, no. 6, Mar. 15, 1919, pp. 25-27: Oxidation of sulphides in slag; conditions under which slag concrete has failed; suggestions for production of reinforced concrete.

Underground Work

The Use of Concrete in Underground Work. Chem. Eng. & Min. Rev., vol. 11, no. 125, Feb. 5, 1919, pp. 130-132, 3 figs. Work done by Wallaroo and Moonta Mining & Smelting Co., Ltd.

Underwater Work

Methods of Depositing Concrete under Water. Eng. & Contracting, vol. 51, no. 13, Mar. 26, 1919, pp. 307-308. Report submitted at convention of Am. Ry. Eng. Assn.

Wasteful Construction

Useless Waste in Concrete Construction Due to Legal Requirements, W. Stuart Tait. Am. Architect, vol. 115, nos. 2250 and 2251, Feb. 5 and 12, 1919, pp. 211-212 and 254-256. Ruling for column design adopted by Am. Concrete Inst. Feb. 12: Comparison of concrete regulations with Lloyd's factors of safety for ship structures.

See also MECHANICAL ENGINEERING, Materials of Construction (Beams, Reinforced Concrete, Mortars, Cement, Lime).

EARTHWORK, ROCK EXCAVATION, ETC.

Cofferdams

Cofferdam and River Wall Construction, T. E. Thain. Practical Engr., vol. 59, no. 1672, Mar. 13, 1919, pp. 124-127, 16 figs. Particulars of dam designed for dock works, where it is proposed to dam up a dock.

Dams

The East Canyon Creek Dam, A. F. Parker. Proc. Am. Soc. Civil Engrs., vol. 45, no. 3, Mar. 1919. Papers and Discussions, pp. 93-113, 4 figs. Design and construction of arched concrete dam.

Conditions of Stability and Suggested Design for Wooden Dam Built on Sand. Eng. & Contracting, vol. 51, no. 11, Mar. 12, 1919, pp. 261-262. Dam is to be built on very permeable sand.

Recent Multiple Arch Dams, John S. Eastwood. Jl. Electricity, vol. 42, no. 6, Mar. 15, 1919, pp. 263-266, 3 figs. Data on four structures of this type.

Dredge, Hydraulic

Operating a Hydraulic Dredge Under Difficulties, Albert S. Fry. Eng. News Rec., vol. 82, no. 9, Feb. 27, 1919, pp. 410-414, 7 figs. Excavation used to dig out log-filled earth in channel which had been filled up by slipping of spoil banks.

Excavation, Balancing

Economic Balancing of Highway Excavation by a Semi-Graphic Method, Dudley S. Babcock. Eng. News-Rec., vol. 82, no. 8, Feb. 20, 1919, pp. 361-364, 6 figs. Device called "trace curve," used in designing Storm King Highway of N. Y. State Highway Dept.

Fills

Dump Cars and Wagons Enlarge Railway Fills. Eng. News-Rec., vol. 82, no. 9, Feb. 27, 1919, pp. 419-420, 2 figs. Methods of raising and widening fills.

Tunnel, Hudson River

Vehicular Tunnels under the Hudson River, Martin Schreiber. Jl. Franklin Inst., vol. 187, no. 3, Mar. 1919, pp. 273-288, 9 figs. Necessity of constructing proposed tunnel is emphasized principally by the fact that out of a total of 40,000 miles of terminal railway within the metropolitan area, 29,000 miles are on the Jersey side. Views, details, and location of various projects for tunnel and bridge are given.

Tunnels

Principles and Scientific Rules for Designing Long Tunnels Under Water Courses (Principes et règles scientifiques pour l'établissement des longs tunnels sous nappe d'eau), Charles Rabut. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 4, Jan. 27, 1919, pp. 220-221. Subordination of plans, profile, and all other details of project to preventing inundation, or in case it happens, to avoid loss of human life by providing suitable means such as accessory exploration galleries, etc.

Regulations for Constructing Long Tunnels Under Water Cources (Règles à suive pour l'établissement des longs tunnels sous nappe d'eau), M. Lecornu. Génie Civil, vol. 74, no. 6, Feb. 8, 1919, p. 114. Rules intended to prevent inundation. Read before the Académie des Sciences.

ROADS AND PAVEMENTS

Asphaltic Concrete Pavements

Two Types of Hard Surface Roads Successfully Employed in New Hampshire, Frederic E. Everett. Mun. & County Eng., vol. 56, no. 3, Mar. 1919, pp. 80-81. Service given by asphaltic concrete pavement.

Bituminous Pavements

Efficiency of Bituminous Surfaces and Pavements Under Motor Truck Traffic, Prevost Hubbard. Mun. & County Eng., vol. 56, no. 3, Mar. 1919, pp. 98-100. Rates increasing efficiency of bituminous types as follows: Bituminous surfaces, bituminous macadam, bituminous concrete, sheet asphalt and asphalt block. Also in Good Roads, vol. 17, no. 11, Mar. 15, 1919, pp. 117-119; Can. Engr., vol. 26, no. 10, Mar. 6, 1919, pp. 117-119.

Brick Pavements

Present Status of Brick Pavements Constructed with Sand Cushions, Cement Mortar Beds and Green Concrete Foundation, Wm. M. Acheson. Mun. & County Eng., vol. 56, no. 3, Mar. 1919, pp. 103-105. Changes in design since 1915.

Canada

Roads in Coleman Township, H. T. Routly. Can. Engr., vol. 26, no. 10, Mar. 6, 1919, pp. 274 and 286-287, 4 figs. History, developments, improvements and organization of personnel. Ontario Land Surveyors.

Chicago

Recent Developments in Design and Construction of Pavements in Chicago, H. J. Fixmer. Mun. & County Eng., vol. 56, no. 3, Mar. 1919, pp. 92-94, 2 figs. Layout of central concrete-mixing plant.

Cost-Keeping

Cost-Keeping for Highway Contractors, Albert B. Gillette. Can. Engr., vol. 26, no. 10, Mar. 6, 1919, pp. 282-283. Recommends securing daily reports that show the total unit cost of every item on which contractor has bid a unit price. Before Convention of the Am. Road Builders' Assn.

Some Points to Observe in the Construction of Concrete Roads, William W. Cox. Mun. & County Eng., vol. 56, no. 3, Mar. 1919, pp. 105-106. Concerning drainage, preparation of sub-grade, selection of materials, workmanship and designing.

Dustless Roads

Smooth, Dustless Roads Maintained by Gang System. Eng. News Rec., vol. 82, no. 11, Mar. 13, 1919, pp. 526-528, 3 figs. Bituminous carpet placed on macadam highways said to prove satisfactory metal on such roads.

Financing

Efficient Methods of Promoting Bond Issues, S. E. Bradt. Good Roads, vol. 17, no. 13, Mar. 29, 1919, pp. 139-140. Considerations generally taken up in issuing state bonds for highway construction.

Drainage

Drainage Methods for Country Roads. Contract Rec., vol. 33, no. 6, Feb. 5, 1919, pp. 110-114, 2 figs. Discussion of foundations and drainage suitable to various soils found in highway construction.

Foundations

Road Foundations, Drainage and Culverts, George Hogarth. Contract Rec., vol. 33, no. 10, March 5, 1919, pp. 197-199, 19 figs. Examples of various constructions. Also in Can. Engr., vol. 26, no. 10, Mar. 6, 1919, pp. 284-285, 6 figs.

Grade Crossings

Grade Crossing Elimination in New York City, William L. Selmer, Mun. Engrs. Jl., vol. 5, no. 3, Mar. 1919, pp. 1-21, 10 figs. Progress made by Public Service Commission for First District during the 11½ years of its existence.

Granite Block Pavements

Some Suggestions on the Proper Construction of Granite Block Pavements, Albert T. Rhodes. Mun. & County Eng., vol. 56, no. 3, Mar. 1919, pp. 106-110, 7 figs. Suggestions based on differences of production in Northern and Southern quarries.

Indiana

Provisions of Proposed Indiana Highway Law. Good Roads, vol. 17, no. 7, Feb. 15, 1919, pp. 58-60. Summary of test of bill introduced in Indiana Senate providing for establishment of state highway commission, state system of highways and state highway fund.

Kansas

Some features of Highway Work in Kansas, M. W. Watson. Mun. & County Eng., vol. 56, no. 3, Mar. 1919, pp. 86-88, 3 figs. State Highway Commission created by legislature.

Labor

Sources of Supply of Unskilled Labor for Highway Work. Good Roads, vol. 17, no. 10, Mar. 8, 1919, pp. 111 and 114-115. From reports of state highway departments, city departments and contractors, it is stated that there will be sufficient supply of unskilled labor for highway projects during coming season and at wages lower than those prevailing during season of 1918. Committee report of Am. Road Builders' Assn. Also in Eng. News Rec., vol. 82, no. 10, Mar. 6, 1919, pp. 466-467.

Macadam Road Reconstruction

Building New Concrete Shoulders to Preserve the Old Macadam Roads of Maryland, John N. Mackall. Mun. & County Eng., vol. 56, no. 3, Mar. 1919, pp. 79-80, 3 figs. Preserving old macadam roads constructed before coming of extremely heavy motor traffic of to-day.

The Reconstruction of Worn Out Macadam Upon a State Road in Rhode Island, I. W. Patterson. Mun. & County Eng., vol. 56, no. 3, Mar. 1919, pp. 81-83, 1 fig. Difficulties encountered in reconstructing; imperfect drainage; resurfacing macadam roads built originally with coarse-grained granite.

Maintenance

System Without Red Tape Makes Success of Day Labor Road Maintenance. Eng. News Rec., vol. 82, no. 8, Feb. 20, 1919, pp. 384-386, 3 figs. Weekly return form to show status of each job.

Methods of Maintaining Highway Systems Prior to Construction by State or County, Frederic E. Everett. Good Roads, vol. 17, no. 13, Mar. 29, 1919, pp. 137-138. Practice followed at New Hampshire. Paper presented before Am. Road Builders' Assn.

Michigan

Low Hauling Cost and No Waste of Material on Construction of Michigan Roads. Better Roads & Streets, vol. 8, no. 10, Oct. 1918, pp. 380-381, 1 fig. Layout of Lake Shore road job; number of men required; material-handling system.

Repairs

Repairing Pavement Openings. Mun. Jl., vol. 46, no. 12, Mar. 22, 1919, pp. 215-218, 2 figs. Practices of various cities as to methods of restoring pavements.

Streets

Street Systems; Their Relation to Highways Outside of Urban Districts, Nelson P. Lewis. Good Roads, vol. 17, no. 9, Mar. 1, 1919, pp. 99-100. Concerning exit from a city to system of roads outside it. Presented at convention Am. Road Builders' Assn.

Street Cleaning

Recommended Procedure in Cleaning Streets in Rochester, N. Y., James W. Routh. Mun. & County Eng., vol. 56, no. 3, Mar. 1919, pp. 90-91. Criticism of common methods of street cleaning, with reference to conditions in Rochester.

Surfaces

Build Permanent Road Surfaces, R. Crawford Muir. Contract Rec., vol. 33, no. 10, March 5, 1919, pp. 200-204, 17 figs. Analysis of methods of constructing the various types of surfaces; importance of gaging amount of future traffic.

Temperature of Road Surfaces

High Relative Temperatures of Pavement Surfaces, G. S. Eaton. Eng. News-Rec., vol. 82, no. 13, Mar. 27, 1919, pp. 633-634, 3 figs. Observations made by engineer of Universal Portland Cement Co. on surface temperatures of various types of surfacing and variation between these surfaces and adjacent localities.

Vitrified Brick

Vitrified Brick Construction for Heavy Motor-Truck Traffic, W. M. Acheson. Eng. News-Rec., vol. 82, no. 10, March 6, 1919, pp. 467-468. Advantages claimed for brick pavements of monolithic type.

Width

Wider Pavements Needed by Motor Vehicles at Curves, G. S. Eaton. Eng. News-Rec., vol. 82, no. 10, March 6, 1919, pp. 461-462, 3 figs. Graph of theoretical and recommended widths of lane for various radii.

SANITARY ENGINEERING

Camp Drainage

Camp Drainage and Sanitation, W. H. Beswick. Jl. Roy. Sanitary Inst., vol. 39, no. 2, Oct. 1918, pp. 70-74. Outline of work done at Salisbury Plain Camps.

Garbage Disposal

Baltimore Adopts Feeding Method for Garbage Disposal. Eng. & Contracting, vol. 51, no. 11, March 12, 1919, pp. 258-259, 1 fig. Specifications of city of Baltimore garbage disposal. Also in Mun. & County Eng., vol. 56, no. 3, Mar. 1919, pp. 96-98.

Suggestions for Improvements in Apparatus and Appliances for Dealing with House Refuse, James Jackson. Surveyor, vol. 55, no. 1415, Feb. 28, 1919, pp. 180-181. Concerning the assignation of special charges and daily removal of refuse.

Sewage Disposal

Sewage Disposal Works at London, Ontario, Willis Chipman. Can. Engr., vol. 26, no. 10, March 6, 1919, pp. 269-274, 12 figs. Two-story, non-reversible sedimentation tanks and enclosed filters with fixed spray nozzle.

St. Catherine's Relief Sewage System, D. H. Fleming. Contract Rec., vol. 33, no. 8, Feb. 19, 1919, pp. 178-181, 12 figs. Details of tunnels, manholes, etc.

Sewage Disposal at Manchester. Surveyor, vol. 55, no. 1408, Jan. 10, 1919, pp. 17-18. Activated sludge investigations; results of operation.

Sewers

Rideau River Intercepting Sewer, Ottawa, L. McLaren Hunter. Can. Engr., vol. 36, no. 1, Jan. 2, 1919, pp. 105-106 and 111, 6 figs. Map showing areas drained; method of supporting pipe under fill; operations in laying 40-in. concrete pipe.

Street Cleaning

Street Cleaning Methods. Mun. Jl., vol. 46, no. 6, Feb. 8, 1919, pp. 101-104, 4 figs. Sweeping by machine and hand, flushing and sprinkling. Report of Rochester Bureau of Municipal Research. (To be continued.)

WATER SUPPLY

Conduit Design

Economical Section of Water Conduit for Power Development, Cary T. Hutchinson. Mech. Eng., vol. 41, no. 4, Apr. 1919, pp. 369-371, 2 figs. Method of determining economical section of water conduit for supplying water to a power plant.

Factory Water Supply

What It Pays to Know About Factory Water Supply, Charles L. Hubbard. Factory, vol. 22, no. 3, March 1919, pp. 453-455, 3 figs. On insuring against well going dry.

Flood Control

Colorado River Flood Control by Storage, E. C. La Rue. Eng. News Rec., vol. 82, no. 10, March 6, 1919, pp. 456-461, 7 figs. It is claimed that reservoirs at various sites would so cut flood at Yuma as to control Imperial Valley.

Freezing of Reservoir

The Freezing of a Reservoir Outlet Works, Gilbert Christie. Surveyor, vol. 55, no. 1408, Jan. 10, 1919, pp. 19-20, 2 figs. Operations to restore supply. Paper before Instn. Water Engrs.

Railway Water Supply

Modern Water Supply Plant on Southern Railway System. Railroad Herald, vol. 23, no. 3, Feb. 1919, pp. 52-54, 1 fig. Sedimentation basin of 2,500,000 gal. capacity, installed to provide improved water supply for operation of locomotives.

Water Treatment

Results of Application of Chloramine Process to Catskill (Esopus) Water of New York City, Frank E. Hale. Eng. & Contracting, vol. 51, no. 11, March 12, 1919, pp. 262-264, 3 figs. Process consists in combining bleach with ammonia just before applying to the water treated.

Chlorine Absorption and the Chlorination of Water, Abel Wolman and Linn H. Enslow. Jl. Indus. & Eng. Chem., vol. 11, no. 3, Mar. 1, 1919, pp. 209-213, 3 figs. Results of the study of the question of chlorination control in Maryland.

Design and Performance of the Iron Removal Plant for Laundry Water at State School, Sparta, Wis., W. G. Kirchoffer. Mun. & County Eng., vol. 56, no. 3, Mar. 1919, pp. 88-90, 3 figs. Removal of iron from deep-well water by aeration, coke and treated sand filter.

Water-Works Operation

Water Works Operation: Reservoir Maintenance. Mun. Jl., vol. 46, no. 6, Feb. 8, 1919, pp. 105-107, 1 fig. Collection of sediment in reservoirs and methods of removing it.

WATERWAYS

Canals

Construction of a Lateral Canal at Allier (Construction de'un canal latéral à l'Allier), René Tavernier. Houille Blanche, nos. 23-24, Nov.-Dec., 1918, pp. 337-338. Study of a joint commission of the Departments of Allier and Puy de Dome.

The Rhone-Rhine Canal (Le canal du Rhône au Rhin.) Huille Blanche, nos. 23-24, Nov.-Dec., 1918, pp. 334-336. History of project. From Bulletin Hebdomadaire de la Navigation et des Ports Maritimes, Aug. 4 and 11, 1918.

The Cher Hydraulic System (Contribution à la détermination du régime hydraulique du Cher), P. Morin. Revue Générale de l'Electricité, vol. 5, no. 11, Mar. 15, 1919, pp. 417-418, 3 figs. Concerning supplying Berry canal at point near bridge from Cher to Montluçon.

Floods

On the Gradually Varying Movement and the Propagation of Floods (Sur le mouvement graduéllement varié et la propagation des crues), Edmond Maillet. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 5, Feb. 3, 1919, pp. 266-268. Suggests modification of Boussinesq's equations.

Inland Waterways

What the Goverament Did in Inland Waterway Navigation. Eng. News-Rec., vol. 82, no. 10, March 6, 1919, pp. 480-481. Abstract of Director General of Railroads' report on progress made during 1918 on waterways taken over by his administration.

Mississippi River

Revival of Mississippi River Traffic—III, M. von Pagenhardt. Int. Mar. Eng., vol. 24, no. 4, Apr. 1919, pp. 295-297, 4 figs. Structural features of barge terminal at St. Louis; arrangements of cargo-handling machinery.

Stream Flow

Stream Flow and Percolation Water, Samuel Hall. Surveyor, vol. 55, nos. 1408 and 1409, Jan. 10 and 17, 1919, pp. 15-16 and 35-37, 5 figs. Sources of supply due to percolation. Paper before Instn. Water Engrs.

Stream Regulation

Meteorology and Stream Regulation, W. F. V. Atkinson. Can. Engr., vol. 36, no. 1, Jan. 2, 1919, pp. 101-103, 1 fig. Chart showing direct effect of weather on flow and indirect effect through protection of forest growth; utilization of data concerning wind, temperature, precipitation and barometer records in fighting forest fires.

RECLAMATION AND IRRIGATION

Concrete

Concrete Box Flume Carried Across Gulch on Trestle, A. W. Collins. Eng. News Rec., vol. 82, no. 10, March 6, 1919, pp. 463-464, 2 figs. Substitution of concrete for steel in irrigation system at Hawaii.

Ditch

Hydraulic Efficiency of a Drainage Ditch for Five Different Channel Conditions, C. E. Ramser. Eng. News Rec., vol. 82, no. 11, Mar. 13, 1919, pp. 522-523, 5 figs. Data of various channels.

Drainage

Land Drainage in Cambridgeshire. Engineer, vol. 127, no. 3295, Feb. 21, 1919, pp. 174-176, 10 figs. Details of work on river and fen improvement.

Irrigation Canal Cleaning

Removing Algæ from a California Irrigation Canal, E. Court Eaton. Eng. News-Rec., vol. 82, no. 8, Feb. 20, 1919, pp. 382-383, 1 fig. Rotary screen with water jet and heavy dose of agent.

Morocco

The Hydraulic Wealth of Occidental Morocco (Les richesses hydrauliques du Maroc Occidental), P. Penet. Houille Blanche, nos. 23-24, Nov.-Dec., 1918, pp. 338-351, 8 figs. Possible industrial utilization; utilization of waters in agriculture; suggested program of study.

Reclamation Work

Reclamation Work on the Key System, Chas. Christopher. Elec. Traction, vol. 15, no. 3, Mar. 15, 1919, pp. 189-190 and 194-195, 4 figs. Installation of electromagnet and Brownhoist for handling scrap material.

SURVEYING

Point Determination

Errors in Position of a Point (Sur les erreurs de situation d'un point), Alf Guldherg. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 3, Jan. 20, 1919, pp. 153-155. Concerning probability of error in position of point determined by rectangular coördinates in series of continuous observations.

Mining Engineering

BASE MATERIALS

Clay

A Method for the Determination of Air in Plastic Clay, H. Spurrier. Jl. Am. Ceramic Soc., vol. 1, no. 10, Oct. 1918, pp. 710-713, and (discussion) pp. 714-715, 2 figs. Apparatus for quantitative determination of air.

Fluorspar

Fluorspar, Percy A. Wagner. South African Jl. Industries, vol. 1, no. 16, Dec. 1918, pp. 1516-1520. Manner of occurrence and sources of supply; dressing, preparation, and commercial uses; position and prospects of the South African fluorspar industry.

Fluorspar in the Ordovician Limestone of Wisconsin, Rufus Mather Bagg. Bul. Geol. Soc. Am., vol. 29, no. 3, Sept. 1918, pp. 393-397, 1 fig. Writer's findings while examining galena limestone quarries at Neenah.

Limestone

Labor Saving at Limestone Quarries, Oliver Bowles. Dept. of Interior, Bureau of Mines, Technical Paper 203, 26 pp. Methods and types of equipment that have been tried and approved by quarry operators.

Phosphates

Industry of Mineral Superphosphates (L'industrie des superphosphates minéraux). Chimie & Industrie, vol. 2, no. 2, Feb. 1, 1919, pp. 123-128, 4 figs. Technical study of French industry which produced two million tons of superphosphates during the twelve months preceding August 1914.

Silica

High-Grade Silica Materials, R. J. Colony. N. Y. State Museum Bul., nos. 203, 204, Nov. and Dec. 1917, pp. 5-29, 15 figs. From field, laboratory and microscopic studies of high-silicia rock, writer concludes that within the borders of the State of New York there is rock of good quality, easy of access, capable of being readily quarried, and which may be used for glass making, ferrosilicon manufacture, silica refractories and tube mill liners and pebbles.

GEOLOGY AND MINERALS

Age of Earth

The Age of the Earth, Harlow Shapley. Sci. Am. Supp., vol. 87, no. 2246, Jan. 18, 1919, pp. 34-35 and 42-43. Discussion of recent evidence from Geology, Astronomy and Physics. From Publ. Astron. Soc. of the Pacific, no. 177.

Anorthosite, Adirondack

Adirondack Anorthosite, William J. Miller. Bul. Geol. Soc. Am., vol. 29, no. 3, Sept. 1918, pp. 399-462. Structures, relations and origin. References are made to anorthosite of other regions and to Bowen's hypothesis, which latter writer pronounces untenable.

Columbia

The Guamoco District of Columbia—I, S. Ford Eaton. Eng. & Min. Jl., vol. 107, no. 12, Mar. 22, 1919, pp. 513-515, 3 figs. History of mining in Columbia and details of travel and physical characteristics of mineral deposits.

Crystallography

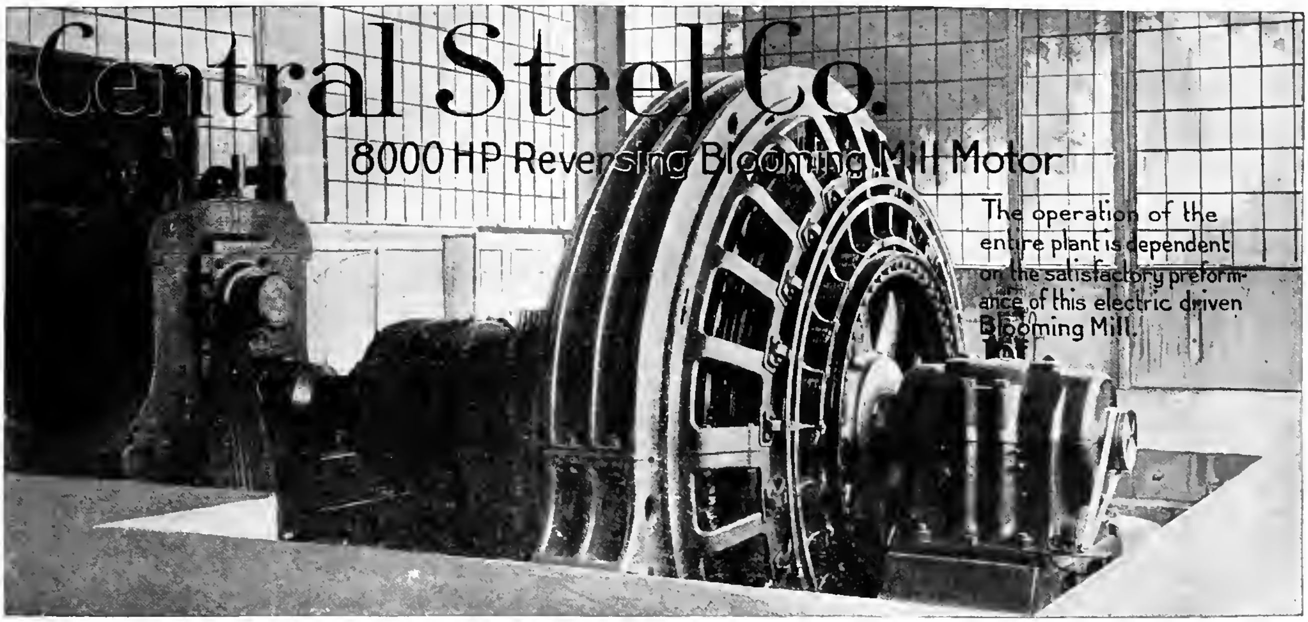
A Laboratory Method of Teaching Elementary Crystallography, Joseph E. Pogue. Am. Mineralogist, vol. 3, nos. 10 and 11, Oct. and Nov. 1918, pp. 179-182 and 193-194. Writer's practice in connection with a course in elementary crystallography at Northwestern University.

Crystallography of some Canadian Minerals. Albite, Titanite, Scapolite and Polycrase, Eugene Poitevin. Am. Mineralogist, vol. 4, nos. 2 and 3, Feb. and Mar. 1919, pp. 11-13 and 22-26, 7 figs. Specimens consisted of cavernous masses composed of association of augite, phlogopite and feldspar.

The Classification of Mimetic Crystals, Edgar T. Wherry and Elliot Q. Adams. Jl. Wash. Acad. Sci., vol. 9, no. 6, Mar. 19, 1919, pp. 153-157. Table showing types of mimetic phenomena, with three prefixtures proposed.

Kansas Crystalline Rocks

Geologic History of the Crystalline Rocks of Kansas, Raymond C. Moore. Bul. Am. Assn.



Westinghouse Has Furnished More than 65% of all Reversing Mill Equipments in the United States.

From the standpoint of economy and reliability of operation, excessive friction load is objectionable.

The friction load on a steam-driven mill may continue unchecked until the roller is warned of its presence by "low steam" or failure of the engine to pull the load.

For this reason useless and objectionable waste may be needlessly prolonged; all the while bearing spindles, boxes and necks continue to wear, the severity increasing with the increase in friction load. Hence, power consumption and maintenance climb upward.

Electric drive provides the roller means of instantly locating the source of trouble or irregularities in rolling operations—enabling the roll turner to take immediate corrective measures. Both the load and the power requirements of the various passes are easily and accurately determined, thus assisting in developing the most favorable rolling schedule. Consequently, power consumption, maintenance and costly shutdowns are held to the minimum

Among our early electric installations is that at the Central Steel Company —an 8000 H. P. Reversing Blooming Mill. The operation of the entire plant is dependent upon the satisfactory performance of this electric-driven blooming mill.

The broad experience of Westinghouse engineers is available in the solution of your power problems.

Westinghouse Electric & Mfg. Co.
East Pittsburg, Pa.

WESTINGHOUSE ELECTRIC

Westinghouse

—The Pioneer—

Petroleum Geologists, vol. 2, pp. 98-113. Material of crystalline mass is described as being for the most part a typical granite containing quartz porphyry and chlorite schist.

Datolite

Famous Mineral Localities: The Datolite Locality Near Westfield, Massachusetts, Earl V. Shannon. Am. Mineralogist, vol. 4, no. 1, Jan. 1919, pp. 5-6. General properties of minerals.

Earthquake Waves

Earthquake Waves and the Interior of the Earth. Engineering, vol. 107, no. 2774, Feb. 28, 1919, pp. 266-267, 1 fig. Facts revealed by examination of seismograph and experimental work of the motion of compressional longitudinal waves in ropes.

Eastern Pennsylvania Highlands

Precambrian Sedimentary Rocks in the Highlands of Eastern Pennsylvania, Edgar T. Wherry. Bul. Geol. Soc. Am., vol. 29, no. 3, Sept. 1918, pp. 375-392, 14 figs. Types described as of ultimate sedimentary origin.

Gettysburg

Glauberite Crystal Cavities in the Triassic Rocks in the Vicinity of Gettysburg, Pa., George W. Stose. Am. Mineralogist, vol. 4, no. 1, Jan. 1919, pp. 1-4, 7 figs. Results of petrographic study of specimens.

Glacial Deposits and Reservoir Sites

Relation of Landslides and Glacial Deposits to Reservoir Sites in the San Juan Mountains, Colorado, Wallace W. Atwood. Department of the Interior, U. S. Geological Survey, Bul. 685, 38 pages, 25 figs. Mountain canyons and deposits commonly found in them; geological conditions associated with the lakes in the mountains.

Kansas Geology

Geological Conditions in Central Kansas, Irving Perrine. Bul. Am. Assn. Petroleum Geologists, vol. 2, pp. 70-97. Review of general geology with notes on the structural conditions.

Litchfield, Maine

Field Relations of Litchfielite and Soda-Syenites of Litchfield, Maine, Reginald A. Daly. Bul. Geol. Soc. Am., vol. 29, no. 3, Sept. 1918, pp. 463-470, 2 figs. Account of field work.

Maine

Famous Mineral Localities: Mt. Mica, Mt. Apatite and other Localities in Maine, James G. Manchester and William T. Bather. Am. Mineralogist, vol. 3, no. 9, Sept. 1918, pp. 169-174, 5 figs. Observations made by writers in automobile trip through localities.

Oolites in Shale

Oolites in Shale and Their Origin, W. A. Tarr. Bul. Geol. Soc. Am., vol. 29, no. 3, Sept. 1918, pp. 587-600, 2 figs. Oolites in shale constituting Papo Algie beds are believed to be due to direct precipitation of colloidal silica introduced into the saline, shallow waters by streams flowing from adjacent land areas.

Peneplains, Appalachian

Ages of Peneplains of the Appalachian Province, Eugene Wesley Thaw. Bul. Geol. Soc. Am., vol. 29, no. 3, Sept. 1918, pp. 575-586. Examination of Appalachian peneplains in light of published and unpublished data concerning buried peneplains in Atlantic and Gulf Coastal Plains.

Quartz

Fibrous Quartz from Rhode Island, Alfred C. Hawkins. Am. Mineralogist, vol. 3, no. 7, July 1918, pp. 149-151. Writer disagrees with Prof. Emerson's theory concerning origin of fibrous quartz.

River Virgin, Utah

Oil Possibilities of the River Virgin Anticline, W. F. Calvert. Salt Lake Min. Rev., vol. 20, no. 24, Mar. 30, 1919, pp. 21-23, 4 figs. Outline of geological features of region in Southwestern Utah, which is believed to possess oil deposits.

Texas, Louisiana Coastal Plain

Minerals of the Saline Domes of the Texas-Louisiana Coastal Plain, Alfred C. Hawkins. Am. Mineralogist, vol. 3, no. 11, Nov. 1918, pp. 189-192. General data of sixty-three domes mapped to date in Texas and Louisiana.

Trilobites

The Facial Suture of Trilobites, H. H. Swinnerton. Geol. Mag., vol. 6, no. 3, Mar. 1919, pp. 103-110, 2 figs. Examination of various evidences lead writer to affirm that trilobites are a compact group, the members of which at first underwent ecdysis along marginal suture

Vivianite

The Color Change in Vivianite and its Effect on the Optical Properties, Thomas L. Watson. Am. Mineralogist, vol. 3, no. 8, August 1918, pp. 159-161. Rapid change of color is said to to due to oxidation and not to inversion.

Wasatch Region, Utah

Relation of Ore Deposits to Thrust Faults in the Central Wasatch Region, Utah, B. S. Butler. Economic Geology, vol. 14, no. 2, Mar.-Apr. 1919, pp. 172-175, 3 figs. Writer's detail work in district.

COAL AND COKE

Ash Yield, Calorific Value

The Relation Between the Calorific Values and the Ash-Yields of Coal-Samples from the Same Seam, Thomas James Drakeley. Trans. Manchester Geol. & Min. Soc., vol. 36, part I, Feb. 1919, pp. 9-20, 3 figs. Plotted calorific values and ash yields of mixtures of coal with calcium carbonate and shale. Equation expressing relation between calorific value and ash percentage.

Coal Pyrites, Tennessee

The Coal Pyrite Resources of Tennessee and Tests on Their Availability, E. A. Holbrook and Wilbur A. Nelson. Resources of Tennessee, vol. 9, no. 1, Jan. 1919, pp. 60-70, 1 fig. Coöperative research of State Geol. Survey with U. S. Bur. of Mines.

Coal-Washing Machinery

The Draper Coal Washing Machine. Engineer, vol. 127, no. 3295, Feb. 21, 1919, pp. 180-181, 3 figs. Machine is intended to deal with fine classes of coal which are generally thrown away on account of difficulty in separating coal from its associated dirt; it is said machine will handle dust so fine that it will pass a 60-mesh screen.

Coke Handling

Handling of Coke, C. J. Woodhead. Gas Jl., vol. 145, no. 2912, Mar. 4, 1919, pp. 391-394, 2 figs. Figures of Huddersfield coke handling plant. Paper read before Manchester and District Junior Gas Assn.

Coke Retorts, Central System

A New Design of Vertical Retorts—the "Central" System. Gas Jl., vol. 145, no. 2912, Mar. 4, 1919, pp. 455-456, 2 figs. Design of type introduced by Firth Blakeley & Co. of Leeds.

England

The Coal Resources of England, H. H. Stoek. Black Diamond, vol. 62, no. 11, Mar. 15, 1919, pp. 298-300, 1 fig. Review showing importance and extent of Great Britain's coal deposits.

Fatalities

Coal-Mine Fatalities in the United States, Albert H. Fay. Dept. of Interior, Bur. of Mines, Jan. 1919, 61 pp. Statistics of coal-mine fatalities in 1918, by states and months; details relating to chief cause of accidents; list of permissible explosives, lamps and motors tested prior to Jan. 31, 1919.

German Coal Classification

The German System of Coal Classification and the Future Economic War—I & II. Colliery Guardian, vol. 117, nos. 3036 & 3037, Mar. 7 & 14, 1919, pp. 535-536 and 593-595, 10 figs. Study of efficiency in utilizing fuel value of coal by partial or complete gasification, direct combustion being reserved for exceptional instances. Utilizing separate products in preparation.

Knox County, Ind.

Knox County Mines and Their Coal. Black Diamond, vol. 62, no. 14, Apr. 5, 1919, pp. 376-377, 11 figs. Activities of Knox County (Indiana) Coal Operators Assn.

Nitrogen in Coal

Researches on Coal (Recherches sur la houille), Amé Pictet. Annales de Chimie, series 9, vol. 10, Nov.-Dec. 1918, pp. 249-330. Undertaken to determine in what form nitrogen is contained in coal. Samples from Montrambert (Loire) were treated with various acid and neutral solvents, notably boiling benzene.

Philippine Islands

The Mindanao Coal Mines, Monroe Woolley. Coal Age, vol. 15, no. 11, March 13, 1919, pp. 492-493, 3 figs. Operation of fuel beds in the Philippines.

Roll Crushers

Rolls for the Preparation of Coking Coals. Coal Age, vol. 15, no. 14, Apr. 3, 1919, pp. 612-615, 9 figs. Comparison of hammer mill and roll crusher.

Shaft Development

Modern Shaft Development of the Consolidation Coal Company—I & II, George W. Harris. Coal Age, vol. 15, nos. 11 and 12, Mar. 13 and 20, 1919, pp. 480-485 and 527-531, 6 figs. General details and dimensions of mine no. 87. Operations involved in mine workings by noting location of old and new gas wells.

Training of Students

The Training of Students in Coal-Mining, with Special reference to the Scheme of the Engineering Training Organization, F. W. Hardwick. Tran. Min. Inst. Scotland, vol. 40, part 8, 1918-1919, pp. 154-162. Maintenance of Central Bureau, where parents and educationalists can obtain accurate and comprehensive information relating to engineering industry and proper course to pursue on behalf of boys who are desirous of making engineering their profession.

Utah

A One-Year Retrospect of the Coal Industry of Utah, A. C. Watts. Coal Age, vol. 15, no. 14, Apr. 3, 1919, pp. 610-611. Growth of industry.

Yellowhead Coal District

The Yellowhead Coal District, S. McVicar. Coal Age, vol. 15, no. 14, Apr. 3, 1919, pp. 608-610, 4 figs. Details of operation of two coal beds on steep pitch worked simultaneously by means of balanced plane.

COPPER

Leaching

Practical Considerations in Ammonia Leaching of Copper Bearing Ores, Lawrence Eddy. Chem. & Metallurgical Eng., vol. 20, no. 7, Apr. 1, 1919, pp. 328-334, 4 figs. Plant installation and operation; leaching tanks; plate joinings, filters and inlets; piping and pumps; evaporators; details of operation; charging and extracting ore; chemical control; cost of leaching; labor, power and ammonia.

Copper Leaching, Percy R. Middleton. Chem. Eng. & Min. Rev., vol. 11, no. 125, Feb. 5, 1919, pp. 133-134, 2 figs. Methods applicable to Australian ores.

IRON

Australia

Australian Iron Ore Resources. Min. Mag., vol. 20, no. 3, Mar. 1919, pp. 150-156, 3 figs. Information relating to iron ore deposits in West Australia, New South Wales and Tasmania.

British Columbia

Utilization of Iron Ores of British Columbia. Canadian Min. Jl., vol. 40, no. 13, Apr. 2, 1919, pp. 212-213. Proposes asking British Columbia Legislature for authority to take from any of the iron ore properties of the Province a quantity of ore, not to exceed 10,000 tons in the aggregate for experimental uses.

Magnetic Concentration

Magnetic Concentration of Pyrrhotite Ores, J. P. Bonardi. Chem. & Metallurgical Eng., vol. 20, no. 6, March 15, 1919, pp. 266-270. Experiments and tests made with a Wetherill type magnetic separator.

Mexico

Iron in Mexico (El fiero en Mexico), Trinidad Paredes. Boletin Minero, vol. 6, no. 3, Sept. 1918, pp. 253-479, 1 fig. Official publication issued by Department of Industry and Labor of Mexican Government. Mining conditions and prospects are considered at length and legislation concerning exploitation of collieries and iron deposits is studied.

LEAD, ZINC, TIN

German Domination of Metal Markets

Report of Alien Property Custodian on the Metal Industry. Chem. & Metallurgical Eng., vol. 20, no. 7, Apr. 1, 1919, pp. 313-317, 3 figs. Regarding German domination of metal markets in Europe, particularly zinc and lead.

Lead, Osotopic

Notes on Osotopic Lead, Frank Wigglesworth Clarke. Chem. News, vol. 117, no. 3062, Dec. 6, 1918, pp. 370-373. Remarks on differences in atomic weight of ordinary lead and lead obtained from radio-active processes.

Northampton (Australia), Lead Ores

The Northampton Lead-Mining District, West Australia, C. M. Harris. Min. Mag., vol. 20, no. 3, Mar. 1919, pp. 140-143. Account of old lead-mining district in West Australia that showed renewed activity during war.

24 Years Carrying 50% Overload

TEN years ago the U. S. Rubber Reclaiming Co. of Buffalo installed a 50 H. P. Link-Belt Silent Chain Drive. That drive has been operating ever since, 24 hours a day carrying a 50% overload. If figured on tne basis of a ten-hour day, that drive has been in operation 24 years.

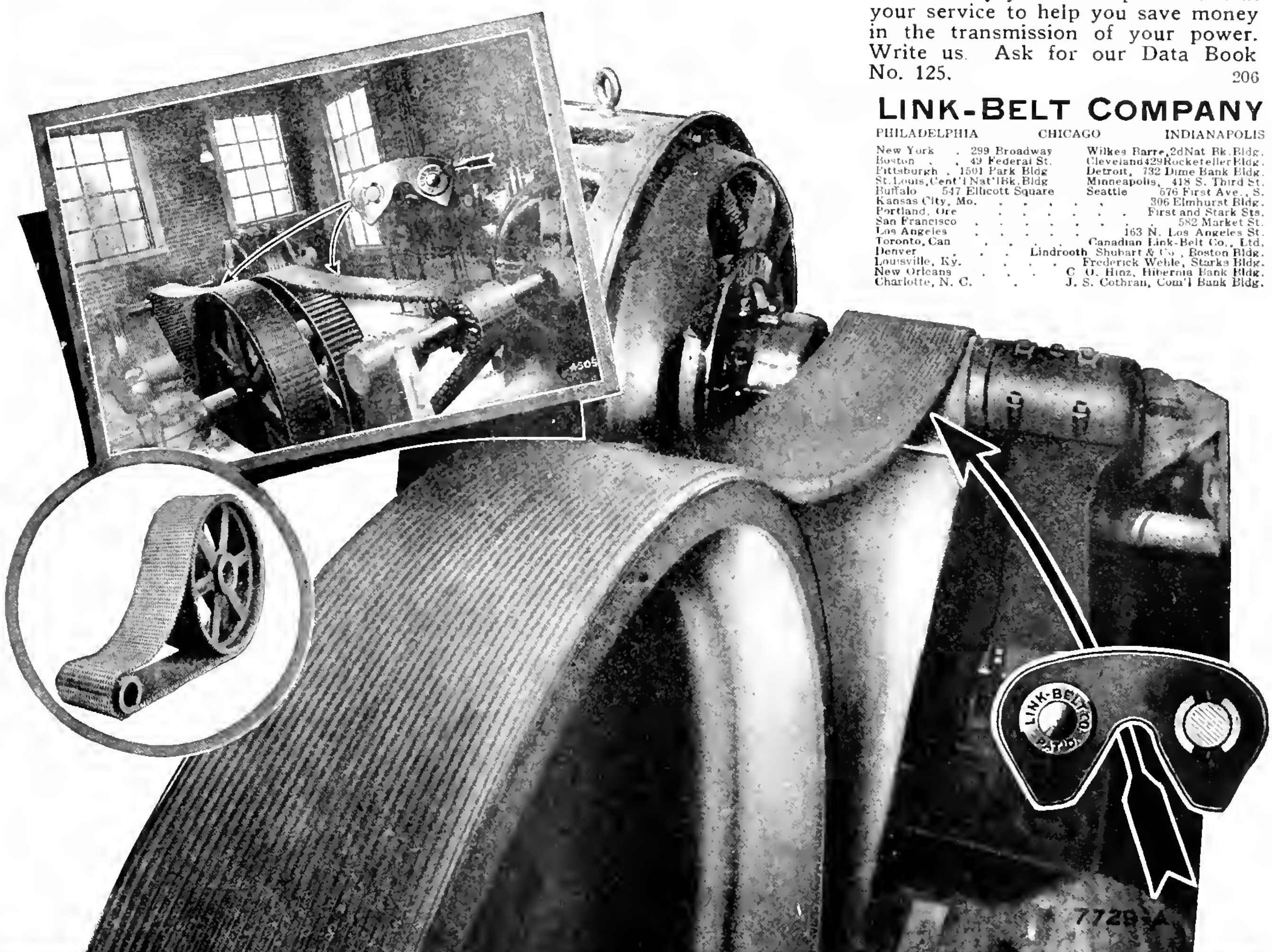
Think of it. Twenty-four years of driving efficiency—unaffected by heat, cold or dampness, carrying 50% greater load than was intended—with never a slip, the load always cushioned and never a moments idleness for chain repairs. That's Link-Belt Silent Chain Drive efficiency and service. It will prove itself "flexible as a belt, positive as a gear, more efficient than either" in your plant. Let us prove it.

Our many years of experience is at your service to help you save money in the transmission of your power. Write us. Ask for our Data Book No. 125. 206

LINK-BELT COMPANY

PHILADELPHIA CHICAGO INDIANAPOLIS

New York . 299 Broadway
Boston . . 49 Federal St.
Pittsburgh . 1501 Park Bldg
St. Louis, Cent'l Nat'l Bk. Bldg
Buffalo 547 Ellicott Square
Wilkes Barre, 2d Nat Bk. Bldg.
Cleveland 429 Rockefeller Bldg.
Detroit, 732 Dime Bank Bldg.
Minneapolis, 418 S. Third St.
Seattle 576 First Ave., S.
Kansas City, Mo. . . . . . . 306 Elmhurst Bldg.
Portland, Ore . . . . . . First and Stark Sts.
San Francisco . . . . 582 Market St.
Los Angeles . . . . . . 163 N. Los Angeles St.
Toronto, Can . . . . Canadian Link-Belt Co., Ltd.
Denver . . . Lindrooth Shubart & Co., Boston Bldg.
Louisville, Ky. . . . Frederick Wehle, Starks Bldg.
New Orleans . . . C. O. Hinz, Hibernia Bank Bldg.
Charlotte, N. C. . J. S. Cothran, Com'l Bank Bldg.



LINK-BELT
SILENT CHAIN DRIVES

We Also Make

- ☐ Elevators and Conveyors
- ☐ Link-Belt and Sprockets
- ☐ Silent Chain Drives
- ☐ Truck and Tractor Chains
- ☐ Electric Hoists
- ☐ Locomotive Cranes
- ☐ Wagon Loaders
- ☐ Coal and Ashes Systems

Write for Catalogs
Place X in Square

Tin-Bearing Mineral, Pleochroism

Pleochroism in a Tin-Bearing Mineral from Siam, J. B. Scrivenor. Geol. Mag., vol. 6, no. 3, Mar. 1919, pp. 123-124. From examination of heavy concentrate of course grains of dark mineral and finer grains of ilmenite, monazite, tourmaline, zircon, and topaz.

Tin, Hydraulic Prospecting for

Hydraulic Prospecting at the Rooiberg Tin Mines, E. R. Schoch. South African Jl. & Eng. Rec., vol. 28, no. 1427, Feb. 1, 1919, pp. 501-502. Method of surface prospecting by means of hydraulic jets or monitors.

Zinc Tailings, Retreating

Retreating Zinc Tailings in Wisconsin, W. F. Boericke. Eng. & Ming. Jl., vol. 107, no. 12, Mar. 22, 1919, pp. 524-527, 2 figs. Details of 5-cell jig with settling tank.

MAJOR INDUSTRIAL MATERIALS

Manganese

Preparation of Manganese Ores, W. R. Crane and E. R. Eaton. Resources of Tennessee, vol. 9, no. 1, Jan. 1919, pp. 48-59, 2 figs. Methods employed in dry mining, washing and concentration.

The Mining and Preparation of Manganese Ores in Tennessee, W. R. Crane. Resources of Tennessee, vol. 9, no. 1, Jan. 1919, pp. 32-47, 5 figs. Different forms of deposits. Minerals found in manganese districts are pyrolusite, psilomelane and manganite.

MINES AND MINING

Accidents

Accidents at Metallurgical Works in the United States, Albert H. Fay. Dept. of Interior, Bureau of Mines, Technical Paper 215, 23 pp. Statistics during calendar year 1917.

British Columbia

Reports of British Columbia Government Mining Engineers. Can. Min. Jl., vol. 40, no. 7, Feb. 19, 1919, pp. 100-108. Review and estimate of mineral production for 1918.

Canada

Mineral Production in Canada for 1918. Contract Rec., vol. 33, no. 12, Mar. 19, 1919, pp. 264-266. Report issued by Mines Branch, Department of Mines.

Drill Attachments

The Swift Drill Attachment. South African Min. & Eng. Jl., vol. 28, no. 1430, Feb. 22, 1919, pp. 604-605, 1 fig. Description of device; tests at Van Ryn Deep and Crown Mines.

Dust Sampling

Sampling of Dust in Mine Air, J. Boyd. Eng. & Min. Jl., vol. 107, no. 9, March 1, 1919, pp. 395-396, 1 fig. Air-testing suction pump as used for dust sampling by Chamber of Mines on Witwatersrand.

Excavators

Model Mining Methods (Metodas modelos de minaria). Revista Mineira e Metalurgica, vol. 1, nos. 10, 11 and 12, Oct.-Dec. 1918, pp. 88-90, 3 figs. Experiments by North West Corporation with Lubecker excavator (German type).

Legal

Abstracts of Current Decisions on Mines and Mining, J. W. Thompson. Dept. of Interior, Bur. of Mines, Bul. 174, law serial 17, 136 pp. Reported from May to September 1918.

Uniform Mining Law for North America, T. E. Godson. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 148, Apr. 1919, pp. 653-665. Mining laws of Canada represented as unassimilated to demands of industry.

Laws, Decrees and Decisions concerning Mines, Quarries, Sources of Mineral Waters, Railways in Operation, etc. (Lois, décrets et arrêtés concernant les mines, carrières, sources d'eaux minérales, chemins de fer en exploitation, etc.). Annales des Mines, vol. 7, no. 3, 1918, pp. 263-264. Documents published by Ministry of Public Works.

Details of Important Mining Bill Before the British Columbia Legislature, Robert Dunn. Coal Age, vol. 15, no. 12, Mar. 20, 1919, pp. 524-526. Provisions concerning miners' examinations, treatment of hoisting ropes and the practical elimination of all but safety lamps for miners' use.

Mining Law and Economics, David Bowen. Colliery Guardian, vol. 117, no. 3035, Feb. 28, 1919, pp. 479-480. Leases and licenses; definition of terms.

Longwall Mining

Longwall Mining in Illinois, Chester Mott. Mine & Quarry, vol. 11, no. 2, Mar. 1919, pp. 1122-1128, 6 figs. Practice in Illinois Third Vein field.

Ore-Dressing Laboratory

The Ore Dressing Laboratory of the Haileybury School of Mines, J. A. McRae. Can. Min. Jl., vol. 40, no. 3, Jan. 22, 1919, pp. 43-44. Summary of tests possible to carry out in plant.

Rescue Training

Rescue Training. Sci. & Art of Min., vol. 29, no. 17, Mar. 22, 1919, pp. 258-259. Fitness to undertake rescue work is said to be possessed by returning soldiers on account of their having been exposed, while in actual service, to constant danger.

Respirators

Industrial Use and Limitations of Respirators, Gas Masks and Oxygen Breathing Apparatus. Chem. & Metallurgical Eng., vol. 20, no. 5, March 1, 1919, pp. 220-221. Statement of Bur. of Mines.

Separation Doors

Separation-Doors at the Bottom of the Upcast Pit, Worked Automatically by Tubs attached to Endless-Rope (Undertub) Haulage, Clement Fletcher. Tran. Instn. Min. Engrs., vol. 56, part 3, Jan.-Feb. 1919, pp. 173-175. Design in which operating catch is disengaged from the tub axle when door is fully opened or closed.

Shaft Design

Shaft Design: Some Comparisons, W. L. White. South African Jl. & Eng. Rec., vol. 28, no. 1427, Feb. 1, 1919, pp. 503-504. On the various types of shafts with reference to those recently erected at South African mines.

Circular Shafts, H. Stuart Martin. Jl. South African Instn. Engrs., vol. 17, no. 7, Feb. 1919, pp. 136-147, 7 figs. Comparison of circular shafts with other types, particularly square and seven-compartment.

Seven-Compartment Rectangular Shafts, C. E. Knecht. Jl. South African Instn. Engrs., vol. 17, no. 7, Feb. 1919, pp. 127-136, 3 figs. Discusses merits in regard to safety in sinking, normal rate of sinking, ability to cope with water and other sinking difficulties, ventilation area, hoisting capacity and cost.

Shoveling

A Study of Shoveling Applied to Mining—H. G. Townsend Harley. Eng. & Min. Jl., vol. 107, no. 12, Mar. 22, 1919, pp. 520-522, 3 figs. Effect of shape of shovel and length of handle on amount of shoveling done. Influence of system of payment for work performed on individual efficiency of miners.

Notes on Rectangular Shafts at Randfontein Central G. M. Co., Ltd., and New State Areas, Ltd., W. L. White. Jl. South African Instn. Engrs., vol. 17, no. 7, Feb. 1919, pp. 148-156, 5 figs. Drawings and figures of two vertical shafts at Randfontein and at New State Area, South Africa.

Shot Drilling

Shot Drilling Around Thetford Mines, J. W. Davis. Can. Min. Jl., vol. 40, no. 3, Jan. 22, 1919, pp. 36-38, 4 figs. Prospecting work in asbestos and chromite iron deposits by Calix shot drills.

Stope Measurement

Cobar Stope Measurement Methods, W. S. Curteis. Instn. Min. & Metallurgy, Bul. 174, Mar. 13, 1919, 20 pp., 6 figs. Analysis of methods employed in measuring the stopes at Great Cobar, Ltd., New South Wales, Australia. Methods were devised primarily for measurement for payment purposes.

Taxation

Principles of Mining Taxation, Thos. W. Gibson. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 148, Apr. 1919, pp. 611-620. Analysis of general systems of taxation and their application to mines, which, it is contended, have to spend part of earning in building for workers' conveniences of living in remoted regions.

Temperatures in Deep Mines

High Temperatures in Deep Mines, William Garnforth. Tran. Instn. Min. Engrs., vol. 56, part 3. Jan.-Feb. 1919, pp. 127-133. Review of reports issued by various official and scientific committees.

Tunnel Driving

Methods and Cost of Driving a 10 x 12 ft. Mining Tunnel at Copper Mountain, B. C., Oscar Lockmund. Eng. & Contracting, vol. 51, no. 12, Mar. 19, 1919, pp. 286-287, 1 fig. Driving of main haulage level at Copper Mountain Mines of Can. Copper Corp. Presented at Chicago meeting, Am. Inst. Min. Engrs.

Ventilation

Ventilation Methods in Coeur d'Alene Mines, Robert N. Bell. Min. & Sci. Press, vol. 118, no. 12, Mar. 22, 1919, pp. 397-398. Abstract from report of State Inspector of Mines.

Mine Ventilating Plant. Engineer, vol. 127, no. 3292, Jan. 31, 1919, pp. 110-111, 6 figs. Arrangements in installation driven by 300 hp., 2-cyl. tandem compound engine.

MINOR INDUSTRIAL MATERIALS

Salt

Separation of Salt from Saline Water and Mud, E. M. Kindle. Bul. Geol. Soc. Am., vol. 29, no. 3, Sept. 1918, pp. 471-487, 12 figs. Laboratory observations on behavior of salt in evaporation of saline mixtures and discussion of their geological significance.

Zirconia

Zirconia. Metal Industry, vol. 14, no. 10, Mar. 7, 1919, pp. 189-190. Its occurrence and application.

OIL

Cuba

The Geology of Cuban Petroleum Deposits, E. DeGolyer. Bul. Am. Assn. Petroleum Geologists, vol. 2, pp. 133-167. Compilation of several geological, stratigraphic and structural data, and comparison with North American Mid-Continent fields.

Gasoline Content in Natural Gas

Testing Natural Gas for Gasoline Content, G. G. Oberfell, S. D. Shinkle and S. B. Meserve. Jl. Indus. & Eng. Chem., vol. 11, no. 3, Mar. 1, 1919, pp. 197-200, 6 figs. Method employs use of solid absorbing medium such as charcoal and is applicable to both lean and rich natural gas.

Geology

Value of Oil Geology in the Mid-Continent Field, Edward Bloesch. Bul. Am. Assn. Petroleum Geologists, vol. 2, pp. 124-132. Value of geology is considered to depend on keeping producers out of territory where there is no chance of production at all.

India

Notes on Structure and Stratigraphy in the North-West Punjab, E. S. Pinfold. Records Geol. Survey India, vol. 49, part 3, Dec. 1918, pp. 137-159. Notes collected while prospecting for oil.

Kentucky

A Résumé of the Past Year's Development in Kentucky from a Geological Standpoint, J. R. Pemberton. Bul. Am. Assn. Petroleum Geologists, vol. 2, pp. 38-52, 1 fig. Wild-cat drilling in 1917 is said to have resulted in the discovery of many new and valuable oil pools; anticlinal structure control and conditions of structures in western Kentucky are described.

Louisiana

The Oil and Gas Fields of Northern Louisiana, Mowry Bates. Bul. Am. Assn. Petroleum Geologists, vol. 2, pp. 61-69. Wells are said to be costly to drill and operate in northern Louisiana and the region is not considered as attractive.

Migration Through Sedimentary Rocks

On the Migration of Petroleum through Sedimentary Rocks, A. W. McCoy. Bul. Am. Assn. Petroleum Geologists, vol. 2, pp. 168-171. Concerning accepted theory that the oil has been formed from various types of animal and vegetable remains, buried in sedimentary rocks.

Santa Clara, Cal.

Tectonic Interpretation of Santa Clara Valley Petroliferous Region (Interprétation tectonique de la région petrolifère de la vallée de Santa Clara en Californie), Max Reinhard. Archives des Sciences Physiques et Naturelles, year 124, vol. 1, Jan.-Feb. 1919, pp. 63-78, 4 figs. Theoretical considerations on petroleum deposits, and Eldrige's and Arnold's studies have led writer to suggest interpretation of southern California formations particularly Santa Clara valley.

Storage

Petroleum Oils (Les essences de pétrole) A. Guiselin. Journal du Pétrole, no. 12, Dec. 1918, pp. 1-6, 3 figs. Losses due to storage and methods of preventing them. (Continuation of serial.)

Evaporation Losses of Crude Oil Decreases Gasoline Content, J. H. Wiggins. Natural Gas & Gasoline Jl., vol. 13, no. 3, Mar. 1919, pp. 89-90. Concerning evaporation losses of crude oil.

Texas

A Review of the Development in the New Central Texas Oil Fields During 1918, W. G. Matteson. Economic Geology, vol. 14, no. 2, Mar.-Apr. 1919, pp. 95-146, 7 figs. Stratigraphy, structural geology, and general tectonic relationships.

Venezuela

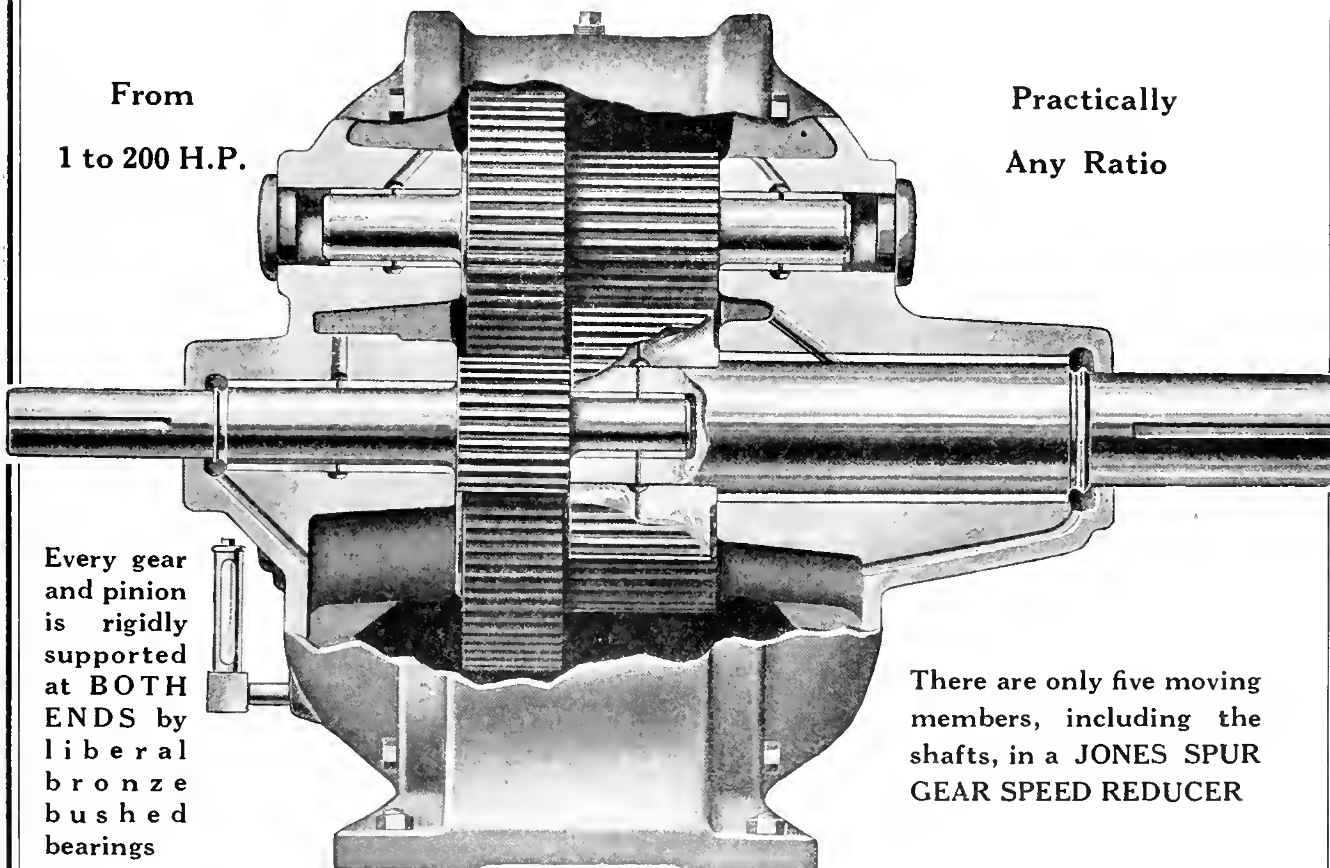
Caribbean Petroleum's Operations in Venezuela. Oil Trade Jl., vol. 10, no. 4, Apr. 1919, p. 72, 3 figs. Transportation of well casing.

COMPARE THE SIMPLICITY OF THE JONES SPUR GEAR SPEED REDUCER

With Other Speed Reducing Devices

From 1 to 200 H.P.

Practically Any Ratio



Every gear and pinion is rigidly supported at BOTH ENDS by liberal bronze bushed bearings

There are only five moving members, including the shafts, in a JONES SPUR GEAR SPEED REDUCER

All shafts are accurately ground to size.

The gears and pinions are not milled with rotary cutters, but are accurately generated, with stub teeth of 20° pressure angle (the recognized standard for automobile and truck transmissions).

The Jones Reducer is just a plain spur gear drive with no internal gears or overhung pinions involving a complicated mounting.

The consistent use of Johannson limit gages insures absolute interchangeability of parts.

Every gear, pinion and bearing is flooded with oil at all times.

Sling rings on the two extended shafts keep all of the oil in the housing.

The height of oil in the housing can be determined instantly by looking at the sight gage.

Every Reducer problem is given a complete engineering analysis, thus insuring the selection of a machine amply proportioned for the full duty to be performed.

Let us assist you in solving your reducing problems.

W. A. JONES FOUNDRY & MACHINE CO.

ESTABLISHED 1890

4400 WEST 12th ST., CHICAGO, U. S. A. NEW YORK OFFICE: 30 CHURCH ST.

Water

The Distribution of Underground Salt Water and its Relation to the Accumulation of Oil and Gas, Roswell H. Johnson. Bul. Am. Assn. Petroleum Geologists, vol. 2, pp. 174-176. On relative roles of ascending and descending waters in oil accumulation.

PRECIOUS MINERALS

Diamonds

The Latest Development of Diamond Winning in S. W. Africa. South African Jl. & Eng Rec., vol. 28, no. 1427, Feb. 1, 1919, pp. 495-496 Search for big mine under the sea; diamond recovery by dredging.

Gold Precipitation

The Theory of the Precipitation of Gold by Charcoal. A. W. Allen. Eng. & Ming. Jl., vol. 107, no. 12, Mar. 22, 1919, pp. 516-519, 2 figs. Abstracted from Bul. 171, I. M. M.

Gold Volatilization

The Volatilization of Gold. Thomas Kirke Rose. Instn. Min. & Metallurgy, Bul. 174, Mar. 13, 1919, 13 pp., 1 fig. Summary of results obtained by various investigators. Writer concludes that true volatilization of gold is so small as to be negligible at temperatures of industrial melting furnaces.

RARE MINERALS

Beryl

Famous Mineral Localities: Beryl Mountain, Acworth, N. H. Edward F. Holden. Am. Mineralogist, vol. 3, no. 12, Dec. 1918, pp. 199-200. Physical features of beryl crystals.

Famous Mineral Localities: Beryl Hill, Grafton, New Hampshire. George M. Flint. Am. Mineralogist, vol. 4, no. 3, Mar. 1919, pp. 21-22, 2 figs. Features of beryl exhibited at various museums.

Radium

Radium Production. Chas. H Viol. Science, vol. 44, no. 1262, March 7, 1919, pp. 227-228. Output of the Standard Chemical Co. of Pittsburgh from 1913-1918.

Uranium

The Determination of Uranium in Alloy Steels and Ferro-Uranium. G. L. Kelley, F. B. Myers and C. B. Illingworth. Jl. Indus. & Eng. Chemistry, vol. 11, no. 4, Apr. 1, 1919, pp. 316-317. Method for determining uranium in presence of any of the other elements now in common use in the manufacture of alloy steels.

Uranium: Its Extraction from Pitchblende. Gustave Gin. Gen. Meeting Am. Electrochem. Soc., Apr. 3-5, 1919, paper 6, pp. 55-60. Discussion of occurrence and composition of pitchblende; methods of treatment by which uranium oxide is separated from it, both when it contains vanadium and when vanadium is absent; writer's proposed method for purification, involving fusion and electric-furnace treatment to convert most of constituents into carbides followed by separation based on differing properties of carbides.

MERCURY

Condensation Losses

Fume and Other Losses in Condensing Quicksilver from Furnace Gases. L. H. Duschak and C. N. Schuette. Dept. of Interior, Bureau of Mines, Technical Paper 96, 29 pp., 8 figs. Report of experiments conducted by Federal Bur. of Mines through its station at Berkeley, Cal.

Metallurgy

BLAST FURNACES

Charging, Mechanical

Mechanical Charging of Silver Lead Blast Furnaces. L. D. Anderson Monthly Jl. Utah Soc. Engrs., vol. 5, no. 1, Jan. 1919, pp. 1-5, 3 figs. Practice of U. S. Smelting & Refining Co. at Midvale, Utah.

Gas Cleaning

New Blast Furnace Gas Cleaning Outfit. Blast Furnace & Steel Plant, vol 7, no. 4, Apr. 1919, pp 193-195, 2 figs. Ruddiman scrubber and combined cooler and dryer; cleaning apparatus combines principle of contact type of cleaner with that of scrubber type

New Dry Cleaner for Blast Furnace Gas. J. C. Barrett. Blast Furnace & Steel Plant, vol. 7, no. 4, Apr. 1919, pp 185-187, 1 fig. King-Weidlein dry gas cleaner developed at Youngstown claims many advantages over wet process; retention of sensible heat of gas; greater steam generation and higher stove temperature.

Hot-Blast Stoves

Forced Draft for Hot Blast Stoves. Oskar Simmersbach. Iron & Coal Trades Rev., vol. 48, no. 2654, Jan. 10, 1919, p. 40, 2 figs. Combats opinion that with natural draft products of combustion are not evenly distributed over whole area of chequer work. From Stahl und Eisen.

COPPER AND NICKEL

Cupro-Nickel Alloys

Cupro-Nickel. H. A. Eastick. Metal Industry, vol. 14, no. 8, Feb. 21, 1919, pp. 141-143, 3 figs. Equilibrium diagram for cupro-nickel alloys; physical properties, tensile strength, elongation curves and characteristic graph of alloy containing 15 per cent nickel.

Nickel Refining

International Nickel Company's Refining Works at Port Colborne, Ontario, W. L. Wotherspoon. Eng. & Min. Jl., vol. 107, no. 10, March 8, 1919, pp. 429-435, 11 figs. Preliminaries incidental to erection and details relating to installation of plant. An annual output of 15,000,000 lb. of nickel is expected.

FLOTATION

Differential Flotation

Differential Flotation of Lead-Zinc (Flottage différentiel de plomb-zinc). Echo des Mines et de la Métallurgie, vol. 47, no. 2616, Mar. 9, 1919, pp. 152-155, 1 fig. Bradford differential process.

Filters

An Electrically Driven Filter. E. J. Richards. Jl. Electricity, vol. 42, no. 6, Mar. 15, 1919, pp. 262-263, 2 figs. Oliver filter in use in flotation process, by Arizona Hercules Copper Company.

Wolf Patent

The Wolf Patent on Flotation. Min. & Sci. Press, vol. 118, no. 12, Mar. 22, 1919, pp. 390-392, 1 fig. Separation of metals from their ores. From text of Letters Patent No. 787,814.

IRON AND STEEL

Acid Bessemer Steel

A Technical Study of Acid Bessemer Steel. Iron Age, vol. 103, no. 10, Mar. 6, 1919, pp. 626-627. Action of manganese and its possible conservation; prevention of spitting; effect of bottom of converter. From Wisconsin Engr.

Cast Iron, Corrosion by Acids

Rupture of Cast Iron in Contact with Mixed Acid. A. C. Cumming. Jl. Soc. Chem. Indus., vol. 38, no. 3, Feb. 15, 1919, pp. 31T-32T. Experiments in connection with manufacture of trinotrotoluene.

Classification of Iron and Steel

Plan to Improve Foreign Trade Statistics. Iron Age, vol. 103, no. 11, Mar. 13, 1919, pp. 685-687. Tentative classification of iron and steel products to be used in reporting exports and imports, prepared by a committee of representatives from Bur. of Foreign and Domestic Commerce and other government organizations.

Ferrotitanium

The Beneficial Results Obtained by Introducing 25 per cent Carbonfree Ferrotitanium into Iron and Steel. Reactions, First Quarter, 1919, pp. 15-17, 7 figs. Cast-iron base of 25-ton Browning crane welded with thermit.

Flaky Steel

Observations on So-Called "Flakes" in Steel. Haakon Styri. Chem. & Metallurgical Eng., vol. 20, no. 7, Apr. 1, 1919, pp. 342-351, 41 figs. Examination of nickel-steel and carbon-steel transverse test bars showed that abnormalities in fractures were associated with impaired physical qualities and exhibited more or less minute slag inclusions.

Observations on Flaky and Woody Steel. Federico Giolitti Chem. & Metallurgical Eng., vol. 20, no. 6, March 15, 1919, pp. 271-273, 2 figs. Discussion of causes of this defect in high-grade alloy steels.

India

The Heavy Steel Industry in India. Andrew McWilliam. Indian & Eastern Engr., vol. 44, no. 1, Jan. 1919, pp. 14a-14b. Account of historical and technical side. (To be continued.)

Molybdenum Steel

Molybdenum Steel versus Gun-Erosion. Masatosi Okôchi, Masaichi Majima and Naoshi Sato. Jl. Soc. Mech. Engrs., Tokyo, vol. 22, no. 54, Nov. 1918, pp. 1-44, 50 figs. Experimental work to determine the resisting power of molybdenum steel against erosion. Investigation was conducted because of a report in which it was stated that steel containing three to four per cent. molybdenum was employed as gun material in the German artillery. Writers found no trace in chemical analyses of specimens taken from captured German guns.

Open Hearth

Water Cooled Equipment for Open Hearths. William C. Coffin. Blast Furnace & Steel Plant, vol. 7, no. 4, Apr. 1919, pp. 188-192 and 197, 6 figs. Equipment for preventing distortion of framework and maintaining economy of refractories. Paper read before Am. Inst. Min. Engrs.

Refractories

See Refractories, under MECHANICAL ENGINEERING.

Rolling Mills

See Mechanical Processes (Rolling Mills), under MECHANICAL ENGINEERING.

Smelting

A New Method for the Smelting of Iron Ores. Jas. W. Moffat. Canadian Min. Jl., vol. 40, no. 13, Apr. 2, 1919, pp. 207-210. Process designed for treatment of Canadian ores.

Tool Steel

The Evolution of a High Speed Tool Steel—II. T. L. Thorne. Am. Drop Forger, vol. 5, no. 3, Mar. 1919, pp. 146-149. Discussion on effects of various elements; methods of handling material when received in during production outlined; selection of furnaces important when treating finished tools.

Trumbull Steel Co. Plant

Valley Plant Produces Own Steel. Iron Trade Rev., vol. 64, no. 10, Mar. 6, 1919, pp. 641-645, 8 figs. General layout of Trumbull Steel Co.'s steel plant which includes seven 100-ton stationary open-hearth furnaces, a 36-in. blooming mill and an 18- and 21-in. bar mill.

Turbine Furnace

The "Turbine" Furnace. Iron & Coal Trades Rev., vol. 48, no. 2658, Feb. 7, 1919, p. 164, 1 fig. Aim is to insure a passage of air which shall be equal over every portion of the grate area. Air enters through five troughs which extend over whole length.

Zirconium Steels

Zirconium Steels (Les aciers au zirconium). Bulletin de la Société d' Encouragement pour l'Industrie Nationale, vol. 131, no. 1, Jan-Feb. 1919, pp. 149-155. English patent in regard to uses of zirconium in metallurgy; other practices in various metallurgical works.

VARIA

Bureau of Standards

Metallurgical Work of Bureau of Standards—II. G. K. Burgess. Blast Furnace & Steel Plant, vol. 7, no. 4, Apr. 1919, pp. 195-197. Review of research work concerning welding, tin conservation, bearing metals, protective metallic coatings, sand investigations, etc.

Diseases of Metals

Decomposition of Metals—I. A. I. Krynitzky. Chem. & Metallurgical Eng., vol. 20, no. 6, March 15, 1919, pp. 277-282, 11 figs. Review of various theories which have been advanced to explain so-called "disease of metal."

FERROALLOYS

Manufacture

The Manufacture of Ferro-Alloys—II. Robert M. Keeney. Automotive Eng., vol. 4, no. 3, Mar. 1919, pp. 121-124. Ores and furnaces used and methods followed to produce ferrochrome, ferromanganese, ferromolybdenum, ferrotungsten, ferrovanadium and ferrouranium.

Testing

Metallurgy and Motor Engineering. J. B. Hoblyn. Auto, vol. 24, no. 949, Mar. 13, 1919, pp. 256-257, 9 figs. Notes on the metallurgical examination and treatment to which materials are submitted in the technical laboratory of Vauxhall Motors, Ltd.

NON-FERROUS ALLOYS

Aluminum and Copper Alloys

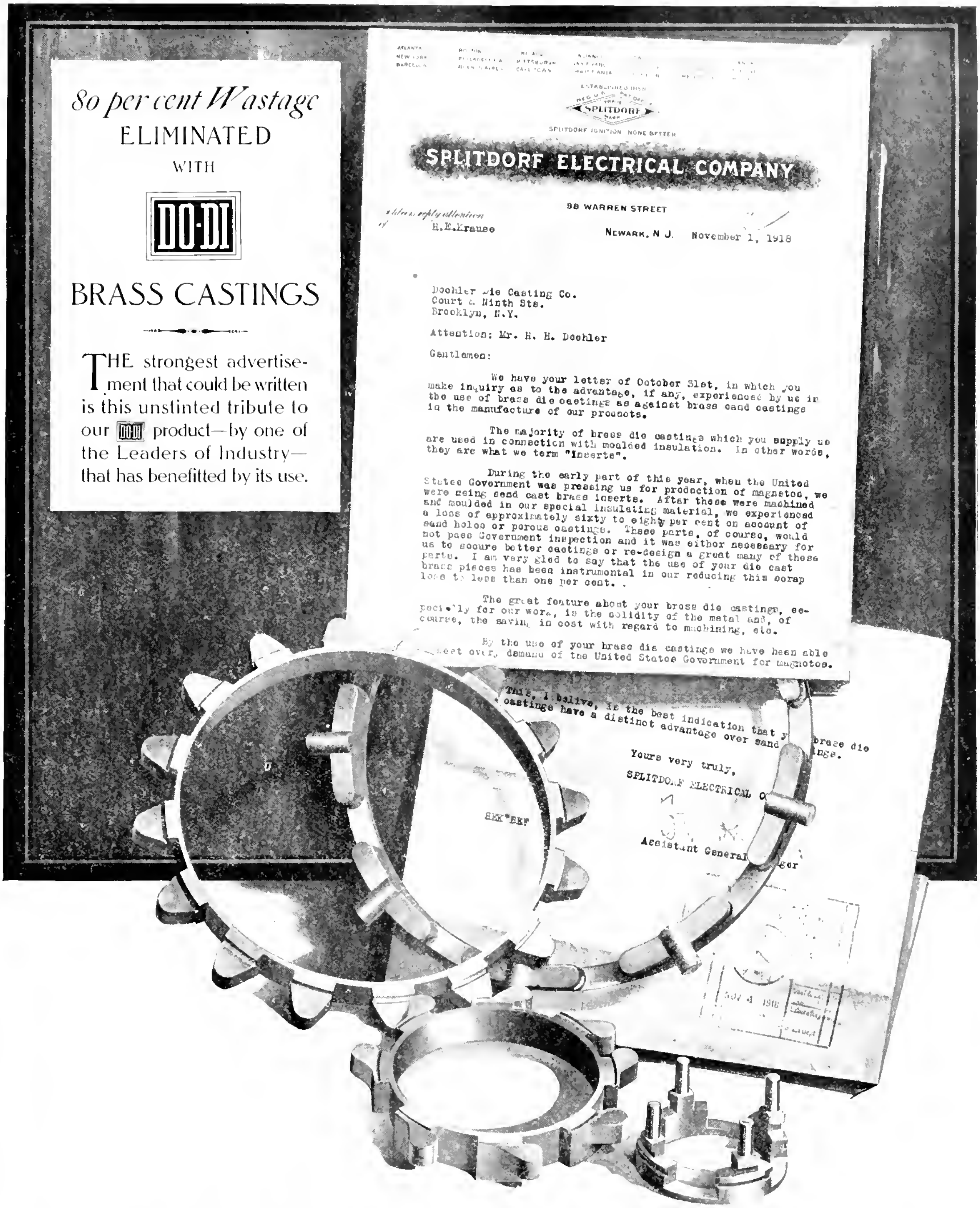
Aluminum and Copper Alloys. Machinery, vol. 13, no. 337, Mar. 13, 1919, pp. 656-659, 2 figs. Field for these alloys and difficulties met with in their manufacture.

Copper Alloys of High Tenacity

Copper Alloys of High Tenacity. O. F. Hudson. Metal Industry, vol. 14, no. 9, Feb. 28, 1919, pp. 163-166. Notes on strength of brasses and methods used to obtain brasses having high tensile strength. Paper before Birmingham Metallurgical Soc.

80 per cent Wastage
ELIMINATED
WITH
DO-DI
BRASS CASTINGS

THE strongest advertisement that could be written is this unstinted tribute to our DO-DI product—by one of the Leaders of Industry—that has benefitted by its use.



DOEHLER DIE-CASTING CO.

MAIN OFFICE AND EASTERN PLANT
BROOKLYN, N.Y.

WESTERN PLANT
TOLEDO, OHIO.

NEW JERSEY PLANT
NEWARK, N.J.

Aeronautics

AEROPLANE PARTS

Starters

The Liberty Starter for Aircraft Engines. Aviation, vol. 6, no. 4, Mar. 15, 1919, pp. 221-222, 3 figs. and Automotive Industries, vol. 40, no. 14, Apr. 3, 1919, p. 739, 3 figs. Combines gear reduction for hand cranking with an electric starter with high reduction ratio. Principal features and details of parts.

The Bijur Electric Starter for Aero Engines. Aerial Age, vol. 8, no. 22, Feb. 10, 1919, p. 10, 6 figs. Its application to Liberty motor.

Struts

Dimensions of Steel Tube Struts, E. S. Bradfield. Aerial Age, vol. 9, no. 2, Mar. 24, 1919, p. 112, 3 figs. Charts for computing dimensions.

AEROSTATICS

Dirigibles

Airships for Commercial Purpose. Aeronautics, vol. 16, no. 277, Feb. 5, 1919, pp. 152-154. A comparison of heavier- and lighter-than-air machines, and how each type may be utilized.

England's Aerial Effort (L'effort aérien de l'Angleterre). Aérophile, vol. 27, nos. 1-2, Jan. 1-15, 1919, pp. 14-15, 3 figs. Dirigibles developed during war.

Mooring Gear

The Possibilities of Airship Transport Services. Flight, vol. 11, no. 9, Feb. 27, 1919, pp. 263-267, 2 figs. Vickers patent mooring gear for rigid airships. Concluded from p. 232.

Schilling Apparatus for Measuring Hydrogen

Utilization of Schilling Apparatus in Control of Industrial Hydrogen (Sur les conditions d'utilisation de l'appareil de Schilling, pour le contrôle de l'hydrogène industriele), F. Bourion and Ch. Courtois. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 4, Jan. 27, 1919, pp. 232-235. Reasons for preference given to Schilling apparatus over hydrogen balance, in the measure of hydrogen destined for airship service.

AIRCRAFT PRODUCTION

Liberty Engine Parts, Manufacture of

Making Liberty Airplane Motor Parts. Machy., vol 25, no. 7, Mar. 1919, pp. 636-641, 13 figs. Methods employed in machining cylinder inlet and exhaust elbows for the Liberty airplane motor at plant of Packard Motor Car Co.

Naval Aircraft Factory

The Naval Aircraft Factory, G. W. Smith. Jl. Worcester Polytechnic Inst., vol. 22, no. 2, Jan. 1919, pp. 91-103, 2 figs. Account of war studies which led to construction and organization of factory.

Trimming Aircraft Parts

Trimming Aircraft Parts, W. A. Ford. Machinery, vol. 13, no. 335, Feb. 27, 1919, pp. 597,598, 4 figs. Boring holes in metal to secure required degree of lightness.

APPLICATIONS

Aerial Photography

Broad Field for Commercial Aerial Photography, M. A. Kinney. Flying, vol. 8, no. 3, Apr. 1919, pp. 250-255, 7 figs. Outline of possibility in scientific research, commercial endeavor and police work.

Aerial Routes

First Steps in Organizing an Aerial Route, Holt Thomas. Aeronautics, vol. 16, no. 281, Mar. 5, 1919, pp. 248-249. Safety of Commercial Air Service.

Canada

The Development and Future of Aviation in Canada, M. R. Riddell. Jl. Eng. Inst. Can., vol. 2, no. 3, Mar. 1919, pp. 200-209, 9 figs. Aero 504-k; J N-4, C. 504-K. Visualization of peace development of aeroplane.

Commercial Possibilities of Lighter and Heavier Than Air Machines

Commercialization of Rigid Airplanes (L'utilisation commerciale des aéronefs rigides). Génie Civil, vol. 74, no. 9, Mar. 1, 1919, pp. 167-169. Comparison of services given by airplanes and zeppelins.

Forest-Patrol Work

Use of Aeroplanes for Forest Patrol Work. Aeronautics, vol. 16, no. 277, Feb. 5, 1919, p. 155. Outlines American scheme for using aeroplanes in forest patrol work.

Preparing for Commercial Flying

Preparing for Commercial and Pleasure Flying, Graham-White. Aeronautics, vol. 16, no. 280, Feb. 26, 1919, pp. 230-234, 2 figs. Forecast of developments and analysis of difficulties.

AUXILIARY SERVICE

Radio Surgical Service

Radio-Surgical Airplane (Avion radio-chirurgical), Foveau de Courmelles. Aérophile, vol. 27, nos. 1-2, Jan. 1-15, 1919, pp. 18-20, 3 figs. Fitted with radiographic and surgical laboratories and power plant which permits speed of 100 miles per hour. Named after designers "Aerochir Némirovski-Tilmant."

DESIGN

Ailerons

Some Points in Aeroplane Design, F. S. Barnwell. Flight, vol. 11, no. 533, Mar. 13, 1919, pp. 345-349, 2 figs. Investigation of controlling power of ailerons. (Concluded.)

Bristol Fighter Design

Some Points in Aeroplane Design, F. S. Barnwell. Aeronautics, vol. 16, no. 281, Mar. 5, 1919, pp. 260-261. Analysis of Bristol fighters. Paper before Royal Aeronautical Society.

Radiators

The Principles of Cooling of Airplane Engine Radiators, H. B. Irving. Automotive Industries, vol. 40, no. 14, Apr. 3, 1919, pp. 740-742. Law of heat transmission from a surface to a fluid flowing over the surface; hp. expended in overcoming head resistance of radiator.

Wing Spars and Stability

Some Points in Aeroplane Design, F. S. Barnwell. Flight, vol. 11, nos. 9 and 10, Feb. 27 and Mar. 6, 1919, pp. 275-280 and 310-313, 9 figs. Graphs and tables in reference to design of wing spars. Comparative data of tail plane required to give longitudinal stability to a monoplane, "square" biplane and "staggered" biplane. (To be concluded.)

DYNAMICS

Flattening Out from Glides

Flattening Out of Aeroplanes After Steep Glides, Genjiro Hamabe. Jl. Soc. Mech. Engrs., Tokyo, vol. 22, no. 54, Nov. 1918, pp. 45-96, 8 figs. Theoretical determination of time required to restore a machine from a steep glide and of the "wing loading" set up during this motion.

Torsional Loads in Fuselage

Torsional Loads in the Fuselage of an Aeroplane, A. J. Sutton Pippard. Engineering, vol. 107, no. 2772, Feb. 14, 1919, p. 195, 1 fig. Suggests method of calculation based on assumption that deformation of fuselage is due to stretch of panel bracing wires, bulkhead bracing wires being considered as inoperative.

ENGINES

Basse-Selve

The 200-hp. Basse-Selve Aero Engine. Flight, vol. 11, no. 10, Mar. 6, 1919, pp. 297-305, 25 figs. Report based on examination of engine taken from remains of a German Rumpler two-seater biplane. Issued by Technical Dept. (Aircraft Production) Ministry of Munitions.

Bugatti-King

The King-Bugatti Aviation Engine, G. Douglas Wardrop. Aerial Age, vol. 8, no. 22, Feb. 10, 1919, pp. 1074-1080, 32 figs. Engineering description. (To be continued.)

Design

The Design of Aeroplane Engines, John Wallace. Aeronautics, vol. 16, nos. 278, 280 and 281, Feb. 12, Feb. 26 and Mar. 5, 1919, pp. 174-177, 220-222, and 251-255, 25 figs. Piston design and construction; distribution of side thrust; piston lubrication; piston rings; gudgeon-pin bearing; connecting rods; big-end bolts; twin connecting rods; Anzani arrangement; Canton system. (Continuation of serial.)

Hall-Scott

A Marine "Liberty," George F. Crouch. Motor Boat, vol. 16, no. 5, March 10, 1919, pp. 17-20, 10 figs. Hall-Scott 4-cyl. and 6-cyl. airplane motors modified to suit marine conditions.

Mercedes

200 Hp. High Compression Mercedes Engine. Aeronautics, vol. 16, no. 279, Feb. 19, 1919, pp. 204-206, 7 figs. Report on running performance, based on examination and tests carried out at R. A. E. on engine taken from Fokker D7 biplane (G/2 B/14). Issued by Technical Dept. of Air Ministry.

German Machines

Thermal Machines. German Aviation Motors (Machines thermiques—les moteurs de l'aviation alemande), Ed. Marcotte. Technique Moderne, vol. 10, no. 12, Dec. 1918, pp. 544-553, 29 figs. The various types are examined in reference to weight per hp., compression space, service given, and details in which they differ from French motors. (Concluded.)

"Le Rhone"

The "Le Rhone" 110 H. P. Engine, G. Douglas Wadrop. Aerial Age, vol. 9, no. 3, Mar. 31, 1919, pp. 156-157 and 177, 6 figs. General data: diagrammatic sketches of oiling and ignition systems.

Liberty

Mechanical Details of the Liberty Engine—II. Automotive Eng., vol. 4, no. 3, Mar. 1919, pp. 117-120, 6 figs. Drawings and specifications of cast-iron cylinder forms for tank use and of steel cylinder type with sheet-metal water jackets for airplane power plants.

Thomas-Morse

The Thomas-Morse Model 8-90 Aero Engine. Aerial Age, vol. 8, no. 26, March 10, 1919, pp. 1348-1349, 2 figs. Characteristics of four-cycle eight-cylinder V-type engine.

Union

The 125 Hp. Union Aircraft Engine. Aviation, vol. 6, no. 4, Mar. 15, 1919, pp. 230-232, 3 figs. Engine is of vertical 6-cyl. water-cooled type with valves in head and develops its rated hp. at 1400 r.p.m. Total weight 485 lb.

INSTRUMENTS

Testing

Tests of Aeronautic Instruments, P. M. Heldt. Automotive Industries, vol. 11, no. 13, Mar. 27, 1919, pp. 691-692, 2 figs. Mercurial standards and vacuum control board used in aeronautic instrument test chamber of Bureau of Standards. (Sixth Article.)

MATERIALS OF CONSTRUCTION

Dope

Fabric and Dope, F. W. Aston. Aeronautics, vol. 16, no. 279, Feb. 19, 1919, pp. 208-209. Rapidity of deterioration at different times of the year; comparison of English and German dope; influence of atmosphere surrounding fibres; methods of protecting fabric from sunlight.

MILITARY AIRCRAFT

Aerial Tactics

Aerial Tactics and the Defense Against Airplanes (La tactique aérienne et la défense contre avions), Jean-Abel Lefranc. Aérophile, vol. 27, nos. 1-2, Jan. 1-15, 1919, pp. 6-9. Remarks on significance of air warfare, based on records of past war.

German War Aviation

Evolution of German Aviation During the War 1914-1918 (Evolution de l'aviation alemande pendant la guerre de 1914-1918). Aérophile, vol. 27, nos. 1-2, Jan. 1-15, 1919, pp. 12-13. Characteristics of reconnoitring planes, bombing and chasing machines, presented in chronological tables indicating time of their development.

Le Père Fighter

The American Built Le Père Fighter. Aeronautics, vol. 16, no. 278, Feb. 12, 1919, pp. 178-179, 4 figs. Dimensions and weights.

PLANES

Ansaldo

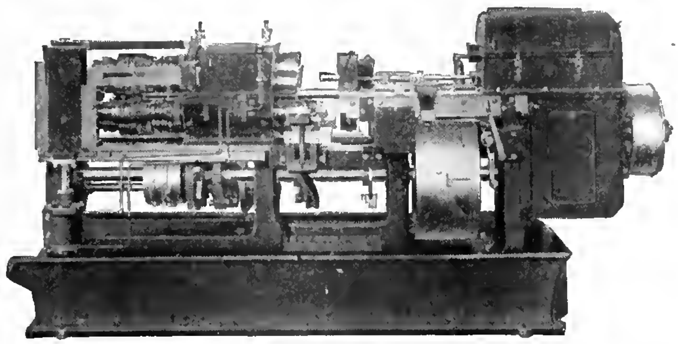
The Ansaldo Single and Two Seater Airplanes. Aviation, vol. 6, no. 4, Mar. 15, 1919, p. 223. Machine was designed with aim of including minimum head resistance and attaining maximum of efficiency. Italian type.

Bristol

Details of Bristol Aeroplane Types. Aeronautics, vol. 16, no. 280, Feb. 26, 1919, pp. 227-230, 6 figs. Fighter F.2B., with Rolls-Royce engine; triplane Braemer, with four Puma engines; fighter, single-seater scout, F, with Mercury engine; all-metal biplane, with Hispano-Suiza engine; and monoplane, M. 1. C., with Clerget engine.

Curtiss Triplane

The Curtiss Model 18-T Triplane. Aerial Age, vol. 9, no. 3, Mar. 31, 1919, pp. 154-155, 5 figs. General dimensions, areas, weights and performances.



F-W-L

F-W-L Navy Flying Boat—I, II, III. S. T. Williams. Automotive Industries, vol. 40, nos. 12, 13 & 14, Mar. 20 & 27, Apr. 3, 1919, pp. 634-637, 703-707 and 755-758, 25 figs. Twin-motored tractor biplane with total flying weight of 7 tons: cruising radius as a fighter, 10½ hours; normal crew four men. Details of hull construction; design and materials of various fittings; panel and strut layout. Details of engine mountings and fuel and oil tanks; gasoline supply system.

Handley-Page

The Handley-Page Type 0-400 Bomber. Aerial Age, vol. 8, no. 22, Feb. 10, 1919, pp. 1082-1083 and 1095, 4 figs. Dimensions, weights and equipment.

NC-1 Naval

The NC-1 Naval Flying Boat. Aerial Age, vol. 9, no. 2, Mar. 24, 1919, pp. 110-111, 5 figs. General dimensions, weights and performances; machine said to be one of largest ever built.

Packard

Packard's Commercial Sport-Type Plane. Motor Age, vol. 35, no. 10, Mar. 6, 1919, pp. 22-23, 4 figs., and Automotive Industries, vol. 40, no. 10, Mar. 6, 1919, pp. 531-534, 9 figs. Specifications of two-passenger biplane Packard company purposes to build and sell at $15,000. Line of three engines; plane designed to take eight-cylinder power plant. Calculated performance charts based on previous similar designs.

Pfalz

The Pfalz Single-Seater Fighting Aeroplane. Engineer, vol. 127, no. 3292, Jan. 31, 1919, pp. 95-97, 14 figs. Official record issued by the Aircraft Production (Technical) Department, Air Ministry.

Phoenix-Cork

Some Notes on the Phoenix-Cork Flying Boat. Aeronautics, vol. 16, no. 279, Feb. 19, 1919, p. 197, 1 fig., and Engineer, vol. 127, no. 3296, Feb. 28, 1919, pp. 194-196, 10 figs. Comparison with F3; performance during war; advantages claimed for this type are lesser weight and lower air resistance.

USD-9A

The USD-9A Airplane. Aviation, vol. 6, no. 4, Mar. 15, 1919, pp. 215-217, 6 figs. Data of machine, which is a two-seater tractor biplane.

Roland

Roland D VI Biplane (Le biplan Roland D VI). Aérophile, vol. 27, nos. 1-2, Jan. 1-15, 1919, pp. 10-11, 6 figs. Principal characteristics.

Siemens

The Siemens Type D IV Single-Seater Fighter. Flight, vol. 11, no. 53, Mar. 13, 1919, pp. 332-339, 14 figs. Elevations and plans; description of Siemens & Halske rotary engine in which cylinders and crankshaft rotate in opposite directions; record of climbing.

Touring

Peace Time Aeroplanes. Flight, vol. 11, no. 10, Mar. 6, 1919, pp. 323-324, 2 figs. Sketches of proposed side-by-side touring aeroplane.

RESEARCH

Altitude Engine Test Laboratory

The Altitude Engine Test Laboratory, P. M. Heldt. Automotive Industries, vol. 40, no. 10, Mar. 6, 1919, pp. 535-539, 8 figs. Installed for Advisory Committee of Bur. of Standards to make tests on aeroplane engines under conditions duplicating those met with when flying at high altitudes.

Atmospheric Conditions

Atmospheric Conditions affecting Power. A. Johnson. Aerial Age, vol. 9, no. 3, Mar. 31, 1919, pp. 166-167, 3 figs. Table showing density and pressure percentage at different heights and its use in calculation of engine power.

Tandem Planes

Experiments with Tandem Planes, Robert Gilbert Ecob. Sci. Am. Supp., vol. 87, no. 2256, Mar. 29, 1919, pp. 204-205, 3 figs. Langley tandem monoplane, Jeansen-Calliex tandem biplane, six-plane tandem models.

PROPELLERS

Graphs of Thrust and Horsepower

A Method of Approximating the Static Thrust and Brake Horse-Power of Air Propellers. W. Bernard Murphy. Aerial Age, vol. 9, no. 2, Mar. 24, 1919, pp. 114-115, 4 figs. Graphs of 2- and 4-bladed flat-faced sector screws.

TESTING

Radiators

Tests of Airplane Radiators, P. M. Heldt. Automotive Industries, vol. 40, no. 9, Feb. 27, 1919, pp. 479-483, 6 figs. Study by Bur. of Standards, bearing on head resistance, resistance to water flow and weight, all in relation to heat dissipated.

Rib Testing

Experimental Design and Testing of Airplane Ribs, George B. Fuller and Lessiter Milburn. Automotive Industries, vol. 40, no. 9, Feb. 27, 1919, pp. 456-460 and 489, 9 figs. Testing machine designed to distribute load as in flight.

Sand Testing

Sand Testing of Aeroplanes, Albert S. Heinrich. Aerial Age, vol. 9, no. 3, Mar. 31, 1919, pp. 158-160, 9 figs. Tests conducted at McCook Field on Victor advanced-training plane. (To be concluded.)

TRANSOCEANIC FLIGHT

Calculations

Civil Aerial Transport—Flying the Atlantic, G. Greenhill. Engineering, vol. 107, no. 2771, Feb. 7, 1919, p. 161. Calculations based on square sine law of Newton.

Transatlantic Route

A Proposed Aeroplane Route Across the Atlantic, William H. Hobbs. Flying, vol. 8, no. 3, Apr. 1919, p. 243, 1 fig. Via Newfoundland-Greenland-Iceland-Scotland.

Transoceanic Liners

Airships Practical for Commercial Use. Automotive Industries, vol. 40, no. 9, Feb. 27, 1919, pp. 461-463. Opinion is expressed that airships are valuable for transoceanic flight and that they can be supplemented by airplanes for short-haul work.

Possibilities of Airship Transport Services. Aeronautics, vol. 16, no. 279, Feb. 19, 1919, pp. 198-201, 5 figs. Scheme for service of transoceanic airship liners.

Marine Engineering

AUXILIARY MACHINERY

Compasses

The Navigational Magnetic Compass Considered as an Instrument of Precision, M. B. Field. Engineering, vol. 107, no. 2771, Feb. 7, 1919, pp. 187-192, 16 figs. Problem is studied from point of view of accepted theories concerning sources of error due to magnetic disturbances and the so-called permanent magnetism hammered into the ship in the course of building. Lecture before Inst. Elec. Engrs.

Evaporators

An Improved Method of Operating Evaporators, M. C. Stuart. Jl. Am. Sos. Naval Engrs., vol. 31, no. 1, Feb. 1919, pp. 63-96, 14 figs. Essential feature of method developed at U. S. Naval Eng. Experiment Station is production of fresh water at constant rate and in any desired amount within capacity of evaporator.

Luffing Cranes

4-Ton "Toplis" Luffing Cranes for Shipyards. Engineering, vol. 107, no 2772, Feb. 14, 1919, pp. 208-210, 4 figs. Example of application of this type of crane in a shipyard.

SHIPS

Boiler Mountings

Boiler Mountings, J. Purves. Mar. Engr. & Naval Architect, vol. 41, no. 498, Mar. 1919, pp. 193-195, 2 figs. Recent developments in marine-boiler-mounting design; suggestions for further safeguarding boiler. (To be continued.) Paper read before Liverpool Eng. Soc.

Cargo-Vessel Design

Speed, Dimensions and Form of Cargo Vessels, G. S. Baker and J. L. Kent. Engineering, vol. 107, no. 2775, Mar. 7, 1919, pp. 306-310, 4 figs. Economics of cargo ship propulsion so far as this is affected by speed and design of hull form; propulsive considerations in settling area of midship section; longitudinal distribution of displacement and type of level lines and body sections; notes on straight-frame ships, based upon test work carried out for British Government. Paper read before Instn. Engrs. & Shipbuilders in Scotland.

Cargo Vessels

Standard Sea-Going Cargo Vessel of 3,500-Tons Deadweight Built on the Lakes. Int. Mar. Eng., vol. 24, no. 4, Apr. 1919, pp. 206-207, 2 figs. Single-deck steamer of maximum Welland Canal size.

9,600-Ton Deadweight Cargo Vessel. Int. Mar. Eng., vol. 24, no. 4, Apr. 1919, pp. 200-203, 4 figs. Shelter-deck freighter designed by Federal Shipbuilding Co. for overseas trade; longitudinal framing adopted.

Specification for 4,300-Ton Steel, Screw, Cargo Steamships for Canadian Government Merchant Marine, Ltd. Can. Ry. & Mar. World, no. 253, March 1919, pp. 146-151, 5 figs. Dominion Government has ordered 45 steel screw cargo steamships aggregating 263,850 tons d. w. Of these 6 are to be according to specifications given in article.

"Robert Dollar" Type of Cargo Vessel. Int. Mar. Eng. vol. 24, no. 4, Apr. 1919, pp. 204-206, 2 figs. Designed by Skinner & Eddy Corporation, Seattle, Wash. to carry 8800 tons deadweight at sea speed of 11½ knots.

Concrete Ships

Economic Size of Concrete Ships, E. O. Williams. Engineering, vol. 107, no. 2772, Feb. 14, 1919, pp. 195-197, 1 fig. Writer discusses theory that disadvantage of weight of concrete ships compared with steel ships diminishes with increased size of vessels.

Stone Ships Cheaper than Steel. Mar. Rev., vol. 49, no. 4, Apr. 1919, pp. 190-191. Comparative costs of constructing and propelling concrete and steel tankers.

Diesel-Engined Motorships

American Diesel-Engined Motorship. Int. Mar. Eng., vol. 24, no. 4, Apr. 1919, pp. 208-211, 11 figs. Gear-reduction transmission applied to twin-screw wooden freighter equipped with high-speed Diesel engines.

Some Aspects of Large Diesel Cargo Ships, H. R. Setz. Int. Mar. Eng., vol. 24, no. 4, Apr. 1919, pp. 212-219, 6 figs. Steam and Diesel machinery installations compared.

Diesel Engines and the Merchant Marine. Mech. Eng., vol. 41, no. 4, Apr. 1919, pp. 377-378. Review of developments on Pacific Coast.

Electric Propulsion

Marine Electric Propulsion. Mar. Engr. & Naval Architect, vol. 41, no. 498, Mar. 1919, pp. 182-184. Development of system and conclusions in regard to operation from records of practice. Paper before Students' Section Instn. Elec. Engrs.

U. S. S. "New Mexico," Henderson B. Gregory. Sci. Am., vol. 120, no. 14, Apr. 5, 1919 pp. 340-341, 4 figs. General arrangement of engines and motor rooms in electrically propelled battleship.

Fabricated Ship

"Fabricated" and "Standardized" Ships, N L. Van Tol. Am. Mar Engr., vol. 14, no. 3 Mar. 1919, pp. 5-6. Outstanding points o question.

Ferryboats

Military French-English Ferryboats (Le ferryboats militaires franco-anglais) P. (Génie Civil, vol. 74, no. 8, Feb. 22, 1919, p 141-146, 16 figs. Plans, dimensions and pa ticulars.

Geared Turbines, Double Reduction

Double-Reduction Geared Turbines for S. "Merida." Engineering, vol. 107, no. 277 Feb. 14, 1919, pp. 207-208, 2 figs. Vessel cargo steamer carrying 9100 tons on draft 25 ft.

Mark Boats

A Mark Boat That Will Mark, Frederi K. Lord. Motor Boating, vol. 23, no. 4, A 1919, pp. 17-19 and 68, 4 figs. How to bu a 10-ft. scow-type boat.

Norwegian Freighters

2400-Ton S. W. Norwegian Steamer. Shbuilding & Shipping Rec., vol. 13, no. 11, M 13, 1919, pp. 311-312, 6 figs. Details of S. Modemi, built and engined by Bergens Mek iske Vaerksted.

Oil Tankers

Oil Tank Steamer of 10,100 Tons D. Int. Mar. Eng., vol. 24, no. 4, Apr. 1919, 196-198, 2 figs. Type of vessel authorized Shipping Board: cargo space divided up i 18 main and 8 summer oil tanks.

Standard 7,500-Ton Oil Tanker. Int. M Eng., vol. 24, no. 4, Apr. 1919, pp. 198-19 2 figs. Single-screw vessel designed for 11 k sea speed.

Parallel Middle Body

Effect of Position of Parallel Middle B Shipbuilding & Shipping Rec., vol. 13, no. 11, Mar. 13, 1919, pp. 317-319, 4 figs. Variation of shaft horsepower, propeller revolutions and

propulsive coefficient with longitudinal position of parallel middle body in a single-screw cargo ship. Abstract of paper before Am. Soc. Naval Architects and Mar. Engrs.

Shaft Alignment

Optical Method of Shaft Alignment. William Norris. Jl. Am. Soc. Naval Engrs., vol. 31, no. 1, Feb. 1919, pp. 56-62, 7 figs. Report of realignment of inboard propeller shaft U. S. S. Mississippi.

Stresses in Ships

Stresses in Ships, Sydney V. James. Jl. Western Soc. Engrs., vol. 23, no. 5, May 1918, pp. 356-376, 8 figs. Discussion of methods for determining principal longitudinal stresses and statement of results of application of such methods to study of ships of well-known type.

Submarines

On the Equilibrium of a Submerged Submarine (Note sull' equilibrio dei sommergibili in immersione), C. de Feo V. Rivista Maritima, vol. 52, no. 1, Jan. 1919, pp. 63-92, 7 figs. Mechanical laws involved in process of submerging and diagrammatic study of systems of forces acting on submarine while submerging and when fuly submerged.

Troopship

Twin-Screw Troopship of 13,000 Tons D. W. Int. Mar. Eng., vol 24, no. 4, Apr. 1919, pp. 192-196, 5 figs. Three-deck combined passenger and cargo vessel of 20,900 tons displacement on draft of 31 ft. 9 in.

Vibrationless Boats

A Vibrationless Cruiser. Motor Boating, vol. 23, no. 4, Apr. 1919, p. 20, 3 figs. Designed to travel at 24 miles per hour with tremble eliminated at 20-mile speed, and to go 500 miles without replenishing fuel.

YARDS

Alabama Dry Dock Co.

A Southern Shipbuilding and Repair Plant. G. F. S. Mann. Int. Mar. Eng., vol. 24, no. 4, Apr. 1919, pp. 251-255, 11 figs. Methods employed in yards of Alabama Dry Dock & Shipbuilding Co.

Australia

Australian Shipbuilding. Commonwealth Engr., vol. 6, no. 6, Jan. 1, 1919, pp. 187-190, 5 figs. Shipbuilding at Government dockyards, Walsh Island, N. S. W.

Carolina Shipbuilding Corporation

Carolina Shipbuilding Corporation. Int. Mar. Eng., vol. 24, no. 4, Apr. 1919, pp. 240-245, 7 figs. Yard erected for building Emergency Fleet vessels. Contract calls for twelve 9,600-ton cargo ships.

Concrete Shipbuilidng in England

Concrete Shipbuilding Work in England. Concrete Age, vol. 29, no. 4, Jan 1919, pp. 12-15. Account of shipyards on South Coast, where eighteen concrete vessels are in course of construction. From Times Eng. Supp.

Concrete-Vessel Building

Shipping and Shipbuilding. Indus. Australian & Min. Standard, vol. 61, no. 1580, Feb. 20, 1919, p. 323. Construction of concrete vessels. Developments in the United Kingdom.

Delaware Wooden Shipyard

Large Wooden Shipyard on the Delaware. R. R. Shafter. Int. Mar. Eng., vol. 24, no. 4. Apr. 1919. pp. 256-259, 7 figs. Shipbuilding corporation organized to build wooden ships for Emergency Fleet.

Federal Shipbuilding Co.

Yard of the Federal Shipbuilding Company. Int. Mar. Eng., vol. 24, no. 4, Apr. 1919, pp. 266-270, 10 figs. Steel shipyard with twelve launching ways built by subsidiary of U. S. Steel Corporation.

Ford Methods

Ford Methods in Ship Manufacture, Fred E. Rogers. Indus. Management, vol. 57, no. 4, Apr. 1919, pp. 289-295, 12 figs. Subassembling and unit erecting. (Continuation of serial.)

Foundation Co., New Orleans

Foundation Company's New Orleans Yard. Int. Mar. Eng., vol. 24, no. 4, Apr. 1919, pp. 237-239, 2 figs. General arrangement of yard.

Great Lakes Shipyards

The Great Lakes Engineering Works. Int. Mar. Eng., vol. 24, no. 4, Apr. 1919, pp. 281-288, 14 figs. Details of shipyards and engine-building plant.

Groton Iron Works

Groton Iron Works Shipbuilding Plant. Int. Mar. Eng., vol. 24, no. 4, Apr. 1919, pp. 247-250, 10 figs. Layout, construction of shipyard and methods for handling material.

Launching

Tides, Terrain and Temper Play Important Parts in Launcaing. Motor Boating, vol. 23, no. 4, Apr. 1919, pp. 28-29, 4 figs. How a small crew can easily and safely launch a heavy cruiser of moderate size.

Manitowoc Shipbuilding Co.

Manitowoc Shipbuilding Company. Int. Mar. Eng., vol. 24, no. 4, Apr. 1919, pp. 271-280, 19 figs. Increase of steel shipyards on Great Lakes to meet demands of sea-going tonnage.

Merchant Shipbuilding Corporation, Bristol

Fabricated Ship Construction at Bristol Yard. Eng. News Rec., vol. 82, no. 12, Mar. 20, 1919, pp. 557-561, 8 figs. General plan and layout of plate-and-angle shop of Merchant Shipbuilding Corp.

Milwaukee

New Shipbuilding Enterprise in Milwaukee, Arthur F. Johnson. Int. Mar. Eng., vol. 24, no. 4, Apr. 1919, pp. 262-265, 6 figs. Yard for construction of steel and concrete vessels.

Naval Engineering

The Achievements of Naval Engineering in this War. William L. Cathcart. Jl. Am. Soc. Naval Engrs., vol. 31, no. 1, Feb. 1919, pp. 1-45, 19 figs. Achievements of Bur. Steam Eng. during the war. Address at Annual Meeting of Am. Soc. Mech. Engrs., Dec. 1918.

New Orleans Canal

Shipyard on New Orleans Canal for Building "Unsinkables." Eng. News Rec., vol. 82, no. 9, Feb. 27, 1919, pp. 434-438, 6 figs. Plan and details. The unsinkable ships being built are of the Le Parmentier (French) type.

Newburgh Shipyard

Construction of the Newburgh Shipyard. Int. Mar. Eng., vol. 24, no. 4, Apr. 1919, pp. 231-236, 7 figs. Description of shipyards and of accomplishments during past year.

See also MECHANICAL ENGINEERING, Heat-Treating (Engine Parts).

TERMINALS

French Ports

French Ports and the War (Les ports francais et la guerre). Génie Civil, vol. 74, nos. 4 & 9, Jan. 25 and Mar. 1, 1919, pp. 73-74 and pp. 161-167, 6 figs. Organization of transport of coal across France to Italy. Description of Calais and Boulogne and notes on the traffic of these ports before and during the war.

New York-New Jersey Port

United Port of New York and New Jersey, Hjalmar E. Skougor. Freight Handling & Terminal Eng., vol. 5, no. 3, Mar. 1919, pp. 89-92. Recommends that States of New York and New Jersey be consolidated to form one state or that all such parts of these states as are immediately affected by comprehensive plan for port development be joined together to form either a separate state or a federalized district similar to the District of Columbia. Paper presented before Soc. Terminal Engrs.

Industrial Technology

Abrasives

Electrothermic Abrasives (Les abrasifs electrothermiques), Jean Escard. Revue Générale de l'Electricité, vol. 5, no. 5, Feb. 1, 1919, pp. 180-190, 5 figs. Origin, manufacture; properties, and uses.

Acetylene

Acetylene and Its Generation. Times Eng. Supp., vol. 15, no. 532, Feb. 1919, p. 75. Risk of explosion; effect of impurities in carbide.

Ammonia

The Synthesis of Ammonia at High Temperatures—III, Edward Bradford Maxted. Jl. Chem. Soc., vols. 115 and 116, no. 676, Feb. 1919, pp. 113-119, 1 fig. Formation of ammonia in single-phase, 50 cycle, 375-volt arc.

Ammonium Nitrate

The United States Ammonium Nitrate Plant, Perryville, Md. Chem. & Metallurgical Eng., vol. 20, no. 7, Apr. 1, 1919, pp. 320-326, 8 figs. Description of manufacture of ammonium nitrate by the double decomposition of Chilean saltpeter and ammonium sulphate; phases, their control and application; plant operations.

Antimony Salts

Antimony in the Textile Industry, E. R. Darling. Textile World Jl., vol. 55, no. 13, Mar. 29, 1919, pp. 31, 33 and 35. Values of the various salts in printing and dyeing.

Benzol

Benzol Recovery. Times Eng. Supp., vol. 15, no. 532, Feb. 1919, p. 72. Problem of distribution form gas works; cost of recovery.

Benzol and Phenols

Separation of Benzol and Extraction of Phenols in Gas Works of Paris and Suburbs (Le débenzolage et l'extraction des phénols dans les usines à gaz de Paris et de la banlieue parisienne), L. Lindet. Bulletin de la Société d'Encouragement pour l'Industrie Nationale, vol. 131, no. 1, Jan.-Feb. 1919, pp. 133-137. Principle of Paul Mallet apparatus consists in washing gas in a liquid less volatile than the one it holds in suspension and distilling resulting mixture.

Carbides, Silicides and Borides

Metallic Carbides, Silicides and Borides (Les carbures, borures et siliciures métalliques), Jean Escard. Revue Générale de l'Electricité, vol. 5, no. 9, Mar. 1, 1919, pp. 339-351. Concerning their industrial utilization, notably in metallurgical and chemical arts.

Charcoal

Manufacture of Charcoal as an Economic Measure, Helge Sylven. Sci. Am. Supp., vol. 87, no. 2251, Feb. 22, 1919, pp. 124-126, 5 figs. Utilization of lumber-mill waste. From West Coast Lumberman.

Chlorine

Commercial Uses of Chlorine, V. B. Kokatnur. Gen. Meeting Am. Electrochem. Soc., Apr. 3-5, 1919, paper 10, pp. 141-155. Classification of direct and indirect ways of possible utilization of chlorine.

Electroplating

Lay-out and Cost of Electro-Plating Plant and Equipment. Metal Industry, vol. 14, no. 10, Mar. 7, 1919, pp. 186-187, 1 fig. Tentative plans prepared for electro-plating and metal-finishing companies.

Enamels

Enamels for Cast Iron, Homer F. Staley. Jl. Am. Ceramic Soc., vol. 1, no. 10, Oct. 1918, pp. 703-709. Tin enamel and antimony enamel compositions.

The Relative Action of Acids on Enamels—III, E. P. Poste. Jl. Am. Ceramic Soc., vol. 2, no. 1, Jan. 1919, pp. 32-43, 9 figs. Tests of acid resistance undertaken by Sub-Committee on Enamels of Committee on Standards of Am. Ceramic Soc. Reference is made to previous investigation.

Fertilizers

Fertilizers, B. de C. Marchand. South African Jl. Industries, vol. 1, no. 16, Dec. 1918, pp. 1521-1529, 1 fig. Attempt to ascertain quantity of fertilizer of all kinds manufactured in the Union of South Africa. Seventh and concluding article.

Galvanizing

The Electro-Galvanising of Booster Cases, Adapters and Detonator Fuse Components, T. C. Eichstaedt. Metal Industry, vol. 14, no. 10, Mar. 7, 1919, pp. 181-182. Method developed by writer.

Modern Processes of Galvanizing Sheet Steel (Procédés modernes de galvanisation des tôles d'acier), Métallurgie, vol. 51, nos. 4, 5, 6, 8, 10 and 11, Jan. 22 and 29, Feb. 5 and 19, Mar. 5 and 12, 1919, pp. 173-174, 224-225, 279-280, 396, 520, 582-583; 1 fig. Tanks, baths, and manipulation: cleaning and scraping; losses; scheme showing arrangement of apparatus; relative cost of various processes; galvanizing tanks; operation of tanks. (Concluded.) From Iron Age.

Gas Industry

Medium Pressure, A. C. Howard. Gas Indus., vol. 19, no. 2, Feb. 1919, pp. 46-48. Distribution of booster system of Citizens Gas & Fuel Co. of Terre Haute.

Springfield Tests Indicate That Retort Life Is Increased by Steaming. Am. Gas Eng. Jl., vol. 110, no. 10, Mar. 8, 1919, pp. 211-213. Tests were made in connection with investigation by Mass. Board of Gas & Elec. Commission relative to adoption of calorific standard for gas.

Standard Gas. Engineering, vol. 107, no. 2775, Mar. 7, 1919, pp. 304-306, 3 figs. Tests performed and conclusions arrived at by Research Sub-Committee of Instn. Gas. Engrs.

Unusual Carbonizing Methods, James A. Brown. Gs. Jl., vol. 145, no. 2904, Jan. 7, 1919, p. 28. Difficulties encountered in operation of inclined ovens at Flint and Evansville, Mich. Paper before Mich. Gas Assn.

A ROW OF MOULDING MACHINES
If you could go through our plant and see the character and completeness of our facilities, you would instantly recognize why we can undersell and outpoint any of the ordinary methods of producing bronze bushings.

The reason we are large producers of bushings

In ever increasing numbers, manufacturers are coming to us for bushings because our selling prices are less than their cost of manufacture.

Because, through specializing, we have succeeded in producing longer wearing and more accurate bushings.

Because, by careful business management and volume operations, we meet any reasonable production time requirement. Practically every bushing user, to the extent of fifty bushings of a kind and over, benefits by our service.

We want you to test that last statement. Ask for quotations

The Bunting Brass & Bronze Co.
729 Spencer Street, Toledo, Ohio

BUNTING
BRONZE BUSHINGS AND BEARINGS
PATENTED

Principles of Gas Purification and Purifier Design, F. W. Steere. Gas Age, vol. 43, no. 6, Mar. 15, 1919, pp. 285-290, 8 figs. Regarding improvements in apparatus employed in removing sulphur from gas. (Continuation of serial.)

Gasoline

Gasoline from Natural Gas, G. A. Burrell. Petroleum Age, vol. 6, no. 3, March 1919, pp. 101-104. Types of plants; points concerning operation.

Greenstreet Cracking Plant, R. H. Kinnear. Petroleum Age, vol. 6, no. 3, March 1919, pp. 76-78, 5 figs. Details of method for making gasoline by cracking petroleum fractions.

Status of Refinery Practice with Regard to Gasoline Production, E. W. Dean. Automotive Eng., vol. 4, no. 3, Mar. 1919, pp. 114-115. Bureau of Mines suggestions in regard to increasing output of gasoline from a given quantity of crude oil.

Properties of Motor Gasoline—II, E. W. Dean. Automotive Eng., vol. 4, no. 3, Mar. 1919, pp. 132-134 and 147. Laboratory methods of testing gasoline and suggested specifications for motor gasoline.

Glass

Welding Glass (Notes sur le soudage des verres), Léon Appert. Bulletin de la Société d'Encouragement pour l'Industrie Nationale, vol. 131, no. 1, Jan.-Feb. 1919, pp. 67-91, 4 figs. History of operation; study of physical characteristics required and of phenomena taking place; classification and description of processes.

The Detection of "Ghosts" in Prisms, T. Smith. Sci. Am. Supp., vol. 87, nos. 2249 and 2245, Feb. 8 and 15, 1919, pp. 92-94 and 108-109, 20 figs. Method for developing optical prisms free from undesirable reflections. From Tran. Optical Soc. Lond.

Glues

Properties and Preparation of Glues. Mech. Eng., vol. 41, no. 4, Apr. 1919, pp. 382-386. Data on properties, preparation, classification, grading and testing of glues, strength of glued joints, etc., based on experimental work of Bureau of Aircraft Production.

Helium

Helium in Natural Gas, G. A. Burrell. Natural Gas & Gasoline Jl., vol. 13, no. 3, Mar. 1919, pp. 97-98. How helium is extracted for use in balloons and dirigibles.

Hydrogen

Hydrogen from Ferrosilicon. Iron Age, vol. 103, no. 10, Mar. 6, 1919, p. 608. French process for filling British dirigible balloons.

Lead Salts

The Sub-Acetate and Sub-Sulphate of Lead, Henry George Denham. Jl. Chem. Soc., vols. 115 and 116, no. 676, Feb. 1919, pp. 109-113. Lead sub-acetate obtained by action of acetic anhydride on lead sub-oxide at 195 deg. cent.; physical and chemical properties of substance.

Linoleum

History and Manufacture of Floor-Cloth and Linoleum, M. W. Jones. Jl. Soc. Chem. Indus., vol. 38, no. 3, Feb. 15, 1919, pp. 26T-31T. Account of development of industry in British Empire.

Mustard Gas

Continuous Vacuum Still for "Mustard Gas," Elford D. Streeter. Jl. Indus. & Eng. Chemistry, vol. 11, no. 4, Apr. 1, 1919, pp. 292-294, 1 fig. Apparatus constructed for continuous distillation of "mustard gas."

Development of Mustard Gas. Jl. Indus. & Eng. Chemistry, vol. 11, no. 4, Apr. 1, 1919, pp. 287-291, 3 figs. Commercial production of ethylene apparatus and plant procedure for absorption of ethylene gas and monochloride. Purification of product.

Nitric Acid

Concentration of Nitric Acid (La concentration de l'acide nitrique), M. Kaltenbach. Chimie & Industrie, vol. 2, no. 2, Feb. 1, 1919, pp. 142-152, 6 figs. Theoretical conditions; scheme of apparatus.

Nitrogen Fixation

The Present Status of Nitrogen Fixation, Alfred H. White. Jl. Indus. & Eng. Chem., vol. 11, no. 3, Mar. 1, 1919, pp. 231-237, 3 figs. Summary of processes.

Odors

An Investigation of Stenches and Odors for Industrial Purposes, V. C. Allison and S. H. Katz. Jl. Indus. & Eng. Chemistry, vol. 11, no. 4, Apr. 1, 1919, pp. 336-339, 3 figs. Apparatus and procedure. Paper read before Am. Chem. Soc.

Organic Chemistry

Future of Industrial Organic Chemistry, Harold Hibbert. Chem. & Metallurgical Eng., vol. 20, no. 7, Apr. 1, 1919, pp. 335-341, 2 figs. Review of industries depending on organic chemical development, such as food, clothing, fuel, drugs and arts.

Photography

A Wax Medium and Process for the Permanent Coloring of Photographs, A. Vernon Godbold. Sci. Am. Supp., vol. 87, no. 2248, Feb. 1, 1919, pp. 74-75. From British Jl. Photography.

The Yellowing of Paper, Alfred B. Hitchins. Sci. Am. Supp., vol. 87, no. 2257, Apr. 5, 1919, p. 222, 3 figs. Study of causes of principal factors producing deterioration. Contribution to Paper from Ansco Research Laboratory.

Pickling

Some experiments with Substitutes for Sulphuric Acid for Pickling, E. S. Thompson. Brass World, vol. 15, no. 3, Mar. 1919, pp. 79-80. Comparative tests on niter cake and sulphuric acid to determine their relative values as pickling agents on hot-rolled flange steel.

Porcelain

Note on Certain Characteristics of Porcelain, A. V. Bleininger. Jl. Am. Ceramic Soc., vol. 1, no. 10, Oct. 1918, pp. 697-702, 1 fig. Tests at Pittsburgh laboratory of Bur. of Standards.

Soap and Candles

The Manufacture of Soap and Candles, M. Rindl. South African Jl. Industries, vol. 1, no. 16, Dec. 1918, pp. 1487-1495. Raw materials and by-products of industry; development and present condition in South Africa.

Sulphuric Acid

Manufacture of Sulphuric Acid by the Chamber Process, George Crisp. Gas. Jl., vol. 145, no. 2907, Jan. 28, 1919, pp. 173-175. Outline of various operations in plant and chemical reactions in chambers. Paper before Midland Section of Coke Oven Managers' Assn.

Tar, Dehydration of

Dehydration of Various Tars, W. A. Twine. Gas Jl., vol. 145, no. 2912, Mar. 4, 1919, pp. 462-464, 2 figs. Operation of Mond gas-pitch plant and of dehydrating plant for carbureted water-gas emulsion. Paper read before Midland Junior Gas Assn.

Trinitrotoluene Residues

Trinitrotoluene Residues and Their Utilisation, Maurice Copisarow. Chem. News, vol. 118, no. 3065, Jan. 10, 1919, pp. 13-14. Derivation of iso-trolyte, liquid T.N.T., chloropicrin and sulphide dyes.

Water Gas

Operation and Chemical Control of Water Gas Sets in Small Plants, H. Vittinghoff. Am. Gas Eng. Jl., vol. 110, no. 8, Feb. 22, 1919, pp. 163-164. Concerning economical operation.

Operating a Water Gas Set Without a Relief Holder in Parallel with By-Product Coke Ovens, A. H. Harris. Am. Gas Eng. Jl., vol. 110, no. 9, Mar. 1, 1919, pp. 185-188, 5 figs. General layout of plant.

All-New Water Gas Plant Results at Providence, Wm. Russell. Gas Age, vol. 43, nos. 6 and 7, Mar. 15 and Apr. 1, 1919, pp. 277-282 and 364-366, 8 figs. Buildings consist of generator house, engine and pump house, washer house and purifying house. (To be continued.) Before N. E. Assn. Gas Engrs.

Railroad Engineering

BRAKES

Brake Tests

Report on the Automatic Straight Air Brake. Ry. Age, vol. 66, no. 13, Mar. 28, 1919, pp. 840-842. Tests of air-brake system of Automatic Straight Air Brake Co. of N. Y., conducted by Bureau of Safety.

ELECTRIC RAILROADS

Financial Condition

Electric Railways and Investors, Francis H. Sisson. Elec. Ry. Jl., vol. 53, no. 11, Mar. 15, 1919, pp. 506-608. Discusses financial condition of electric railways, which in writer's opinion is serious and has been aggravated by large wage awards. Paper before Am. Elec. Ry. Assn.

Narrow-Gage Railways

The Electric Railway of 0.60 m. Gage (Le chemin de fer électrique à écartement de 0.60m.), L. Esbran. Bulletin de la Société Française des Electriciens, vol. 9, no. 76, Jan. 1919, pp. 53-71, 4 figs. Steam locomotives vs. electric locomotives for 24-in. gage roads; transmission of power; construction of track.

High Power Electric Locomotives for Narrow Gauge Goods Trains. Elecn., vol. 82, no. 2128, Feb. 28, 1919, pp. 250-252, 5 figs. Comparison of various electrical locomotives. (Concluded.)

Single-Phase Locomotive, Swiss

The Single-Phase Locomotives of the Swiss Federal Railways and the New Oerlikon Locomotives (Las locomotoras monofásicas de los ferrocarriles federales suizos y nuevos tipos de locomotoras de los talleres de construccion Oerlikon). Energia Eléctrica, vol. 21, no. 2, Jan. 25, 1919, pp. 21-23, 2 figs. General features and dimensions of types—I-C-I and I-BB-I. (To be continued.)

ELECTRIFICATION

American

Some Possibilities of Steam Railroad Electrification, Calvert Townley. Elec. Rev., vol. 74, no. 12, Mar. 21, 1919, pp. 452-454. Plea for greater coöperation between railroad and electrical interests.

French

Partial Electrification of a Great Railway System (L'électrification partielle d'un grand réseau de chemins de fer), Revue Générale de l'Electricité, vol. 5, no. 11, Mar. 15, 1919, pp. 422-427, 4 figs. Economic considerations involved in electrification project of Cie. d'Orleans. Supplements article in issue of Nov. 16, 1918, p. 730. Paper before Société d'Encouragement pour l'Industrie Nationale.

EQUIPMENT

Dynamometer Car

Old and New Dynamometer Cars, London & North-Western Railway. Ry. Gaz., vol. 30, no. 8, Feb. 21, 1919, pp. 304-305, 4 figs. Mechanism consists of laminated spring having 30 flat plates, each separated from next by rollers; a cast-iron bracket is bolted on the spring and moves with it, so actuating traction pen, which registers amount of pull in tons on paper record.

Motor Inspection Cars

A New Rail Motor Inspection Car. Railway Gaz., vol. 30, no. 11, Mar. 14, 1919, pp. 489-490, 1 fig. Report of tests of Midland Railway Co.

LABOR

British

The Personnel of the Railway Engineer's Department Under State Control. Ry. Gaz., vol. 30, no. 7, Feb. 14, 1919, pp. 249-250. Writer, who claims 20 years' railroad experience, takes gloomy view of British railway nationalization.

LOCOMOTIVES

Adhesion

Locomotive Adhesion, H. C. Webster. Ry. Gaz., vol. 30, no. 10, Mar. 7, 1919, pp. 447-449, 2 figs. Analysis of variation in pressure between tire and rail; graph showing resistance to slipping per wheel against coefficient of friction.

Australian Locomotives

Australian Railways. Indus. Australian & Min. Standard, vol. 61, no. 1581, Feb. 27, 1919, p. 375, 2 figs. Australian types of locomotives.

Balancing

Balancing of Locomotives, S. H. Jenkinson. New Zealand Jl. Sci. & Technology, vol. 2, no. 1, Jan. 1919, pp. 19-28, 2 figs. Equations for balancing for various defined positions of balance wheels.

Consolidation

Large Consolidation Type Locomotive for the P. & R. Ry. Age, no. 12, Mar. 21, 1919, pp. 760-762, 2 figs. With tractive effort of 61,260 lb. and small drivers, they are adapted to heavy drag service.

Electric Locomotives

See Electric Railroads, above.

Powdered Fuel

Powdered Fuel Burning Apparatus for an Australian Railway. Ry. Rev., vol. 64, no. 12, Mar. 22, 1919, pp. 457-459, 4 figs. Details of 50-ton, 6-wheel switching locomotive operating on powdered fuel with Fuller engineering equipment.

Standard Heavy 2-10-2

Standard Heavy 2-10-2 Locomotive. Ry. Mech. Engr., vol. 93, no. 3, March 1919, pp. 119-123, 14 figs. Plans, sections and dimensions of heaviest Administration single-unit type.

Heavy Type Locomotive for Rock Island. Ry. Jl., vol. 25, no. 4, Apr. 1919, pp. 17-18, 2 figs. Details of 2-10-2 type, designed for load of 60,000 lb. on each pair of drivers and said to be capable of traversing 16-deg. curves.

MAINTENANCE

Car Inspection

Unified Inspection and Maintenance of Car Equipment, J. J. Tatum. Ry. Rev., vol. 64, no. 13, Mar. 29, 1919, pp. 473-474. Explanation of purposes of railroad administration in its efforts to standardize railway rolling stock and in establishment of uniform rules for maintenance of already existing equipment. Also in Ry. Age, no. 12, Mar. 21, 1919, pp. 773-775.

Labor-Saving Devices

30 Labor-Saving Devices or "Kinks" for Railway Maintenance of Way Work. Eng. & Contracting, vol. 51, no. 12, Mar. 19, 1919, pp. 288-290. Report of Committee on Labor-Saving Devices at convention of Am. Ry. Eng. Assn.

OPERATION AND MANAGEMENT

Freight Handling

Reducing the Cost of Handling Freight. Ry. Rev., vol. 64, no. 12, Mar. 22, 1919, pp. 453-454. 4 figs. Operation of N. Y. Central freight terminal in Cleveland.

Loading, Train and Engine

Train and Engine Loading, T. H. Williams. Proc. Pacific Ry. Club, vol. 2, no. 11, Feb. 1919, pp. 3-15 and (discussion) pp. 16-23. Definition and explanation of terms used in connection with train and engine loading.

Maximum Car Loading, Wm. H. McClymonds. Ry. Rev., vol. 64, no. 13, Mar. 29, 1919, pp. 474-475. Discusses advisability of keeping freight-car loads up to the maximum possible and consistent in the circumstances. Paper read before Pacific Ry. Club.

Railroad Problem

Compensation of Railroads Under Federal Control, J. M. Souby. Ry. Age, no. 12, Mar. 21, 1919, pp. 751-754. Writer believes that less than justice has been done by Administration in its interpretation of the law taking over the roads.

A Possible Solution of the Railroad Problem—II, F. J. Lisman. Ry. Age, vol. 64, no. 14, Apr. 4, 1919, pp. 883-889, 3 figs. Maps showing tentative combination of railway systems, indicating possibilities of combining strong and weak systems so that strong will easily be able to carry weak.

San Francisco

New Facilities to Eliminate Congestion in San Francisco, C. W. Geiger. Elec. Traction, vol. 15, no. 3, Mar. 15, 1919, pp. 177-180, 4 figs. Construction of extra tracks for relieving congestion at terminals of United RR. of San Francisco.

PERMANENT WAY AND BUILDINGS

Pearson's Permanent Way

Pearson's Patent Permanent Way, J. D. Pearson. Indian Eng., vol. 65, no. 7, Feb. 15, 1919, pp. 96-97, 7 figs. In principle it resembles longitudinal rail formerly used in 7-ft. gage. It provides continuous support for rail without use of transverse ties.

Rail Bonds

Conditions Govern the Choice of Rail Bonds, G. H. McKelway. Elec. Ry. Jl., vol. 53, no. 12, Mar. 22, 1919, pp. 591-592, 5 figs. Discussion of common types of rail bonds and their adaptation to conditions.

Surveys

Railway Right-of-Way Surveys and Descriptions, Ed. Thompson Wilkie. Can. Engr., vol. 26, no. 10, March 6, 1919, pp. 277-279, 1 fig. Suggests method of making right-of-way surveys. Presented at the Meeting of Assn. Ontario Land Surveyors.

Ties, Waterproofing

Waterproofing Railway Ties to Preserve Them, H. K. Wicksteed. Ry. Age, vol. 66, no. 13, Mar. 28, 1919, pp. 849-850. Method of treatment involves thorough drying and then sealing against moisture. Paper read before Can. Ry. Club.

RAILS

Conservation

Some Results of Rail Conservation, W. R. Dunham, Jr. Elec. Ry. Jl., vol. 53, no. 12, Mar. 22, 1919, pp. 562-565, 7 figs. Aligning of old rails and elimination of low joints.

Creep

Rail Creep and Expansion, E. Capone. Tramway & Ry. World, vol. 45, no. 13, Mar. 13, 1919, pp. 115-117, 8 figs. Anchors for conductor rails. Method for anchoring sleepers.

Specifications

Change in Rail Specifications Proposed. Iron Age, vol. 103, no. 13, Mar. 27, 1919, p. 819. Results of experiments on gagging and testing rails. Presented at Convention Am. Ry. Eng. Assn.

See also MECHANICAL ENGINEERING, Welding (Rail Joints, Thermic Welding).

ROLLING STOCK

Automobile Cars

Automobile Cars for the I. C. Ry. Mech. Engr., vol. 93, no. 3, March 1919, pp. 141-145, 12 figs. Design features of single-sheathed type of 80,000 lb. capacity.

Concrete Cars

Concrete Freight Car. Ry. Jl., vol. 25, no. 4, Apr. 1919, p. 25. Gondola type built for Illinois Central R.R. Claimed that tests of completed cars, both empty and loaded, demonstrated its practicability for rough service.

Gondola Car of Reinforced-Concrete Construction. Ry. Age, no. 12, Mar. 21, 1919, pp. 776-778, 3 figs. Design incorporating steel center sills with concrete floor, sides and ends.

Concrete Freight Car. Ry. Rev., vol. 64, no. 13, Mar. 29, 1919, pp. 475-476, 3 figs. Description of gondola-type car in which the body structure has been made of reinforced concrete resting upon and amalgamated with a steel center sill and body bolster assembly of usual form.

Freight Equipment

Freight Equipment as Handled Under Present-Day Interchange, T. J. O'Donnell. Official Proc. Car Foremen's Assn. Chicago, vol. 14, no. 5, Feb. 1919, pp. 78-87. Conditions, from mechanical standpoint, which determine selection and movement of freight cars.

Lighting, Electric

Electric Lighting of Railway Cars, B. H. Ehringer. Official Proc. Car Foremen's Assn., Chicago, vol. 14, no. 5, Feb. 1919, pp. 29-33 and (discussion) pp. 33-35. Ball bearings vs. brass bearings in lighting equipment, from point of view of maintenance.

Workshop Trains

60. Cm. Workshop Trains for France. Ry. Gaz., vol. 30, no. 4, Jan. 24, 1919, pp. 135-137, 8 figs. Each train (narrow-gage road) comprises generating car, two machinery cars, tool van, stores van and officers' car. Generating car is fitted with gasoline-electric generator sets in duplicate.

SAFETY AND SIGNALING SYSTEMS

Tunnel Signals

An Automatic Audible Warning for Tunnels. Ry. Gaz., vol. 30, no. 4, Jan. 24, 1919, pp. 141-142, 1 fig. Tube slung throughout length of Metropolitan Ry. 2200-ft. tunnel is struck by hammers actuated by electro magnets which train sets in operation on entering.

SHOPS

Forge Work

Buckles for Laminated Springs and Other Forge Work. Ry. Gaz., vol. 30, no. 4, Jan. 24, 1919, pp. 142-144, 5 figs. Manufacturing operation in forge department of a railway shop.

Locomotive Driving Boxes

Machining Locomotive Driving Boxes, M. H. Williams. Ry. Mech. Engr., vol. 93, no. 3, March 1919, pp. 155-159, 8 figs. Appliances designed to obtain accuracy and reduce time.

Superheater Locomotives

Shop Treatment of Superheater Locomotives, A. D. Williams. Railroad Herald, vol. 23, no. 3, Feb. 1919, pp. 67-69. Practice of Southern Pacific in converting saturated locomotives to superheated. From paper before Pacific Coast Ry. Club.

Welding

Spot Welding Railroad Tinware. Ry. Mech. Engr., vol. 93, no. 3, March 1919, pp. 151-153, 3 figs. Equipment used by I. C.

See also MECHANICAL ENGINEERING, Welding (Frog Shop; Tires, Welded).

TERMINALS

Akron

Modern Terminal in Akron. Elec. Traction, vol. 15, no. 3, Mar. 15, 1919, pp. 167-169, 4 figs. Prominent feature in arrangement of train shed with separate subway entrances to boarding platforms located between each pair of tracks.

Cleveland

New Plan for a Union Station at Cleveland, Ohio. Ry. Age, no. 12, Mar. 21, 1919, pp. 755-758, 5 figs. Suggested design for passenger station with a two-level street entrance. Also in Ry. Rev., vol. 64, no. 13, Mar. 29, 1919, pp. 469-472, 6 figs.

Glasgow

North British Railway Improvements at Glasgow, Frederick C. Coleman. Ry. Age, vol. 66, no. 13, Mar. 28, 1919, pp. 843-846, 6 figs. Layout of freight yard and warehouses. Said to be largest terminal in Scotland.

STREET RAILWAYS

Fares

Rate of Return in Service-at-Cost Franchises, Edwin Gruhl. Elec. Ry. Jl., vol. 53, no. 11, Mar. 15, 1919, pp. 502-505. Remarks that while commissions and courts have not established basis for fixing rate of return necessary to attract capital, nevertheless position of company, basis of fair value and various safeguards, all influence investor's demand. Before Am. Elec. Ry. Assn.

How the Public Feels About It. Elec. Ry. Jl., vol. 53, no. 13, Mar. 29, 1919, pp. 639-643. Opinions of representative public leaders of various classes regarding guarantee of return, aid through taxation, municipal vs. state ownership, and indeterminate franchise.

Car Lighting

Urban Rapid Transit Car Lighting, Clifton W. Wilder and Albert E. Allen. Tran. Illum. Eng. Soc., vol. 14, no. 1, Feb. 10, 1919, pp. 24-35 and (discussion) pp. 36-44, 16 figs. Study of problem in New York City, undertaken by writers in behalf of Public Service Commission.

Freight Traffic

Development of Freight Traffic on Interurban Lines, A. B. Cole. Elec. News, vol. 28, no. 6, Mar. 15, 1919, pp. 29-30 and 40. Considered in its relations to the law, the public, shippers, electric-railway operators, the traffic bureau, service, rates and facilities.

Maintenance

Maintenance Problems, Arthur C. Carty. Elec. Traction, vol. 15, no. 3, Mar. 15, 1919, pp. 184-186, 4 figs. Account of endurance of tramway for traveling 750,000 miles in 22 years.

Maintenance Practice of the San Francisco Municipal Railway, N. A. Eckhart. Elec. Ry. Jl., vol. 53, no. 12, Mar. 22, 1919, pp. 559-561, 3 figs. Results of five years of operation with reference to relation of construction to upkeep.

Maintenance of Door Operators, George E. Oakley. Elec. Ry. Jl., vol. 53, no. 12, Mar. 22, 1919, pp. 588-589. Writer outlines methods used for operating and controlling movement of doors and describes general methods used in inspection and overhauling of door apparatus.

Traffic Check

The Traffic Check and What It Showed on the Public Service Railway. Elec. Ry. Jl., vol. 53, no. 13, Mar. 29, 1919, pp. 644-648, 2 figs. Origin to destination check of passenger traffic, conducted during latter part of last year, and study of location of various traffic centers. Third article.

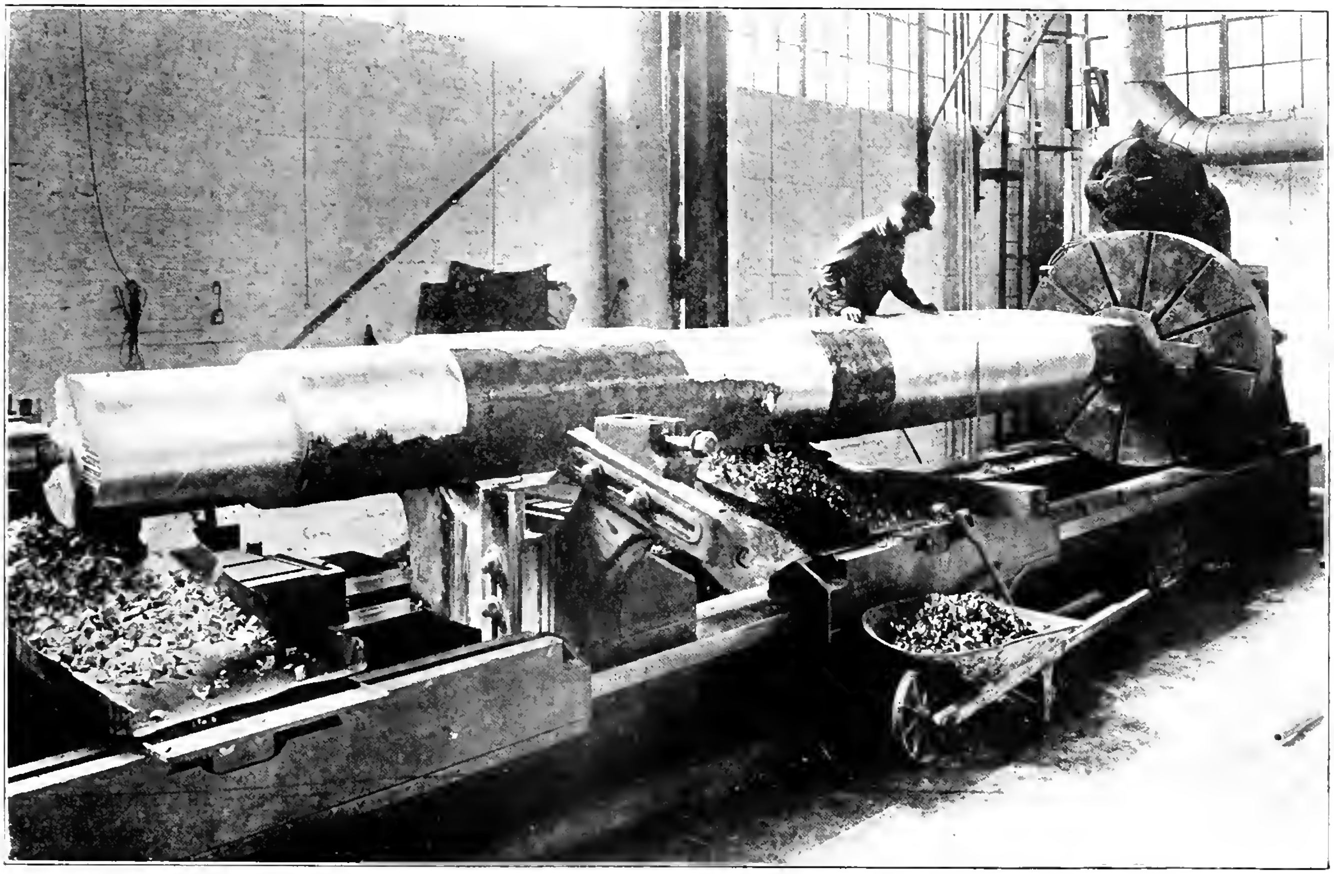
Troughwork

Troughwork and Other Protection, G. H. McKelway. Elec. Traction, vol. 15, no. 3, Mar. 15, 1919, pp. 172-176, 6 figs. Methods of installing various kinds of troughwork and protection for overhead structures and other construction above trolley wire.

Wartime, Europe

Continental Tramways in War-Time—II. Elec. Ry. & Tramway Jl., vol. 40, no. 961, Mar. 7, 1919, pp. 85-90, 2 figs. Repair shops of General Omnibus Co. and Metropolitan Railway.

CAMDEN



JUST AS

quick work is made of the ox going to the slaughter, so we secure speed in the machining of the

CAMDEN FORGINGS

made in our press and hammer shops.

We're well and largely equipped so that forgings ranging in weight from 100 to 60,000 pounds are all "Grist for our Mill."

Here are some of the things we make—

BUYERS' MEMO

High and Low Carbon Bars
Press Columns and Rams
Pull Back Cylinders
Water Cylinders
Valve Bodies
Plungers
Weldless Steel Rings
Lathe Spindles, solid and hollow bored
Long Feed Screws
Power Press Crank Shafts
Rudder Arms

Rudder Stocks
Cam Shafts
Eccentric Shafts
Crusher Shafts
Gear and Pinion Blanks
Locomotive: Side and Main Rods; Crank Pins; Axles; Rod Straps; Guides; Parts of frame both in iron and steel

Hammered Iron Bars for locomotive repairs
Marine Shaft
Marine Connecting and Eccentric, Rods
Rolls: Bending; Feed; Straightening; *Embossing*
Large Wrenches
Saw Arbors

Steam Engine Forgings
Pump Crank Shafts
Pump Connecting Rods
Large Nuts
Turbine Shafts
Mill Shafting
Trolley Car Axles
Electric Motor Axles
Any forging to your print, and specifications, in either iron or steel

CAMDEN FORGE CO.
CAMDEN, N.J., U.S.A.

Zone Systems

Zone System for New Jersey. Elec. Ry. Jl., vol. 53, no. 11, Mar. 15, 1919, pp. 523-528, 2 figs. Details of the petition of public service railways to Public Utility Commission.

How the Public Service Railway Established and Will Collect Its Zone Fare. Elec. Ry. Jl., vol. 53, no. 12, Mar. 22, 1919, pp. 598-604, 9 figs. Company proposes to put a ticket-issuing machine on front platform by which each passenger will receive a check indicating the zone in which he boards the car, then he pays the appropriate fare as he leaves by the rear platform.

The Zone Fare in Practice—Glasgow, Walter Jackson. Elec. Ry. Jl., vol. 53, nos. 10 and 13, Mar. 8 and 29, 1919, pp. 446-453, and 632-638, 15 figs. Layout of tramway system, service on different lines as regards speed and headways and application of graded fare. Second article. Mar. 29: Considers standard double-deck car, the make-up of schedules, the hours and rates of pay of transportation employees and the checking and auditing of the differential system of graded fares.

Munitions and Military Engineering

Aberdeen Ordnance Proving Ground

History of the Aberdeen Ordnance Proving Ground III, F. P. Lindh. Am. Mach., vol. 50, no. 13, Mar. 27, 1919, pp. 607-611, 4 figs. Development of railway artillery, meteorological work and airplane bombing. Concluding article.

Construction Division

The Construction Division of Our Army, George W. Fuller. Eng. News-Rec., vol. 82, no. 9 and 10, Feb. 27, and Mar. 20, 1919, pp. 416-419 and 562-564. Organization and work accomplished. Mar. 20: Details of organization; plea for continuance as independent unit of military establishment.

Trains, Armored

Armored Trains for Coast Defense. Engineer, vol. 127, no. 3294, Feb. 14, 1919, pp. 150-162, 6 figs. Engine is in middle of train, infantry vans on either side of engine, and gun carriage at ends.

Engineering Activities

Civil Engineering in the War, George K. Scott-Moncrieff. Times Eng. Supp., vol. 15, no. 532, Feb. 1919, pp. 65-66. Rapidity in erecting of construction work.

Engineering Achievements of the Army. Mech. Eng., vol. 41, no. 4, Apr. 1919, pp. 372-374, 5 figs. Activities in railroading, bridges, searchlights, map production and forestry operations.

Fire Control

On a New Application of Viscosity (Sur une application nouvelle de la viscosité), Georges Claude. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 5, Feb. 3, 1919, pp. 274-276, 2 figs. Apparatus utilizing viscous liquid for regulating firing of projectiles.

Gas Water

The Development Division, Chemical Warfare Service, U.S.A., F. M. Dorsey. Jl. Indus. & Eng. Chemistry, vol. 11, no. 4, Apr. 1, 1919, pp. 281-287, 8 figs. How development division developed gas masks for protection of American soldiers.

Production of Gas Defense Equipment for the Army, Bradley Dewey. Jl. Indus. & Eng. Chem., vol. 11, no. 3, Mar. 1, 1919, pp. 185-197, 20 figs. Plant, organization, divisions and operations involved in manufacture of gas masks.

Gun Manufacture

How the 155-Mm. Howitzer Is Made—VII, J. V. Hunter. Am. Mach., vol. 50, no. 13, Mar. 27, 1919, pp. 587-593, 23 figs. Methods used in producing breech mechanism, with reference to tolerances permitted.

Making the U. S. 75-Millimeter Field Gun, Erik Oberg. Machy., vol. 25, no. 7, Mar. 1919, pp. 624-630, 27 figs. Methods developed by Wisconsin Gun Co. in producing light field artillery. First article.

Manufacturing the 4.5-Inch British Howitzer III, J. H. Garrett. Machinery, vol. 13, no. 335, Feb. 27, 1919, pp. 589-596, 22 figs. Austin Motor Company's methods of production.

Gunnery

Notes on Gunnery, O. A. Randolph. Univ. Colo. Jl. Eng., vol. 15, no. 2, Jan. 1919, pp. 20-28, 6 figs. Classification of guns and projectiles; interior ballistics; factors which influence the trajectory.

Guns, Long-Range

A 121-Mile Gun, J. Bernard Walker. Sci. Am., vol. 120, no. 13, Mar. 29, 1919, pp. 312-313, 4 figs. Theoretical study of a 10-in. gun with a range of 121.3 miles.

Guns, Naval

Heavy Naval Gun is Given Field Mounting, C. M. McCrea. Iron Trade Rev., Vol. 64, no. 11, Mar. 13, 1919, pp. 707-709, 3 figs. Caterpillar mounting of 7-in. naval gun.

Illuminating Engineering

The Illuminating Engineer at War, George H. Stickney. Tran. Illum. Eng. Soc., vol. 13, no. 9, Dec. 30, 1918, pp. 439-447. Reviews work of society during war.

Monitors

The British Monitors, Engineer, Vol. 127, no. 3294, Feb. 14, 1919, pp. 143-145, 7 figs. Purpose and details of ships.

Mounts for Large Guns

Heavy Field Pieces with Mobile Mount, C. L. McCrea. Mech. Eng., vol. 41, no. 4, Apr. 1919, pp. 375-376, 1 fig. On design and construction of caterpillar mount of high-power 7-in. gun by Navy Bureau of Ordnance.

Railway Mounts for Large Naval Guns. Ry. Rev., vol. 64, no. 13, Mar. 29, 1919, pp. 477-480, 5 figs. History of organization, construction details and work of naval batteries in France.

Making Naval Gun Mounts, Franklin D. Jones. Machy., vol. 25, no. 7, Mar. 1919, pp. 600-605, 12 figs. Special tools, gages and fixtures used at the plant of the Mead-Morrison Mfg. Co. for construction of 1000 complete mounts for 4-in. guns for U. S. Navy. Second installment.

Munition Plants

How a Munitions Plant Was Built and Operated in Canada, Using Tons of Copper and Zinc Each Day. Brass World, vol. 15, no. 3, Mar. 1919, pp. 71-73, 3 figs. Organization work of Imperial Munitions Board.

Paravane

The Protection of Ships Against Mines. Engineer, vol. 127, no. 3297, Mar. 7, 1919, pp. 222-224, 5 figs. Arrangement of paravanes, or towed devices for cutting mine mooring wires, on a merchant ship. First article.

The Mysterious Paravane, William Washburn Nutting. Int. Mar. Eng., vol. 24, no. 4, Apr. 1919, pp. 289-293, 7 figs. How machine countered German mines.

Projectiles, Special

Curious Projectiles. Sci. Am. Supp., vol. 87, no. 2245, Jan. 11, 1919, pp. 28-29, 6 figs. Specimens of German and Austrian production, such as Gebauer projectile that discharges small shells to rear, Brust projectile for use on masked batteries, etc. From Science et Vie.

Psychological Service

The Measurements and Utilization of Brain Power in the Army. Science, vol. 44, no. 1262, March 7, 1919, pp. 221-226. History of psychological service; methods of measuring intelligence; summary of results. (To be concluded.)

Railway Troops

Work of American Railway Forces in France, O. C. F. Randolph. Ry. Age, vol. 64, no 14, Apr. 4, 1919, pp. 889-890. Review of problems encountered by Sixteenth Engineers in building transportation facilities.

The Canadian Railway Troops' Work on the Western Front, Herbert Forder. Can. Ry. & Mar. World, no. 253, March, 1919, pp. 117-120, 3 figs. Army organization with particular reference to duties and achievements of railway troops.

Shell Manufacture

Manufacture of Steel Shells (La fabrication des obus allongés en acier), Ch. Dantin. Génie Civil, vol. 74, no. 3, Jan. 18, 1919, pp. 41-45, 10 figs. Heat-treating process at Couzon foundry, near Rive-de-Gier (Loire). Other processes in manufacture of shells have been described in Génie Civil, vol. 72, no. 21, Nov. 20, 1915, p. 321.

Sound Detectors

Hunting Submarines with a Sound Detector, Brewster S. Beach. Sci. Am., vol. 120, no. 14, Apr. 5, 1919, pp. 335 and 353-354, 3 figs. Device which permits detection of direction of a sound by shifting it from one ear to the other. Also in Elec. Rev., vol. 74, no. 13, Mar. 29, 1919, pp. 500-505, 5 figs.

Supply Bases

The Boston Army Supply Base.—General Features of Project, Frederic H. Fay. Jl. Boston Soc. Civil Engrs., vol. 6, no. 3, Mar. 1919, pp. 67-76. Historical account of development.

The Boston Army Supply Base.—Construction Features, Charles R. Gow. Jl. Boston Soc. Civil Eng., vol. 6, no. 3, Mar. 1919, pp. 77-113, 31 figs. Warehouse, wharves, wharf shed, pier shed, power plant, administration building, railroads, roads and underground work.

The Boston Army Supply Base.—General Data, Charles M. Spofford. Jl. Boston Soc. Civil Engrs., vol. 6, no. 3, Mar. 1919, pp. 125-137. Purpose, location, area of site and buildings.

The Brooklyn Army Base. Freight Handling & Terminal Eng., vol. 5, no. 3, Mar. 1919, pp. 94-97. Considerations influencing selection of site and construction features.

Swords

On Japanese Swords (in Japanese), Kuiichi Tawara. Jl. Soc. Mech. Engrs., Tokyo, vol. 22, no. 54, Nov. 1918.

Training Engineering Officers

Training Officers for the Naval Auxiliary, Gregor S. Affleck. Wisconsin Engr., vol. 23, no. 6, Mar. 1919, pp. 202-205. Outline of six-months course intended for training engineering officers for auxiliary service in Navy.

Transport

Modern Armies and Modern Transport. Ry. Gaz., vol. 30, nos. 4 and 8, Jan. 24 and Feb. 21, 1919, pp. 123-124 and 295-298, 1 fig. Work of South-Eastern & Chatham Ry. during war, Feb. 21: War work of Great Northern and Lond., Brighton & South Coast railways.

See also MECHANICAL ENGINEERING, Handling of Materials (Shell Shops), Heat Treating (Gun Forge), Motor-Car Engineering (Military Chassis, Tanks); AERONAUTICS, Military Aircraft.

General Science

CHEMISTRY

Analysis

The Accurate Determination of Carbon Monoxide in Gas Mixtures, J. Ivor Graham. Jl. Soc. Chem. Indus., vol. 38, no. 2, Jan. 1919, pp. 10T-14T, 2 figs. Methods of determination by means of iodine pentoxide, based on reaction $5CO + I_2O_5 = CO_2 + I_2$.

Notes on Chemical Standards and Their Bearings on the Unification of Analysis, C. H. Ridsdale. Jl. Soc. Chem. Indus., vol. 38, no. 3, Feb. 15, 1919, pp. 15T-25T and (discussion) pp. 25T-26T. General study of discrepancies in chemical analysis, and writer's experiences on the prepartion and issue of analytical steel standards, both private and prepared on wider basis.

Colloids

The Degree of Dispersion of Colloids and Its Determination, George King. Jl. Soc. Chem. Indus., vol. 38, no. 2, Jan. 31, 1919, pp. 4T-7T. Ultramicroscopic methods of determining dispersion in colloids.

Properties of the Colloid State and Their Application to Industry, W. C. McC. Lewis. Jl. Soc. Chem. Indus., vol. 38, no. 2, Jan. 31, 1919, pp. 1T-4T. Holds Laplace's fundamental assumption in regard to field of attraction round a molecule as ineffective for explaining colloidal phenomena.

Flavoring Matters

The Chemistry of Flavoring Matters, François Barral. Sci. Am. Supp., vol. 87, nos. 2251 and 2252, Feb. 22 and Mar. 1, 1919, pp. 114-115 and 134-135. Relationship between constitution of a body and its taste. From Revue Scientifique.

Gas Reactions

The Influence of Temperature on Homogeneous Gas Reactions, George W. Todd. Lond., Edinburgh and Dublin Phil. Mag., vol. 37, no. 218, Feb. 1919, pp. 224-230. Deduction from Maxwell's distribution theory of an expression for the number of gas molecules per cc. having velocities greater than an assumed value.

Tungstic Oxide

The Reduction of Tungstic Oxide, C. W. Davis. Jl. Indus. & Eng. Chem., vol. 11, no. 3, Mar. 1, 1919, pp. 201-204. Result of experimental work.

Central-Station Heating in Detroit

By J. H. Walker,[1] Detroit, Mich.

This paper discusses the general problem of the utilization of the heat ordinarily discharged to the condensing water in a central electric generating station. The impossibility of its complete utilization for the purpose of heating buildings and the difficulties in the way of even its partial utilization are pointed out, with particular reference to conditions existing in Detroit.

The development of the central heating system of the Detroit Edison Company is traced, showing how the use of exhaust steam for heating was abandoned in favor of live steam. The reasons why it is more commercially expedient under the existing local conditions to supply live steam to the heating system and to generate all electric current in the condensing stations, are also fully brought out.

The latter part of the paper describes some interesting features of the central heating system in Detroit, such as the boiler plants, distributing system, underground construction of pipes and tunnels, consumers' installations and meters. Special mention is also made of the method of transmitting steam through feeders at high velocities and with large pressure drops.

The complete paper concludes with a discussion of the advantages of central heating service and of the obstacles to its wider use. It also points out the possibility of operating individual plants in combination with the central plant.

ONE of the natural results of the grouping together of human beings, in civilized communities is the existence, in our cities, of central plants for the generation and distribution of heat to surrounding buildings. The advantages of central heating service to the user, over the alternative of operating a heating plant in his own building are comparable to those accompanying any other public service. To the community, also, a properly operated central heating plant is a distinct asset, commercially and economically.

Started in a limited way about forty years ago, the central heating industry has grown steadily, though not with the rapidity of some other utilities, until at the present time there are between two and three hundred enterprises operating as public utilities in cities of all sizes in most of the northern states and doing an annual gross business estimated at from ten to fifteen million dollars. The capital invested is perhaps thirty to forty million dollars. As media for distributing the heat both hot water and steam are used, but because of the impracticability of metering hot water and because of the greater adaptability of steam to the requirements of the average building the trend of progress is toward the later. Further development of the business now hinges mainly upon the possibility of the establishment of the proper relationship between rates and the cost of service so as to insure adequate return upon invested capital. In many instances this relationship is not satisfactory at present, chiefly because the actual cost and the value of the service are not known. The engineering practicability has been amply demonstrated; and that there is a pronounced economic demand for the service is beyond question.

The central heating business is closely allied with the electricity supply business and in most cities is carried on directly or indirectly by the electricity supply companies. The task of supplying the demand for heating service falls quite naturally to the electric company because of the partial similarity in the methods of production and distribution of the two commodities; and because the ability to offer to its prospective customers both electric and heating service, with the consequent entire elimination of any sort of power plant from the customer's building, is of great advantage to an electric company doing business in a large city.

Other reasons for the combining of the two utilities are the economies in the consumption of fuel, and to some extent in the investment costs, which are sometimes made possible by the physical combination of the electric and heating plants.

The heat carried away by the condensing water in the central electric stations of the United States, equivalent to about 60 per cent of the total fuel burned by them, is one of the more obvious, although not by any means the greatest, wastes of the country's resources. Like many other similar losses this one exists, not because its reduction is theoretically impossible but because it is seldom commercially practicable. But although commercial considerations have always dictated certain practices in the utilization of fuel and will continue to do so in the future, the increasing cost

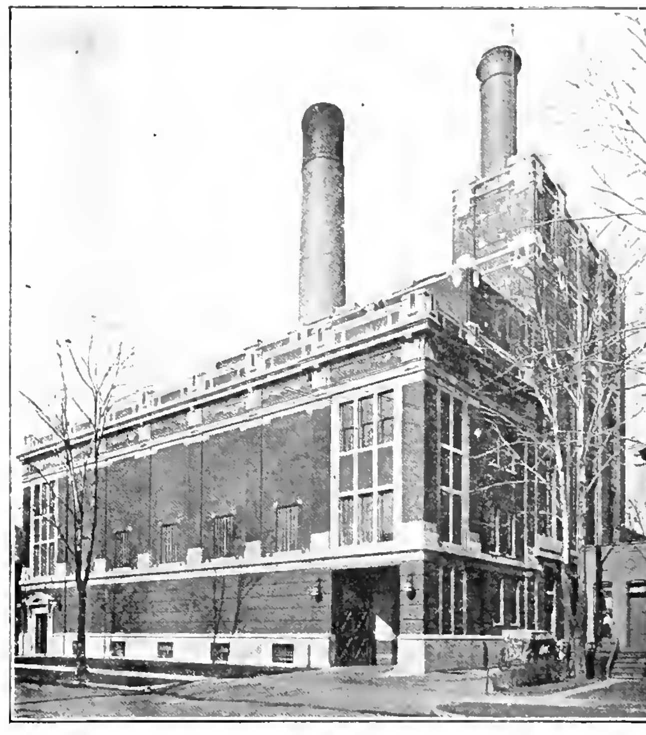


Fig. 1 Willis Avenue Central Heating Plant

of coal and the present impulse toward its conservation now direct attention to some of the fundamental problems involved.

This great quantity of heat, rejected at low temperature from the generating units, may be considered as a by-product of electricity supply and as such its rate of production will depend upon the rate of production of electricity, the primary product. The complete utilization of any by-product becomes possible only when an outlet for it exists or can be created. Moreover, since neither electrical energy nor heat can be stored to any great extent, it is necessary for the complete recovery of this by-product that the demand for it be equivalent, hour by hour, and day by day, to the rate of electricity supply. The warming of the interior of buildings is of course a natural means of utilizing this heat, but the great diversity in the rate of use of the two commodities renders impossible even an approximately complete realization of the theoretical economy. The lack of agreement in their use from week to week throughout the year is illustrated in Fig. 2, in which the 1918 load curves for electrical and heating service in Detroit are plotted to a percentage scale with the maximum point on each curve taken as 100 per cent.

The possibility of establishing a better relation between the rates of use is rather slight. The rate of heat supply is largely

[1] With Detroit Edison Company, Detroit, Mich.

For presentation at the Spring Meeting, Detroit, Mich., June 16 to 19, 1919, of The American Society of Mechanical Engineers. Contributed by the Detroit Section. The paper is here printed in abstract form and advance copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

fixed by unalterable climatic conditions. The use of electricity for lighting is also governed by natural elements. The demand for electricity for industrial use, which now constitutes a major fraction of the output of most central stations is not governed by these factors, and is the only kind of load whose characteristics could conceivably be adjusted to suit the requirements for exhaust heat and even this could probably not be done to any practicable extent.

Another important obstacle to the full use of this by-product heat through the warming of buildings is due to the great development of the central electric stations which in many industrial centers in the United States have so increased in size that the amount of exhaust heat which would be available as a by-product is greatly in excess of that which it would be commercially feasible to distribute

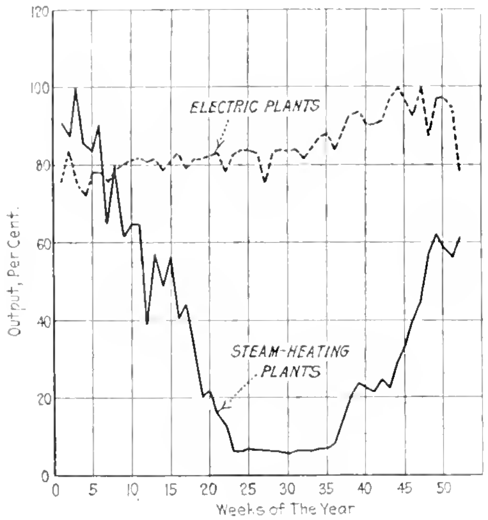


Fig. 2 Load Curves of Electric and Steam-Heating Plants

for the heating of buildings. For example, in 1918, the central electric-generating stations in Detroit produced approximately 774,000,000 kw.-hr. of electricity. The exhaust steam which would have been available if discharged at pressures above atmosphere and which could have been utilized for heating, considering the winter months only, would have amounted to over 9,000,000,000 lb. This is five times the quantity actually distributed in the existing central heating system of the city, which entirely covers the only portion of the city in which the heating load is sufficiently dense to render the laying of distribution mains commercially justifiable. For because of the great investment costs the distribution of heat by the medium of steam is feasible only in the districts of relatively great density of load, which, in most of our cities, comprise only the business district and the very best residence districts. Nor are the economies to be gained by using by-product heat sufficient to enlarge this area appreciably. The central heating business in the average American city could keep pace with the electricity supply business only if the density of population were far greater than is compatible with present standards of living.

Thus it is apparent that the exhaust heat from central electric stations can at best be utilized for heating only during the times when heat is required and then only in so far as it can be commercially distributed. But there are certain obstacles which stand in the way of its utilization even to this extent—obstacles which arise primarily from the difficulty of transmitting steam over long distances.

Systems of Central Heating

Assuming that a central heating load exists and is to be supplied by the electric company, there are in general three methods by which this can be done:

1 The heating load can be served from a condensing generating station so designed that steam is available for heating at pressures above atmosphere after partial expansion in the electric-generating units, the remainder of the steam used for current generation being fully expanded and condensed at high vacuum.

2 Separate heating plants may be built in locations near the heating load and equipped with non-condensing generating units which will generate current only to the extent of the requirements for exhaust steam for heating, the remainder of the electricity being produced in a condensing station.

3 The heating system may be supplied entirely with live steam from boiler plants located near the center of the heating load.

It may so happen that the natural location for the main generating station serving a city is near the heating load, and if this is the case, the first method is preferable. Often, however, a consideration of land values or of railroad connections requires that the main condensing station be located at such a distance from the heating load as to preclude the possibility of transmitting steam from it. This is the case in Detroit. The Delray plant and the Connors Creek plant, the two main generating stations operated by The Detroit Edison Company, are respectively $3\frac{1}{2}$ and $4\frac{1}{2}$ miles from the heating district. A condensing plant, located on high-priced land near the heating district and with inconvenient railroad connections, or none, would be necessary if this first method were to be used. To such a plant, built for electricity supply and consequently, for reasons previously stated, burning more coal than a plant built solely for heating, this matter of proper railroad facilities is particularly important. Here again enters the matter of the transmission of steam, for the size of the pipes required to transmit a given quantity of steam over a given distance decreases as the density of the steam and the amount of pressure drop along the pipe increase. The most economical method from the standpoint of investment costs would

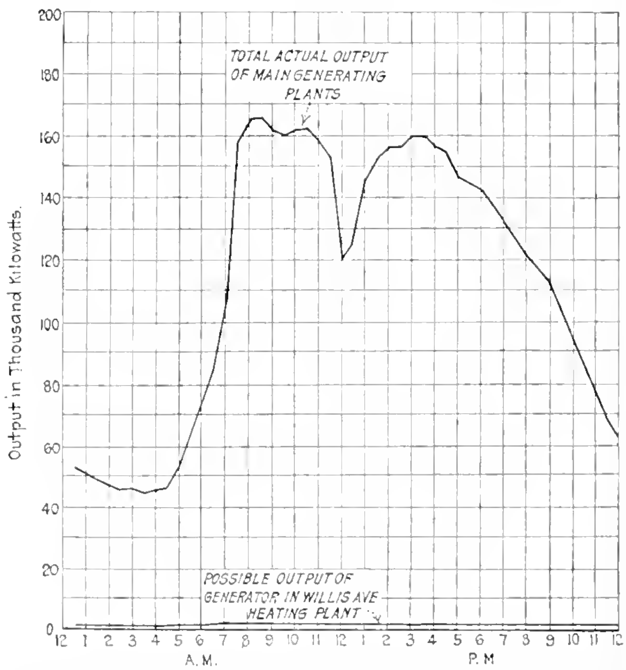


Fig. 3 Load Curves Showing Possible Electric Output of Heating Plant as Compared with Output of Main Station

be to extract steam from the high-pressure stages of the turbine; but the amount of electricity which could be generated per pound of steam would then be reduced.

In Detroit many of these conditions conspire to make the use of exhaust steam for heating unattractive. Generating units exhausting into the heating mains were operated in one of the heating plants for several years, but this practice has since been definitely abandoned and the heating system is now being supplied with live steam. Current generation is limited to the output of small house-service turbo-generators whose exhaust is utilized to heat the feedwater. The history of the central heating industry in Detroit is one of steady progress toward this method of live-steam operation.

Development of Central Heating in Detroit

The immediate motive which, in 1903, led to the establishment of the central heating industry in Detroit was the possibility of obtaining a high thermal efficiency in the generation of electricity through the utilization of the exhaust steam. The generating plant from which steam was first supplied for heating had previously discharged its exhaust to the atmosphere. Owing to the building, at this time, by The Detroit Edison Company, of a large condensing plant, the smaller plant, with several others, would have been shut down, but the possibility of selling the exhaust steam made it appear desirable to continue the generation of current there to the extent of the exhaust-steam requirements. Also, since the plant was located in a district served with direct current the loss involved in converting an equivalent amount of alternating current received from the main plant to direct current would be saved for such current as might be generated there. The plant was in a high-class residence district and the heating service proved very popular, but the actual overall economy of the plant was not as great as had been anticipated.

A year later the construction of a central heating plant was begun in the business district of the city. This second project was undertaken, not as a means of disposing of exhaust steam, but for the express purpose of supplying the demand for central heating service among the owners of downtown buildings who were considering shutting down their plants and purchasing electric service. The downtown plant was built primarily as a heating plant and though provision was made for electric generating units they were never installed and the heating mains were supplied with steam from the boilers through reducing valves.

With the development of the large condensing generating stations the generation of current in the heating plants grew less and less attractive and when a third heating plant became necessary because of increasing demand for steam heat no provision was made for electric generators. The same practice was followed when, in 1916, the original exhaust-steam plant was rebuilt; and when the steam distribution system of another company which had been engaged in the generation of electricity and the distribution of exhaust steam in the business district was purchased by The Detroit Edison Company the new plant which was built to supply this district was also designed as a heating plant only. The entire combined distribution system is now being supplied with live steam from the boilers through reducing valves.

Since there are no generating units exhausting into the heating system the pressure carried on it is not limited by considerations of back pressure. On those sections of the system formerly supplied with exhaust steam at from 2 to 5 lb. pressure, the pressure now maintained ranges from 5 to 15 lb. and is being increased from year to year, toward the upper limit permitted by the strength of the pipes. The pressure on the section originally designed as a live-steam system is about 30 lb. Because of the increased capacity of the distribution system at higher pressures, due to the greater density of the steam and the greater allowable pressure drop, these higher distribution pressures are desirable.

The steam is delivered to the network of mains through connections made at the plants and also through feeders, from the plants which deliver steam to certain feeding points in the distribution network, the method being similar to the feeder and main method employed in electric distribution systems.

Reasons for Using Live Steam in Detroit

The supplying of live steam to the heating system and the abandonment of the generation of current in the heating plants is commercially justifiable, even though such current would be generated at a high thermal efficiency. The underlying reason for this is that there exist certain unfavorable conditions which outweigh the thermal advantage and make the total cost of such current higher than the generating cost at the large and efficient main generating stations.

In considering the cost of generating current, when the heat in the exhaust is recovered, it should be borne in mind at the outset that the amount of coal consumed, though small, is not by any means negligible as compared to that consumed in a condensing station. For each kw-hr. so generated, there would be extracted from the steam, if the conversion were 100 per cent efficient, its heat equivalent 3415 B.t.u. Taking into account mechanical and electrical losses in the generating unit and the losses involved in generating steam from the coal, the actual number of heat units devoted to the generation of electricity is not less than 5700 B.t.u. per kw-hr. This is 27 per cent of the corresponding figure for the Connors Creek plant (a condensing station) which in 1918 generated its total output at an average of 20,900 B.t.u. in the coal per kw-hr. of output. So that at the outset, the additional fuel which would have to be burned in the heating plants if current were generated, would be over one-quarter of the amount required to produce the equivalent amount of current at the Connors Creek plant.

One of the principal elements of cost which militates against current generation in the heating plants is the attendant labor, which, because of the low load factor and small size of any generating units which might be installed there, makes the cost of this item per kw-hr. generated much higher than in the large stations where the size of the units and the load factor are much greater.

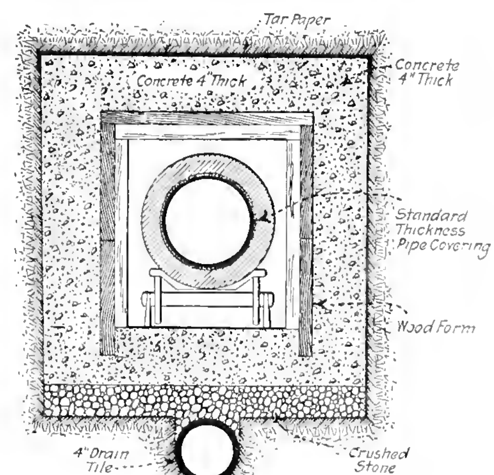


Fig. 4 Underground Steam-Line Construction

But the deciding factors are the investment charges. The change of policy involving the final abandonment of exhaust steam heating was made in 1916, with the rebuilding of the Willis Avenue heating plant, the original exhaust-steam plant. At this time the electrical load in Detroit was increasing rapidly and several new turbine-generator units were being purchased. At the Willis Avenue heating plant the existing and future exhaust steam requirements would have called for a generating unit of about 2000 kw. capacity. The unit purchased at the time for the Connors Creek plant was the 45,000-kw. machine which has since been put into service. Would the existence of small generating units in the heating plants, aggregating altogether possibly 4000 kw., actually reduce the number of machines in the Connors Creek plant at that time or at any future time, if the latter were to increase in steps of this magnitude? Regardless of theoretical considerations, as a matter of fact it actually would not have done so and it became clearly evident, therefore, that any investment in generating units in the heating plants must be reckoned as *additional* investment and the cost of any electricity generated by them must include the fixed charges on that investment and could not be credited with having saved any investment elsewhere. The relatively insignificant proportion of the total system load which could be born by a unit in the Willis Avenue plant is strikingly illustrated in Fig. 3.

The small size of the unit and its low load factor would make

these investment charges relatively high per kw-hr. generated. Furthermore, while the chief advantage of the heating plant generating units would lie in their ability to avoid conversion losses by generating direct current required for the downtown district, this advantage could not be completely made use of because of the lack of coördination between the heating and electrical loads of that district, which would make it necessary to convert some of the direct current back to alternating current for transmission to some other district or else would reduce the load factor of the unit.

For a quantitative economic study of the subject the Willis Avenue heating plant offers a favorable example, for it had been operated as a generating plant and the distribution mains had been designed for exhaust-steam pressures. Based on the performance of the old engine-driven units there would have been generated about 6,000,000 kw-hr. per year.

In accordance with the considerations which have been mentioned, the proposed turbo-generator installation should be

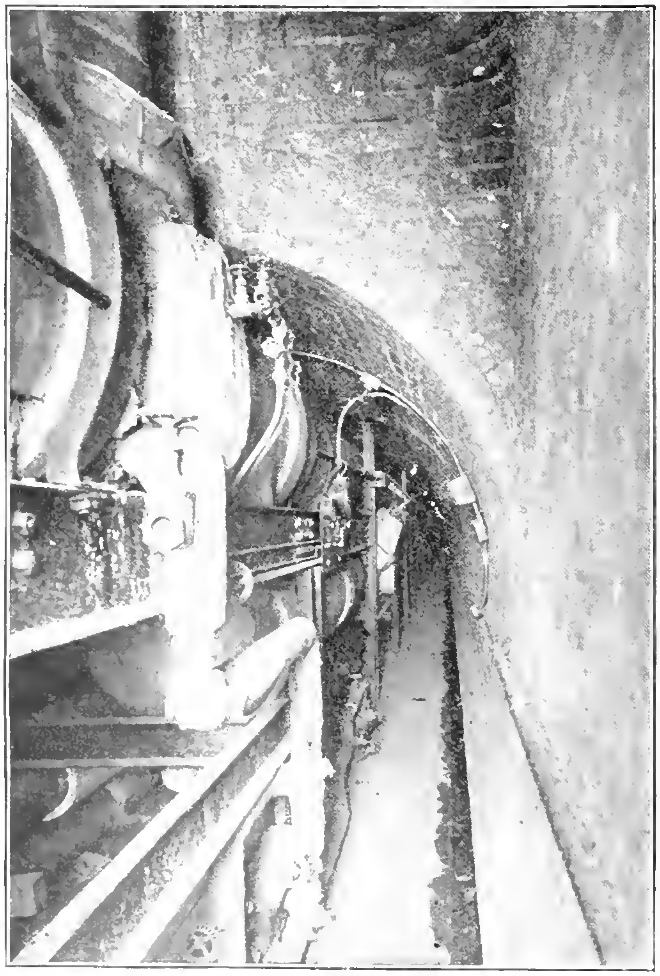


Fig. 5 Tunnel Construction for Steam Lines

charged with its operating and maintenance costs including, labor, supplies, and the fuel equivalent of the energy produced. It should also be charged with the fixed charges on the unit itself and on the building space occupied. Based on the fairly stable pre-war prices existing in 1916, these items might be conservatively estimated as follows, neglecting the disadvantage due to the lack of coördination between steam and electrical loads.

Charges Against Generating Unit (Operation and Maintenance):

Labor (3 oilers)	$3,360
Supplies, etc.	200
Fuel cost (1221 tons at $2.66)	3,247
Maintenance	200
	$7,007

Fixed Charges (Additional Items Only):

2000-kw. turbo-generator at $15 per kw.	$30,000	
Installation cost, wiring and piping	4,000	
Building and foundations	10,000	
	$44,000	
Depreciation at 4 per cent		1,760
Return on investment at 6½ per cent		2,860
Total charge against turbine		$11,627

The turbo-generator must of course be credited with the cost of generating an equivalent amount of energy at the main plant, of transmitting it to the heating plant district, and of converting it to direct current, since these costs would be incurred if the turbo-generator were not installed.

The production cost of electric current generated by a central station consists of two parts, the demand or "readiness to serve" component and the "energy" component. The former may be defined as that portion of the total production cost which would be incurred if no electricity were actually delivered, but if the plant were merely held in readiness to deliver the loads actually sustained, in other words, with steam pressure up, turbines and auxiliaries in motion, a sufficient number of boilers banked and the operating crew on duty. The energy component may be considered as that part of the total cost which is directly proportional to the amount of energy delivered. Although the exact separation of these components is impossible, the distinction between them is none the less real and is one that is generally recognized.

In the present case the heating-plant generating unit can be credited only with energy component, since it is not to be considered as having reduced the size or number of units in the main generating plant. The energy component may fairly be considered as including 75 per cent of the fuel cost, 50 per cent of the cost of maintenance of plant equipment and that part of the labor such as coal handling which may be considered as depending upon the amount of electricity generated, and amounting in this case to 9 per cent.

The actual combined efficiency of transmission to the heating plant district and of conversion to direct current is approximately 80 per cent, so that to deliver 6,000,000 kw-hr. of direct current to the heating plant district there would be generated at Connors Creek 7,500,000 kw-hr.

The credit which can be allowed to the heating plant for the current which it would generate would then be as follows:

Fuel—4112 tons at $2.38	$9,786
Wages	285
Maintenance	617
Total credit allowable	$10,688

This credit of $10,688 compared with the larger figure of $11,627 which is to be charged against the heating-plant unit, thus indicates that the generating of current in the heating plant would not be justified.

The foregoing study, however, is based only upon conditions in the plant itself and no mention has been made of the effect upon the distribution system when exhaust steam is distributed. It is common practice in exhaust-steam systems to carry a back pressure of from 2 to 15 lb. At these pressures the specific volume of the steam is high and the allowable pressure gradient throughout the system is very limited, making it necessary to install much larger pipes than is the case when live steam at higher pressures is used and consequently increasing the investment. While it is true that turbines have been built for exhaust pressures up to 30 lb., the electrical energy which can be extracted per pound of steam under such conditions is reduced and the cost per kilowatt of turbine capacity is increased; furthermore, in the method of feeder operation which is actually employed and which has proved of inestimable value, the pressure of delivery to the feeders is much higher than this.

The method of live-steam operation was adopted in Detroit before the recent great advance in the price of coal. The present high price of coal makes exhaust-steam operation appear somewhat more favorable and it is of course conceivable that at

some future date a very high coal price may compel a change of policy. But with the cost of underground lines also increasing, the saving in distribution investment will probably continue to be sufficient to justify a continuation of the present methods.

Most of the foregoing facts only apply in cases where the generating capacity in the heating plant is negligible in comparison with the main generating stations. If this is not the case, if the discrepancy in size is not great so that investment in the main plants is actually saved, or if the additional current required from the condensing station is actually not produced at a relatively low cost, then the situation may be entirely changed, and there are many instances of this in the United States. The consideration of the steam-transmission investment when low-pressure steam is used is usually controlling, however, and is being increasingly well recognized.

Boiler Plants

The four boiler plants in Detroit which supply steam to the heating system are equipped with water-tube boilers and underfeed stokers and are of modern design throughout. Their location in the central district of the city necessarily restricts the amount of land which they may occupy and demands a suitable type of architecture, absolutely smokeless operation, and extreme cleanliness in the handling of coal and ashes. Fig. 1 shows how these ideas have been carried out in the Willis Avenue plant.

The Congress Street plant, the newest of the four, is designed to eventually contain four 1300-hp. boilers and two 2600-hp. boilers of the "W" type. In the effort to reduce the amount of attendance labor at this plant the auxiliaries are located, for the most part, on the boiler-room floor so as to be within convenient reach of the few men constituting the operating crew. Coal is hauled from bunkers at the railroad sidings to the plant in drop-bottom buckets of 5 tons capacity, which are lifted by a crane and emptied into overhead hoppers from which the coal is distributed by belt conveyors to the boiler bunkers. Ash-handling equipment is practically nil, the boilers being set at sufficient elevation to allow wagons to be driven beneath the hoppers.

Because of the fact that only a relatively small amount of condensation is returned to the plants, careful treatment of the raw water is necessary. The feedwater flows through live-steam purifiers, operating at boiler pressure, in which the scale-forming materials are precipitated. In addition, sodium carbonate is fed in automatically graduated amounts to reduce the slight amount of hard scale-forming material which finds its way into the boiler. Although Detroit water is not a bad boiler water, these precautions are necessary because of the large percentage of make-up water and the rather high rates of steaming at which the boilers are sometimes driven.

The auxiliaries are almost entirely motor-driven. The current is supplied by a 750-kw. turbo-generator unit exhausting into an open feedwater heater. The load carried on this generator is adjusted according to the requirements for exhaust steam for heating the feedwater and any excess current generated is delivered to the outside electric-distribution system. Conversely, if the electricity requirements of the plant exceed the output of the generator, current is drawn from the outside supply. Exhaust steam is thus made available for heating the feedwater and the advantages of motor-driven auxiliaries are also secured. Moreover the turbo-generator constitutes a source of electricity supply for the plant in case of local interruption of the outside service.

Steam is generated at a pressure of 130 lb. gage. This pressure is chosen in order to provide for considerable pressure drops in the outgoing feeders as calculated for present conditions. It may be raised to 160 lb. at some future date. The outgoing steam lines leave the plant through a tunnel shaft.

Distribution System

The popularity of the heating service in Detroit has led to its development on an extensive scale. The present distribution system covers an area of about 2 miles long and half a mile wide which includes the entire central shopping, business, and financial districts and a small portion of the residence district. About 2,700,000 sq. ft. of radiation, besides numerous water heaters and cooking fixtures, are served. The distribution system contains about 20 miles of underground mains and 2 miles of tunnels. The four boiler plants which supply steam to the system contain 17,470 rated boiler hp., and they delivered in 1918 nearly two million pounds of steam to the system. Over 1700 consumers are served.

The distribution mains, though originally built in three distinct sections, are now a practically continuous network and the plants are so much interconnected that the load can readily be shifted from one to another. In spring and early autumn two of the four plants serve the entire area.

Because of the great increase in connected load the transmission capacity of the distribution network, most of which was installed several years ago, is now quite inadequate. To have raised the pressure throughout the system would have increased its capacity; but the system pressure was permanently limited

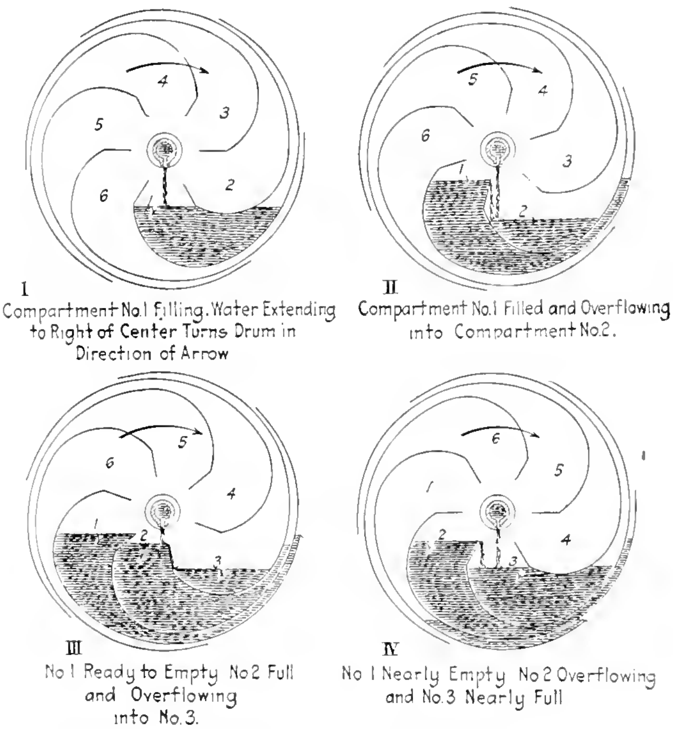


FIG. 6 CONDENSATION METER AND ITS PRINCIPLE OF OPERATION

by the fact that most of the underground fittings are of a low-pressure pattern, and temporarily by the fact that in those sections of the system formerly supplied with exhaust steam the customers' installations are not provided with reducing valves. Instead of attempting to change these conditions, which would have involved the reconstruction of much of the distribution network, the less expensive plan was adopted of running feeders from the plants to various centers of distribution. In selecting the pipe sizes for feeders, advantage is taken of the difference between boiler pressure and distribution pressure, and the size of the pipe is so chosen that at times of maximum load much or even all of this pressure drop will take place in the pipe itself. The diameter and the cost of the pipe line are thus materially reduced. In operation, the pressure of the steam delivered to the feeder is raised or lowered as required by the adjustment of a reducing valve at the plant, in order to maintain a constant pressure at the center of distribution which the feeder supplied. The pressure existing at this center of distribution is recorded at the plant by a long-distance gage, electrically operated.

The velocity of the steam flow in feeders at times of heavy load is very high. Velocities as great at 75,000 ft. per min. have

been measured. This high velocity does not appear to be at all objectionable, however, there being no apparent erosion of the pipe and no hammer, or objectionable vibration. The fact that the steam is in a superheated state because of the pressure drop is an advantage in these respects. Feeders are constructed with long radius bends and where the connection is made to the distribution mains the diameter of the pipe is gradually increased by special taper fittings so as to reconvert a portion of the velocity head to static pressure.

A considerable pressure gradient is also allowed to take place in the distribution mains as well as in the feeders; but this is relatively small, since the upper limit is fixed by the allowable working pressure of the older mains. The more recently laid mains are capable of withstanding a working pressure of 125 lb.

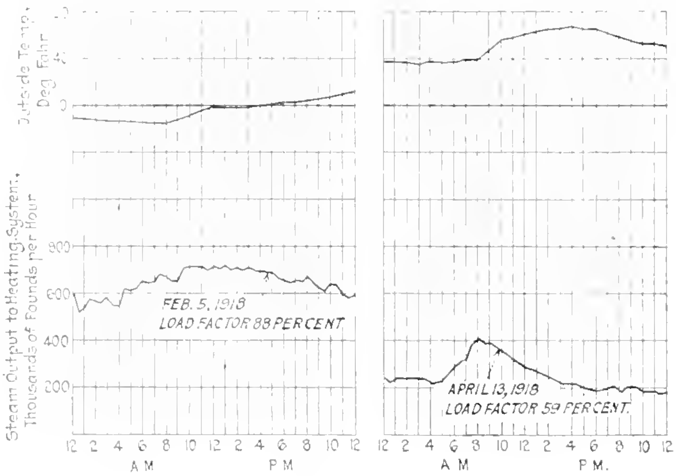


Fig. 7 Typical Load Curves of Heating System

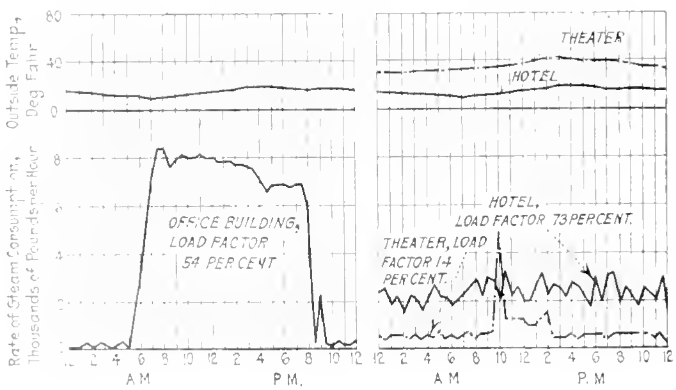


Fig. 8 Typical Load Curves of Individual Consumers

and the gradient in the mains can therefore be increased at some future date. From a standpoint of safety, however, the desirability of carrying pressures in excess of about 50 lb. on the service connections to buildings is questionable until further development in pressure-reducing apparatus is made.

This method of steam distribution is obviously an adaptation to previously existing conditions and would doubtless be modified if an entirely new system were being laid out.

Underground Construction

The distribution mains range in size from 20 in. near the stations to 4 in. at the outskirts of the system. The original underground pipes were laid in a segmental wood casing bound with wire. This construction has been fairly successful under favorable soil conditions, but the concrete conduit shown in Fig. 4 has been found to be superior in many respects and has been used exclusively for several years in all new construction. In this construction the pipe is insulated with a standard thickness of pipe covering and surrounded with an envelope of concrete poured over a wooden form, leaving an air space around the pipe. Proper underdrainage is of course essential.

The longitudinal expansion and contraction of the pipe, due to changes in its temperature, are absorbed, in the earlier construction, by means of expansion fittings of the copper-diaphragm type. In recent construction a slip joint, consisting of a brass sleeve, sliding in a packed gland, has been used. The use of slip joints decreases somewhat the cost of the pipe line as they will absorb more travel and can be placed at wider intervals than the diaphragm fitting.

The underground mains have not been laid sufficiently long to permit of an accurate estimate of their life. The oldest lines laid in wood casing have now been in service 15 years and, while the casing in many places has deteriorated considerably, in other places it is in fairly good condition. The concrete construction, dating back 10 years, seems to have deteriorated very little. The only repairs or replacements which have been made to date have been made necessary by external corrosion or pipe arising from some outside and local cause such as a water-pipe leak. An average life of 20 years for the wood-log construction and 30 years for the concrete construction would seem to be a very conservative estimate. Soil conditions in that part of the city where the heating mains are laid are particularly favorable, the soil being very well drained.

Manholes are located at intervals of about one city block (300 to 400 ft.), to house the slip joints, valves, and bleeder traps.

In the heart of the business district the pipes are in tunnels, of which there are about 2 miles, lying from 25 to 40 ft. below the street level. In cross-section they are similar to a horseshoe and are built of brick, with concrete floors. (Fig. 5.) For the most part they are about 6 ft. in height and 6 ft. wide. The tunnels are ventilated by suction fans which draw a small amount of air through them continuously and much larger amount when it becomes necessary for men to work in the tunnels. Their temperature ranges between 90 and 130 deg. fahr. When two of more pipes are to be laid under a street in a congested district it has proved desirable to build a tunnel to avoid the inconvenience to the public attendant upon tearing up the street, either for the original construction work or for subsequent changes. The tunnel permits of ready access to the pipes at any time, and since it is far below any other structures, no obstructions are met with. Tunnel construction is exceptionally simple in Detroit where the subsoil is a blue clay nearly impervious to water and well adapted to tunneling operations. The cost of tunnel construction is high but the advantages gained are compensatory.

Consumers' Installations

The consumer's equipment includes, besides the usual radiators and piping, a pressure-reducing valve, which reduces the service pressure to the lower pressure required for heating, and a trap whose function is to discharge the water of condensation from the system.

Any existing steam-heating system can be adapted for service by making a few minor changes. A hot-water system can be served with steam by substituting for the fuel-burning water heater a surface heater in which the water in the system is heated by the steam. A hot-air system can be adapted to the use of steam by substituting steam coils for the furnace and using the same duct system, though this is rarely done.

Economizer coils, utilizing the heat in the condensation, are recommended by the Company but not required. They are seldom installed in any but the largest buildings as few consumers see fit to make the necessary investment even though a demonstrated saving can be made. In some buildings the condensation is passed through a surface heater which preheats the water used for lavatory purposes, and this seems to be the most satisfactory form of economizer for large buildings.

The consumer's installation is the least reliable factor in the maintenance of uninterrupted and satisfactory service. Boiler plants can be and are designed and operated so as to be extremely

reliable. A distribution system, if properly laid out, with ample capacity and duplicate feeding routes, can be operated so that the steam supply to a building is practically never interrupted. But the consumer's piping system and the special appliances attached to it, operated by persons unfamiliar with mechanical apparatus, are a frequent source of trouble. Tagging of the valves to indicate their proper operation, distribution of printed instructions and other educational measures are employed with varying success, and the service is on the whole much more reliable than that obtained from the ordinary individual plant. A "trouble service" is maintained day and night to insure immediate attention to minor repairs and adjustments of consumers' equipment.

The regular heating season covers 8 months of the year, though summer service for cooking and water heating is supplied to a few consumers conveniently located. Cool weather in September usually makes necessary the commencement of service before the contract date of October 1. It has, in fact, been started in August. Steam was originally sold to some extent for power purposes but this service is now practically discontinued.

Meters

With the exception of a number of calibrated steam jets used in cooking fixtures, the steam is sold entirely on a condensation basis, the condensation flowing from the system through a meter and thence to the Company's return line or to the sewer.

The art of metering condensation was comparatively new when the Company commenced operations and although many advances have been made, it has not yet reached, and probably never will reach, the standards of reliability and accuracy of electrical metering. The troubles experienced are largely mechanical; but there are certain fundamental obstacles in the way of their entire elimination. The operating conditions, because of excessive temperatures, moisture, and dirt, are severe, and the allowable size and cost of the meter are limited.

The meter first used in Detroit was of the tilting type, consisting of a rectangular pan of two compartments hung on knife-edge or ball bearings, the compartments filling alternately and, when full, tipping the pan so as to bring the opposite compartment to the filling position. In 1907 a revolving meter was devised, consisting of a drum of four compartments which filled and dumped successively, the drum being revolved by the weight of the water. This meter was fairly successful and a few of that design are still in use, but a greatly improved design of revolving meter, operating on the same general principle, (Fig. 6) was originated in 1909 by Hans Resert and is being used at present, with slight modifications.

Load Characteristics

The daily boiler-plant load curves vary considerably both in magnitude and in shape with different outdoor temperatures. In moderate weather steam is used in many buildings only for a few hours in the morning, resulting in a decided peak at that time with a steady decrease in load throughout the remainder of the day. On the very coldest days, however, the heat is used continuously throughout the 24 hours, in most buildings, giving a daily load factor on such days of between 85 and 95 per cent. This is illustrated in Fig. 7. The monthly sales of steam are very closely proportional to the difference between 70 deg. fahr. and the average outside temperature. The annual load factor is about 35 per cent.

The load curves of the individual buildings show these same general characteristics although different types of buildings have markedly different daily load curves. In Fig. 8 are shown the load curves of three buildings of different types. The high peak, in the case of the theater was caused by the throwing on of the fan system. The steam in the office building was shut off at night, while in the hotel it was used continuously.

Detroit rates at the present time take no account of varying load factor, though this is done in some other cities in an approximate way. Possibly future progress in the art of metering will lead to the general establishment of rate schedules having a demand component as well as a consumption charge.

Fire Engines and Effective Fire Fighting

By CHARLES H. FOX,[1] CINCINNATI, OHIO

The importance of the fire engine and the methods employed in fire fighting are frequently underestimated by both layman and engineer, and this is due in no small part to the fact that the principles involved are not sufficiently understood. In this paper the author presents the essentials of effective fire fighting and shows the important relation thereto of the fire engine.

A brief historical sketch of the development of the fire engine is first given, and performances and methods of rating fire engines, as outlined by the National Board of Fire Underwriters, are next presented. The paper concludes with a discussion of the losses in fire hose and the design of nozzle areas.

STEAM power was not successfully applied to fire engines until the beginning of the year 1853. Up to that time the so-called "hand engines" were used exclusively, and it should also be understood that at that time the present-day system of water works was still in its infancy and therefore the chief dependence for a supply of water was upon methods of storage in vogue before water mains came into general use.

The conventional hand fire engine of that day comprised a rectangular wooden box suitably mounted on four low wheels. Pumps of the piston type were housed within, and since at this early period fire hose was not plentiful (the best was crudely made up of leather), the pumps were therefore placed close to the scene of the fire. Water, largely conveyed by a hand-to-hand passing of fire pails, was poured into the engine trough, where it was picked up by the pumps and forced through the leading hose and onward to be thrown on the fire. Somewhat later it became customary to equip these hand engines with a non-collapsible suction hose, so that water could be drawn directly from cisterns or wells, but the wooden tub or reservoir always remained a characteristic feature of these old-time machines.

Early Steam Fire Engines

Early in January 1853, Mr. A. B. Latta successfully tested his new steam-driven fire engine. Mr. Latta was a citizen of Cincinnati, and, although his pioneer effort resulted in the production of an extremely heavy machine, the engine was purchased by the city and known as the *Joe Ross*. This first steamer marked the beginning of a new epoch in fire fighting.

The real basic element of Latta's invention was embraced chiefly in a quick-steaming water-tube boiler, dependent entirely upon a forced circulation of water through the steam-generating coils. The fire pumps were of an ordinary piston type. They were laid horizontally and occupied positions forward on opposite sides of the machine. Two steam cylinders, in alignment with the pumps, were placed so that the pump rods extended to the steam pistons;

[1] President Ahrens-Fox Fire Engine Co. Mem.Am.Soc.M.E.

For presentation at the Spring Meeting, Detroit, Mich., June 16 to 19, 1919, of The American Society of Mechanical Engineers. Contributed by the Cincinnati Section. The paper is here printed in abstract form and advance copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

while the steam piston rods, passing through the rear cylinder heads, were each coupled to a crosshead and by the use of connecting rods motion was communicated to the two rear wheels of the engine. This arrangement obviously provided means for propelling the apparatus under its own power. As a matter of fact, however, the *Joe Ross* and later engines of similar model were always drawn by horses, as the rear driving wheels could be disconnected from the engine and the pumping mechanism by means of clutches.

Mr. Miles Greenwood, another of Cincinnati's public-spirited citizens and prominent as a manufacturer, was at that time greatly interested in fire-department affairs. He was a staunch advocate of anything which would improve conditions, and to further his unselfish aims he took personal charge and became chief of the department, with the result that, within three months following the installation of the *Joe Ross* engine, the fire-fighting forces were completely reorganized under his leadership and the first paid fire department was inaugurated in the city of Cincinnati. The year 1853, therefore, also marks the beginning of the present paid system, and which has since been extended and generally applied to all large fire departments.

Latta's second steam fire engine was built and installed in the year 1853. The purchase of this machine was made possible by popular subscription, and the engine was named and long known in Cincinnati as the *Citizens' Gift*. From the begnning, Latta's new industry did not result in a monopoly, for rival steam fire-engine builders were soon in the field. Before tracing the further development which followed, it seems proper to refer briefly to the salient factors associated with fire streams and the fire engine.

Essentials of Effective Fire Fighting

It may first be stated that many of the methods employed by fire departments are not properly appreciated, either by the layman or the engineer. The importance of the fire engine is frequently underestimated and the possibilities of averting disaster are also undervalued, this being due in no small part to the fact that the principles involved are not sufficiently understood. There is therefore need for greater knowledge of fire prevention and fire fighting.

When fire must be fought, fire streams can be effective only when the water is expelled from the nozzle at an appropriate speed. In other words, unless enough of the initial pressure available for starting the flow through the hose survives at a point immediately back of the nozzle orifice, the resulting jet will not measure up to its mission. The characteristics of a fire stream—good, bad or indifferent—are directly dependent upon the velocity of the jet, and obviously the velocity is proportionate to the surviving pressure just mentioned. For the best results the flow may be too slow, while on the other hand disappointment will follow when the velocity of discharge goes beyond what might be termed the maximum economical limits of nozzle pressure.

It can be shown that little is to be gained by forcing nozzle discharges at much beyond 100 lb. pressure, and the proper remedy when only such high pressures are available is to substitute a nozzle of larger bore. On the other hand, if the jet seems to lag, it is an indication that the surviving pressure is not high enough to afford the required velocity of discharge, and under these circumstances if the initial hydrant or pump pressure is already at its highest possible point, or if it is also impossible to augment the volume of water passing, then the proper remedy is to substitute a nozzle having a smaller bore.

It may be of interest in this connection to note that the range of nozzle discharge pressures is not large between a stream of inferior reach and the swiftest jet within the economical power limit. While it is true that larger nozzles will "carry" farther at the same velocity than nozzles of smaller bore, yet for practical purposes it will be found that the most efficient fire streams are developed under the following conditions:

A jet issuing at a velocity under 60 ft. per sec. (about 25 lb. pressure) would not be considered a good stream. Above 60 ft. per sec. the jet stiffens, and as the velocity of flow increases the stream becomes the more effective. However, when the flow attains a speed of approximately 120 ft. per sec., with a corresponding discharge pressure of nearly 100 lb. per sq. in., a point is reached where additional forcing fails to contribute much in the way of added distance.

Fire-Engine Performance

The function of a fire engine is either to draw water from any basin or other conveniently located source, or, when fire hydrants are available to make up the pressure which is seldom high enough in ordinary water mains to serve for effective fire service. In fighting fire, it is not uncommon to elevate the nozzle far above the source of the water supply. This procedure, of course, involves loss of forcing pressure, which is in proportion to the static head of the column. The greatest power-absorbing medium between the source of supply and the point of discharge is the fire hose. It may also be said that here is involved the point which is least understood in the subject of hydraulics as applied to fire-fighting practice.

Fire-engine pump pressures must necessarily be kept within limits compatible with the strength of the fire hose, and when working pressures are maintained at upward of 250 lb. there is always considerable risk, because the average fire department is not always supplied with hose which will safely withstand the high pressures which modern fire engines are capable of developing. The initial pressure as indicated at the pumps drops off steadily toward the point of discharge, and it should be well understood that all pressure which is not thus absorbed by the friction of the flow through the hose is finally manifested as velocity at the nozzle orifice. Hence, unless the several factors that enter are considered together it cannot possibly follow that the best results will be attained.

The preceding paragraph expresses the gist of fire-engine performance, and the variable features always associated with the work may be definitely stated as follows:

Pumping Capacity: The number of U. S. gallons discharged per minute—

$\left.\begin{array}{l} a \text{ At 120 lb.} \\ b \text{ At 200 lb.} \\ c \text{ At 250 lb.} \end{array}\right\}$ pressure registered at pump.

Water Supply: The source and adequacy of the supply—

d If at draft—height of lift represented by the vertical distance of water surface below center of pump intake

e If at hydrant—capacity as indicated by pressure registered when water is flowing.

[Note: High static pressure, as indicated when hydrant is not flowing, is no index to its capacity to discharge any required volume.]

The Layout: Conditions affecting the discharge are—

f Size and character of the fire hose
g Number of hose lines in use
h Lengths of hose stretched between engine and nozzle
i Number of streams played
j Bore and style of nozzles used
k Elevation at the point of discharge.

During a long period manufacturers of fire engines were unrestricted as to the ratings which they assigned to their machines, and when "gallons per minute" were given, no definite discharge pressures were associated with the expressed pumping capacity. In pumping tests, the actual discharge was seldom checked or verified, with the result that comparisons of fire-engine performance were more a matter of guess than of accurate determination. This condition, however, no longer obtains, and the change is largely due to the exacting supervision initiated and persistently pursued under the auspices of the National Board of Fire Underwriters. A corps of expert engineers is constantly in the field for the purpose of investigating and keeping in touch with the fire-fighting situation in all cities, and pursuant to this policy of the insurance interests, it is now generally known what may be expected of fire engines when new and in prime condition, and periodical inspections disclose weaknesses subsequently developed in service.

According to the standards formulated by the National Board of Fire Underwriters in addition to the normal rating of a fire engine, expressed in gallons per minute, there must also be suffi-

cient power to expel the rated volume of discharge at a pressure of not less than 120 lb. per sq. in. Inasmuch, however, as certain situations may demand higher initial pressures, the pumps must also be so related to the attending power plant that higher pressures can be realized. Therefore further qualifications are demanded, as follows: One-half the rated capacity should be discharged by the pumps at 200 lb. pressure and one-third the capacity at 250 lb. pressure. Furthermore, fire engines should not be limited to 250 lb. pressure, for the fire departments of our large cities are confronted with the so-called "sky-scrapers," and when water must be forced to their upper floors, the overcoming of the static head alone greatly lowers the effective pressure.

However, when the power of an engine is fully utilized in forcing water to extinguish fire in a lofty building the work and the consequent strains are perfectly legitimate. On the other hand, when pressures much in excess of 250 lb. are employed simply to overcome resistance, which could be reduced by a more intelligent use of hose and nozzles, then the work evidently represents not only a waste of power, but also very bad practice.

Losses in Fire Hose

A good engineering axiom to observe is that all work should be accompanied with the least expenditure of force, and the aim here is to express the fact that many firemen have yet to learn how to smooth their own way. The point can best be illustrated by an example.

The inside diameter of fire hose ordinarily used is 2½ in. Cotton-jacketed, rubber-lined hose is the most common kind and lengths of 50 ft. (each such length constituting a section) are the recognized standard. The conventional way of expressing friction loss, or the loss pressure when water is flowing through the hose, is in terms of pounds per square inch for a unit length of 100 ft. for any given rate of flow stated in gallons per minute. This drop in pressure or so-called friction loss varies somewhat with quality or make-up of the hose; varying diameters and the fact that some makes of hose present a smoother waterway than others are also causes which prevent formulating a coefficient which can be applied to all kinds of 2½-in. fire hose and by which friction losses can be predetermined with precision.

It therefore follows from the foregoing statements that all tables setting forth friction loss in fire hose should be accepted only as close approximations, and in actual practice the results may therefore not agree. However, within the range of velocities and the lengths of hose ordinarily encountered in actual service, it has been found that for water flowing through 100 ft. of average good quality 2½-in. rubber-lined and cotton-jacketed fire hose, the friction loss will be about 14 lb. when the rate of the flow represents 250 gal. per min. Accepting this approximation as a basis, it must also be kept in mind that the friction loss increases in direct proportion to the length of the hose; hence, for the same rate of flow (250 gal. per min.) through 200 ft. the total loss would be twice as much as indicated for 100 ft.

The effect of varying the rate of flow follows a different and more intricate law, the friction loss increasing more nearly in proportion to the square of the flow. Therefore, if the loss per 100 ft. is 14 lb. when 250 gal. are flowing, it will be quite correct to assume that it will require nearly 2×2, or four times as much pressure, i. e., 56 lb. to discharge 500 gal. through 100 ft., 112 lb. through 200 ft., etc. Stated as a formula,

$$L = 0.00023G^2$$

where L is the friction loss per 100 ft. of 2½-in. rubber-lined, cotton-jacketed fire hose of good quality, and G is the flow in gallons per minute. The results obtained by using this approximate formula agree closely with those in the tables compiled by Mr. John R. Freeman, which appear in Fire Stream Tables, issued by the Inspection Department of the Associated Factory Mutual Fire Insurance Companies, Boston, Mass.

The red book, Fire Engine Tests and Fire Stream Tables, published by the National Board of Fire Underwriters, New York, gives the formula,

$$L = 2Q^2 + Q$$

in which L represents the friction loss, as before, and Q the volume flowing in gal. per min. divided by 100. Mathematical precision is always laudable, but in action firemen could hardly be expected to work out problems other than such as might readily be solved mentally. However, while extreme accuracy is entirely unnecessary in fire fighting, it would seem altogether feasible that fire engines could be set to work with hose layouts arranged with nozzles compatible with the general conditions of a situation, so that the efficiency latent in modern apparatus and appliances would be more frequently realized.

A close approximation, reasonably well gaged according to a correct and definite line of reasoning, is preferable to merely a guess or no system at all. Given sufficient study, the difficulties of apparently intricate hydraulic formulæ will vanish most surprisingly, and the real need today is for a greater cultivation of mental capacity to the end that commanding officers in the fire service become especially proficient in obtaining the best possible results with the apparatus at their disposal.

Nozzle Areas

It will be evident from what has been presented that the characteristic of a fire stream develops according to the following interlocking factors:

a The pressure which survives at the nozzle
b The volume of water reaching the nozzle
c The relation of the nozzle bore to *a* and *b*.

The difficulties which attend in the existing system of nozzle bores are largely due to the fact that the diameters vary after the order of ordinary machine-shop reamers, i.e., ⅞ in., 1 in., 1⅛ in., 1¼ in., and it therefore follows that the areas of the orifice have increments which increase in arithmetical progression.

A more logical system has long been proposed, wherein the nozzle orifices would be multiples of a fixed standard. In accordance with this method it was suggested that the 1¼-in. nozzle, a size now most common, be designated as "100 caliber." Other nozzles in the same system would be made with orifices of such areas that the water-discharging capacity at the same pressures would be respectively as the caliber number by which each is to be distinguished. Therefore, instead of nozzles measuring ⅝, ¾, ⅞, 1, 1⅛, 1¼, 1⅜, 1½, 1⅝, 1¾, 1⅞ and 2 in. in diameter, the caliber system would leave the ⅝- and 1¼-in. sizes as before, calling these 25 and 100 calibers, with others, to cover practically the same limits, but with fractional bores arranged in multiple, such as 25, 50, 75, 100, 125, 150, 175, 200, 225, 250, 275 calibers. Table 1 gives these proposed caliber values in more detail, and for a complete discussion the reader should consult Caliber of Fire Streams, Report of Transactions of the International Association of Fire Engineers, 1911.

TABLE 1 CALIBER SYSTEM OF STANDARD FIRE STREAMS

Devised and Proposed by Charles H. Fox

Caliber Value	Area, Sq. In.	Diam. of Bore, In.	Nominal Diam., In.
25	0.3068	0.625	⅝ Exact
50	0.6136	0.883	⅞ plus 0.008
75	0.9204	1.082	1 1/16 plus 0.019
100	1.2272	1.250	1¼ Exact
125	1.5340	1.397	1⅜ plus 0.022
150	1.8408	1.530	1½ plus 0.030
175	2.1476	1.652	1⅝ plus 0.027
200	2.4544	1.767	1¾ plus 0.017
225	2.7612	1.875	1⅞ Exact
250	3.0680	1.976	1 15/16 plus 0.039
275	3.3748	2.072	2 1/16 plus 0.010
300	3.6816	2.165	2⅛ plus 0.040
325	3.9883	2.252	2¼ plus 0.002
350	4.2951	2.337	2 5/16 plus 0.025
375	4.6019	2.420	2⅜ plus 0.045
400	4.9087	2.500	2½ Exact

Note:—The true basic caliber unit is the area of a circle ⅛-in. in diameter, viz., .012271875.

THE RETURN OF THE ELEVENTH ENGINEERS

After 22 months of service over seas the famous Eleventh Regiment of Engineers, which made a glorious record at Cambrai, returned to America, and on April 30 marched down Fifth Avenue in final review, 1300 men strong. Col. Wm. Barclay Parsons and his staff, accompanied by Lt. Col. William T. Chevalier, headed the parade and the regiment was reviewed by Governor Smith, Mayor Hylan and other prominent men. Following the parade a dinner was tendered by the Military Engineering Committee and thus was brought to a fitting close the career of the Eleventh Engineers in the Great War.

This is the regiment which was recruited by the Military Engineering Committee of the Engineers' Club of New York, with which in this effort the National Societies of Civil, Mechanical, Mining and Electrical Engineers coöperated. Recruiting began before war was declared, for the purpose of forming a reserve regiment of engineers, and the Eleventh Engineers proved to be the first step toward the organization of the National Army.

The deeds of the Eleventh Engineers have been followed with the greatest interest by engineers throughout the country and the following abstract of a recent article in the New York *Evening Post* by Col. Wm. Barclay Parsons gives a brief history of "the Fighting Engineers."

Sailing on the *Carpathia* from "an Atlantic port" in the middle of July, the regiment arrived at Plymouth and was promptly ordered to a camp at Borden, in the Aldershot district. On July 18, it was reviewed by King George, having the honor of being the first American unit to be reviewed by a King of England.

Our training at Borden began in the use of gas masks, but before the instruction was completed we were ordered to the continent, arriving at Boulogne the evening of August 7. From there we were ordered to Audruicq and finished our instruction in the gas school at Calais. We were then ordered south to Plateau, in the valley of the Somme, northeast of Peronne and to our regiment was assigned the task of getting the railroads there in improved physical condition, building sidetracks, which were intended later to receive fleets of tanks, and also to prepare for the reconstruction and maintenance of the Nord railroad from Peronne to Cambrai. All the territory had been in German hands but had been abandoned in the retirement of February and March, 1917, following the battle of the Somme, in the summer and fall of 1916.

When the Germans retired they had destroyed this road, blowing up bridges and removing the rails and ties. Part of the line to be reconstructed was in advance of the British guns; part of it was in view of the German first line trenches. It was imperative, however, that our labor attract no attention from the enemy. The work was done in scattered pieces—first in one spot and then another—and sometimes we worked at night.

While engaged in this work two of our men were wounded—Sergeant M. J. Calderwood and Private Brannigan. These men were the first American sodiers to be wounded in an engagement in France.

On our arrival at Peronne we were assigned to the British Third Army under General Byng. By the end of October we knew an attack was planned on Cambrai. This attack was not to be preceded by heavy artillery fire, according to past custom, but instead, there was to be a surprise advance by the fleets of tanks, which had been unloaded on the sidings the boys of the Eleventh had constructed.

Two weeks before the battle all conditions favored the British. The country was completely shut in every night by a dense fog, making it impossible for the enemy to detect our movements. All through the night the British moved forward with troops, guns, ammunition, and tanks. All was quiet in the daytime and the German aviators could find nothing.

The battle began on November 20. Six-thirty was the zero hour. The attack was successful beyond expectations. The Germans were completely surprised. By two o'clock on the same afternoon I personally was a mile and a half beyond the Hindenburg line. That night the attack had progressed sufficiently for our men to begin laying track on the roadbed they had already constructed. The Germans had abandoned their railhead and when the Americans laid rails up to the beginning of the German road there was connection between Paris and Berlin for the first time since 1914.

The British advance continued until November 22, when a heavy artillery duel took the place of infantry action. The British had gained 6 miles, had captured 11,000 prisoners, and had inflicted heavy casualties with slight losses to their own forces.

On the morning of the 30th the Germans began their celebrated counterattack. It was concentrated at two points, Moevres on the north and Gonzeaucourt on the south. The northern attack failed, but at Gonzeaucourt the British line was lightly held, and the Germans, acting as the British had previously without preliminary artillery warning, broke through in great masses.

Our men, suddenly surprised at their work, were without arms. The gray-clad German forces were seen rushing up the road. Hurriedly a miscellaneous force was gathered to stem the advance. Seizing picks, shovels, the few rifles they could find—anything—the Americans joined what British infantry was available. The defence soon took the form of hand-to-hand fighting, the Americans and British battling desperately to halt the Germans, greatly superior in numbers. While our resistance was not sufficiently powerful to stop the Germans, it did delay them and enabled the British to reconstitute the holding line.

We suffered heavily in killed, wounded and prisoners. It was the first real fight of the war in which American forces had taken part. The fighting continued severely all day. At night the British held and the Americans took positions in the back-line trenches in case the Germans renewed their offensive. Finally the British straightened their lines by giving up part of the territory they had gained and leaving our rail connection in German hands.

At the end of January, 1918, we were withdrawn and ordered to report for duty in central France in the construction of railway lines and yards. On March 21 the big German offensive began. The Allies realized it was a really dangerous attack, aiming to break through to the Channel ports and sever the British and French armies. The British asked General Pershing for two regiments of engineers. The 11th was the first to be selected.

On our arrival in the northern sector we were assigned to the First British Army under General Horne. Our first duty was to build trenches and other defence works just behind Arras, the British having laid out a very complete series of trenches, one behind the other, realizing that a further German advance would seriously cripple the lines of communication. The British program was to hold at whatever cost.

After a month we were moved further north, just south of Bethune, to engage in the same kind of work. During the two months we were there we built about 36 miles of complete trenches, 6 ft. deep, with fire-steps, machine gun posts, dugouts, tunnels, drains, and all other details of trench construction. We also put in place about 7 miles of heavy wire entanglements.

We were kept in this section until the middle of June, but the Germans failed to renew their offensive. Then we were moved south again. One battalion was posted below Chateau-Thierry to build an ammunition dump. The other half of the regiment was sent east of Issoudon for the same purpose.

At the end of August we were ordered to report to the chief engineer of the First Army to make reconnaissance for changing a meter gage railroad into a standard-gage line and for strengthening the bridges so they could bear heavier traffic. This line was just south of St. Mihiel, running from Commercy through the French lines, across No Man's Land to the German lines east of St. Mihiel, and north to near Verdun. So the regiment proceeded to Commercy. As in the Somme country in the previous year, we began working in small groups so as to attract the least attention. The line was rebuilt, following up the American advance with both ammunition and food.

On September 24 orders were received for half of the regiment, with headquarters, to go north and build a new railroad line down the valley of the Aire, through points which were then well behind the old German lines, the work to begin immediately following the opening of the attack. This attack is known as the Battle of the Argonne. Later, as the movement developed, more of the regiment was ordered to participate, being located north of Verdun. In this district we remained, improving communications which would facilitate further Allied advances, until the armistice was signed.

Before the Eleventh Engineers left France the general staff authorized the placing of five silver bands on the staff of the regimental colors, denoting as many major engagements, as follows: Cambrai offensive, Nov. 20-24, 1917; Cambrai defensive, Nov. 30-Dec. 3, 1917; St. Mihiel offensive, Sept. 12-16, 1918; Toul sector, Sept. 25-Nov. 11, 1918; Meuse-Argonne offensive, Sept. 26-Nov. 11, 1918.

Value of Government-Owned Machine Tools

Referring to the note in the April issue of Mechanical Engineering regarding Proposals for Technical Institutions to Obtain Government-Owned Machinery, in which through a typographical error it was stated that there are probably \$2,000,000 worth of these machines throughout the country, a member writes as follows:

At the Rifle Plant of the Midvale Steel and Ordnance Company, Eddystone, Pa., there were 11,000 machine tools which were government-owned, and placing the extremely low valuation of \$500 per machine it will be readily seen that there was more than \$5,000,000 worth of machine tools at this plant alone.

The American Brake Shoe and Foundry Company was given more than \$8,000,000 for its plant at Erie, Pa. Altogether there were approximately 300 plants which were Government-aided with "increased facilities" and it is doubtful if any of these plants received less than from two to three hundred thousand and many of them went into a million or several millions of dollars. This estimate applies only to army ordnance.

A rough estimate of the amount expended for machine tools to provide increased facilities for Government contractors is about \$250,000,000.

Mechanical Lifts—Past and Present

And Particulars Regarding a New Balancing Method in Which the Movements of the Supporting Elements Are Synchronized

By LIEUT. J. F. ROBBINS,[1] U. S. N. R., WASHINGTON, D. C.

In this paper the author first describes at some length the various types of mechanical and hydraulic lifts that have been developed for use in canal locks. He then gives particulars regarding a new type of lift in which the points of support of two counterbalancing loads are so interconnected that the movements of the supporting elements of the structure are synchronized and it is made impossible for the supports to get out of level. The advantages of this scheme and its adaptation to freight-car lifts, lifts for launching and dry-docking, and lift bridges, as well as to canal-lock lifts, are also brought out.

MANY types of mechanical lifts or elevators for lifting vessels over elevations have been proposed and built in the course of the development of waterways. However, the original principle involved in the masonry lock invented by Leonardo da Vinci still holds its superiority mainly because efforts to develop mechanical lifts have failed to keep pace with the increasing size of vessels to be transported.

The inclined railway for hauling the load up and over elevations by cable served its purpose, to a certain extent, in the early days of canal development, but had its apparent limitations.

A gated tank on wheels was built in 1874 on the Chesapeake and Ohio Canal, to be hauled up an incline by means of cables with counterweights, but failed in its practical application.

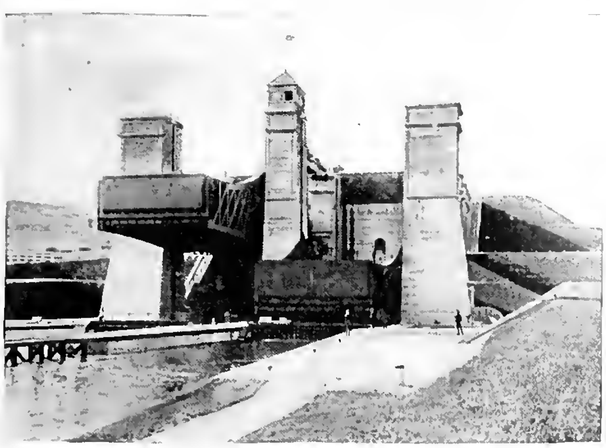


Fig. 1 Peterborough Hydraulic-Lift Lock, Trent Canal

In the same year, 1874, Edwin Clark, an English engineer, invented and built the first balanced hydraulic lift lock. This structure, built at Anderton, England, provided means for transferring vessels between levels of the canal on single plunger lifts.

Clark and his associates later built balanced lifts at La Louvière, Belgium, and Les Fontinettes, France, having a lift of 50 ft., the lock chambers being 140 ft. long and 19 ft. wide with a navigable depth of 7 ft. 10 in. He also proposed to use this principle for transferring trains of freight cars between different levels, but did not put the idea into practical use.

Canal Lift Developed in Germany

In Germany much work has been done in developing mechanical lift locks. Hoffman, a German engineer, invented and built a floating lock supported on tanks; and later, in the Dortmund and Ems Canal, locks were built on this principle, having a lift 68.5 ft. The lock chamber was built in the shape of a box with end gates 229.6 ft. long, 28.2 ft. wide and 8.2 ft. deep, supported on five steel cylinders or tanks. The weight of the structure and water load was supported by the buoyancy of these tanks, which floated in wells 30.17 ft. in diameter. The lift is made in approximately 15 min. by four large screws operated by 150-hp. motors. This installation, while larger than any mechanical lift previously built, fails to take advantage of the counterbalancing effect that obtains in the balanced lifts built by Clark. This necessitates a considerable expenditure of energy in overcoming the attraction of gravity which is, of course, unnecessary in any form of balanced lift.

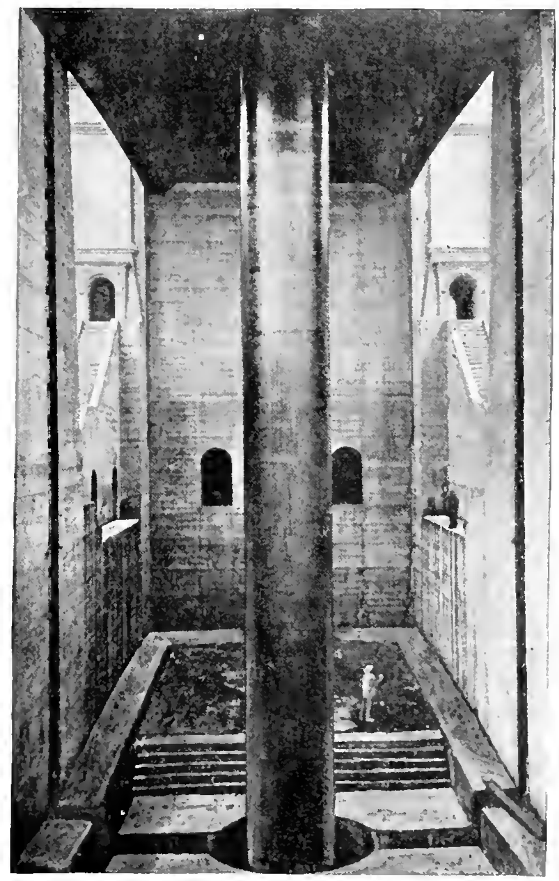


Fig. 2 One of the Plungers of the Peterborough Lock

The firm of Hoppe in Berlin has made a study of the application of a multiple of hydraulic plungers for operating large lifts, but found an insurmountable difficulty in maintaining the perfectly uniform and synchronous movement of a number of plungers which is absolutely necessary when handling loads greater than can be carried on one plunger.

Trent Canal Lift Locks

The largest and most successful example of the application of the balanced hydraulic lift was built in 1905 in Canada in

[1] Bureau of Steam Engineering, Navy Dept. Assoc.-Mem.Am.Soc.M.E.

For presentation at the Spring Meeting, Detroit, Mich., June 16 to 19, 1919, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and advance copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

the Trent Canal at Peterborough.[1] This lock, shown in Fig. 1, together with the similar one at Kirkfield on the Trent Canal, has been in successful operation since put into commission and has various economic advantages over the masonry type of lock. The total lift of 65 ft.—over twice the height of the lift of the Panama Canal locks—has been made in the record time of 6½ min., the average time necessary to pass a vessel being from 10 to 12 min. Since only a comparatively small amount of water is used in making a lockage, most of the normal flow through the canal is available for water power, some of which is used for operating auxiliary pumps and lighting.

The lock at Peterborough consists of two steel boxes 140 ft. long, 33 ft. wide and carrying 10 ft. of water, each supported on its centrally located plunger 7½ ft. in diameter with a 65-ft. stroke. (Fig. 2). The cylinders or presses into which the plungers extend are connected by a 12-in. pipe with a gate valve, so that with one box with its water load at the upper level and the other at the lower level of the canal, by opening the valve in the cross-connection the position of the lock chambers is changed and the lockage made.

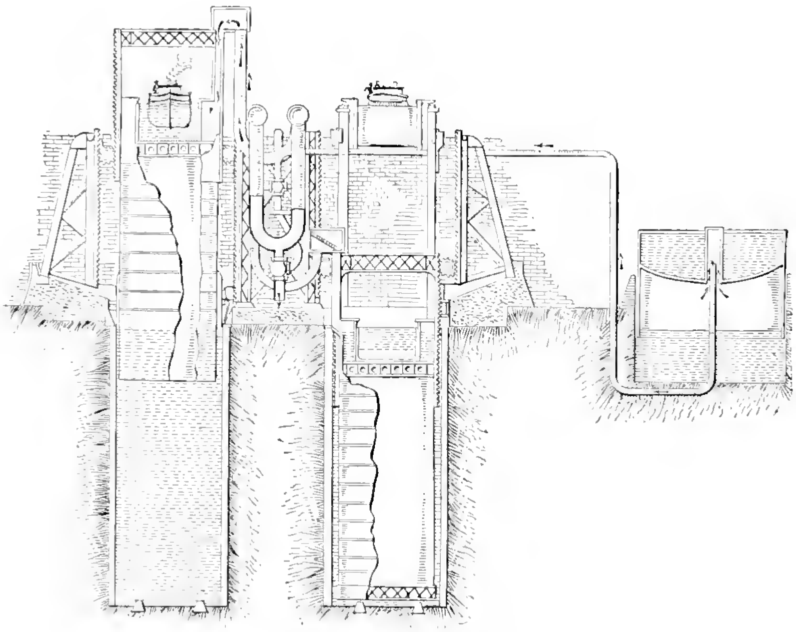


FIG. 3 AIR-SUPPORTED LIFT LOCK PROPOSED FOR N. Y. STATE BARGE CANAL

The stroke of the plungers has been set so that the box at the upper level stops with the water level in the box about four inches below the water level in the canal, and takes on this additional water load. This excess load, amounting to about 50 tons, when taken into the upper lock acts as a surcharge to overcome friction and gravity and bring the upper lock down and the lower one up.

When it is desired to transfer a boat from one level to the other, the boxes being in their respective positions at the end of the stroke of the plunger, the clearance between the end of each box and canal is first closed by inflating an air hose laid down the side walls and across the sill. Then this clearance space is filled through wicket gates in the end gates of the lock and canal. The clearance space having been filled and water levels in canal and lock having been equalized, the end gates which are hinged across the sill of lock and canal are folded down, making a continuous stretch of water from the canal to lock. Then the vessel is moved into the lock, displacing its own weight of water, of course, so that the load is constant, regardless of the size of the vessel. After the entrance of a vessel into one or both of the locks the end gates are closed, the clearance space emptied, and the cross-connection valve gradually opened, allowing the upper box to come down and forcing the lower one up.

While this installation of balanced lifts has proved to be economical in first cost, operation, time and quantity of water required to make a lockage, the locks are not large enough to accommodate vessels or cargo barges of very great capacity.

It was found, however, that the size and load to be handled were about as extensive as could be supported on the cantilever structure of the box over one plunger. Also, the total weight of one lock chamber, plunger and water load, which is in the neighborhood of 1900 tons, was about the maximum that could be safely supported on the masonry foundation for the cylinder castings.

For these reasons, and because no scheme has been found for safely supporting the load on more than one plunger, no balanced lift has ever been built of greater size than the one at Peterborough.

PROPOSED LIFT LOCKS FOR N. Y. STATE BARGE CANAL

A vertical lift lock was proposed for the Erie Canal at Lockport, N. Y., where a single mechanical lift was to take the place of a double flight of masonry locks there used to overcome an abrupt change in elevation of 56 ft. The design called for a steel box 225 ft. long, 29 ft. wide, and 9 ft. deep, which was to be supported by 88 link-and-pin chain cables attached to floor beams and running up and over sheave pulleys and down to 1000 tons of cast-iron counterweights. The sheave pulleys were to be carried by steel shafts supported, one on each side, in the permanent structure built at each side of the canal. The movement of the load was to be controlled by a number of brakes on the shafts.

At Cohoes, on the New York State Barge Canal, the installation of a mechanical lift lock was seriously considered, and a board of engineers investigated and reported on three different designs. Here, in the place of 16 masonry locks, it was proposed to install a pair of balanced lifts to overcome an elevation of about 120 ft. The specifications called for two counterbalancing tanks 310 ft. long, 28 ft. wide, and 12 ft. deep, each capable of floating two vessels of 1000 tons capacity. The three designs considered proposed to make use of three different supporting mediums; air, sets of cables, and hydraulically operated plungers.

Air-Supported Lifts. In the pneumatic design the weight of the steel box, or lock and water load, was to be directly supported on the elastic cushion of air maintained under the load by having the steel sides of the box extend downward below the surface of water maintained inside a large rectangular caisson built in the canal. See Fig. 3.

The two similar structures, either in tandem or parallel, were to have the air space under each box connected by huge air mains 21 ft. in diameter, with the necessary return bends and valves for shifting the supporting air from the space below one lock to the other when the locks were to be shifted between levels.

Cable-Supported Lifts. The second design considered by the board of engineers covered a pair of steel boxes of the specified dimensions supported by numerous cables running over sheave pulleys on the permanent structure from one box to the other, each load thus counterweighting the other and being shifted from one elevation to another by a surcharge of water in the upper box.

Plunger-Supported Lifts. The third proposal covered a pair of steel boxes working up and down in balance with each other and supported on three steel plungers under each load. The cylinders were to be connected by piping with suitable valves so that when the upper lock came down the lower lock would be forced up, registering with the upper level of the canal. As in the pneumatic scheme, it was recognized that some device for maintaining the level of the box would be necessary. In

[1] This lift has been fully described and illustrated in the *Scientific American*, July 7, 1906, the *Engineering Record*, March 30, 1907, and various other engineering publications.

this case the movement of the three plungers was to be coordinated by a central counterweight directly connected with both ends of the tank "in such a manner that the weight would always act to overcome the effect of any unbalanced load."

In this, as well as in the second proposal, the equilibrium of the structure and water load was to depend on the operation of a mechanical device, the positive action of which would be questionable for maintaining the level of an unstable water load.

The report of the board of engineers shows considerable interest in the future possibilities of the hydraulic plunger lift, but recommended four masonry locks with a lift of 28 ft. each.

Proposed Cable-Supported Lift Locks

An interesting design for a balanced lift lock has been described by Dr. J. A. L. Waddell[1], in connection with the proposed Lake Erie and Ontario Sanitary Canal and Power project. See Fig. 4.

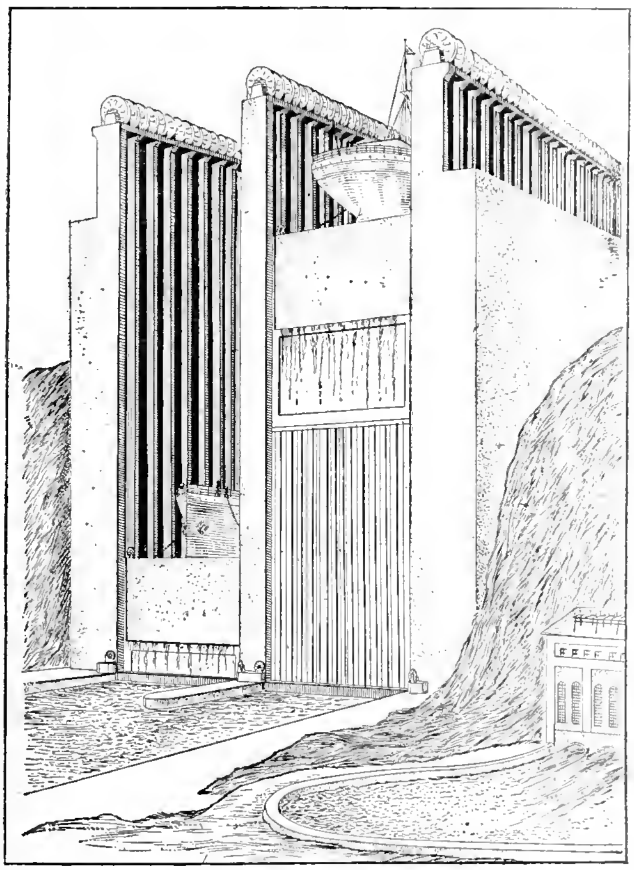


Fig. 4 Cable-Supported Lift Lock Proposed for Lake Erie and Ontario Sanitary Canal

Here, in order to make available for power purposes the water which would be used for lockage in the masonry type of lock, it is proposed to install two pairs of balanced lifts, one of 208 ft. and one of 104 ft. lift. The lifts, as described, are to be supported by cables connecting the inboard side of the two parallel boxes and running over fifty-six 20-ft. diameter sheave pulleys, mounted on the retaining wall between the boxes. The outboard edge of each box is connected by a similar set of cables running over pulleys and to counterweights suspended outside the two outer retaining walls.

This design, adopted as the most feasible *known* method of overcoming the high lift with locks of large size, is somewhat similar to that which was proposed for the New York State Barge Canal. It is believed that there would be considerable difficulty in maintaining the equilibrium of these lock chambers, which are to be 660 ft. long, 70 ft. wide, and carrying 30 ft. of water; and that some extensive braking apparatus would be necessary on the sheaves or supporting shafts. Any excess load on one end of one lock, tending to force it down, would lift the same end of the other up and would be cumulative in effect with the water load.

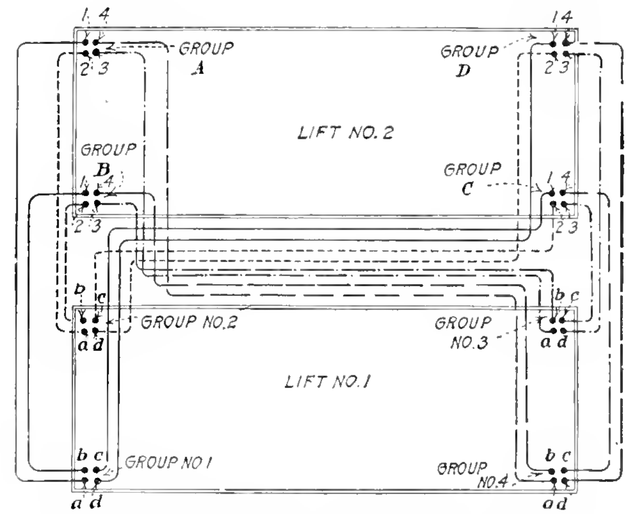


Fig. 5 Diagram Showing Connections for Harris Balanced Lifts

Lift No. 1: Plungers of Groups Nos. (1, 2, 3, 4) connected to plungers Nos. (1, 2, 3, 4) of Groups (A, B, C, D) of Lift No. 2, and conversely from Lift No. 2 each plunger of Groups A, B, C, D is connected to a similar plunger in Groups (1, 2, 3, 4) of Lift No. 1.

(Plungers of each group of one lift are hydraulically connected to the four corners of the other lift, so that the pressure due to one lift is uniformly distributed to the other, making it impossible for either lift to get out of level)

As has been well said by the inventor of one of the many designs of balanced lifts, "No mechanic has yet put into successful operation an apparatus in which a number of hydraulic plungers are so controlled and synchronized as to move at equal speed, as they must in operating a lock chamber."

This difficulty of synchronizing the movement of a number of supporting plungers has stood in the way not only of the development of hydraulic lifts of a size sufficient to meet the demands of modern canals, but also has prevented the use of balanced lifts in other applications where their use might be the means of solving urgent economic problems.

A Basic Principle Solving the Balancing Problem.

Through many years of study of this problem no feasible scheme has been proposed up to the discovery of the simple method of interconnecting systems of balancing plungers, or cables, as hereinafter presented.

This scheme virtually does away with limitations as far as size of the lift and load to be handled is concerned. The accompanying diagram, Fig. 5, illustrates this principle of interconnecting the points of support of each load. As indicated in the figure, each lift is supported by a group of four plungers (or cables) at each corner. The plungers *a*, *b*, *c* and *d* in group No. 1 of lift No. 1 are hydraulically connected with plunger No. 1 of groups *A*, *B*, *C*, and *D* of lift No. 2; plungers in group No. 2 of lift No. 1 are connected with plunger No. 2 of groups *A*, *B*, *C* and *D* of lift No. 2; plungers in group No. 3 of lift No. 1 are connected with plunger No. 3 in groups *A*, *B*, *C* and *D* of lift No. 2; plungers of group No. 4 of lift No. 1 are connected with plunger No. 4 of groups *A*, *B*, *C* and *D* of lift No. 2. Conversely, from lift No. 2, each plunger of groups *A*, *B*, *C* and *D*

[1] *Scientific American*, March 23, 1918.

is connected to a similar plunger in groups Nos. 1, 2, 3 and 4 of lift No. 1.

Thus the plungers of each group of one lift are hydraulically connected with the four corners of the other lift, so that the pressure due to one load is uniformly distributed to the other.

A simple illustration of a cable-supported lift of this type is shown in Fig. 6, in which two shelves are supported by 16 cords. In this model four cords are white, four are red, four are brown and four are blue and white twisted. In the figure the red and brown cords cannot be distinguished from each other.

To each corner of shelf No. 1, supporting the glass of water, four cords of the same color are attached, each cord passing through a screw eye directly above the point at which it is attached. The four white and four twisted cords can be followed in the figure from the corner to which they are attached, up through the screw eyes, across the frame, where one of each color passes through a screw eye over each corner of shelf No.

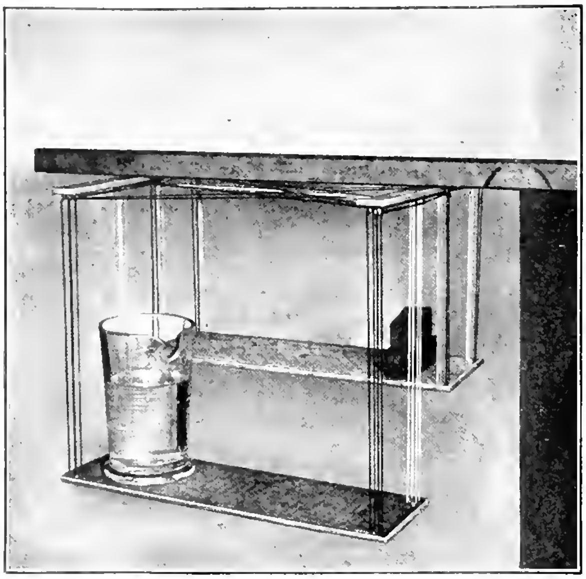


Fig. 6 Simple Model of Harris Type of Balanced Cable-Supported Lift

2 supporting the lead weights and finally down to each corner of shelf No. 2, where they are attached.

If pressure is applied downward on the corner of shelf No. 1 where the white four cords are attached, the other ends of these cords being attached to the four corners of the shelf carrying the weights, the latter shelf will be raised and will at all times be level. Also, since the red, brown and twisted cords are carried in the same way from the other three corners of the first shelf to all corners of shelf No. 2, no part of either shelf can move up or down without all parts of the other shelf moving an equal distance in the opposite direction.

Any part of either shelf will sustain loads equal to the full combined strength of the cords supporting that part.

The device is not limited to any one size or shape in securing these results. If the shelf is too long to carry the necessary load by the cords supporting it at the corners, a second group of cords can be attached to each shelf at any equal distance from the center of each shelf, carrying from each part of shelf No. 1 to each corresponding part of shelf No. 2, and duplicating the arrangement of the first set, these shelves can then be loaded to the combined strength of the 32 cords and at the same time practically divided into three sections as to their strength for carrying these loads. Then, if force enough to overcome the combined friction of all the cords be applied to either shelf, all parts of each one will travel up or down the same distance at the same time.

It is apparent that with the two loads supported in this manner, either by plungers below the lifts, or overhead cables, no load, up to the limit of the design of the structure, could force either lift out of its normal plane or level, however eccentrically the load might be placed. If it were desired to build a pair of lifts several hundred feet long, the total length would be divided into a certain number of spans required by economy of design, and the required number of similar systems of balancing plungers would be used and the various systems connected as shown in the sketch of a single system. Thus, by increasing the number of similar systems it would be possible to build lifts of practically unlimited size.

Freight Lifts

The utilization of the potential energy of one of two similar loads to shift them between different levels, has only been applied in a large way to the transfer of vessels in canals. But the foregoing illustrated scheme of supporting two such loads makes it feasible to apply the principle to other uses.

Clark's idea of transferring trains between different levels on single-plunger lifts may now be applied to the handling of freight between subway and surface levels, on lifts of sufficient size to carry any number of freight cars.

In view of the difficulty and expense of present methods of delivering freight, for example, into New York City by car ferry and the fact that no feasible method has hitherto been proposed for getting freight from subways to surface levels other than the hauling of trains up inclines or breaking freight below and lifting it on elevators of small capacity, this scheme is put forward as a solution to the problem of overcoming freight congestion.

With the increasing value of real estate, the use of large surface areas becomes prohibitive, making many floors above and below surface levels necessary. This scheme, applying balanced lifts to freight-terminal warehouses and points of distribution, would obviate present long hauls both by truck and train, and make it possible to utilize space to the greatest advantage.

For the handling of freight it would be advisable to design the lifts so that a certain load could be lifted up in excess of that coming down. This could be done by having a certain number of lifting plungers under each lift with a pumping plant of the necessary capacity to lift the e-cess load.

Fig. 7 shows a typical design of a freight lift for handling fifteen cars on each of two three-track bridge structures between subway and surface levels. After assuring the level and uniform travel of the lifts by a certain number of balancing systems of plungers, certain plungers of the remaining groups have their pipe connections led through a pumping plant for controlling and lifting excess loads.

While it is true that in less-than-carload-lot freight terminals the outgoing tonnage is usually two or three times the incoming tonnage, this capacity for lifting a certain per cent excess load would be advisable and methods of handling such incoming and outgoing freight would have to be so coördinated as to make use of the loads in so far as possible. The available portion of the potential energy of the excess outgoing tonnage might be used to advantage to lift occasional excess incoming loads by storing the excess energy in accumulators and using it to assist in elevating incoming tonnage.

Lifts for Launching and Dry-Docking

This principle may have a possible application in the field of shipbuilding in connection with the dry-docking and launching of vessels. For example, it might have been applied to advantage in the launching elevator recently built at the Ford plant for launching Eagle boats. In this installation two pairs of simple hydraulic jacks on each side of the platform are used to support the movable structure and boat and to lower the boat into the water. It is then necessary to pump the jack plungers and platform back up into position.

An elevator of this kind might be supported by groups of four plungers under each corner with a nearby counterweight to balance the weight of the platform, supported on an equal

number of plungers. With the plungers connected as described, there would be no possibility of their tipping or binding, of plungers, even though the platform were eccentrically loaded. The counterweight would bring the platform back up into position, without the necessity of a pumping plant or any power for control or operation.

Lift Bridges

This scheme may be applied to lift bridges where the span is too great for the use of the so-called "jack-knife" bridge. Here again the bridge structure could be supported by four plungers at each corner connected to four plungers under each corner of the counterweight situated under the roadway at one end of the bridge. The plungers under the counterweight might be two or three times the diameter of the plungers supporting the bridge, and so reduce the stroke of the counterweight to one-half or one-third of that of the bridge.

The same principle of interconnecting the points of support of bridge and counterweight may be applied with supporting cables instead of plungers. It is probable, however, that the plunger lift would be the most economical design as no heavy overhead truss would be necessary and the towers now used in counterweighted vertical-lift bridges to support the overhead truss, counterweights and motors could be made very much lighter, since these towers would only be needed as guides at each end of the bridge.

The movement of the bridge would be properly regulated by a train of throttling valves in the system of interconnecting pipe lines, and all operations would be governed by an interlocking system of automatic control.

Balanced Lifts as Applied to Erie and Ontario Canal Projects

While the lift of 208 ft. in the proposed lock of the Erie and Ontario Canal project is considerably higher than any existing plunger lift, it is within the range of the feasible application of a multiple of supporting plungers. Such lifts as are proposed, supported on plungers, would be absolutely positive in their relative movement and would have their equilibrium and level assured without auxiliary apparatus. Plunger lifts would render unnecessary the immense counterweights, the total weight of which has to be equivalent to the weight of one lock with its water load. By supporting the loads on plungers below the structure, the retaining walls, which support the sheaves and total weight of the locks, could be made very much lighter as they would be needed simply to act as guides to the movable structure. With these locks supported on the proper number of systems of balancing plungers, as determined by economical design, the groups of four plungers at several points in their travel upward would pick up guides to act as stiffeners similar to those used with long single plungers of passenger elevators. These guides would hang by chain or cable from the lock structure and would be provided with a loose collar for each plunger and guide in tracks in the side walls, thus breaking up the unsupported length of the plunger columns sufficiently to carry the load without bending.

In the cable-supported lifts described by Dr. Waddell it is proposed to use electric motors connected to the sheave pulley shafts for shifting the locks. Since the friction of the extensive cable system and the inertia of two such loads, estimated to be approximately 50,000 tons each, would be very great, this would entail a considerable expenditure of power. In view of this fact it would seem more economical to make use of a surcharge of water in the upper lock for shifting the locks, similar to the manner in which the Peterborough locks are operated. With the two loads supported on systems of balancing plungers, assuring perfect synchronism of movement, control in starting and stopping would be maintained by a train of simultaneously operated throttling valves in the various interconnecting pipe lines.

The proper sequence of events in the operation of such an installation, as a whole, would be governed by semi-automatic interlocking control systems under the supervision of one man, so there would be little possibility of anything going wrong.

Figs. 8 and 9 illustrate the hydraulic-plunger application of this principle. Fig. 8, a view of the underneath side of Model No. 3, shows the four pipes running from the four balancing plungers at each corner of one platform to the four corners of the other platform. Under the middle of each platform are two groups of four pump plungers connected to a common pipe through a small geared pump to the other platform. At the left end of the model is a small accumulator, with a hand pump, which can feed through a common pipe and check valve in each of

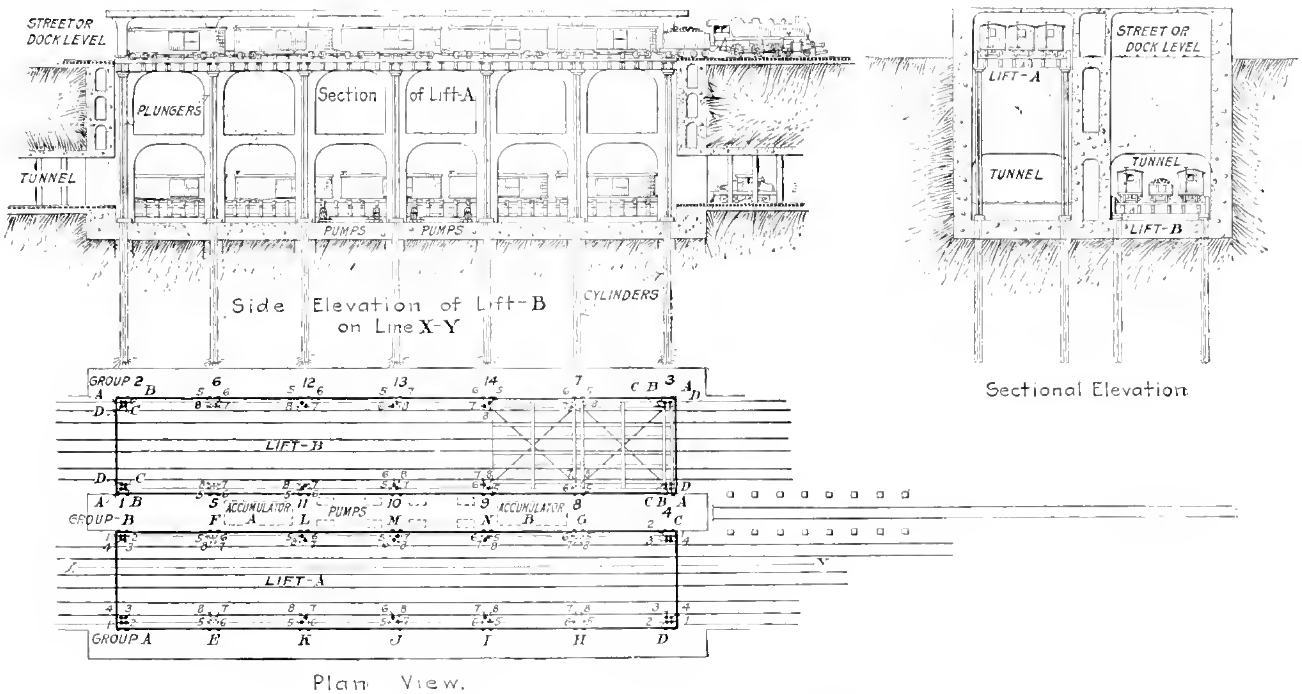


FIG. 7 TYPICAL DESIGN OF A HYDRAULIC BALANCED FREIGHT-CAR LIFT

the 16 small pipe connections between the balancing plungers. The accumulator is kept under sufficient pressure to feed through any check valve to replace leakage in any part of the system. Another train of check and throttling valves, one in each of the 16 interconnecting pipe lines—connects to a common pipe and back to the accumulator for throttling down the platform that happens to be in the upper position when it is desired to put the lift out of commission for repairs.

In the other view of Model No. 3 (Fig. 9) the pump plungers were secured down out of the way, and a load of two pigs

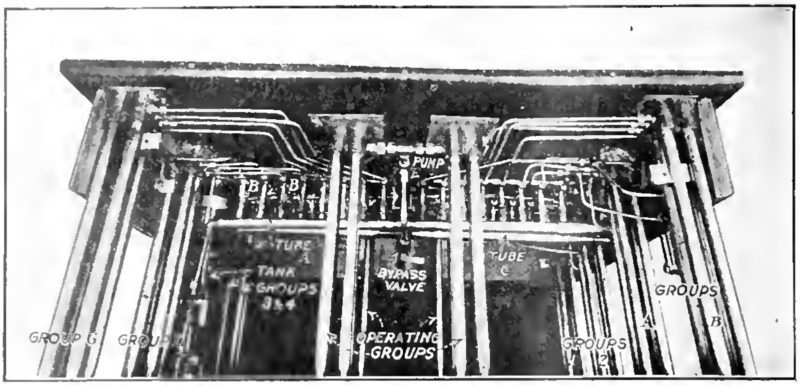


Fig. 8 View Underneath Model No. 3 of Harris Hydraulic Balanced Lift, Showing Plungers, Piping Connections, Etc.

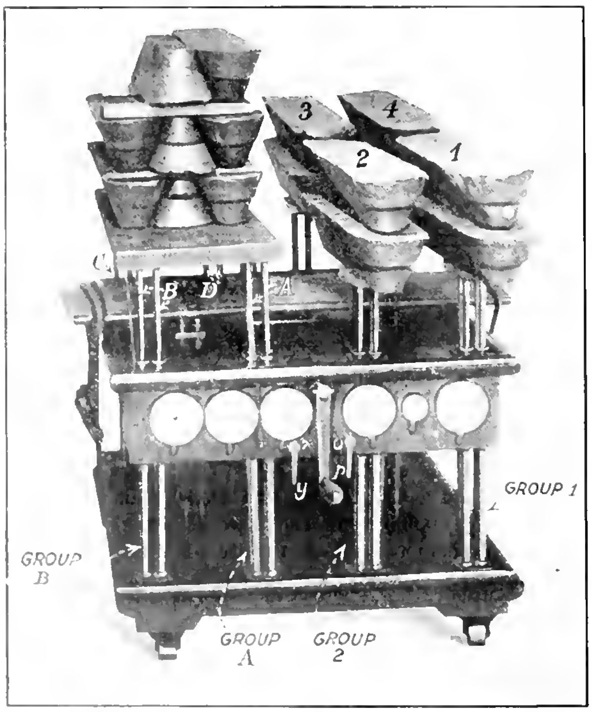


Fig. 9 Model No. 3 with Each Group of Plungers of One Lift Carrying Individual Loads, an Equal Load Resting on the Platform of the Other Lift

of lead was balanced over the cap of each set of balancing plungers. An equal load was placed on the other platform. With the model loaded in this way, it was possible to force down any one of the four groups of plungers by the pressure of the hand, when the other platform would rise and the remaining three groups of plungers would descend at the same rate; showing that no dependence was necessary on the platform structure for maintaining the level of the groups and that no strains would be produced in such a structure for maintaining the loads level. Moreover, when loads of 1200 lb. were placed eccentrically on each platform, the lifts remained level when moved up or down by means of the pump and pump plungers.

The gages on the front of the model were installed for the purpose of studying the various pressures. The first one on the right shows the accumulator pressure; the small gage indicates the pump pressures, and the remaining four gages are installed in the pipe lines from the cylinders of one group of balancing plungers.

In its application to canal-lock lifts this principle has no limit to which it may not be extended. It may be applied in the great canal systems being developed in Canada, and in the possible future canalization of the United States for ocean-going shipping. It has the very great advantage of economy of water necessary to supply the leakage of vessels. This feature makes it possible to build canals over territory where the rainfall over areas at summit levels is insufficient to supply the water necessary for lockage in the old masonry type of lock. This matter of taking the water supply now used for water power for use in proposed canal systems has alone been a considerable item of cost of proposed waterways.

While this scheme of interconnecting points of support of two loads, as described, has been granted basic patent rights and some little work has been done in the design and development of models and in anticipating the many engineering problems involved, no application of it has yet been undertaken.

It is believed, however, that by the development of this principle of so connecting the points of support of two counterbalancing loads as to synchronize the movement of the supporting elements of the structure and make it impossible for the loads to get out of level, its inventor, William Thomas Harris, of Chicago, has solved an important mechanical problem and has opened a way to the future development of waterways and to more efficient methods of handling freight.

The shipment of 50 locomotives without the use of lighters was recently accomplished directly from Erie Railroad Pier H at Weehawken, N. J., into the holds of the single-decked ocean freighter *Feltore*. The work was done with the standard pier equipment, and no special preparations were necessary. Direct loading of vessels had never been attempted before because of the well founded impression that damage to fixed equipment would result, which is based on the fact that in many ships the hatches do not have sufficient area to permit free passage to packages of large dimensions, with the result that forcing methods in loading have had to be resorted to. That is to say, large packages often became wedged in the hatchway, and when pried loose would drop and shift quickly, setting up strains sufficient to break rigid equipment. As the hatches of the *Feltore* extend across the ship for almost its full width, no difficulty of this nature had to be overcome while loading it directly, and the operation proved to be a complete success.

The 50 locomotives were delivered unassembled to the pier in 200 cars. The car loads were made up of 20-ton locomotive boilers, 14-ton tender tanks, 12-ton locomotive frames, 4-ton cabs, 4-ton drivers and 3-ton cylinders. During the first day 19 of the 20-ton boilers were loaded in seven hours, a cycle being completed in about 22 minutes.

Following usual methods, the ship would have been anchored off shore and the cargo moved from the pier by cranes, loaded on to barges, and from these transferred to the hold of the vessel by the usual lighterage methods.

As the cargo could not be loaded on to barges in less time than is required to load it into the ship, the initial saving by the method of loading directly into the ship is apparent. The time which would be required to transfer the load from the barges to the ship would depend on the location of the ship in reference to the pier and cannot be arrived at definitely. As a comparison, however, it may be said that the estimated time for transferring a 20-ton locomotive boiler from a barge to a ship is about one hour as compared with the 22 min. mentioned. (*Railway Age*, April 18, 1919)

The Status of Industrial Relations

By L. P. Alford,[1] New York, N. Y.

At the Annual Meeting of the Society in 1912, a report was presented by the Sub-Committee on Administration, of which the late James M. Dodge was Chairman and L. P. Alford Secretary, on The Present State of the Art of Industrial Management. This report was replete with information upon the broad aspect of the management problem as it then existed in the industries of the country.

During the seven years which have intervened since the preparation of this report, the question has been studied from many different angles and has come to be viewed in quite a different light from that in which it was regarded when the original report was prepared. In consequence, the Committee on Meetings and Program appointed Mr. Alford a committee of one to prepare the following new report upon the subject for presentation at the Session on Industrial Relations at the Detroit meeting.

This report not only comprises a review of the new aspects of the problem which have recently developed, but also a historical summary of the progressive stages in the development of industrial relations since the period immediately following the Civil War. It has proved to be inevitable that after any great economic disturbance like that produced by the Civil War, or the present period of unrest following the world conflict in Europe, there should be unrest and uncertainty in the field of labor and employment; and it thus seems appropriate at this time to outline briefly the most important transactions which have occurred in this field, beginning with the time of the Civil War and including the situation which now exists, so similar in character, but greatly amplified.

IN the presidential address made to this Society in 1882 is the following remarkable statement of the responsibility of engineers in solving the problems involved in the relations of employers and employees:

> In singular and discreditable contrast with all the gains in recent and current practice in engineering, stands one feature of our work which has more importance to us and to the world, and which has a more direct and controlling influence upon the material prosperity and the happiness of the nation than any modern invention or than any discovery of science. I refer to the relations of the employers to the working classes and to the mutual interest, of labor and capital. It is from us, if from any body of men, that the world should expect a complete and satisfactory practical solution of the so-called "Labor problem." More is expected of us than even of our legislators. And how little has been accomplished.

Dr. Thurston was speaking of conditions as they were a full generation ago, yet his words are as true today as they were then. The world is looking to the engineers for leadership in these matters "and how little has been accomplished."

The topic of industrial relations is so complex and far-reaching that any treatment within the space of a professional paper must of necessity be restricted to certain aspects of the problems. So in attempting to outline the present position of the body of fact that is comprehended in the term "industrial relations," the scope will be limited to a survey of the more important developments of the last thirty or thirty-five years, and to a statement of a few of the more outstanding tendencies revealed by events of the immediate present.

Before we can attempt to outline the status of industrial relations it is necessary to define what we mean by the term. To that end this statement is offered:

> *Industrial relations comprises that body of principle, practice and law growing out of the interacting human rights, needs and aspirations of all who are engaged in or dependent upon productive industry.*

[1] Chief of Staff, *Industrial Management*. Mem. Am. Soc. M. E.

For presentation at the Spring Meeting, Detroit, Mich., June 16 to 19, 1919, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and advance copies of the pages are available to the members gratis upon request. All papers are subject to revision.

It will be observed that this definition does not include directly the feelings of uneasiness and unrest among industrial workers, but views them as the expression of real, or fancied, rights or needs, and considers strikes and lockouts as but the assertion of the same or similar claims. On the other hand, the definition does include not only the interests of employers and employees who are actually engaged in industry, but likewise of others who are dependent upon productive industry for the satisfaction of some of their needs, or for the safeguarding of some of their rights.

Beginning with about 1880 there were developed and put into use two practices expected to mitigate or help solve the labor difficulties of that time, namely, profit sharing and methods of wage payment intended to give the worker a direct share in the benefits of increased production. At the present time we are seeing another heightening of interest in profit sharing and the widespread installation of the so-called shop-committee system. Thirty years ago and today are similar periods of experimentation in industrial relations.

Although the beginnings of the development of industrial relations took place during the 80's of the last century the situation in industry did not become acute in the United States until about 1905. That date fixes approximately the time when the evils of absentee directorate of large corporations came into prominence. Many of our great industrial consolidations had taken place before 1905 and the owners had put into effect a system of control and management arbitrarily determined in a few of our large cities, principally New York City, while the plants of these corporations were spread throughout the country.

It is frequently stated that the necessity for establishing industrial relations today is the growth of the factory system wherein all personal contact is lost between owner or manager and the worker. While this is true, it does not sum up the entire loss. In the system of absentee directorate there are other evils as well, and these taken together have set up situations where there have been clashes over the rights, needs and aspirations of those who belong to the class of employers and those who form the great group of employers. These losses in fitness for control may be stated in this wise:

a The loss of personal contact and relationship that formerly existed between the master and his skilled workmen and apprentices

b The loss due to the lack of personal knowledge of the work being done on the part of present-day directors and managers

c The loss due to the lack of personal knowledge of the tools and equipment used in production on the part of present-day managers

d The loss of the direct oversight of saving and conserving materials and human effort on the part of present-day managers

e The withdrawal from productive work of the families of the directors and managers

f The loss of equality of living conditions between the families of the directors and managers and the workers.

The effect of these losses in creating a situation where there may be a clash of interest, and failure on each side to understand and appreciate the other, is brought home when we contrast the human relationships in the days of craftsmanship with those of the factory system. In former time the employer or master knew how to do all parts of the work himself, had in fact done so with his own hands, was in personal contact with all of the tools, equipment and materials used in his shop, had complete personal oversight of everything that was done, and held a relationship of almost father to son with his apprentices who, in many cases, lodged and boarded in the master's home and were served by the master's wife and daughters. Not only did the master instruct his ap-

prentices in the requirements and skill of the trade, but he likewise set them the example of right living. All of the activities of the master opened to the apprentice as he became able to exercise them. There was a complete community of interest between the master and his family, his workmen, their families and his apprentices.

By contrast, in American industry today far too often the owners and directors live hundreds and thousands of miles away from the workers in their plants, under entirely different conditions, as varying as New York City and a Massachusetts mill town or a Middle-West factory community. All exact knowledge one of the other is lacking, there is no community of interest or purpose, and no assurance that a policy determined upon in the directors' room will meet the needs and rights of the workers in some far distant locality.

It is the creation of this situation of absentee directorate that has done much to focus attention upon the necessity of developing a body of principles, practice and law to satisfy the needs and safeguard the rights of all who are engaged in or dependent upon American industry.

Examination reveals six major lines of development amid the various methods, plans and systems that have been tried in seeking to work out better industrial relations. These are:

a Profit-sharing plans
b Methods of wage payment
c Methods and laws to reduce the hazards in industry and mitigate the effects of injuries and also of occupational diseases
d Employment management
e Declaration and enforcement during the period of war of three rights of workers, namely, collective bargaining, restricted hours of labor and the living wage. Declaration of these same rights and others in the Treaty of Peace.
f Systems for mutual or joint control by employers and employees.

A controlling reason for considering these six lines of development is their actual or promised permanence and widespread acceptance and application. For this same reason it does not seem pertinent to the purpose of this paper to devote space to welfare methods, industrial betterment, suggestion boxes or systems, shop gardens, factory bands, dances, minstrels, glee and athletic clubs, employees' loans, benefit associations, pensions and many other activities that properly classify under our definition of industrial relations. Without doubt successful applications of every one of these activities can be mentioned, and likewise, without doubt, experiences can be pointed out where they have had a beneficial effect in promoting satisfactory conditions and assisting to develop a "spirit of the organization." It is more than likely that many of these activities will always find a place in industry, but none of them seem to be a major line of development, and in fact all classify under welfare work or industrial betterment, which have fallen into disrepute because of the motive of charity or paternalism that has inspired them in many places.

The element of failure in all these agencies is the lack of removal of the fear of unemployment. For the fundamental cause of industrial unrest is the dread of losing the opportunity to work and thereby secure the necessities of life, or of being cut off from deserved promotion.

Profit Sharing

Profit sharing has been mentioned as one of the lines of development that became prominent during the period ending in 1889. A few of these were mercantile establishments, but all were large employers of labor.

Not only is there reason to believe that these attempts were inspired by conditions of industrial unrest, but there is direct testimony to this effect in two cases. The Globe Tobacco Company, of Detroit, Mich., entered into an agreement in regard to its profit-sharing plan in 1886 with the district board of the Knights of Labor; and the plan of the H. O. Nelson Company, of St. Louis, Mo., which was announced on March 20 of that year, was an outgrowth of the great railroad strike, strikes in the building trades and the movement for the eight-hour working day.

Within the past six months a number of large industrial plants in this country have announced or put into effect profit-sharing plans, so we seem to be having a repetition of what took place during the 80's of the last century.

It is worth while to point out that although profit sharing was put into effect in a number of American industries a generation ago, it has never had widespread adoption. This fact may cause us to question its effectiveness as a promoter of good industrial relations. Several reasons are recognized for this situation: Payment of gains under profit-sharing plans are deferred and so lack an immediate appeal; the gains do not come directly nor entirely from the efforts of the workers, but are dependent upon the hazards of the enterprise; the amount distributed to any individual worker is equivalent to an increase of only a few cents an hour for the year; the amount shared by each person among the owners and managers is many times greater than that received by each workman.

Plans for stock participation have the same purpose and value as those for profit sharing.

Methods of Wage Payment

The pioneer work that has since yielded the science and practice of industrial management was performed during this same period of industrial unrest, that is, from 1880 to 1889. During this decade Mr. Henry R. Towne presented two papers before this Society that have been frequently referred to as the beginnings of the literature of industrial management. The first was read in 1886. In it Mr. Towne called the attention of his fellow-engineers to the need of a study of the financial and profit-making aspects of shop management. He urged his associates to become "economists" because the engineer is one who essentially effects economy. His second paper was presented in 1889 and in it was described a gain-sharing plan that Mr. Towne had applied in his own shop. The object was to enable his employees to share the profits of the business depending upon gains in efficiency as shown by careful accounting.

Influenced by his study of the epidemics of strikes during the same decade, Mr. F. A. Halsey originated his premium plan of wage payment that was disclosed to this Society in a professional paper read at the Providence meeting in 1891. A recent letter written by Mr. Halsey to the author mentions the activities of the Knights of Labor and the great street-car strike in New York City as two of the events that influenced him to study the possibility of some form of wage payment that would reward the worker for increased effort and production.

This same decade was the period of the work of Dr. Frederick W. Taylor, which later on gave to this Society several papers outlining his system of shop management. It will be recalled that a part of his methods was a system of wage payment known as the "differential system."

Since that time several other methods of wage payment have been originated and developed, so that today we recognize some half a dozen that have more or less extensive application. Each one has been developed with the purpose of improving the relationships between employer and employee in regard to the division of the earnings and profits of industry, or to provide an extra reward for extra productive effort.

The "Safety-First" Movement and Workmen's Compensation

About 1910 American juries began to award large sums in suits for personal damages, where the plaintiff had been injured by machinery or otherwise in industry. Employers turned to liability-insurance companies to defend these suits and settle with their employees, thus bringing an outside party between them and their workers. Appreciation of the hazards in industry and the hardships endured by incapacitated workmen and their families, not only during the period of recovery from the injury itself but perhaps throughout the life of the wage earner due to decreased

earning power, gave rise to the "safety-first" movement and the enactment of workmen's compensation laws.

It is interesting to note that the safety-first movement was fostered largely by men residing west of Pittsburgh, many of whom were in the employ of large corporations where directorates were in New York City. Furthermore it was from the outset a young man's movement. Here and there a few progressive firms paid generous compensation voluntarily before laws were passed making this practice compulsory. Mr. John L. Henning instituted such a plan in 1904 in a mining operation in Louisiana of which he was chief engineer. This is the earliest attempt of this kind in the United States that has reached the author's attention.

In the enactment of compensation laws the rights and needs of the community were recognized. An entirely different view of the legal relationship of employer and employee was taken than that which had existed before, and which was summed up in the expression "master and servant." The responsibility for the injuries was placed squarely upon the industry through the employer, and in boards and commissions, machinery was set up to make sure that employees would receive the compensation to which they were entitled. The leader among the states having compensation laws is New Jersey and the effective date was July 4, 1911.

But the safety-first movement has yielded much more than this group of legal enactments. There has grown up a large body of practice in regard to safeguarding machinery and working spaces, establishing and operating first-aid rooms and factory hospitals, toward improving the heating, ventilation and sanitary conditions in factories, removing or mitigating conditions tending toward occupational disease, providing medical, dental and nursing service for the families of employees, establishing medical examinations before employment and at stated intervals thereafter, teaching personal hygiene to employees and their families, and, in fact, a complete new outlook in regard to the health and physical welfare of all who are engaged in industry. Through it all there has been a moral motive.

The movement has also brought into being two strong organizations, the National Safety Council and the Workmen's Compensation Bureau. In addition there is an association of physicians who are engaged in industrial practice.

The American Society of Mechanical Engineers has contributed to this development through taking the initiative in preparing several safety codes or standards. It is estimated that the safety-first movement of the past ten years has reduced the number of annual fatal accidents in the United States from 35,000 to 22,000 with a corresponding lessening of maiming and disabling accidents. This line of development is the most significant of all from the viewpoint of the interests of the community.

Employment Management

Since 1916 there has come into prominence what is now recognized as a new profession in industry, that of employment management. It comprehends in its broadest interpretation the establishment of all policies and direction of all of the functions having to do with personnel. It has taken over, expanded and developed the former work of hiring and discharging, has sought to reduce labor turnover and has fostered and directed those activities which are usually comprehended under the term welfare.

The oldest organized employment department of which the author has knowledge has been in operation about nineteen years in the plant of the B. F. Goodrich Company, Akron, Ohio. In 1907 Mr. H. F. J. Porter in a discussion of a paper presented before this Society called attention to the evils of labor turnover and outlined some methods that he had taken for its reduction. In 1914 Mr. Magnus W. Alexander presented a striking address before a convention of the National Machine Tool Builders' Association in which he gave statistics gathered from some twelve metal-working plants revealing the tremendous amount of the turnover of labor and its excessive cost. A small group of men in and around Boston, Mass., worked on this problem of employment for a number of years and as early as 1910 organized the Boston Employment Managers' Association.

But the movement did not gain headway until about 1916 when it was ready for the truly marvelous expansion that has taken place during the period of the war. No other line of development in industrial relations has had the rapidity of growth of employment management. But the impelling motive has not been entirely that of fostering good industrial relations, although that result has come in many cases where the work has been well done. The major reason in the minds of most industrial executives in establishing employment departments has been to secure employees during the period of labor scarcity and to find out why men leave. Another impetus to the movement came through the action of the United States Government in insisting that such departments should be installed in plants manufacturing munitions, war supplies and ships. To meet the demand for trained managers a number of colleges and universities established six-week courses in employment management under the direction of the War Department. Since the signing of the armistice several of these have been modified and put on what will probably prove to be a permanent basis.

Declared Rights in Industrial Relations

As a war measure President Wilson by proclamation created a National War Labor Board to establish principles and policies in regard to the employment and utilization of labor during the period of war, more particularly in war industries, and to set up machinery for considering and adjusting grievances. At the outset this Board declared three rights of labor: The right to organize and bargain collectively; the right to a limited number of hours of labor; the right to a living wage. The Peace Treaty written at Versailles recognizes these three rights and several other principles that are of "special and urgent importance." The recognition of these rights is a great step in the development of industrial relations, and they can never be abrogated in American industry. The same situation is reflected in British conditions as shown by the report of the Employers' Industrial Commission of the United States Department of Labor.

Mutual or Joint Control

The sixth major line of development has to do with control in industry. Students of the present condition of unrest have pointed out that the fundamental is a "struggle for control," the opposing forces being the owners and the workers. The expression "industrial democracy" is frequently used as describing a state that is about to come, or is now being ushered in. The parallel between our political democracy and the expected industrial form is sometimes put in this wise: The slogan that gave birth to this nation and brought our political democracy was, "No taxation without representation." The parallel slogan expressive of the movement to bring industrial democracy is "No control without representation."

The method that is being followed to put this ideal into practice is the shop committee. It is a new development. The oldest was put into effect in 1903 and most of them were started in 1918. Bridgeport alone has 44 plants where this system is in force. The plan installed by Mr. H. F. J. Porter in 1903 in the plant of the Nernst Lamp Company in Pittsburgh was described by him in an article published in *The Engineering Magazine* in August 1905. The shop committee was made up of secretly elected employees under the chairmanship of the shop superintendent. Conditions in the plant that might be bettered for the employees were discussed, and the committee evidently functioned as a safety-first committee as well as a representative shop committee.

Without doubt the success of the safety committees, with which there has been some six or seven years of experience, has paved the way in many plants for the representative shop committee. In fact, a prediction of this development is found in a paper presented before this Society in 1915 written by Mr. W. H. Cameron.

A general classification of these shop committee plans yields three types:

The first sets up an organization roughly paralleling the Cabinet, Senate and House of Representatives of the United States

Government. The Cabinet may consist of some or all of the directors or higher executives of the plant. The Senate may consist of all or a portion of the foremen, while the House of Representatives is a body secretly elected by the employees.

A second type divides the workers in the plants into divisions, each having a definitely determined and equal number of employees, not necessarily defined accord to craft or occupation. Any one division may include employees from several trades and doing varying kinds of work. Each division secretly elects its own representative, and these representatives coming together form the shop committee. This plan is simple, but is not adapted to industries where there is a high degree of organization or where the workers naturally divide into a series of recognized trades.

The third plan is the one adopted by the National War Labor Board and installed under its direction in a number of plants making war materials. Its essential features are outlined in the following official statement of procedure for election:

> Shop committees shall be selected to meet with an equal or lesser number of representatives to be selected by the employer. Each department or section of the shop shall be entitled to one committeeman for each one hundred employees employed in the department or section. If in any department or section there shall be employees in excess of an even hundred, then an additional committeeman may be elected providing the additional employees beyond the even hundred shall be fifty or more; if less than fifty no additional representation shall be allowed. As an example: In a department or section employing 330 men, three committeemen will be elected; in a department employing 375 men, four committeemen will be elected.

In plants where shop committees have been in operation for some time, a wide variety of topics has come up for discussion and determination. One grouping lists some forty-two different kinds of matters, of which only one was wages. The plans are too new, however, to estimate the extent of the effect they may have in developing good industrial relations. But a sufficient amount of experience has already been accumulated to indicate that the application of the ideas of joint consideration and control on the part of employers and employees will produce favorable results. To reach a workable basis, the employer must voluntarily limit his own authority and agree to conduct his business by the rule of reason and even-handed justice as interpreted by the representative shop committee that he may set up. The plan seems to restore, so far as possible in a large-scale business, the simple and effective relationship that used to exist between the master and skilled workman, and which largely exists even to-day between the small employer and his half-dozen employees.

A rather more formal mechanism for establishing representation in industry is the protocol system worked out in the coat and suit trade in New York City, and which has been applied in a few other instances in similar trades.

From one viewpoint the rapidly developing movement to put shop committees into effect in the United States is a confession on the part of employers and those who have the responsibility for industrial enterprises that they have already lost some of their control. Under such condition there is a readiness to experiment. From another viewpoint it is an earnest attempt to find a basis of democratic coöperation in the control of industry.

A parallel movement has taken place in Great Britain leading to the proposal to establish Industrial Councils through which the British Government may promote effective coöperation between the organized employers and workers, believing that representative government in industry will foster good relations.

DEVELOPMENT OF MOTIVES

After having sketched these six lines of development in improving industrial relations and in building up a great body of principle, practice and law, it is wise to examine some of the predominating motives.

One that came into play early and brought to the front those practices and activities summed up under the headings welfare work and industrial betterment was the motive of altruism. The successful manufacturer, taking the part of the autocratic benefactor, enjoyed the swelling of the heart and feeling of personal gratification that came to him when he arranged for the spending of money to provide conveniences and benefits for his employees, as bathrooms, restaurants, flower gardens, reading rooms, rest rooms, and the like. But workers are quick to resent favors if they are substituted for justice, and the welfare movement as such has very properly been discredited and has practically disappeared, although many of its activities have been retained but inspired by a different and proper motive.

The safety-first movement from its inception was influenced by engineers who saw the essential economy in preserving the life and limb of the workers. The employers translated this engineering economic viewpoint into the commercial motive "it pays." Selfish though this was and is, nevertheless it was neither charitable nor paternalistic, and because the movement had a firm basis in sound industrial economics and in morals it has met with deserved and widespread success.

But even this engineering-commercial motive is inadequate to provide the impetus for the developing of the industrial relations that we all hope for. It does not comprehend the interests of all who are dependent upon and must be served by productive industry; so many of the leaders of thought on industrial matters have declared and emphasized another motive, saying that it must predominate and prevail, else we will never have the development that we need. This is the one of *service*. A recent magazine article by Mr. H. L. Gantt clearly presents this motive. Once it becomes active we can hope for the working out of a new body of principle and practice in regard to industrial relations that will bring far happier conditions than any we have yet experienced.

INTERESTS IN INDUSTRY

With this development of motive has been a broadening of the recognition of those who are interested in the proper carrying on of industry itself. In the early days the expression "master and man" or the legal "master and servant" summed up these interests and relationships, but as industry developed and the clash of rights, needs and aspirations became apparent the familiar term became "capital and labor," used more particularly to denominate antagonistic forces. In fact, this term is used very generally at the present time, although it has been pointed out that there can be no conflict between capital as such and labor, for we cannot conceive of a man fighting with accumulated wealth represented in the physical means of production. So, to clarify thinking, some authors have insisted that we should use the term "capitalists and laborers" instead of capital and labor. Point is given to this contention by a quotation from a speech delivered by President Lincoln before the Wisconsin Agricultural Society in 1859: "Labor is prior to, and independent of, capital —in fact, capital is the fruit of labor, and could never have existed if labor had not first existed. Labor can exist without capital, but capital could never have existed without labor."

The next development of interests brought consideration of the needs and rights of the public, which depends upon the proper carrying on of industry for much of its well-being. This thought brought a new grouping—"capitalists, laborers and the public." Quite recently in studies of industrial relations some writers have included five parties, namely: The capitalists who supply the materials and means for production; the laborers who supply productive capacity; the managers who provide direction and control; the community in which the industry is located and upon whose operation its welfare to a certain extent depends; and the public that purchases the articles and goods produced.

There is more than ample reason for including the interests of the community and public in any such classification. The laws regulating the hours of labor for women and children, for the elimination of hazards in industry, and for compensation for industrial accidents are but one expression of the rights of the community as well as the worker in the operation of industry.

Before justice can be framed in the form of law there must have been developed a body of general principles. It is evident that the principles underlying industrial relations are now in a process of rapid formulation. It is probable that before long our courts will have to pass upon an increasing number of industrial-

(*Concluded on page 556*)

Production of Liberty Motor Parts at Ford Plant

By W. F. Verner,[1] Detroit Mich.

The Liberty motor was designed for quantity production and consequently many interesting methods were developed to speed up the work. Those employed in producing cylinders in six operations are particularly unique and this paper gives a brief account of the process as carried on at the Ford Motor Company's plant at Detroit during the period November 1917 to December 1918. A description is also given of the twenty-one operations necessary to produce connecting-rod crankshaft bearings, and in the complete paper will be found details regarding the method of installing crankshaft bearings in the upper and lower halves of the crankcase.

On November 22, 1917, the Ford Motor Company entered into a contract with the United States Government to build 5000 Liberty motors. The contract was accepted at a time when Ford cars were being manufactured at the rate of 3500 per day and to change over from their production to that of Liberty motors was by no means a minor undertaking. The manufacture of Liberty motors differs in many essentials from the manufacture of the ordinary type of motor used for automobiles, and of the 14,000 tools used on Ford car production only 987 were adaptable to the production of Liberty motors.

It was estimated that 350,000 sq. ft. of floor space would be required to produce 50 Liberty motors per day of eight hours. The ultimate space required was 550,000 sq. ft. As no floor space was available, this necessitated the dismantling and removing of several thousand machines and the rearrangement of over 50 per cent of the regular plant equipment. The new arrangement was so made as to allow an entire building for the production of Liberty motors. This permitted the concentration of production and therefore maximum efficiency and production in the shortest time, and since production in the shortest time possible was the great issue, no expense was spared in this shop rearrangement.

The shifting of labor from standard-car production to Liberty motor production was gradual. No labor trouble was experienced as the curtailment in regular products released enough labor for the production of Liberty motors. Table 1 shows the growth in the number of men employed in the Liberty Motor Department.

TABLE 1 SHOWING GROWTH OF FORCE BUILDING LIBERTY MOTORS AT FORD MOTOR CO. WORKS

Date	No. of Men Employed	Date	No. of Men Employed
Nov. 22, 1917	0	Aug. 1, 1918	7,976
Feb. 2, 1918	675	Sept. 5, 1918	9,390
March 1, 1918	779	Oct. 1, 1918	10,653
April 1, 1918	1,550	Nov. 1, 1918	11,288
May 1, 1918	2,450	Dec. 1, 1918	826
June 1, 1918	3,412	Jan. 2, 1919	543
July 1, 1918	5,141		

In accordance with the terms of the contract deliveries were planned as follows:

April 1918	200
May 1918	800
June 1918	1000
July 1918	1000
August 1918	1000
September 1918	1000
Total	5000

This schedule was subsequently revised with instructions from the Government to attain a maximum production of 100 motors per day in anticipation of an order for 7000 additional motors. The schedule was revised to obtain a production of 2500 motors per month by December 1918.

Production was fast approaching the goal when the armistice was signed, as evidenced by Fig. 1, which shows the production of Liberty motors at the works of the Ford Motor Company for the period from November 1917 to December 1918. As is invariably the case in any new undertaking, the production of these motors was retarded by many factors which it was the effort of the engineers to eliminate. Among the predominating ones were the following:

1 Orders for raw material could not be placed immediately on account of incomplete detailed specifications
2 There were many changes. For a period of 14 months, 1013 changes were authorized: March 1918 showing 167, April 109 and May 115; then tapering off to December 1918 which showed only eight changes. These changes represent Government changes and do not include those made by Ford Motor Company in dies, jigs and fixtures, which averaged from three to five for each of the above

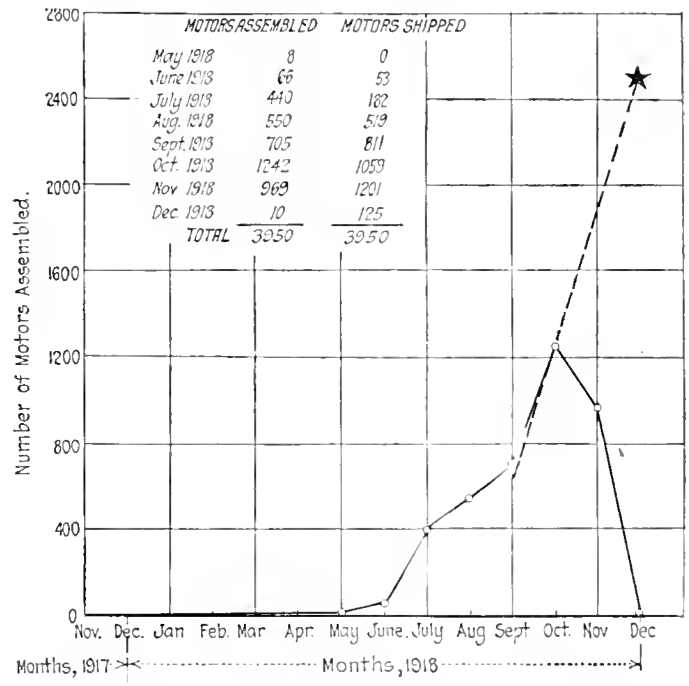


Fig. 1 Production of Liberty Motors at the Ford Motor Company's Plant

3 Material specifications were constantly revised
4 Shortage of fuel, especially with sub-contractors
5 Railroad embargoes delayed shipment on shop machines and raw materials
6 A-4 priority on shop machinery instead of A-1
7 Lack of acceptable thread gages
8 Lack of actual shop experience by Government inspectors.

The falling off in production in November was of course due to the signing of the armistice. On the day the armistice was signed, the highest mark was reached in the number of motors assembled in one day, namely, seventy-five.

Method of Producing Motor Cylinders

Several major and important developments were brought about by the Production Department of the Ford Motor Company. First among these was the cylinder forging made from tubing.

[1] Mechanical Engineer, Ford Motor Company, Detroit, Mich. Mem.Am. Soc.M.E.

For presentation at the Spring Meeting, Detroit, Mich., June 16 to 19, 1919, of The American Society of Mechanical Engineers. Contributed by the Detroit Section. The paper is here printed in abstract form and copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

This method resulted in an enormous saving when considering the cost of machining a cylinder from a solid forging and also the cost of making a solid forging. The Liberty motor cylinder was forged from a high-carbon steel tube $5^3/_4$ in. outside diameter, $4^3/_4$ in. inside diameter by $39^3/_4$ in. mill length, and completed in six operations as follows:

Operation A—Cut off
Operation B—Close head
Operation C—Form the head
Operation D—Rough-drill bosses for inlet- and exhaust-valve ports
Operation E—Upset and form flange
Operation F—Heat-treat.

Operation A—Cut Off. The tube was heated, at the point at which it was to be cut to about 1200 deg. fahr., in a specially

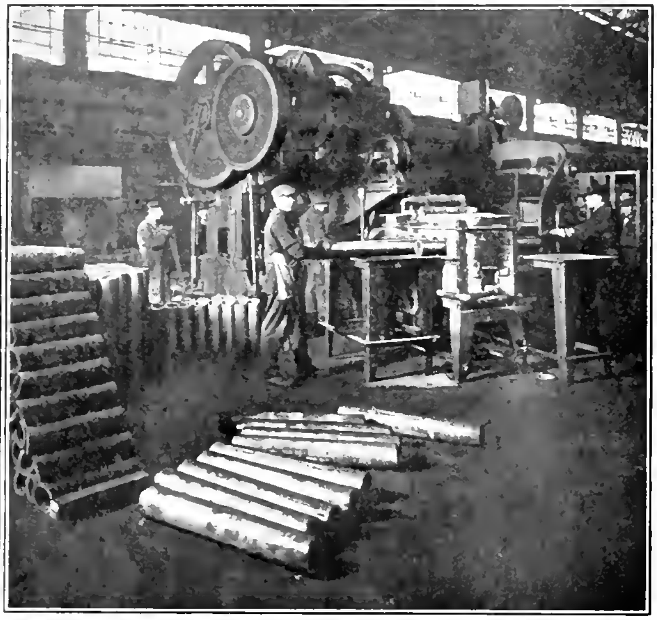


FIG. 2 GAS FURNACE FOR HEATING TUBES—OPERATION A

designed rectangular gas furnace having a series of circular openings along two sides, and through which the tubes were inserted. The capacity of the furnace (Fig. 2) was such that the successive tubes were heated sufficiently for cutting within the time required for the cutting operation. Once started, the operation was continuous with a production rate of 150 tubes per hr. per machine.

Upon removing the tube from the furnace it was placed in the shearing die of a press equipped with a special punch and die. The tube was then fitted with an arbor so constructed that as the punch of the press sheared the outer wall of the tube, the arbor transmitted the shearing power to the lower wall, thus shearing the whole without distorting the tube. The punch and die were set on the press so that the end of the tube was cut at an angle of 19 deg. with the center line of the tube, to the required length of $20^5/_8$ in. at one side of the angle and $19^1/_8$ in. at the other side. This angular cut was essential to Operation B.

Operation B—Close Head. It was considered for a long time next to impossible to forge a Liberty motor cylinder from a tube on account of the manufacturing difficulties encountered in closing the head. When the end of the tube to be closed was cut at right angles to the center line, it was found unsatisfactory due to cold shuts or unfused sections in the metal occurring in the center of the dome.

However, by cutting the tube at an angle of 19 deg. with the center line of the tube it was found that the forming dies could be so constructed as to cup or draw inward the tube wall, the high or extended portion of the wall causing the converging or closing of the metal to one side of the center line of the tube until, in the final forming of the head, the metal was joined at right angles to the 19-deg. cut (See Fig. 3.) After this operation the appearance of the closed end resembled the common type of explosive shell with the nose portion at an angle of 19 deg. The central portion of the dome is thus formed without a weld and retains to the fullest extent its fibrous strength.

The angular head of the tube was then heated in a furnace similar to the one previously described to about 1900 deg. fahr. preparatory to forming the head so that the point could be used as a part of the boss which later was drilled for an intake or exhaust post.

The die used in this operation was of the double-action type and comprised two semicircular steel jaws, tapered on the upper outside diameter and pivoted in the rear to swing horizontally. A cast-iron locking plate was attached to the blanking foot of the press and tapered to correspond to the taper of the jaws, so that when the blanking foot was in down position the tapered surfaces of the jaws served to lock the tube in position. The interior upper parts of the jaws were bored and fitted with split bushings or bronze bearings to fit the punch. Resting flush normally with the upper surface of the jaw was a semicircular steel supporting band equipped with three guide pins supported on springs.

When the jaws were swung in position around the tube, they formed a steel ring which gripped the tube around the top or heated portion and as the punch descended, the ring slipped down the tube, and the supporting springs depressing under the pressure of the punch thus prevented the tube from bulging when the punch closed in the head. The punch was designed so that the dome was drawn to a point 19 deg. to one side of the center line of the tube, as previously described.

Operation C—Form the Head. This operation was performed on a press (Fig. 4) provided with a specially designed punch and die. To serve as a die, a bolster or base plate was mounted on the bed of the press. The base plate was bored in the center to re-

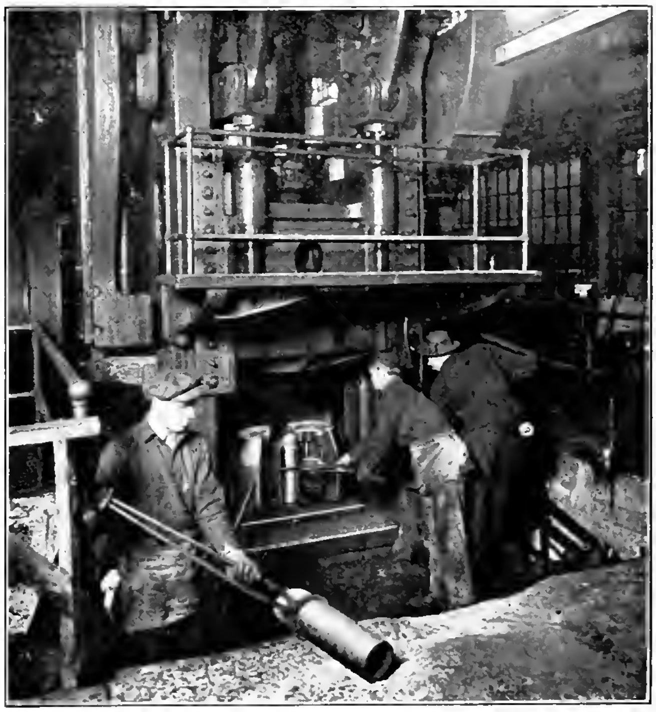


FIG. 3 PRELIMINARY FORMING OF THE CYLINDER HEAD—OPERATION B

ceive the shank end of an upright cylindrical locating arbor and counterbored to receive a thrust plate. Two sections made up the arbor, the lower of which was made of soft steel bored to receive the hardened-steel tip or top section. The top section tapered slightly inward at the extreme end and the top surface was curved to properly form the dome or head of the cylinder.

Horizontal sliding jaws around the locating arbor were held open by springs and operated by cams attached to the ram of the press. The upper interior portion of the jaws was shaped to form the expanded area for the combustion chamber. When the jaws were closed by the cams, they fitted snugly around the punch.

As the ram descended, the cams attached thereto forced the jaws together so that as the punch pressed down the head of the tube on the arbor it formed the valve-port and spark-plug bosses and the jaws formed the expanded area for the combustion chamber. On the back stroke, the jaws were forced apart by the springs as soon as the pressure of the cams relaxed. In case of adhesion to the cylinder, a wedge attached to the ram and operating between the two ends of the jaws breaks the adhesion on the back stroke. A knock-out sleeve located about the base of the arbor and operated by an arm beneath the bed of the press on the back stroke was carried upward and loosened the cylinder on the arbor. Production on one machine totaled 150 per hour.

Operation D—Rough-Drill Bosses for Inlet- and Exhaust-Valve Ports. The cylinder was held in a trunnion fixture attached to a drill press so that the center line of the valve port swung in line with the spindle. The cylinder was located by using the valve-port bosses.

Operation E—Upset and Form Flange. These operations were performed on a 5-in. forging machine in one heat-treat on two separate dies. The die used for the first portion of the operation (upset) comprised two horizontal sliding steel jaws operated by cams and bored at both ends to fit tightly about the body of the cylinder. At the middle the jaws were undercut or recessed so that in the upsetting the metal would so flow as to form a heavy ring of metal at the section at which the flange was to be located on the cylinder. The punch was in the form of a mandrel with a shoulder which fitted the closed jaws and which on striking the bottom of the skirt or open end of the cylinder forced the heated metal to the proper upset dimensions about the mandrel and in the recess of the jaws.

The die employed in the second portion of the operation (form flange) was of the same type above described, with the exception

Fig. 4 Press Used in Final Forming of Cylinder Head—Operation C

that the jaws were counterbored at the entrance end to the forged flange dimensions, instead of being recessed in the middle. The punch consisted of a mandrel with a shoulder surrounded by a sleeve which extended beyond the shoulder. The sleeve fitted the closed jaw of the die and the inside extended portion upset the metal by pressing it against the die, thus forming the flange. The sleeve was provided with two vent holes permitting gases that might be formed during the forging to escape.

In operation the skirt of the cylinder was first heated to about 1900 deg. fahr. in a furnace, then dipped in water to a depth of about 1½ in. This cooling was done to form a ring of hard metal at the bottom of the skirt for the punch to act upon. The cylinder was then placed in the forging machine and the flange made. Production totaled 85 per hour on one machine.

Operation F—Heat-Treat. The completed forged cylinder was placed in a large rectangular heat-treating furnace and heated to a temperature of 1525 deg. fahr. and then quenched in a brine solution. After quenching it was heated in an annealing furnace to a temperature of 1125 deg. fahr. and cooled in air. Brinell test was 217-255. This heat treatment left the cylinder ready for the machine operations.

Method of Machining Connecting-Rod Crankshaft Bearings

Next in importance to the method just described of producing Liberty motor cylinders was the development of a special process of making bronze babbitt-lined bearings for the crankshaft end of

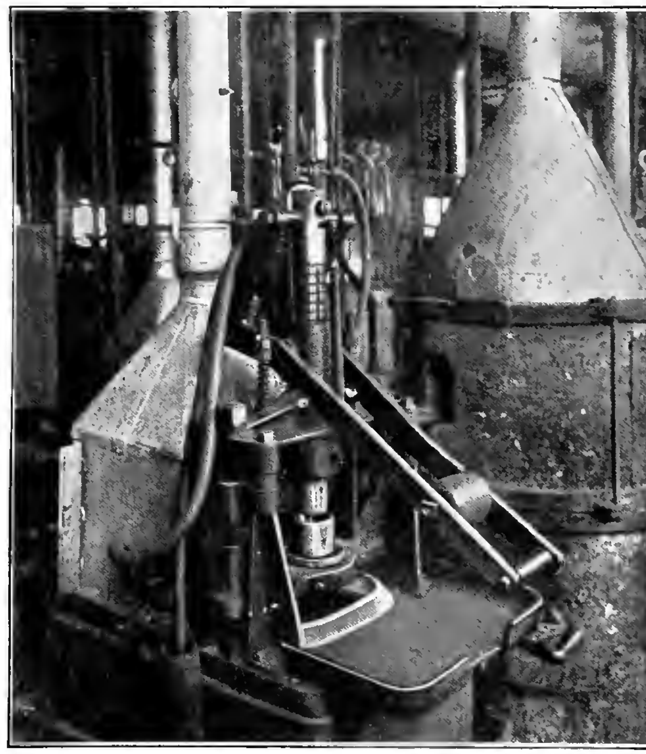


Fig. 5 Babbitting Machine—Operation 4

connecting rods which would stand up under the Government's 50-hour test. The method comprised 21 operations, as follows:

1. Rough-drill closed end
2. Rough- and finish-bore bronze and face one end
3. Turn outside diameter to fit babbitting fixture and face one end
4. Babbitt
5. Cut off gate, rough- and finish-bore babbitt
6. Finish-turn outside diameter to 3.095 in. and face ends to length
7. Press in broaching ring
8. Broach hole to 2.4275 in. in diameter
9. Press out of broaching ring
10. Grind outside diameter to 3.075 in.
11. Cut in halves with 3/64 in. saw (2 on)
12. Close in
13. Swage
14. Finish-mill the parting line
15. Face ends to length
16. Fillet both ends
17. Cut two grooves for forked-end rod
18. Drill and ream dowel holes in lower half bearing only
19. Cut two ⅛-in. semicircular oil grooves on the parting line
20. Cut twelve oil pockets in both halves
21. Burr.

Operation 1—Rough-Drill Closed End. A 21-in. drilling ma-

chine was used in this operation, which was necessary only on castings where a thin web of metal entirely closed one end.

Operation 2—Rough- and Finish-Bore Bronze and Face One End. This operation was performed in a 12-spindle 14-in. multiple machine. The bushings were gripped in a chuck and bored at the rate of about 80 per hour.

Operation 3—Turn Outside Diameter to Fit Babbitting Fixture and Face One End. A 12-spindle 14-in. multiple machine was also used for this operation. The bushings after boring were clamped on special arbors and the outside diameter turned to fit babbitting fixture.

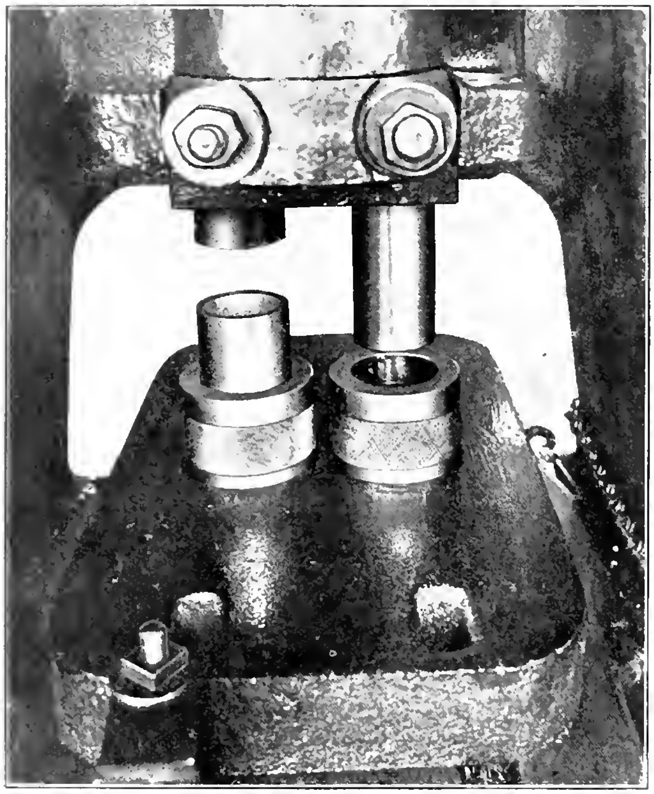


FIG. 6 PRESSING IN BROACHING RING—OPERATION 7

Operation 4—Babbitt. The equipment required for this operation consisted of acid vats, tinning furnaces, die-casting machines with water circulating systems, a furnace large enough to supply a unit of four die-casting machines with molten babbitt and a compressed-air outfit to use with the gas furnaces.

The bushing was first dipped into a flux made proportionately of 11 lb. sal ammoniac, 9 lb. zinc chloride, 6 qt. muriatic acid and 13 qt. water. The hydrometer reading was 23 to 25 deg. B.

Before placing the bushing in the specially designed die-casting machine to be babbitted it was immersed in the molten tin. The die casting machine, Fig. 5, consisted of a rectangular plate mounted on suitable legs or base, having a cored hole for receiving a crucible containing the metal; a crucible with suitable rim having two bosses on which were fitted bearings for a pump-lever shaft; a pump fastened to two bosses of the rectangular plate for forcing the metal through a nozzle into the die proper; and a fixture mounted on the plate straddling the pot for casting the bearing.

The fixture for casting the bearing was made up of a circulating water cooled mandrel or arbor sliding vertically in a housing. This housing was secured to two side support brackets which were bolted to the plate. The lower die holder carrying the die spans the crucible and slides vertically on guide pins. Springs received the weight of the holder in suspension. Just inside of the guide-pin bearings and screwed into the holder were two suitable rods which extended through the housing. The housing was drilled and counterbored to receive rods and springs. The lower die holder in its normal or loading position was suspended on the springs so that the opening or gate of the die was slightly above the nozzle of the pump.

For babbitting, a tinned bushing was inserted in the lower die and the water-cooled arbor was moved downward until stopped by the arbor stripper ring, clamping on the upper end of the bushing to be babbitted and the gate end of the lower die on the pump nozzle. The movement of the arbor was controlled by an upward movement of the hand lever. While holding the arbor firmly in position with one hand, the operator with the other hand pulls upward on another hand lever attached to the pump lever, thereby forcing the molten babbitt from the pump cylinder through the nozzles and into the bushing.

The metal was allowed to set for about 30 sec., when the pump-control lever was pushed downward. The piston of the pump upon its return uncovers ports permitting molten metal to flow into the cylinder preparatory to another casting. Simultaneously the arbor-control lever was thrown downward, assisted by the weighted end, causing the arbor stripper ring to strike violently against the lower face of the arbor housing and thereby stripping the babbitted bushing from the arbor. This upper movement of the arbor allowed the lower die holder to regain its normal position

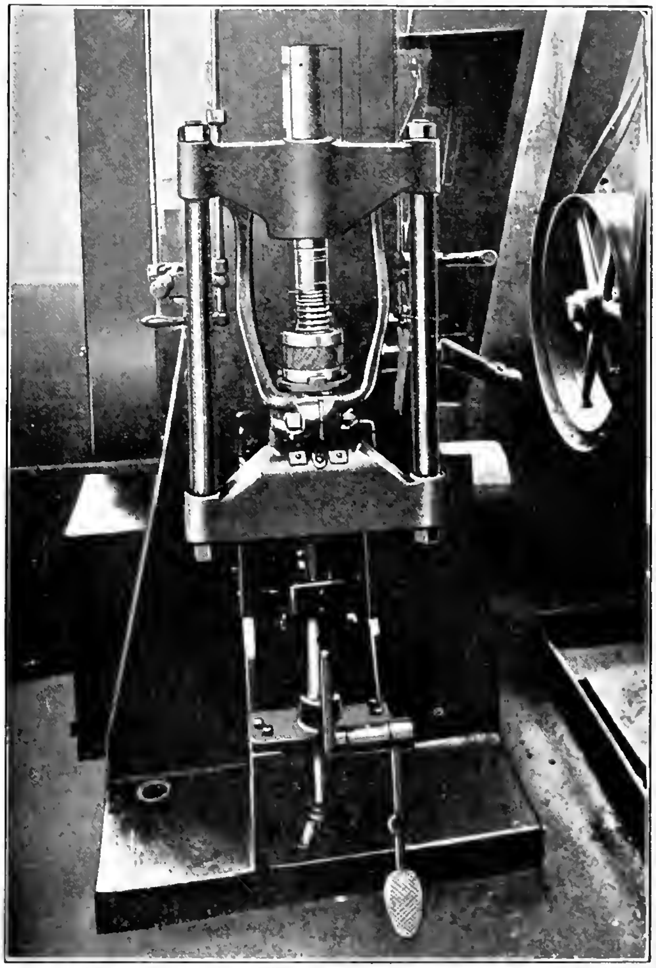


FIG. 7 SPECIAL BROACHING MACHINE—OPERATION 8

and severed the connection between the lower die and pump nozzle, which assured the bushing sticking to the water-cooled arbor and not becoming gate-anchored to the lower die. The thickness of the babbitt wall at the top for best results in babbitting was 3/32 in. and for the bottom 3/16 in.

Operation 5—Cut Off Gate, Rough- and Finish-Bore Babbitt. Geared-head screw machines were used for this operation. The bushing was held by a three-jaw clutch; an ordinary cut-off tool held in the tool block of the cross-slide was used for cutting off the gate, and a boring bar with two cutters (one for roughing and one for finishing) was mounted in the turret for boring hole to proper diameter, with an allowance for broaching.

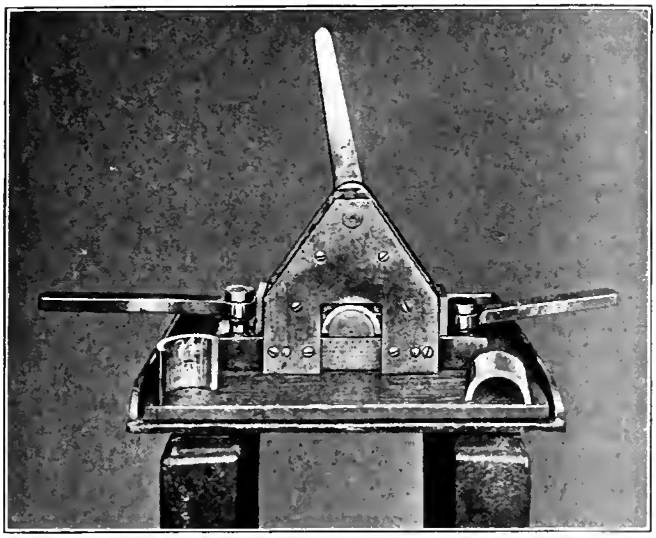


Fig. 8 Machine for Bending Bearings—Operation 12

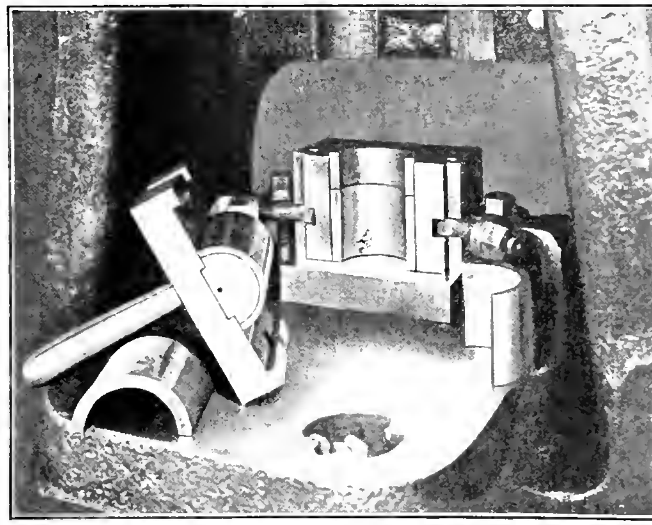


Fig. 9 Upsetting of Bearings to Finished Dimensions—Operation 13

Operation 6—Finish-Turn Outside Diameter to 3.085 In. and Face Ends to Length. In this operation 14-in. x 4-ft. lathes with back-arm attachments were used. The bushings were held on an expanded arbor, which was held in the spindle of the machine. A cutter mounted in the tool block of the lathe cross-slide turned the outside diameter to fit the broaching ring. The back arm carried a tool block with two cutters spaced to face the bushing to its proper length.

Operation 7—Press in Broaching Ring. For this operation (see Fig. 6) a bolster plate with two holes bored large enough to allow the bushing to drop through and counterbored to suit outside diameter of the broaching ring was strapped to the bed of a press. In the ram of the machine were carried two cylindrical punches slightly smaller in diameter than the outside diameter of the bushing but differing in length.

In operation a ring into which had been pressed a broached bushing was placed in the counterbored hole under the long punch and a bushing that was not broached was slightly entered into an empty ring and placed under the short punch. When the press was tripped, the long punch forced the broached bushing out of the ring and the short punch forced the bushing, which had not been broached into the ring.

Operation 8—Broach Hole to 2.4275 In. Diameter. A special broaching machine, Fig. 7, was designed for this operation. The legs were removed from a No. 1 Knowles keyseater and the body complete with gears, rack, slide, etc., was bolted in a vertical position to a special base casting. An upper guide of cast iron, with a hardened and ground steel bushing for the broach-holder quill was dovetailed to the ways of the machine. Below this upper guide was the extended work-holding bracket (a part of the bed of the Knowles keyseater) which carried the work holder. This work holder was a hardened steel bushing ground on its outside diameter to fit the hole in the bracket and counterbored to fit the broaching ring. On the special base casting below the work-holding support was bolted the lower guide, a gray-iron casting with a hardened bushing ground to fit the broach holder. The broach holder was a long tool-steel bar hardened and ground on one end to fit the guide bushings and on the other end to fit the holes in broach and broach-holder quill.

The foot-pedal bracket was bolted to the base of the machine and was bored to fit the broach holder to which it served to guide and keep in alignment. Between the lower guide casting and the foot-pedal bracket was disposed a collar firmly fastened to the broach holder, and attached to this collar was a yoked lever. This lever was so fulcrumed that the weight of the broach was just slightly more than counterbalanced by a cast-iron weight which insured the broach end of the holder being piloted in the quill when the broaching was being done. A hand lever with lift rods was attached to the yoked lever to control the loading.

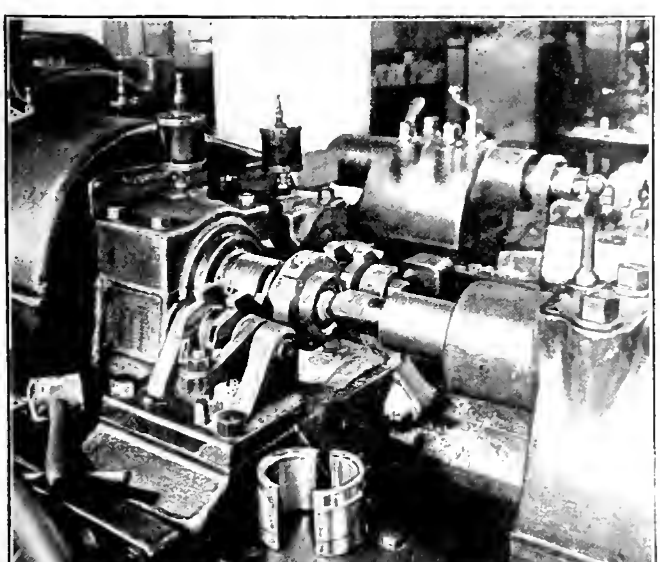


Fig. 10 Method of Cutting Grooves for Forked-End Rod—Operation 17

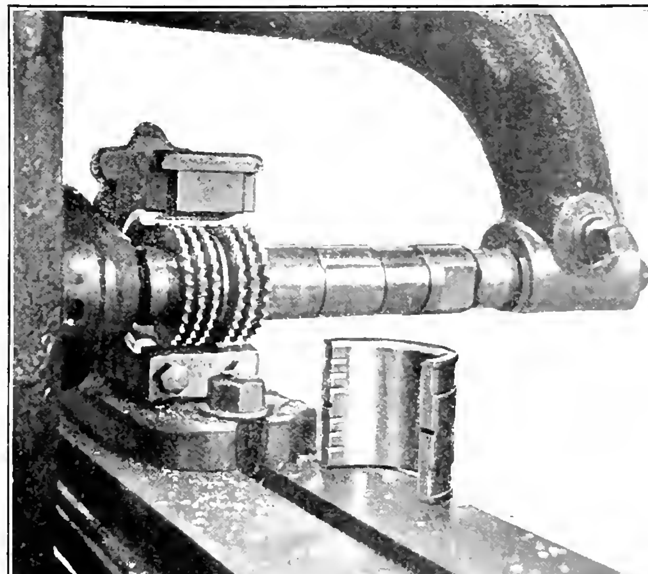


Fig. 11 Method of Cutting Oil Grooves—Operation 20

The broach had eight cutting edges varying in size from 2.422 in. diam. to 2.4273 in. diam. In addition to the cutting edges, the upper end of the broach had three burnishing surfaces, the diameters of which were 2.4274 in. The broach was 5 in. long and had a hole ground to 1.625 in. diam. to fit the end of the broach holder.

In operation the keyseater functions normally, with the exception that the down (or what would be the return) stroke of the ram is utilized for pushing the broach through the work. The hand lever controlling the broach holder is pulled down until the latch on the foot lever engages the top of the collar on the broach holder. This operation holds the pilot end of the holder and the broach-holder quill apart, allowing the broaching ring containing the work to be mounted in place. The broach holder was then allowed to ascend until the end of the holder protruded enough to allow slipping on the broach, and then further until its end was piloted in the hole of the quill. The machine was then tripped and the broaching was done on the downward stroke of the slide carrying the quill, the broach being forced through the work by the pressure exerted on descending quill. This downward stroke was carried far enough to allow the foot-lever latch to engage the collar on the broach holder automatically. The machine was reversed, disengaging the quill and the broach holder. The broaching ring containing the work was then lifted out and the broach was removed from the holder, leaving the machine ready for the next operation.

Operation 9—Press Out of Broaching Ring. This operation has been previously described under Operation 7, and is shown in Fig. 6.

Operation 10—Grind Outside Diameter to 3.075 In. The bushing was ground between centers on a 6 x 18-in. plain grinder. A split hardened steel ring ground on its outside to a diameter of 2.4275 in. was inserted in the bushing and a hardened arbor ground with a slight taper was in turn inserted into the split ring, the hole of the latter being ground tapering to conform to the arbor. A light pressure applied to the end of the arbor expanded the ring sufficiently to firmly hold the bushing for grinding.

Operation 11—Cut in Halves with 3/64-in. Saw (2 on). This operation was done on a plain milling machine with an indexing type of fixture. The work-holding arbor of the fixture was made long enough to accommodate two bushings. The bushings were clamped on the arbor with a "C" washer and stud bolt. A common 3/64-in.-wide milling cutter was used.

Operation 12—Close In. After being cut in half, the bearings were bent to decrease their diameter so as to allow their fitting easily into the swaging fixture used in Operation 13. The bending fixture, Fig. 8, was made with a semicircular arbor bolted to a base plate. A housing with three cam-lever slides was fastened to the base plates. Openings in both sides of the housing allowed for the insertion of the bearing over the arbor. The top cam lever clamped the work in position and the side cam levers closed in the bearing the necessary amount.

Operation 13—Swage. This operation, which was performed on a press, was the keystone operation in the successful production of accurate bearings, as the set given them insured their holding the shape of the master forms.

The fixture, Fig. 9, comprised a hardened and ground steel base plate fastened to a hardened steel form. Two eyebolts were held by pins in each side of the form. These parts assembled formed the female section and were fastened to the bolster plate. The male section was made up of a half-round arbor of hardened steel on the clamping plate, the joining surfaces of which were also ground. Two slots in each end of the clamping plate allow the eyebolts to hold the two sections together. A tongue-and-groove construction on the joint surfaces of the sections kept them in alignment. A filler piece made of hardened steel and ground to the finished bearing dimensions was used to take the flow from the ram of the press. A hardened-steel cylindrical punch with a flat-ground bottom surface was fitted into the ram of the machine.

In operation, a half-bearing with a filler piece on top of it was clamped between the male and female section of the fixture; the press was then tripped and the cylindrical punch on descending struck the filler piece, which projected slightly above the upper surface of the fixture. This upset the metal to the finished bearing dimensions with an allowance on the parting-line surfaces of about 0.003 in. for finish-milling.

Operation 14—Finish-Mill the Parting Line. A plain milling machine on this operation was very satisfactory considering the close limits of plus or minus 0.00025 in. A fixture with a half-round seat or nest bored to fit the outside diameter of the half-bearing was bolted to the plate of the machine. The parting-line surfaces of the half-bearing were leveled by the hinge gage attached to the fixture. The work was clamped with a half-round hardened and ground steel clamp, the curved surface of which was made to fit the inside diameter of the half-bearing. Two plain milling cutters were mounted on the arbor and were so spaced that they straddled the clamping bolt and nut.

Operation 15—Face Ends to Length. A 14-in. x 4-ft. lathe without a tailstock was used for this operation. A hinged clamping ring was used to clamp the work tight on the steel arbor, which was mounted in the spindle of the lathe. Two halves, or one complete bearing, were machined at one setting. A special tool block with two cutters straddling the clamping ring faced the bearing to the proper length.

Operation 16—Fillet Both Ends. The fillet cuts in both ends of the bearing, to clear the radius of the crankshaft pin, was done on 21-in. drill presses. The fixture comprised a circular-shaped base bored in the center to receive a flanged hardened-steel pilot bushing. The outside diameter of this pilot bushing above the flange was made to fit the inside diameter of the bearings and the hole of the pilot bushing was a fit to the pilot of the filleting cutting holder. The half-bearings were clamped in pairs about the piloting bushing by means of two hinged clamps rotating on a pin located in the rear of the fixture. A single formed filleting center was fastened in a slotted holder. The holder was held in the spindle of the drill press with a tapered shank.

Operation 17—Cut Two Grooves for Forked-End Rod. A 14-in. x 5-ft. lathe, Fig. 10, with a special cross-slide arranged with front and back tool blocks, was used for this operation. A stub arbor mounted in the spindle of the machine was made with a flange to serve as a stop for locating the work while clamping with a hinged ring, similar to the one used for Operation 15. The half bearings were clamped on the arbor at one setting. The arbor was provided with a center so that the lathe tailstock could be utilized to stiffen the support of the work under the pressure of the cut. The grooving cutters were of the circular forming type, with six cutting edges. The adjustment of the cutting edges was controlled by the movement of a toothed lever. The teeth of this lever meshed with the teeth in the boss about the center of the grooving cutter. The cutter in the rear tool block was used for roughing, and the front cutter for finishing. Suitable stops were arranged on the cross-slide to control the depth of the cut.

Operation 18—Drill and Ream Dowel Holes in Lower Half-Bearings Only. A two-spindle 14-in. drill was used on this operation. The drill jig comprised a base with side supports, to which was fastened the drilling plate. On the under side of this plate was fastened a locating block formed to fit the contour of the work. A slide disposed between the side supports and actuated by a cam lever served to clamp the work in position for drilling and reaming. Slip bushings were used in the drilling plate, one for the drill and one for the reamer to insure accuracy.

Operation 19—Cut Two 1/8-in. Semicircular Oil Grooves on the Parting Line. This operation was done on a hand miller. The cast-iron fixture supported the work in a semicircular nest and was clamped in place with a strap and thumbscrew.

Operation 20—Cut 12 Oil Pockets in Both Halves. This operation was also done on a hand miller. The fixture, Fig. 11, was made to so clamp the work that the parting surfaces were in a vertical position. The oil pockets were cut on a radius; the cut being 1/32 in. deep at the parting line and running out to the inner surface of the bearing 1/4 in. below the parting line. An arbor with six 1/32-in. wide plain cutters properly spaced was mounted in the spindle of the machine and supported by the over arm.

Operation 21—Burr. A No 1 keyseater was used for removing

(Concluded on page 556)

Economy of Arizona Power Plants Using Oil Fuel

By C. R. Weymouth,[1] San Francisco, Cal.

This paper treats of the performances of three steam-electric power plants situated in Arizona where load factor and high fuel cost demand economical operation. Tables and curves of operating characteristics are accordingly given and some of the difficulties encountered in practice are enumerated.

In certain Arizona steam power plants the combination of favorable load factor and high fuel cost has not only nessitated but has also made possible the attainment of high fuel economy, and even in plants where cooling ponds are used for condensing purposes. This paper refers to the performance of three such power plants, namely, those of the Inspiration Consolidated Copper Company, Inspiration, Ariz.; the New Cornelia Copper Company, Ajo, Ariz.; and the Arizona Power Company, Clarkdale, Ariz. These plants embody many similar features. They differ, however, in methods of condensing as cooling ponds are used at the Inspiration and New Cornelia plants, and water from the Verde River at the Arizona Power Company's plant.

The Inspiration plant was designed in the winter of 1913-14. The International Smelting and Refining Company's smelter adjoins the Inspiration power plant site, and the steam generated in wasteheat boilers in the smelters is utilized for the operation of the reciprocating blowing engines, which are designed for about 175 lb. steam pressure. These blowing engines are located in the same power-plant building as the steam turbines, and since the waste-heat boilers are connected to the same steam header as the oil-fired boilers, their steam pressure and the economy of the turbine plant have been limited by the common steam pressure of from 175 to 185 lb. The New Cornelia Copper Company's plant was designed in the winter of 1915-16, and being independent of blowing engines, the boilers were selected for 250 lb. pressure. While a higher steam pressure would have been possible, the remote location of the plant and experience at the date of design led to the lower boiler pressure being selected. The Arizona Power Company's plant was designed in the winter of 1916-17, and has boilers for 250 lb. pressure.

The Inspiration plant is 25-cycle, 3-phase, 6500 volts. The New Cornelia plant and the Arizona Power Company's plant are both 60-cycle 3-phase, 2300 volts. The maximum load at the Inspiration plant was estimated to be 12,000 kw.; three 6000-kw. Curtis turbines were therefore selected, thus giving one spare turbine. For the New Cornelia Copper Company's plant the load was estimated to be 7500 kw., and this led to the selection of two 7500-kw. turbines, one unit being a spare. The Arizona Power Company's plant was designed as an auxiliary to a hydroelectric system, and intended to carry a peak load of 5000 kw. Owing to the quick shipment required, however, a turbine previously ordered for another company, and rated at 6000 kw., was installed, whereas the remaining equipment was selected for a 5000-kw. load.

All three plants have Stirling steel-encased boilers, with Peabody-Hammel oil furnaces, Green fuel economizers, Moore automatic fuel-oil regulating systems, Wheeler surface condensers, Wheeler dry vacuum pumps, centrifugal hotwell pumps, direct-connected exciters, steamer-driven boiler-feed pumps, etc. Superheaters are installed in all plants, specified to give 100 deg. superheat for the Inspiration plant, and 150 deg. superheat for both the New Cornelia and the Arizona Power Company's plants, all measured at the boiler, and at normal rated capacity of boilers. All the plants also have centrifugal circulating pumps, the Inspiration pumps being turbine-driven, and the others motor-driven.

[1] Chief Engineer, Chas. C. Moore & Co., Engineers. Mem.Am.Soc.M.E.

For presentation at the Spring Meeting, Detroit, Mich., June 16 to 19, of The American Society of Mechanical Engineers. All papers are subject to revision.

The nozzles for the cooling pond for the Inspiration Copper Company's plant were furnished by one of the spray pond companies, who also proportioned and designed the pond arrangement. The actual vacuum shown by the operation of this plant, however, has been a disappointment, as a pond of insufficient area was installed. Since the design of the Inspiration plant this detail has been corrected by the addition of cooling towers. The condensate is returned to the oil-fired boilers, and make-up water for the pond is purified by a Booth water softener. A Cochrane hot-process purifier purifies the make-up for the oil-fired boilers if needed, but it is primarily for purifying boiler feed for the waste-heat boilers installed at the smelter. The blowing engines operate at slightly lower vacuum than the turbines, and advantage is taken of this fact to heat slightly the turbine condensate by passing it through the Volz heaters in the surface condensers of the blowing engines.

Cole-Bergman water weighers and Lea recorders are installed for feedwater measurements, for computing the steam supplied from the waste-heat boilers and the steam required by blowing engines, as well as the steam consumption of the turbines. Steam-flow meters are also used for checking purposes. By this means a separate record is kept of the economy of the turbine plant on the basis of operation independent of the blowing engines.

The feedwater for the New Cornelia plant contains from 30 to 50 grains of impurities per U. S. gallon. The water is low in calcium sulphate and carbonate, high in sodium sulphate, and very high in sodium chloride. It is not practicable to purify this water by chemical treatment. The condensate from the condensers is returned to the boilers, and raw make-up water is used for the pond and boiler-feed make-up purposes. Frequent blowing down is required for the cooling pond, as well as for the boilers. Scale is also formed both in the condensers and the boilers, and this requires frequent cleaning, as condenser scale tends to impair the vacuum.

The Arizona Power Company uses Verde River water for condensing purposes, this being taken through a flume at such a point that the pumping head is reduced by gravity flow. The condensate is returned to the boilers, and the raw make-up water is purified in a Cochrane hot-process purifier.

Economy of Inspiration Consolidated Copper Company Plant

Upon the completion of the Inspiration plant it was placed in regular service. The performance of the individual pieces of apparatus was investigated in order to make certain that everything was working to the best advantage, particular attention being paid to the efficiency of boilers, the adjustment of burners, furnaces, and the automatic firing system. A number of uniform load tests were made of boilers for checking purposes, and the results obtained are given in Table 1 and the curves of Figs. 1 and 2. These tests show a fairly high efficiency at rating, and, rather contrary to the usual results obtained with non-easing boilers, a higher efficiency at fractional loads than at rating. The higher efficiency is due to the tightness and the insulating efficiency of the steel casing. As a result of these tests, instructions were given the operators to divide the load equally among all boilers and this, of course, was done automatically by the firing system. The operators, however, were instructed to keep as many boilers on the line at light loads as could be properly fired, maintaining a fire in each of the three burners per boiler; below this load boilers were cut off the line, and only refired when the load again increased.

The curves of Figs. 1 and 2 show the relation between the steam pressure of the atomizing steam and the oil pressure, both

measured in the supply pipes at the individual burner, between the throttle valve and burner. From data obtained from these curves, the steam-to-burner regulator was set to give the proper pressure of atomizing steam, based on the momentary oil pressure.

A complete description of the automatic oil-firing system in use in these plants will be found in a paper by the writer entitled Unnecessary Losses in Burning Oil Fuel, and an Automatic System for Their Elimination, page 797, Vol. 30, of

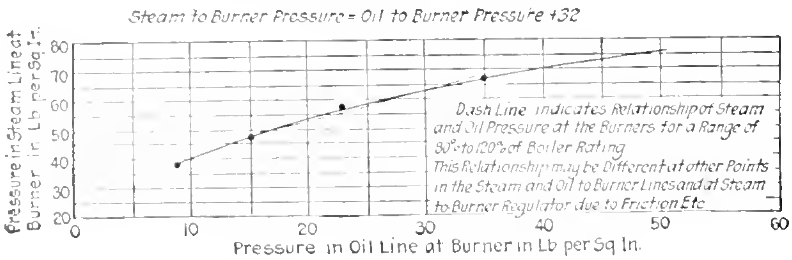


Fig. 1 Steam and Oil Pressures at Burner Lines

Transactions, and the system used in these plants differs from that described in the paper merely in the use of a diaphragm pump governor to maintain a constant predetermined maximum pressure at the oil pumps; the oil-to-burner regulator then operates a throttle valve to give the desired pressure at the oil burners.

Under variable load the damper controller has been able to maintain CO_2 readings varying from 12 per cent to 14.5 per cent CO_2, for which the corresponding excess air for normal conditions is 28 per cent and 6 per cent, respectively.

After instructing the operators, and while the plant was still under the control of the engineers, an average economy was obtained for the month of September, 1915, as given in the following table:

Average number of turbine units in operation	1
Average daily load, 24-hour basis, kw	5980
Average steam pressure at boilers, lb. per sq. in.	178
Average vacuum in condensers, in. of mercury, absolute	2.66
Average rating on boilers, per cent	95
Gross boiler efficiency, per cent	80.9
Average economy, kw-hr. per bbl. of oil as fired	281
Average economy B.t.u. per kw-hr.	2,5900

In the subsequent operation of this plant by the owners the economy has been maintained practically equal to that shown under the direction of the engineers, but during the winter, due to colder circulating water, the economy is even better than indicated above. On the other hand, during the summer months, with the warmer circulating water and falling off in vacuum, the economy naturally drops to a lower figure than that given for the month of September.

This plant operates in conjunction with the hydroelectric plant at the Roosevelt Dam, and at periods of the year preference is given to hydroelectric power. As a result, there is a fractional load, or partial shutdown of the steam plant, and for certain months this in turn has naturally resulted in a reduced economy.

The operating results for the plant, furnished by Mr. W. W. Jourdin, Mem.Am.Soc.M.E., Chief Engineer of the Inspiration power plant, are given by the curves of Fig. 3. It will be noted that the best monthly economy for winter conditions has been 294.5 kw-hr. per bbl. of oil, or 20,910 B.t.u. per kw-hr.; and the poorest economy for summer conditions for the normal load has been 257.5 kw-hr. per bbl. of oil, or 23,700 B.t.u. per kw-hr., although for the month of September 1917, due to the very light load, the economy was only 237 kw-hr. per bbl. or 25,970 B.t.u. per kw-hr. As previously stated, this plant, in comparison with non-cooling-pond plants, is subject to an accumulation of scale in the condensers, and as a result there is a slight loss in vacuum. Since purified feedwater is used, the plant is not subject to troubles from scale formation in the oil-fired boilers, nor does any loss of fuel result from shutting down boilers for cleaning or boiler blow-off.

The curves of Fig. 3 give the operating records for combined boiler and economizer efficiency, atomizing steam deducted; this being the form in which the power-plant records are kept. A comparison of this result with the boiler efficiency tests would seem inconsistent without the explanation that the economizers at this plant heat the feedwater through a temperature range of from 40 deg. to 45 deg., whereas it will be noted that results for the Arizona Power Company's economizers, given in Table 2, indicate a temperature rise in the economizer of 91 deg. fahr. In proportioning the Inspiration economizers with reference to the investment and fuel saving, it was assumed that the average period of operation would be less than half the year, owing to the use of hydroelectric power; it was also assumed that the fixed charges would be very high. This combination of circumstances, together with high freight rates and construction costs in Arizona, resulted in the selection of an economizer of comparatively small surface, giving a favorable return on the investment but a result considerably less favorable than that attained in the average economizer with oil fuel, when measured only by temperature rise.

Economy of the New Cornelia Copper Company's Plant

Following the installation of the New Cornelia plant in November 1917, an attempt was made by the designing engineers to check the economy of the station, but owing to the war and a scarcity of labor this work had to be abandoned before completion. While it has never been possible to show the best performance of which the plant is capable, the operating crew have, for the most part, been very efficient in handling it, except during an illness of the chief engineer, when the economy of the plant fell off to a disappointing figure. This occurred during the summer and fall of 1918, and the figures for economy for that period are thus hardly fair to the plant. It should also be borne in mind, in connection with performance data, that the feedwater condition at this plant is such that the frequent shutdowns for boiler cleaning and the large amount of hot water blown off from the boilers affect appreciably its economy.

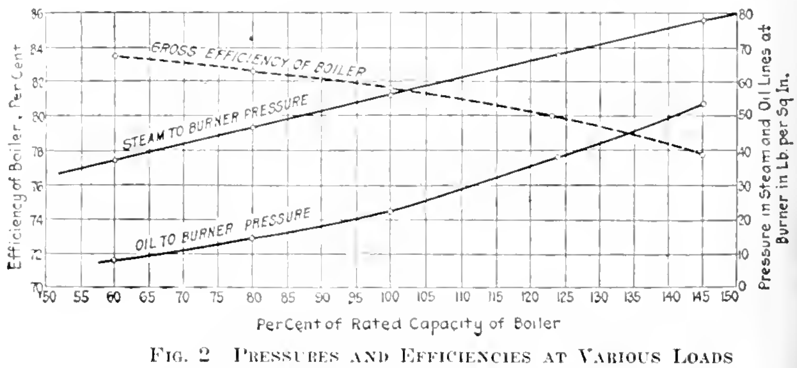


Fig. 2 Pressures and Efficiencies at Various Loads

This plant, due to its location in the southwestern portion of Arizona, is subject to more intense summer heat than probably any other power plant in the western territory, and this in turn gives rise to considerably less favorable cooling-pond and condenser performance, with respect to vacuum, for the summer months than for the winter months. The vacuum performance is also influenced by the accumulation of scale within the condensers between the periods of cleaning condensers, due to concentration of salts in the cooling pond.

The best economy for this station known to the writer is for the month of January 1918, the average performance for four successive days being about 324 kw-hr. per bbl. of oil, as shown in the following table:

Date 1918	Average load, kw.	Economy, kw-hr. per bbl. of oil	B.t.u. per kw-hr.
January 26..........	7921	321.7	18,975
January 27..........	7830	324.1	18,833
January 28..........	7725	324.2	18,829
January 29..........	7800	326.2	18,711

The poorest economy for this station, during the summer of 1917, was for the month of July, namely, 293.5 kw-hr. per bbl. The average vacuum was 1.66 in. absolute and the average load 5550 kw. The poorest economy during the summer of 1918 was also for the month of July, or 287.5 kw-hr. per bbl. The average vacuum was 2.14 in. absolute, the average load 5850 kw., and consequently the economy for the summer of 1918 was abnormally low.

The monthly report for December 1918 gives the following: Average load, 7800 kw.; average economy, 312 kw. per bbl. and 19,913 B.t.u. per kw-hr. The monthly report for January 1919 gives: average load, 7790 kw.; average economy, 317.9 kw. per bbl., and 19,535 B.t.u. per kw-hr. The improvement for the month of January over December is due to a straightening out of the aforementioned difficulties experienced in the summer of 1918, and it is the writer's belief that the station will soon be operating at its best previous economy for the corresponding season.

It will be noted that the economy of the New Cornelia plant is materially better than that of the Inspiration. This is due somewhat to the larger turbine units installed, but in the main to the higher steam pressure and to the improved design of cooling pond, which results in better vacuum. In comparing the economy of these cooling-pond stations with that obtained in tidewater plants, allowance should be made for the size of turbine units, the obtainable vacua under operating conditions, the increased head on circulating pump due to the greater quantity of water which must be handled through the condensers, and the increased pumping head due to the cooling-pond nozzles and longer lengths of circulating-water line.

Economy of the Arizona Power Company's Plant

This plant was completed in September 1917, and due to the war conditions in the mining region it was difficult to assemble a skilled operating crew. The plant was furnished under a contract covering a complete plant-economy guarantee at 5000-kw. load, and the final test, covering 48 hours' operation in regular commercial service, under variable load, was concerned mostly with the economy at this load, although a run was made at 6000-kw. load, which is the rated capacity of the turbine. The results for the final test are given in Table 2. At all times during this test the plant was subject to a variable load, due to the regulation of the hydroelectric system. The oil was carefully weighed and the electrical output was measured by calibrated meters. The electrical output given is the net useful output for the station at the 2300-volt bus, deduction having been made for the power consumption of electric auxiliaries, including lighting for the operators' cottages, circulating water pump, deep-well pump and air washer. The average electrical auxiliary load was 46 kw., which is somewhat smaller than would have been the case had the entire head on the circulating water been overcome by pumping; against this condition is the fact that during the test the quantity of circulating water was somewhat less than specified, so that, roughly speaking, the one condition nearly offsets the other.

It is not possible to give daily operating results for this plant, at the load for which it was designed, for since its installation it has been maintained only for reserve purposes, carrying occasional peaks but the majority of the time a very light load, and for a number of hours during an average day with the turbine at standstill. Of course favorable economy is not possible under such conditions, as the fuel losses due to keeping hot boilers, piping, etc., the dead-load losses for the operation of auxiliaries, and the zero-load steam consumption of turbine result in a zero-load fuel consumption of the plant which is an appreciable percentage of the full-load fuel consumption. With the foregoing explanation, the results for February 1918 are as follows:

Total kw-hr.	1,235,580
Total bbl. of fuel oil used	4783.9
Total hours of operation	444
Average kw. for operating period	2800
Kw-hr. per bbl. of oil (delivered to lines, net)	258.5
Operating period load factor	0.467
Average kw. for monthly period	1838
Monthly period load factor	0.306

It is of interest to note that the turbine at the Arizona Power Company's plant is practically a duplicate of those at the Inspiration Copper Company's plant, having the same number of stages; the difference in the operating economy of the turbines being largely due to steam pressure. Here again is a marked

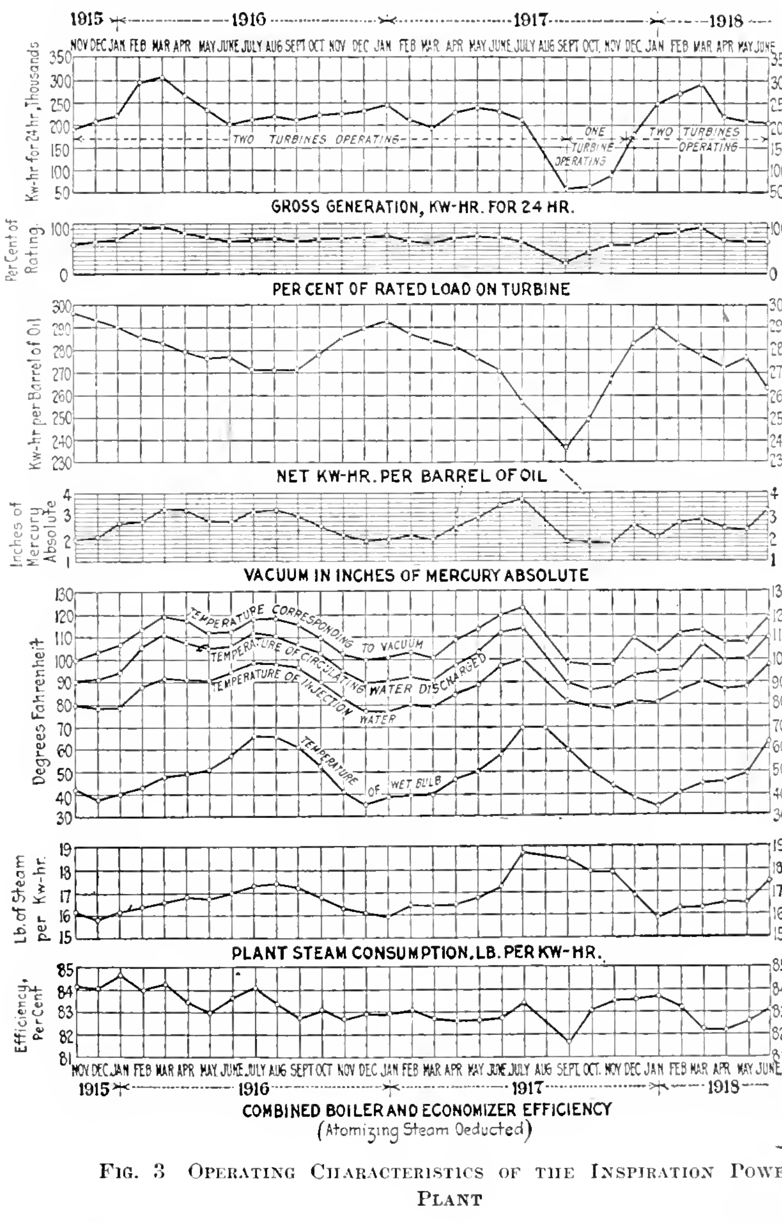


Fig. 3 Operating Characteristics of the Inspiration Power Plant

TABLE 1 RESULTS OF EFFICIENCY TESTS ON STIRLING WATER-TUBE BOILER IN INSPIRATION CONSOLIDATED COPPER COMPANY'S PLANT

Class M No. 26 battery Stirling water-tube boiler with steel casing. Heating surface per boiler, 7129 sq. ft. Rated boiler hp., 712.9 (based on 10 sq. ft. per hp.). Boiler-room floor elevation, 3615 ft. Normal barometer, 26.13 in.

		Test at 100 per cent rating[1]	Test at 80 per cent rating[2]	Test at 60 per cent rating[2]	Test at 125 per cent rating
Date of test, 1915		May 29	June 1	June 2	June 4
Number of test boiler in plant		5	5	5	5
Duration of test, hours		10	6	6	10
Temp. feedwater entering boiler, deg. fahr.		210.15	200.0	191.0	209.5
Temp. superheated steam, deg. fahr.		503.9	502.4	491.0	517.3
Deg. fahr. superheat		122.1	122.0	111.0	135.5
Temp. steam to burner, deg. fahr.		504.2	502.7		
Temp. oil to burner, deg. fahr.		187.8	186.9	186.0	185.0
Temperature of flue gases, deg. fahr. measured across breeching outlet and in rotation	No. 1	466.5	423.7	389.0	495.0
	No. 2	469.0	427.5	391.0	502.0
	No. 3	470.1	434.7	389.0	507.5
	No. 4	473.3	434.7	391.0	508.0
	No. 5	472.5	432.5	391.0	507.5
	No. 6	470.8	429.0	390.0	510.5
	No. 7	471.3	427.0	392.0	506.0
Temp. outside air, deg. fahr.		95.0	90.2	86.5	69.0
Temp. air entering ashpit, deg. fahr.		93.1	100.3	95.0	75.9
Steam pressure, lb., gage		187.4	184.03	182.3	187.3
Pres. in oil line before burners, lb., gage		22.0	15.0	9.+	36.8
Pres. in steam line to burner, lb., gage	Before burner valves	56.6	46.8	38.0	67.0
	After burner valves	..	..	..	..
Draft, in. water	Top of first pass No. 1	.014	+.016	.013	.005
	Bottom of 2nd pass No. 2	.062	.080	.032	+.076
	Front of damper No. 3	.076	.070	.020	+.091
Draft, inches of water (power-plant instrument), front of damper		.065	.074	.033	.110
Analysis of fuel oil by Smith, Emery & Co.:					
Water, per cent (by centrifuge)		.480	.490	.490	.490
Sand		Trace	Trace	Trace	Trace
Sulphur in per cent of dry oil		1.06	1.06	1.06	1.06
Carbon in per cent of dry oil		85.58	85.58	85.58	85.58
Hydrogen in per cent of dry oil		12.87	12.87	12.87	12.87
Net B.t.u. per lb. of oil as fired		18,540	18,540	18,540	18,540
Sulphur corrected in B.t.u. per lb. oil		85	85	85	85
Total water actually evaporated, lb.		232,736	104,394	76,857	269,963
Lb. water actually evaporated per hour		23,273.6	17,399	12,809	26,996.3
Factor of evaporation		1.124	1.134	1.137	1.131
Total water evaporated from and at 212 deg. fahr., lb.		261,594	118,383	87,386	305,328
Lb. water evaporated[1] from and at 212 deg. fahr. per hr.		26,159	19,730.5	11,564	30,532.8
Total oil fired, lb.		16,713	7,498.5	5,458.5	19,907
Oil fired per hour, lb.		1,674.3	1,249.7	909.5	1,990.7
Boiler horsepower developed		758	572	422	885
Per cent of rated capacity, based on work done by water-heating surface		106.7	80.3	59.2	124
Lb. water actually evaporated per lb. oil		13.90	13.92	14.08	13.56
Lb. water evaporated per lb. of oil from and at 212 deg. fahr.		15.62	15.73	16.00	15.34
Efficiency of boiler based on gross evaporation per cent		81.76	82.61	83.74	80.29
Per cent CO_2 in flue gas at top of first pass		15.5	15.17	15.4	15.1
Percentage analysis of gases at bottom of second pass	CO_2	15.6	15.41	15.0	14.4
	O	0.8	1.11	1.1	1.94
	CO	Trace	0	0	0
	N	83.6	83.48	83.6	83.66
Percentage analysis of gases at front of damper	CO_2	14.5		14.5	14.3
	O	2.3		2.1	2.11
	CO	Trace		0	0
	N	83.2		83.4	83.59
Per cent excess air over chemical requirements at front of damper		4.19		4.19	6.14

[1] Apparent discrepancies in the draft readings of power-plant instrument and thermometers are due to the different location of the nozzles and to slight leaks in flue-gas piping.

[2] On account of the waste-heat boilers and intermittent firing of the other boilers the load was very jerky. On this account the damper was fixed to a low point on the draft and the ashpit door was regulated during the test.

TABLE 2 RESULTS OF TEST OF THE ARIZONA POWER COMPANY'S STEAM PLANT AT TAPCO, ARIZ.

Duration of test, hours	6
Boiler pressure, lb. per sq. in., gage	250
Steam pressure at turbine throttle, lb. per sq. in., gage	238.5
Avg. temp. of superheated steam at boilers, deg. fahr.	546
Temp. of superheated steam at turbine, deg. fahr.	516
Temp. of feedwater entering boilers, deg. fahr.	207
Temp. of water leaving feedwater heater, deg. fahr.	116
Temp. of circulating water from condenser, deg. fahr.	62.4
Temp. of circulating water to condenser, deg. fahr.	45.7
Room temperature, deg. fahr.	83.2
Barometer, inches of mercury	26.773
Vacuum in condenser, inches of mercury	25.783
Absolute vacuum, inches of mercury	0.990
Temp. of flue gases leaving economizer No. 3, deg. fahr.	276
Average load, kw. per hr.	5,815
Power factor by power-plant indicator	0.93
Electrical Output by Integrating Meters:	
Gross kw. generated	34,890
Gross kw-hr.	5,815
Auxiliary power, kw.	277
Net kw. output	34,613
Net kw-hr. output	5,769
Oil Measurements:	
Total oil weighed, lb.	34,516
Correction due to diff. in temp. at start and finish, lb.	46
Oil actually used, lb.	34,470
Average gravity of oil (analyzed by Smith, Emery & Co.), deg. B.	17.65
Weight of oil per bbl. of 42 gal.	332
Heat value of oil (analyzed by Smith, Emery & Co.), B.t.u. per lb.	18,703
Economy:	
Fuel used per gross kw-hr., lb.	0.988
Fuel used per net kw-hr., lb.	0.996
Kw-hr. per bbl. of oil, gross	336.0
Kw-hr. per bbl. of oil net	333.3
B.t.u. per kw-hr., gross	18,478
B.t.u. per kw-hr. net	18,628

increase in plant economy due to an increase in steam pressure, and also by reason of the colder river water at the Arizona Power Company's plant as compared with the cooling-pond water at the Inspiration plant and the consequent improvement in vacuum. All economy figures are based on oil as fired, without deduction or correction for moisture, sulphur, or silt.

The engineers have endeavored to instill in the minds of the operators of these plants and to show by example that high economies need not merely be looked for during the test period, but can be maintained during the operating period. The Inspiration plant is large enough to permit the employment of a boiler-room engineer, but, due to their smaller size, such an engineer is not maintained at the other two plants. This plant was designed on the assumption that the average load would be maintained for a period of six months only during the year, and that oil delivered would cost about $1.45 per bbl. The New Cornelia plant was designed on the assumption that oil would cost $1.25 per bbl., but since the date of design of these plants the cost of oil has materially increased.

PERSONNEL

The selection of the principal equipment for the Inspiration plant and its general layout were made jointly by John Langton, Consulting Engineer for the Inspiration Consolidated Copper Company, and Chas. C. Moore and Co. Engineers, which firm was also responsible for the detailed designs, installation and tuning up of the plant.

For the New Cornelia plant the entire work was in the hands of Chas. C. Moore and Co. with the approval of A. G. McGregor, Consulting Engineer for the New Cornelia Co.

The Arizona Power Company's plant was designed and built by Chas. C. Moore and Co. Engineers, with the approval of R. S. Mason, Chief Engineer for the Arizona Power Co.

A considerable portion of the testing work on the Inspiration plant was handled by A. G. Budge, under the writer's direction, and for the New Cornelia and Arizona Power Company plants by T. B. Paulson, also under the writer's direction.

Air Fans for Driving Generators on Airplanes

By CAPT. G. FRANCIS GRAY[1], U. S. A.; LT. JOHN W. REED,[1] U. S. A.; and P. N. ELDERKIN [1]

In this paper the authors first briefly describe the method employed by the Radio Development Section of the War Department in testing air fans used for driving the electric generators usually installed on airplanes for radio communication. They next discuss at some length the various types of air fans used during the war and present numerous photographs and curves clearly illustrating the construction of the fans and their operating characteristics.

The difficulty of the problem lay in designing a fan which would turn at constant speed in the air streams of widely varying speed set up by the airplane in flight. The various types of fans tested were: Fixed-blade fans of special blade shape; fixed-blade fans with wind brakes centrifugally regulated; fixed-blade fans using a friction clutch or a friction brake centrifugally regulated, and pivoted-blade fans in which the pitch is centrifugally regulated.

DURING the war extensive use was made of radio telegraph and telephone apparatus on military airplanes, and the problem of power supply for such equipment received a great deal of attention. The possible sources of energy may be listed as follows:

a Storage batteries or dry batteries
b Generators driven from the airplane engine, with or without floating storage batteries, and supplying the radio sets directly or through dynamotors
c Generators driven by separate gasoline engines
d Generators driven by air fans, or "windmills" placed in the air stream outside the airplane fuselage.

From an economical point of view, method *b* is preferable. It was seriously considered, but since it involved coöperation between organizations normally operating independently, its adoption was delayed. Meanwhile the practice in our Army followed that of our Allies, principally the French, in the use of method *d*, mounting the generator outside the airplane fuselage and driving it with an air fan.

The work done on the development of air fans for this service was carried out by the Radio Development Section of the Signal Corps, and since it was done under the press of military necessity it was directed entirely by utilitarian considerations, was often fragmentary, and neglected investigations, the need of which was realized, but for which time and personnel were not available. This record is presented with the work still in unfinished form in the hope that results obtained may be useful to those who may have occasion to carry out further investigations on the problem.

Conditions for Which the Air Fans Were Designed

Two sizes of generators were to be driven by the air fans it was desired to develop. The essential data on these are as follows:

	Generator for Radio Telegraph Sets	Generator for Radio Telephone Sets
Generator diameter, in.	6¼	4 13/16
Generator output, watts	200	80
Required power from fan, watts	330	250
Normal speed, r.p.m.	4500	4000

[1] Engineering and Research Division, Radio Development Section, War Department, Washington, D. C.

For presentation at the Spring Meeting, Detroit, Mich., June 16 to 19, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

Methods of Test

Practically all of the tests recorded in this paper were made with the wind tunnel of the Bureau of Standards, and the management and personnel of the Bureau aided materially in expediting them. A special testing generator was mounted in the wind tunnel and the fan to be tested was attached to it. This generator was provided with a magnetic tachometer, a separately excited field, and convenient means for applying load to the armature circuit. The external shape and size of the machine were made identical with those of the radio generators, with which the air fans were to operate in service, and with this generator and the regular wind-tunnel equipment for measuring wind velocity, tests could be made rapidly and accurately.

All of the air fans considered in this development have normal speeds of 4000 r.p.m., or above, and the centrifugal forces are very considerable. It was therefore found necessary to provide an overspeed test to precede the wind tunnel test. For this purpose a 30-hp. motor operating through a 43-to-3 De Laval speed-increasing gear to a suitable shaft extension for the fan was set up. This device was capable of driving the air fans at speeds up to 14,000 r.p.m. and to prevent damage to gears or bearings in case of failure of the fan, a "weakest point" was provided by a replaceable notched-shaft extension. Failure at this point merely resulted in the breaking of the replaceable shaft extension and of course the destruction of the fan, without injury to bearings or gears. Heavy guards prevented the flying fragments from causing any damage. This equipment was designed by Capt. F. E. Pernot, Officer in Charge of the Signal Corps Laboratories at the Bureau of Standards.

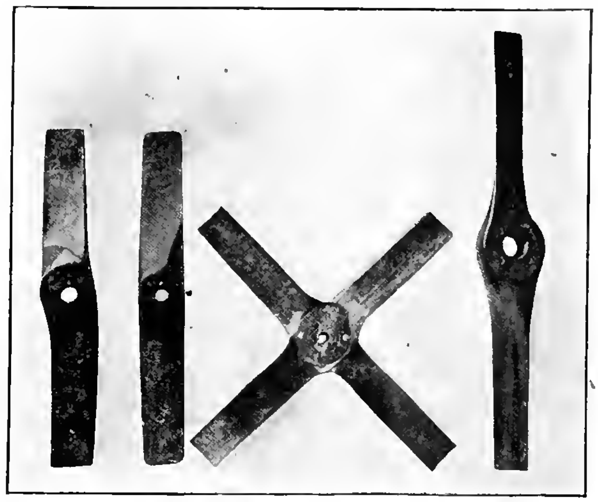


Fig. 1 Pre-War Air Fans

There is one serious objection, however, to this method of overspeed testing in that it absorbs a large amount of power and puts abnormal thrust strains on the fans. A baffle to prevent air flow materially reduced this effect, and later experience indicated that it would have been preferable to make the overspeed test in a very simple auxiliary wind tunnel with an aperture just large enough to drive the unloaded fans at the speed desired. Nevertheless the apparatus just described was used in all tests discussed in this paper.

In cases where the strength of a fan was problematical, it was first given an overspeed test only slightly in excess of the running speed expected in the wind tunnel. After the wind-tunnel test it was again tested to the required overspeed or to destruction. The best fans were required to withstand up to practically double normal speed.

Simple Non-Regulating Air Fans

As in all power-plant problems, the ideal in this development was a constant-speed drive for the radio generator. When the development began, the only air fans available were non-regulating wooden fans such as those illustrated in Fig. 1. These fans have the characteristic that rotational speed is practically proportional to air speed, and when combined with the normal variations in the speed of the airplanes this fact leads to very severe requirements for the generator. As an example, a generator which would give satisfactory performance at 3750 r.p.m. was required to withstand an overspeed test of 14,000 r.p.m. for mechanical performance and, with the addition of a very special regulating device, to hold its voltage within 15 per cent at speeds from 4000 to 12,000 r.p.m.

Although the need for better air fans was obvious, the non-regulating types had to be used until others could be developed, and a considerable amount of work was done in adapting them to the particular requirements to be met. Fig. 2 shows the construction of one of the final forms used with generators for radio-telephone sets, and Fig. 3 its performance in the wind tunnel. Figs. 4 and 5 give similar information on a larger-size fixed-blade fan used for radio-telegraph sets. Fig. 5 also gives an idea of the variation in individual fans supposed to be identical. Considerable trouble was experienced with these fans due to the fact that the method for calculating air fans was assumed to be the same as that used for propellers.

Obviously it is desirable to establish the correct method of calculating these fans, but the pressure of more important work prevented its being undertaken by the Radio Development Section. The subject, however, was given much attention by Mr. E. N. Fales, of the Airplane Engineering Department, Bureau of Aircraft Production of the Army, who assisted the Section very materially during the early stages of the development described in this paper, and it is hoped he will publish his conclusions.

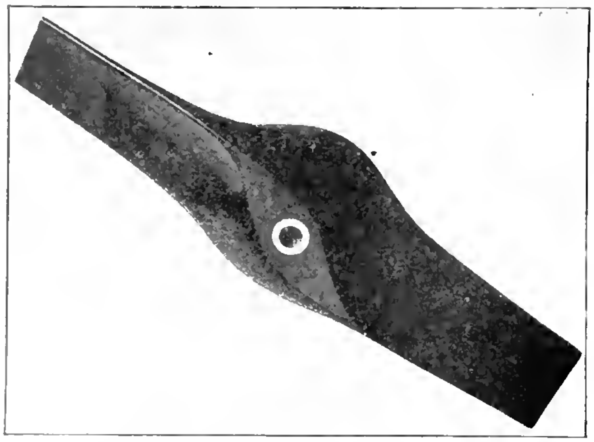


Fig. 2 Type FA-3, Non-Regulating Air Fan, for Radio-Telephone Generators

Regulating Air Fans

No one can work with simple air fans without being impressed with the desirability and apparent simplicity of modifying them so that instead of the straight-line relation between air speed and speed of rotation there will be more or less tendency toward constant rotational speed with varying air speed. Among the disadvantages which may be corrected by making the air fans self-regulating are the following:

a Undue head resistance
b Excessive centrifugal stress in armature windings
c Vibration
d Commutator and bearing troubles
e Troubles with voltage regulators
f Troubles in radio sets due to varying voltage.

During the progress of this development a great many schemes for the construction of self-regulating fans were proposed. As all previous experiences led to the conclusion that the performance of a fan could not be predicted with any degree of accuracy, every reasonable suggestion was carefully considered and if possible tried out. Fundamentally all the fans tested may be classified under five principles of operations as follows:

a Fixed-blade fans of special blade shape
b Fixed-blade fans with wind brakes centrifugally regulated
c Fixed-blade fans using a friction clutch centrifugally regulated
d Fixed-blade fans using a friction brake centrifugally regulated
e Pivoted-blade fans in which the pitch is centrifugally regulated.

Fixed-Blade Fans of Special Shapes. Certain air fans submitted to the Signal Corps were supposed to give speed regulation on the principle that the angle of attack and efficiency can be made to alter with the wind velocity in such a way that the ratio of wind velocity to r.p.m. need not be constant. Tests were made first on a series of blade sections and later on a fan, shown

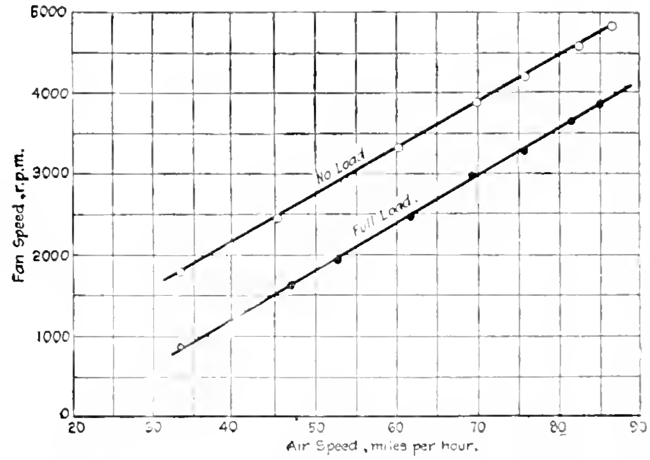


Fig. 3 Performance Curves of Type FA-3 Air Fan
(Diam., 15 in.; pitch, 2.1 ft.)

at the right in Fig. 1, which was said to possess the regulating features in a marked degree. The conclusion from these tests was that at no load the performance of properly designed fans tends to confirm the hopes of the designers though the magnitude of the regulating effect is small; but under load, particularly varying load, it was impossible to distinguish any improvement over the ordinary fixed-blade types of fans. Consequently this method was discarded as of no practical value.

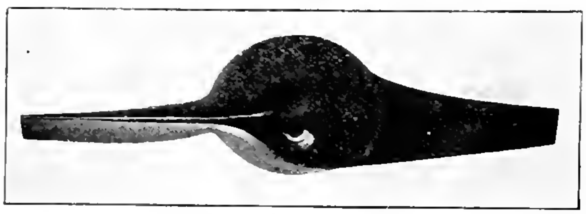


Fig. 4 Type FA-6, Non-Regulating Air Fan, for Radio-Telegraph Generators

Fixed-Blade Fans with Wind Brakes. Fans of this type are provided with wings, pins or other projections which are normally enclosed in a recess in the blade, but which are caused by centrifugal force to emerge and so retard the rotation of the fan. They have the disadvantage of low efficiency and consequent high head resistance, but were considered worth trying. Fig. 6 shows various development models. Round rods, rods with cloth and metal wings, flat strips, etc., were tried for the moving brake element. Many showed practically no regulation of course, but others were reasonably promising. Among such was the type in which the brake arms were pivoted and moved out into the

air by the action of centrifugal weights. Another interesting fan had the break arms actuated not by centrifugal force but by the air pressure on a plate mounted in advance of the nose of the fan, and gave a curve in which, for a certain range, the r.p.m. actually decreased with increase in air velocity.

The net conclusion from this research was that the wind-brake principle would give fairly good characteristics over a limited range of air speed, and with further refinement it might have been worth putting into production. However, that stage was never reached due to the work on the pivoted-blade type of fan described below.

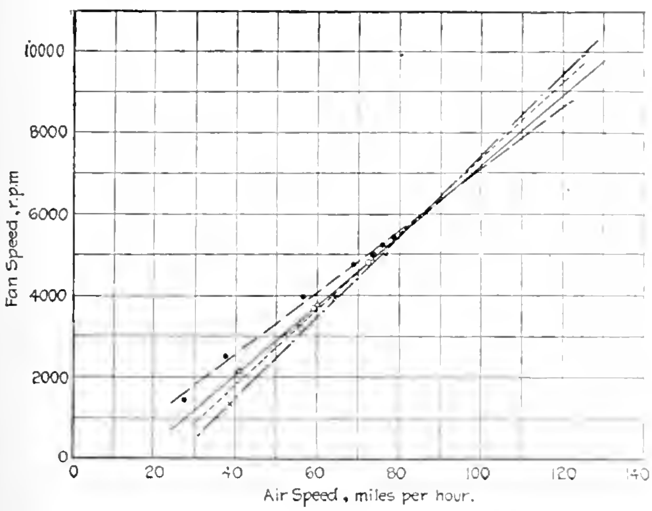


FIG. 5 PERFORMANCE CURVES OF TYPE FA-6 AIR FAN
(Diam., 20 in.; pitch, 1.75 ft.)

Friction-Clutch and Friction-Brake Fans. As in the types of regulating air fans discussed above, the friction-clutch and friction-brake principles of operation are inherently objectionable on account of their low efficiency and consequent high head resistance. They offered a possible solution, however, and were tried out experimentally. In the friction-clutch type of fan the fan hub is capable of free rotation about the shaft of the generator, which it drives through a friction clutch. The clutch is released by the action of centrifugal weights when the speed passes the predetermined maximum, permitting the fan to run at higher speed than the driven shaft of the generator. The curve of this fan

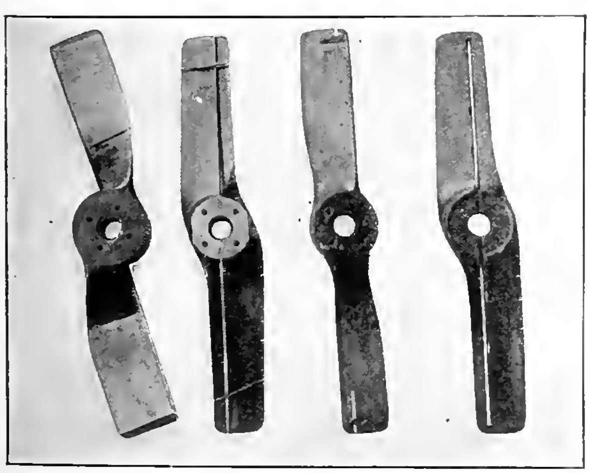


FIG. 6 FIXED-BLADE FANS WITH WIND BRAKES

was satisfactory for the first model, but the heating due to slipping of the clutch at high velocities was too great to permit the use of the fan in practice and the development was abandoned.

In the friction-brake type of fan the fan is keyed to the generator shaft and is prevented from exceeding normal speed by a brakeshoe operated by a centrifugal weight and bearing on a plate attached to the generator frame. This also was tried, and gave results essentially similar to those obtained with the clutch type. With the very considerable variation in air speed met with on airplanes, the friction devices generated so much heat that their use was impossible.

Variable-Pitch Air Fans. The ideal principle for the design of a regulating air fan is that of varying the pitch of the blades to correspond to the variation in air speed; this principle is by no means new, having been considered in a variety of forms for propellers for a number of years. The great difficulty in actual construction has been that the mechanical strength necessary to withstand the very high centrifugal forces and the delicacy of operation necessary for close regulation are very hard to combine.

This objection does not apply so forcibly to fans using very thin blades which are expected to warp under centrifugal action to change the pitch and a few samples which it was hoped would operate on this principle were tested. They were unsuccessful principally on account of mechanical construction and improved samples were never made up. The method is in any case of doubtful utility since it can probably take care of only limited variations in speed, whereas the pivoted blade fans are capable of regulating over the widest variations in air speed likely to be met with in airplane practice.

Pivoted-Blade Air Fans. The earliest pivoted-blade fan to come to the attention of the Radio Development Section was made by the Sperry Gyroscope Company, but it proved unsuccessful, due to mechanical weakness. It was, however, the forerunner of very successful fans, and serves to illustrate the general principle on which all operate. The blades are mounted on bearings and are capable of rotating through a considerable angle. Centrifugal weights are mounted on arms attached to these blades and tend to turn them in the proper direction to increase the pitch. A resisting spring and necessary hub complete the mechanism.

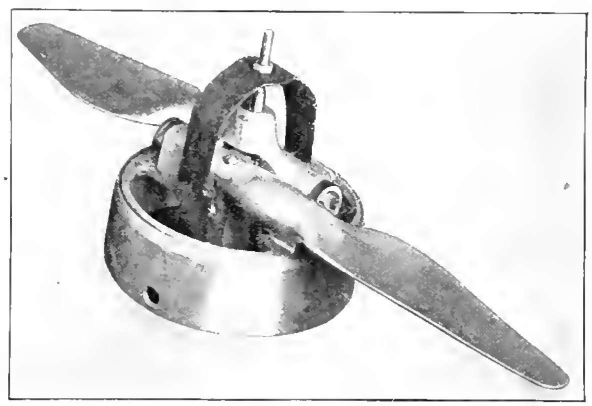


FIG. 7 TYPE FA-4-A. VARIABLE-PITCH AIR FAN

The first model to perform satisfactorily was designed by Mr. Thomas Slate, of the American Mechanical Improvement Company, of Washington, D. C. The very great improvement over the fixed-blade fans then in use made the production of this fan highly desirable, and it was undertaken at once under purchase specifications as follows:

Operating air-speed limits	45 to 300 m.p.h.
Normal speed	4500 r.p.m.
Speed variation less than	Plus or minus 4 per cent
Overspeed test	8000 r.p.m.

It was, of course, realized that this fan was by no means in its final form, and work toward improving it and providing new sources of production was carried on as rapidly as possible. One of the objections to the original design was that the particular mechanism used caused the centrifugal force to increase as the sine of twice the angle, while the spring restraining force increased according to a straight-line relation. In the second successful design this was corrected by the use of a special linkage between spring and blade which modified the curve of spring resistance to fit that of the centrifugal weight. Fig. 7 shows one of these fans and Fig. 8 its performance. In this as in many other cases of radio develop-

ment work, the design was conceived and outlined by the Signal Corps engineers and the details worked out at once by the manufacturer (in this case the American Propeller and Manufacturing Company) in a form ready for immediate production.

The third successful design of variable-pitch air fan was the work of Mr. Pinaud, of the Des Lauriers Aircraft Corporation, and differs very radically from those previously described. It uses

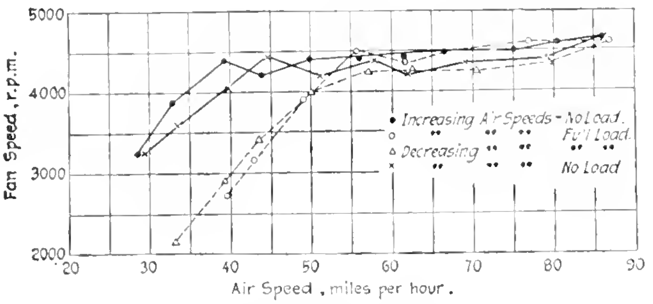


FIG. 8 PERFORMANCE CURVES OF TYPE FA-4-A AIR FAN (Diam., 20 in.; pitch variable)

only one blade, and its principal advantage is that by ingenious counterbalancing practically all strain is taken off the bearings whereas in other forms the thrust bearings must carry a very considerable load—both radial and thrust—due to the high speed of rotation, and the unbalanced designs of the blades. Friction, of

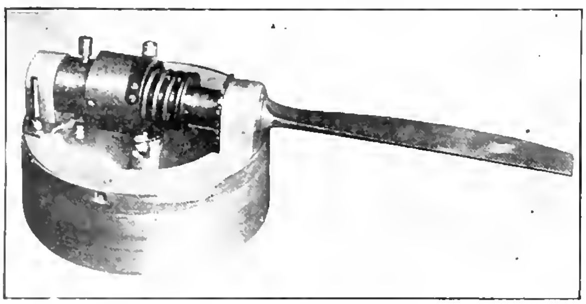


FIG. 9 TYPE FA-8, VARIABLE-PITCH AIR FAN, SINGLE-BLADE, 200-WATT

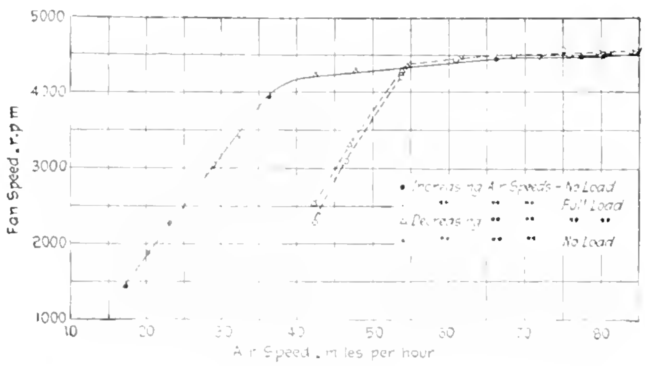


FIG. 10 PERFORMANCE CURVES OF TYPE FA-8 AIR FAN (Swept diam., 20 in.; pitch variable)

course, results in considerable "lag" in the performance of the fan. The mechanical construction of the Pinaud fan is also a considerable improvement over its predecessors in simplicity and ease of manufacture. Figs. 9 and 10 show its construction and performance.

HEAD-RESISTANCE TESTS

A demonstration of the value of the regulating air fans in reducing head resistance was made by the direct test of a complete radio-telegraph transmitting set in the wind tunnel. A run was first made with the set equipped with a fan hub and nose cap but no blades; then a second run was made with a fan operating normally with the generator both loaded and running light, and finally a third run was made with the fan blades locked at several values of pitch. The results of these tests are shown in Fig. 11, from which the following conclusions may be drawn:

The head resistance of the set fully loaded in an air stream of 75 miles per hour is 6.5 lb. At this air speed the resistance of the blades alone equals the resistance of the body, after which the resistance of the blades remain nearly constant, while that of the body increases as the square of the air speed. The body alone has 5 lb. head resistance at an air speed of 90 miles per hour, and at the usual ratio of 1/8 hp. from the engine per lb. of head resistance, this requires 0.36 hp. from the engine. On a basis of 20 lb. in the fuselage per hp. from the engine, the set would weigh 13 lb. more than it now does and still be no more load on the

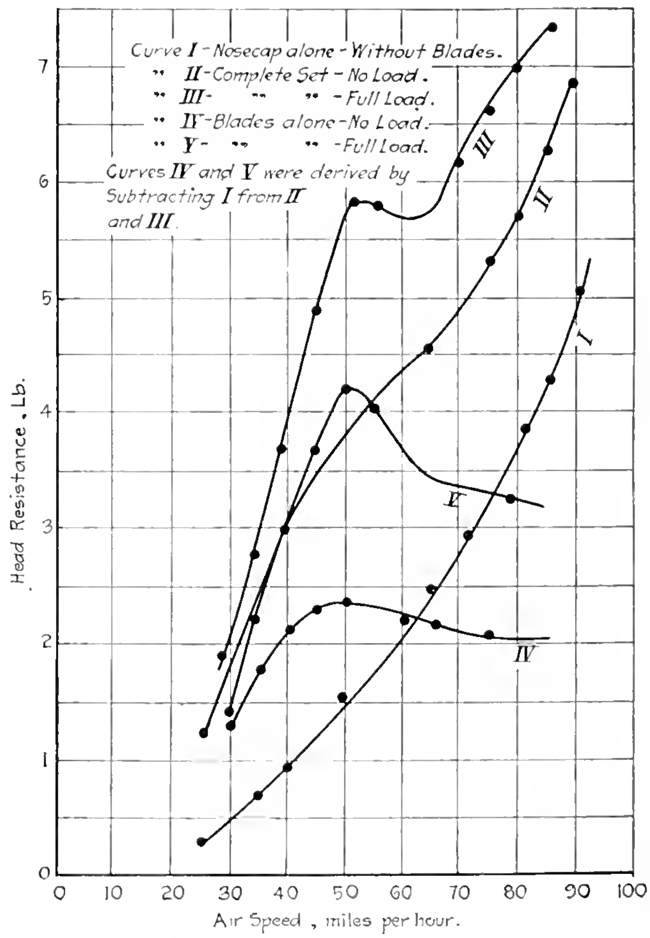


FIG. 11 HEAD-RESISTANCE CURVES, TYPE FA-4 AIR FAN

engine provided it was mounted in the fuselage and obtained its power directly from the engine. This emphasizes the desirability already mentioned of obtaining all electric power by direct drive from the engine rather than from air fans where it is possible to do so.

AIRFOIL TESTS ON BLADES FOR REGULATING AIR FANS

In designing blades for regulating air fans, the effect of wind pressure in producing torque around the blade axis has been questioned, and obviously such an effect might seriously interfere with the performance of the fan. To obtain data on this point tests were made on blades from a fan of the type shown in Fig. 7, using an airfoil balance.

The results thus obtained show that this effect is negligible so far as practical designing is concerned.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Departments of MECHANICAL ENGINEERING by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in this journal, or brief articles of current interest to mechanical engineers.

Threads and Thread Gages[1]

TO THE EDITOR:

The war brought with it many new problems, among which were the building up quickly from raw labor of a force capable of attaining and maintaining a high standard of work upon an emergency production basis, and the organization and education of a competent force to inspect the work done.

A cause of misunderstanding has been the fact that the inspection force, not being well grounded in the fundamentals of manufacture, have thought the manufacturer lax in his methods or deficient in knowledge, and the manufacturer on the other hand has taken it for granted that the inspector was familiar with manufacturing methods and has not taken pains to explain manufacturing difficulties.

The greatest of our troubles in this respect has probably been the question of threads and thread gages. Threads at best are a debatable and theoretical subject of which more is guessed at than known, and of which figures do not tell all that should be said. At the beginning of the war the Bureau of Standards was asked to devise means of checking gages, and with its usual thoroughness at once developed excellent means of measurement; but unfortunately no gages that were manufactured could pass their tests.

This, however, was remedied in time, but our ability to measure still outstripped our ability to make gages and much time and money was wasted. Eventually such progress was made in thread-gage manufacture that today almost perfect gages are turned out; but to what end? Threads have not improved nor the method of making them, and again in our gages we have far outstripped our ability to make threads. There seems to be no reason for making the production of threads more costly than at present, since they are satisfactory as regards strength; and whether they are or are not satisfactory otherwise the gage does not definitely tell us.

In no other place that I can at present recall is the gaging of a piece made more severe than the service required by the use to which it is to be put. For instance, if we are to measure the outside diameter of a cylindrical body, we do not use a cylindrical gage the height of the piece and set the piece in it; we use a snap gage or a ring gage. In the case of a thread, however, we make our gages at least one diameter thick—in some cases more—and while we use a wrench for ultimately screwing down a bolt and usually throw it out if it goes in by hand, we expect every bolt to go in the thread gage by hand and without force and make no allowance in our gages for final screwing down, thus defeating the very object we are striving for, to wit: a good fitting male and female thread. I do not think it an exaggeration to say that if we took a bolt and nut that fitted perfectly in the gages, we would reject both when we used them. The inaccuracies or burrs are what make the apparent good fit.

Further, we do not cut the same thread upon different kinds of material with the same die. In manufacturing we have to deal with open-hearth and bessemer steel, brass and copper, which neither tap nor thread the same. Should we not then make our gages different for each material? The number of good threads in a given lot of pieces made with the same die or tap is dependent first upon the nature of the material used; second, the tolerance allowed; third, the method of relieving threading tools; fourth, the relation of the weight of the die and the nature of the piece it is cutting; fifth, the mechanical means used to cut; sixth, the nature of lubricant used and uniformity is thus a matter of percentage.

In a mechanical sense the only part of the thread that is vital is at or near the pitch line. Still, we have insisted upon 100 per cent height of thread because the draftsman so pictured it and it has been necessary to make taps and dies to cut as the gage demanded, rather than to make them as they should be.

Another fact to be considered is that in most other things we usually gage only finished parts. We never think of holding to close limits on a roughing cut, but still we insist upon doing so on a thread which is precisely a rough cut as it is made in a single cut with a tool which fundamentally lacks necessary clearance, rake, and rigidity.

Another point which shows the weakness of our thread-gaging methods is that many threads enter the maximum gage with difficulty the first time and shake the second time. The answer to this, of course, is that the threads are rough at first and fit the gage snugly. In the process of trying them in the gage, however, they become smooth and where gaged a second time are a loose fit. This is more particularly true of brass. Also, using a ring gage often takes off the point of the thread so that it will not pass the maximum-diameter test. I know of a firm that lost thousands of brass pieces with a fine thread by their being pressed into a ring gage, and it took very little cocking or pressure to do it.

While we must maintain standards, we do not need watchmaking on locomotives. Traction engines are built differently from automobiles and while both use practically the same parts, the gaging that may be vital on an automobile is a non-essential on traction engines.

In practice it is usually the difference in the lead between the male and female thread that makes the fit. We make our gages accurately in this respect and then find it is impossible to procure taps and dies anywhere near as accurate.

The question of lead and angle has never been considered so important as since we entered the war. I think it may be stated without exaggerating that there are not a hundred lathes in the United States having lead screws of identically the same characteristics, considering as a basis the degree of accuracy used by the Bureau of Standards in measuring gages. This being so, it follows that it is impossible to get taps from different makers, or even from the same maker, which will check up accurately with a gage made by some one else, and a lead adjuster does not entirely cure this fault.

With the introduction of the wire method of measuring, it is now necessary in cutting a thread to figure out in abstruse mathematics the angle the thread tool should have in order to generate a thread of the required angle and pitch diameter.

The question naturally arises, then, Are we not making our threads to conform to the results secured by wire measurements, and misleading ourselves as to the angle and pitch diameter obtained? Are we not taking the wire system as an end and making our threads conform to the wire rather than using the wire as a means of measurement? In other words, we do not know whether we are getting the correct angle and pitch diameter with our wires, but we make our threads conform to them, nevertheless, and i believe that the wire system of measurement should be used for duplication only and not to set standards.

When the cross-section of the thread of a gage is projected on a screen the surface is shown to be full of hills and valleys even when ground—quite often the tooth is rounded. The object of the projectoscope is to indicate whether or not the tops of these hills constitute the desired angle. It is obvious that in using

[1] Contributed as a discussion of the subject of Threads and Thread Gages presented at the Annual Meeting, December, 1918.

wires one may rest in a valley and the other on top of a hill—which shows the fallacy of attempting to say that a thread is 0.0002 in. or 0.0003 in. undersize or oversize on the pitch diameter. We do not know that we are measuring on the pitch diameter, which is simply a mathematical point of departure where two theoretical circles touch.

It may be asked why a thread is not as readily measured on the pitch diameter by the wire method as is a gear, where the method originated. The answer is that on a gear the wire has a long bearing on a finished, smooth surface with the tool marks parallel with the wire and much finer in proportion, giving it a true seat. It would not be attempted to measure helical or bevel gears by this method. It is obvious that the only way to do this would be with a ball and not a wire. This same is true of helical threads.

Many thread gages have been rejected because they were 0.0002 in. off on the pitch line, and when this occurs it begins to tax our credulity as to the ability of man to make these measurements, since we know that on a straight, flat piece two men can seldom measure within 0.0002 in., even with the same micrometer, the difference being due to the difference in pressure and feel. Of course here again we must not confuse the facilities of the Bureau of Standards with those available to the tool manufacturer doing war work.

When we consider that 0.0001 in. on the wire used for measuring a 32-pitch thread makes a difference in angle of 0.5 deg., we can see to what impossible refinement we are carrying things when gages were rejected that showed an error of more than 10 min.

The question of the maximum diameter is always a subject of discussion and dispute. Most drawings call for a theoretical 100 per cent thread or leave it to be inferred. In practice in the past we have been able to secure 75 to 85 on bessemer rod; from 85 to 90 with open-hearth rod and 90 to 95 on good brass. With the thread miller it is possible to get 75 to 85 per cent of pieces with 100 per cent thread, but fine threads usually require burring; and it is also in some cases possible to get a 100 per cent thread by cutting a slot in the bottom of the thread on the tap, thus allowing the metal to flow.

Having hypothetically gone to the practice of milling our threads and having secured thereby what by individual measurements we call a 100 per cent thread of the proper lead and pitch diameter; and having also secured from the Bureau of Standards a gage as near perfect as they can manufacture, what will the gage tell us with regard to the thread? It does not tell us whether the thread angle is too small nor whether the pitch is correct. It does not tell whether the outside diameter is too small. It simply tells us three things: (1) whether the outside diameter is too great, (2) whether the bottom of the thread is oversize, and (3) whether the lead is correct.

I am assuming that the above was a maximum gage. Adding a minimum gage would establish only one thing more; i.e., the minimum outside diameter.

I have stated that if we had perfect gages and a perfect nut and bolt, we would reject them when we came to use them. So, logically, if perfection is not satisfactory, less than perfection must be. We may lay it down as an axiom that two threaded pieces, the angles of the threads of which are the complement of each other, cannot, if made correctly, produce a tight fit. What is required is to place enough metal on the male member to fill the female threads, and by this process any desired fit may be secured, regardless of tolerance.

C. B. Lord,
Gen. Supt. Wagner Elec. Mfg. Co.

St. Louis, Mo.

Laying a 6-ft. Water Pipe Across Passaic River

To the Editor:

An interesting problem in mechanical and civil engineering may be observed at Delawanna, N. J. (nine miles from Hoboken via D., L. & W. R.R.), where the Jersey City Water Department is laying a new 6-ft. diameter water-supply pipe across the Passaic River.

The pipe, which is built of 5/8 in. steel plate, is to be riveted together and tested hydraulically before being placed in position.

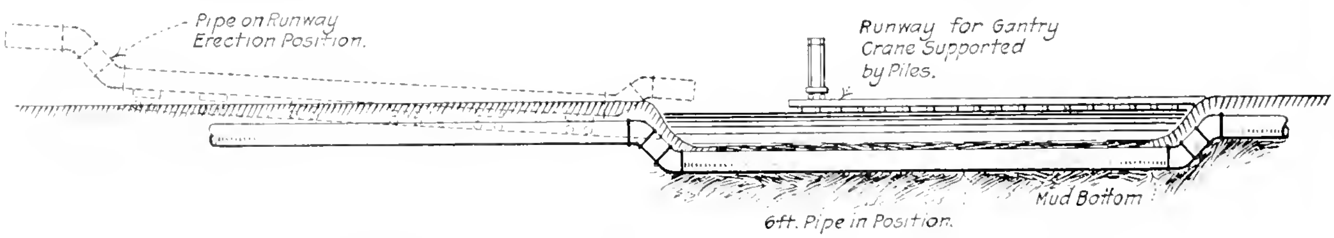
On the west side of the river and sloping gradually toward it, a narrow-gage track has been laid. About two-thirds the distance across the river, which at this point is about 200 ft. wide, two parallel rows of piles to support a gantry crane have been driven. The gantry could not be carried all the way across the river because navigation had to be kept open.

The plan of operation is to build the pipe on the wheeled carriages placed on the narrow-gage track, and then gradually to move it into the river, supporting it partly by the crane, by the traveling carriages, and by floating.

When the correct position has been reached the pipe will be sunk to its proper level, set and connections made to the existing pipe on each bank of the river. The pipe to be handled is about 250 ft. in length and weighs in the neighborhood of 65 tons.

Robt. Lacy.

Washington, D. C.



Method Employed in Laying a 6-Ft. Water-Supply Pipe Across the Passaic River

Lubrication of Air Compressors

To the Editor:

The report of Mr. H. V. Conrad, page 384 of the April issue of Mechanical Engineering, concerning the lubrication of air compressors is excellent, and should be given serious consideration by the owners and operators of such machinery.

If I may add a suggestion in this connection, I would strongly advocate the use of a suitable oil separator to be placed on the discharge line between the air cylinder and air receiver, and so arranged as to permit the blowing out of the entrapped oil at regular intervals, say once each day.

An oil separator such as is used on the gas-discharge lines of ammonia compressors would meet the requirements.

By following this plan most of the oil passing from the air-compressor cylinders will be entrapped and prevented from getting over to the air receiver, and this oil when drawn off can usually be used to advantage somewhere about the plant if properly filtered.

Another thing in this connection: It would help matters to place on the drain of the air receiver a suitable trap to automatically drain it of moisture and oil. This trap would, of course be similar to the ordinary steam trap, except that its valves should be designed for the character of the work they are to perform. It should be by-passed, permitting hand draining of the receiver in case trap repairs are to be made.

C. T. Baker.

Atlanta, Ga.

WORK OF THE BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York City.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation in the form of a reply is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in MECHANICAL ENGINEERING, The Journal of the Society, in order that any one interested may readily secure the latest information concerning the interpretations.

Below are given the interpretations of the Committee in Cases Nos. 228-235, inclusive, as formulated at the meeting of April 25, 1919, and approved by the Council. In this report, as previously, the names of the inquiries have been omitted.

CORRECTION

Case No. 223: Through an oversight certain typographical corrections in Case No. 223 which were ordered by the Boiler Code Committee were overlooked in their publication in MECHANICAL ENGINEERING. The reply in this Case should read as follows:

Reply: Under the requirements of Par. 239, the furnace will not require staying. There remains, therefore, only the crown sheet, top head of the boiler and the flue to be considered. Par. 203*d* or the latter part of Par. 216 are applicable to the crown sheet and top head, if formed from flat sheets. If, on the other hand, the crown sheet and top head are dished, the maximum allowable working pressure is calculated from Par. 195. Par. 241 applies to the flue.

CASE NO. 228

(In the hands of the Committee)

CASE NO. 229

Inquiry: Is it not permissible under the requirements of the revised edition of the Boiler Code (Edition of 1918) to equip a boiler with safety valves set for the pressure for which the boiler is designed, even though the boiler is to be operated at a pressure lower than this maximum allowable working pressure? It frequently occurs that a boiler will be built for a certain pressure, but will be operated initially at a lower pressure and the pressure increased later, and it would obviously be of great convenience to boiler manufacturers if the safety valve could under such conditions be set for the maximum allowable working pressure.

Reply: There is no way by which the exact safety valve capacity can be determined without knowing the pressure under which the boiler is to operate. Pars. 270, 271 and 274 give the rules for determining the capacity under the construction and after the operating pressure is known.

CASE NO. 230

(In the hands of the Committee)

CASE NO. 231

Inquiry: Is it necessary under the requirements of the Heating Boiler Section of the Code, to construct boilers which exceed 60 in. in diameter but are to be operated at pressures not exceeding 15 lb., according to the requirements for power boilers?

Reply: Part I, Section II of the Boiler Code, does not specify that heating boilers exceeding 60 in. in diameter, need to be built in accordance with power boiler rules. The only special requirement of steam heating boilers over 60 in. in diameter carrying not to exceed 15 lb. per sq. in., is that under Par. 341, the longitudinal joint shall not be of lap-seam construction.

CASE NO. 232

Inquiry: Is it necessary that the bolting face of a pressed steel flange as shown in Fig. 1 riveted to a boiler shell for use

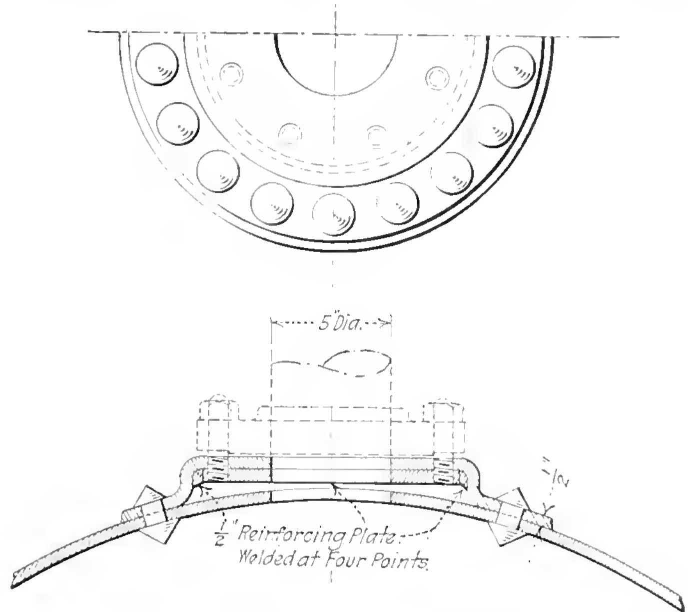


FIG. 1 PRESSED STEEL FLANGE FOR USE AS BOILER NOZZLE

as a nozzle, must comply with the requirements for flanges given in Tables 16 and 17? Should the thickness of such a steel flange conform to that required in these tables for cast iron?

Reply: It is the opinion of the Committee that any form of construction of flange within the stress limits used in boilers specified in the Code may be used for a flange which is attached to the boiler. The diameter of bolt circle and requirements as to number and size of bolts, should conform to the requirements of Tables 16 and 17.

CASE NO. 233

Inquiry: Do the requirements of Par. 258 of the Boiler Code, respecting the reinforcement of handhole openings, apply in general or only to handholes placed in boiler shells?

Reply: The requirements of Par. 258 are intended to apply to handholes placed in the cylindrical sheets of shells or drums.

CASE NO. 234

Inquiry: Is it necessary that washers used between the curved surface of the dished head of the drum of a water tube boiler and the nuts of threaded stays, be of cast steel, or may they be of cast or malleable iron? These washers which are of special wedge shape, are not exposed to any high heat, but are merely used in compression.

Reply: It is the opinion of the Committee that the washers shall be made of wrought or cast steel, or wrought iron.

CASE NO. 235

Inquiry: Is it permissible under the Rules of the Boiler Code to form an outlet nozzle on the steel pipe header of a boiler by inserting a nipple through a hole bored in the side of the pipe header for a driving fit, and flaring the interior projecting end, and then subsequently welding to the header around its outside circumference for steam tightness, the metal in the pipe header being of a lesser thickness than that required to make an expanded joint?

Reply: It is the opinion of the Committee that this method of of forming an outlet nozzle on a pipe header, does not meet the requirements of the Rules in the Boiler Code, which sanction the use of autogenous welding only where the strain is carried by other construction conforming to the requirements of the Code.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A. S. M. E.

Research Needs

Dr. W. R. Whitney, Director of the Research Laboratory of the General Electric Company, writes regarding the need of developing research men and the importance of holding those who have demonstrated their ability in research in this field. He suggests the possibility of the Society's aiding by financial support in the following way:

> I have also felt, in the case of our Chemical Society, that if it could raise the money to insure at least one pure research investigator a year, it could scarcely find a better way of advancing the science. I thoroughly believe that there is nothing which could do as much good for American science as to pick out a few good, young students, and by cold cash insure their continuance in pure and independent scientific work. This might be called the personal method, but I am sure that I have already noticed, in watching men, that a good man can do wonderfully good work in the advance of science or engineering if it can be arranged that he devote his entire attention to it with either a fair outlook or an assurance of safety on his part.

Erratum

In the description of the Thermal Testing Plant of the Experiment Station of Pennsylvania State College on page 464 of Mechanical Engineering for May, the statement that the Tagliabue thermostats hold room temperatures within 5 deg. should read 0.5 deg.

A—Research Results

Cement and Other Building Materials A1-19 Tests on Kansas Sands for Use in Mortar and Concrete, by R. A. Seaton and I. I. Taylor. Bulletin No. 3, Engineering Experiment Station, Kansas Agricultural College. Address Director A. A. Potter.

Results of experiments show that all samples met the requirements of the joint Committee on Concrete and Reinforced Concrete from the four national engineering societies. Thirty-two of fifty-two samples have to be used with a small excess of cement. Only one sand had more than 6 per cent of its sample pass through a 100-mesh sieve. The sands in general were well graded.

Cement and Other Building Materials A2-19 An Investigation of Blended Portland Cement, by E. S. McCandliss and H. H. Armsby, School of Mines and Metallurgy, University of Missouri. Address Director, Rolla, Mo.

Electric Power A1-19 Electric Cooking Appliances, R. G. Kloeffler. Bulletin No. 9, Engineering Experiment Station, Kansas Agricultural College, Manhattan, Kan. Address Dean A. A. Potter.

Advantages of electric cooking: safety, cleanliness, convenience, excellent results. First appliances exhibited in London, 1891. A cooked banquet to Lord Mayor of London, 1894.

$$\text{Efficiency} = \frac{\text{change in temperature} \times \text{lb. of water}}{3415 \times \text{kilowatt-hours.}}$$

Electric Irons: 0.97 kw-hr. for ironing wash for family of two; 1.25 kw-hr. for 70 pieces, family of six. Iron disconnected $28\frac{1}{2}$ per cent of time.

Electric Toasters: 0.11 kw-hr. to make eight pieces of toast.

Coffee Percolators: about 0.08 kw-hr. to make five cups of coffee; efficiency 72 per cent.

Electric Grills: 0.10 kw-hr. for eight pieces of toast; efficiency 39 per cent.

Chafing Dishes, efficiency 60 per cent.

Immersion Water Heater, efficiency 80 per cent.

Cost of breakfast of 5 cups coffee, 4 slices of toast, 2 slices of bacon, 2 fried eggs, 0.19 kw-hr.

Electric Ranges: Efficiency range from 32 to 60 per cent.

Cost of cooking for a week (comparative values): 20.7 kw-hr., 320 cu. ft. of gas, 70.25 lb. of coal, 2 gal. of kerosene.

Foundry Equipment, Materials and Methods A1-19 Silica Refractories. Factors affecting their quality and methods of testing the raw materials and finished ware. Technologic Papers of the Bureau of Standards No. 116. Address Director S. W. Stratton, Bureau of Standards, Washington, D. C.

The work of this paper was carried out to obtain by simple, accurate means the degree to which the amorphous silica is gradually transformed to crystal forms of lower specific gravity when bricks are burned. Points concerning raw materials and methods of manufacture are touched upon as possible improvements. Molding with a pressure of 1500 lb. per sq. in. after mixing of sized materials in a batch mixer. The experiments show that the best method to burn is to raise the temperature to 1250 deg. cent. in the usual manner and then keep it between 1250 and 1350 deg. for several days, at the end of which time it is raised until the Orton pyrometric cones from 18 to 20 bend over. The specific gravity and porosity of most of the leading varieties of silica brick have been determined. They vary between 2.650 and 2.270 with an average of 2.384. The porosity varies from 22.6 to 31.5 per cent. The investigations show that the specific gravity between 2.65 for quartz and 2.270 for tridymite crystals indicates the degree to which the brick has been burned.

Foundry Equipment, Materials and Methods A2-19 Molding Sand. A method to determine the optimum water content of molding sands consists of adding an excess of water and whirling the mixture in a centrifuge. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Fuels—Gas, Tar and Coke A1-19 Preliminary Studies of Missouri Cannel Coal, by H. L. Dunlap. School of Mines and Metallurgy, University of Missouri, Rolla, Mo. Address Director.

Iron and Steel A1-19 Purification of Magnetite Ore Containing 4 per cent Sulphur—Commercially Successful Process of Purification to 0.10 per cent. Pittsburgh Testing Laboratories, Pittsburgh, Pa.

Mathematics A1-19 Physical Quantities. A Relation Connecting the Derivatives of Physical Quantities. Applying dimensional calculations used in wind tunnels to other problems as those in predicting errors in instruments. Scientific Paper, Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Metallurgy and Metallography A1-19 Aluminum and Its Light Alloys. Bureau of Standards Circular No. 76. Bureau of Standards, Washington, D. C. Address Director.

Metallurgy and Metallography A2-19 Bibliography on Roasting, Leaching, Smelting and Electrometallurgy of Zinc, by H. L. Wheeler. School of Mines and Metallurgy, University of Missouri, Rolla, Mo. Address Director.

Metallurgy and Metallography A3-19 The Effect of Addition Agents in Flotation, by M. H. Thornberry and H. T. Mann. School of Mines and Metallurgy, University of Missouri, Rolla, Mo. Address Director.

B—Research in Progress

Air B1-19 A Commercial Method for the Measurement of High-Pressure Air Flow (100 lb. per sq. in. gage). H. S. Dickerson, School of Mines and Metallurgy, University of Missouri. Address Director, Rolla, Mo.

Apparatus and Instruments B3-19 Measuring Device for Effective Diameter of Thread Ring Gages. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Apparatus and Instruments B4-19 Lead-testing Machine for Threads. Improvement of apparatus shown in Figs. 3 and 4, page 412, of Mechanical Engineering, April, 1919. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Apparatus and Instruments B5-19 Balanced Micrometer Holder. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Apparatus and Instruments B6-19 Specific Gravity of Finely Powdered Materials. A new method to obviate difficulty due to the presence of air. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Chemistry, Organic B1-19 Preparation of Anhydrous Oxalic Acid by Use of Buffalo Vacuum Self-Drier. W. D. Turner and P. D. Wilkinson, School of Mines and Metallurgy, University of Missouri. Address Director, Rolla, Mo.

Chemistry, Organic B2-19 Preparation of Tri-methyl-amine by Means of J. P. Devine Autoclave at 650 to 700 Lb. per Sq. In. from Methyl Alcohol and Ammonium Chloride. W. D. Turner and B. G. Nichols, School of Mines and Metallurgy, University of Missouri. Address Director, Rolla, Mo.

Economics B1-19 Cost and Accounting. System for a Machine Shop. Worcester Polytechnic Institute, Worcester, Mass. Address Prof. W. W. Bird.

Electric Power B2-19 The Efficiency of Coal, Kerosene, Gasoline and Electric Water Heaters. Engineering Experiment Station, Kansas Agricultural College. Address A. A. Potter, Manhattan, Kan.

Heat B4-19 Resistance of Air to the Transmission of Heat. Engineering Experiment Station, Kansas State Agricultural College. Address Dean A. A. Potter, Manhattan, Kan.

Heat B5-19 Heat Transmission Through the Various Insulating Media. Engineering Experiment Station, Kansas Agricultural College. Address Dean A. A. Potter, Manhattan, Kans.

Hydraulics B2-19 Weir Coefficients. Determination of coefficients for 10-ft. weir. Worcester Polytechnic Institute, Worcester, Mass. Address Prof. C. A. Allen.

Internal-Combustion Motors B4-19 Temperature of Oil Films and Various Parts of Engines During Operation. Determination of flame propagation and temperature within cylinder. Preliminary measurements on single-cylinder Liberty engine. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Internal-Combustion Motors B5-19 Fuel Consumption of Ford Engine with Different Adjustments of Stock Carburetors to Demonstrate Fuel Saving. Bureau of Standards, Washington, D. C. Address Director S. W. Stratton.

Leather and Glue B1-19 Leather Belting. Relative capacity of various materials to transmit power. Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa. Address Director R. F. Bacon.

Lubrication B3-19 An Investigation of Various Cylinder Lubricating Oils. Engineering Experiment Station, Kansas Agricultural College. Address Dean A. A. Potter, Manhattan, Kan.

Machine Tools B1-19 Twist Drills. Point Thinning of Twist Drills. Used to reduce thickness of web so as to reduce thrust without weakening drill. Worcester Polytechnic Institute, Worcester, Mass. Address Prof. W. W. Bird.

Machine Tools B2-19 Proper Drill Speeds for Given Feeds. Worcester Polytechnic Institute, Worcester, Mass. Address Prof. W. W. Bird.

Metallurgy and Metallography B1-19 Determination of Cadmium in Zinc by Means of a Microscope. H. T. Mann and H. P. Gill. School of Mines and Metallurgy, University of Missouri. Address Director, Rolla, Mo.

Metallurgy and Metallography B2-19 The Relation of Exact Pyrometric Control of Heat-Treatment Furnaces to the Efficiency of Drill Steel. C. Y. Clayton, School of Mines and Metallurgy, University of Missouri. Address Director, Rolla, Mo.

Road Materials and Equipment B2-19 Tests on Kansas Road Materials. Engineering Experiment Station, Kansas State Agricultural College. Address Dean A. A. Potter, Manhattan, Kan.

Steam Power B2-19 Coefficient of Friction of Low-Pressure Steam in Pipes. University of Michigan, Ann Arbor, Mich. Address Dean M. E. Cooley.

Transmission B5-19 Minimum Center Distance of Pulleys for Belt Drives. Relation Between Elasticity, Tension and Time Element. Worcester Polytechnic Institute, Worcester, Mass. Address Prof. W. W. Bird.

Transmission B6-19 Windage of Belt Drives. Loss of Power Due to Skin Friction and Variation With Speed. Worcester Polytechnic Institute, Worcester, Mass. Address Prof. W. W. Bird.

C—Research Problems

Heat C1-19 Transmission of Heat Through Cast-Iron Pipes in Annealing Furnaces. Transfer of heat from waste gases at 1000 to 1400 deg. fahr. moving with a velocity of 1000 to 2000 ft. per min. Temperature of furnace between 300 and 500 deg. fahr. Address G. L. Ostgren, New Jersey Zinc Co., 55 Wall St., New York City.

Light C1-19 Optical Surfaces. Improved methods of polishing optical surfaces, including metals, glass, rubies, etc. Address F. G. Pease, Mt. Wilson Solar Observatory, Cal.

Photography C1-19 Speed of Photographic Plates. Mt. Wilson Solar Observatory is desirous of having plates of higher speed. The time required for exposure with 72-in. reflector is 1½ hours. F. G. Pease, Mt. Wilson Solar Observatory, Cal.

Properties of Engineering Materials C1-19 Steam Packings. Relative value of steam packings, red packings, black packings, packings with more than 30 per cent rubber. Asbestos rubber packings. Frederick Dannerth, 325 Academy St., Newark, N. J.

Properties of Engineering Materials C2-19 Elastic Limit of Small-Size Commercial Drawn Tubing of Various Materials in Tension, Compression and Torsion. Harrison Safety Boiler Works, Philadelphia, Pa.

Properties of Engineering Materials C3-19 Hysteresis of Metals Under Reversed Stress and Torsion. Harrison Safety Boiler Works, Philadelphia, Pa.

Properties of Engineering Materials C4-19 Fatigue of Metals Made in Small Tubes. Harrison Safety Boiler Works, Philadelphia, Pa.

D—Research Equipment

Aircraft D1-19 Wind Tunnels, Washington Navy Yard. One tunnel 8 ft. square with maximum velocity of 80 miles per hour. Liners can reduce this to 8 x 4 ft. or 4 x 4 ft., giving wind speeds of 150 or 200 m.p.h. Tunnel equipped with Eiffel-type balance of 30 lb. capacity. A three-dimensional balance is being designed. One wind tunnel is 4 ft. square with maximum wind speed of 65 m.p.h. Small tunnel equipped with balance of Curtiss Engineering Corporation, capacity 20 lb. Address Commander McEntee, Navy Yard, Washington, D. C. (see Research Personal Notes, *Marine Engineering E1-19*).

Pittsburgh Testing Laboratory D1-19 This laboratory is equipped for chemical and physical tests in industrial chemistry and mine operation; tests of ores, fuels and raw materials; cement, sand and stone and concrete structures; inspection of asphaltic and other paving materials with portable

laboratories; inspection at mills and shops for bridges, buildings, shops, cars, locomotives, machinery, rails and inspection of steel and cast-iron pipes; testing of power plants and pumping plants. Address Pittsburgh Testing Laboratory, Pittsburgh, Pa.

University of Illinois D1-19 The equipment of the mechanical laboratory.

Steam Boilers
- 210-boiler hp. Heine boiler
- Foster superheater of 3100 sq. ft.
- Sturtevant economizer
- Kewanee down-draft smokeless house-heating boiler
- Small Arco cast-iron steam-heating boiler
- One Mercer cast-iron sectional steam-heating boiler

Steam Engines
- 7 x 10-in. and 10 x 12-in. Chandler & Taylor cross-compound engine with surface condenser
- Two 10 x 10-in. Ideal engines
- One 8 x 12-in. Meyer automatic engine
- One 8 x 18-in. Murray Corliss engine
- One 12 x 24-in. Allis-Chalmers Corliss engine belted to a 100-kw. generator
- One 60-hp. Kerr turbine
- Two 100-kw. Curtis turbo-alternators

Pumps
- One 300-gal. 150-lb. Fairbanks pump
- One 140-gal. two-stage DeLaval turbo pump

Main Steam Piping
- Steam piping is arranged to deliver saturated and superheated steam to any of the above units

Small Power-Plant Group
- 25-hp. portable boiler with 7 x 10-in. Atlas steam engine with feedwater heater, boiler-feed pumps, water meter

Heating and Ventilation
- Four-unit steam-radiator testing plant
- Experimental hot-blast heating unit with each section arranged for individual determination of condensation
- Warren, Webster & Co. air washer with temperature and humidity control
- Fans with facilities for making traverses of air duct and with fan driven by Sprague electric dynamometer
- Heat-transmission plant for finding heat through building materials
- Warm-air-furnace testing plant equipped for measuring temperatures, air velocity, effect of register faces, leaders and stacks

Air Compressor
- Two-stage 12¼-in. and 18¼ x 12 in. Ingersoll-Sargent compressor

Refrigeration Equipment
- Ten-ton York ammonia compressor
- Ten-ton Vogt absorption refrigerating machine with ice-making equipment and apparatus for measuring refrigerating effect

Internal-Combustion Engines and Gas Producer
- Two four-cylinder motors
- One six-cylinder motor
- One Sprague dynamometer of 150-hp.
- One 10 x 19-in. Otto engine
- One 5¾ x 12½-in. Otto engine
- One 9 x 9-in. Bogart engine
- One 9 x 10-in. Mietz and Weiss engine
- One 10 x 20-in. tandem Sargent engine
- One 75-hp. Smith producer

University of Kansas D1-19 The equipment in the mechanical laboratory of the University of Kansas is as follows:

Steam Equipment
- One 100-hp. Stirling boiler, hand-fired, with induced draft
- One superheater
- One 10 x 24 x 30-in. cross-compound Corliss engine
- One 20-hp. DeLaval turbine driving circulating-water pump
- One 75-hp. Ball engine, high-speed
- One Wheeler condenser, 500 sq. ft., with electrically driven wet vacuum pump and Mullen dry vacuum pump
- One equipment for demonstrating steam equipment and for exercises on same
- Power-developing units, including high-speed steam turbine, cross-compound high-speed engine, condensing, and boiler equipped with stokers available for commercial tests

Gas Equipment
- One 75-hp. tandem single-acting gas engine
- One 5-hp. Olds gas engine
- One 12-hp. I. H. C. oil engine
- One Ford automobile engine
- One 75-hp. Smith gas producer

Refrigeration
- One 5-ton Cleveland ammonia compressor

Small Equipment
- Gages, indicators, oil and friction testing machines, gas-analyzing apparatus, fuel calorimeters, steam calorimeters, speed counters, etc.

University of Missouri, School of Mines, D1-19 The Laboratory of the School of Mines, University of Missouri, includes the following equipment:

Boilers
- Four 130-hp. Heine safety boilers with soot blowers and measuring apparatus.

Engines and Generators
- 10-hp. Wickes boiler and engine plant
- 75-kw. Erie-Ball engine and Westinghouse d.c. generator
- 50-kw. Ideal engine with Westinghouse d.c. generator
- 50-kva. General Electric marine-type engine with a.c. generator
- 10-kw. General Electric turbo-generator
- 30-hp. Kerr steam turbine
- 9 x 14-in. Brownell engine
- 5 x 7-in. Davis & Rankin engine
- 21-hp. Otto engine
- 3-hp. Ferro gas engine
- 8-hp. Bessemer gas engine
- 6-hp. Continental automobile motor

Pneumatic Equipment
- One Laidlaw-Dunn-Gordon air compressor
- One Rand Imperial air compressor
- One Sullivan air compressor
- One 36-in. Sirocco blower
- One 72-in. Buffalo fan
- One 62-in. Buffalo blower
- Air tanks.

Testing Machines
- 200,000-lb. tension, compression and bending machine
- 60,000-lb. Olsen torsion machine
- 50,000-lb. Riehlé machine

Mining Equipment
- 42-in. furnace with coal, gasoline and coke
- 20-in. blast furnace
- One gyratory breaker and one Dodge breaker
- One pair of rolls
- Two plane shaking screens, three trommel screens
- One duplex Callow belt screen
- One 3½-ft. Huntington mill and one three-stamp mill
- Two Vezin samplers.
- One Richards pulsating classifier, three-spigot cone classifier, four-spigot classifier, Tamarack classifier
- Four settling cones
- Three 5-cell Herz jigs and one pulsator jig
- Tables for sands: one Card, one Deister-Overstrom, one James, and two Wilfley
- One 4-ft. Frue vanner
- One 5-ft. Sperry slimer
- Breakers, grinders, and rolls with bucking boards, mullers and tube mill.

Drills
- Two Ingersoll-Rand, two Sullivan, one Wood, one Leyner, one Stoper, one Waugh, and one Sullivan. Ingersoll Rand jackhammer, one Hardsocg, one Cleveland, one Fort Wayne Electric, One Scott gas.

Shops
- Pattern shop
- Forge shop
- Foundry
- Machine shop.

E—RESEARCH PERSONAL NOTES

General E4-19 Steel Treating Research Society.

The American Steel Treaters' Society, with headquarters at Chicago, Ill., T. E. Barker, President, and Arthur G. Henry, 154 East Erie St., Chicago, Ill., Secretary, is doing work along the lines outlined in the March, 1919, number of MECHANICAL ENGINEERING. The Chairman of their Research and Standards Committee is Thos. E. J. Janitzky, Illinois Steel Co., South Chicago, Ill.

Lynite Laboratories E1-19

The Lynite Laboratories of the Aluminum Castings Company, under R. E. Carpenter, Manager, are divided into a Research Division under Dr. Z. Jeffries and a Development Division. The Research Division is divided into Sections of Special Research, Metallurgy, Metallography, Chemistry, Physics, and Tests, while

the Development Division is divided into Sections on General Engineering, Automotive Engineering, Permanent-Mold Section, Sand-Casting Section and a Forging Section. The plan of the laboratory is to connect the experimental work with the production work of the country. Address R. E. Carpenter, 2800 Harvard Ave., Cleveland, Ohio.

Marine Engineering E1-19 Use by Private Parties of Naval Experimental Basin.

The Naval Experimental Basin at Washington, D. C., is available for testing models or other devices for private parties provided the expense is borne by the parties and the work does not interfere with Government work. No profit is made, but actual cost to Government is charged. Apply to the Bureau of Construction and Repair, Navy Department, Washington, D. C.

F—BIBLIOGRAPHIES

Air F1-19 Air Conditioning. Cooling-Spray Ponds and Nozzles. Bibliography prepared for Research Committee. Address A.S.M.E., 29 West 39th St., New York.

Hydraulics F1-19 Air-Lift Pumps. Bibliography prepared for Research Committee. Address A.S.M.E., 29 West 39th St., New York City.

Hydraulics F2-19 Cooling Water. Cooling-Spray Ponds and Nozzles for Air Conditioning. Bibliography prepared for Research Committee. Address A.S.M.E., 29 West 39th St., New York.

Materials of Engineering F1-19 Bearing Metals. Bibliography prepared for Sub-Committee. Address A.S.M.E., 29 West 39th St., New York City.

REPORT OF SUB-COMMITTEE ON LUBRICATION

RESEARCH COMMITTEE OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

THE Sub-Committee on Lubrication has recognized certain problems as definitely awaiting solution. Among these problems are those relating to the behavior of lubricants at high pressures and temperatures. The conditions existing in bearings operating under moderate pressures, with therefore relatively thick oil films, are fairly subject to analytical treatment based on the assumption that the viscosity of the lubricant is the sole factor affecting its operation. On the other hand, under conditions of very high pressures or high temperatures or both, it is a common experience that certain organic oils, e. g., lard oil and sperm oil, are much more effective in reducing friction than are mineral oils of similar viscosity, as ordinarily measured. The property or properties causing such differences in lubricating value are at this date more or less obscure. Various terms have been used in recognition of the existence of this lubricating property, such as "oiliness," "greasiness," "unctuosity," "body," etc., but thus far no conclusive experimental evidence has been obtained to show the nature of the physical processes accounting for the observed differences in lubricating value. In discussing this general problem the Committee has recognized the following lines along which investigation might be conducted:

1 *Effect of Pressure Upon Viscosity.* It has long been known that high pressure produces measurable changes in the viscosity of certain fluids. Mr. M. D. Hersey[1] has experimented on this subject, using the ball-and-tube type of viscosimeter described by Prof. A. E. Flowers[2]. Mr. Hersey found that lard oil and (mineral) machine oil, of nearly the same viscosity at atmospheric pressures, showed great increase in viscosity under pressures of 200 to 500 atmospheres. Further experiments in this direction are desirable.

2 *Effect of Temperature on Viscosity.* It is well known that all lubricants decrease in viscosity with increase of temperature, and also that certain organic oils, notably sperm oil, decrease relatively less than the mineral oils. Under very high pressures, such as occur with metal-cutting tools, the temperature of the effective portion of the lubricant may be very high. Viscosity measurements are rarely made at temperatures above 100 deg. cent., but this temperature is probably much lower than that actually reached in severe service: hence, it is desirable to experiment on the viscosities of lubricants up to the temperatures of volatilization or of disintegration.

3 *Adhesion (Capillarity).* Experiments have thus far not shown slipping at the boundary surface between the lubricant and the solid surfaces at moderate rates of shear in the lubricant; but it is still a question whether such slipping may not occur under excessive rates of shear, such as may exist when the film is exceedingly thin. Mr. Albert Kingsbury has experimented with a device consisting of a slightly tapered plug rotating in a ring, the parts being of hardened steel, closely fitted by grinding. The thickness of the oil film between the surfaces was determined by micrometric end adjustment of the plug. With films as thin as 0.000025 in. and rates of shear up to 261,000 radians per sec., at atmospheric pressure and temperature, there was no indication of slip, and no deviation from the ordinary law of viscosity that could not be attributed to inaccuracy of the fitted surfaces. It is possible that some form of experiment might be devised which would extend our knowledge in this direction. If slipping should be shown in any case, there would further arise the question whether it depends on the nature of the bearing metals.

4 *Adsorption.* The suggestion is made that the lubricants that exhibit oiliness in a marked degree may contain solids in solution, which tend to concentrate at the boundary surfaces, thus increasing the viscosity at the surface, and therefore enhancing the lubricating value under conditions of very high pressure. There is at this date no direct evidence on this point, except in the case of the use of soap dissolved in the water used in hydraulic cylinders, the soap being found to concentrate upon the metal surfaces, forming a good lubricating film.[1] It is possible that this may account for the good lubricating properties of the various "cutting mixtures" containing soap and water, used for lubricating metal-cutting tools; and possibly the valuable properties of lard oil and of sperm oil, for examples, may be due to similar phenomena.

ALBERT KINGSBURY, *Chairman.*
ALAN E. FLOWERS.
MAYO D. HERSEY.
GEORGE B. UPTON.
Sub-Committee on Lubrication.

[1] *Journal of the Washington Academy of Sciences,* Vol. VI, 1916, p. 525.
[2] *Proceedings of the American Society for Testing Materials,* Vol. XIV, Part II, 1914.

Tentative report for presentation at the Spring Meeting, Detroit, Mich., June 16 to 19, 1919, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[1] Lubrication and Lubricants—Archbutt and Deeley (Lippincott).

REPORT OF SUB-COMMITTEE ON BEARING METALS

RESEARCH COMMITTEE OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

IN THE January number of MECHANICAL ENGINEERING, our Committee made a brief report giving concisely the reason for abandoning our original plan of first publishing a complete compendium of the technical literature on bearing metals. At the time we also pointed out what we considered the most promising outlook for future study and investigation.

It is our conviction that a large amount of valuable time is being wasted in testing bearing alloys, in determining characteristics that are of no consequence and are utterly meaningless. The only mechanical or physical test of a bearing alloy, in the

Tentative report for presentation at the Spring Meeting, Detroit, Mich., June 16 to 19, 1919, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

aggregate, that can serve any useful purpose is that of determining whether the given alloy has a sufficiently high factor of safety against possible distortion or rupture under specified service conditions at service temperature. All other characteristics are of a microscopic nature, depending entirely upon the properties of the individual crystals of the alloy, upon their orientation, relative hardness, fusing temperature, quantitative proportions and the like.

Our studies have convinced us that any work on our subject without the application of modern metallography is an absolute waste of time; we also feel that studying the hardness of the individual microscopic crystals is of the greatest importance in supplementing the application of metallography to our subject.

The instrument shown in our last report has been perfected to a much higher degree and three of them have been substantially completed, one for each member of our Committee. This instrument determines the characteristic of a crystal which is the combination of three of the five fundamental conceptions of hardness[1]; namely, the combined effect of cutting hardness, scratch hardness, and penetration hardness. This is done by very slowly moving an exceedingly hard and sharp point[2] under a definite pressure, over a highly polished surface of the crystal to be tested; in fact, the point is moved so slowly that no additional penetration is effected by stopping. The point is a solid right angle or the corner of a cube, mounted in such a manner that the diagonal of the cube will be normal to the surface tested, and having an edge of the cube advance directly in the line of motion. The motion is effected by a slow micrometer feed. The width of the cut, scratch, or penetration is a function of its depth and, therefore, measuring the width of the mark gives us the means for determining this combined characteristic representing the hardness of any crystal. The instrument is properly called a *Microcharacter*.[3]

In order to lay the broadest foundation for our work, one that will facilitate the coöperation of other investigators and will make all results directly comparable, it is necessary that conventional units be established; that is, that a *Scale of Microhardness* be determined upon. With the establishment of this scale it will be possible to consider the various crystals in the many different alloys in terms of exact degrees of hardness. This is the work that occupies the attention of your Committee at the present time.

Experience well shows that a single homogeneous metal is not suited for bearing purposes, and that the first requirement for a bearing metal is that it be an alloy composed of at least two metals, or a metal and a metalloid, which shall have at least a limited degree of solubility while in the molten state; but that upon cooling it shall partially separate out into dissimilar crystals, and thus form the proper microstructure which is necessary in all bearing alloys. It is not only necessary that a bearing alloy shall be composed of chemically dissimilar crystals, but it is all-important that these crystals shall have a marked degree of difference in their physical hardness and wearing qualities.

The degree of relative solubility necessary for the constituents of bearing alloys is well illustrated by the copper-tin and the copper-zinc compounds, and this also illustrates why bronze is a better bearing alloy than brass. For example, with the addition of not more than 11 per cent of tin to copper, a three-phase alloy is ordinarily produced—less than a two-phase alloy cannot be produced; even with the most instantaneous chilling effect, crystals of different chemical composition are produced. While on the other hand, with 11 per cent of zinc added to copper only a single-phase alloy can be produced, however slowly it may be cooled; that is, all of the crystals in this copper-zinc alloy are of the same chemical composition, and therefore all have the same physical properties. Quite the opposite is true in the copper-tin alloy, an extreme dissimilarity of crystals existing both as to chemical composition and physical hardness. Now, it is due entirely to this dissimilarity of crystals in the bronze that makes it a better bearing alloy than brass.

In the solidifying of the molten bronze the tendency of the tin to separate from the copper is far greater than that of the zinc in the solidifying of brass, for the reason that the bronze solidifies with a distinct microscopic heterogeneity. The matter of having a proper microstructure in a bearing alloy is always of far greater importance than its exact aggregate chemical composition. The value of an exact or definite chemical composition is secondary, in that it can serve only in producing the desired microstructure in a given alloy, provided the alloy is subjected to the proper cooling conditions.

The essential characteristics of all bearing alloys is a structure made up of alternately hard and relatively soft microscopic particles intimately mixed. The function of the hard particles or *bearing crystals* is to support the load and resist the wear. These bearing crystals should not be hard enough to prove distinctly abrasive to the journal surface. General experience shows that an extreme hardness of the bearing crystals is characterized by an excessive wear of the journal. The function of the softer or more readily abraded crystals is that of being plastic and permitting the bearing crystals to adjust themselves to surface requirements of the journal. These softer crystals are also more readily abraded, and therefore wear slightly below the surface of the bearing crystals and thus form slight depressions upon the bearing surface which serve for the retention of the lubricant. However infinitesimal in amount this may seem, nevertheless it is this lubricant that prevents scoring or seizing when the journal is starting up from rest at a time when actual metallic contact between the bearing surfaces exists. The same is equally true under an excessive load. This function of retaining a slight quantity of the lubricant upon the bearing surfaces when metallic contact exists, characterizes a bearing alloy in its truest sense. Therefore a bearing metal may be defined as: *An alloy that is capable of retaining a lubricant on a bearing surface.*

In the operation of a bearing under normal conditions, when a continuous and unbroken film of lubricant exists it matters little what metals are used while the film is sustaining the entire load. In the starting and stopping of the journal, however, or at all such other times when the film is interrupted and metallic contact exists, it then becomes very important that the properties of a bearing metal should be present.

A matter of importance, which seems not to have been considered heretofore, is the fusing temperature of the bearing crystals. From observations made it is evident that under severe conditions where relatively low-fusing bearing crystals exist in a high-fusing alloy these bearing crystals actually fuse on their surfaces during the process of the "running in" of the bearing. The delta copper-tin crystal (Cu_4Sn) may be cited as a particular example, and in some severe conditions corresponding to automotive worm-drive service the alpha copper-phosphorus crystal (Cu_3P) seems to function in a similar manner. It is doubtful whether these conditions ever obtain in any of the babbitts, since their bearing crystals are the highest-fusing compounds of these alloys.

The study of bearing metals is very incomplete unless these alloys are considered in conjunction with the other corresponding bearing member. The extreme variety of modern steels makes this necessary, since a bearing alloy suited for a soft low-carbon machine-steel journal would not be an economic selection for a high-carbon nickel-chrome heat-treated journal, and a proper selection for the latter would prove destructive for the former.

It seems exceedingly improbable that laboratory accelerated service tests can ever give general satisfaction owing to the difficulty of reproducing in a few hours' time the equivalent of many years of service conditions. It is our conviction that much more can be learned from the study of failures, and also in studying old bearings (together with their journals) which have given eminently satisfactory service for an exceptionally long period.

C. H. BIERBAUM, *Chairman*
J. A. CAPP
H. DIEDERICHS
Sub-Committee on Bearing Metals.

[1] General Metallurgy—Hofman.
[2] MECHANICAL ENGINEERING, Jan., 1919, p. 71.
[3] μικρο'σ, small; χαράσσειν, to engrave, or scratch.

ENGINEERING SURVEY

A Review of Progress and Attainment in Mechanical Engineering and Related Fields, as Gathered from Current Technical Periodicals and Other Sources

SUBJECTS OF THIS MONTH'S ABSTRACTS

AIR MACHINERY

GOVERNOR FOR REGULATING PRESSURE OF GAS EXHAUSTERS AND BOOSTERS. Description of a new device designed to react instantaneously upon slight changes of pressure applied to the governing of rotary exhausters. To comprehend it thoroughly, it is necessary to understand the difference between throttling regulation and cut-off regulation.

In a rotary exhauster working within the limits of intake and discharge pressure the work done by the engine per revolution is constant as long as the elements are constant.

If two engines work side by side, one regulated by a throttling governor and the other by a cut-off governor the indicator cards will be as shown in Fig. 1. In the case of throttling regulation any increase in the speed of the engine will have a given position of the governor result in a greater throttling loss and in less work per revolution. With a cut-off regulation if the engine speeds up the work per revolution remains practically constant and no large force is required to return the speed to normal unless that force comes from the engine governor.

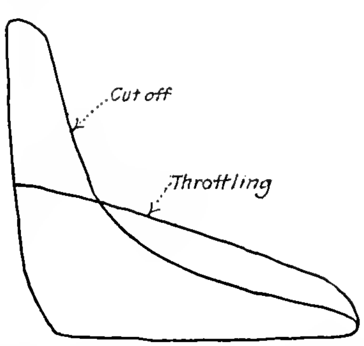


FIG. 1 INDICATOR CARD FOR TWO ENGINES, ONE WITH THROTTLING AND THE OTHER WITH CUT-OFF REGULATION

In gas exhausters, particularly in connection with by-product extraction, the pressure at the exhauster must be kept constant within 5 mm. of water, which means a closeness of regulation of 0.05 per cent, or, roughly, 100 times as much as in compressor practice.

The new governor shown in Fig. 2 is of the float type. It is equipped with a stabilizing chamber which is partly filled with water to prevent it from following the influence of the pressure too far. (Should the float tend to rise under the influence of less vacuum inside of it, the water in the stabilizing chamber is lifted so that the float becomes heavier and resists being carried too far.) To enable the float to find its correct position the stabilizing chamber is purposely made leaky, the extent of the leak being determined by an adjustable valve, of which the screw is shown at 3. With the valve wide open the governor surges; with the valve dead shut it does not maintain a constant pressure.

The motion of the float is communicated to a vertical pilot valve 1 by means of light rods with very small pin joints which approach frictionless knife edges in their action. The pilot valve is equipped with a compensating return mechanism provided to prevent slight displacements of the valve from moving the valve gear of the engine continuously away from the starting position

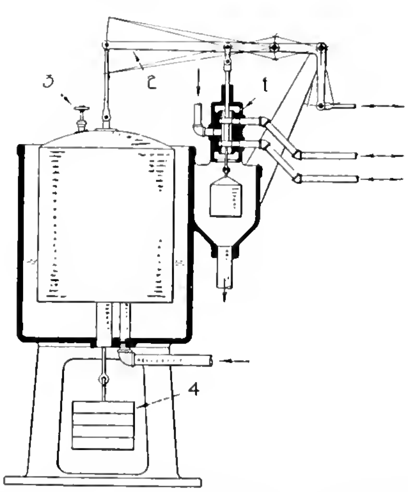


FIG. 2 SECTION OF THE ROOTS PRESSURE GOVERNOR FOR GAS EXHAUSTERS

until the resulting speed change and pressure change move the governor and displace the pilot valve in the opposite direction.

The lever 2 is so connected with the valve gear that motion of the latter induced by opening of the pilot valve closes it.

It has been found by experiment that with releasing gear for Corliss or poppet valves 3 mm. total fluctuation of suction pressure can be obtained, except during periods of excessively quick changes in the various pressures and gas volume when the pressure fluctuation will reach 10 to 15 mm. of water. (*The Iron Trade Review*, vol. 64, no. 17 April 24, 1919, pp. 1086-1087, 2 figs., *d*)

BUREAU OF STANDARDS

New Instruments for Measuring Combustible Gas in Air

NEW FORMS OF INSTRUMENTS FOR SHOWING THE PRESENCE AND AMOUNT OF COMBUSTIBLE GAS IN THE AIR, E. R. Weaver and E. E. Weibel. A study has been made of the combustion of small amounts of gas in the air at the surface of electrically heated wires and the application of this phenomenon to the design of instruments for the purpose of detecting the presence

and indicating the amount of combustible gas in the air. As a result of this study three types of instruments, each especially adapted to certain uses, have been designed, tested and found to work satisfactorily.

The action of one of these instruments depends upon a resistance change, one upon a heating effect upon an adjacent bimetallic strip, and one upon the light emitted from the heated wire.

A discussion of the principles involved in the design of the instruments and specifications for their construction are given. (Abstract from Scientific Paper No. 334)

Solar Radiation as It Affects Balloons

EFFECT OF SOLAR RADIATION UPON BALLOONS, J. W. Edwards and M. B. Long. This paper describes briefly the effect of solar radiation upon balloons and includes experimental measurements on typical balloon fabrics.

Preliminary to the subject proper a summary is given of the characteristics of solar radiation and atmospheric conditions which have a direct relation to the problem. The radiation characteristics of the fabrics themselves are discussed. A series of measurements on representative balloon fabrics showed an absorbing power for solar radiation varying from 45 to 90 per cent.

The fundamental relations governing the temperature of balloon fabrics when exposed to solar radiation are outlined and the application of these to the calculation of balloon temperature is discussed. The multiplicity of factors involved makes the calculation of such temperatures of very limited value, but by means of measurements on a model balloon the magnitude and distribution of the temperature involved, in both gas and fabric, are well illustrated. The temperature of the upper surface of the model balloon in bright sunlight under certain definite conditions, varied from 20 deg. cent. to 39 deg. cent.

The importance of the radiation characteristics of fabrics in governing buoyancy changes, in causing increased permeability of the fabric to hydrogen and in its effect on the life of the fabric is emphasized as a factor in the selection of fabrics for various purposes. Other factors affecting the selection of fabrics are summarized and their relation to the radiation characteristics is pointed out. (Abstract from Technologic Paper No. 128)

Methods of Testing and Specifications for Soaps

SPECIFICATIONS FOR AND METHODS OF TESTING SOAPS. This circular includes a general discussion of the composition of soap and the varieties of toilet, laundry, scouring and soft soaps for which specifications are proposed. These specifications cover milled toilet soap, white floating soap, liquid soap, shaving soap, salt-water soap, special-grade laundry soap, ordinary-grade laundry soap, chip soap, soap powder, hand grit soap, scouring soap (A), scouring soap (B), and automobile soap. The methods described include those for sampling deliveries, for preparation of the laboratory sample and for the following tests and determinations: Matter volatile at 105 deg. cent.; free alkali or acid; alkali as alkaline salts; silicate; sulphate; matter insoluble in water (insoluble siliceous material); unsaponified saponifiable matter; preparation of total fatty acids; titer test; acid number of fatty acids; total alkali; chloride; rosin; total anhydrous soap; sugar (qualitative test); feldspar and quartz; potash and soda. (Abstract from Circular No. 62, 2nd edition).

ENGINEERING MATERIALS (See also Heat-Treating)

EFFECTS OF PHOSPHORUS ON MALLEABLE CAST IRON, J. H. Teng. Discussion based on experiments conducted at the University of Birmingham. Two series of test bars were prepared; one by adding phosphoric iron to a pure American wash white iron, and the other by adding the same to iron supplied by malleable-iron founders in Birmingham.

Tensile transverse and bending tests were made and Figs. 3 and 4 show the relation between transverse strength, deflection and the proportion of phosphorus in both types of irons.

In the tensile-strength tests it was generally found that the maximum stress elongation and reduction of area are gradually lowered with increasing phosphorus, while the yield point is gradually raised.

The bars belonging to the pure-iron series show a higher yield point but a lower maximum stress, a lower elongation and a smaller reduction of area than those belonging to the common-iron series, which may, however, be due to the higher silicon content in the former.

The following general conclusions were reached:

The addition of phosphorus does not result in any improvement in the mechanical properties of the malleable casting.

Any addition of phosphorus leads to a deterioration in the mechanical properties, as shown by tenacity, elongation, and toughness.

The ill effects of phosphorus do not become marked until about 0.2 per cent of phosphorus has been reached, and this

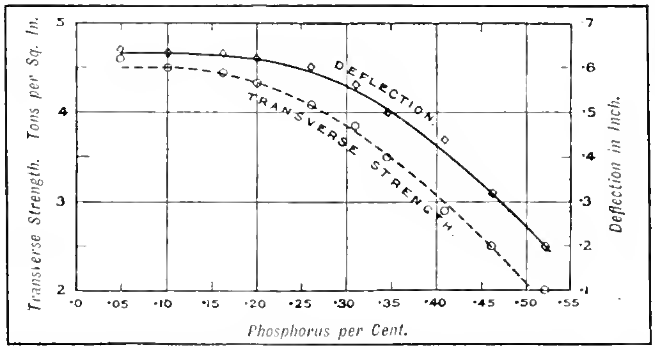


FIG. 3 CURVES SHOWING THE RELATION BETWEEN TRANSVERSE-STRENGTH DEFLECTION AND THE PROPORTION OF PHOSPHORUS IN THE PURE-IRON SERIES

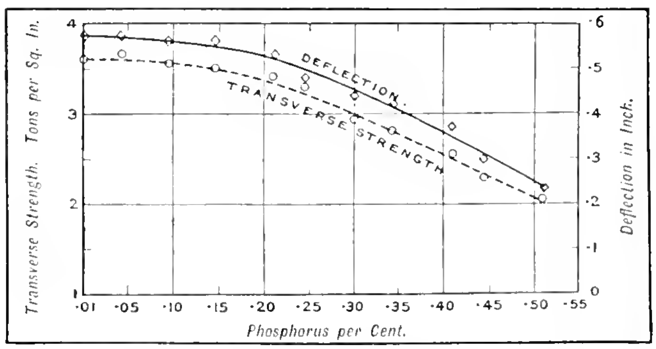


FIG. 4 CURVES SHOWING THE RELATION BETWEEN TRANSVERSE-STRENGTH DEFLECTION AND THE PROPORTION OF PHOSPHORUS IN THE COMMON-IRON SERIES

may be considered to be the approximate limit for commercial purposes.

The presence of a considerable amount of silicon and manganese is of more importance than the absence of sulphur with regard to the success of the annealing operation.

The origin of the sulphide of iron in the spent oxide is attributable to the presence of sulphur compounds in the reducing atmosphere in the furnace near 900 deg. cent. (Paper before British Iron and Steel Institute, reported through *Foundry*, vol. 47, no. 320, April 1, 1919, pp. 151-156, 9 figs., *e*)

HEAT-TREATING

Dilatometer Method of Investigating Heat-Treating of Carbon Steel

MECHANISM OF TEMPERING CARBON STEEL, Pierre Chavenard. An extensive discussion based on experimental research and abstracted from a recent issue of *Revue de Metallurgie*.

In order to observe in all details the transformation of steel during tempering and in order to connect in a quantitative manner the intensity of observed phenomena with other experimental conditions, it is necessary to have at every instant and in all points of the test piece under investigation the same temperature and hence the same rate of cooling.

For purposes of investigation little value must be placed on methods of thermal analysis, as their sensitiveness is proportional to the mass of the test piece and nearly independent of its shape. To this class belong all methods based on the study of temperature-time curves, variation of magnetic properties, etc. If, with these methods, very small pieces are used for purposes of investigation, certain details may remain unnoticed through lack of sensitiveness of the process employed. On the other hand, if large pieces of steel are used, there is a danger of the presence of excessively different conditions in various parts of the test piece.

Because of hysteresis phenomena, the use of electrical reactions for discovering changes of state of steel leads to considerable experimental difficulties.

The "dilatometer" method avoids all these pitfalls. The measurement of dilatation of a test piece refers only to one of its dimensions, and that is why in experiments made with a very fine wire it is sufficient to secure uniformity of temperature and rate of cooling in reference to its length. Moreover, the wire may be comparatively short (only a few centimeters long), because the transformation is accompanied by an important irregularity of dilatation, which it is easy to amplify materially by optical means. Furthermore, it is easy to secure uniformity of conditions of cooling, and finally the examination of the wire treated will, in the great majority of cases, enable one to verify in how far this uniformity has been actually secured.

The sensitiveness of this method is not only very high but it is practically independent both of temperature and velocity of reaction. This extremely important property makes it possible to disclose at low temperatures the most feeble manifestations of change of state from γ to α. Finally, the phenomena of dilatation are accompanied by the exercise of considerable forces with respect to which the inertia of the amplifying apparatus is quite negligible. Because of this, the readings of the dilatometer translate faithfully and without lag the maximum of transformation, no matter how great may be the velocity of cooling.

Of course, to cool a wire a few hundredths of a millimeter in diameter, immersion into a liquid was out of question, but the spontaneous cooling in an inert gas of a steel wire previously brought to red heat by an electric current may be rapid enough to produce tempering. In fact, according to a deduction from Newton's law, the velocity of cooling varies in inverse proportion to the diameter of the wire, and for a wire of small section attains a high value. In order to vary in a continuous manner the rate of cooling, resort is made to an experimental process based on the high heat conductivity of hydrogen. All other conditions being equal, the fall of temperature in hydrogen is about three times what it is in nitrogen, and mixtures of these two gases in various proportions provide a means of carrying out on the same test piece a series of temperings at various predetermined rates of cooling.

The extremely low mass of this test-piece wire appears to be an obstacle in the way of directly measuring the temperature during cooling, but this difficulty is circumvented by the use of a comparison wire made of "baros," a metal whose heat properties are very close to those of steel in the γ state. The two wires heated to the same temperature and then at the same time permitted to cool, will, with proper precautions, maintain the same temperature up to the beginning of transformation from γ to α. In the arrangement used by the author the expansion of a sample of baros measures its temperature and indirectly determines also the temperature of the steel sample.

The comparison wire permits also to employ the dilatometric method under a differential form, which gives it an extremely high sensitiveness. The apparatus based on that principle automatically draws a curve whose abscissæ represent the expansion of the sample and the ordinates the difference in the expansions of the two samples. This curve is recorded on a photographic plate, while the periodic interruption of the luminous ray marks the time in conformance with the principle previously employed by Le Chatelier. This makes it easy to compute the velocity of cooling at any point in the photographic diagram.

A question may be raised as to how far the conclusions drawn from a study of extremely fine wires may be applied to the case of commercial tempering of pieces having a considerable mass.

There is no doubt that fundamentally the phenomena must remain qualitatively the same notwithstanding the changes in the dimensions of the piece treated. On the other hand, however, it is certain that the magnitudes of the necessary rates of cooling for tempering are dependent on these dimensions. In fact, during rapid cooling of a large piece the central zones are subjected to a high pressure due to the contraction of the layers lying on the periphery and first reaching a low temperature. This pressure tends to oppose transformation from γ to α, which takes place with increase in volume.

In other words, the physical variables which determine for each element of volume of steel the occurrence of transformation

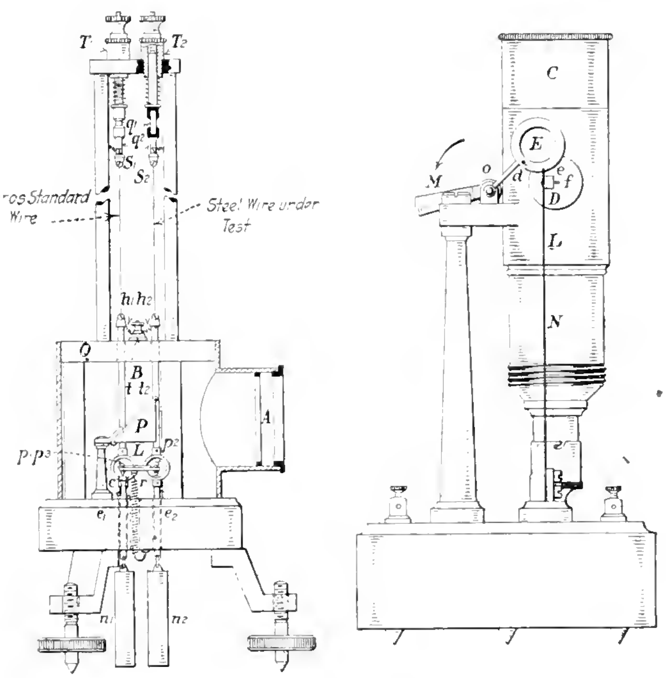


Fig. 5 Chavenard Differential Dilatometer

are temperature, pressure and their variations as a function of time.

In the present investigation the author leaves the action of pressure practically out of consideration. The rates of tempering measured by the method employed here are really the upper limits, but their determination is nevertheless of great interest because it enables one to classify different kinds of steel in accordance with their aptitude for tempering.

The whole article is too extensive for abstracting and because of this only the conclusions are reported here, in addition to which is given a description of the differential dilatometer employed in the present investigation.

The following conclusions are reached by the author:

In most reversible steels, such as the carbon self-hardening steels, the tempering occurs always in accordance with the same mechanism, even though the velocities of reaction necessary to obtain comparable states may be in two different cases extremely different from each other.

When the transformation in cooling takes place entirely at a high temperature, say, 600 to 700 deg. cent. (Ar′), it leaves the metal in a state of physicochemical equilibrium, state of anneal. In accordance with the rapidity of the change of state the steel may consist of pearlite or troostite.

The tempering takes place because of the fact that at low

temperatures (150 to 300 deg. cent.) there is a transformation from γ to α of the austenite. Its intensity is the greater in proportion as this transformation Ar'' is nearer to completion; when the tempering has been completed entirely the steel consists practically exclusively of martensite.

Between the two extremes of treatment, anneal and full temper, there may be had a series of semi-tempers due to the superposition in each elementary volume of steel (the linear dimensions of which are of the order of 0.01 mm.) of the transformation of anneal (Ar') and of temper (Ar''); the semi-tempered steels consist of troostite and martensite, or of ferrite and martensite.

The beginning of tempering is always clearly defined, while the disappearance of Ar', that is, the completion of the tempering, is a limited phenomenon, which sometimes proceeds quite slowly. If the energy of the treatment be carried out to exaggeration, the increase in the proportion of austenite is maintained in the steel and the efficiency of tempering is decreased.

Either by studying tempering on wires or by determining the magnitude of anomalous occurrence of cementite in treated steels, exact indications may be secured as to the nature of the constituents of tempering and annealing. Martensite, which is due to the transformation of austenite at low temperature, appears to be an unstable solid solution of carbon in α iron. Troostite in negative tempers, or half-tempers, osmondite and sorbite in anneal must be considered as aggregations of iron and cementite.

In order to obtain a steel of the same strength of temper recourse must be had to cooling, which must be the more rapid the less the heating was carried beyond the Ac state. If it be desired to obtain tempers of approximately equal strengths in different steels heated to the same initial temperature, the velocity of cooling which must be employed must increase in proportion to the decrease in carbon content. The experiments described in this paper have, it appears, for the first time led to a quantitative expression of these relations for the most simple cases, namely, infinitely small strength of temper and samples of negligible mass.

The ability of a steel to take temper may be defined quite precisely by the temperature of heating, the initial velocity and the limit curve of anneal. The determination of this curve is of essential theoretical and practical importance. Hitherto it could be obtained exactly only with self-hardening steels and the investigation of very reversible steels has been carried out to a much smaller extent because of the lack of a convenient and exact process for the determination of very high velocities of cooling.

The method of thermal analysis based on automatic record, of the dilatation of a steel wire during its cooling in an inert atmosphere appears to fill this need and the availability of an exact and convenient method for measuring the degree of irreversibility of steels opens a field for new investigations, one of the most important of which will have to do with the specific action of traces of elements which ordinary steels contain as impurities, or of special alloying elements which may enter into their composition.

Differential Dilatometer. In the dilatometer, Fig. 5, the steel wire as well as the standard wire having a diameter of 0.23 mm. are attached on the top to invar holding screws S_1 and S_2, which are in one piece with the suspension heads P_1 and P_2. These wires are held by invar rods t_1 and t_2 to the weights W_1, W_2, which give to the wires a tension of 0.5 kg. per sq. mm. (711.16 lb. per sq. in.). The suspension heads are so arranged as to permit an adjustment of the position of the wire, namely, the twist about its axis and a slow upward movement.

The dilatations of the wires are transmitted to the optical lever L, the purpose of which is to amplify them. This lever, provided with a flat mirror M, is carried on three tempered chrome-steel pin points p_1, p_2, p_3, arranged in a right-angled triangle. The dilatation of the wire gives to the optical lever a complex movement equivalent to two rotations: one about an axis OX, this rotation being proportional to the difference of the elongation of the two wires; and another around axis OY, proportional to the elongation of the standard wire. The curves traced by the ray reflected from the mirror enable reading the indications of the apparatus.

In order to compute the velocity of cooling the luminous ray is eclipsed periodically so that the photographic curve consists of a succession of interrupted lines, each of which has been drawn within the same time interval.

The original article describes in detail the method of using the differential dilatometer and the results obtained therewith. (Mechanisme de la trempe des aciers au carbone, Pierre Chavenard, *Revue de Metallurgie*, vol. 16, no. 1, January-February 1919, pp. 17 to 79, 17 figs., *etA*)

Troubles in Case-Hardening and Their Elimination

The Application of Heat in Case-Hardening, Theo. G. Selleck. The practical case-hardener has four important factors to consider: (1) the nature and quality of the material to be treated [laboratory reports of analyses or specifications from manufacturer], (2) temperature at which the material is treated, (3) the carbonizing agent, and (4) time.

The writer considers especially temperature and its uniform application, but points out that the nature and quality of the material to be treated are a prolific source of trouble for the case-hardener.

Steel is not always what it seems to be or what specifications and analyses show it to be. Chemical analysis of steel does not take into account mill faults which may be hidden in various segregations of elements nor does it always find variations of carbon beyond the limits of specifications which are not unusual.

The original article illustrates by photomicrographs cases of segregation which occurred in a steel plate supposed to carry 0.10 to 0.15 per cent carbon. The plate was carbonized and hardened, after which it proved to be very brittle.

Not only upon fracturing the plate did there appear to be no soft center, but in the center of the cross-section of the plate there were numerous little cracks expanding perpendicularly in the direction of the surface of the plate but not quite reaching it. Such conditions cannot be anticipated or determined in advance and often cause heavy loss of material and labor.

The cause of another mill fault frequently discussed in treating plates is that commonly known as lamination due to ferrite ghosts. The remarkable part of this fault lies in the fact that it occurs almost on the weld line or the line between the carbonized area and the soft center.

In addition to such segregations as have been referred to above and which are due to the previous history of the carbonized pieces, there are other segregations called by the writer "segregations of heat" for which the case-hardener is entirely to blame if they occur.

Heat is the primary element of all case-hardening. As iron must be in the gamma state before it can dissolve carbon, heat must be applied in such a manner as to establish this essential condition of the iron.

After pointing out the importance of having a uniform degree of heat throughout the process of carbonizing, the author states that he discovered that by close observation the operator may know almost to a certainty, practically from the beginning of a case-hardening heat, what the final results will be.

It is further claimed that for this purpose no special equipment is needed but only a fair knowledge of heat colors and a proper familarity with the fundamental principles of the case-hardening process. The method developed is based on optical observations made by the writer, which consisted merely of keeping a close watch on the boxes from the time they were put into the furnace cold until they were thoroughly heated or until the color of the boxes blended into the color of the heating chamber of the furnace and noting the manner in which the heat colors displayed themselves over the boxes. From the results of these observations it is claimed that the first show of heat color displayed upon a case-hardening box will indicate without fail the regularity or irregularity of the results of the operation.

In presenting his paper before the American Steel Treaters' Society the author used colored plates which are reproduced in

single color in the paper from which this abstract is made. This limits the ability of describing the color observations of the writer.

In this connection even the original article does not help very much because all illustrations therein are made in black prints. The original paper presented before the American Steel Treaters Society was accompanied by colored plates.

From what he says, it appears, however, that irregularities in coloring of the boxes may be taken as portents of irregularities and results of carbonization, and contrasts of colors tell a story of variations both of penetration and of carbon content which is not told either by physical or chemical tests.

The writer claims that this new method of observation in case-hardening, namely, by colors, opens up a new field for investigation. One of the factors which may be cleared up by such an investigation is the occurrence of inequalities of penetration due to unequal temperatures. Variations of carbon content, however, also affect the amount of penetration. Indeed, it is claimed that in the tests made by the author facts were observed which give a strong impression of possibilities of great variations of carbon existing in the test pieces.

Further, the author emphasizes the fact that the heat diffusion in case-hardening operations does not take place at a uniform rate, because of the different conductivities of the materials through which the heat has to flow. Because of this it is highly desirable to avoid all possible obstacles to uniform diffusion of heat and for the material to be treated as near as practicable to the point of heat generation, which means preheating the case-hardening boxes.

The author secured an even and uniform pentration of carbon content throughout on a batch of several hundred bars of mild steel 8 ft. long. The closed muffle type of furnace was used and 20 bars were handled in each operation, the weight of each charge being more than 950 lb. These bars were placed in the muffle already heated to 1500 deg. fahr. and were held in position until they were uniformly heated to about 1250 deg. fahr. The compound was then introduced and the holding devices removed. The temperature dropped about 200 deg. but rapidly regained an equilibrium between the steel and the compound and in two and one-half hours was at the carbonizing point.

For this purpose the closed-muffle furnace is necessary, but boxes may be used with only slight changes. By a closed-muffle furnace the author means one which can be closed and sealed airtight and so constructed that it may be evenly heated all over. Since the muffle is sealed airtight there is no necessity for covers on the boxes. When the operation of preheating is completed the boxes are removed, covers placed on them if desired, and they are handled just as in the old method. (*Journal of the American Steel Treaters' Society*, vol. 1, no. 3, December, 1918, pp. 87-89, 11 figs., *ptA*)

Advantages of Slow Cooling in Annealing Bronze Castings

HEAT-TREATING BRONZE CASTINGS, G. F. Comstock. Discussion of the effects of annealing bronze-alloy castings and data of experiments made by the author.

The writer describes an experiment in which six tensile-test bars were cast from the same crucible in the same manner. One bar was tested as cast without heat treatment and three bars were heated slowly in an electric muffle furnace to 700 deg. cent. and held there for 30 min. Then one bar was quenched in water, one was taken out and allowed to cool in the air and one was left to cool in the furnace.

This made four bars. The fifth bar was heated to 800 deg. cent. held in the furnace for 30 min. and cooled slowly in the furnace to 600 deg. cent. Then the remaining bar was put in and its temperature maintained at 600 deg. cent. for 30 min., after which both of these bars were allowed to cool slowly in the furnace.

The bars were then tested for yield point, tensile strength, elongation, reduction of area, and hardness, and the results obtained appear to show that annealing at about 700 deg. cent. benefits the alloy, while quenching in water spoils it. (The metal contained 88.5 per cent copper, 9.5 per cent tin and 2 per cent zinc.) In general, however, heat-treated bars show practically no change in yield point or hardness as compared with the untreated bar, while the other properties, especially elongation, were decidedly improved by annealing. (This result is, however, made somewhat doubtful by the fact that the untreated bar had a small flaw.)

An attempt was made to explain by the use of a microscope the failure of the bar quenched in water which proved to be extremely weak in every test, but its structure appeared to be no different from that of the other bars. It seems likely, therefore, that this alloy simply cannot stand the strains produced by sudden cooling in water from a red heat, which makes impractical the idea of trying a double heat treatment consisting of quenching and tempering on copper-tin alloys.

TABLE I PHYSICAL TESTS OF BARS WITH AND WITHOUT HEAT-TREATMENT

Bar heated to (deg. cent.)	Cooled in	Yield point, lb. per sq. in.	Tensile strength lb. per sq. in.	Elongation, per cent	Reduction of area, per cent	Hardness Number	Remarks
Not heated	....	22,100	43,400	26 5	23.7	67	(*a*)
700	Water	18,200	18,700	7 5	6 7	66	(*b*)
700	Air	21,600	44,600	41 5	33 5	67	.....
700	Furnace	20,700	45,400	41.5	34.3	68	.....
600	Furnace	21,800	48,500	50.5	46.2	71	.....
800	Furnace	21,000	48,200	58 0	38 0	67	.....

(*a*) Small flaw. (*b*) Unsound.

The tests also show that the gun metal or 88-10-2 bronze castings can be improved in strength and especially in ductility by annealing at a red heat or 600 to 800 deg. cent. for at least 30 min., followed by slow cooling. The structural change produced is the removal of the dendrites or soft cores and of the eutectoid or delta constituent resulting in a homogeneous polygonal structure. The same change can be produced by annealing any of the ordinary copper-tin alloys.

As to bronze casting in a chill mold, it is said that it solidifies with great rapidity but the liquid metal heats the chill so much that the rate of cooling below 500 deg. cent. is never fast enough to prevent the better constituent from breaking down into the eutectoid. In other words, the chill prevents the development of great differences in composition between the low-tin dendrites and the high-tin ground mass of the alloy.

Very little is said to be known as to the possibilities for heat-treating of manganese-bronze castings and the writer has therefore made a few experiments along this line.

The effect of quenching manganese bronze in water from a red heat is to fill the metal with invisible cracks which ruin the tensile properties of the alloy. If the best elongation is desired, manganese-bronze castings should cool slowly in their molds and should not be shaken out of the sand hot, unless stiffness is desired rather than ductility.

Interesting data are also presented on the subject of heat treatment of aluminum bronze. (*The Foundry*, vol. 47, no. 321, April 15, 1919, pp. 189-194, 18 figs., *dp*)

HYDRAULIC ENGINEERING

Swiss and French Devices for Automatically Limiting Output of Pressure Piping

AUTOMATIC APPARATUS FOR REGULATING THE OUTPUT OF PRESSURE PIPING, Prof. W. De Schoulepnikow. Pressure piping which connects the starting chambers in hydroelectric plants is often subject to extremely high pressure and to water hammer, which increases the pressure still more. Rupture of such piping is by no means rare and may have grave consequences, as in such cases both the starting chamber and the supply channel

may be emptied and the plant located below runs great danger of being swamped and destroyed. It is therefore absolutely necessary to provide some means to stop the flow in case of rupture of piping.

The simplest method is to put a watchman on the starting chamber and make him responsible for closing the inlet sluice on the piping as soon as an accident becomes in evidence. This method, however, is expensive and not convenient as it is impossible to rely on the constant attention of a watchman.

A better solution is to operate the sluice by means of electric motors receiving their current from the plant. This method, however, likewise requires a certain amount of attention on the part of the plant personnel.

Because of this it appears to be a better plan to employ apparatus which will automatically stop the flow in the piping as soon as it has exceeded a certain amount fixed in advance. Such apparatus may be made to operate either hydraulically or mechanically. Bouchayer and Viallet, engineers in Grenoble, France, have invented a siphoning automatic apparatus which has been employed in the installation at Soulom and the sketch shown in Fig. 7 has been given to the author by the inventors.

The pressure piping $A\ B\ C$ has the form of a siphon in which the point B is above the maximum level h-h of the reservoir. The pipe AI equipped with the sluice K connects the two branches of the siphon and serves to fill up the pressure piping. This latter is also equipped with a snuffle valve E connected to the peak of the siphon by the pipe G. The priming in the Soulom plant is effected by means of a special water jet, which, at a given moment, aspirates the air from the siphon. The pressure piping is then ready to function.

According to the Bernoulli law, when water flows through the pipe the level in the snuffle valve E sinks as the flow of water in the conduit increases. If it goes below the point F, air enters, the siphon is deprived of its priming and the flow of water is stopped at once. Because of this, all that is necessary is to determine the height H in such a manner as to produce this loss of priming when the velocity has attained a dangerous magnitude, such as would happen, for example, in case of a rupture of the conduit.

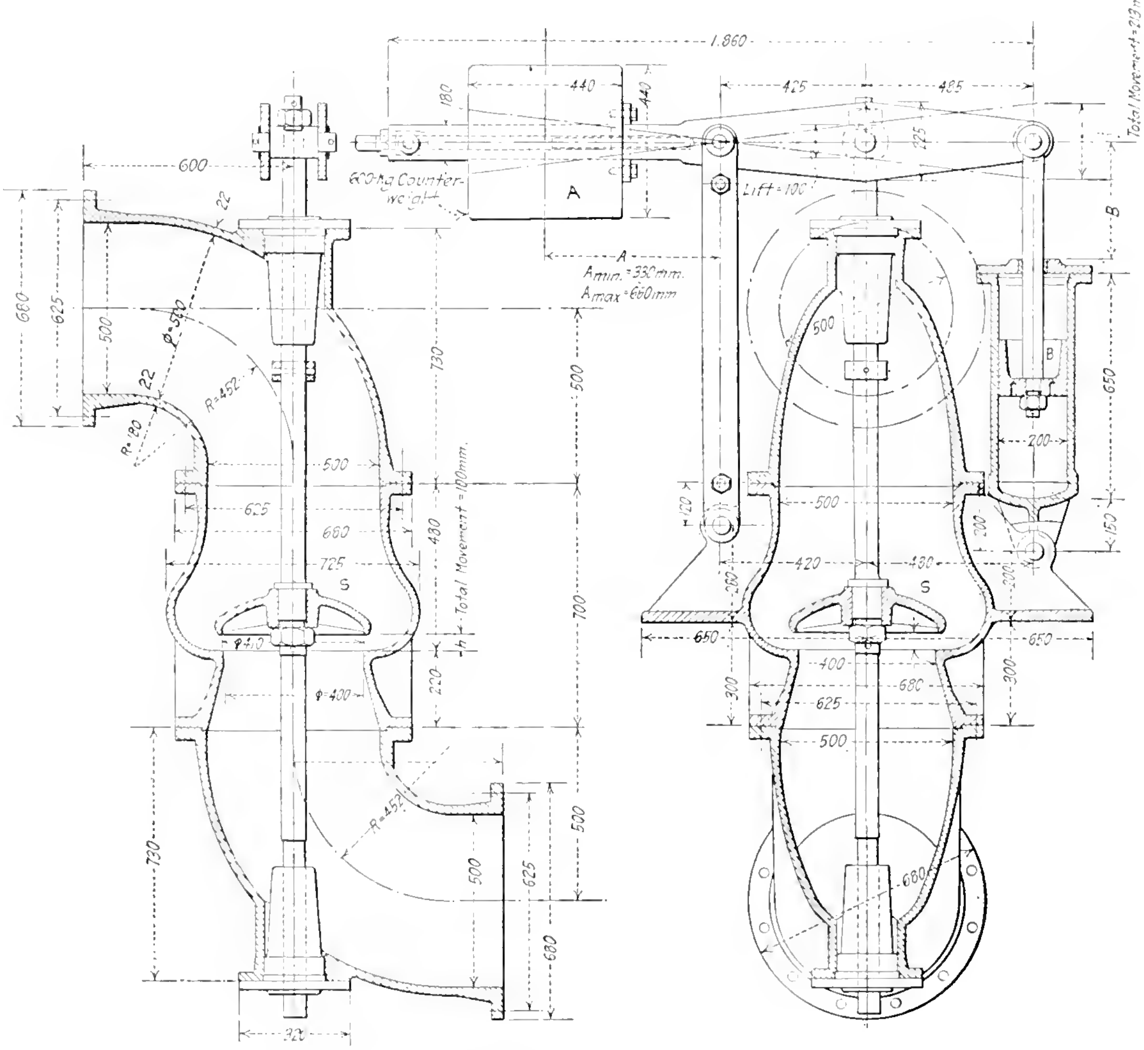


Fig. 6 Automatic Valve-Closing Device in the Pipe at the Fully Plant, Switzerland

This apparatus requires, however, that the level of water in the starting chamber should not vary too much.

Apparatus in which the stoppage of flow is effected mechanically are free from this rather inconvenient condition, but require a certain amount of attention to maintenance. There are several types of them.

As an example, in Fig. 6 is shown a gate located at the origin of the pressure piping in the Fully plant, which uses the highest head in the world, namely, 1650 m. It is easy to see that the rupture of a pipe working at that pressure would produce a tremendous amount of damage.

The automatic apparatus comprises a valve S balanced by an adjustable counterweight A which keeps the valve open as long as the velocity of water does not exceed a given value. If this value is exceeded the pressure of the water tends to force the valve against its seat. The hydraulic brake B protects the valve against an excessively sudden closure which might break it. Table 2 and Fig. 8 indicate the output for the different values of

TABLE 2 GATE REGULATION FOR VARIOUS RATES OF FLOW

Flow in liters per sec.	Valve Opening		Position of Counterweight
	h	B	
	mm.	mm.	mm.
330	50	350	420
400	50	350	570
440	50	350	660
420	66.7	386	478
470	66.7	386	510
580	66.7	386	545
600	66.7	386	580
630	66.7	386	612
662	66.7	386	660
740	83.3	421	545
775	83.3	421	580
802	83.3	421	612
842	83.3	421	660
888	100	457	545
966	100	457	612
1014	100	457	660

the valve lift h, as well as the position which the counterweight has to occupy for each of these values.

It is believed that this is the first publication of these data ever made. (*Bulletin Technique de la Suisse Romande*, 45 anneé, no. 7, April 5, 1919, pp. 57-58)

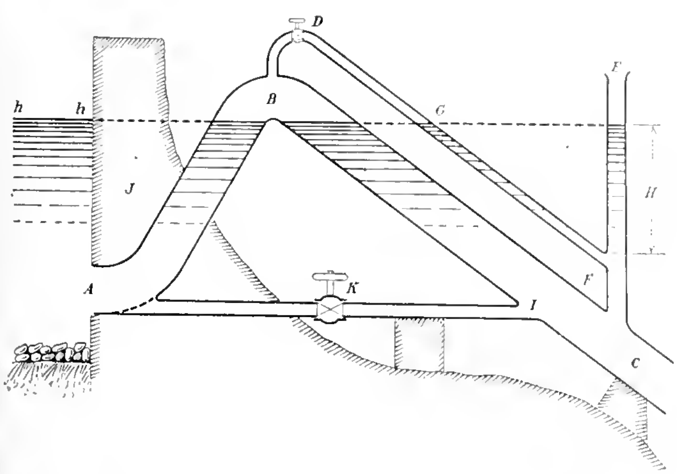


Fig. 7 Automatic Flow Arrester for Pressure Piping in Hydroelectric Plants

INTERNAL-COMBUSTION ENGINEERING

Atmospheric Humidity as It Affects the Output of Internal-Combustion Engines

Atmospheric Humidity and the Testing of Internal-Combustion Engines, Capt. Ch. Boileau. The writer discusses the question whether atmospheric humidity really affects the output of internal-combustion engines, and if so, how the proper correction shall be made. In the precision testing of engines it is usual to reduce the engine power to a pressure of 760 mm. by multiplying the value actually obtained at a pressure H by $760/H$. Calculation and experiment likewise prove the correctness of this so-called barometric correction.

The second correction (that for temperature) which is always applied in testing gas engines is not as a rule resorted to in testing explosion-type engines with heat-jacketed carburetors. However, with carburetors having no heat jacket such a correction may be necessary, as will be shown later on.

In central and western Europe the atmospheric pressure may easily vary 5 per cent either way, which indicates the amount of error which would be committed if a proper correction were not applied. But there is a third source of error, which, as a rule, is not taken into consideration and the importance of which is equally great. This is the humidity of the atmospheric air. In the present article an attempt is made to show the theoretical basis for such a correction and, as far as possible, evaluate the influence of this factor. An objection may be made to the effect that at the instant of the explosion, phenomena of dissociation occur which it is impossible to measure. This is true; and in the present instance only comparative results may be considered on the assumption that no dissociation occurs.

As regards the method employed in the present instance, it is claimed that it is nothing but a simple application of the usual thermodynamic formulæ—the Zeuner tables for water vapor and the Sorel tables for gasoline vapor. The specific heat at constant volume for superheated water vapor was taken to be 0.55:

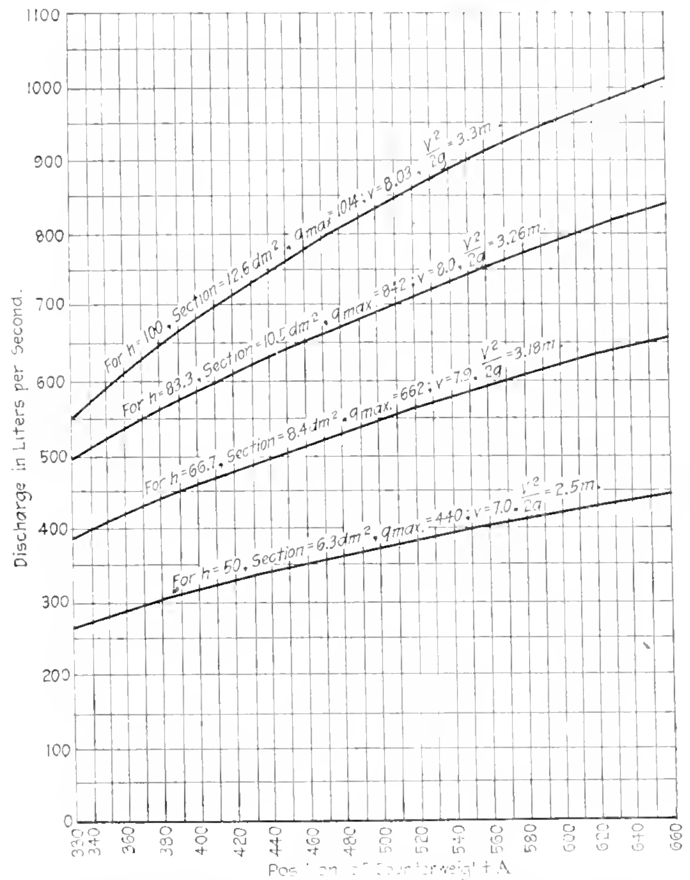


Fig. 8 Diagram of Flow as a Function of the Position of Counterweight in the Apparatus Shown in Fig. 6

1.3 = 0.42 at high temperatures and 0.39 at low temperatures during the period of compression, in calories per kilogram. The following calculation is presented. A swept cylinder volume of 1 cu. m. is assumed with a coefficient of volumetric compression of 4.7, and at first constant atmospheric pressure and temperature (760 mm. and 15 deg. cent.), the only variable being the humidity of the air. Furthermore, since the e ternal pressure does not vary, the same calculations are repeated for different constant temperatures such as 0 deg., 30 deg. cent., etc. Finally, a third variable is introduced, atmospheric pressure, to determine whether its influence is properly taken care of by means of the correction factor $760/H$ when both temperature and hygrometric tension are taken into consideration together.

Constant Atmospheric Pressure

In this connection two cases are considered under the general assumption that the atmospheric pressure is 760 mm. and that the air is first absolutely dry at 15 deg. cent. and next absolutely humid (i.e., saturated) at 30 deg.

Case 1. $H = 760$, $t = 15$ deg. cent., $f = 0$. The tension of the gasoline at the saturation point and at 15 deg. cent. is equal to 0.304 kg. per sq. mm. The density of gasoline vapor is taken as 3, with air as unity. Hence, in order to saturate 1 cu. m. at that temperature, it is necessary to have

$$1.293 \times 3 \times \frac{0.304}{1.033} \times \frac{273}{288} = 1.083 \text{ kg.}$$

The tension of the gasoline vapor will be given if we assume that the carburetor has an exhaust regulation at 1/20 and is expressed by the equation

$$1.293 \times \frac{273}{288}\left(1 - \frac{x}{1.033}\right) = 20 \times \frac{1.083}{0.304} x$$

whence

$$x = 0.017 \text{ kg. per sq. cm.}$$

and the weight of the air is then

$$1.293 \times \frac{1.033 - x}{1.033} \times \frac{273}{288} = 1.203 \text{ kg.}$$

and hence the weight of the gasoline is 60.15 grams.

Compression. For the mixture $pv^{1.41} =$ Constant, and hence $p = 7.75$ kg. per sq. cm., and $t = 187$ deg. cent.

Explosion. The amount of heat produced by explosion is 661.65 cal. The air necessary is $15.1 \times 0.06015 = 0.908$ kg. and the excess air is therefore 0.295 kg., hence

$$661.65 = (T - 460)\ \{[0.06015\ (3.091 \times 155 + 11.62 \times 0.174) + 0.295 \times 0.17] + 0.42 \times 0.0849\}$$

from which

$$\tau = 3293, \text{ and pressure} = 55.43 \text{ kg. per sq. cm.}$$

The work of one cycle is equal to the difference between the work of expansion and the work of compression, where both are evaluated by the formula

$$\tau = \frac{\gamma - 1}{p_1 v}\left(1 - \frac{1}{\left(\frac{p_1}{p_2}\right)^{\frac{\gamma - 1}{\gamma}}}\right)$$

whence

$$\tau = 58.6v$$

The author uses conventionally 58.6 to express the value of this factor.

Case 2. $H = 760$, $t = 30$ deg. cent., $f = 100$ per cent, $F = 0.043$ kg. per sq. cm. The tension of gasoline at saturation equals 0.403 kg. per sq. cm.; the weight of the water equals 30.15 grams, the weight of air equals 1.115 kg.

Gasoline to the amount of 55.75 grams is injected and the whole brought to 760 mm. pressure and 15 deg. cent. temperature by means of the heat jacket. Calculation shows that 1 cu. m. of the mixture contains

1.190 kg. of air
0.0596 kg. of gasoline
0.0128 kg. of water vapor and
0.0194 kg. of entrained condensed water.

Compression. First the writer considers the behavior of a cubic meter of dry steam. If it be treated as superheated steam, a final pressure of 0.132 kg. and a temperature of 202 deg. cent. are obtained.

Under the assumption that 19.4 grams of water are gradually evaporated with the change in compression, it is found that the final state will be the same as if this amount of water were injected into the volume of superheated steam maintained at 0.132 kg. pressure and 202 deg. cent. temperature. This final state is computed from the ordinary equation of mixtures, bearing in mind that if x grams have been evaporated then $(12.8 + x)$ grams of vapor saturate exactly 212.8 liters at that temperature.

From the tables it is found that the final state is then $t = 44.25$ deg., whence $r = 16.13$ and $r = 0.37$ grams, or

$$0.39\ (202 - 44.24) \times 0.0128 = (44.25 - 15)\ 0.0194 + 0.00037 \times 575.6$$

On the other hand, the mixture of air and gasoline passes at the temperature of 187 deg. and the pressure of 7.62 kg. These two equal volumes of carburated air and wet steam are now mixed. According to the tables 212.8 liters are saturated by 33.2 grams of water at 63.1 deg., which corresponds to a tension of 0.237 kg. per sq. cm. The heat lost by the gas in cooling to t deg. will then serve to raise the internal heat of 13.17 grams of water vapor from 44.25 deg. to 63.1 deg., and to superheat it from 63.1 deg to t deg.; also to raise 19.03 grams of liquid from 44.25 to 63.1 deg. and to vaporize and superheat it to the same temperature of t deg., whence $t = 117$ deg.

In fact

$$(187 - 117)\ (1.190 \times 0.170 + 0.0596 \times 0.35) = 0.06585 + 0.39 \times 0.01317\ (117 - 63.1) + (63.1 - 44.25) \times 0.01903 + 0.01903 \times 562.3 + (117 - 63.1)\ 0.39 \times 0.01903.$$

The pressure of the vapor equals $0.237 \times (390/336.1) = 0.275$ and this pressure is equal to $7.62 \times (390/460) + 0.275 = 6.74$ kg.

The exponent of the polytropic transformation is given by

$$6.74 = 4.7\ x \times 1.033, \text{ where } x = 1.21$$

and the work of compression as determined by the above formula is 9.34.

Explosion. By similar reasoning the theoretical pressure is found to be 52.61. The work according to the same conventions is then represented by

$$52.61 \times \frac{0.381}{0.31} - 9.34 = 55.2$$

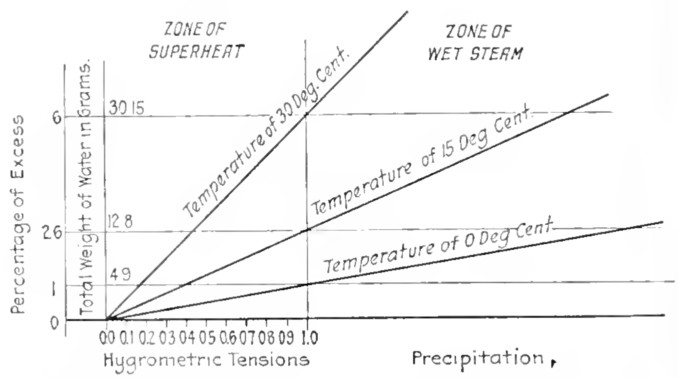


Fig. 9 Nomographic Curve of Corrections for Air Humidity

instead of 58.6, which was the value found for 15 deg. cent. and absolute dryness in the first case.

Discussion of Results

The foregoing shows the method adopted, which is applicable for every case.

In Case 1 it is found, as might have been expected, that at absolute dryness and any temperature whatsoever the work performed is the same in all cases, which is due to the fact that the carburetor is supposed to bring the gas to a temperature of 15 deg. always and to maintain the gasoline content in the mixture constant.

With constant humidity the work as calculated diminishes with increase of temperature. That is why the values found at 0 and 30 deg. and absolute humidity (saturation) are respectively 58 and 55.2. Therefore, it would be necessary to multiply the value obtained for power output in the test by a coefficient which might vary from 1.01 to 1.06. This indicates that the error from this source is by no means negligible.

For the same temperature the increase in power output is materially proportional to hygrometric tension and, therefore, the law of correction may be quite simply represented by a nomographic curve such as shown in Fig. 9. There the hygrometric tensions are indicated as abscissæ and the percentage by which the power read off the instruments should be increased as ordinates. The corresponding points for the same temperature are found to be located along straight lines passing through the region. On the other hand, care should be taken that the hygrometric state of the air does not go below 0.30. It may be admitted that the average state of the air is about 0.65 and it is

more practical to refer the constants for a motor to this average state rather than to the state of absolute dryness. A simple transformation of Fig. 1 shows that then the coefficient of correction may vary from 0.975 to 1.025. The extreme deviations with reference to operation under the average hygrometric state (0.65) are less important, namely, 2.5 per cent either way instead of 6 per cent in excess of the reading. Nevertheless in acceptance tests their value remains quite important.

Saturation with Precipitation

If the air sucked in by the motor contains droplets of water in suspension, the presence of this liquid should be taken into consideration. The problem is then treated in the same manner as the second case above referred to from the moment of an appearance of condensation.

If the corresponding points for the same quantity of water (vapor or water of condensation) contained in the air are calculated, it is found that the coefficient of correction is essentially the same no matter what may be the temperature under consideration. Hence, if the corresponding straight lines in Fig. 9 for each temperature be extended beyond the abscissæ for 100 per cent, the points corresponding to the same total quantity of water will be found to be essentially on the same ordinate, which may be graduated in percentages of increase of magnitude of power output or in units of water. The values already calculated make it possible to determine the scale of graduation without much trouble. It is found as a matter of fact that within the limits considered the power output should be increased by approximately 1 per cent for each 5 grams of water contained in 1 cu. m. of air.

Variable Atmospheric Pressure

If the foregoing calculations are carried through with a pressure H other than 760 mm. it is found that the results obtained under the same conditions of temperature and hygrometric tension are materially in the ratio of $H/760$. This is particularly so in one of the most unfavorable cases, say, 30 deg. cent. temperature and saturation, since then the water tension 0.043 is of material importance as compared with the atmospheric pressure; still the two coefficients calculated for $H = 760$ and $H' = 0.9$ do not differ from each other except by fractions of one per cent. The barometric correction must therefore be applied in addition to the combined temperature hygrometric correction.

Specific Fuel Consumption

The calculations indicated above give all the elements necessary for evaluating the various specific fuel consumptions. It is found that air humidity has only a very slight influence on the specific fuel consumption and affects it under the most unfavorable conditions to the extent of barely 2.5 per cent. It would appear, therefore, that in practice the increase of specific fuel consumption due to humidity of air falls within the range of errors of reading, of indicating instruments, and of such other errors which are generally covered by the tolerance in determination of experimental results.

All the above results apply to the case of carburetors capable of regulating the temperature of the gas so that it will remain at 15 deg. cent. and of maintaining the mixture in the ratio of gasoline to air of 1 to 20, which is the case with all modern carburetors.

As a matter of fact, however, the preheating never carries the gas to 15 per cent at the instant of admission. This temperature has been selected only as a basis, because it permits the operation of suction carburetors, but it is *a priori* evident that power is gained by maintaining the feed at the lowest possible temperature, or rather would have been gained if there were no danger of condensation of fuel or even congelation of atmospheric vapor as happens all the time with injection carburetors regulated by needle valves in winter.

A computation with zero temperature and dry air will show for τ a value of 61.7 instead of 58.6 under the assumed standard conditions, or a gain of more than 5 per cent.

Because of this, designers do not try to push preheating beyond a few degrees above zero. There is no difficulty in remaking the above calculations, for example, on the basis of heating the gas to 5 deg. and coming still closer to actual conditions by introducing a suitable coefficient of throttling.

Comparative results will be approximately the same, as might have been seen from the start—the effects of lesser heat and reduced admission compensating each other.

Engines with Forced Water Injection

There is no contradiction between the results that have been indicated and those actually obtained on engines with forced water injection, such as the Capitaine-Banki type. All the above considerations had reference to an engine with a normal volumetric compression equal to 4.7. In the Banki motor the volumetric compression went as high as 9.82 and the amount of water injected at full load was 4.84 times the weight of the gasoline, while in the example considered earlier (with the temperature of 30 deg. cent.) the weight of water was only 0.53 times that of gasoline, or one-ninth of that in the Banki motor.

A brief calculation applying the above-discussed principles to the Banki motor is given in the original article. (*La Technique Moderne,* vol. 10, no. 6, June, 1918, pp. 266-269, 1 fig., *e*)

MACHINE ELEMENTS

Sykes Flexible Reversible Coupling. Description with illustration of a flexible coupling made by a British concern. Broadly, it is constructed after the fashion of a crab coupling, one half being provided with pockets, the number of which is determined by the size and duty of the coupling. This portion is keyed on to the half-flange coupling on the shaft, the pockets being designed as in a crab coupling, to receive the radially disposed tenons on the other member, which is keyed on to the motor shaft. Flexibility is obtained by the insertion of rubber blocks, a coupling being assembled so that the rubber is under compression. Hence, as the driving block is further compressed, the idle block expands and prevents backlash.

Provision for longitudinal expansion is accomplished by not pushing the tenon portion right home in the pocket when assembling, but allowing a space between it and the inner face of the pocket.

Slight tilting in the event of the shafts getting out of alignment has been allowed for by forming an annular concave recess on the inner face of the half-flange coupling, so that while the rubber blocks allow slight tilting to take place, the recess permits the end of the tenon portion to accommodate itself to the new position.

It is claimed that such an arrangement is superior to the ordinary spring coupling, because in the latter the flexibility depends upon the springs which must be designed either for the maximum load or for average load. In the first place they possess relatively no flexibility at light load, and in the second place they become practically a solid coupling at heavy loads. The use of rubber provides a degree of latitude in flexibility claimed to be impossible with springs, while its elastic qualities enable it to readily absorb shocks from impulsive loads. (*The Iron and Coal Trades Review,* vol. 98, no. 2667, April 11, 1919, pp. 437, 2 figs., *d*)

MECHANICS

Investigation of Rigidly Connected Reinforced-Concrete Frames

Analyses and Tests of Rigidly Connected Reinforced-Concrete Frames, Mikishi Abe. Discussion of the mechanics of rigidly connected frames and formulæ for moments and other indeterminate quantities for several types of indeterminate structures derived by a method involving the use of the prin-

ciple of least work; also data of tests on frames designed according to the formulæ found by the analyses. The paper is far too extensive to be suitable for abstracting and only the conclusions and general comments of the author are here reproduced.

1 Considering the errors involved in the measurement of the deformations and in the determination of the modulus of elasticity of the concrete, as well as those due to assumptions with reference to the distribution of stresses across the section and over the gage length, the results presented indicate a fair agreement between analyses and tests and justify the conclusion that the formulæ given in the bulletin for statically indeterminate stresses as applied to reinforced-concrete structures will give values for stresses in the members well within the limit of accuracy required in design.

2 The elastic action of the frames under external load and the manner of stress distribution along the members of the frame agree fairly well with the analyses given.

3 The location of the point of inflection in the members of the frames under load agrees closely with the location found by analyses.

4 If a frame is carefully designed and well reinforced, there need be no anxiety as to the rigidity of a joint. Effective continuity of members has been found in the tests.

5 No sudden failure took place in the frames tested. The increase in the deflection was uniform, indicating as great reliability for reinforced-concrete frames as for steel structures.

6 The load at which the first fine crack appears near the juncture of members is increased by fixing the lower column ends of a frame. This is obviously due to the increase in horizontal thrust at the lower column end over that developed when the lower end is free to turn.

7 At sharp inside corners, high compressive stresses were developed in the concrete due to so-called curved-beam action and in several cases local failure occurred by the crushing of the concrete at these corners under high loads.

8 A slight deviation of the axis of vertical members from a vertical line, that is to say, a slight "out-of-form" of the vertical columns, produced an appreciable variation in the stress distribution in the frame.

9 Owing to the existence of a horizontal thrust (which varies from $P/8$ to $P/18$ in most common cases of simple frames) at the ends of a vertical or inclined member, it is advisable to incline the member slightly toward the direction of the reaction at the end. Such arrangement will greatly reduce the bending stress in the member. If this arrangement is not practicable, a slight increase in the top width of a vertical member and a slight decrease in its bottom width, brought about by inclining the inner surface and making the outer surface vertical will add materially to the rigidity of a frame without a proportional increase in the amount of material used.

10 For a frame having an inclined column, it may be possible to select the form of frame in such a way that the column will take no bending stress throughout its length.

11 Due attention should be paid to the rigid joint of a tie member to insure the stiff connection with a main member. A marked tendency to cause a sudden breaking of such a joint was found to accompany an increase of bending moment in the main member.

12 The use of a footing rigidly connected to the lower end of a vertical member is advisable, for it will reduce the bending moment at the juncture of the vertical and inclined members. A frame having such a footing is solvable analytically, since it approaches the case halfway between that of the hinged end and that of the fixed end of the vertical member, provided the foundation is sufficiently unyielding. A little consideration is needed to provide proper reinforcement at the juncture of the column and the footing.

13 The formulæ derived by analysis may be applied to a variety of forms of frames and are of wide applicability. (*Bulletin No. 107 of the Engineering Experiment Station, University of Illinois*, 106 pp., 59 figs. and 16 tables, *pc A*)

POWER GENERATION

Interconnection as Means to Reduce Necessary Steam Reserves, L. J. Moore. Article based on experiences in central California where important benefits have been realized by tying together various power systems.

One of the important advantages obtained by the interconnection of neighboring transmission systems operating hydroelectric plants with steam reserves is the reduction of steam reserve necessary to maintain reliable service.

This is brought about in two ways: (1) by the improvement of diversity factor due to connecting together of dissimilar groups of load; and (2) by the pooling of water resources.

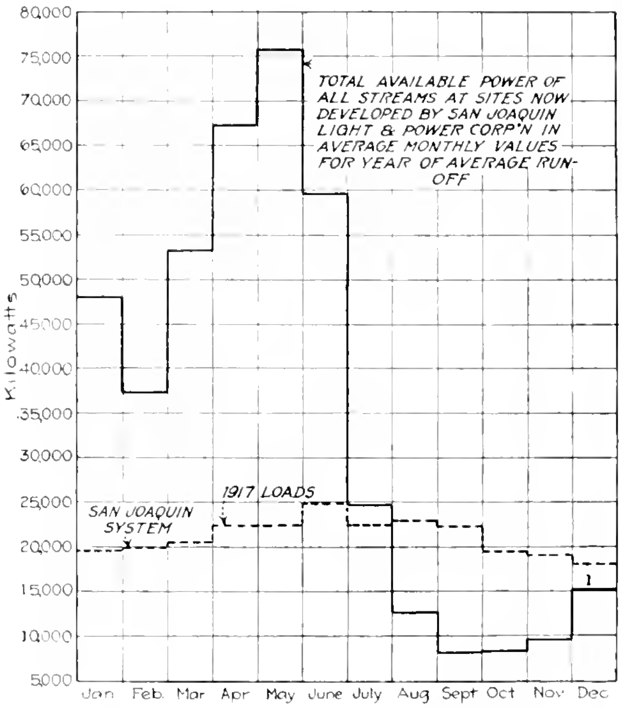


Fig. 10 Curves Showing the Necessity for Water Storage for Steam Reserve in the San Joaquin Valley, Southern California

The interconnection of three power and light systems operating in the central and southern districts of California is described and discussed in the present article. One of these systems is provided with a 45,000-acre-ft. reservoir for water storage, and two steam reserve plants (one 12,000 kw. and the other 2000 kw.). The second system has a water-storage reservoir of 88,000-acre-ft. and a big steam reserve plant. The third system has no water-storage facilities, but does have a 5000-kw. steam plant.

In addition, one of the companies operates at 50 cycles and the other two at 60 cycles.

The necessity for water storage or steam reserve for hydroelectric plants operating in this region is shown in the curve in Fig. 10 applying to one of the systems. This curve shows the heavy flow in spring and early summer when the plants cannot utilize all the power and the low discharge during the late summer and fall which makes it necessary for plants on this system to be supported by either storage or steam reserve unless they are utilized simply as minimum flow plants.

The flatter curve shows the load on the system for the year 1917 and makes evident the effect of the water-storage reservoir which made it possible to carry the entire load by water.

The article describes in some detail the conditions prevailing in the district and the manner in which the interconnection was effected. Because of this interconnection some of the plants at flood times are run at full capacity, permitting the other parts of the systems to increase their water-storage facilities.

Interconnection of systems operating at different frequencies made frequency changes necessary. Typical results on August 10, 1918, before the installation of the frequency changer, are shown in Fig. 11. The two lower curves show the Edison delivery to the San Joaquin system (the entire Kern River No. 1 plant was running at 60 cycles at the time) and the Mount Whitney demand at Strathmore. The separation of these two curves measures the amount of power the San Joaquin system was absorbing or delivering. These values added algebraically to the load of the San Joaquin system, had no interconnection existed, give the actual power delivered by the San Joaquin plants. The effect on diversity factor in direction of flow of power at Strathmore are evident. This flow has been controlled somewhat on the day shown by variation of the load on the Visalia steam plant, but the fact remains that in practice often one system may be delivering power to the other at a time of light load for itself and peak load for the other, when within a very short space of time the conditions may be completely reversed. This means that they help each other over peaks without the excessive use of steam necessary if they were all operating separately.

The Edison company realizes a saving in delivering power to the Mount Whitney in this way and preventing operation of the Visalia steam plant even at the expense of operating the Long Beach or Redondo steam plant, on account of the much greater efficiency of these two plants. It even pays to let San Joaquin's Bakersfield plant supply the difference, for the reason that Bakersfield is both more efficient than Visalia and because the plant is situated near the oil fields. Delivery of oil to the fire room is much less expensive, and besides a large quantity of natural gas is burned. A gas pipe line connects the Bakersfield plant directly with the oil fields.

The operation of the interconnected system on July 20, 1918, is indicated by Fig. 12, which represents conditions just before low water had raised the Mount Whitney demand and decreased the Edison delivery; as a result a considerable quantity of power was delivered to the San Joaquin company.

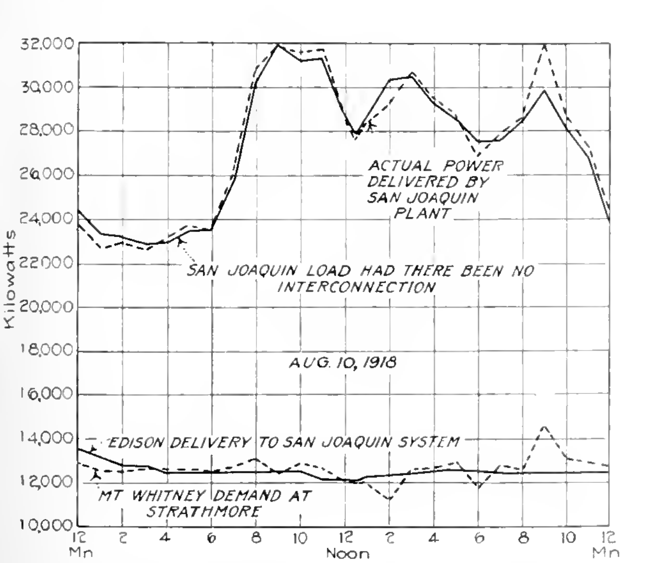


FIG. 11 TYPICAL RESULTS ON THE SOUTHERN CALIFORNIA SYSTEM BEFORE INSTALLATION OF FREQUENCY CHANGERS

When one of the 50-cycle impulse wheels at Kern River No. 1 is operating at 60 cycles it is found that the water necessary to generate 5000 kw. at 50 cycles generates only about 4500 kw. at the higher speed. Furthermore, the field current is only approximately two-thirds of normal under this condition. The San Joaquin's prime mover on Kern River is a turbine instead of an impulse wheel, but it gives somewhat analogous results in that a slightly higher output is obtained with the same water when operating on the Edison 50-cycle system. The field current is proportionately higher, too. No particular difficulties are experienced. In fact, the operation is quite satisfactory. (*Electrical World,* vol. 73, no. 17, April 26, 1919, pp. 840-842, 4 figs., *d*)

POWER PLANTS

HIGH-PRESSURE STEEL ECONOMIZERS AT KANSAS CITY. The conditions of boiler operation of the present day lead to increasingly high flue-gas temperatures and great weight of gases passed in a unit time interval. These conditions are very favorable to

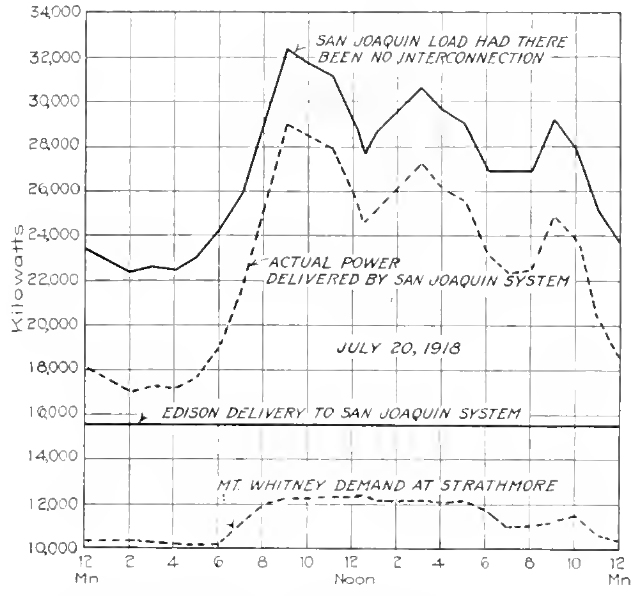


FIG. 12 CONDITIONS AFTER INTERCONNECTION BUT JUST BEFORE LOW WATER HAD RAISED MT. WHITNEY DEMAND

the employment of economizers especially with large boilers. On the other hand, they raise the question of proper materials to be used for economizers.

Cast iron has given efficient and safe service for pressures now common, but it is uncertain whether it will do for pressures of 300 lb. or more. Steel which would be safe for these pressures is, however, not so durable as cast iron, and condensation of the vapors in the flue gas on the relatively cold tubes results in rapid corrosion, especially if the cold steel is high in sulphur. Nevertheless, steel will have to be used if boiler pressures go up still higher and, for example, at around 1000 lb. cast iron would be entirely out of the question.

In the new power station now being erected for the Kansas City Light and Power Company this problem has been met by dividing the economizer into two sections, a high-pressure and a low-pressure section.

The low-pressure section (cold part) of the economizer is of cast iron while the hotter part, which is the high-pressure section, is of steel construction something like a section of a Stirling boiler.

The feedwater has to be pumped first through the low-pressure economizer into a tank which forms a suction tank for the boiler-feed pumps by which it will be pumped through the high-pressure economizer and into the boiler. The economizers are so proportioned that the water is to be heated in the low-pressure economizer to a temperature not over 200 deg. fahr., which will prevent the formation of steam in the low-pressure economizer and at the same time put the water into the high-pressure economizer at a temperature sufficiently high to prevent any condensation there. In this way the condensation and consequent corrosion is confined to the low-pressure sections where leakage and deterioration are much more easily controlled.

The high-pressure economizer is made up of two 36-in. drums, 23 ft. long, having 306 3¼-in. cold-drawn seamless tubes ¼ in. thick, arranged in 38 sections of 8 tubes each, front to back.

Each high-pressure economizer contains 4205 sq. ft. of heating surface and, moreover, is so baffled that the gases are compelled to pass over the tubes transversely three times. It is supported from the building steelwork, the support being at the upper end so as to be free to expand downward. The economizer is inclined 35 deg.

Each low-pressure cast-iron economizer, of the Green type, has 336 12-ft. tubes, 7 tubes per header, with a total of 5500 sq. ft. of heating surface. Each economizer is 16 ft. 11 in. long and the outside overall width is 16 ft. 2 in. The induced fans, one for each boiler unit, are of the multivane type, with two single inlets, driven by one 150-hp. slip-ring induction motor. Each boiler and economizer is intended to evaporate 80,000 to 100,000 lb. per water per hour, going up to 120,000 lb. per hour when forced. (*Power*, vol. 49, no. 15, April 15, 1919, pp. 556-557, 1 fig., *d*)

PUMPS

Submersible Motor-Driven Pumps for Salvage Work

Submersible Salvage Pumps and Engines. Description of a type of pump extensively employed of late by the Salvage Section of the British Admiralty and, as far as known, not previously described in full.

This machine consists of a centrifugal pump directly connected to an electric motor, so designed that it is capable of indefinitely operating while submerged in water.

It frequently occurs in the earlier stages of salvage operations that if powerful pumps can be brought to work immediately, there is a good chance of success, but a short delay may mean total loss or, at best, a much greater expenditure of time and money. In such cases the time required for rigging steam or oil-driven pumps is too great while a salvage vessel carrying submersible electric pumps can run alongside the wreck and in a very short time have the pumps working with current supplied from dynamos on board. This has in fact been done on several occasions by Admiralty salvage vessels. The S. S. *Westmoreland*, worth over £2,500,000, was salvaged in this way under circumstances in which no other kind of pump could have been employed.

The submersible electric pumps when at work are usually suspended by a rope from a derrick, or any other convenient part of the wreck, and will work in any position. One of these pumps was recently put to work on a vessel which had capsized, and continued to work at its maximum output while the vessel was being righted to an angle of 90 deg.

When the compartment in which it was situated was unsealed, the pump was found to be upside down and to have rolled to quite a different position to that in which it was placed.

Since it is not always convenient to supply current from a salvage vessel, an oil-engine-driven dynamo had to be developed which would be waterproof and unaffected by water conditions. This is especially important for use in tidal waters where the engine may have to remain in position while the tide rises and completely submerges the plant. An engine type has been developed which is capable of being covered with water without coming to any harm. The engine cannot, of course, work while submerged.

The means adopted to permit the engine to withstand submergence in water are very simple, but required a large amount of experimentation in working out.

The foremost characteristic is that the engines have a very plain outline. Every possible part of the mechanism is arranged inside the trunk or crankcase, and those parts which protrude are of very robust construction. In order to prevent water from getting into the interior of the engine all the openings such as the inlet and exhaust are provided with easily attachable covers and the crankshaft where it emerges from the crankcase passes through a stuffing box. The gland of this stuffing box is left slack when the engine is running and only screwed up in the event of probable submergence. In a test after a submergence of 24 hours only about two pints of water had found their way into the crankcase while the electrical fittings were unaffected. The whole of the ignition gear (both magneto and battery) is enclosed in a gun-metal case with a good-fitting cover.

Two types of this engine are now built: one with two cylinders of 12 b.hp., and the other with four cylinders giving from 45 to 50 hp.

The oiling system in these engines is of the same general type as that used in the Allen high-speed steam engines, that is to say, oil is pumped into a duct cast in the bedplate and led up through the hollow pedestals to the main bearings. Thence, some of it finds its way through holes drilled in the crankshaft to the crankpins and big ends, while the hollow connecting rods take the supply up to the gudgeon pins.

The construction of the motor has been generally known for some time. The water is actually encouraged to enter for the purpose of cooling the machine and the windings are protected by the simple expedient of making them from one piece of heavily rubber-covered wire. Because of the ample cooling made possible by admitting the water, rubber insulation becomes permissible and this is the only waterproof material that seems to meet the requirements. The squirrel-cage type has been adopted, as it makes electrical connections with the rotating parts unnecessary.

The pump itself is of the usual single-inlet pattern with a gun-metal impeller. The 4-in. pumps are capable of delivering

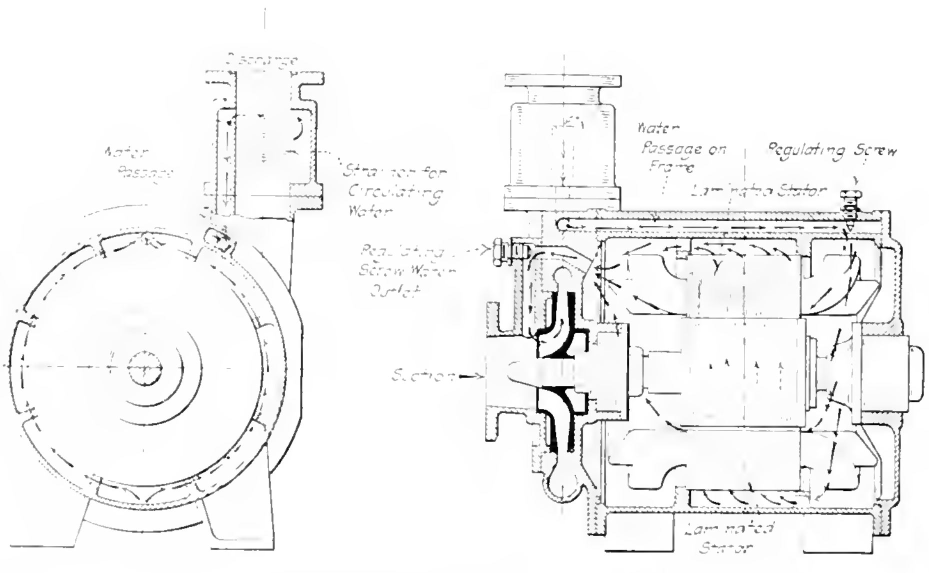


Fig. 13 Sections Through Submersible Pump and Motor Used by the Salvage Section of the British Admiralty

100 tons of water per hour against the head of 75 ft. and require 17 kva. The largest set built is 18 in. and is capable of raising 1750 tons per hr. to a height of 30 ft. Fig. 13 gives a section through the pump and motor. Unfortunately the illustrations showing the engines are not suitable for reproduction. (*The Engineer,* vol. 127, no. 3299, March 21, 1919, pp. 274-276, illustrations on page 278, 9 figs., *d*)

RAILROAD ENGINEERING

Water Treatment on the Great Northern Railroad, C. Herschel Koyl. East of the Rocky Mountains the Great Northern crosses a strip of country 600 to 700 miles wide where the water not only contains a considerable amount of mineral matter but is also very irregular in its composition, being sometimes alkaline and sometimes hard; and during the past six years it has been developing a system of water treating adapted to its special purposes.

The methods developed have now given water satisfactory for its content of sodium sulphate over a strip of 1100 miles.

The character of the chemical treatment of the water varies with the character of the water, but all cases are covered by the use in proper proportion of hydrated lime, soda ash (sodium monocarbonate) and sulphate of iron (ferrous sulphate).

The purpose of using hydrated lime is to neutralize carbon dioxide. Soda ash is used to replace the scale-making lime sulphate by a non-scaling medium sulphate, while ferrous sulphate is used in the first place for the treatment of the last grains of calcium carbonate so that it will not clog the injector pipe; second, for the conversion of caustic sodium hydrate into neutral sodium sulphate; and third, for the further weighing and more rapid settling of particles of light suspended matter. Treatment with ferrous sulphate is stated to be a device introduced by the author for the first time in this connection.

Important advantages are claimed to have been secured by the use of water treatment. Not only has foaming disappeared, but with freedom from leaks boiler operation became far more reliable. In this way a large amount of time was saved on the road, not merely because boilers did not leak and fail but also because the service became more dependable, and in this way speeding up of each department has been made possible.

The following illustration of what water treatment has done is given in a report from the master mechanic of one of the districts. Engines on a certain section used untreated water and a set of flues never lasted longer than six months. Since water treatment has been introduced the scale has all come off from stays, crown bolts and flues, and with the aid of a little kerosene the flues and sheets have been kept as clean as on the day the engine came out of the shop, notwithstanding the fact that it has been in service under the new conditions for 15 months.

On the other hand, no attempt has been made to reduce boiler washing, because on account of the concentration of sodium sulphate and sludge in the mud ring, the boilers are washed every round trip, same as before the water treatment was introduced.

Other important advantages are mentioned in the original article and a water-treating plant briefly illustrated. (*Railway Age,* vol. 66, no. 17, April 25, 1919, pp. 1053-1056, 1 fig., *d*)

VARIA

Fracture of Two Compressed-Gas Cylinders and the Cause (*Zeitschrift des Vereines deutscher Ingenieure,* March 8, 1919). The present writer made a most complete investigation into the cause of fracture of two compressed-gas cylinders—one for hydrogen and the other for oxygen—which burst while in course of filling.

The hydrogen cylinder was being filled with the gas at a pressure of 140 atmos. The explosion was extremely violent; the floor on which the cylinder was standing was found to have a hole in it 75 cm. deep; the flask or cylinder flew upward like a projectile, passed through the roof of the filling room, and fell in a garden some 85 m. distant.

An examination of the plant (compressor and fittings) revealed it to be in order.

The gas was produced electrolytically and collected in a gasholder, after which it passed into a two-stage compressor and was compressed to a filling pressure of 150 atmos.

A full chemical, mechanical and micrographic examination was made of the fractured cylinder, from which the writer concludes that it satisfied the requirements of the authorities. Probably a "fold" or crease formed in the steel while being mechanically treated, and this creasing gave rise to a crack or cracks, which were most likely the cause of the explosion.

He suggests that in addition to the prescribed precautions relating to the inspection of these vessels, each seamless vessel should be "flash-tested" (this test is not defined) before the head is put on, in order to find faulty places. This method has been adopted by the military authorities prior to the acceptance of all shells. This test would enable any creases to be discovered in the steel.

In the case of the oxygen cylinder a greater number of splinters were available.

The cylinder is said to have burst during the process of filling at a pressure of 80 to 100 atmos. The oxygen used was obtained from liquid air.

The cylinder was of similar construction to the hydrogen cylinder, being of the seamless-steel type. The same official regulations applied in this case also.

The article describes in detail the mechanical, chemical, etc., tests carried out on the fragments collected.

Numerous causes contributed to the bursting of the cylinder as shown by the experimental results.

The steel was weakened at one particular part where the test initials were stamped, as the stamp penetrated to half the wall thickness of the cylinder.

The steel was too brittle for the purpose in question. It was very sensitive to dynamic stresses.

The author suggests that the regulation regarding the stamping of these cylinders should be modified. The stamping should be reduced to a minimum, and be done when the steel is in a red-hot state.

A mere pressure test is, when employed alone, very defective. It is much more important to test the inside and outside surfaces and the thickness of wall of each cylinder prior to putting on the top.

Complete tables, illustrations, etc., accompany the above paper. (*Technical Supplement to the Review of the Foreign Press,* vol. 3, no. 9, April 29, 1919, p. 311, no. 4910).

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

The following statement of the National Advisory Committee for Aeronautics shows the development in airplanes which has been made since 1903. The first man-carrying airplane flights were made in December, 1903, with the Wright Bros. engine, developing 12 hp. and weighing 152 lb., or 12.7 lb. per hp. In 1910, the average horsepower for aeronautic engines had increased to 54, and the weight had decreased to 5.7 lb. per hp. After another 7 years, in 1917, the average power output had advanced to 243 hp., and the weight had decreased to 2.8 lb. per hp. In March, 1918, the Liberty motor developed 432 hp. for a weight of 808 lb., or 1.86 lb. per hp. At present, the Liberty motor is developing a maximum of 450 hp. for a weight of 825 lb., or 1.83 lb. per hp. The average consumption of fuel decreased from about 0.8 lb. per hp. in 1903 to 0.55 lb. in 1918, and for the Liberty engine to 0.50 lb. The present consumption is about 0.46 lb. per hr. (*Machinery,* p. 744, April 1919)

MECHANICAL ENGINEERING
THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Published Monthly by the Society at
29 West Thirty-ninth Street, New York

M. E. Cooley, *President*
William H. Wiley, *Treasurer* Calvin W. Rice, *Secretary*

PUBLICATION COMMITTEE:
George A. Orrok, *Chairman* J. W. Roe
H. H. Esselstyn George J. Foran
Ralph E. Flanders

PUBLICATION STAFF:
Lester G. French, *Editor and Manager*
Leon Cammen, C. M. Sames, *Associate Editors*
W. E. Bullock, *Assistant Secretary Editor Society Affairs*
Frederick Lask, *Advertising Manager*
Walter B. Snow, *Circulation Manager*
136 Federal St., Boston

Yearly subscription $3.00, single copies 35 cents. Postage to Canada, 50 cents additional; to foreign countries $1.00 additional.

Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

It is proposed to publish in Mechanical Engineering for July a complete account of the Detroit Meeting. Inasmuch as the meeting does not end until June 19, the day before the usual closing date for the journal, the publication of the July number will necessarily be delayed several days. The volume of work entailed in reporting a convention is very large, involving as it does the summarizing of perhaps 600 pages of stenographer's notes, besides handling the written discussion; but it is hoped that it may not be necessary for the July number to be more than one week late in reaching its subscribers.

Major Fred J. Miller Joins the A. S. M. E. Staff as Consultant

Major Fred J. Miller has joined the staff of the Society in the capacity of consulting engineer and advisor upon its publications. In this he will coöperate with the Papers and Publication Committee in the development of Mechanical Engineering, which has made notable progress during the past year through the acquirement of The Engineering Index and the addition of other features of direct benefit to the practicing engineer.

Major Miller has served on the Council of the Society and on various committees and has been intimately acquainted with its activities over a period of many years. He was one of the earliest to advocate the establishment of the Society's journal, at first known as the Proceedings, and it is fitting that he should now be able to render additional service to the publication in which he has long taken so deep an interest.

For ten years he was editor-in-chief of the *American Machinist*, which reached a high plane of technical journalism under his direction and to which he personally made notable contributions that attracted wide attention. Following this he became Factory Manager of the Remington Typewriter Company. Shortly after the United States declared war against Germany he entered the service and organized and directed the Civilian Service Division at the Rock Island Arsenal. Later he went to the Office of the Director of Arsenals at Washington, when, at the request of the War Labor Board, he was detailed to the Bethlehem Steel Works. He has recently resigned from the service and is now in consulting practice. The Society is to be congratulated upon having at this time of progressive development the benefit of his sound judgment and long experience in publication and organization work.

The Spring Meeting

On the opposite page is given tentatively the complete program for the Spring Meeting of the Society to be held at Detroit, Mich., June 16 to 19. The papers for the meeting are being published progressively in Mechanical Engineering, the first appearing in the April number, and practically the whole of the technical section of this issue is given up to these papers.

Unusual interest attaches to the opening of the meeting on Monday because of the progress report to be presented by the large and representative Committee on Aims and Organization which has long been in preparation. On Tuesday morning there will be what is perhaps the most important, or keynote, session, on the subject of Research in Engineering, under the direction of the very active Research Committee of the Society. In view of the marked development in research work throughout the country and the recent reorganization of the National Research Council to promote and coördinate research, this session ought to have the attention of all the members in attendance. Several timely papers are to be presented, together with reports by three of the Sub-Committees on Research.

In the afternoon of Tuesday there will be a general session of non-technical character, such as is provided at each convention, for discussion of administration topics according to the current developments in the field of industry. The general theme will be Industrial Relations, with addresses bearing on the needs of the time for securing industrial peace and the recent movement toward greater representation on the part of employees in the conduct of the affairs of industrial firms.

Several papers on Wednesday morning, as well as at other sessions, are contributed by the Mid-West Sections, these constituting some of the best contributions offered for the meeting. They are indicative of the prominent place which the Sections have attained in the affairs of the Society and of the substantial assistance which they are rendering in building up the Society's publications through their contributed articles.

There will be one session under the auspices of the Gas Power Sub-Committee, a General Session for miscellaneous technical papers, and on Thursday morning a closing session very pertinent to the power-plant situation at the present time, for the discussion of fuels. There will be three papers on pulverized and crushed coal and one on oil fuel. In view of the fact that low-grade fuels are necessarily assuming a more important place in power-plant operation, and also that power-plant efficiency through the development of the steam turbine and improvements in steam boilers permits the use of high-pressure and superheated steam, the next step forward appears to be in the boiler furnace. Under these conditions the possibilities of fuel in finely divided or pulverized form becomes an absorbing subject for discussion.

The Detroit Local Committee has drawn on the wonderful resources of the city of Detroit for the entertainment of their guests and, as outlined in the program, there will be numerous excursions to industrial plants of very great interest. An afternoon and evening will be spent on the Lake and dinner served on the excursion boat. There will be an evening of music and dancing at Arena Gardens, and the Ladies Committee has arranged various entertainments for the visiting ladies, including motor trips, etc.

Records of War Service

It is intended to publish an account of service rendered by members of the Society in the World War.

To that end it is requested that every member of the A. S. M. E. who served in the Army or Navy, or who in any other way rendered direct service to the Government during the war, send to the committee a full account of his service. Address Committee on War Service, care of the Society.

SPRING MEETING PROGRAM

Detroit, Mich., June 16-19. Headquarters, Hotel Statler

Monday, June 16

10:00 a. m. Opening of headquarters and registration at Hotel Statler
10:00 a. m. Council Meeting
2:00 p. m. Business Meeting followed by Report of Committee on Aims and Organization
8:30 p. m. Address of Welcome by Mayor James Couzens. Reception and Dance. Refreshments

Tuesday, June 17

10:00 a. m. Professional Session

Research Session
(Under auspices of Research Committee)

The Present Condition of Research in the United States, Arthur M. Greene, Jr.
Research Work on Malleable Iron, Enrique Touceda
Reports of Sub-Committees on Flow Meters, Bearing Metals and Lubrication
The Organization and Conduct of an Industrial Laboratory, A. D. Little and H. E. Howe.

10:30 a. m. Trip to Burroughs Adding Machine Company. Luncheon at plant
12:30 p. m. Luncheon at Hotel Statler for Council and Sections Representatives
2:00 p. m. Professional Session

Industrial Relations Session

Industrial Personnel Relations, Arthur M. Young (contributed by the Chicago Section)
The Status of Industrial Relations, L. P. Alford
Certain Aspects of the Management Problem, Magnus W. Alexander

(Other speakers to be announced)

2:30 p. m. Trip to Morgan and Wright Company's Plant
8:30 p. m. Musical entertainment, Arena Gardens, 1253 Woodward Avenue. Dancing, Cards, Refreshments

Wednesday, June 18

10:00 a. m. Simultaneous Sessions

Sections Session
(Under auspices of Sections of Mid-West)

Central-Station Heating in Detroit, J. H. Walker (contributed by Detroit Section)
Production of Liberty Motor Parts at the Ford Plant, W. F. Verner (contributed by Detroit Section)
Fire Engines and the Essentials of Fire Fighting, C. H. Fox (contributed by Cincinnati Section)
Electrical Method for Measuring the Flow of Fluids in Pipes, J. M. Spitzglass (contributed by Chicago Section)

Gas Power Session
(Under auspices of Sub-Committee on Gas Power)

Crude-Oil Motors vs. Steam Engines in Marine Practice, J. W. Morton

(Other papers to be announced)

10:00 a. m. Trip to Connors Creek Plant of the Detroit Edison Company. Luncheon at plant
2:30 p. m. Steamboat trip through St. Clair Flats. Steamer Britannia leaves foot of Bates Street, returning at midnight. Dinner on boat. Entertainment, dancing, refreshments.

Thursday, June 19

10:00 a. m. Simultaneous Sessions

Fuel Session

Pulverized Coal as a Fuel, N. C. Harrison
Economy of Certain Arizona Steam-Electric Power Plants Using Oil Fuel, C. R. Weymouth
Pulverized Coal for Stationary Boilers, H. G. Barnhurst and Frederick A. Scheffler

General Session

Elements of a General Theory of Wing Design, Walter C. Durfee
Air Fans for Driving Electric Generators on Airplanes, Capt. G. Francis Gray, Lieut. John W. Reed and P. N. Elderkin
Mechanical Lifts, Past and Present, and a New Method for Their Balancing, Lieut. J. F. Robbins
General Equations for the Design of Riveted Butt Joints, A. A. Adler
The Economical Section of a Water Conduit, Cary T. Hutchinson (By title only)

Morning left open for special trips. Members are requested to indicate, upon arrival at headquarters on Monday, which plants they desire to visit.

2:00 p. m. Trip to Ford Motor Company, Highland Park

The Crossing

On May 26, 1819, an American ship, the *Savannah*, was the first steam-driven vessel to cross the ocean. One hundred years later, on May 17, 1919, an American seaplane fully commissioned as a ship in the United States Navy crossed from Trepassey Bay, Newfoundland, to Horta, on the Island of Fayal, Azores, making port in 15 hr. 18 min. after leaving ground at Newfoundland. (This is as far as the flight has progressed at the time of going to press.)

There are several elements in this flight worthy of the most careful consideration by engineers.

The ship was of the heavy-load-carrying type with its full water-landing equipment and wireless. Furthermore, it was of the multi-motor type, this also materially increasing its weight. The fact that a seaplane of this type could make a flight of over 1200 miles without forced landing, in record time for a craft of its weight, is a strong proof both of the high state of the development of aeronautical engineering generally and of the advance made in particular by the American Navy.

The working of an aeroplane, and in particular of the aeroplane engine, has been correctly compared to that of a racing car. Every part of the engine and plane is at full load under high stresses and moreover the aeroplane is in some respects in a less fortunate position than a racing car, because it is more subject to vibrations and does not have the damping protection of the road under the tires.

Because of this, there is a far greater tendency toward fatigue in both the engine and frame of the plane. A car that could make 1200 miles at the rate of 85 miles per hour without stoppage for adjustments and without engine or frame trouble would have been a very remarkable car, indeed, and yet the Navy seaplanes have done it.

This performance is also a proof that the Liberty engine, with which the seaplanes have been driven, has passed through the period of development and may now be considered as a fully completed product entitled to the highest consideration for its reliability of performance and economy in fuel consumption.

The American Navy has been famous for its proverbial luck. The flight from Trepassey to Fayal Island gives a little insight into the secret of Navy's "luck." Such a flight would have been impossible without the most careful preparation and in fact it would be no exaggeration to say that, roughly, the performance of May 17 is a direct outcome of work of close upon two years.

It would have been impossible unless everything had been prepared in such a manner as to work close to an efficiency of 100 per cent. The failure of a small part in the plane, of a few spark plugs in the engine, of some connecting rod, or valve push rod might have marred or made impossible the crossing, and the fact that the crossing has been achieved shows that everything from the large factors to the smallest details must have been approximately 100 per cent perfect.

Transatlantic passenger transportation will not follow right on the heels of the crossing by the Navy seaplanes. In fact, if anything, this flight has shown not only that it is possible to cross the Atlantic in the air but also that it is by no means easy to do so. Notwithstanding the elaborate precautions taken for guiding the fliers, the NC 1 and NC 3 lost their bearings in a dense fog and even the NC 4, which completed the flight, stopped at Horta instead of Ponta Delgada, the spot designated for landing. The NC 3, after being "lost" for two days, was discovered on May 19 only seven miles from the harbor of Ponta Delgada, proceeding under her own power, but the NC 1, after being located and taken in tow by a destroyer, was later wrecked through heavy seas.

Spurred on, doubtless, by the departure of the Navy squadron, Harry G. Hawker, the famous Australian aviator, made on May 18 his daring plunge from Newfoundland for the British Isles in the Sopwith biplane. Entirely unprotected against a fall at sea, and even without protection against a dangerous alighting upon the land in order to reduce the weight of his machine, he took the hazardous risk—and failed.

Nevertheless, in spite of the tremendous difficulties to be overcome, a start has been made in the air voyages across the Atlantic.

Thirteenth Engineers Return to Chicago

The Thirteenth Railway Engineers recruited from the six railroads which center in Chicago were given a most royal welcome upon their return to that city on May 12. Approximately 10,000 people are reported to have lined Michigan Boulevard to witness the parade, which was reviewed by Major General Black, Chief of Engineers; Colonel R. D. Black, general staff, and one of the organizers of the Thirteenth Engineers; S. M. Felton, president of the Chicago Great Western; and W. L. Park, federal manager of the Chicago Great Western, and chairman of the reception committee. Major General Leonard Wood was also to have reviewed the regiment but was caught in the crowd at one of the street crossings and was unable to pass. The parade started at 11.30 with Colonel C. L. Whiting in command. As the men marched along Michigan Boulevard the engineers on the Illinois Central and other railroads opened their whistles and the resulting din silenced the famous band of the regiment. Following the parade the men were dined and entertained and later entrained for Camp Grant where they will shortly be demobilized.

The Thirteenth Regiment was largely an operating unit and during the greater part of their stay overseas were engaged in transporting troops and munitions in the Argonne and St. Mihiel sectors. The regiment is credited with having moved 103 trains of men and munitions during a period of only 24 hr. They also operated the trains which carried the famous 14-in. Navy guns.

Past-President Henry R. Towne Reaches a Business Anniversary

A souvenir booklet of historic value has been issued by the Yale and Towne Manufacturing Company, of which Henry R. Towne, Past-President, Am.Soc.M.E., was one of the founders. It is issued as a Semi-Centennial Souvenir of the company, and contains, besides a history of the works, an account of the various men who have contributed to its upbuilding and various other data and information concerning the organization, products, war activities, etc., of the company.

The birthplace of the Yale industry was at Newport, Herkimer County, New York, where, about 1840, Linus Yale, Sr., began the manufacture of "pin-tumbler" locks. His son, Linus Yale, Jr., a talented and ingenious inventor of locks, formed a partnership with Henry R. Towne, which resulted, in October, 1868, in the organization at Stamford, Conn., of what is now The Yale and Towne Manufacturing Company. Mr. Towne undertook the manufacturing management of the company. The corporation was organized in 1868, with Mr. Yale as president, but upon the latter's death, a month later, Mr. Towne succeeded as chief executive and president, and continued in that position until his resignation as president in 1915 to accept the chairmanship of the Board.

The products of the Yale firm, just prior to the formation of the partnership with Mr. Towne, were bank locks, seven varieties of key locks, and the metallic post-office lock box, the employees numbering about 35. The present daily output is 25,000 locks, with an organization under normal conditions of 3000 men.

Westinghouse Scholarships as War Monuments

E. M. Herr, president Westinghouse Electric & Mfg. Co., Pittsburgh, has announced the establishment of four technical scholarships by his company to commemorate the part played during the war by its employees. Selection of the candidates will be determined by annual competitive examination conducted by the company's educational department under the direction of a committee consisting of three vice-presidents, who will also prepare the regulations and all details of administration. Each scholarship carries with it an annual payment of $500, and the student may take any course of engineering at whatever school he selects having the approval of the committee. Scholarships are for one year only, but will be continued for four full years provided the student maintains the standards required by the institution he has elected to attend. The number of new scholarships will be four each year. (*Iron Age*, May 8, 1919.)

Aims and Organization Committee

A COMMUNICATION on Standardization of Aims has been prepared by James Hartness, Past-President, Am.Soc.M.E., and member at large of the Aims and Organization Committee of the Society, for the consideration of the Sub-Committee on Relations of the Mechanical Engineer to His Work. From this communication the following extract has been taken which is of interest to those who are giving thought to present conditions and the general trend of events:

One of the points that I wish to emphasize is the importance of having an aim that fits the world's best ideals—an aim that will disarm all destructive isms.

We must aim to make the high special knowledge and experience of the engineering profession of value in guiding all the individual activities along lines of highest beneficial results to all people. We must select a slogan that everyone can understand, one that would put to shame any disruptive activity on the part of advocates of sham scientific or sham economic doctrines. We have reached a point where something more than argument and logic must be served out to the American people.

The war has started the functioning of something we call the heart, and this something, which for convenience we call the inner man, is a thing that dominates, is a thing that may be swayed by noble purposes or it may be stampeded into mob action. While educational institutions are instructing the brains, Bolshevism is stampeding the inner man. The lines of communication between the average highly trained engineer and the great mass of workers are absolutely down. For instance, the engineer thinks that he can direct mechanical and industrial activities by specifications and drawings issued from some central office. The workers know that specifications miles long and diagrams that would cover the whole continent cannot give sufficient direction to enable him to skillfully perform certain operations. We know the ship cannot be rigged and the industry cannot be economically and successfully operated without special skill and ability in each of the jobs, from the highest skilled down to the lay president's job.

In view of this, engineers who insist on disturbing the workers by office type of management should be looked upon as drags and menaces, and The American Society of Mechanical Engineers should make for its chief slogan "FITNESS FOR SERVICE," with the interpretation of fitness that includes enthusiasm, optimism, good will, noble purpose, integrity, appreciation of the other fellow, readiness to pay in honor and tribute as well as cash, and to admit, to begin with, that the real people in this world are those who are rendering an effective service in an essential work.

The inner man is now deeply stirred throughout our whole land, and if we go on and talk of refinements of organization; if we go on drawing diagrams, showing the relative position of each officer; if we go on issuing tabulations of dimensions in three- or four-place decimals of the inch relative to the sizes of rubber bands and screws when not under tension, we will be living in a fool's paradise. It is one that is sorely threatened at the present time, and there should be an awakening even of the so-called highly cultured people that will match and help to head off the stampede of those who are doing things with their hands.

When we get the right slogan: "Fitness for Service," the administration of our railroads, of our coal distribution, and in fact every other part of our glorious republic will be properly handled. Then, the affairs of this great industrial country will be handled by men competent to manage such things; committees for investigating industries will be composed of men with practical industrial knowledge and experience; political preferment will pass away.

Then the influence of the speculator in Wall Street will vanish, and the men of Wall Street will stay where the war has put many of them—in positions in which they are rendering essential service; men who have been struggling for special laurels of wealth will be struggling to attain the higher laurels of real value, the new and true standard of greatest service and greatest fitness for service. Then we will realize the vision of Washington, Lincoln and of the true leaders who are being born out of the travails of war. Then the activities of the country will no longer be handicapped by unwise guidance of labor.

The American Society of Mechanical Engineers must have such a slogan or it will gradually become farther and farther removed from the head of the procession. There is nothing so deadening to an organization as to lay behind general progress. It leads to indifference, to pride, and to all those things that are distinct menaces, and that is what The American Society of Mechanical Engineers is up against at the present time. We point to our growth in power and numbers and forget that we have a thousand times our present power and should lead the whole world in administrative as well as constructive achievement.

[The report of the Committee on Aims and Organization has now been drafted and will be presented at its meeting in connection with the Spring Meeting on Monday, June 16, at Detroit, Michigan, at 10 a. m. The Council is expected to receive the report and to order it transmitted to the semi-annual business meeting at 2 p. m. on the same day, where it will be thrown open for discussion by the membership. To prepare the field for this discussion a preliminary draft of the report has been referred to the members of the Committee for them to discuss with the Sections they represent and to this end several Sections have already arranged special meetings.—EDITOR.]

Spokane Engineers Want to Meet You

Mr. A. D. Butler, Secretary, Spokane (Wash.) Engineering and Technical Association, has sent a note to the Secretary saying it is the desire of his association to come in contact with engineers who may be going to that section of the country, or passing through Spokane. There is a meeting of some one of the committees of the association nearly every day in the week, and it would afford them much pleasure to have at luncheon any engineers who are in touch with important matters, at which time a gathering would be arranged to talk over the engineering field in general. Spokane engineers desire to keep well informed on problems in the different parts of the United States and to broaden their field of acquaintanceship.

Government to Give Motor Trucks to States

Twenty thousand motor trucks valued at more than $45,000,000 are about to be distributed by the Secretary of Agriculture through the Bureau of Public Roads to the state highway departments. These trucks have been declared surplus by the War Department and will be distributed to the states under the provisions of Section 7 of the Post Office Appropriation Bill. They must be used by the states on roads constructed, carried on in whole or in part by Federal aid. All that the states need do to acquire the use of these 20,000 trucks, which range in capacity from 2 to 5 tons, is to pay the loading and freight charges. Of the trucks to be thus given to the states 11,000 are new. All, however, are declared to be in serviceable condition. They will be apportioned to states only upon request of the state highway departments on the basis of the requests received from the respective states, and in accordance with the apportionment provided in the Federal aid law approved in 1916.

Three-Cylinder 60,000-kw. Turbine Installation

The largest turbo-generator and the first three-cylinder unit in the United States was placed in service on October 9, 1918, at the 74th Street station of the Interborough Rapid Transit Company of New York City. The new unit consists of one high-pressure turbine and two low-pressure turbines, each directly connected to a generator. When in normal operation all three elements are electrically connected. The turbines run at a speed of 1500 r.p.m., and each generator will deliver at that speed 20,000 kw. at 25 cycles (3-phase) and 11,000 volts. The new unit thus has a maximum continuous rating of 60,000 kw. It is also capable of carrying a load of 70,000 kw. for two hours. It occupies a floor space of 50 by 52 ft. When operating with a load of 40,000 kw., which is the most economical load, steam is supplied to the high-pressure element at 211 lb. per sq. in. abs. and a temperature of 250 deg. fahr. This is exhausted into the low-pressure turbines at a pressure of 29.7 lb. per sq. in. abs. and a temperature of 250 deg. fahr., and in the low-pressure elements the steam is further expanded to the pressure in the condenser (1 in. mercury abs. and 79 deg. fahr.).

The electrical features of the installation are of the most modern type. Each generator is protected by reactance coils and a relay system. Should a burnout occur in the windings of any generator, this relay system will at once disconnect it from the line. In addition to the usual governing mechanisms there has also been provided an arrangement whereby any turbine can be operated should the others, for any reason, be taken out of service. For example, if it becomes necessary to shut down the high-pressure element, each low-pressure turbine will automatically receive high-pressure steam. On the other hand, if both low-pressure elements are removed from service, then the high-pressure turbine will automatically exhaust to the atmosphere, but if only one low-pressure turbine has been removed, then the one remaining will still continue to receive high-pressure steam.

Since it is also necessary to control the three turbines when they are operated independently, each turbine is provided with a governor, which will immediately cut off the supply of steam if the speed exceeds a predetermined value. There is also provided between the high-pressure and low-pressure turbines a butterfly valve which will automatically close should the speed of the low-pressure turbine become excessive. In a similar manner, if the high-pressure turbines speed becomes excessive, then a governor will cut off steam to the entire system, and when the speed reaches a lower fixed value the governors of the low-pressure turbine will operate and admit steam directly to them. (*Electrical World*, May 10, 1919, pp. 933-935)

Advances in Automatic Control in Hydroelectric Plants

In the West, during the period of war stress, many helpful economies in power development were brought about that must inevitably be felt in the industrial life of the nation for many years to come. Not only was the production of fuel oil increased, but the generation and utilization of electric power both from water resources and from fuel supply was vastly forwarded. In some instances the task involved the establishment of new records in magnitude of engineering attainment such as the interconnected systems of long-distance power lines which have not been even approached in length of transmission or magnitude of distribution anywhere else in the world.

But perhaps the advances that have been made in automatic control will ultimately prove of even more lasting benefit to the industry in lessening labor costs, and hence in decreasing the cost of power production, than any other single cause.

The one-man cars for street railways, the automatic control of substations, such, for instance, as the new installation from Salt Lake City to Saltair in Utah, and the automatic control of power house generators as installed quite recently by the San Joaquin Light & Power Corporation, are forceful instances of this recent trend in economic design.

The Crane Valley power house of the San Joaquin Light & Power Corporation is of unusual interest. Here it is estimated that an average of over three million and one-half kilowatt-hours will be saved by taking advantage of power not hitherto used in the rise and fall of the lake level of Crane Valley Reservoir.

The unusual feature of variable head, ranging from 120 feet down to 80 feet, has been successfully overcome. This power house, in addition to a second installation below, is operated without attendants, and only the regular dam tender and reservoir tender make visits to the plant from time to time. An alarm system is installed in the caretaker's cottage so that he is notified if the machine is tripped off the line. The machine, in the meantime, may attain runaway speed. However, should the machine trip off the line and increase in speed, a centrifugal switch on the shaft of the unit closes a circuit on the wicket gate, operating a motor, which closes the wickets and shuts down the machine. The water in the ditch immediately starts to rise, and flows over the weir by-pass until such time as the caretaker of the plant arrives and puts the machine back on the line.

The recent advances in automatic control witnessed on all sides, combined with the irresistible trend toward outdoor switches and transformer stations, augur well for increased economic power generation and lend a certain hope to the power situation that is pleasing to contemplate. (*Journal of Electricity*, April 15, 1919)

U. S. Trade Commissioner

Secretary Redfield has appointed Alexander Luchars, publisher of *Machinery*, New York, United States Trade Commissioner to Great Britain, France, Belgium, Italy, Switzerland, Holland and Scandinavia, to study conditions in those countries affecting our engineering and machinery industries. Mr. Luchars' acquaintance with European manufacturers and engineers, and his connection with similar industries in this country as a publisher, will enable him to render effective service to American manufacturers. Mr. Luchars will spend about four months in Europe.

Production of Liberty Motor Parts at Ford Plant

(*Continued from page 522*)

the burrs on the inside or babbitted surface of the bearings. The fixture was made in halves, the lower half having a cylindrical section which served to hold the fixture in the machine. Ways for the slide carrying the broach were machined in the lower half, and also recesses cut for the hardened and ground blocks on which the parting surfaces of the work rested. The upper half was made in the form of a clamp, this part being bored to fit the half-section of circular hardened and ground steel liner, the inner surface of which fits about the outside of the work. Bosses bored for guide pins extended from the fixture and served to keep the halves in alignment. The weight of the upper half was disposed on springs coiled about the guide pins. The broach was of a semicircular section and bolted to the slide. This slide was connected to the ram of the machine. A copious flow of oil was kept on the work, keeping the locating block and broach free from chips and dirt. The cutting was done on the pull or regular stroke of the machine.

The Status of Industrial Relations

(*Continued from page 516*)

relations controversies. Such matters are justiciable today; they were not twenty years ago. We may look forward to a time when controversies in regard to such rights will become just as justiciable as any controversy in regard to property. It is possible that when this time comes it will be properly referred to as the era of industrial democracy.

Three tendencies in this development of industrial relations seem to be new though they are not novel.

The first is the acceptance of motive of service, which on moral grounds declares for recognition of the rights, needs and aspirations of every one engaged in or dependent upon industry. It is the engineering viewpoint rendered unselfish.

The second is the willingness to consider workers in groups. By training and experience the engineer has only been willing to look upon workers as individuals. Two of the governing principles that have brought modern industry to its present heights are the division of labor which minutely subdivides the job, and the selection and adaptation of the worker which individualizes him and attempts to fit him to some particular task, tool or machine. This is the viewpoint of specialization which deals only with units.

But in industrial relations the workers must be considered in groups or in the mass. This is the viewpoint of the industrial psychologist as contrasted with that of the technical engineer, and the latter has been slow to understand that his methods of subdivision and specialization cannot be used successfully in dealing with the problems of industrial relations. Much has been said about fostering coöperation, but little progress has been made. A reason for this situation is found in the lack of understanding on the part of industrial executives that to build *morale* or the *spirit of the organization* their working people must be appealed to in the mass and not as individuals.

The development of the safety committees began to open the eyes of industrial executives as to what might be accomplished once employees as a body had a chance to express their desires and opinions. The present movement to establish shop committees will carry this experience further and into new aspects of the problems of industrial relations. The experience so gained will show the possibilities and advantages of discarding the individualistic viewpoint of the engineer. It will also bring the passing of arbitrary and autocratic decisions.

The third tendency is toward mutual or joint control, toward mutuality and the working out of representation. It is an expression of democratic ideals.

From the experience of the past and in the face of the tendencies and forces now operating we may confidently expect a greater development in industrial relations during the immediately forthcoming years than in any preceding equal period of time. May engineers accept their entire responsibility and perform fully their duty in working out proper solutions of the problems presented!

ENGINEERING COUNCIL

Engineering Council[1] is an Organization of National Technical Societies of America, Created to Consider Matters of Common Concern to Engineers, as Well as Those of Public Welfare in Which the Profession is Interested

Conference on a National Department of Public Works

IN a recent number of MECHANICAL ENGINEERING announcement was made of the conference on the subject of a National Department of Public Works called by Engineering Council to meet in Chicago April 23 to 25. While in the years before the war a great deal of the engineering and construction work done independently by the different departments of the Government could probably have been accomplished more efficiently and expeditiously if placed under one directing head, the urgent need for such centralization of authority has only come to be generally recognized since the signing of the armistice.

Apart from the military engineering required for the conduct of the war, a vast quantity of civilian engineering was required, aggregating 800 million dollars' worth of hospitals, storehouses, railroads, waterworks, etc., which was carried through by the Construction Division of the Army, the personnel of which included a large number of the best engineers in the country.

The Construction Division's existence is, by law, to terminate 90 days after the signing of peace, and unless the maintenance and operation of these Government facilities, and the disposal of them where they are not to be maintained, are turned over to some board which is familiar with their details and requirements, chaos is sure to result.

It is proposed, therefore, that a Department of Public Works shall be formed, of which the present Construction Division of the Army, under civilian control, shall be a part. Also, that various other of the Government's engineering activities shall be consolidated under this new department for unified control.

The conference at Chicago for the consideration of the project was attended by 71 delegates representing 74 organizations, with a membership of over 100,000; and 7 members of Engineering Council and three members of the National Service Committee of the Council, these latter not as delegates, but with voting privileges. The Chairman of the Conference was M. O. Leighton, Chairman of the National Service Committee, and the Secretary, E. S. Nethercut, Secretary of the Western Society of Engineers, both elected by the conference. J. Parke Channing, Chairman of the Engineering Council, made the introductory speech, giving the purpose of the conference and setting forth the reasons why engineers urge the formation of a National Department of Public Works.

After a general discussion, the main question of the recommendation that such a department be established was referred to a resolutions committee, whose report was adopted as follows:

1 That the services and bureaus of the National Government having to do chiefly with matters of engineering and architecture, be grouped in one department to be known as the Department of Public Works.

2 That the Department of Public Works comprises those works which are built and operated for the use of the Public.

3 That the Department of Public Works be made available when desirable for the performance of special engineering and architectural work for the use of other Government bureaus.

4 That there be a systematic classification and organization of engineers, architects and other employees whose status shall be such that they may be recruited and maintained on merit.

Also, a committee on the scope of a Department of Public Works presented the following report, which was adopted:

1 That the establishment of a National Department of Public Works should be accomplished by grouping those Government bureaus, services, commissions and other activities whose functions are predominantly of an engineering or architectural character, in what is now the Department of the Interior and thereafter designating that department "The Department of Public Works."

2 That the transfer of any bureau, service or commission from any other department to a Department of Public Works should be accomplished without change of personnel, compensation and general plan of organization, leaving the coördination of the several activities, the simplification of organization and the establishment of additional bureaus such for example as a bureau of chemical engineering, to be effected as the need for the same may from time to time become apparent.

3 That in transferring river and harbor work and other work non-military in character, but now in charge of the Engineer Corps of the United States Army, to a Department of Public Works, the relation of the army engineers to such work be not changed and that there should be no relinquishment of non-military duty by the army engineers now on such duty until transfer of these engineers to military duty can be made without detriment to the public interests.

Your Committee finds that among the bureaus, services and activities, which logically belong to a Department of Public Works, are the following:

- A Bureau of Public Roads.
- The United States Reclamation Service.
- The Alaskan Engineering Commission.
- The Construction Division of U. S. Army,
- A Bureau of River, Harbor and Canal work, including such functions as are now exercised by the Mississippi River Commission and the California Debris Commission.
- A Bureau of Architecture.
- A Bureau of Surveys, including the Coast and Geodetic Survey,
- A Bureau of Mines.
- The Geological Survey,
- The Forest Service—at least until the same is divorced from the supervision of water powers and road building.
- The Bureau of Standards.

Your Committee believes that it would be unwise to determine at this time to what extent the proposed Department of Public Works should control the engineering activities of the General Land Office; of the National Park Service; of the Bureau of Lighthouses; of the Bureau of Indians Affairs, and of the Public Health Service and of various commissions, such as Commissions on buildings and grounds, and therefore suggests that such matters may well be deferred for consideration to a later date, preferably until the Department has been organized.

Following an extended discussion of ways and means for continuing the work of the conference and promoting the passage of a bill in Congress for the establishment of a Department of Public Works, a permanent organization was effected. It was voted that the conference should be designated as the Engineers, Architects and Constructors Conference on National Public Works, and that it continue in existence until dissolved by its own action.

An Executive Committee, a Committee on Text of Bill and a Campaign Committee were appointed.

[1] Officers of Engineering Council; J. Parke Channing, *Chairman;* Alfred D. Flinn, *Secretary*, Engineering Societies Building, 29 West 39th Street, New York.

NATIONAL SERVICE COMMITTEE

Contributed by the Washington Office[1]

Standardization for War Department

A SYSTEMATIC effort is being made in each Division of the War Department to make permanent the meritorious practices which grew out of the strenuous war experience. Because of the realization of the need of standardization there grew the Engineering and Standardization Branch of the Purchase, Storage and Traffic Division under the General Staff. This has shown that by working out standardization in all War Department specifications, savings at the rate of many millions a year can be effected in time of war and very material reductions in expenditures effected even with the army on a peace basis.

There are nine divisions under the General Staff which depend largely on engineering work for their operation—namely, Ordnance, Engineer Corps, Signal Corps, Construction Division, Chemical Warfare, Aircraft Production, Military Aeronautics, Quartermaster and Motor Transport Corps. Formerly each of these divisions had its own specification for each article purchased by the War Department. The electrical catalog, for instance,

[1] Washington Office in charge of M. O. Leighton, *Chairman*, National Service Committee, McLachlen Building, 10th and G Streets.

contains 25,000 items. Through the Engineering and Standardization Branch uniform specifications are being devised so that compact but complete catalogs for each class of commodity can be written up which will cover the requirements of every department. This at once simplifies the matter of specifications and purchases for the War Department, makes it possible for them to order in greater quantities and enables the manufacturer to get out his product and deliver it to the various departments at a maximum of efficiency.

Every effort is being made to accomplish the enormous task in a comprehensive and scientific manner. Authorities from various fields are being called in for consultation and wherever questions of engineering are involved Engineering Council, through its National Service Committee, has been called in to consult.

The organization of the Engineering and Standardization Branch is at present subdivided into research, production, inspection, standardization and catalog sections. The research section for instance, will make such investigations as are necessary to assist in standardization work and will arrange for definite forms of procedure in research work through various departments of the Government so that there will be not only standard methods but also standard departmental routine in which these methods will be followed. The production section will lay out definite schedules for quantity and specialty production, which they will recommend for use in the manufacturing arsenals and to individual manufacturers. The standardization of material will take place along lines that will insure interchangeability of a given article with the same article used in another department.

Information Service for Engineers

The National Service Committee of Engineering Council announces a National Legislative and Departmental Information Service for Engineers in all branches of the profession. The statistical, research and construction bureaus of the Government have become valuable sources of engineering information, but have not been used by engineers to the extent merited by the character of their material. Many matters before Congress involve engineering consideration, of which members of the profession should be aware. When in need of information from the above sources, or concerning congressional matters, set forth specifically what is wanted and address the National Service Committee, M. O. Leighton, *Chairman*, 502 McLachlen Building, Washington, D. C.

Scientific and Technical Employees of the Government in Washington Organized

Steps were taken for a permanent organization of the scientific and technical employees of the Government at their mass meeting on May 8, 1919. This was the result of an informal meeting on April 23 of 30 representative Government scientists and technical men who organized the preliminary committee and called the mass meeting. This subject has been widely discussed during the last year and was brought acutely to the fore by the work of the Joint Congressional Reclassification Commission, because that commission has stated that it wished to deal with employees only through organizations.

Rodney H. True of the Department of Agriculture, Acting Chairman, pointed out that the principal advantages to be expected from such an organization were: (1) Improvement of conditions and facilities for more effective scientific and technical work; (2) Adequate presentation of the needs and results of such work to the public and to legislative and administrative officers; (3) Greater freedom in both official and non-official activities; (4) Just and reasonable salaries based on service performed and the economic and social conditions which prevail; (5) Greater public recognition of the aims and purposes of research; (6) Advancement of science and technology as an essential element of national life.

Three plans of organization were offered to the meeting, which covered the fundamental principles which could be utilized by these Government employees. The first plan would have permitted the new organization to work only through existing scientific organizations. This is the plan that scientific and technical government employees in England have adopted and an outline of the English plan was read to the meeting. An independent organization of federal employees doing scientific and technical work was also proposed and a third plan, which was finally adopted by the meeting, provided for the forming of a scientific and technical branch of the Federal Employees' Union. This was upheld principally by Dr. Rosa of the Bureau of Standards. He pointed out the unfavorable conditions under which scientists working for the Government had to solve big problems, and that this, the richest nation, can afford the best scientific service. The present service is fast drifting from efficient channels because of the loss of their best personnel.

His principal reason for recommending the affiliation with the Federal Employees' Union at once was because of the going organization and the prestige that it had already established.

This is an important step forward for the scientific and technical Government employees because it is contemplated that it will lead to important reforms in classification and compensation. It is closely connected with the work that Engineering Council has aimed to accomplish through its committee on Classification and Compensation of Engineers, and it is contemplated that Council will be able to give effective coöperation in the work of classification that must be inaugurated.

Plans for Training of the Commercial Engineer

The Commissioner of Education has issued a call for a public conference on business training for engineers and engineering training for students of business. This conference, national in scope and character fully representative of all interests, will be held in Washington, D. C., on June 23 and 24.

This conference has been called on behalf of the Conference Committee on Commercial Engineering, which is composed of administrative professors in engineering and commerce from several of the large educational institutions and representatives, from the Society for the Promotion of Engineering Education, the American Society of Civil Engineers, The American Society of Mechanical Engineers, American Institute of Mining and Metallurgical Engineers, American Institute of Electrical Engineers and a Committee of Fifteen on Educational Preparation for Foreign Service. The major topics to be discussed are Business Training for the Engineer; Engineering Training for Commercial Enterprises; Significance of the War Experience for Engineering Education; and Training of the Engineer for Foreign Projects.

Plans for Railroad Control

Many interesting plans covering the ownership, operation and control of railroads have been shown in Washington. It is always interesting to the engineer to note the position of the various organizations directly connected with this work, because all branches of the profession are intimately related to the vicissitudes of the railroads.

On the one side generally stands labor and on the other side stand all the other interested parties. This is the case with the railroads. The railway executives, railroad security owners, Interstate Commerce Commission, Director General of Railroads and numerous individual financiers and railroad men all stand for private ownership and operation of the railroads because they believe that efficient operation can be had in no other way. The railways brotherhoods on the other hand stand for Government ownership and they want the operation of the roads to be by private corporation, run by employees and paying Government rental out of the receipts of operation.

Government ownership and operatives' management of railroads is summed up in what is known as the "Plumb Plan." Mr Glenn E. Plumb is attorney for the "Big Four Railroad Brotherhood" and the ten brotherhoods affiliated with the American Con

federation of Labor. He has just arrived in Washington to care for the interests of this plan. He announced that it is to be incorporated in the form of necessary bills for legislative action which will be introduced at the approaching special session of Congress. Mr. Plumb expects the railroad problem to develop into a presidential campaign issue and contemplates that the railroad question will have to be "put up to the people direct." Mr. Plumb says, "If these demands (for rate decreases) were fully met, any deficiency must be made by wage reduction." His own words perhaps best explained his reason for coming to the national capital.

The brotherhoods' plan for the control of the railroads provides that there will be no "Secretary of Transportation" but there will be continuation of powers of Interstate Commerce Commission. The directors shall be elected, one-third by non-appointed employees, one-third by appointed officers and employees, and one-third by the President.

The railway executives recommend that a cabinet officer, to be known as "Secretary of Transportation," be appointed. They say that the Interstate Commerce Commission should be relieved of the executive and administrative duties, except as to the valuation and accounting, and they are to act as a quasi-judicial body with regional commissions.

Railway security owners recommend federal regulation through the Interstate Commerce Commission, as at present constituted, and coördinating with six regional commissions, who in turn will coördinate with the state officials.

The present Interstate Commerce Commission wants a better defined relationship between state and federal control, with a broadening of federal control.

The Director General, as is commonly known, stands for five-year extension of federal control with modified private operation and control thereafter. This plan provides for Government representation on boards of directors.

NATIONAL RESEARCH COUNCIL

Dr. George E. Hale Resigns as Chairman and Dr. James R. Angell is Appointed as His Successor. New York Office of the Council Opens in the Engineering Societies Building

In the last number of Mechanical Engineering reference was made (p. 485) to the recent organization of the National Research Council of the National Academy of Sciences on a peacetime basis, and to the pioneer work which its distinguished chairman, Dr. George E. Hale, Director of Mt. Wilson Observatory, had done in coördinating and directing its activities.

Announcement has been made that Dr. George E. Hale will hereafter be the Honorary Chairman of the National Research Council and Dr. James R. Angell, ex-president of the University of Chicago Settlement and member of the American Psychological Association, who so eminently served the Nation on the committee of the Adjutant General's office on classification of personnel in the Army and as advisory member of the committee on education and special training, will replace Dr. Hale in the executive direction of the Council.

The chairmen of divisions of the National Research Council have been appointed as follows:

Division of Physical Sciences. Chairman, C. E. Mendenhall; acting chairman until June 30, A. O. Leuschner.

Division of Engineering. Chairman, Henry M. Howe; vice-chairman and acting chairman, Galen H. Clevenger.

Division of Chemistry and Chemical Technology. Acting chairman until June 30, E. W. Washburn; chairman, July 1, 1919, to June 30, 1920, W. D. Bancroft; vice-chairman, Julius Stieglitz.

Division of Geology and Geography. Vice-chairman and acting chairman, E. B. Mathews.

Division of Biology and Agriculture. Chairman, C. E. McClung; vice-chairman, L. R. Jones.

In these divisions there are representatives of the various leading societies associated in the particular work covered by the divisions. In the Engineering Division the societies represented are the Civil, Mining, Mechanical and Electrical, Illuminating and Automotive Engineers, the Society for Testing Materials and Western Society of Engineers. The representatives from The American Society of Mechanical Engineers are Arthur M. Greene, Jr., Chairman of the Research Committee of the Society, and Past-Presidents W. F. M. Goss and D. S. Jacobus, the two latter being members of the Engineering Foundation.

According to a note in *Science,* May 16, 1919, the National Research Council has announced the following initial appointments to national research fellowships in physics and chemistry:

In Chemistry. F. R. Bichowsky, of Washington, D. C., A.B., Ph.D., physical chemist at the geophysical laboratory of the Carnegie Institute of Washington since 1916; Mr. Bichowsky plans to conduct researches at the University of California. Emmett K. Carver, of New York City, A.B., Ph.D., formerly assistant to the director of the Wolcott Gibbs Memorial Laboratory at Harvard, Captain, Chemical Warfare Service, U. S. S. A. W. H. Rodebush, Ph.D., present research chemist for the United States Industrial Alcohol Company, of Baltimore, Md.; Mr. Rodebush will conduct researches at the University of California on a Study of the Specific Heats and Other Properties of Substances at Low Temperatures.

In Physics. Leonard B. Loeb, of New York City, B.S., Ph.D., formerly assistant physicist at the Bureau of Standards, Washington, D. C., Lieutenant, Aviation Service, U. S. A.; Mr. Loeb will conduct his researches at the University of Chicago. Robert A. Patterson, of Bristol, Conn., A.B., Ph.D., formerly instructor in physics at Yale University, Major, Field Artillery, U. S. A. George P. Paine, of Madison, Wis., A.B., Ph.D., instructor in engineering mathematics University of Wisconsin; Mr. Paine will conduct research work at Harvard University and at Blue Hill Meteorological Observatory.

Another important development which no doubt will bring about practical results of value to the engineering profession is the recent affiliation of the Engineering Foundation with the National Research Council. To contribute to the mutual collaboration of the two institutions, office space in the Engineering Societies Building has been provided by the Engineering Foundation to serve as the New York Office of the Engineering Division of the National Research Council, and the Foundation, having brought its office to the adjacent room, in addition proffers to the Council and its Engineering Division such secretarial services as the Foundation may from time to time determine.

The office of the Engineering Division of the National Research Council was opened on June 1, and is now operating under the direction of Galen H. Clevenger, acting chairman of the division. The National Research Council proposed that its Engineering Division, comprising in all not less than 23 or more than 28 members, of whom at least 7 and not more than 12 shall be members at large, be so organized as to include at least 5 members of the Engineering Foundation, and, including these 5, 17 members of the Founder Societies; this proposal was accepted by the Engineering Foundation as well calculated to meet the mutual requirements of the Foundation and the Council. It is the purpose of the Engineering Foundation to collaborate with the National Research Council in the activities of its Engineering Division and to make such appropriations to aid its specific undertakings as the Foundation may from time to time determine.

Patents originating in Government service or patents which may be turned over to the Government by private inventors who are not able to develop their inventions commercially are to be administered by the Department of Commerce if the proposed bill for this purpose is passed by the next Congress.

NEWS OF THE ENGINEERING SOCIETIES

Report of Annual Meetings of Electrical Engineers, American Institute of Architects, National Metal Trades Association, United States Chamber of Commerce, etc.

Institute of Radio Engineers

At its meeting of May 7, held in the Engineering Societies Building at New York, the Institute of Radio Engineers presented to Mr. E. F. W. Alexanderson, of the General Electric Company, a gold medal in recognition of his achievements in the field of radio communication. The wireless telephone, declared Mr. Alexanderson in his remarks following the presentation of the medal, was the result of an attempt to transmit power without wires. The possibilities of the wireless telephone having once been conceived, however, experiment and research soon developed it so that today it is an accepted fact.

American Institute of Electrical Engineers

At the annual business meeting of The American Institute of Electrical Engineers, held in New York on May 16, the presentation of the Edison Medal for meritorious achievement in electrical science or electrical engineering took place, it being awarded this year to Benjamin G. Lamme, of the Westinghouse Electric and Manufacturing Company. The presentation was made by William B. Jackson, Vice-President of the Society.

The award was made to Mr. Lamme for inventions and developments of electrical machinery. During the war he served as a member of the Naval Consulting Board, to which he was appointed on the recommendation of the institute. Mr. Lamme has taken out more than a hundred patents for electrical devices, appliances, and systems now in general use.

The society recently held its annual election and announcement was made of the election of Calvert Townley of New York as president and of the reëlection of F. L. Hutchinson as secretary for the administrative year, beginning August 1, 1919. Mr. Townley is assistant to the president of the Westinghouse Electric and Manufacturing Company. He served as an active official of the New York, New Haven and Hartford Railroad in connection with the electrification of the New York terminal zone of that property and is an authority on electrification.

National Machine Tool Builders' Association

The need of continued close attention to production costs and their relation to selling prices and the disposal of the machine tools which the United States Government has on its hands both here and in Europe were the leading topics before the Spring meeting of the National Machine Tool Builders' Association at Atlantic City, May 12-13.

Colonel Guy Hutchinson, assistant director of sales, War Department, expressed appreciation for the part which the machine-tool industry had played in the war. It was production more than man power, the speaker said, that determined the issue of the war. He regretted that production had not got an earlier start, saying that the small quantity of munitions which the United States got to the front before the crucial time arrived had cost a large number of the lives of our allies. The big mistake made, he asserted, consisted of turning factories into playgrounds for engineers for about one year.

The Committee on Safety Codes reported that the Bureau of Standards at Washington was calling for nation-wide regulation of safety provisions, and that two plans had been suggested. Under one of these the Bureau of Standards would draw up general regulations which were then to be adopted by the states, and under the other the work of securing uniformity would be undertaken by the American Engineering Standards Committee made up of members of the national engineering societies.

In his address President A. E. Newton foresaw a keen competition in the near future between manufacturers of machine tools. He warned against what he termed the fallacies of an erroneous study of cost-accounting systems. He advised that in reducing prices it was not sufficient to consult the cost as shown by the individual machines, but also to take into account the real cost as shown by the annual statement. A full report of the meeting is contained in the *Iron Age* for May 15, 1919, from which the foregoing notes were taken.

American Institute of Architects

A prominent feature of the fifty-second annual convention of the American Institute of Architects, held at Nashville, Tenn., April 30, May 1 and 2, was the discussion of the principles set forth in the program of the Post-War Committee on Architectural Practice. The debate on the various topics taken up was a serious and thoughtful consideration of the elements of architectural practice that are now considered of vital significance in the reorganization of the profession. Preliminary to the discussion, John Bell Keeble, member of the bar of the state of Tennessee, spoke on the Relationship of the Professions.

In his address on Professional Principles, President Thomas R. Kimball pointed out the part professionalism should play in developing adequate relations between architects, the public and the other professions. He condemned the practice, as he termed it, among professional men of indulging in tales of discomfiture to and of each other and before audiences inclined to be more interested than discerning, and expressed his belief that through professionalism as a common factor architects may reach an interprofessional understanding based on the common factor of giving skilled service to others.

N. Max Dunning, chairman of the Post-War Committee, stated that in his opinion two important things had been emphasized by our war experience: the value and necessity of organization, and the proper appreciation of the value and nobility of service.

National Foreign Trade Convention

Necessity for an expanded foreign trade in stabilizing domestic conditions was emphasized and the vital factors wherein this country is at a present disadvantage in overseas commerce were set forth by the National Foreign Trade Council in summing up the deliberations of its sixth convention at Chicago, April 24-26, which was dedicated to the theme, Foreign Trade Essential to the American Industry. A forward-looking recommendation was that congressional consideration be given to suitable plans for developing aerial navigation, and it was declared that the promotion of airship service to overseas countries demands the establishment of a separate government department. It was suggested that local chambers of commerce entertain the advisability of having public aerodromes in all centers which expect to develop large foreign markets in order that prompt delivery of plans and specifications, blueprints and invoices may be made from seaports to the interior. Throughout the convention stress was laid upon the fundamental rule that if this country is to have an enlarged export trade it must also be prepared and should expect to receive a greatly expanded volume of imports. Enduring foreign trade, it was stated, must be reciprocated.

National Metal Trades Association

That 86 per cent of the metal-working establishments of the country have a working schedule of 50 or more hours per week,

was brought out at the annual meeting of the National Metal Trades Association, held at New York, April 23-24. Less than 10 per cent of the members of the association have an 8-hour basic day, and few have an actual 8-hour working day. The opinion prevailed that nothing further should be done at this time to reduce hours of labor or to take other action affecting the length of the working day while present conditions prevail.

J. W. O'Leary in his presidential address foreshadowed the formation of a National Peace Labor Board similar to the National War Labor Board during the war. Referring to the activities of the National Industrial Conference Board he said that the presidents of 23 national industrial associations meet monthly and discuss the general problems of industry. Secretary of Commerce William C. Redfield urged the members of the association and business men generally to avail themselves of the resources of the Department of Commerce, the scientific organization of which employs 1200 scientists and occupies nine buildings with 24 acres of floor space.

United States Chamber of Commerce

Stimulation of domestic and foreign trade by federal enactments, speedy termination of river improvement projects already authorized and provision by Congress for a comprehensive system of waterways with coördination of the services of waterways and railways, prompt return of the railroads to their owners and immediate resumption of construction activities was the import of resolutions adopted by the Chamber of Commerce of the United States in its seventh annual convention at St. Louis, Mo., April 28 to May 1.

While the business men of the country pledged themselves to whole-hearted coöperation with the Government, they declared that the final responsibility before the country in the matter of readjustment rested with the federal authorities. The suggestion was made to consider the revision of all federal laws dealing with business conditions to the end that by proper readjustment of their provisions and of the functions of federal agencies, industry and commerce in the United States may clearly know at all times their powers, rights, limitations and obligations.

It was notable that Director General of Railroads Walker D. Hines and Secretary of Commerce Redfield expressed themselves in accord with some of the most vital principles advocated by the chamber. Mr. Hines recommended the return of the railroads, as did Senator A. B. Cummins, another speaker, while Mr. Redfield favored the abolishment of old-time restrictions on trade and the keener coöperation of the Government with private industrial enterprise.

Chairman Edward N. Hurley of the United States Shipping Board took a most hopeful view of the outlook of the American ship industry. He called attention to the excellent opportunity this country has now to establish on a solid footing the merchant marine which it wants and needs, and felt confident that Congress would pass legislation which would be helpful in accomplishing a permanent and efficient American merchant marine.

American Gear Manufacturers' Association

Standardization of gears was the predominant question of the American Gear Manufacturers' Association at their annual convention in Cleveland, April 14-16. The standardization committee reported that while their work could not be considered as yet in its final form, still the investigations which the committee has performed would eventually lead to remarkable results in obtaining a better standard for gear users and gear manufacturers. The standardization of inspection was also extensively discussed, and it was expected that uniform practice would soon be established, particularly in regard to complaints by users of gears for claims which are in no way the fault of the gear manufacturer.

The composition and physical characteristics of steels for gear making, as well as suggestions in heat treating in this connection, were given in a paper on Gear Steels by J. Herber Parker. Tempered gears have been criticized on account of pitting of tooth surfaces, which was found after limited service. Mr. Parker mentioned several experiences where the condition of pitted surfaces was corrected by reducing the unit tooth pressure. The following are of particular interest:

(1) Misalignment of gears was believed to be the cause of the trouble, thus throwing an excessive load upon only a part of the tooth and vastly increasing the unit tooth pressure. When the gears were properly adjusted and the load properly distributed, pitting disappeared.

(2) A little lower drawing temperature after hardening, which resulted in an increase of about five points in scleroscope hardness, eliminated pitting. The slight increase in hardness was sufficient to enable the gear tooth to withstand the unit tooth pressure put upon it.

(3) Pitting was eliminated by increasing the length of the tooth face. This increase resulted in decreasing the unit tooth pressure to a safe figure. Properly case-hardened gears which have a scleroscope hardness of about 90 will undoubtedly withstand, without pitting, unit tooth pressures which will give trouble in the case of a tempered steel gear which is about 75 scleroscope hard.

Other technical papers presented before the convention were: Worms and Worm Wheels, by G. W. Carlson, and Proper Sizes and Materials for Gears for Tractor Construction, by E. J. Frost.

Air Brake Association

Results of tests and numerous opinions as to the cause of excessive leakage in the auxiliary devices of the locomotive air-brake system and the method that should be used to overcome it were presented at the twenty-sixth annual convention of the Air Brake Association, held at Chicago May 6 to 8.

The Committee on Air Consumption of Locomotive Auxiliary Devices entrusted with this investigation performed both standing and running tests. The standing tests were made on locomotives in roundhouses, and consisted in measuring the amount of air used by the auxiliary devices operated while the locomotives were standing. The running tests were made on freight engines working over the road in service, and consisted of the continuous measurement of air used by the auxiliary devices in operation while the engine was running. A total of 489 individual tests were classified and arranged in the report submitted by the committee. A summary of their principal results is as follows:

1 Auxiliary devices under average conditions were found to use too much air.

2 Conditions frequently exist where compressor capacity may be exceeded by the demands of the auxiliary devices.

3 Some of the data justify the conclusion that auxiliary devices should be operated separately from the air-brake system. On the other hand, some of the data show that with proper maintenance this conclusion might not be warranted.

4 Under some conditions it would not be satisfactory to connect the auxiliary devices to the air-brake system and increase the compressor capacity accordingly, unless the air-brake main reservoir were protected from the consequences of excessive air requirement by the auxiliary devices.

5 Cost-basis data show that better maintenance would be profitable.

6 Standards of performance, including maximum permissible leakage, should be established.

7 Means should be devised for checking and testing the performance of auxiliary devices.

The committee did not consider their work as complete and recommended that their data be further increased by investigations on individual railroads. They concluded by advocating the plan of operating the auxiliary devices at a pressure lower than that carried in the air-brake system main reservoir. This plan would effect a large saving in air used, but would require a separate air-supply reservoir with means provided for controlling the reduced pressure.

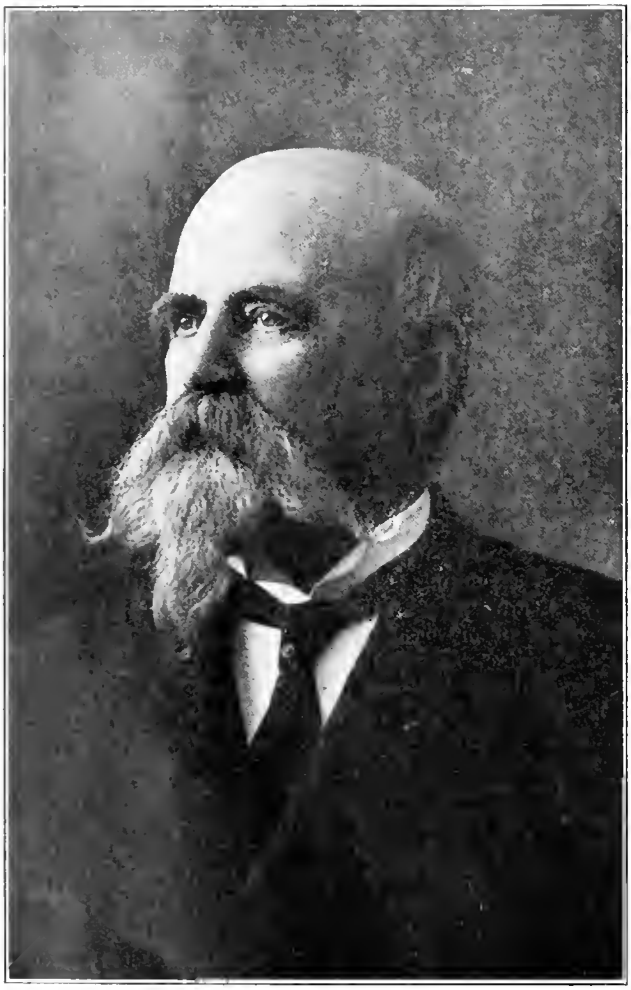
An American Petroleum Institute has been formed with its headquarters in Washington. Its function will be to promote mutual coöperation between representatives of the industry and the departmental or legislative organizations of the Government.

NECROLOGY

CHARLES H. MANNING

Captain Charles H. Manning, honorary member of the Society and for many years prominent in engineering circles in New England, died at Manchester, N. H., on April 1. Captain Manning was born in Baltimore, Md., on June 9, 1844, and received his early education in that city and in Cambridge, Mass., later entering the Lawrence Scientific School of Harvard University, from which he was graduated in 1862 with the degree of B. S.

In February 1863 he was appointed third assistant engineer of the



Charles H. Manning

Navy. His knowledge and comprehensive grasp of scientific matters brought him to the attention of Chief Engineer Isherwood, who assigned him to the making of experiments on superheating steam on the U. S. S. *Adelaide*. He served on the *Adelaide* for two years, when he left her to join the sloop-of-war *Dacotah*. In 1870 Captain Manning was assigned to shore duty as an instructor in the Naval Academy where he remained five years. During this period he assisted in organizing a course of instruction for cadet engineers at the Academy, and this is considered one of his most valuable achievements.

Captain Manning also served as a member of the first Advisory Board that prescribed the specifications for the so-called "New Navy." Other members of the Board were Rear-Admiral John Rogers and Chief Engineers Benjamin F. Isherwood and Charles H. Loring.

In 1882 Captain Manning retired from active duty in the Navy and was not called into active service again until the Spanish-American War, when he was stationed at the Naval Station at Key West as chief engineer of the repair of the machinery of warships which gathered there. He was commissioned chief engineer on the retired list in February, 1911.

In 1883 Captain Manning became associated as chief engineer with the Amoskeag Manufacturing Company, Manchester, N. H., the largest cotton mills in the world. He had charge of all their power plants and saw the steam power plant grow from one with 870 sq. ft. of grate surface and burning about 400 tons per week, to one with 5,800 sq. ft. of grate surface and capable of burning some 3,000 tons of fuel per week.

The resourcefulness of Captain Manning is well typified by the following incident: In the fall of 1891 a 30-ft. flywheel burst, and being dissatisfied with the metal put into flywheel rims at the time, he designed a new wooden-rimmed wheel of the same diameter with a face of 108 1-4 in. and a thickness of 12 in. This rim was made up of forty rings of ash, and was doubtless the largest wooden-rim wheel in the world.

In addition to his position with the Amoskeag Company, Captain Manning acted as consulting engineer for several other large mills. He was the designer of the well-known Manning boiler and was associated with many pioneer power-plant designs, including one of a 200-hp. horizontal water turbine which at the time of its installation in 1885 was the largest of its kind.

In 1913 Captain Manning retired from the Amoskeag Company and opened offices as a consulting engineer.

As a resident of Manchester, Captain Manning was a very useful citizen. For 28 years he was a member of the Board of Water Commissioners—most of the time its president, and during his incumbency the system was greatly extended and improved. For 18 years he was a member of the school board, where his advice was much respected.

Captain Manning became a member of the Society in 1884 and was made an honorary member in 1913. From 1893 to 1895 he served as manager and from 1895 to 1897 as vice-president of the Society. He was also a member of the Army and Navy Club of New York, the American Society of Naval Engineers, the United States Naval Institute, the American Society of Naval Architects and Marine Engineers, the American Association for the Advancement of Science and the American Association of Cotton Manufacturers.

HARRY H. COOK

Harry H. Cook, chief engineer of the Chapman Valve Manufacturing Co., Indian Orchard, Mass., died on December 15, 1918. Mr. Cook was a 1906 graduate of the Massachusetts Institute of Technology. He was formerly connected with the Coffin Valve Company as chief engineer and with the Providence Engineering Works as sales engineer. Mr. Cook became a junior member of the Society in 1910 and was promoted to full membership in 1918.

JOSEPH FRANZ DIEPENBROCK

Joseph F. Diepenbrock, who until five months ago was in the employ of the Arnold Engineering Co. on important work in connection with Fort Sheridan, died on April 7, 1919. Mr. Diepenbrock was born in Germany on August 28, 1874. He was educated in Essen, attended the Fachschule at Hagen and was graduated from the College Charlottenburg.

He came to the United States in 1901 and became associated with the Dickson Manufacturing Co., Scranton, Pa. From 1902 to 1910 he was employed by the Allis-Chalmers Co., when he resigned to accept a position with the H. R. Worthington Co. He was with the Arnold Engineering Company when his health failed and he was forced to give up active work. Mr. Diepenbrock became a member of the Society in 1912.

MARSHALL TENBROECK DAVIDSON

Marshall T. Davidson, president of the M. T. Davidson Co., Brooklyn, N. Y., died on April 10, 1919. Mr. Davidson was born on February 17, 1837, in Albany, N. Y. He was graduated from the Albany Academy and Polytechnic Institute. During the Civil War he served in the Navy as second assistant engineer and later was promoted to the position of chief engineer in the Revenue Cutter service where he superintended the construction and installation of machinery on vessels for this department. At the close of the War Mr. Davidson engaged in the contracting business and later established the company of which he was president for the construction of the Davidson steam pumps, pumping engines, condensers, evaporators, etc. He was a member of the Society of Naval Architects and Marine Engineers, the Naval Order of the United States and a life member of the Navy League. He became a member of our Society in 1886.

JOSEPH ESREY JOHNSON, JR.

Joseph E. Johnson, Jr., consulting engineer and metallurgist, New York City, died on April 4, 1919. Mr. Johnson was an 1888 graduate of Haverford College, Pa., and received his master's degree in mechanical engineering from Cornell University in 1892.

Mr. Johnson was first employed in the drafting room of the Baldwin Locomotive Works, where he was located for about two years. In 1893 he entered the employ of John E. Sweet of the Straight Line Engine Co. He was next connected with the Solvay Process Co. and in 1894 became assistant to the president of the Ames Iron Co., Oswego, N. Y. In 1895 he became associated with the Longdale Iron Co. as engineer and assistant manager. From 1899 to 1901 he was with the Carnegie Steel Co. when he again returned to the Longdale Iron Co., remaining there until 1906 when he became general manager

of the Princess Furnace Co., Glen Wilton, Va. In 1909 Mr. Johnson was appointed general superintendent of the furnaces and coke ovens of the Republican Iron & Steel Co., Birmingham, Ala., and the following year he became manager of the blast furnace and chemical plant of the Lake Superior Iron & Chemical Co., Ashland, Wis. In 1913 he opened consulting offices in New York City.

Mr. Johnson was a director of the American Institute of Mining and Metallurgical Engineers, member of the American Electrochemical Society, the American Iron and Steel Institute, the British Iron and Steel Institute, the American Institute of Weights and Measures and the American Society for Testing Materials. He became a member of our Society in 1896.

WILLIAM D. KELLEY

William D. Kelley, general superintendent of meters of the Consolidated Gas Company of New York, died on April 12, 1919, at his home in Mount Vernon, N. Y. Mr. Kelley was identified with the gas industry in New York City for forty-one years. He began this business career as a "fitter" but developed rare business qualifications and received frequent advancements so that at the time of his death Mr. Kelley was considered one of the most efficient men in the gas industry.

Mr. Kelley was educated in the public schools of New York City. At the time of his death he was a member of the American Gas Association, the Society of Gas Engineering of New York City and the National Association of Corporation Schools. He became a member of our Society in 1915. Mr. Kelley took a very active part in the proceedings of these organizations and was greatly interested in their work.

His funeral was held on April 15 at Mount Vernon, N. Y., and was attended by many officials and employes of the Consolidated Gas Company of New York.

EDWARD BYRON McKINNEY

Edward B. McKinney, who until his retirement in 1917 was superintendent of power of the New Orleans Railway & Light Co., died on March 30, 1919. Mr. McKinney was born in New York on February 14, 1854, and was educated in the city schools. He served his apprenticeship with the Delamater Iron Works, New York, and afterward served as assistant and later as chief engineer on ocean-going steamers. From 1889 to 1895 he was chief engineer of the Louisiana Electric Light Co., New Orleans, later holding similar positions with the St. Charles St. Railroad Co. and the New Orleans Traction Co. In 1905 he was appointed to the position of superintendent of power of the New Orleans Railway & Light Co. Mr. McKinney became a member of the Society in 1907.

FREDERICK LEO NEELY

Frederick L. Neely, who was engaged on important development work for the E. I. du Pont de Nemours Co., died on January 5, 1919, of influenza. Mr. Neely was born on January 1, 1883, in St. Petersburg, Pa., and was graduated from the Pennsylvania State College in 1904. For five years he was associated with the Allis-Chalmers Co. as superintendent of their erection department and in connection with their sales work. He was also connected for a few years with the Macon Railway & Lighting Co., as superintendent of the public utilities plants of the company. His work with the du Pont Company dealt in great part with the mechanical, experimental and development work on smokeless powder. Mr. Neely became a junior member of the Society in 1909 and was promoted to full membership in 1914.

CHARLES B. RICHARDS

Charles Brinckerhoff Richards, Higgin professor of mechanical engineering in the Sheffield Scientific School, Yale University, for a quarter of a century and since 1909 professor emeritus, died at his home in New Haven, Conn., on Sunday, April 20, 1919, in his eighty-sixth year. Professor Richards was born in Brooklyn on December 23, 1833, and was educated in private schools in that vicinity.

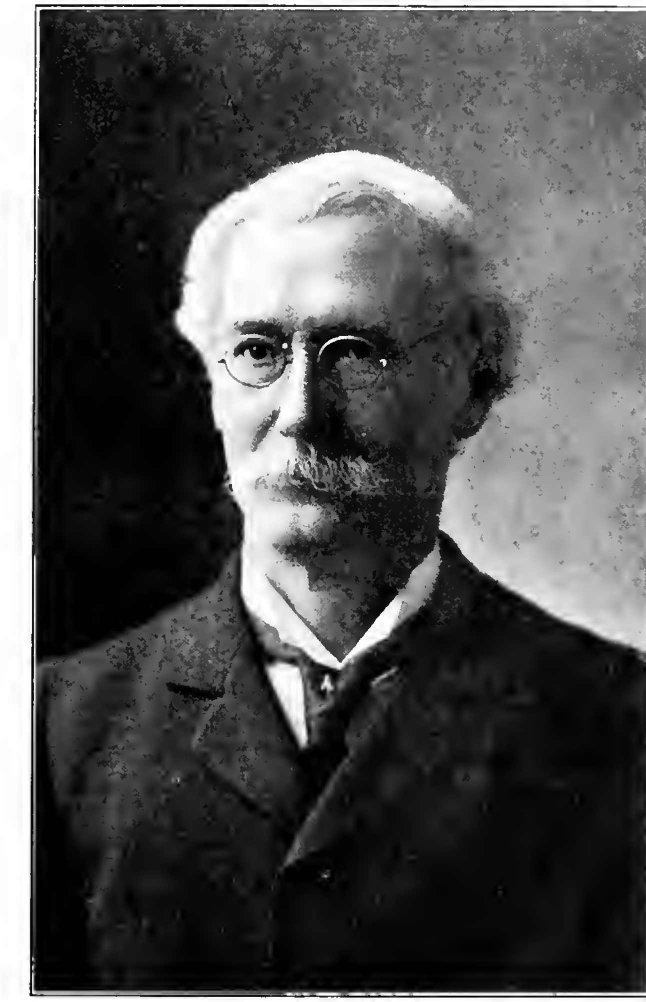
In an article for the *Yale Daily News* Professor Lockwood of Sheffield writes:

"In the death of Professor Charles B. Richards, the mechanical engineering profession loses one of its most prominent members. His early life was spent in Hartford, Conn., at a period when engineering colleges were unknown. He was obliged, therefore, to acquire his theoretical education by the power of personal application, of broad reading and diligent study—this all carried on while busily engaged in practical daily work along manufacturing lines.

"His school was the famous Colt's Armory where his mechanical genius was early recognized. At the age of twenty-seven he opened an office in New York as consulting engineer and at once leaped into wide prominence by his invention of the steam-engine indicator, which made the name of Richards a familiar one wherever steam engines were used. This instrument was produced at a time when the high-speed engine was in its infancy and aided greatly in its development. For this achievement he was made a Chevalier of the Legion of Honor of France, as well as receiving medals from the London Exposition of 1862, the American Institute in 1869, and the French Exposition in 1878.

"With the outbreak of the Civil War Mr. Richards was recalled to Colt's as their assistant superintendent and consulting engineer, where he spent nineteen years of active life. He developed the platform-scale testing machine for testing the strength of metals and was also an authority on the heating and ventilation of buildings, acting as consulting engineer for several large projects, among them the Capitol at Hartford and several of the Yale University buildings. His fertile mind was constantly at work on inventive problems. He was deeply interested in the microscope and made several improvements for which he was granted patents.

"In 1880 Mr. Richards became superintendent of the Southwark Foundry and Machine Company in Philadelphia, manufacturers of the



Charles B. Richards

Porter-Allen high-speed engine, marine and other large machinery. Four years later he was invited to become professor of mechanical engineering at the Sheffield Scientific School of Yale University and entered upon the new work of teaching. An inborn taste for study and research undoubtedly led to this choice. For twenty-five years Professor Richards served as the head of the mechanical engineering department, where successive classes were inspired by his friendly spirit and high ideals.

"He was engaged in occasional activities in addition to teaching. He was an American Commissioner at the Paris Exposition in 1889, and edited the report of mechanical appliances. As associate editor he was responsible for the technical terms in two editions of Webster's New International Dictionary.

"In 1909 at the age of seventy-five Professor Richards retired from active work. The esteem of his classes was expressed on this occasion by their presentation to the school of an oil portrait of Professor Richards. This portrait now hangs in the faculty room of the Sheffield Scientific School.

"Professor Richards was a stern disciplinarian and believed in the doctrine of work. Yet his friendly interest in the individual student and his enthusiasm for engineering aroused and maintained a helpful spirit of coöperation with his classes while his great ability and wide experience were recognized and admired."

Professor Richards was a member of the Société Industrielle de

Mulhouse, Alsace, the Society of Naval Architects and Marine Engineers, the Connecticut Academy of Sciences, and a Fellow of the American Academy of Arts and Sciences. He was a charter member of our Society, being present at the organization meeting on April 7, 1880.

DAVID BRAINERD OVIATT

David B. Oviatt, assistant engineer, Board of Water Supply, New York City, died on February 12, 1919. Mr. Oviatt was born in Salem, N. Y., on May 20, 1858. He was graduated from Cornell University in 1887 with the degree of M. E. He was at one time connected with the American Bridge Co., Trenton, N. J., and with the New York Rapid Transit Railroad Co. For several years he also held the position of steel inspector for the New York & Long Island Railroad Co. Mr. Oviatt was appointed to the Board of Water Supply in 1909. He became a member of the Society in 1891.

CARL A. STROM

Carl A. Strom, manager of the Cooke Works of the American Locomotive Co., at Paterson, N. J., died in New York, on March 26, 1919. Mr. Strom was born on August 22, 1868, in Motala, Sweden, and was graduated from the Royal Polytechnic Institute, Stockholm, Sweden, in 1889. He was formerly connected with the Chicago, Omaha and Southwestern Railroad and the Illinois Central. He was also chief mechanical engineer with the Isthmian Canal Commission on the construction of the Panama Canal. Mr. Strom became a member of the Society in 1905.

PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by June 15 in order to appear in the July issue.

CHANGES OF POSITION

R. L. Thomsen has become associated with the Terry Steam Turbine Company, Hartford, Conn., in the capacity of sales manager. Mr. Thomsen was previously connected with the Griscom-Russell Company, New York, as manager of the marine department.

Arthur C. Lindholm, formerly affiliated with the Colt's Patent Fire Arms Company, Hartford, Conn., as mechanical engineer, has assumed the position of general manager of the Franklin Machine and Tool Company, Springfield, Mass.

Raymond A. Cole has become connected with the engineering department of the Norton Grinding Company, Worcester, Mass. He was, until recently, engineer in the machine gun department of the Colt's Patent Fire Arms Company, Hartford, Conn.

L. W. Helmreich, formerly engineer, Electricity, Gas, Heat and Water Department of the Public Service Commission of Missouri, Jefferson City, Mo., has accepted the position of chief engineer of the Corporation Commission of the State of Arkansas.

Lester B. Paterson has resigned his position as scheduling engineer and shop accountant, Readville Shops, N. Y., N. H. and H. R. R. Company, and has accepted the position of planning engineer of The Carrie Gyroscopic Corporation, New York.

W. F. Rockwell, vice-president in charge of engineering and manufacturing with the Torbensen Axle Company, Cleveland, Ohio, has resigned, effective May 1, to become general manager of The E. B. Hayes Machinery Corporation at Oshkosh, Wis.

Edward P. Warner, formerly aero engineer, Bureau of Aircraft Production, U.S.A., Massachusetts Institute of Technology, Cambridge, Mass., is now employed as chief physicist by the National Advisory Committee for Aeronautics, Research Laboratory, Langley Field, Hampton, Va.

Henry B. Dirks, formerly assistant professor of civil engineering, Princeton University, Princeton, N. J., has accepted the position of professor of mechanical engineering, Michigan Agricultural College, East Lansing, Mich.

Adolf Aeberli has severed his connection with the Canadian Allis-Chalmers Company, Ltd., Toronto, Ont., Canada, and has become associated with the Hydro-Electric Power Commission of Ontario, Toronto, Canada.

Arthur F. Worden, until recently connected with the DuPont Engineering Company, Jacksonville, Tenn., in the capacity of fire protection engineer, has entered the service of the American District Telegraph Company, New York, as plant engineer.

J. G. Berger has become associated with L. K. Comstock and Company, which has recently established a Newark office under the direction of Mr. Berger. This office will engage in the sale of complete industrial and power equipments, as well as construction service. Mr. Berger was formerly connected with the William Gordon Corporation, Philadelphia, Pa., in the capacity of chief engineer.

Norbert S. Atwell, formerly in the employ of the Bureau of Aircraft Production, New York, has entered the engineering department of the United States Ball Bearing Manufacturing Company, Chicago, Ill.

Harold Prigoff, until recently assistant works engineer, Savage Arms Corporation, Utica, N. Y., has become associated with the machinery sales department of the Syracuse Supply Company, Syracuse, N. Y.

S. L. Simmering has resigned his position as research associate in the engineering experiment station, University of Illinois, to accept a position as assistant professor of mechanical engineering in the University of Colorado, Boulder, Colo.

Walter H. Hall has accepted the position of plant engineer, Champion Ignition Company, Flint, Mich. He was formerly connected with the Remington Arms Union Metallic Cartridge Company, Swanton, Vt., in the capacity of works engineer.

ANNOUNCEMENTS

Lieut. C. W. Nickerson, U.S.N.R.F., was relieved of all active duty on April 19 and is now associated as mechanical engineer with the North American Dye Corporation, Mt. Vernon, N. Y., manufacturers of Sunset soap dyes.

Alvan L. Grout has assumed the duties of plant engineer of the Saco Lowell Shops, Biddeford, Me.

Harry J. Angell, formerly 2d Lieutenant, 26th Engineers, 1st Army Water Supply Service, has returned to the Goulds Manufacturing Company, of New York, in the capacity of sales engineer.

John F. Vaughan has resumed his engineering practice. His resignation as district manager for the Emergency Fleet Corporation (New England district) was accepted, to take effect May 1.

Dr. William P. Gerhard was recently asked by the United States Housing Corporation to serve on a committee composed of four engineers, to investigate and list the plumbing work in several groups of buildings of the Corporation at Bridgeport, Conn.

James L. Myers, Lieutenant Army Ordnance, Engineering Division, Motor Equipment Section, Washington, D. C., has received his discharge and is now connected with the Cleveland Graphite Bronze Company, Cleveland, Ohio, in the capacity of sales engineer.

Clarence Boyle, Jr., secretary of Clarence Boyle, Inc., Chicago, Ill., and formerly district sales manager of the Taylor-Wharton Iron and Steel Company, is changing his residence from Chicago, where the main office of the former company is located, to Atlantic Beach, Fla., to manage the Florida interests of his company.

A. L. Menzin, industrial engineer, has moved his office from Philadelphia, Pa., to San Francisco, Cal., in which city he was formerly located.

Francis D. Ammen, for a time identified with the Emergency Fleet Corporation, St. Louis, as production assistant, has formed a partnership with Bruce S. Elliott, for the practice of patent trade-mark and copyright law. They will practice under the firm name of Elliott and Ammen, with offices in St. Louis, Mo.

Henry C. Meyer, Jr., William E. S. Strong and Bassett Jones announce the formation of the firm of Meyer, Strong and Jones, Inc., which will conduct an engineering office for reporting upon and designing power plants and the mechanical and electrical equipment of buildings and industrial establishments. Offices of the firm are at 101 Park Avenue, New York.

Ronald K. MacMaster, who has served as 1st Lieutenant, Ordnance Department, U.S.R., Gun Division, Production Section, has been promoted to the rank of Captain.

Max Toltz announces the association of Beaver Wade Day, architect, with the Toltz Engineering Company, the name of the company being changed to Toltz, King and Day, Inc., engineers and architects. In addition to the consulting engineering work previously carried on by The Toltz Engineering Company, the reorganized company engineers the general field of architecture, specializing upon industrial and public buildings.

E. Rees, of Chicago, Ill., has assumed the duties of chief division lubrication engineer, Sinclair Refining Company, St. Paul, Minn.

Hillard W. Jarrett has been released from the service as ensign, Naval Aviation, Supervisor of Aircraft Production, and has accepted the position of assistant fuel engineer, U. S. Bureau of Mines, Pittsburgh, Pa.

Lieut.-Col. John J. Swan, formerly Personnel Branch, Operation Division, General Staff—after the armistice, Classification Division, Adjutant General's Office, resigned April 7, to become associated with the Prest-O-Lite Company, of Indianapolis, Ind.

S. Clifford Merrill has become associated with the United States Aluminum Company, Edgewater, N. J., as mechanical engineer.

George W. Cravens has left Government service and will establish himself independently as a consulting engineer with headquarters at Westfield, N. J., and a branch office in New York City. Mr. Cravens was automotive engineer in the Maintenance Division of the Motor Transport Corps, Washington, D. C. Upon leaving the Army he was granted a commission as Major in the Reserve Corps.

George Wilfert, Captain Ordnance Department, U.S.A., has received his discharge from the service and has accepted a position with the Remington Arms Company, Ilion, N. Y., as consulting engineer on sporting rifles.

Ralph W. E. Yardley, recently Captain in the Ordnance Department, in charge of the construction of Inspection Division Proving Grounds during the war and later in charge of the Buildings and Land Section of the Ordnance Department Salvage Board, has resigned his commission and has become associated with Perkins, Fellows and Hamilton, architects.

Frank P. Rhame, Captain Ordnance Department, U.S.A., has secured his release from military service and has become associated with the Lunkenheimer Company, of Cincinnati, Ohio, in charge of a branch of the sales department which is devoted to power-plant development.

Jacob A. Teach, Chairman of the Minnesota of the Am. Soc. M. E., 1918-1919, has assumed the duties of contracting engineer, mechanical and structural departments of the Minneapolis Steel and Machinery Company, New York.

John Frick, for many years in charge of the designing, developing and constructing of the automatic vending machines used by the Horn and Hardart Baking Company, Philadelphia, Pa., has severed his connection as superintendent and designer of the machinery department to enter into business for himself as designer of tools and automatic machines, with offices in Philadelphia, Pa.

Col. H. M. Byllesby, president of H. M. Byllesby and Company, has been elected president of the Chicago branch of the National Security League.

Through an error, Arthur A. Merry's position with the Pratt and Whitney Company, Hartford, Conn., is given in the new issue of the Year Book as assistant works manager. Mr. Merry is associated with the company as production manager.

APPOINTMENTS

William D. Ennis, who has, since his release from military service, been acting professor of mechanical engineering at Columbia University, has been appointed professor in marine engineering in the Post-Graduate Department of the United States Naval Academy.

John H. Romann, in charge of the export department of Joseph T. Ryerson and Son, New York, has been appointed the company's representative for France, Belgium, Holland, Switzerland, Italy, Spain and Portugal. Mr. Romann sailed for France in March and will make his permanent home in Paris.

Fred W. Fischer, recently assistant power superintendent of the DuPont Engineering Company, Nashville, Tenn., has been appointed mechanical superintendent in charge of power, electric and maintenance divisions. This plant was recently taken over by the Ordnance Department and will be known as the Old Hickory Powder Plant.

LIBRARY NOTES AND BOOK REVIEWS

Aeroplane Construction and Assembly. By J. T. King and N. W. Leslie. Press of the William Hood Dunwoody Industrial Institute, Minneapolis. Cloth, 6 x 9 in., 115 pp., 77 illus., 5 pl., $1.50.

This work is intended as a practical manual for mechanics engaged in constructing and rigging airplanes and as a guide to instructors. Airplane assembly, construction and materials and the theory of flight are discussed.

Industrial Goodwill. By John R. Commons. McGraw-Hill Book Co., Inc., New York, 1919. Cloth, 6 x 8 in., 213 pp., 3 charts, $2.

The author discusses the present-day problems of labor and capital, their relations to each other, and the method of solving them which have been practiced or proposed. The contents: Commodity, Machinery, Goodwill, The Public, Democracy, Solidarity, Theory and Practice, Security, Labor Market, Insurance, Health, the Shop, Education, Loyalty, Personalty, Depression, The World.

Iron and Steel. (A pocket encyclopedia.) Including Allied Industries and Sciences. By Hugh P. Tiemann, with an Introduction by Henry Marion Howe. Second edition. McGraw-Hill Book Co., Inc., New York, 1919. Flexible cloth, 4 x 7 in., 514 pp., $4.

In a volume of pocket size the author provides a combination of dictionary encyclopedia and handbook of the iron and steel industries, intended for the metallurgist. The number of terms, and the text also, have been increased about one-half, the chief additions being more extended discussions of heat treatment, physical properties and testing, and of metallographic subjects.

The Mineral Deposits of South America. By Benjamin L. Miller and Joseph T. Singewald. First edition. McGraw-Hill Book Co., Inc., New York, 1919. Cloth, 6 x 9 in., 598 pp., illus., maps, $5.

An account of the economic geology of the countries of South America, based on an extended visit by the authors in 1915, and a study of the literature. It forms a digest of the available information on the mineral deposits of the continent. Selected bibliographies are appended to each chapter and an adequate index is provided.

Mining Practices. Compiled from the *Engineering and Mining Journal* by the Editorial Staff. Mc-Graw Hill Book Co., Inc., New York, sole selling agents, 1919. Cloth, 9 x 12 in., 105 pp., 56 illus., 11 tables, $1.50.

These articles have been selected to illustrate the range in conditions that must be met in mining operations and to indicate in both a general and a specific way how mining practices are developed.

Office Administration. By J. William Schulze. First edition, second impression. McGraw-Hill Book Co., Inc., New York, 1919. Cloth, 5 x 8 in., 295 pp., illus., folded chart, $3.

Written to present a thorough discussion of the principles and methods which underlie efficient and economical management, for use by executives and students of business. It embodies the author's added experience and observation and is intended to replace his earlier book, The American Office.

Office Management. Its Principles and Practice covering Organization, Arrangement, and Operating with Special Consideration of the Employment, Training and Payment of Office Workers. By Lee Galloway. Second printing. The Ronald Press Co., New York, 1919. Flexible leather, 6 x 9 in., 701 pp., 97 illus., 1 pl., $6 (delivered).

This book is intended as an exposition of the basic principles of office administration in its widest sense, with adequate illustration by examples of successful practice.

Physics and Chemistry of Mine Ventilation. A Practical Handbook for Vocational Schools, and for those qualifying for mine foreman and mine inspector certificates. By Joseph J. Walsh.

Second edition. D. Van Nostrand Co., New York, 1918. Cloth, 5 x 8 in., 219 pp., illus., tables, $2.

A textbook of theory and practice for students with limited mathematical knowledge. This edition has been thoroughly revised and a chapter on the sampling and analysis of mine gases has been added.

Principles of Radiotelegraphy. Prepared in the Extension Division of the University of Wisconsin, by Cyril M. Jansky. First edition. McGraw-Hill Book Co., Inc., New York, 1919. (Engineering Education Series.) Cloth, 6 x 9 in., 242 pp., 179 illus., $2.

A textbook in which the use of mathematical expressions is employed, while an attempt has been made to explain the principles involved so fully that a reader unable to follow the mathematical demonstrations may still acquire some understanding of the subject.

A considerable part of the book is devoted to a discussion of electromagnetic theory and apparatus in order that the student may acquire an intelligent idea of the principles of the operation of radiotelegraphic apparatus.

Punches and Dies. Layout, Construction and Use. By Frank A. Stanley. First edition. McGraw-Hill Book Co., Inc., New York, 1919. Cloth, 6 x 9 in., 434 pp., 618 illus., $4.

This book has been written to provide die-makers, tool-makers, and tool draftsmen with certain definite information heretofore not available as a whole. Almost ninety per cent of the material, the author states, has not been published before.

Quantitative Analysis. By Edward G. Mahin. Second edition. McGraw-Hill Book Co., Inc., 1919. Cloth, 5 x 8 in., 605 pp., 122 illus., tables, $3.50.

The author has endeavored to produce a volume that would occupy a position between the complete reference work and the bare outline of laboratory exercises. It covers the material that he wishes to take up in his college courses and at the same time presents a theoretical and practical discussion of the subject. In addition to the presentation of the general subject, a section on the analysis of industrial products and raw materials is included. This edition has been carefully revised and partly rewritten, and new material has been added.

Sewage Disposal. By Leonard P. Kinnicutt, C. E. A. Winslow, and R. Winthrop Pratt. Second edition, rewritten. John Wiley & Sons, Inc., New York, 1919. Cloth, 6 x 9 in., 547 pp., 141 illus., 136 tables, $4.

This volume offers a general survey of the problem from the various viewpoints of the chemist, the sanitary biologist and the engineer, with particular reference to the conditions of American practice. The aim has been to discuss rather fully the fundamental principles of chemistry and bacteriology which are involved and to include the more important aspects of the engineering works designed to carry them into operation. This edition has been completely rewritten so as to bring in new data and recent viewpoints on all the topics treated. Several chapters have been much enlarged and several new ones have been added.

Structural Engineers' Handbook. Data for the Design and Construction of Steel Bridges and Buildings. By Milo S. Ketchum. Second edition. McGraw-Hill Book Co., Inc., 1918. Flexible cloth, 6 x 9 in., 896 pp., 165 tables, $5.

In preparing the new edition of this working manual for engineers, draftsmen and students, the author has added details for steel windows and doors, data on cement and gypsum tile roofs, solutions for bending moments in mill-building columns and stresses in stiff frames, has rewritten and enlarged the chapter on steel highway bridges, and has corrected all known errors.

ACCESSIONS TO THE LIBRARY

Advantages of Rope Transmission in Textile Plants. By Frederick S. Greene. Transactions No. 76 of the New England Cotton Manufacturers' Association, *Boston, Mass., 1904.* Gift of Geo. F. Fowler.

Aeronautical Engineering and Airplane Design. By Lieut. Alexander Klemin. *New York, 1918.*

The Alkali Industry. By J. R. Partington. Industrial Chemistry Series, edited by S. Rideal. *London, 1919.* Purchase.

An Interpretation of the Engine Fuel Situation. By J. E. Pogue. 1919. To be presented at annual meeting of the Society of Automotive Engineers, Feb. 4-6, 1919. Gift.

Anaconda Reduction Works, The. Anaconda Copper Mining Company, *Anaconda, Mont.,* Jan. 1919. Gift of Mr. Benj. B. Thayer of the Company.

Annuaire de la Houille Blanche Francaise. By M Auguste Pawlowski. 2nd year. *Paris, 1918-1919.* Gift.

Boston Transit Commission. 15th Annual Report for the year ending June 30, 109. Gift of Geo. F. Fowler.

Chlorine Control Apparatus. Wallace & Tiernan Co., Inc. *New York, 1919.* Gift of company.

Comptes-Rendus de l'Athénée Louisianais. Vol. 4, no. 3. Gift of Wm. Beer.

Comunicacoes da Comissao do Servico Geológico de Portugal. Tom. XII., 1917. *Lisboa.* Gift.

De Beers Consolidated Mines, Ltd. 30th Annual Report for year ending June 30, 1918. *Kimberley, So. Africa.* Gift of Company.

Dyeing with Coal Tar Dyestuffs. By C. M. Whittaker. Industrial Chemistry Series, edited by S. Rideal. *London, 1919.*

Suggested College Course on the Human Side of Engineering. By Industrial Service Movement, New York.

TRADE CATALOGS

Adam Hilger, Ltd., 75A Camden Road, London. N. W. 1. Abbe Refractometers, with water jacketed prisms. Oct. 1, 1918.
The Hilger Wavelength Spectrometer (Constant deviation type).
The nutting photometer. February, 1919.

American Steam Conveyor Corporation, 326 West Madison Street, New York. Modern Methods of Ash Disposal. 1919.

Armstrong Cork & Insulation Company, Pittsburgh, Pa. A Few Service Records.

The Bayone Casting Company, Bayonne, N. J. Monel Metal, for Superheated Steam. 1917. Nickels Castings.

Burt Manufacturing Company, Akron, Ohio. Oil filters, exhaust heads and ventilators. 1917.

Delta Star Electric Company, 2433 Fulton Street, Chicago, Ill. Bulletin No. 34. High Tension Outdoor Universal "Unit Type" Bus Bar and Wiring Supports. Jan. 1919.
Bulletin No. 302. Three-Phase Low Tension Equipment. Jan. 1919.
Addenda Bulletin No. 31A. Unit Type Indoor Bus Supports. Jan. 1919.

The Deister-Concentrator Company, Fort Wayne, Ind. No. 7 Deister-Overstrom Diagonal Deck Coal Washing Table.

The Esterline Company, Indianapolis, Ind. The Esterline Graphic. Power factor surveys.

The J. D. Fate Company, Plymouth, Ohio Catalog No. 4. Bulletin B. Plymouth Gasoline Locomotives.
Catalog 4. Bulletin H. Plymouth Gasoline Locomotives.

Flannery Bolt Company, Pittsburgh, Pa. Staybolts (A Bi-Monthly Digest). vol. 6, no. 5. Feb. 1919.

Ingersoll-Rand Company, 11 Broadway, New York. Equipment for Sugar Factory and Refinery Service.
Form No. 9010. March 1918. The "Sargeant" Ticket Cancelling Box.
Form 9026. June 1918. High Speed-Piston Valve Steam Engine Class "FP" Horizontal Center Crank Type.
Form No. 9123. January 1919. Imperial Tie Tamping Outfits.
Form 3137. Straight Line Dry Vacuum Pumps.
Form 4333. "Little Tugger" Hoists.
Form 4131. "Jackhamer."
Form 4042. "Jackamer Sinker."
Form 9123. "Imperial."
Form 3039. "Imperial Type Fourteen," Single Stage, Vertical Air Compressors for Belt Drive.
"Imperial" Duplex Dry Vacuum Pumps, Steam and Power Driven, Types "X," "XPV" and "XB."
Form 9026. High Speed, Piston Valve Steam Engine, Class "FP," Horizontal Center Crank Type.
Form 9120. Leyner Oil Furnace, No. 3.
Form 4037. Leyner "Jacksteel" Sharpener Model No. 33.
Form 8014. Drift Bolt Drivers, Types "CC-25" and "CC-251."
Form 3015-2. Electric Driven Portable Ai Compressors.
Form 9011. Air Reheaters.

The Jeffrey Mfg. Co., Columbus, Ohio. Catalog No. 245. The Jeffrey Type-A Shredder.
Jeffrey Belt Conveyers. Catalog No. 175.
The Jeffrey Pivoted Bucket Carrier. Catalo No. 210.
Jeffrey Bucket Elevators. Catalog No. 244.
Jeffrey Retarding Conveyers. Catalog No. 23

Klaxon Company, Industrial Division, New Yo City. Klaxon Products. Intercommunicati and Signal Equipment of Ships. Treati No. 1.

The Leeds & Northrup Company, 4901 Stent Avenue, Philadelphia, Pa. Checking Thern couple Pyrometers. Bulletin No. 867-B.

Locomotive Superheater Company, 30 Chu Street, New York City. Superheaters for S tionary Power Plants. Bulletin No. T1. 19

THE ENGINEERING INDEX

Published Monthly by The American Society of Mechanical Engineers

The Engineering Index was Founded in 1884 by the Association of Engineering Societies; Published from 1895 to 1919 by The Engineering Magazine Company; and Acquired January 1919 by The American Society of Mechanical Engineers

THE following pages form a descriptive Index to articles on engineering and related subjects in current periodicals. In its preparation the Society's engineering staff regularly examines all of the technical journals and society publications received by the Engineering Societies Library, which form one of the greatest and most complete collections of scientific periodicals in the world, comprising upward of 1100 distinct publications in some ten languages. Cross-references are freely introduced in the Index, and in all cases where the titles of articles are not sufficiently descriptive, explanatory sentences are appended. The main abbreviations used in the items are given at the bottom of this page.

PHOTOSTATIC COPIES OF ARTICLES LISTED

THE Society is prepared to supply photostatic copies (white printing on brown background) of any of the articles listed. Copies of the periodicals themselves, or clippings of articles, cannot be supplied.

Price of each print (up to 11 x 14 in. in size), 25 cents plus postage. A separate print is required for each page of the larger-size periodicals, but where possible two pages will be photographed together on the same print. Bill will be mailed with the prints.

Those holding coupon books for clippings formerly issued by The Engineering Magazine Company may use the coupons in payment for photostatic prints. In ordering, state plainly

(1) Page number of Index on which item appears
(2) Title of article
(3) Name of periodical.

Orders should be sent to

Harrison W. Craver, *Director,*
Engineering Societies Library,
29 West 39th Street, New York City.

DIVISIONS OF THE ENGINEERING INDEX

Note.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
New York (N. Y.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

Mechanical Engineering

AIR MACHINERY

Compressed-Air Applications

Compressed Air in the Manufacture of Concrete Pipe, D. W. C. Grove. Compressed Air Mag., vol. 24, no. 4, Apr. 1919, pp. 9104-9106, 1 fig. Filling and tamping forms with pneumatic rammer.

See also MECHANICAL. ENGINEERING, Lubrication (Compressors, Air).

CORROSION

Chemistry of Corrosion, Non-Ferrous Metals

Fourth Report to the Corrosion Committee of the Institute of Metals, Guy D. Bengough. Iron & Coal Trades Rev., vol. 98, no. 2665, Mar. 28, 1919, pp. 388-389. Nature of actions that take place when zinc, copper, aluminum, 70:30 brass, etc. corrode in neutral or nearly neutral liquids; behavior of condenser tubes in similar liquids, and variations in behavior in different samples of tubes of the same composition. Also in Min. Jl., vol. 124, no. 4362, Mar. 29, 1919, pp. 190-191. Also abstracted in Engineer, vol. 127, no. 3300, Mar. 28, 1919, pp. 300-301.

Rustproofing

Rustproofing Steel. Machy. (N. Y.), vol. 25, no. 8, Apr. 1919, pp. 736-737, 2 figs. Methods used in plant of Hudson Motor Car Co., Detroit, Mich., for rustproofing passenger-car steel bodies preparatory to painting by means of deoxidine process.

Parker Rustproofing Process, Edward K. Hammond. Machy. (N. Y.), vol. 25, no. 9, May 1919, pp. 851-854, 4 figs. Method which is said to be applicable to machine surfaces without changing their shape or size.

Ships

Corrosion of Ships. Am. Mar. Engr., vol. 13, no. 9, Sept. 1918, pp. 8-9. Manner of protection against corrosion. From Liverpool Jl. of Commerce.

FORGING

Dies

Obtaining Maximum Service from Dies, James C. Cran. Am. Drop Forger, vol. 5, no. 4, Apr. 1919, pp. 172-173 and p. 185. Electric steel recommended.

See also Hammer and Dies below.

Engine Cylinders

Operations on the Liberty Motor Cylinders—I, Fred H. Colvin. Am. Mach., vol. 50, no. 16, Apr. 17, 1919, pp. 757-758, 6 figs. Method of forging.

Hammer, Bement Steam

Forgings from Forty-Eight-Inch Ingots. Pac. Mar. Rev., vol. 16, no. 4, Apr. 1919, pp. 118-119, 2 figs. Double-arch Bement steam hammer said to be capable of delivering a blow of 150,000 lb.

Hammer and Dies

A Review of Hammer and Die Problems, R. C. Jennings. Am. Drop Forger, vol. 5, no. 4, Apr. 1919, pp. 180-182, 3 figs. Describes machine patented by writer and designed to use either American or English die blocks.

FOUNDRIES

Brass Foundry

Materials and Chemicals Used in Brass Foundry Practice—V, Charles Vickers. Brass World, vol. 15, no. 4, Apr. 1919, pp. 113-115, 2 figs. History, properties, appearance, physiological action and commercial use of substances commonly used in brass founding. Method for making phosphor-tin.

Crucibles

The Use and Abuse of Crucibles, A. C. Bowes. Min. & Sci. Press, vol. 118, no. 15, Apr. 12, 1919, pp. 505-506, 3 figs. Alleges that principal cause of failure of crucibles is lack of proper annealing; states that a temperature of 250 deg. fahr. is required to dispel moisture absorbed from atmosphere.

Engine Castings

Inland Plant Sets Record on Marine Engine Castings, D. M. Avey. Foundry, vol. 47, no. 5, Apr. 15, 1919, pp. 196-204, 23 figs. Rapid production of castings at plant of Hooven, Owen, Rentschler Co., builders of Corliss type engines; foundry said to have turned out heavy castings for a complete engine per day.

Malleable Castings

Malleable Plant to Revert to Destined Work. Foundry, vol. 47, no. 5, Apr. 15, 1919, pp. 221-224, 6 figs. General arrangement of Nat. Malleable Castings Co. foundry where cast-steel anchor chains are being manufactured. Plant was originally designed for production of malleable castings for automobile service and is being refitted to undertake this work.

Patterns

Patternmaking Methods—II, Joseph A. Shelly. Machy. (N. Y.), vol. 25, no. 8, Apr. 1919, pp. 722-726, 7 figs. Examples of pattern work and methods used in general pattern making practice.

Patterns and Moulds for Engine Cylinder Castings—I, Joseph Horner. Foundry Trade Jl., vol. 21, no. 206, Feb. 1919, pp. 90-94, 13 figs. Principles which control the various classes of work, by reason of the double practice of both patternshop and foundry.

Risers

Hot Water Practice in Relation to Risers—I, W. B. Gray. Metal Worker, vol. 91, no. 15, Apr. 11, 1919, pp. 455-456. Method of determining size.

Sand Blast

Application of the Sand-Blast to General Foundry Work, Parts I and 2, H. D. Gates. Pt. 1: Metal Trades, vol. 10, no. 4, Apr. 1919, pp. 172-175, 4 figs. Discusses general question of cleaning castings by sand blast and describes various types of hose machines. Pt. 2: Can. Foundryman, vol. 10, no. 4, Apr. 1919, pp. 90-94, 9 figs. Its applicability and advantages for general foundry work together with examples and data of what has actually been accomplished.

Standardization

Standardisation of Foundry Practice, S. W. Wise. Foundry Trade Jl., vol. 21, no. 206, Feb. 1919, pp 95-97. Records of operation of various cupolas and discussion of the possibility of standardizing cupola practice. Paper read before Newcastle Branch, British Foundrymen's Asso.

Steel Castings

Steel Castings from the Engineer's Viewpoint, H. A. Neel, Proc. Steel Treating Research Soc., vol. 2, no. 3, 1919, pp. 14-16 and 43-44 and (discussion) pp. 44-50. Developments in molding and metallurgical practice which have made it possible to use steel castings in operations formerly undertaken with forgings.

Manufacture of Steel Castings by Various Processes, David D. MacGuffie. Foundry Trade Jl., vol. 21, no. 206, Feb. 1919, pp. 85-89, 3 figs. Remarks on the crucible, Tropenas, Stock oil-fired converter, and electric-furnace processes. Paper read before British Foundrymen's Assn.

See also MARINE ENGINEERING, Yards (Castings); ELECTRICAL ENGINEERING, Furnaces (Crucibles).

FUELS AND FIRING

Ash

Fusibility of Ash from Coals Found in the Interior Province, W. A. Selvig, W. C. Ratliff and A. C. Fieldner. Coal Age, vol. 15, no. 16, Apr. 17, 1919, pp. 698-703. Table of softening temperatures of coal ash from coals of interior province obtained at Fuels Chemical Laboratory tests conducted by Bureau of Mines.

Coal, Lignite

Lignite Coals and Their Utilization, C. C. O'Harra. Pahasapa Quarterly, vol. 8, no. 2, Feb. 1919, pp. 15-35, 18 figs. Extent and estimated reserve of coal deposits of the world; developments in industrial recoveries of coal by-products.

Combustion Experiments with North Dakota Lignite, Henry Kreisinger, C. E. Augustine and W. C. Harpster. Dept. of Interior, Bur. of Mines, tech. paper 207, 44 pp., 13 figs. Tests were made by burning lignite—both as it comes from mine and as carbonized residue from gas retorts—at various rates in experimental furnaces and by studying process of combustion.

Coal, Pulverized

Pulverized Coal and Its Bearing on the Fuel Situation, H. G. Barnhurst. Manufacturers Rec., vol. 75, no. 16, Apr. 17, 1919, pp. 107-108. Table giving cost of preparing coal in plants of various capacities.

The Use of Pulverized California Coal, Chas. H. Delany. Jl. Electricity, vol. 42, no. 8, Apr. 15, 1919, pp. 357-359. Its substitution for fuel oil is discussed from standpoint of initial costs and comparative operating expense. Paper prepared for Spring Convention of Pac. Coast Section N. E. L. A. by Engineering Committee.

Pulverized Coal as the Reconstruction Fuel for all Industrial Heating Operations, C. F. Herrington. Iron & Steel of Can., vol. 2, no. 4, Apr. 1919, pp. 77-83, 4 figs. Equivalent prices of powdered coal and other fuel. Details of powdered-coal plant.

Coal, Southwestern

Burning Coals of the Southwest, W. M. Park. Power, vol. 49, no. 15, Apr. 15, 1919, pp. 574-575, 4 figs. Large furnace volumes, liberal grate area and unusual quantities of refractory material in the ignition arch and bridge wall, are advocated.

Coal, Storage of

Storage of Coal and Spontaneous Combustion. Ry. & Locomotive Eng., vol. 32, no. 4, Apr. 1919, pp. 99-100. Analysis of causes and approved methods of suppression.

Coal, Western

Western Coal, R. D. MacLaurin. Can. Chem. Jl., vol. 3, no. 4, Apr. 1919, pp. 124-125. Means taken by Government officials to stimulate development of these resources. (Concluding article.)

Draft

The Securing of Economy in the Burning of Fuel, J. F. Patton. Power House, vol. 13, no. 4, Apr. 5, 1919, pp. 94-95, 3 figs. Influence of draft on burning of coal; use of draft gages; importance of eliminating air leaks.

Firing

Utilization of Fuels in Industrial Furnaces (L'utilisation des combustibles dans les foyers industriels), Roger Hartmann. Société Industrielle de l'Est, Bul. 145, Feb. 1919, pp. 3-21, 3 figs. Theoretical study of economical combustion based on chemical phenomena of ignition; means suggested by the governments of England, America and France for efficient utilization of fuels.

Flue-Gas Analysis

Combustion and Flue Gas Analysis. Dept. of the Interior, Bur. of Mines, tech. paper 219, 12 pp., 6 figs. Recommends use of measuring instruments. Reprint of Eng. Bul. no. 4, prepared by United States Fuel Administration.

Fuel Conservation

National Saving of Fuel and Power, Arthur V. White. Can. Engr., vol. 36, no. 11, Mar. 13, 1919, pp. 299-303. Activities of Canadian Committee of Conservation.

Gas, Blast-Furnace

Fuel Economy (Economies de combustible dans une aciérie moderne). Métallurgie, vol. 51, no. 14, Apr. 2, 1919, pp. 777-778. Utilization of gases from blast furnaces. (Concluded.)

Gas and Oil Fuels

See Producer Gas, page 14-*a*; Items under INDUSTRIAL TECHNOLOGY; and Oil and Gas, under MINING ENGINEERING.

Grates

Recent Improvements in Sintering Equipment and Practice. Eng. & Min. Jl., vol. 107, no. 17, Apr. 26, 1919, pp. 744-745, 3 figs. Device intended to prevent grates from getting dirty. Designed for use with the straight-slot type of grate.

Oil Firing

Saving the Waste in the Chimney—V, Robert Sibley and Chas. H. Delany. Jl Electricity, vol. 42, no. 7, Apr. 1, 1919, pp. 318-320, 7 figs. Operating test of steam power plant operated by fuel oil in San Francisco.

Peat

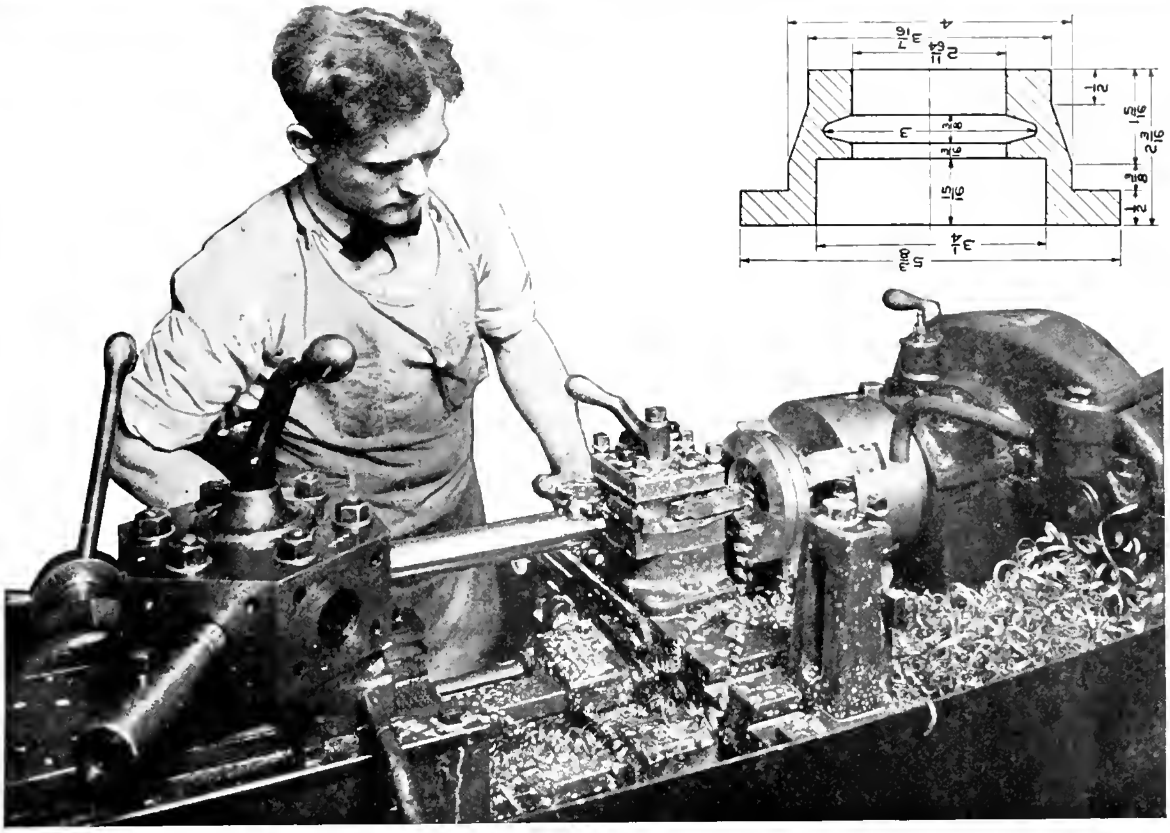
The Utilisation of Peat for Power Generation—I & II, John B. C. Kershaw. Engineer, vol. 127, nos. 3298 & 3299, Mar. 14 and 21, 1919, pp. 239-240 and 265-267, 11 figs. Processes for carbonizing followed at various plants in France, Sweden and Germany.

See also MECHANICAL ENGINEERING Motor-Car Engineering (Benzol, Kerosene).

FURNACES

Davis Furnace for Baking Electrodes

Davis Furnace for Baking Electrodes (Four Davis à cuire les électrodes). Revue Généra de l'Electricité, vol. 5, no. 12, Mar. 22, 191 p. 458. Installed at Hecla works of Diamor Foundry, Luton, England, where, it is sai



Value of the Square Turret

THIS shows the amount of material removed and how well the many operations on these tough power sprocket clutches were finished on the No. 4 Universal Screw Machine. The hexagon turret was used only for boring. The square turret, loaded to capacity with cutters, did the rest with the aid of its eight power cross and longitudinal feeds.

For Work Too Complicated for Ordinary Screw Machines

The special features of the No. 4 Universal (in this case the unusual use for the square turret) adapt them to a wide range of work too complicated for ordinary screw machines or turret lathes

SEND FOR DETAILS
Turret Lathes and Screw Machines
from 5/8 in. x 4 in. to 4½ in. x 44 in., Maximum Swing 21½ in.

THE WARNER & SWASEY COMPANY

CLEVELAND, OHIO, U. S. A.

NEW YORK Office—Singer Building. **Boston Office**—Oliver Building **Buffalo Office**—Iroquois Building. **Detroit Office**—Ford Building. **Chicago Office and Show Rooms**—618-622 Washington Blvd. **FOREIGN AGENTS:** Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. Allied Machinery Company, Paris and Turin. Van Rietschoten & Houwens, Rotterdam. Yamatake & Co., Tokio. Benson Brothers, Sydney and Melbourne. A. Asher Smith, Sydney. A. R. Williams Machinery Co., Ltd., Toronto, St. John, Winnipeg and Vancouver. Williams & Wilson, Ltd., Montreal.

30,000 tons of electric steel are produced per year at average consumption of 11 lbs. of electrode per ton of steel.

Gas Furnaces

Heating Gas Furnaces, O. L. Kowalke. Gas Rec., vol. 15, no. 7, Apr. 9, 1919, pp. 231-234, 6 figs. Tests to determine maximum temperature which can be obtained in a given furnace, using three types of mixers with regulated and unregulated air supply, by burning carbureted water gas in bunsen flame and also under adapted surface combustion conditions. Paper before Wis. Gas Assn.

Gas Furnaces as Re-Heaters of Iron Piles, etc. Iron & Coal Trades Rev., vol. 98, no. 2664, Mar. 21, 1919, p. 354. Function gas furnace has to perform in smelting steel and in reheating iron.

Heat-Treating Furnaces

Heating Furnaces and Annealing Furnaces—III, W. Trinks. Am. Drop Forger, vol. 5, no. 4, Apr. 1919, pp. 174-180, 8 figs. Method of computing fuel consumption from losses.

The Design of Heating Furnaces from a Practical Standpoint, George J. Hagan. Proc. Engs. Soc. Western Pa., vol. 35, no. 1, Feb. 1919, pp. 31-47 and (discussion) pp. 48-57, 5 figs. On design and method of construction, with reference to furnaces used in sheet and tin-plate industry and to a continuous rotary furnace for wash and heat.

Melting Furnaces

Metallurgical Furnaces, Adolph Bregman. Metal Indus., vol. 17, no. 4, Apr. 1919, pp. 159-162, 7 figs. Conditions that govern size, shape and type of metal-melting furnaces.

See also ELECTRICAL ENGINEERING, *Furnaces.*

GAGES

Hoke Precision Gages

Manufacture of Hoke Precision Gages at the Bureau of Standards, H. L. van Keuren. Am. Machinist, vol. 50, no. 14, Apr. 3, 1919, pp. 625-630, 6 figs. Gage blocks are being produced at the Bureau with an accuracy limit of a few millionths of an inch. Apparatus used in testing flatness and parallelism to one millionth of an inch. Development of process for their commercial manufacture has taken place within period of 6 months. Special reference is made to light-weight interference method for determining accuracy.

Johanssen Tolerances

Johanssen System of Tolerances. Machinery, vol. 13, no. 339, Mar. 27, 1919, pp. 718-719, 1 fig. On Swedish system based on diameter of hole.

Measurement of Gages

The Measurement of Gauges—I & II, E. A. Forward. Engineer, vol. 127, nos. 3300 & 3299, Mar. 21 and 28, 1919, pp. 282-283 and 294-295, 24 figs. Methods used for measuring three classes of gages: (1) plate or form gages the profiles of which are combinations of straight lines and curves; (2) conical plugs, rings and disks, combinations of cones with cylinders and planes, and castellation gages; (3) position gages.

Plug Gages, Angular

Angular Plug-Gage Making, Hugo Pusep. Am. Machinist, vol. 50, no. 14, Apr. 3, 1919, pp. 635-640, 15 figs. Lays emphasis on elimination of errors in preliminary operation, in order to prevent their accumulation and the appearance of serious defects which will be difficult to eliminate in later operations.

GAS ENGINEERING

Distributing Systems

Increasing Capacity of Low-Pressure Mains by Admitting Gas at More Than One Point, A. C. Howard. Am. Gas Eng. Jl., vol. 110, no. 16, Apr. 19, 1919, pp. 329-331. Using an artificial gas distributing system for natural gas. From Gas & Elec. News.

Flow of Gas

Flow of Gases Under Heavy Pressure (Sur l'écoulement des gaz à tres fortes pressions), A. Rateau. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 7, Feb. 17, 1919, pp. 330-335. Changes in gas equation to make it applicable to the flow of gases in guns.

Lighting

The Group and Duct System of Lighting. Gas World, vol. 70, no. 1810, Mar. 29, 1919, pp. 237-239, 3 figs. Also in Gas Jl., vol. 146, no. 2916, Apr. 1, 1919, pp. 30-32, 3 figs. System is designed to utilize one injector for supplying any number of burners, in place of each individual burner having gas injector and air intake. There are three separate sets of types—one supplying high-pressure gas, one carrying air to an injector for mixing with the gas, and one supplying mixture of gas and air from injector to burners.

Mantles, Gas

Influence of Quality of Gas on the Efficiency of the Gas Mantle, Pts. 2 and 3, R. S. McBride, W. A. Dunkley, E. C. Crittenden and A. H. Taylor. Gas World, vol. 70, nos. 1805 and 1810, Feb. 22 and Mar. 29, 1919, pp. 128-130 and 233-236, 10 figs. Pt. 2: Graphs showing effect of gas-pressure variations upon efficiency, gas consumption and candlepower of various lamps. Pt. 3: Lean water gas reported to have shown qualities for mantle lighting superior to those of rich water gas in proportion to total heating values. Section 1 appears in Gas World for Feb. 8.

Production, Gas

Distribution of Light, Heat, and Motive Power by Gas, Dugald Clerk. Gas Journal, vol. 145, no. 2915, Mar. 25, 1919, pp. 637-640 and (discussion) pp. 640-642; also Gas World, vol. 70, no. 1809, Mar. 22, 1919, pp. 210-212. Efficiency of gas production compared with efficiency of electricity generation. Claim to electric superiority over gas in coal economy considered as unjustified. Thermal efficiency of carbonizing gas coal in horizontal retorts. Paper read before Roy. Soc. of Arts.

Purification, Oil Gas

Liquid Purification of Gas, O. B. Evans. Gas Rec., vol. 15, no. 7, Apr. 9, 1919, pp. 215-216. Concluded from tests of Atlantic Refining Co. that cold liquid purification of oil gas may result in a loss of 25 per cent in candle power. Paper before Am. Gas Assn.

Principles of Gas Purification and Purifier Design, F. W. Steere. Gas Age, vol. 43, no. 7, Apr. 1, 1919, pp. 361-363, 2 figs. Review of methods and suggestions regarding improvements in apparatus employed in removing sulphur from gas. (Concluded.)

Water Gas

Gas Machine Factors Involved in the Manufacture of Carbureted Water Gas. Am. Gas Eng. Jl., vol. 110, no. 15, Apr. 12, 1919, pp. 312-316 and 320-324. Fundamentals upon which process is dependent and suggestions toward locating cause of variations in results.

HANDLING OF MATERIALS

Car Dumper

The Biggest Car Dumper in the World. Sci. Am., vol. 120, no. 15, Apr. 12, 1919, pp. 363 and 382, 4 figs. Virginian Ry. installation designed to handle two 60-ton cars simultaneously; cars are tipped sidewise.

Ship Loading

Radical Departure in Loading Ocean Freighters. Ry. Age, vol. 66, no. 16, Apr. 18, 1919, pp. 981-984, 7 figs. Reported that Erie R. R. utilizes existing equipment in handling 50 locomotives direct from pier to ship.

HEAT-TREATING

Brass

Effects of Heat when Annealing Alloys, H. C. H. Carpenter and L. Traverner. Am. Drop Forger, vol. 5, no. 4, Apr. 1919, pp. 193-196, 2 figs. Chart showing ultimate stress after heating various metals, also time required to cause drop of three points in scleroscope hardness in a brass strip. Paper presented before Inst. Metals London.

Bronze

Results of Heat-Treating Bronze Castings, George F. Comstock. Foundry, vol. 47, no. 5, Apr. 15, 1919, pp. 189-194, 18 figs. Effects of annealing bronze-alloy castings studied with the aid of photomicrographs of test sections.

Case-Hardening

The Application of Heat in Case-Hardening, Theodore G. Selleck. Jl. Am. Steel Treaters Soc., vol. 1, no. 3, Dec. 1918, pp. 87-98, 11 figs. Value of laboratory reports of analysis and specifications under which material was shipped from manufacturer, as a source of information for determining nature and quality of material to be treated.

Case-Hardening of Carbon Steels (Mécanisme de la trempe des aciers au carbone), Pierre Chevenard. Revue de Métallurgie, vol. 16, no. 1, Jan.-Feb. 1919, pp. 17-79, 36 figs. Results of micrographic analysis and tests have caused writer to establish that case-hardening results from transformation at low temperatures (150 to 300 deg. cent.) γ-α of austenite; when hardening is complete, steel is made up almost exclusively of martensite. Thus the theory announced by Le Chatelier in 1895 appears to have been confirmed.

Notes on the Process of Case-Hardening, J. R. Handforth. Can. Machy., vol. 21, no. 12, Mar. 20, 1919, pp. 277-280, 10 figs. Photomicrographs of structures produced by case-hardening. From Machine Tool Rev.

Improved Packing Methods for Carburizing, William H. Addis. Am. Mach., vol. 50, no. 15, Apr. 10, 1919, pp. 679-680, 3 figs. Two methods for spacing pieces.

Steel, Low-Carbon

Heat-Treatment of Low-Carbon Steel, W. M. Wilkie. Can. Machy., vol. 21, no. 17, Apr. 24, 1919, pp. 396-401, 12 figs. Characteristic structures found in steel, their formation by heat treatment and effect each has in quality of steel. Paper read before Toronto Section Am. Soc. Mech. Engrs.

Steel, Tool

Heat Treatment of Tool Steel, S. N. Brayshaw. Ironmonger, vol. 167, no. 2369, Apr. 12, 1919. Believes that precision can only be attained by makers and users of steel by carrying out heat treatments in liquids instead of in atmospheric furnaces. Paper read before Birmingham Metallurgical Soc.

See also MECHANICAL ENGINEERING, *Furnaces (Heat-Treating Furnaces).*

HEATING AND VENTILATION

Hot-Water Heating

Designing Data as Applied to a Large Hot-Water Heating Plant, George E. Reed. Heat & Vent. Mag., vol. 16, no. 4, Apr. 1919, pp. 26-34, 13 figs. Western practice, illustrated in layout for Franklin High School, Portland, Ore. (Concluded.)

Industrial Heating

Saving Steam in Industrial Heating Systems. Dept. of the Interior, Bur. of Mines, tech. paper 221, 14 pp., 7 figs. Calls attention to faults of design and operation which lead to uneconomical use of live steam for heating and other purposes. Reprint of Eng. Bul. no. 6, prepared by U. S. Fuel Administration.

Steam Flow

Simplifying Calculations for Flow of Steam in Pipes. Heat. & Vent. Mag., vol. 16, no. 4, Apr. 1919, pp. 19-26, 3 figs. Curves based on generally acepted formulæ.

Tunnel, Simplon

The Ventilation Plant of the Simplon Tunnel (Die Ventilationsanlage des Simplon-Tunnels), F. Rothpletz. Schweizerische Bauzeitung, vol. 73, nos. 1, 2, 5 and 7, Jan. 4, 11 and Feb. 1, 15, 1919, pp. 3-4, 14-16, 41-44 and 72, 20 figs. Instead of two fans, one at each entrance, 1913 project provided for one ventilation plant at Brig with two 11½-ft. fans with central suction openings 8.5 ft. in diameter. Arrangement of plant and details of operation of fans as worked out from study of barometric conditions and past experience are mentioned.

HOISTING AND CONVEYING

Conveyor, Cinder

New Type of Cinder Conveyor. Ry. Age, vol. 66, no. 16, Apr. 18, 1919, p. 1017, 1 fig. Conveyor discharges cinders through pipe line by action of steam jet.

Conveyors, Power Requirements of

Power Plant Management; Coal and Ash Handling—II, Robert June. Power House, vol. 13, no. 4, Apr. 5, 1919, pp. 87-89, 4 figs. Power required for various types of conveyors and conditions under which these are operated.

Conveyor, Scoop

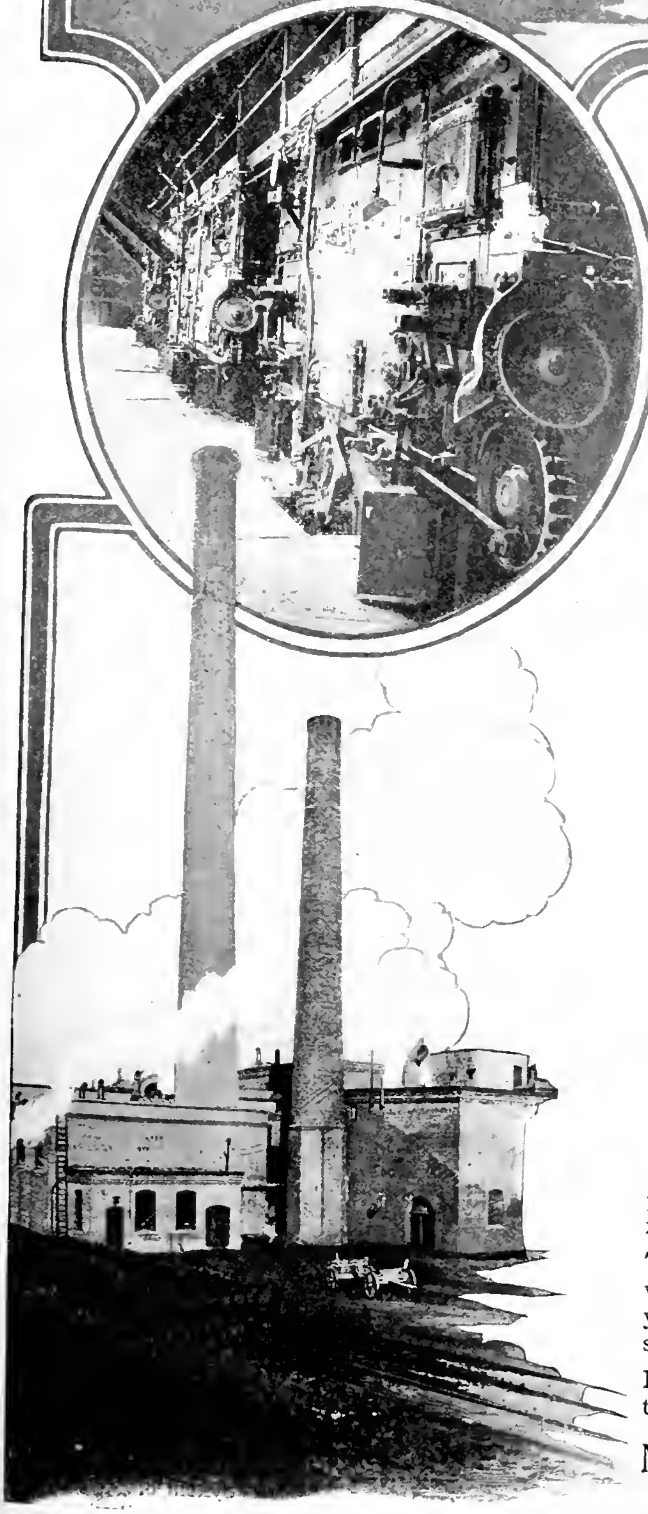
A New Type of Conveyor that Reduces the Cost of Handling Coal, Coke, Ashes, Sand, Etc. Popular Engr., vol. 11, no. 4, Apr. 1919, pp. 22-23, 6 figs., also Cement & Eng. News, vol. 31, no. 4, Apr. 1919, pp. 42-44, 7 figs. Distinctive feature is scoop on feeding end, which can be pushed or completely buried into material to be conveyed. Conveyor is equipped with a 16-inch belt and driven by 2-hp. electric motor.

A New Portable Elevator. Coal Trade Jl. vol. 50, no. 16, Apr. 16, 1919, pp. 410-411, 5 figs. Elevator has scoop on feeding end which can be pushed or completely buried into the material to be conveyed.

Cranes

Lifting Cranes in Shipbuilding Yards (Les appareils de levage dans les chantiers de constructions navales). Génie Civil, vol. 74, no. 14, Apr. 5, 1919, pp. 265-268, 8 figs. The construction and location as affecting economical and rapid transportation of material. Examples of installations in English yards.

Down in Maine



Paper Mill Plants are often tucked away in the neck of the woods. The very nature of the business places this industry nearest its source of supply.

Because of their isolation, paper mills must have equipment of unfailing reliability—good equipment upon which they can depend—such equipment as:

MURPHY AUTOMATIC FURNACES

At the Orono Pulp and Paper Company four boilers are fired by Murphy Furnaces. For every pound of paper produced these automatic stokers use the minimum of fuel—it makes little difference what the fuel is—because Murphy Furnaces "burn anything that has heat in it."

As for labor saving, Murphy Furnaces keep on operating continuously without a man in sight.

Contrast the cleanliness—the efficiency—the economy—of this or any Murphy plant with plants using the old methods of stoking.

Remember this! Just as Murphy Furnaces have forged ahead in the Paper Mill industry from 1 to 113 installations, so have they in the Chemical, Metallurgical, Textile, Steel, Automobile, Industrial, Central, Electric R. R. and Hospital.

In fact, wherever coal is used to furnish light, heat or power—wherever the service is the hardest—there you will find Murphy Automatic Furnaces.

The country is so completely dotted with installations that we can direct you to plants in your vicinity who will tell you their experiences and what Murphy Furnaces have saved for them in money, men and fuel.

If your boilers are 50 H. P. or larger you should write us today. Catalog A-6 sent on request.

MURPHY IRON WORKS, Detroit, Mich.

BURNS ANY FUEL THAT HAS HEAT IN IT

Luffing Cranes. Eng. World, vol. 14, no. 7, Apr. 1, 1919, pp. 55-57, 4 figs. Description of Toplis crane used in an English shipyard.

See also MINING ENGINEERING, Mines and Mining (Hoisting Machinery); MARINE ENGINEERING.

HYDRAULIC MACHINERY

Backwater

New Methods for the Solution of Backwater Problems, H. R. Leach. Eng. News Rec., vol. 82, no. 16, Apr. 17, 1919, pp. 768-770, 6 figs. Suggestions in regard to simplifying reduction of complications by using diagram with only one major variable.

Bernoulli's Formula

On Bernoulli's Formula (Sur la formule de Bernoulli), Emile Cotton. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 11, Mar. 17, 1919, pp. 547-549. Modification by taking into account actual conditions of motions of natural liquid in tube of finite section.

Conduit Protection

Devices for Regulating Automatically the Delivery of a Pressure Conduit (Appareils automatiques d'arrêt du débit des conduites forcées), N. de Schoulepnikow. Bulletin Technique de la Suisse Romande, vol. 45, no. 7, Apr. 5, 1919, pp. 57-59, 3 figs. Bouchayer-Viallet syphon.

Drops

Flow of Liquid Drops Through Cylindrical Pipes (Sur les lois de l'écoulement des liquides par gouttes dans des tubes cylindriques), L. Abonnenc. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 11, Mar. 17, 1919, pp. 556-557. Experimental confirmation of formula developed by Vaillant, in which time between consecutive drops is a parabolic function of weight of drop.

Flood Protection

Panels of Movable Weir Collapse Automatically. Eng. News-Rec., vol. 82, no. 17, Apr. 24, 1919, pp. 818-820, 5 figs. Details of automatic tripping control operated by float in chamber which is filled as flood rises.

Flow

On the Flow of Fluids (Sur l'écoulement des fluides), L. Lecornu. Comptes rendus des séances de l'académie des Sciences, vol. 168, no. 10, Mar. 10, 1919, pp. 481-484. Velocity of fluid in a conduit of variable cross-section.

Ram, Hydraulic

The Hydraulic Ram. Fire & Water Eng., vol. 65, no. 16, Apr. 16, 1919, pp. 873-875, 2 figs. Principle of operation and discussion of its possibilities for small-town installations.

The Hydraulic Ram, W. S. H. Cleghorne. South African Jl. Industries, vol. 2, no. 2, Feb. 1919, pp 135-142, 6 figs. Principles of action and conditions necessary for successful operation.

Turbines

Economical Operation of Water Turbines, F. H. Rogers. Elec. World, vol. 73, no. 14, Apr. 5, 1919, pp. 680-683, 7 figs. Value of principal losses that may occur and methods of locating their origin; inquiry into effect of losses on output.

Water Economy

Water Economy in Hydroelectric Plants, L. W. Wess. Elec. World, vol. 73, no. 15, Apr. 12, 1919, pp. 727-728, 1 fig. Claims that output of plant is increased by allowing excess water to run off at night.

Water Hammer

Water Hammer in Conduits of Variable Diameter (Sur les coups de bélier dans les conduites de diamètre variable), G. Guillaumin. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 12, Mar. 24, 1919, pp. 605-608. Theory based on assumption that water travels at uniform speed.

INTERNAL-COMBUSTION ENGINES

Acetylene

Acetylene Motors, C. F. Keel. Acetylene & Welding Jl., vol. 16, no. 186, Mar. 1919, pp. 48-49. General summary of actual position in regard to developments accomplished during war in utilization of acetylene as a motor fuel. (To be continued.) Translated from paper published by Swiss Acetylene Assn.

Bore-Stroke Ratio

The Problem of Bore-Stroke Ratio, Georges Funck. Autocar, vol. 42, no. 1225, Apr. 12, 1919, pp. 528-532, 4 figs. Study of bore-stroke ratio as dependent on number of cylinders, their disposition and system of cooling, and for the purpose for which engine is intended to be used.

Compound Gas Engines

Expansion, Robert Miller. Motor Boat, vol. 16, no. 8, Apr. 25, 1919, pp. 21-24, 5 figs. Possible increase in efficiency of internal-combustion engine by increasing expansion, with reference to compound gas engine with two jacketed high-pressure cylinders each discharging into a low-pressure unjacketed cylinder.

Design

A Comparison of Airplane and Automobile Engines, Howard C. Marmon. Jl. Soc. Automotive Engrs., vol. 4, no. 4, Apr. 1919, pp. 237-239. Deals particularly with weight in cylinder construction, design of crankshaft and crankcases and economy in fuel and oil consumption.

Diesel-Engine Pistons, Seizure of

Seizures of Diesel Engine Pistons, Edward Ingham. Electrical Review, vol. 84, no. 2160, Apr. 18, 1919, pp. 451-452. Seizures are attributed to overheating of piston and resulting expansion of metal, consequently proper lubrication and cooling of piston are advised.

Fuels

More Efficient Utilization of Fuel, Charles F. Kettering. Jl. Soc. Automotive Engrs., vol. 4, no. 4, Apr. 1919, pp. 263-269, 10 figs. Distillation curves of various internal-combustion engine fuels; specific gravity fuels. Conclusions obtained from examination of causes which produce cylinder knocks.

An Interpretation of the Engine-Fuel Situation, Joseph E. Pogue. Jl. Soc. Automotive Engrs., vol. 4, no. 4, Apr. 1919, pp. 247-252 and (discussion) pp. 252-255, 3 figs. Future of automotive industry is represented as depending on three factors: adaptability of "internal-combustion" engines to use of liquid fuel, supply of crude petroleum, and production of substitute fuel.

Fuel Economy of Automotive Engines, H. C. Dickinson. Jl. Soc. Automotive Engrs., vol. 4, no. 4, Apr. 1919, pp. 227-233, 6 figs. Properties of fuels which are subject to specification test are examined and trend of future development in utilization of new fuels of internal-combustion engines is discussed from viewpoint of expediency in adopting single fuel for all automotive engines.

Gas Engines, High-Power

High-Power Gas Engines, William Stead. Gas and Oil Power, vol. 14, no. 163, Apr. 3, 1919, pp. 93-96. Part large gas engine may play in state control scheme of electric power generation for power and light supply.

Motorcycle

The Engine of the Side Car Motorcycle—II, E. Cauldwell. Automotive Industries, vol. 40, no. 17, Apr. 24, 1919, pp. 911-913, 6 figs. Lift, velocity and acceleration curves for 3000 r. p. m. of crankshaft; lubrication features of 4-cyl. Henderson engine. Paper presented to Instn. Automobile Engrs.

Oil Engines

The Oil Engine—Its Economic Position in the Marine Field, Theodore Lucas. Pac. Mar. Rev., vol. 16, no. 4, Apr. 1919, pp. 93-98, 3 figs. Advantage of liquid-fuel engines over steam engines is said to consist in reduction of cost and adding to useful carrying capacity of ship. Comparison of methods of mechanical atomization with reference to arrangement of Lucas engine.

The High-Compression Oil Engine, W. G. Gernandt. Gas Engine, vol. 21, no. 5, May 1919, pp. 155-161, 3 figs. Comparison of various methods of injecting liquid fuel into combustion chamber of engine. Opinion is expressed that high-compression type of engine is suitable for burning of heavy fuel oils.

Pressed-Steel Engines

Pressed Steel Engines. Autocar, vol. 42, no. 1225, Apr. 12, 1919, pp. 537-538, 5 figs. Process for stamping from steel sheets main parts and various details of engines.

Ricardo Tank Engines

The 150 H. P. Ricardo Tank Engine, H. A. Hetherington. Automobile Engr., vol. 9, no. 125, Apr. 1919, pp. 116-120, 5 figs. Details of piston, valve and valve gear. (To be continued).

Wisconsin Engines

Liberty Line of Wisconsin Engines. Automotive Industries, vol. 40, no. 15, Apr. 10, 1919, pp. 796-798, 4 figs. Principal characteristics include unit power-plant design, aluminum crankcases, pressure lubrication and "all steel" three-point support.

See also ELECTRICAL ENGINEERING, Ignition Apparatus; MECHANICAL ENGINEERING, Motor-Car Engineering.

LUBRICATION

Compressors, Air

Lubrication of Air Compressors, H. V. Conrad. Coal Age, vol. 15, no. 16, Apr. 17, 1919, pp. 704-706, 1 fig. Discusses rate of feed and carbon-cutting methods and concludes with remarks on steam-engine lubrication.

Journal Boxes

Lubrication and Care of Journal Boxes, M. J. O'Connor. Ry. Rev., vol. 64, no. 17, Apr. 26, 1919, pp. 620-621. Directions for preparing oil and waste for packing journal boxes; reclaiming old packing removed from cars; inspection of cars so that lubricating trouble may be kept down to a minimum.

Lubricants

Lubricants for the Power Plant, Reginald Trautschold. Power Plant Eng., vol. 23, no. 8, Apr. 15, 1919, pp. 353-358, 3 figs. Qualities of a good oil; tests of grade of oil and grades for various uses.

Properties of Representative American Lubricating Oils for Use in Internal Combustion Engines. Aerial Age, vol. 9, no. 6, Apr. 21, 1919, p. 289. Table showing physical properties and percentage of distillation under 300 deg. cent. in vacuum.

See also ELECTRICAL ENGINEERING, Generators and Motors (Lubrication); MECHANICAL ENGINEERING, Motor-Car Engineering (Lubrication).

MACHINE ELEMENTS AND DESIGN

Belting

Fiber Belting (Zellstoff-Treibriemen), E. O. Rasser. Kunststoffe, vol. 8, no. 11, June 1, 1918, pp. 122-125. Describes various types such as woven paper belting, paper belting with cloth filler, paper-yarn belting, knitted paper-yarn belting, plaited belting, paper-yarn belting with wire filler, and the processes of their manufacture. Also type of joints and care of this type of belting.

Gears

Gears for Tractor Construction, E. J. Forst. Automotive Industries, vol. 40, no. 17, Apr. 24, 1919, pp. 891-892. Importance of using high-grade steel on account of resulting compactness of transmission and greater facility of enclosing it.

Worm Gear Efficiency, C. H. Calkins. Automotive Industries, vol. 40, no. 15, Apr. 10, 1919, pp 786-787, 2 figs. Bausch company's worm-wheel testing stand for determining efficiency of worm-and-wheel rear-axle drives.

Worms and Worm Gears, G. W. Carlson. Am. Mach. vol. 50, no. 17, Apr. 24, 1919, pp. 809-811. Application of this form of gearing is suggested for other purposes than automotive drives.

Gears, Magnetic

Magnetic Gears (Engrenages magnétiques), Leópold Reverchon. Industrie Electrique, vol. 28, no. 643, Apr. 10, 1919, pp. 133-135, 4 figs. Escapement wheel rotated by alternative actions of a fixed magnet on one side and a magnet attached to an oscillating pendulum on the other upon magnetic needles placed in periphery of wheel symmetrically with respect to its center.

Joints

The Design of Riveted Butt Joints, Alphonse A. Adler. Mech. Eng., vol. 41, no. 5, May 1919, pp. 433-436. Design equations derived from Schwedler's graphical method.

See also AERONAUTICS, Engines (Crankshafts).

MACHINE SHOP

Babbitting

Babbitting High-Speed Vertical Spindles, Stanley White. Wood-Worker, vol. 38, no. 2, Apr. 1919, pp. 42-43. Cautions against pouring metal before aligning spindle.

Boring, Dudgeon System of

Dudgeon System of Precision Boring. Machy. (N. Y.), vol. 25, no. 9, May 1919, pp. 803-805, 7 figs. Method of boring jigs and similar work by means of simple equipment and without depending upon accuracy of machine used for operating boring bar.

Crankshaft Machining

Crankshaft Machining. Automobile Engr., vol. 9, no. 122, Jan. 1919, pp. 10-12, 11 figs.

Equipment manufactured by Le Blond Co., Cincinnati.

Cylinder Machining

Cylinder Boring and Reaming—I & II. Machinery, vol. 13, nos. 338 & 339, Mar. 20 and 27, 1919, pp. 681-689 and 713-717, 26 figs. Classification of methods, their application to different kinds of work, and illustrations of actual operations. Description of tools, fixtures and machines used.

Cylinder Grinding—II, Franklin D. Jones. Machy. (N. Y.), vol. 25, no. 8, Apr. 1919, pp. 711-715, 11 figs. On advantages of finishing cylinder bores by grinding; machines used; practice in plants making automobile and airplane engines.

Equipment Layout

Arrangement of Equipment in Shops, James Forrest. Am. Mach., vol. 50, no. 15, Apr. 10, 1919, pp. 699-701. Straight-line and contract-shop layout problems contrasted and cardboard models suggested.

Jigs and Tools

Jig and Tool Design—II, G. H. Hey. Machinery, vol. 13, no. 338, Mar. 20, 1919, pp. 704-708, 7 figs. Method of using drills and reamers in multispindle machine; standard wall handles, knurled nuts and index plungers.

Microscope

The Microscope in the Tool-room, John Scott. Machy. (N. Y.), vol. 25, no. 9, May 1919, pp. 799-802, 6 figs. Its application to precision work on master plates and for cutting screw threads.

Milling

Continuous Rotary Milling—I & II, Edward K. Hammond. Machy. (N. Y.), vol. 25, nos. 8 and 9, Apr. and May 1919, pp. 687-694 and 842-846, 24 figs. Types of milling machines that operate without interruption; work-holding fixtures and methods of setting up parts to be milled.

Motors

Planning Efficient Motor Drives and Connections, G. B. Howe. Wood-Worker, vol. 38, no. 2, Apr. 1919, pp. 34-35, 6 figs. Examples of individual motor drive arrangements in wood-working plants.

Methods of Mounting Motors on Ceilings, Ralph G. Bradshaw. Can. Machy., vol. 21, no. 16, Apr. 17, 1919, pp. 373-375, 10 figs. Practice followed at various shops.

See also MECHANICAL ENGINEERING, Standards and Standardization (Standardized Parts Production).

MACHINERY, METAL-WORKING

Boring Heads

Tools for Boring Closed-Bottom Work. Machinery, vol. 13, no. 339, Mar. 27, 1919, pp. 735-736, 6 figs. Types of blades used in boring heads and methods of grinding and setting the blades.

Chuck, Spillman Automatic

Spillman Automatic Chuck (Mandrin à centrage automatique système H. Spillman). Génie Civil, vol. 74, no. 13, Mar. 29, 1919, pp. 251-254, 5 figs. Description of instrument; characteristic curves determined from measurements effected during actual performance.

Cylinder-Boring Machine

Quadruplex Cylinder Boring Machine. Engineering, vol. 107, no. 2779, Apr. 4, 1919, pp. 432-434, 7 figs. Model after French enclosed type.

Cylinder Boring and Reaming Fixtures, Franklin D. Jones. Machy. (N. Y.), vol. 25, no. 9, May 1919, pp. 822-825, 11 figs. Designs of fixtures for locating and holding automobile engine cylinder castings during the boring and reaming operations.

Jigs

Jigs, Tools, etc., for the Production of Standardized Parts, Herbert C. Armitage. Engineer, vol. 127, no. 3300, Mar. 28, 1919, pp. 309-310, 1 fig., also Iron & Coal Trades Rev., vol. 98, no. 2665, Mar. 28, 1919, pp. 378-379, 2 figs., and Engineering, vol. 107, no. 2779, Apr. 4, 1919, pp. 434-437, 8 figs. Advantages derived by use of jigs and tools are claimed to be: interchangeability of work; cheapening of production; ability to use less skilled class of labor on manufacturing work. Effect of war conditions on engineering practice; curves showing relation between output and cost of components. Scheme for milling both ends of twenty connecting rods per hour.

Lathes

Italian Lathe for Gun Turning (Di un tornio Italiano per la lavorazione di pezzi d'artiglieria), Augusto de Marchi. Industria, vol. 33, no. 5, Mar. 15, 1919, pp. 136-143, 26 figs. Description of lathe specially designed for accurate work. Reference is made to tolerances permitted in manufacture of artillery parts.

Planers

Cincinnati Open-Side Planing Machines. Am. Mach., vol. 50, no. 16, Apr. 17, 1919, pp. 725-728, 6 figs. Among the points of interest cited are power rapid traverse for rail heads, box-type table, forced lubrication of the V's, patent "tu-speed" drive on 36-in. and 48-in. machines, quick-reverse aluminum pulleys and extra capacity table.

A Combination Machine Tool. Iron Age, vol. 103, no. 16, Apr. 17, 1919, pp. 1001-1003, 6 figs. Planer equipped with tool head and accessory parts designed for performing fundamental machining operations.

Thread-Cutting Machine

Thread-Cutting and Spindle-Boring Tools, J. H. Moore. Can. Machy., vol. 21, no. 16, Apr. 17, 1919, pp. 371-732, 4 figs. Description of standard lathe for precision thread cutting.

Tools, Forming

Tools for Automatic Machines, H. E. Thomas. Machinery, vol. 14, no. 340, Apr. 3, 1919, pp. 16-18, 13 figs. Types of forming tools; diagrams for determining diameter of forming tools. Read before Manchester Assn. of Engrs.

See also MECHANICAL ENGINEERING, Machine Shop (Gages and Tools).

MACHINERY, SPECIAL

Balancing Machines

Dynamic and Static Balancing. Machinery, vol. 14, no. 341, Apr. 10, 1919, pp. 40-44, 12 figs. Machines for balancing high-speed pulleys; aeroplane propeller static balancing machine; combination static balancing and drilling machine; "umbrella" type of balancing fixture. Second article.

Clutches

Automatic Clutch Design, M. H. Sabine. Machinery, vol. 14, no. 340, Apr. 3, 1919, pp. 1-5, 7 figs. Designed for controlling power unit from distant position. Clutch is electromechanically operated.

Designs

Developing Designs for Machinery and Tools. Machinery, vol. 13, no. 338, Mar. 20, 1919, pp. 690-691, 5 figs. Example of design evolution of two-wheel construction with traversing wheel slides.

Dividing Machines

Special Dividing Machines (Máquinas especiales para granduar), J. Y. Hunter. Ingenieria Internacional, vol. 1, no. 1, Apr. 1919, pp. 20-21, 8 figs. Type designed for circular division.

Portable Machinery

The Use of Portable Machinery in Ship Construction, G. F. Mackay. Elecn., vol. 82, no. 15, Apr. 11, 1919, pp. 429-431, 9 figs. Features of electric caravan, winches, sawing machines, electric drills, and electric deck planers.

Tool Equipment

Principles of Special Machine Design, F. E. Johnson. Machy (N. Y.), vol. 25, no. 9, May 1919, pp. 797-798. Concerning tool equipment of manufacturing machines.

Thread-Milling Machine

Continuous Thread Milling Machine of Unusual Design, Edward K. Hammond. Machy. (N. Y.), vol. 25, no. 8, Apr. 1919, pp. 727-729, 3 figs. Description of machine designed for use in turning and threading bars of large diameter and indeterminate length.

See also CIVIL ENGINEERING, Building and Construction (House-Building Machinery); CIVIL ENGINEERING, Earthwork, Rock Excavation, etc. (Excavator, Tunneling), Roads and Pavements (Scarifier).

MACHINERY, WOODWORKING

Pattern-Turning Machine

Pattern Turning—I, Joseph A. Shely. Machy. (N. Y.), vol. 25, no. 9, May 1919, pp. 836-841, 12 figs. Equipment required and methods used in turning.

MATERIALS OF CONSTRUCTION AND TESTING OF MATERIALS

Brass

Structural Characteristics of Rolled Sheet Brass, H. A. Eastick. Metal Indus., vol. 17, no. 4, Apr. 1919, pp. 176-178, 6 figs. Chart showing temperature at which recrystallization of alpha brass of different degrees of hardness commences.

Building Materials

Cheap Building Materials (Die Ausstellung "Sparsame Baustoffe" in der Austellungshalle am Zollogischen Garten), Zentralblatt der Bauverwaltung, vol. 38, nos. 102 and 103, Dec. 18 and 21, 1918, pp. 506-507 and 513-514, 6 figs. Describes exhibits shown at exhibition in Zoological Garden in Berlin, specially two types,—the "Vogt" concrete wall built of thin blocks of channel section interlocked and with certain interstices filled with cement grouting, and the "Ambi," built of thin concrete plates, with projecting ribs which interlock, the key being of cement grouting.

Cast Iron

Properties of Cast-Iron Test Bars, H. J. Young. Foundry Trade Jl., vol. 21, no. 207, Mar. 1919, pp. 157-160, 16 figs. Photomicrographs showing defects in test bars. Paper read before Newcastle Branch British Foundrymen's Assn.

Glues

Compositions of Glues (Diferentes composiciones de cola en la industria). Boletin de la Sociedad de Fomento Fabril, vol. 35, no. 12, Dec. 1918, pp. 834-840. Preparation of glues and allied productions for industrial purposes. (Concluded.)

Leather

Physical Examination of Leather and Leather Substitutes (Zur physikalischen Prüfung von Leder und Ersatzstoffen für Leder), R. Lauffmann. Kunststoffe, vol. 8, no. 8, Apr. 2, 1918, pp. 85-87, 3 figs. Examination regarding wearing qualities, tearing resistance, elongation, water absorption capacity, water permeation capacity and water resistance, and specific gravity.

Resistance of Materials

The Resistance of Materials—II, G. S. Chiles and R. G. Kelley. Ry. Mech. Engr., vol. 93, no. 4, Apr. 1919, pp. 181-184, 7 figs. Effect of sudden or abrupt changes in section on the distribution of unit stresses.

Steel

Dynamic Resistance of Steel (Sur la résistance dynamique de l'acier), Louis Roy. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 6, Feb. 10, 1919, pp. 304-307. Account of theoretical study and experimental verifications with gun bullets.

On the Elasticity of Steel, Akimasa Ono. Memoirs of the Coll. of Eng. Kyushu Imp. University, Fukuoka, Japan, vol. 1, no. 4, 1919, pp. 269-332, 18 figs. Experimental research; effect of elastic hysteresis on indication of load; temperature effect on deformation and effect of mechanical and thermal treatments on the constancy of elastic properties.

Wire Rope

Investigation of Wire Rope, J. H. Griffith. Eng. & Min. Jl., vol. 107, no. 17, Apr. 26, 1919, pp 737-738. Tests on wire ropes having diameter smaller than those of average mine hoisting ropes. Report by Bur. Standards, Pittsburgh.

MECHANICAL PROCESSES

Belt Shifter

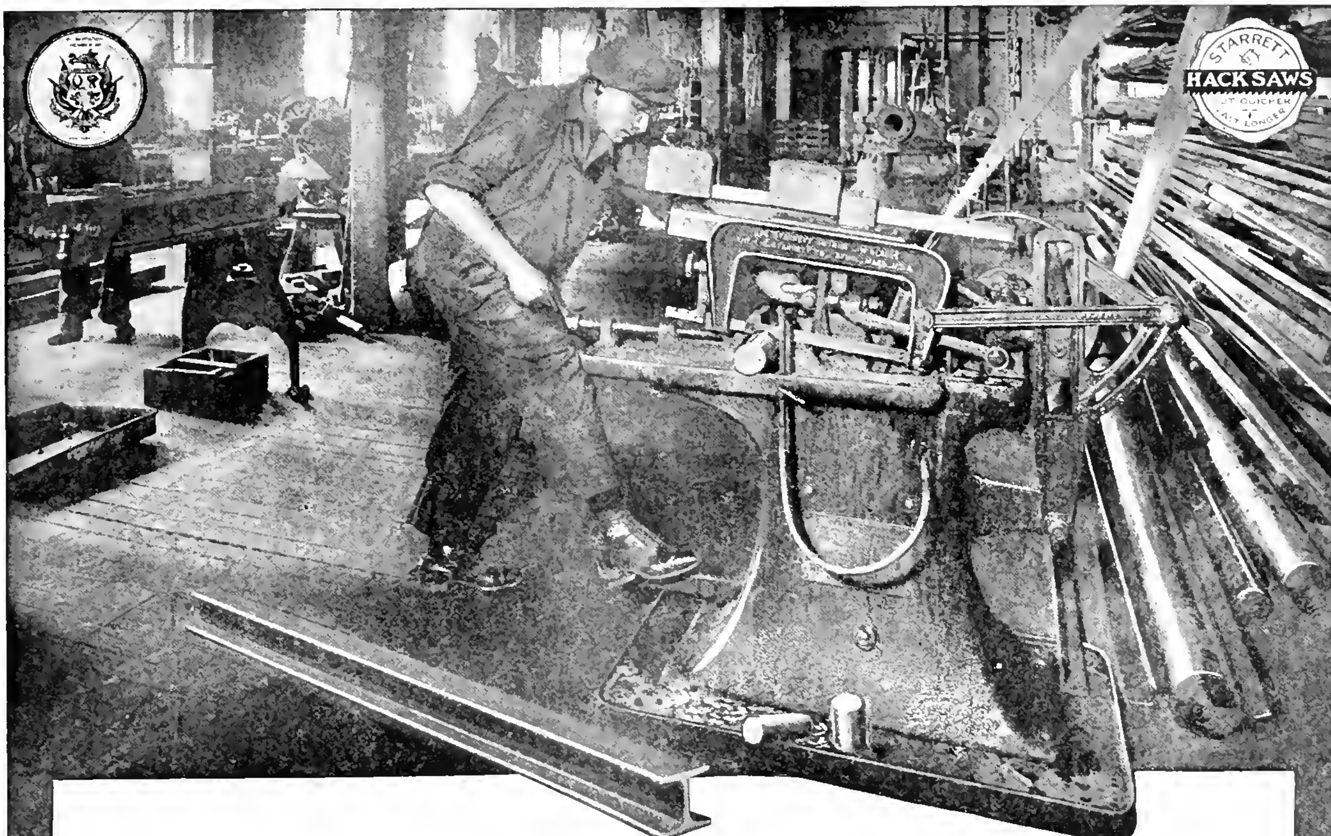
Manufacturing a Safety Belt Shifter, Robert Mawson. Am. Mach., vol. 50, no. 16, Apr. 17, 1919, pp. 743-745, 9 figs. Shifting mechanism consists of three rollers, one straight and two tapered; belt is pushed by means of straight roller, and owing to the shape of taper rollers the tendency is for the belt to slide onto the pulley as the shifter slides away.

Bending, Cold

The Bending and Forming of Brass Rod and Tubes, P. W. Blair. Metal Indus., vol. 17, no. 4, Apr. 1919, pp. 172-173, 5 figs. Machines for cold bending.

Boilers

How to Design and Lay Out a Boiler—VI, William C. Strott. Boiler Maker, vol 19, no. 4, Apr. 1919, pp. 103-106, 2 figs. Why the longitudinal seam must be stronger than the circumferential seam; formulæ for finding strength of boiler shell.



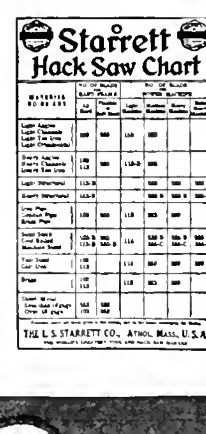
CHOOSE YOUR BLADE TO FIT YOUR WORK

If you've been cutting 3″ round machine steel with a heavy gage, coarse blade and find your next job is on structural beams—7″ I Beams, for instance—it's cheaper to change to a blade designed for that class of work than to keep on with the coarse blade you used on round stock.

If you use the same blade on both jobs, all the weight and strain of cutting the I Beam at any period in the cut must be borne by a smaller number of teeth than were engaged at any single instant on the round stock. The fewer the teeth that are cutting at any given time, the sooner they will become dull and the greater likelihood there is of their stripping.

That's *one* reason why the Starrett Hack Saw Chart recommends different kinds and shapes of metal. In this case, our tests show that a blade with more teeth to the inch should be used on structural steel than on round stock.

Follow the Starrett Hack Saw Chart LD and watch your cutting cost go down.



THE L. S. STARRETT COMPANY, Athol, Mass.

The World's Greatest Toolmakers
Manufacturers of Hack Saws Unexcelled

New York London Chicago

42-933

Starrett Hack Saws

Brass Rods

The Manufacture of Brass Rods—I & II. H. Mawson. Metal Industry, vol. 14, nos. 11 & 12, Mar. 14 & 21, 1919, pp. 203-207 and 229-232, 14 figs. Account of processes with reference to specification of Am. Soc. for Testing Materials. Paper read before Liverpool Eng. Soc.

Carburetors

Organization of a Carburetor Plant—I. Fred H. Korff. Machy. (N. Y.), vol. 25, no. 9, May 1919, pp. 847-850. Functions of different departments and their relation to product.

Chains, Cast-Steel

Cast-Steel Anchor Chain. A. E. Crockett. Proc. Engrs. Soc. Western Pa., vol. 35, no. 1, Feb. 1919, pp. 1-25 and (discussion) pp. 26-30, 24 figs. Investigation and trials which finally led to adoption of present method of manufacturing cast-steel anchor chain, and account of dynamic tension tests of cast chains.

Chuck, Universal

Universal Chuck Manufacture. Machinery, vol. 14, no. 341, Apr. 10, 1919, pp. 33-39, 21 figs. Methods employed by A. A. Jones & Shipman, Leicester.

Crushers, Stone

Detroit United Railway Builds Large Stone Crusher Plant. Elec. Ry. Jl., vol. 53, no. 15, Apr. 12, 1919, pp. 726-727, 5 figs. Crushers taken from abandoned quarry used to equip plant of 500 cu. yd. per day capacity in salvaging waste materials for ballasting.

Earthenware

Earthenware (Fabricacion de articulos de arcilla o barro). Boletin de la Sociedad de Fomento Fabril, vol. 35, no. 12, Dec. 1918, pp. 825-829, 5 figs. Processes followed and machinery used in manufacture of earthenware.

Engines, Marine

Manufacture of Marine Engines at the Joshua Hendy Iron Works. H. S. Rexworthy. Metal Trades, vol. 10, no. 4, Apr. 1919, pp. 153-157, 10 figs. It is stated that engines weighing 100 tons and developing 2800 hp. are being delivered at the rate of one every 30 days.

Extrusion of Metals

The Present and Future of the Extrusion of Metals—I & II. A. E. Tucker and P. A. Tucker. Machinery, vol. 14, nos. 340 & 341, Apr. 3 and 10, 1919, pp. 29-30 and 47-48. Effect of a powerful deoxidizer on metal. Paper read before Birmingham Metallurgical Soc. Also abstracted in Ironmonger, vol. 166, no. 2366, Mar. 22, 1919, p. 79.

Gas Engines

The Manufacture of Marine Gas Engines. J. V. Hunter. Am. Mach., vol. 50, no. 17, Apr. 24, 1919, pp. 787-791, 20 figs. Manufacture of jigs and fixtures to adapt standard machine tools to rapid production of standard work in order to meet demands for powerful gas engines of comparatively light weight for marine and other powers.

Gear Cutting

Commercial Gear Cutting. W. Duckett. Machinery, vol. 13, no. 339, Mar. 27, 1919, pp. 723-725, 8 figs. Basis of machine cut gearing in engineering practice; particularly in manufacture of aero engine and automobile parts.

Hosiery Machine

Manufacturing the Banner Hosiery Machine, pts. II and III. Robert Mawson. Can. Machy., vol. 21, nos. 15 and 17, Apr. 10 and 24, 1919, pp. 345-348 and 391-394, 22 figs. Apr. 10: Operations performed on Jones and Lamson machines. Apr. 24: Operation of form milling sinker cams on Briggs milling machine; cutting raised cams; milling fashion cams and clutch cams.

Miller, Ford-Smith

Manufacturing the Ford-Smith Miller. J. H. Moore. Can. Machy., vol. 21, no. 12, Mar. 20, 1919, pp. 271-275, 9 figs. Concerning inspection methods involved.

Motor Parts

Making Liberty Aeroplane Motor Parts—I. Machinery, vol. 14, no. 340, Apr. 3, 1919, pp. 8-13, 13 figs. Methods employed in machining cylinder inlets and exhaust elbows.

Pressed Steel, Reinforcing

Making Pressed-Steel Reinforcing. Iron Trade Rev., vol. 64, no. 17, Apr. 24, 1919, pp. 1073-1080, 16 figs. How various shapes of beams, plates, studs, concrete bars, etc., are adapted for building purposes.

Roller Bearings

Making the Timken Roller Bearing—I. Edward K. Hammond. Machy. (N. Y.), vol. 25, no. 9, May 1919, pp. 829-835, 13 figs. Methods of heat-treating, machining and inspecting.

Rubber Goods

Railroad Rubber Goods. G. W. Alden. Official Proc. Car Foremen's Assn. of Chicago, vol. 14, no. 6, Mar. 1919, pp. 65-100. Classification of various goods according to process of manufacture, together with exposition of recent developments of rubber industry.

Sanding Machine

Building a Sanding Machine. Robert Mawson. Machy. (N. Y.), vol. 25, no. 8, Apr. 1919, pp. 738-742, 15 figs. Methods of machining parts of a sanding machine; describing jigs and fixtures used and general procedure in assembling.

Steel Mills

Westinghouse Electric Blooming-Mill (Train blooming à Commande électrique système Westinghouse). Génie Civil, vol. 74, no. 12, Mar. 22, 1919, pp. 225-228, 7 figs. Scheme of a. c. instalation developed by British Westinghouse Co. From Engineer, Dec. 13, 1918.

Large Rolling-Mill Plant. Electrical Review, vol. 84, no. 2157, Mar. 28, 1919, pp. 340-342, 7 figs. Electrical equipment for a 38-in. reversing cogging mill designed to roll 3-ton steel ingots 18 x 22 in. to 4 x 4-in. billets, with an output of 60 tons per hour. (Concluded.)

See also ELECTRICAL ENGINEERING, *Power Applications (Mill Drive).*

Tractors

Turning Out 100 Tractors per Day. P. M. Heldt. Automotive Industries, vol. 40, no. 15, Apr. 10, 1919, pp. 788-792, 7 figs. Machining and assembling methods employed at Milwaukee plant of Int. Harvester Co. (To be continued.)

Westinghouse Marine System

Building the Westinghouse Marine System. Edward K. Hammond. Machy. (N. Y.), vol. 25, no. 9, May 1919, pp. 789-796, 16 figs. Operations involved in forging, machining, assembling and testing various parts of equipment.

MEASUREMENTS AND MEASURING APPARATUS

Calorimeter

An Improved Form of Throttling Calorimeter. W. R. Woolrich. Power, vol. 49, no. 12, Apr. 1, 1919, pp. 495-496, 2 figs. Explains how instrument may be made self-contained by having necessary curves drawn on a metal plate fastened to barrel or calorimeter.

Clinometer

A Useful Instrument. H. L. Seymour. Can. Engr., vol. 36, no. 13, Mar. 27, 1919, pp. 335-337, 2 figs. Abney Hand level, pocket altimeter or clinometer and its uses in surveying, engineering and architectural work.

Coal Meters

A Coal Meter for Boilers. Engineer, vol. 127, no. 3298, Mar. 14, 1919, p. 261, 2 figs. Lea recorder intended for boilers fitted with chain grates; similar in operation to the well-known V notch recorders and integrators for water measurement.

Colorimeter

The Numerical Expression of Color Properties. Paul H. Geiger. Michigan Technic, vol. 32, no. 1, Mar. 1919, pp. 36-40, 2 figs. Principle upon which Nutting colorimeter operates.

Flow in Pipes, Fluid

Electrical Measurement of Fluid Flow in Pipes. Jacob M. Spitzglass. Mech. Eng., vol. 41, no. 5, May 1919, pp. 429-432 and 487, 6 figs. Theory and development of device embodying ammeter and watt-hour meter in which the electric current flowing is proportional to the quantity of fluid passing through pipe.

Hardness Tests

Hardness Tests of Gun-Barrel Steel. William Kent Shepard. Am. Mach., vol. 50, no. 16, Apr. 17, 1919, pp. 739-742, 2 figs. Ultimate strength, yield point, Brinell and scleroscope hardness number. Percentage reduction in area and elongation in 2-in. Brinell diameter and scleroscope hardness number.

Indicating Instruments, Residence of

The Concept of Resilience with Respect to Indicating Instruments. Frederick J. Schlink. Jl. Franklin Inst., vol. 187, no. 2, Feb. 1919, pp. 147-169, 2 figs. Deals particularly with instruments of index-and-scale and value-controlling types of class of non-integrating instruments, as distinguished from integrating instruments and those used for comparison purposes strictly.

Microscope

Usefulness of the Metallurgical Miscroscope to the Engineer. E. D. Fahlbarg. Wisconsin Engr., vol. 23, no. 7, Apr. 1919, pp. 255-257, 4 figs. Examples of its uses in examination

Pyrometers

Standards of Temperature and Means for Checking Pyrometers. Jl. Am. Steel Treaters Soc., vol. 1, no. 3, Dec. 1919, pp. 99-110, 7 figs. A consideration of sources of error in thermocouple pyrometers leads writer to advise that in order to secure reliable measurements in plant turning out high-grade heat-treated product, following equipment should be available: Standard precision and double range potentiometers with accessories, one mounted and two unmounted platinum thermocouples, checking furnace with control panel and extra standard cell.

Scale Conversion

Conversion of Uneven into Even Scales (Die Umwandlung einer ungleichmäßigen Teilung in eine gleichmässige), Hugo Krüss. Zeitschrift für Instrumentenkunde, vol. 38, no. 12, Dec. 1918, pp. 195-200, 6 figs. Conversion effected by means of two equal bars hinged at one end and constrained to move at the other along a straight line reproducing both scales. When hinged end is moved along a curve, the shape of which depends on nature of uneven scale, the other ends point at corresponding values in the scales.

Steam Generation

Determining Economy of Steam Generation. G. H. Sheasley. Power Plant Eng., vol. 23, no. 9, May 1, 1919, pp. 395-397. Methods of procedure and equipment required.

Temperatures, Low

The Measurement of Low Temperatures with Thermocouples. Thomas Spooner. Jl. Franklin Inst., vol. 187, no. 4, Apr. 1919, pp. 509-511, 2 figs. Chromel-alumel thermocouple for measuring temperatures below 0 deg. cent.

Thermometer, Mercury, Testing

Simple Boiling Point Apparatus for Testing Mercury Thermometers at Temperatures over 100 deg. C (Ein einfacher Siedepunktapparat zur Prüfung von Quecksilberthermometern bei Temperaturen über 100 deg. C.), Gottfried Dimmer. Zeitschrift für Instrumentenkunde, vol. 38, no. 3, Mar. 1918, pp. 33-40, 2 figs. Describes tests with thermoelement and mercury thermometer and results: Substances used were aniline of 184.1 deg.; naphthaline at 218 deg.; benzophenone at 306 deg.; and sulphur at 444.6 deg.

Turbo-Alternators, Efficiency

The Determination of the Efficiency of the Turbo-Alternator. S. F. Barclay and S. P. Smith. Engineer, vol. 127, no. 3299, Mar. 21, 1919, pp 290-291, 2 figs. Determination from measurements of the cooling air and by the "air-heating" method.

Water Level, Distant

Measuring Distant Water Levels. C. G. Brown. Electricity, vol. 33, no. 1482, Apr. 4, 1919, pp. 201-202, 3 figs. Instrument employs relay connected to solenoid resistance in which contact placed alongside is controlled by height of river by means of float. Suitable arrangement records motions of float at hydraulic station.

Water-Waste Testing

Devices for Water-Waste Surveys at Oak Park, Illinois. Eng. News-Rec., vol. 82, no. 17, Apr. 24, 1919, pp. 829-831, 2 figs. Portable venturimeter to test pipe districts with pitometer inserted in house service.

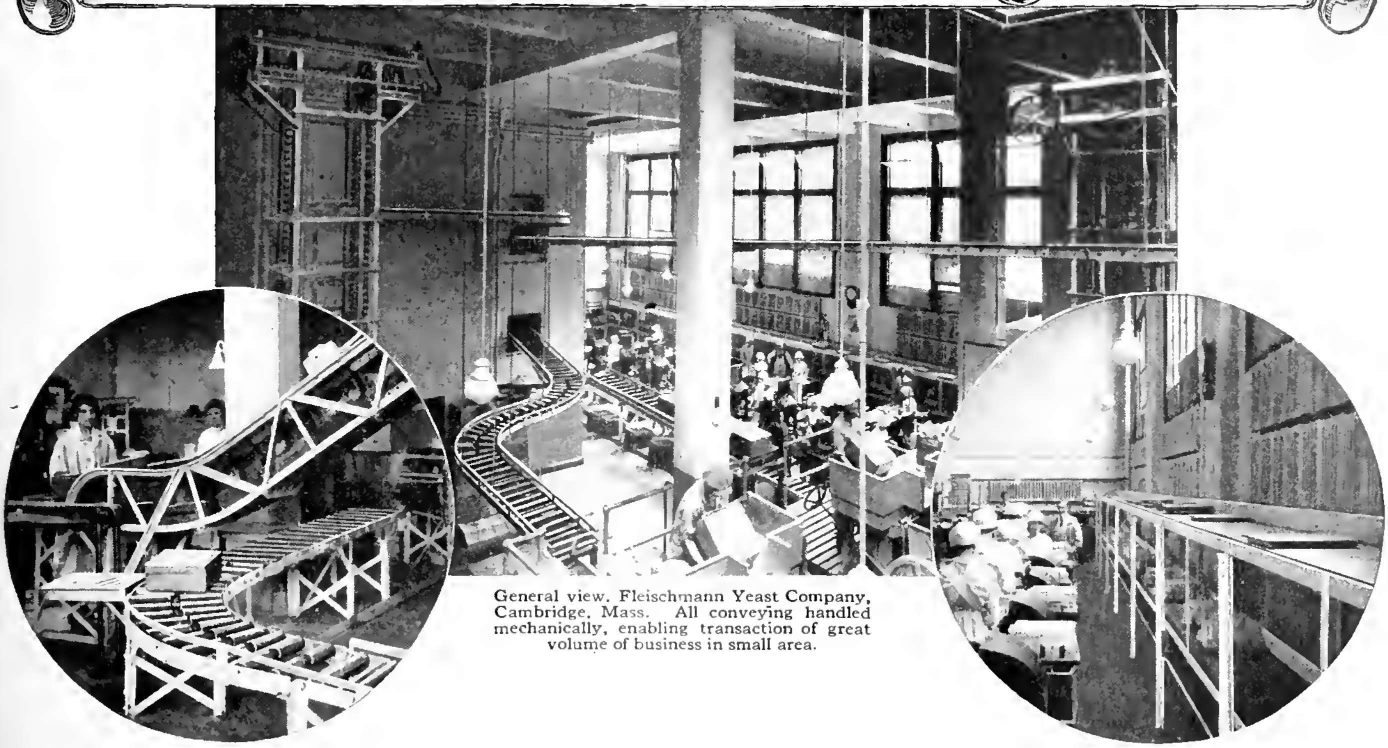
See also ELECTRICAL ENGINEERING, *Measurements and Tests (Temperature Determination by Weighing, Timing).*

MECHANICS

Articulated Rods

The Articulated Rod. T. L. Sherman. Automobile Eng., vol. 9, no. 125, Apr. 1919, pp 102-106, 16 figs. Formulæ for various mechanical quantities and inertia forces curves on articulated-rod system in which two cylinders are fixed in one plane at a certain angle.

Lamson Conveyors



General view. Fleischmann Yeast Company, Cambridge, Mass. All conveying handled mechanically, enabling transaction of great volume of business in small area.

Empty boxes descending chute from shipping-platform to wrapping-machines; loaded boxes carried by conveyor to storage.

Belt conveyors (at side) bringing yeast to wrapping-machines.

100% CONVEYING SERVICE

In planning a conveying system, it is necessary to consider the nature of the product—its texture, liability to damage, etc.; the nature of the receptacles in which the product must be carried; the points to and from which the conveying is to be done; the different levels to be joined; the quantity of the flow of product and also the periodicity of the flow.

Yeast is delicate stuff to handle, and this factory called for an automatic pick-up, hoisting and delivering without danger of jar or collision.

The Lamson System is performing this delicate function perfectly. Tons of yeast are carried throughout the section of the factory shown and are not out of the ice-box long enough to lose the chill.

The yeast comes from the ice-box in 80-pound cases to the mixing-machine, where it is molded. Then a conveyor carries it automatically to the wrapping-machine, where it is either packed in boxes, or piled five or six inches high on pallets and automatically delivered back to the ice-box without jar, disarrangement or disturbance to the slippery cakes.

Write for book on Conveying illustrating the versatility of the Lamson System for carrying things—delicate and rough, small and large, light and heavy.

THE LAMSON COMPANY

100 BOYLSTON ST., BOSTON, MASS.

Boston	100 Boylston St.
New York	15 West 44th St.
Philadelphia	1200 Walnut St.
Pittsburg	319 Third Ave.
Rochester	194 Main St. East
Detroit	97 Woodward Ave.
Cleveland	2063 East 4th St.
Cincinnati	119 East 5th St.
Indianapolis	Illinois & Washington Sts.
Chicago	6 N. Michigan Ave.
Toronto	136 Simcoe St.

LAMSON SERVICE

Minneapolis	221 Tribune Annex
Omaha	Brandeis Bldg., Room 675
Denver	1622 Arapahoe St.
St. Louis	709 Pine St.
Seattle	215 Stewart Bldg.
San Francisco	617 Mission St.
Los Angeles	627 So. Broadway
Dallas	905½ Elm St.
Baltimore	10 E. Fayette St.
New Orleans	124 St. Charles St.
Atlanta	30 Moore Bldg.
Vancouver, B. C.	603 Hastings St.

Beams

Economical Sections of Simple Reinforced-Concrete Beams (Recherche des sections economiques des poutres simples en béton armé travaillant à la flexion), G. Guillaumin. Génie Civil, vol. 74, no. 13, Mar. 29, 1919, pp. 249-251. Proposes simplification of calculation and formulæ which have appeared in Eng. News, Feb. & June 1907, and in Technique Moderne, Jan. 1910.

Distribution of Metal in Beams and Levers, Eugene Motchman. Scale Jl., vol. 5, no. 7, Apr. 10, 1919, pp. 13-14, 7 figs. Application of design and formulæ to beams used in scales.

Elastic Stresses

Strains due to Temperature Gradients, with Special Reference to Optical Glass, Erskine D. Williamson. Jl. Wash. Acad. Sciences, vol. 9, no. 8, Apr. 19, 1919, pp. 209-217, 1 fig. General equations for elastic stresses produced by temperature differences in spheres, cylinders and slabs when the temperature distribution is symmetrical about the center axis or central plane, respectively. More specific equations are given for the case of temperature distribution due to uniform surface heating.

Frames

Analysis and Tests of Rigidly Connected Reinforced Concrete Frames, Mikishi Abe. University of Illinois Bul. no. 107, vol. 16, no. 8, Oct. 21, 1918, 106 pp., 59 figs. Formulæ for moments and other indeterminate quantities for several types of indeterminate structures. Formulæ have been derived by methods involving use of principle of least work, and their applicability and reliability were tested in frames designed according to them.

Irregularity, Coefficient of

Coefficient of Irregularity of Steam Engines, Gas Engines and of Electric Generators Running in Parallel (Coefficient d'irregularité des machines à vapeur, moteurs à gaz et marche en parallèle de génératrices électriques), M. Barrusta. Industrie Electrique, vol. 28, no. 642, Mar. 25, 1919, pp. 104-109. Formulæ developed from assumption that flywheel possesses two motions, one uniform and one pendular; in the case of electric generators motion is considered as resulting from action of two couples and its regularity is expressed in terms of a parameter in the differential equation of motion.

Pendulum

Note on the Motion of a Simple Pendulum after the String has Become Slack, W. B. Morton. London, Edinburgh and Dublin Phil. Mag., vol. 37, no. 219, Mar. 1919, pp. 280-284, 1 fig. Finds from graphs constructed from theoretical considerations that ultimate motion approaches asymptotical to oscillation between ends of horizontal diameter.

Shafts, Critical Speed of

Critical Speed in Tapered Shaft Design. Machinery, vol. 13, no. 338, Mar. 20, 1919, pp. 694-695, 1 fig. Diagram for determining critical speed of tapered shafts.

Shafts, Whirling Speed of

The Lateral Vibration of Loaded Shafts in the Neighbourhood of a Whirling Speed—the Effect of Want of Balance, H. H. Jeefcott. London, Edinburgh and Dublin Phil. Mag., vol. 37, no. 219, Mar. 1919, pp. 304-314, 4 figs. Discusses how want of balance causes so-called "whirling speeds" and to what extent it is practical to carry balancing.

Springs

Thermodynamics of Springs (Zur Thermodynamik der Federn), H. Bock. Zeitschrift für Instrumentenkunde, vol. 38, no. 7, July 1918, pp. 109-115, 3 figs. Method evolved after *p-r* diagram of Gast theory for presenting thermal processes; application of method to theory of springs makes it possible at least partly to calculate "elastic after effect" by means of entropy theorem.

A New Theory of Plate Springs—III, David Landau and Percy H. Parr. Jl. Franklin Inst., vol. 187, no. 2, Feb. 1919, pp. 199-213, 3 figs. On "nip" stresses and "life" of plates under varying stresses produced in metal when in use.

See also CIVIL ENGINEERING, Cement and Concrete (Beams).

MOTOR-CAR ENGINEERING

Aluminum

The Why of Aluminum in Motor Cars, H. M. Taylor. Motor Age, vol. 35, no. 16, Apr. 17, 1919, pp. 7-9, 3 figs. Feature of 8-cyl. engine built almost entirely of aluminum; welding and machining aluminum parts.

Brake Levers

Determining Correct Location of Brake Levers, Walter C. Baker. Automotive Industries, vol. 40, no. 17, Apr. 24, 1919, pp. 914-917, 6 figs. Attempts to show how braking action may be remedied by changing their loads and their location. Maintains that brakes are not to blame for pedal motion due to torque and spring action.

Benzol

Benzole as a Motor Fuel, Eric W. Walford. Autocar, vol. 42, no. 1223, Mar 29, 1919, pp. 439-441, 2 figs. Hints concerning its use, either by itself or mixed with petrol.

Design

Progressive and Retrogressive Designing, Otto M. Burkhardt. Jl. Soc. Automotive Engrs., vol. 4, no. 4, Apr. 1919, pp. 216-226, 15 figs. Technical considerations on elimination of certain links and members in design of motor vehicle. Elimination of torque and radius rods is one of various examples considered.

Probable Effect on Automobiles of Experience with War Airplanes, O. E. Hunt. Jl. Soc. Automotive Engrs., vol. 4, no. 4, Apr. 1919, pp. 243-245. Holding improvements in airplane engines not suitable for cars, writer believes that the most important contribution which the airplane has made to the automobile is stimulus to thought of industry as a whole that has resulted from study of design and manufacturing problems.

Engines

Possible Effect of Aircraft Engine Development on Automobile Practice, Henry M. Crane. Jl. Soc. Automotive Engrs., vol. 4, No. 4, Apr. 1919, pp. 240-242. Writer does not expect any radical change in automobile design, but only a probable increase in number of "valve-in-the-head" engines.

European Cars

Post-War Cars Designed by Europe, W. F. Bradley. Motor Age, vol. 35, no. 15, Apr. 10, 1919, pp. 24-27, 11 figs. Comparison of types shown at Lyons fair with American models.

The Angus Sanderson Car. Automotive Industries, vol. 40, no. 17, Apr. 24, 1919, pp. 888-890, 6 figs. Embodies engine with slipper-type piston, counterbalanced crankshaft, integral cylinder block and top half of crankcase, and forced-feed lubrication.

Automotor Design and Construction of 1919. Auto, vol. 24, no. 15, Apr. 10, 1919, pp. 360-364, 8 figs. Mechanical arrangement of the 16-hp. Panhard.

A New British Quantity-Production Car. Automotive Industries, vol. 40, no. 15, Apr. 10, 1919, pp. 807-808, 4 figs. Austin 20-hp. open touring car.

A New Eight-Cylinder Piccard-Pictet. Autocar, vol. 42, no. 1223, Mar. 29, 1919, pp. 432-434, 7 figs. Franco-Swiss high-powered car. Features are front-wheel brakes and single sleeve-valve V engine.

The 20-25 Hp. Six-Cylinder Straker. Autocar, vol. 42, no. 1223, Mar. 29, 1919, pp. 429-431, 5 figs. Car with engine having separate cylinders, aluminum pistons, and overhead valve-operating mechanism.

Kerosene Burning

Paraffin as Fuel, Harry R. Ricardo. Automobile Engr., vol. 9, no. 122, Jan. 1919, pp. 2-5, 5 figs. Principle of utilization; type of carburetor required; results of tests.

Lubrication

The Lubrication of Motor Cars, G. W. A. Brown. Automobile Engr., vol. 9, no. 125, Apr. 1919, pp. 110-115, 34 figs. Suggests improvement in oiling of gear box, universal joints, live axle, steering gear and other components of chassis. Paper read before Instn. Automobile Engrs.

State Regulation

Regulation of the Speed, Weight, Width and Height of Motor Trucks and Trailers, George Graham. Can. Engr., vol. 36, no. 6, Feb. 6, 1919, pp. 200-202. Plan of Am. Assn. of State Highway Officials for uniform truck laws.

Steam Cars

The Clarkson Steam Chassis, Type IX. Automobile Engr., vol. 9, no. 122, Jan. 1919, pp. 17-21, 12 figs. Four-cylinder tandem compound engine, with coke as fuel.

Temperature Control

Controlling the Water Temperatures, Eric W. Walford. Autocar, vol. 42, no. 1224, Apr. 5, 1919, pp. 471-473, 5 figs. Methods for increasing thermal efficiency and ease of starting and for promoting vaporization of fuel, by regulating effective radiating surfaces.

Tires, Rubber-Substitute

Substitute for Rubber Tires (Ersatz für Kautschukreifen), II. Jahr. Kunststoffe, vol. 8, nos. 14 & 15, Jul. 2, and Aug. 1, 1918, pp. 157-160 and 173-175, 26 figs. Substitutes used are principally leather, all kinds of woven materials, felt, paper, vegetable fibers, hair, bristles, etc. Various types of tires and methods of fastening them to rim are described.

Notes on German Mechanical Transport, G. F. Randall. Motor Traction, vol. 28, no. 736, Apr. 9, 1919, pp. 305-307, 5 figs. Tires substituted by device consisting of hardwood blocks let into rims of ordinary steel or artillery wheels and held in place by split steel bands bolted up on each side of blocks in such a way as to render the wooden tires easily removable.

Tires, Truck

Pneumatic Tires on Trucks, B. B. Bachman. Jl. Soc. Automotive Engrs., vol. 4, no. 4, Apr. 1919, pp. 298-302. Advantages claimed for pneumatic tires are reduction in mechanical repairs, increase in permissible speed, decrease in gasoline and oil consumption, less fatigue for men, lessened depreciation of roads and greater tractive ability.

Tractors

Twin City 12-20 Kerosene Tractor, P. M. Heldt. Automotive Industries, vol. 40, no. 16, Apr. 17, 1919, pp. 836-839, 5 figs. Three-plow tractor with double intake and exhaust valves, enclosed drive, pressure lubrication, thermostatic temperature control, backbone frame construction and front-spring suspension.

The Velie Biltwell Tractor, P. M. Heldt. Automotive Industries, vol. 40, no. 15, Apr. 10, 1919, pp. 799-804, 15 figs. Three-plow machine with kerosene-burning engine, 3-speed sliding-gear transmission and inclosed bull-gear drive.

Trucks, 4-Wheel Drive

Special Parts for Four-Wheel Drive Trucks, Harry C. Satterthwaite. Am. Mach., vol. 50, no. 15, Apr. 10, 1919, pp. 691-698, 21 figs. Operations on ball-and-socket joint placed on each end of front axle. Truck is both steered and driven in front.

War Experience

Touring Cars on War Service. Automobile Engr., vol. 9, no. 122, Jan. 1919, pp. 13-16, 3 figs. Notes on performance of lighter transport chassis.

Motor-Lorry Design. Times Eng. Supp., vol. 15, no. 533, Mar. 1919, p. 103. Lessons of war service.

See also RAILROAD ENGINEERING, Locomotives (Gasoline-Electric Locomotive), Operation and Management (Road Motor Vehicle Department); ELECTRICAL ENGINEERING, Ignition Apparatus; MECHANICAL ENGINEERING, Internal-Combustion Engines.

PIPE

Layout

A Problem in Piping Layout, James Leslie Lane. Boiler Maker, vol. 19, no. 4, Apr. 1919, p. 93, 1 fig. Mathematical computation of angles and lengths of lines.

Piping

Piping and Pipe Fittings. Southern Engr., vol. 31, no. 2, Apr. 1919, pp. 36-50, 17 figs. Calculations, layout, sizes, bends, traps, and other arrangements of piping.

POWER GENERATION

California

Water Power in California, Andrew H. Palmer. Sci. Am. Supp., vol. 87, no. 2260, Apr. 26, 1919, pp. 260-261 and 271, 4 figs. Factors on which it depends and the extent to which it might be utilized.

Canada

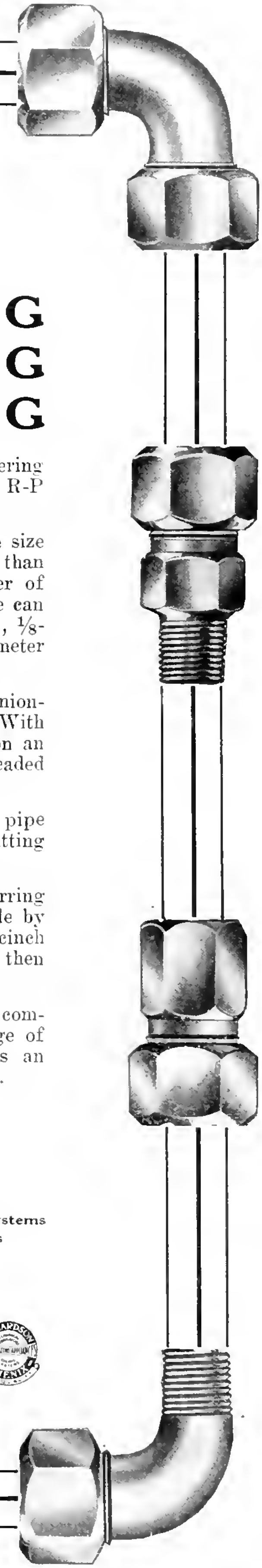
The Present Electrical Outlook in Canada, A. S. L. Barnes. Electrical Review, vol. 84, no. 2159, Apr. 11, 1919, pp. 421-423. Councils furthering British electrical trade with Canada. (Concluded.)

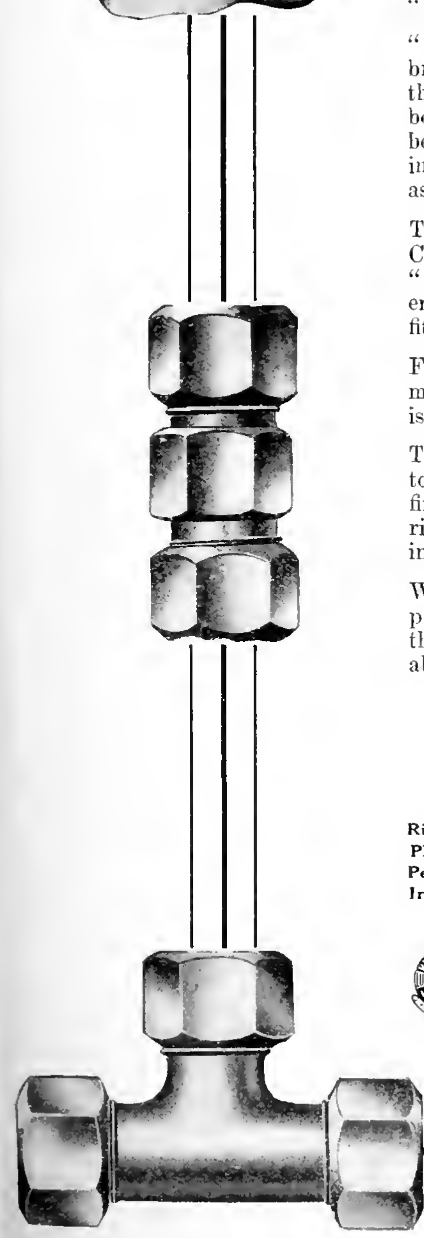
Coquitlam Buntzen

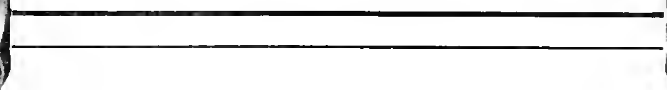
The Coquitlam Buntzen Hydro-Electric Plant, F. C. Perkins. Power House, vol. 13, no. 4, Apr. 5, 1919, pp. 83-86, 5 figs. Originally designed for 12,000 hp., plant has grown to 85,000 hp. Growth of project is described and capabilities of economically developing 750,000 hp. are examined.

Eastern States

Hydro-Electric Development in Eastern States, D. H. Colcord. Power Plant Eng., vol. 23, no. 8, Apr. 15, 1919, pp. 362-364, 4







NO THREADING SOLDERING FLARING

Oil-tight joints can be easily made without threading, soldering or flaring out the ends of the pipe or tubing by using R-P "Union Cinch" Fittings.

"Union Cinch" fittings are made to fit standard iron pipe size brass or steel tubing. Tubing has a larger inside diameter than the same size standard pipe, although the outside diameter of both are the same. Therefore when tubing is used, the size can be reduced one size smaller all around. As an illustration, ⅛-inch drawn steel tubing has practically the same inside diameter as ¼-inch iron pipe size pipe.

The only tools necessary to install an oil line with "Union-Cinch" fittings are a hack saw, file, and monkey wrench. With "Union-Cinch" fittings the oil pipe lines can be installed on an engine in one-half the time needed when ordinary threaded fittings are used.

Furthermore, every "Union-Cinch" fitting being a union, pipe may be taken down and put together at any point where a fitting is inserted.

These fittings will be more thoroughly understood by referring to the sectional view shown above. The connection is made by first slipping the union nut "4" and then the soft-brass cinch ring "1," over the end of the tubing "2." The tubing is then inserted into the fitting up against shoulder "3."

When the nut "4" is drawn up, the cinch ring "1" is compressed in such a manner as to grip the pipe on each edge of the ring at "5-5," making a double-cinch, which insures an absolutely tight joint that will not shake loose or come out.

Write for Bulletin C-30 describing "Union-Cinch" Fittings and other accessories for Automatic Oil Circulating and Filtering Systems.

WE MANUFACTURE

Richardson Sight Feed Oil Pump
Phenix Mechanical Lubricator
Peterson Power Plant Oil Filter
Individual Oiling & Filtering Systems
Central Oiling & Filtering Systems
Turbine Oil Filtration Systems
Sight Feed Oilers
No Kut Globe & Angle Valves

THE RICHARDSON-PHENIX CO.
LUBRICATION ENGINEERS AND MANUFACTURERS
WORKS 122 RESERVOIR AVE., MILWAUKEE, WIS.

[illegible] Portsmouth Nameplates, [illegible] and [illegible]

Gas and Electricity

Distribution of Heat, Light and Motive Power by Gas and Electricity, Dugald Clerk. Colliery Guardian, vol. 117, no. 3039, Mar. 28, 1919, pp. 713-714. Theoretical efficiency of estimated average performances of gas works and of electric undertakings of United Kingdom. Paper read before Roy. Soc. of Arts.

Illinois

Independent Illinois Power System. Power Plant Eng., vol. 23, no. 9, May 1, 1919, pp. 391-393, 5 figs. Abbott Light & Power Co.'s 45 miles of line supplying lighting and power load of 400 kw. to ten towns.

Interconnection

Interconnection Reduces Steam Reserve Necessary, L. J. Moore. Elec. World, vol. 73, no. 17, Apr. 26, 1919, pp. 840-842, 4 figs. Results obtained by tying together power systems in Central California.

Muscle Shoals

Features of Muscle Shoal Station, Edward R. Welles and W. A. Shoudy. Elec. World, vol. 73, no. 15, Apr. 12, 1919, pp. 729-732, 4 figs. Characteristics of power-plant, particularly boiler, furnace, stoker, condensers and auxiliaries.

Pittsburgh District

Power Production for Electrochemical Purposes, C. S. Cook. General Meeting Am. Electrochemical Soc., Apr. 3-5, 1919, paper no. 10, pp. 167-171. Cost in Pittsburgh district, particularly when generated in large stations and when off-peak power is used for electrochemical and electrometallurgical purposes. Writer concludes that this kind of steam power can compete with water power in all except the most favorable cases for developing hydraulic power.

State Aid

State Aid for Water Power Development, Alfred M. Beale. Can. Engr., vol. 36, no. 13, Mar. 27, 1919, pp. 333-334. Complete ownership by Government is not considered essential, but it is suggested that Government furnish capital and control rates.

Swift Rapids Plant

Electric Power from Swift Rapids Plant. Elec. News, vol. 28, no. 7, Apr. 1, 1919, pp. 27-31, 9 figs. Combination generating plant and ship lift lock.

POWER PLANTS

Boiler Mountings

Boiler Mountings. Mar. Engr. & Naval Architect, vol. 41, no. 499, Apr. 1919, pp. 210-214, 5 figs. Blow-out apparatus. (Continued.) Paper read before Liverpool Eng. Soc.

Boiler Room

Saving Coal in the Blackstone Power Plant, W. A. Eberman. Power, vol. 49, no. 17, Apr. 29, 1919, pp. 632-634, 3 figs. Remodeling of boiler furnaces together with coöperation of operating force and intelligent use of instruments is said to have resulted in saving fuel amounting to 12 per cent.

Clinker Grinders

The Clinker Grinder in Modern Boiler Practice, Charles H. Bromley. Power, vol. 49, no. 16, Apr. 22, 1919, pp. 592-598, 12 figs. Describes various grinders and gives their performance data as obtained in different installations.

Condensers

Surface Condensing Plant for Large Power Stations, R. J. Kaula. Electrical Review, vol. 84, no. 2160, Apr. 18, 1919, pp. 453-455 and discussion pp. 455-456, 2 figs. Graph showing [illegible] of free air at atmospheric pressure against plant capacity in 1000 lb. of steam per hour, arrangement of strainers and pumps on [illegible] Paper read before Instn. Elec. Engrs.

Economizers

Proportioning Fuel Economizers, A. E. Clark. Power, vol. 49, no. 16, Apr. 22, 1919, pp. 613-615, 5 figs. Data showing advantages of contraflow over parallel flow of water and gas.

Equipment

Modern Steam Power Station Equipment, Joseph G. Worker. Coal Indus., vol. 2, no. 4, Apr. 1919, pp. 157-163, 13 figs. Review of equipment installed in various power plants.

Governor

An Electrically Operated Steam Engine Governor, G. T. Garwood. Model Engr. & Elecn., vol. 40, no. 936, Apr. 3, 1919, pp. 234-236, 2 figs. A throttle actuating solenoid is switched in and out by a centrifugal device similar to an ordinary shaft governor.

Oil Filters

Reducing Cost of Production by Saving Coal and Oil (Die Verminderung der Betriebskosten durch Ersparnisse an Kohlen und Oel), Otto Grunner. Kunststoffe, vol. 8, no. 8, Apr. 2, 1918, pp. 88-92, 10 figs. Recommends counter current preheaters as efficient in reducing coal consumption and repair work, and suggests installation of oil filter for steam in order to prevent oil particles from getting into pipe system, thereby reducing efficiency of preheater.

Stand-By Operation

Converting a Steam Plant to Stand-by Operation, L. M. Klauber. Jl. Electricity, vol. 42, no. 8, Apr. 15, 1919, pp. 353-357, 3 figs. Problems met in turbine and boiler rooms. From report of Eng. Committee for Spring Convention of Pac. Coast Section N. E. L. A.

Stokers

Influence of Chemistry upon Improvement in Stoker Design, Clyde H. McClure. Elec. Rev., vol. 74, no. 16, Mar. 19, 1919, pp. 620-621. States that from viewpoint of chemical engineer future improvement in mechanical stokers, specially for territory dependent upon Indiana and Illinois coal, lies in combination of chain-grate and underfeed types.

Turbines

United States Nitrate Plant No. 2 at Muscle Shoals, Charles H. Bromley. Power, vol. 49, nos. 13 and 15, Apr. 1 & 15, 1919, pp. 482-488 and 558-561, 14 figs. Description of triple cylinder, pure-reaction, parallel-flow turbine; 60,000-kw. unit has four condensers, each of 25,000 sq. ft. of Muntz-metal tube surface.

Turbo-Generators

Narragansett Company Installs 45,000-kw. Turbo-Generator, J. P. Rigsby. Power Plant Eng., vol. 23, no. 8, Apr. 15, 1919, pp. 349-353, 3 figs. Installation is of cross-compound double-unit type, consisting of a high- and a low-pressure unit, each connected through a flexible coupling to its own generator.

Valves and Fittings

Valves and Fittings in Marine Work, A. G. Christie. Shipping, vol. 7, no. 2, Apr. 12, 1919, pp. 19 and 22. Comments on marine practices from viewpoint of central station man. Paper presented before Baltimore Section, Am. Soc.Mech.Engrs.

Water Treatment

Principles of Boiler Water Treatment. Ry. Rev., vol. 64, no. 14, Apr. 5, 1919, pp. 547-549. Origin, effects and means of removing scale; processes and economies of water treatment.

Boiler Water Treatment. Dept. of the Interior, Bur. of Mines, tech. paper 218, 1919, 8 pp. How a reduction in heat losses may be effected through substitution of softened for hard boiler water. Reprint of Eng. Bul. no. 3, prepared by U. S. Fuel Administration.

See also CIVIL ENGINEERING, Water Supply (Softening); MECHANICAL ENGINEERING, Standards and Standardization (Turbo-Generators).

POWER TRANSMISSION

See ELECTRICAL ENGINEERING, Power Applications (Mill Drive); MECHANICAL ENGINEERING, Machine Shop (Motors).

PRODUCER GAS

Gas-Producer Plant

Details of Operation of a Gas Producer Plant, J. S. McClimon. Gas Age, vol. 43, no. 8, Apr. 15, 1919, pp. 421-423, 4 figs. Recommendations to operators and superintendents.

PUMPS

Cost of Pumping

Cost of Pumping Through Pipe Lines, G. C. Habermeyer. Can. Engr., vol. 36, no. 17, Apr. 24, 1919, pp. 402-403. Table showing cost in dollars per mile per million U. S. gal. of pumping water at various rates through different sizes of cast iron pipe lines.

Pumping Station Design

Design of New Electric-Drive Water-Pumping Station was Governed by Power Rate, Henry W. Taylor. Eng. News-Rec., vol. 82, no. 14, Apr. 3, 1919, pp. 653-655, 2 figs. Water consumption change in power, power rates and changes in design involved in development of pumping station of water works at Cohoes, N. Y.

Pumping Station, Distribution

Vergennes Pumping Station, Henry W. Taylor. Fire & Water Eng., vol. 65, no. 18, Apr. 30, 1919, pp. 984-985, 4 figs. System of distribution.

Submersible Pumps

Submersible Salvage Pumps and Engines. Engineer, vol. 127, no. 3299, Mar. 21, 1919, pp. 274-275 & 278, 9 figs. Means adopted to permit ability of engines to withstand submergence in water are: Every part of mechanism is arranged inside trunk of crank-case and those parts which protrude are of robust construction; all openings, such as inlet and exhaust are provided with easily attached covers, which prevent water from getting into interior of engine.

REFRACTORIES

Zirconia

Zirconia: Its Utilisation as a Refractory Substance, an Opacifier, and an Abrasive, M. A. Granger. Chemical News, vol. 118, nos. 3073 and 3074, Mar. 7 and 14, 1919, pp. 115-118 and 121-123. Mar. 7: Chemical nature of zirconiferous minerals. Mar. 14: Experiments on extraction of zirconia by alkaline carbonate.

REFRIGERATION

Absorption System

Mechanical Refrigeration—III. Southern Engr., vol. 31, no. 2, Apr. 1919, pp. 54-57, 2 figs. Diagram of absorption system and direction diagram showing course of gas and aqua ammonia.

Ammonia Compression

Economical Ammonia Compression, A. G. Solomon. Power Plant Eng., vol. 23, no. 8, Apr. 15, 1919, pp. 370-373. Advises stopping of leaks and regulating pressures.

Compression Refrigerating Machine

The Compression Refrigerating Machine, Gardner T. Voorhees. Ice & Refrigeration, vol. 56, no. 4, Apr. 1919, pp. 257-259. Operation of water and steam cycle; general comparison of refrigerants. (Continuation of serial.)

The Ammonia Compression Refrigerating System—XXIX, W. S. Doan. Refrig. World, vol. 54, no. 4, Apr. 1919, pp. 32-34, 4 figs. Methods of purging permanent gases from condenser without losing a great amount of ammonia. (Concluding article.)

Refrigeration by Steam Compression (Entwicklungsformen des Dampf-Kälteprozesses), P. Ostertag. Schweizerische Bauzeitung, vol. 73, no. 4, Jan. 25, 1919, pp. 33-35, 8 figs. Schemes of plants operating on this principle, with reference to plant exhibited by Sulzer Bros. at Berne exposition in 1914.

Fruit, Cold Storage for

Cold Stores for Fruit in Denmark (Forsøgsanlæg paa Statens Havebrugs-Forsøgsstation ved Blangstedt), Erik Helten. Ingeniören, vol. 28, no. 14, Feb. 15, 1919, pp. 89-91, 4 figs. Installation of horizontal double-acting CO_2 machine.

Ice Plants

Deterioration of Ice Plants, Fred Ophuls. Ice & Refrigeration, vol. 56, no. 4, Apr. 1919, pp. 201-202. Advisability of making repairs of any defect as soon as same is discovered.

Competition and Coöperation among Ice Manufacturers, T. Robert Appel. Ice & Refrigeration, vol. 56, no. 4, Apr. 1919, pp. 202-205. Coöperation as a remedy for eliminating competition.

RESEARCH

Bureau of Mines, Pittsburgh Station

The New Pittsburgh Station of the Bureau of Mines, Pts. 1 and 2, George W. Harris. Coal Age, vol. 15, nos. 16 and 17, Apr. 17 and 24, 1919, pp. 707-711 and 749-751, 6 figs. Apr. 17: Consists of central administration building and two wings, one containing the chemical laboratories and the other the mechanical laboratory. Apr. 24: During war, station was devoted to assisting in war work. It is now being organized to operate on a peace basis. (To be continued.)

Government Bureau, Heating and Ventilation

Heating and Ventilation a National Issue, Werner Nygren. Domestic Eng., vol. 87, no. 2, Apr. 12, 1919, pp. 47-49 and 86. Advocates Government research bureau.

Laboratory Organization

The Functions of a Research Laboratory, Saul Dushman. Can. Chem. Jl., vol. 3, no. 4, Apr. 1919, pp. 118-121. Internal organizations and results of research laboratory of General Electric Co.

Laboratory Research and Mill Practice

Relations of Laboratory Research to Mill Practice. Metal Indus., vol. 17, no. 4, Apr. 1919, pp. 174-176, 7 figs. Value of metallurgical research and chemical analyses. Illustrated by examples in which the defects in structure were determined by these processes. From Scovill Bul.

The Relationship between the Laboratory and the Workshop, W. R. Barclay. Engineering, vol. 107, no. 2779, Apr. 4, 1919, pp. 456-457. In reference to principles of operation and objects of accomplishment both in laboratory and in workshop. Paper read before Inst. of Metals.

The Scope of the Works Laboratory, Frederick C. A. H. Lantsberry. Engineering, vol. 107, no. 2779, Apr. 4, 1919, pp. 437-438. Particular reference is made to service given by research laboratory in metallurgical and chemical works. Paper read before Inst. of Metals.

Municipal Testing Laboratory

The Organization of a Standard Municipal Testing Laboratory, J. O. Preston. Cornell Civil Engr., vol. 27, no. 2, Mar. 1919, pp. 50-65, 1 fig. Reasons for establishing it and fundamentals of design.

Organization

The Government and the Organisation of Scientific Research—I & II, Frank Heath. Chemical News, vol. 118, nos. 3074 & 3075, Mar. 14 and 21, 1919, pp. 127-129 and 134-137. Policy advocated by Advisory Council is encouraging research workers, organizing research by industries and establishing national research. Paper read before Roy. Soc. of Arts.

STANDARDS AND STANDARDIZATION

Chemical Standards

Chemical Standards in Relation to the Iron and Steel Trades, H. W. Brearley. Jl. Soc. Chem. Indus., vol. 38, no. 6, Mar. 31, 1919, pp. 97R-98R. Claims that advent of regular microscopic examination and what are called metallographic methods has caused a steady decline in the value of chemical analysis as a means of determining specifications for high-class steel material. Comments on Chem. Standards in issue of Feb. 15, p. 15T.

Industrial Standards

Engineering and Industrial Standardization, C. A. Adams. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 4, Apr. 1919, pp. 549-559. Machinery proposed by Am. Engrs. Standards Committee to create and regulate industrial standards.

Standardized-Parts Production

The Production of Standardized Parts—I, Herbert C. Armitage. Machinery, vol. 14, no. 341, Apr. 10, 1919, pp. 55-57, 2 figs. Jigs, tools and special machines; formulæ of output to pay for tools. Paper read before Instn. Mech. Engrs.

Turbo-Generators

Standardization of Turbo-Generators (Normalisation des groupes électrogènes à turbines à vapeur). Revue Générale de l'Electricité, vol. 5, nos. 14 and 15, Apr. 5 and 12, 1919, pp. 517-527 and 551-556, 4 figs. Specifications prepared by technical committee of the Chambre Syndicate des Constructeurs de Gros Matérial électrique. Apr. 5: concerning turbine and coupling. Apr. 12: relating to electrical part.

See also MECHANICAL ENGINEERING, Foundries (Standardization).

STEAM ENGINEERING

Boiler Heads

Areas of Segments of Boiler Heads, C. H. Berry. Power, vol. 49, no. 17, Apr. 29, 1919, pp. 644-645 4 figs. Charts based on formulæ quoted in paragraphs 214 and 217 of Am. Soc. Mech. Engrs. boiler code, edition of 1918.

Boiler, Hudson

The Hudson Patent Cylindrical and Water Tube Boiler. Colliery Guardian, vol. 117, nos. 30-40, Apr. 4, 1919, p. 777, 4 figs. Large water-holding capacity and steam reserve of Lancashire type, combined with quick steaming properties and positive circulation of water-tube type, has been aimed at in design.

Cross-Compound Engines

Checking Up Alignment, George H. Wallace. Power Plant Eng., vol. 23, no. 8, Apr. 15, 1919, pp. 367-368. Procedure in case of cross-compound engine.

Safety Valves

Some Important Points on Boiler Heating Surface, G. J. Wells. Mar. Eng. of Canada, vol. 9, no. 3, Mar. 1919, pp. 120-121 and 70. Report of committee giving regulations for determining size of safety valve of ordinary type required on each boiler. Paper read before Inst. Mar. Engrs.

Turbines

Some Aspects in Steam Turbine Design. Steamship, vol. 30, no. 358, Apr. 1919, pp. 229-232. Progress of steam turbine as commercial proposition, particularly as applied to marine propulsion. Paper read before Assn. Eng. & Shipbuilding Draftsmen.

See also MECHANICAL ENGINEERING, Heating and Ventilation (Steam Flow), Power Plants (Turbines, Turbo-Generators).

THERMODYNAMICS

Gasoline Vapor

Physical Properties of Gasoline Vapor (Propriétés physiques de la vapeur de pétrole), Jean Rey. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 10, Mar. 10, 1919, pp. 509-513. Deduced from the entropic diagram presented in Comptes rendus vol. 166, 1918, p. 387.

Heat Flow

The Transmission of Heat Through Heavy Building Materials, Eng. & Contracting, vol. 51, no. 18, Apr. 30, 1919, pp. 442-443. Experiments carried out by Dept. of Heating and Ventilating Eng. of University of London.

Mechanical Equivalent of Heat

Sadi Carnot's Determination of the Mechanical Equivalent of Heat (La détermination de l'équivalent mécanique de la chaleur par Sadi Carnot), L. Décombe. Revue Générale de l'Electricité, vol. 5, no. 12, Mar. 22, 1919, pp. 442, 443. Expressions used by Carnot in his Reflexions on the Motive Power of Fire are quoted to prove that he was the first to establish the two thermodynamic laws. Paper before l'Académie des Sciences, Feb. 3, 1919. (See Comptes rendus, vol. 168, pp. 268-271.)

How Carnot Calculated the Mechanical Equivalent of Heat. An unpublished Document (Comment Carnot a calculé l'équivalent mecanique de la chaleur. Un document inédit), C. Raveau. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 11, Mar. 17, 1919, pp. 549-552. Quotes from Notes Inédites de Sadi Carnot expression writer used in connection with experiments on work done in isothermal expansion of a given volume of gas.

Radiation

Note on the Coefficient of Total Radiation of a Uniformly Heated Enclosure, W. W. Coblentz. Jl. Wash. Acad. Sci., vol. 9, no. 7, Apr. 4, 1919, pp. 185-187. Experimental verification of writer's previous conclusion in regard to value of Stefan-Boltzmann constant of radiation.

Specific Heats of Aqueous Solutions

The Specific Heat of Aqueous Solutions, with Special Reference to Sodium and Potassium Chlorides, W. R. Bousefield and C. Elspeth Bousfield. Phil. Trans. Roy. Soc. London, Ser. A, vol. 218, no. 562, Feb. 25, 1919, pp. 119-156, 7 figs. Experimental study of contraction of water when a solute is dissolved in it with reference to specified heat of solution. A cylindrical Dewar vessel immersed in water bath as the calorimeter, and a "mercury resistance thermometer" as the electric heater.

WELDING

Acetylene Welding

Oxy-Acetylene Welding in the Railroad Shops, F. Hazeldine. Can. Machy., vol. 21, no. 14, Apr. 3, 1919, pp. 334-335. Facts regarding use of oxy-acetylene welding and cutting torch in railroad shop. Paper read before Instn. Mech. Engrs.

Oxy-Acetylene and the Safety First Movement, A. Cressy Morrison. Jl. Acetylene Welding, vol. 2, no. 11, May 1919, pp. 543-549. Safety in relation to manufacture and transportation of materials and apparatus used in connection with art of welding and cutting. Address delivered before Western Pa. Division of Nat. Safety Council.

The Oxy-Acetylene Torch in the Railway and Locomotive Engineering Field, J. F. Springer. Jl. Acetylene Welding, vol. 2, no. 11, May 1919, pp. 570-576. Principles of gas welding methods and survey of various applications in welding of sheet metal.

Oxy-Acetylene Welding, J. H. Davies. Acetylene & Welding Jl., vol. 16, no. 186, Mar. 1919, pp. 46-47. Experiments in welding of steels for the purpose of determining conditions for securing good results. Paper read before Instn. Mech. Engrs.

Oxy-Acetylene Welding An Important Factor in Poison Gas Manufacture. Jl. Acetylene Welding, vol. 2, no. 11, May 1919, pp. 556 and 558. Work of Chem. Warfare Service.

Welding by the Oxy-Acetylene Method—II, J. F. Springer. Automotive Eng., vol. 4, no. 4, Apr. 1919, pp. 181-183, 3 figs. Details of apparatus used and reasons for the use of each part. Suggestions in regard to adjusting flame. (To be continued.)

Aluminum

Improvements in the Autogenous Welding of Aluminum or Its Alloys. Acetylene & Welding Jl., vol. 16, no. 186, Mar. 1919, p. 60. Object of invention is to obtain a flux having melting point desired with use of no other salts than those of the halogen group.

Blowpipes

Improvements in Blowpipes. Acetylene & Welding Jl., vol. 16, no. 186, Mar. 1919, p. 59, 2 figs. Invention relates to welding blowpipe of the type having an attachment in the form of a tube adapted so as to be readily attached to the blowpipe.

Cast-Iron Welding

Hard Spots in Cast Iron Welding, S. W. Miller. Welding Engr., vol. 4, no. 4, Apr. 1919, pp. 19-24, 23 figs. Examination of various structures containing different percentages of carbon in the light of accepted metallurgical phenomena taking place in heat treatment, forms basis of suggesting cause of formation of hard spots and proposing remedy for avoiding same.

Electric Welding

Electric Arc Welding, F. A. Anderson. Mech. Eng., vol. 41, no. 5, May 1919, pp. 452-454, 8 figs. Its application to expanding pipe into flange, with reference to special instance in which weld was tested in various ways. Paper read before San Francisco Section Am. Soc. Mech. Engrs.

The Application of Electric Welding to Steel Shipbuilding, H. A. Hornor. Proc. Engrs. Soc. Western Pa., vol. 34, no. 10, Jan. 1919, pp. 641-670 and (discussion) pp. 671-676, 35 figs. Survey of extent of employment of electric welding in U. S. Set of standard symbols and nomenclature prepared by Electric Welding Branch, United States Shipping Board Emergency Fleet Corporation.

Electric Welding: Its Theory, Practice, Application and Economics, H. S. Marquand. Elecn., vol. 82, nos. 13 and 14, Mar. 28 and Apr. 4, 1919, pp. 350-352 and 377-379, 7 figs. Mar. 28: Properties of metals considered from welding point of view. Apr. 4: Thomson process of resistance welding; requirements of plants and application of method to chain welding, tire welding and wire welding; electro-percussive method. (To be continued).

Electric Welding and Welding Appliances—V, VI & VII. Engineer, vol. 127, nos. 3298, 3299 and 3300, Mar. 14, 21 & 28, 1919, pp. 241-243, 267-268 and 296-299, 18 figs. Quasi-arc coated-metal-electrode process.

Electric Arc Welding Principles, E. Wanamaker and H. R. Pennington. Ry. Elec. Engr., vol. 10, no. 4, Apr. 1919, pp. 107-110, 1 fig. Practice concerning metals used, their application and electrical characteristics. (Continuation of serial.)

Electric Welding and its Applications, Walter Leonard Lorkin. Jl. Roy. Soc. Arts, vol. 67, no. 3463, Apr. 4, 1919, pp. 304-314 and (discussion) pp. 315-317, 3 figs. Endeavors to show that process is simple, that it can be carried out with ordinary labor and that welds are efficient and effected at small cost.

Fusion in Arc Welding, O. H. Eschholz. Power, vol. 49, no. 12, Apr. 1, 1919, pp. 504-506, 19 figs. Effect of arc length, welding procedure, electrode material, arc current and electrode diameter upon such characteristics as penetration and overlap.

Notes on Electric Arc Welding. Eng. & Min. Jl., vol. 107, no. 17, Apr. 26, 1919, p. 743, 4 figs. Practice in construction of transformer tanks at Pittsfield works of General Electric Co.

Some Recent Applications of Arc Welding, Frank C. Perkins. Can. Machy., vol. 21, no. 12, Mar. 20, 1919, pp. 281-283, 8 figs. Explanation of process and of methods in use; illustrations of work done by aid of arc welding.

Suggestive Applications of Electric Arc Welding. Am. Blacksmith, vol. 18, no. 7, Apr 1919, p. 177, 9 figs. Welding of locomotive back flue sheet, flanged head and similar operations.

Electric Welding Machines

Winfield Electric Welding Machines. Car

Question What is the average life of a Heine boiler?

Answer: We don't know. The first Heine boiler ever built, after 35 years of constant use, is still serviceable, according to a certified statement by the Fidelity and Casualty Co.

Question Why is the Heine boiler capable of withstanding higher pressure than other boilers?

Answer: Made throughout of high grade tough steel of high tensile strength. Double staybolts are used for high pressures. Round—not elliptical—handholes.

Question Why is the Heine the most efficient boiler?

Answer: Large reverberatory combustion chamber. Hot gases are in constant touch with the heating surface from beginning to end of passes. No waste at turns. No dead gas pockets. Entire heating surface fully utilized. Always clean because of permanently installed soot cleaner.

Our war contribution was—nearly half a million horsepower of strong, durable, efficient Heine boilers.

Our peace contribution is—*more* strong, durable, efficient Heine boilers.

HEINE SAFETY BOILER CO.

5321 MARCUS AVENUE ST. LOUIS, MISSOURI

HELIOS

Machy., vol. 21, no. 15, Apr. 10, 1919, pp. 353-354, 3 figs. Motor-driven spot welder.

Emergency Repairs

Trials of an Army Welder in France. Jefferson A. Snyder. Jl. Acetylene Welding, vol. 2, no. 11, May 1919, pp. 566-570. Emergency repairs conducted under handicap of insufficient equipment.

Expansion and Contraction

Making Expansion Outwit Contraction. David Baxter. Jl. Acetylene Welding, vol. 2, no. 11, May 1919, pp. 558-566, 4 figs. Welding 400-lb. gasoline engine flywheel. Fractures consisted of two cracked spokes and a crack full length of the hub; cracks in spokes were near juncture of spokes and hub.

Gas Welding Apparatus

Some Welding Shop Ideas. David Baxter. Am. Blacksmith, vol. 18, no. 7, Apr. 1919, pp. 159-162, 5 figs. Construction details of compound heater gas burner and ladle and preheating torch.

Locomotive-Cylinder Welding

Welding a Locomotive Cylinder. Welding Engr., vol. 4, no. 4, Apr. 1919, pp. 34-40, 6 figs. Break was caused by cylinder bushing being loose in cylinder and turning around so that cylinder cock hole was plugged up, and piston coming forward pushed out whole front of cylinder including valve-chamber front.

Plastic Arc

The Plastic-Arc System of Welding. J. O. Smith. Motorship, vol. 4, no. 5, May 1919, pp. 36-37, 15 figs. Technical discussion of methods employed.

Preheating

Discussion of the Merits of Both Charcoal and Gas Preheating, Fred J. Maeurer. Welding Engr., vol. 4, no. 4, Apr. 1919, pp. 25-27, 8 figs. Recommends use of charcoal in preheating castings where expansion and contraction must be taken into consideration.

Steel, Mild

Welding Mild Steel, H. M. Hobart. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 4, Apr. 1919, pp. 561-609, 19 figs. Investigations undertaken by Welding Research Sub-Committee of Welding Committee of Emergency Fleet Corporation. General object was to extend use of welding in construction of merchant ships.

Thermite Welding

Repairing a Broken Crankshaft by Thermite, W. F. Sutherland. Can. Machy., vol. 21, no. 17, Apr. 24, 1919, pp. 404-405, 3 figs. Repair job on a 10-in. upsetting press crank done at Metal & Thermite plant, Toronto.

Welded Materials, Tests of

Tests of Welded Materials, Paul C. Tris, Maurice Kapetensky. Proc. Steel Treating Research Soc., vol. 2, no. 3, 1919, pp. 18-24 and 56, 16 figs. The metallurgical laboratory where welded parts of Liberty engine are tested is operated in three divisions, the chemical, the physical and metallographic laboratories. The experimental data secured in these divisions and the interpretation given to micrographs are set forth.

Welders, Training

Training a Welder. Jl. Acetylene Welding, vol. 2, no. 11, May 1919, pp. 550, 552 and 556, 1 fig. On training by apprenticeship. (To be continued.)

Welding and Cutting

Modern Welding and Cutting, pts. VII, VIII and IX. Ethan Viall. Am. Mach., vol. 50, nos. 14, 15 and 16, Apr. 3, 10 and 17, 1919, pp. 641-645, 675-679 and 733-737, 20 figs. Apr. 3: Thermit welding of cast iron and other parts. Apr. 10: History and uses of the gas torch. Apr. 17: Oxygen and hydrogen by the electrolytic method.

See also RAILROAD ENGINEERING, Shops (Welding); MARINE ENGINEERING, Yards (Welding).

WOOD

Seasoning

Practical Rules for the Seasoning of Wood, Harold S. Betts. Ry. Maintenance Engr., vol. 15, no. 5, May 1919, pp. 169-170, 2 figs. Suggestions in regard to uniform drying of timber with minimum exposure to decay.

Statistics of Production

Production of Lumber, Lath, and Shingles in 1917, Franklin H. Smith and Albert H. Pierson. U. S. Dept. of Agriculture, bul. no. 768, Apr. 5, 1919, 44 pp. Collection and compilation of statistics. Estimated total lumber production was 36,000,000,000 board feet.

See also RAILROAD ENGINEERING, Permanent Way and Buildings (Ties), Rolling Stock (Lumber for Freight Cars); MARINE ENGINEERING, Yards (Wooden Ships); CIVIL ENGINEERING, Harbors (Timber, Impregnated).

Organization and Management

ACCOUNTING

Brick Plant

Simplified System of Counting Cost, C. F. Mattes. Brick & Clay Rec., vol. 54, no. 7, Apr. 8, 1919, pp. 591-594. Suggested plan for average size brick plants.

Cost Accounting

Cost Accounting to Aid Production—VIII, G. Charter Harrison. Indus. Management, vol. 57, no. 5, May 1919, pp. 400-404, 1 fig. Diagram illustrating use of specification costs in ascertaining profits and losses made by individual salesmen.

Highway Contractors

Cost Keeping for Highway Contractors, H. P. Gillette. Contract Rec., vol. 33, no. 15, Apr. 9, 1919, pp. 336-338. Methods for determining unit costs, obtaining overhead costs and prorating them.

Inventories

How We Prepare for and Take Inventory, H. F. Harris. Factory, vol. 22, no. 4, Apr. 1919, pp. 681-686, 10 figs. Instructions given to men at plant of Republic Motor Truck Co.

EDUCATION

Employment Management

Government Course for Training Employment Managers, Meyer Jacobstein. U. S. Dept. Labor, Bur. Labor Statistics, Bul. 247, Jan. 1919, pp. 19-24. War-Emergency course.

Engineers

Specialization in Education of Engineers (Sulla specializzazione della educazione degl' ingegneri), Giuseppe Astorri. Ingegneria Italiana, vol. 3, no. 63, Mar. 13, 1919, pp. 169-171. High-school courses in Italy are found to be insufficiently adaptable to form a basis for subsequent engineering education.

Foundrymen

Industrial Education. Foundry Trade Jl., vol. 21, no. 206, Feb. 1919, pp. 98-102. Considered as means for developing industry, particularly in relation to the operation of a foundry. Address delivered before Scottish Branch British Foundrymen's Assn.

Mining

Mining and the Industrially Disabled, J. C. Murray. Can. Min. Inst. Bul. no. 84, Apr. 1919, pp. 393-398. Work being done by Canadian Government in rehabilitating war cripples.

Telephone Operation

The Cripple in the Telephone Field, Douglas C. McMurtrie. Telephony, vol. 76, no. 17, Apr. 26, 1919, pp. 31-32. Reëducation of injured or crippled employee estimated as more profitable to all concerned than disability compensation.

Vocational Training

Army Vocational Training, C. R. Dooley. Eng. Education, vol. 9, no. 7, Mar. 1919, pp. 263-277, 10 figs. Plan for organization adopted by Committee on Education and Special Training during emergency, which necessitated rapid training of 90,000 men for military service.

FACTORY MANAGEMENT

Clerical Work

Systematic Superintendence, Charles F. Dingman. Concrete, vol. 14, no. 3, Mar. 1919, pp. 84-87, 5 figs. Routine covering field clerical work on construction operations.

Cooperation, Internal

Necessary Internal Coöperation between Employer and Employee must be Mutually Evolved, Charles P. Steinmetz. Automotive Industries, vol. 40, no 16, Apr 17, 1919, pp. 831-833. Declares that capital and labor are equal necessities in modern industry and must be equally represented in management and distribution of profits.

Employment Management

Handbook of Employment Management in the Shipyard. United States Shipping Board Emergency Fleet Corporation, Employment Management Branch, Indus. Relations Division, bul. 3, 61 pp. Methods to be followed in process of selection and placement of new worker.

The Principles of Employing Labour. Eng. & Indus. Management, vol. 1, no. 9, Apr. 10, 1919, pp. 273-276. Factors determining selection of workpeople taking into account suitability of applicant for class of work he is expected to perform.

Employment Problem of the U. S. Naval Aircraft Factory, Frederic C. Coburn. Indus. Management, vol. 57, no. 5, May 1919, pp. 359-365, 9 figs. Organization of employment department.

The Organization of an Employment Department, Charles E. Fouhy. Eng. & Indus. Management, vol. 1, no. 8, Apr. 3, 1919, pp. 231-236, 16 figs. Routine of employment department of Curtiss Aeroplane & Motor Co.

Factory Layout

The Automobile Factory—I. Automobile Engr., vol. 9, no. 122, Jan. 1919, pp. 22-25, 9 figs. Layout, construction and equipment.

New South Philadelphia Plant of the Westinghouse Electric & Mfg. Co., H. T. Herr. Elec. Jl., vol. 16, no. 4, Apr. 1919, pp. 114-121, 22 figs. Layout indicating shop arrangement and safety features.

Garment Trade

Factory Management in Garment Trades, Mack Gordon. Indus. Management, vol. 57, no. 5, May 1919, pp. 345-349, 1 fig. Methods of controlling production, economizing materials and expediting manufacture. (To be continued.)

Industrial Conferences

The Joint Industrial Conference. Eng. & Indus. Management, vol. 1, no. 8, Apr. 3, 1919, pp. 242-243. Methods of negotiation between employers and trade unions. Report of Provisional Joint Committee appointed by Nat. Indus. Conference.

Machine-Tool Plant

Organization and Management of a Machine Tool Plant—II & III, Oskar Kylin and Erik Oberg. Machy., vol. 25, nos. 8 and 9, Apr. and May, 1919, pp. 698-702 and 813-820, 29 figs. On principles of organization and details of system used in a medium-size machine tool-manufacturing plant making a single line of machines.

The New Home of Pratt & Whitney Co., Ltd., J. H. Moore. Can. Machy., vol. 21, no. 14, Apr. 3, 1919, pp. 321-324, 8 figs. Description of plant design and arrangement to manufacture small tools on great scale.

Material Keeping

Keeping Track of Factory Material—H. J. G. Hickman. Factory, vol. 22, no. 4, Apr. 1919, pp. 702-707, 12 figs. Forms used in disbursing purchased and manufactured material.

Office Arrangement

The Largest Gas Utility Company in the World. Gas Age, vol. 43, no. 7, Apr. 1, 1919, pp. 335-338, 8 figs. Office arrangement of Consolidated Gas Co. of New York.

Organization in Industry

"Technicracy"—Ways and Means to Gain Industrial Democracy, William Henry Smyth. Indus. Management, vol. 57, no. 5, May 1919, pp. 385-389. Discusses ways and means to develop, guide and direct social organization in industry.

Industrial Coöperation, Charles P. Steinmetz. Eng. & Min. Jl., vol. 107, no. 17, Apr. 26, 1919, pp. 748-749. Systems for developing coöperation between capital and labor. Speech delivered at special session of Editorial Conference.

The Part of Capital and Management in Industry. Stone & Webster Jl., vol. 24, no. 4 Apr. 1919, pp. 289-292. Argues that coöperation is none the less real or mutually helpful because the division of profits is unequal.

Problems of Industrial Organization, Major Greenwood. Quarry, vol 24, no. 266, Apr 1919, pp. 106-108. Also Machy. Market, no 961, Apr. 4, 1919, pp. 21-22. Researches on conditions, excluding those determining efficiency of inanimate machines, which help or hinder industrial output, conducted under auspices of Health of Munition Workers Committee and the Welfare and Health Section of the Ministry of Munitions. Paper read before Roy. Statistical Soc.

Pacific Coast

Possibilities of Intensive Manufacturing on the Pacific Coast, G. N Somerville. Pac. Ma Rev., vol. 16, no. 4, Apr. 1919, pp. 110-112,

Let Us Do Your Special Work

Production Work and Special Work *started right* will be *finished right*

Work to be finished right must be started right—must be designed right—and that is where the S. A. S. designing and drafting departments come in. These departments are made up of specialists who can solve your problems—to develop and perfect your special device or duplicate accurately your unusual special part. Here is where your work starts and starts right.

Designing and Engineering Department

A department of high-salaried experts—thoroughly skilled and experienced, who can and will give authoritative supervision to designing, development and production—in this department all speculative elements are eliminated, and accuracy and perfection assured in the finished product.

Drafting Department

A department of specialists—well versed in layout, design, detail and materials — each draftsman thoroughly familiar with every detail of the particular work in which he specializes from practical experience as well as through years of study.

Get the benefit of this expert service

Where we fit in to help you:

—when your proposition is nothing but an idea, or planned out, so to speak, on paper
—when doubt arises whether to continue production of a special part or device
—when you meet continuous trouble in production
—when necessary special work becomes profitless and too expensive for you to produce
—when you lack room or special equipment for production

This is the third of a series of advertisements showing our plant, our methods and the work we do—Our model room in the next issue.

Our staff of experts and our developing and production laboratories are especially organized to assist you.

Write to-day and learn just how we can serve you.

LET US BUILD YOUR SPECIAL MACHINES

SLOCUM, AVRAM & SLOCUM LABORATORIES, Inc.

Factory
NEWARK
New Jersey

SLOCUM-AVRAM-SLOCUM MANAGEMENT

New York Office
Woolworth Building
New York, N.Y.

IT WILL BE RIGHT IF WE BUILD IT

figs. M... ...ing activities of Pacific Coast during w... ... as promising further industrial d... ...ments.

Production Control

Keeping Tra... ... Production. Henry A. Noar. Am. Mac... ...l 50, no. 16, Apr 17, 1919, pp. 745-747, 5 figs. Device designed ... provide uniform met...ods throughout plant.

Production Systems

Turning Out ... Tractors per Day—II. P. M. Heldt. Automotive Industries, vol. 40, no. 16, Apr. 17, 1919, pp. 852-857, 10 figs Production system employed at Milwaukee plant of Internat. Harvester Co.; details of machining and ...ssembling methods.

Railroad Tracks

The U. ... & S. Co.'s Operating Methods. Coal Trade J., ... 50, no 16, Apr 16, 1919, pp. 407-409, 5 figs. Arrangement of railroad tracks said to have effected important economies.

Shop Management

Lay-out and P...-Rate Card System. Machinery, vol. 13, no. 338, Mar. 20, 1919, pp. 692-694, 13 figs. Forms for use in shop management.

Scientific Factory Management—II & III. A. D. Denning. Eng. & Indus. Management, vol. 1, nos. 8 & 9, Apr. 3 & 10, 1919, pp. 246-249 and pp. 278-282. Functions of foremen; functions of workers. Third and concluding lecture of series delivered under auspices of Birmingham Section of Inst. of Metals.

Advances in Industrial Management. John Calder. Am. Mach., vol. 50, no. 17, Apr. 24, 1919, pp. 807-809. Address before Indus. Conference of N. Y. Business Publishers Assn.

Shop-Order Origination

Managing for Maximum Production—III. L. V. Estes. Indus. Management, vol. 57, no. 5, May 1919, pp. 379-384, 11 figs. Takes up origination of shop order and shows its connection with the various operations and control of manufacturing.

Standardized Parts

Production of Standardized Parts. Herbert C. Armitage. Eng. & Indus. Management, vol. 1, no 9, Apr. 10, 1919, pp. 266-272, 8 figs. Development of engineering methods in manufacture of jigs, tools and special machines (To be continued.)

Task Setting

The Human Factor in Task Setting. Eng. & Indus. Management, vol. 1, no. 9, Apr. 10, 1919 pp. 263-265, 1 fig. Suggests that task be not made so small as to prevent cost reduction, nor so large that worker can exceed it by a wide margin and so have it lose its significance

Tool Rooms

The Tool Room. E. Hayes Page's Eng. Weekly, vol 34, no 759, Mar 29, 1919, pp. 185-187, 4 figs Interchangeability of tools as factor in economic production of machinery.

See also MARINE ENGINEERING, *Yards (Ford Methods*

FINANCE AND COST

Foundry, Steel

Compiling Cost Data at ... Naval Steel Foundry. Wa... S. Dexsey. Foundry, vol. 47, no. 5, Apr 1... 1919, pp. 206-211, 11 figs. System of cross-... ... reports as basis for production and ... analyses

LABOR

Employee Representation

How ... Democracy Works at Our Plant. Factory, vol 22, no. 4, Apr. 1919, pp. 677-681, 2 figs. Evolution from national government form of management to present day structure of employee representation in plant of Printz Biederman Co.

Housing

The Town of K... ...wa. Thomas Adams. Can Engr., vol ... ... Feb. 27, 1919, pp 260-262, 3 figs. Housing ... for employees of Riordon Pulp & Paper Co.

Miners' Cottages in Kent. Iron & Coal Trades Rev., vol. 98, no 2664 Mar. 21, 1919, p. 354, 2 figs. Particulars and dimensions of accommodation provided.

Good Housing and Labor Turnover. Leslie H. Allen. Am. Contractor, vol. 40 no. 15, Apr. 12, 1919, p. 23. Labor turnover is attributed to poor housing, because, it is stated, good housing has not kept up with healthful factory surroundings.

Labor Policies

Labor Program of the Department of Labor. William B. Wilson. U. S. Dept. Labor, Bur. Labor Statistics, Bul. 247, pp. 160-171. Based, it is said, on experience acquired during war.

Outline of a National Labor Policy. Ordway Tead. U. S. Dept. Labor, Bur. Labor Statistics, Bul. 247, pp. 148-155. Criticises statements advanced by employers in regard to policy followed by Government during war.

The Principles of Industrial Relations. Eng. & Min. Jl., vol. 107, no. 17, Apr. 26, 1919, pp. 754-756. Statement prepared by special committee of Chamber of Commerce of U. S. A., with a view of furnishing a basis on which American industry can build a national labor program

Labor Situation

The Present Labor Situation. Morris L. Cooke. U. S. Dept. Labor, Bur. Labor Statistics, Bul. 247, Jan. 1919, pp. 63-65. Suggestions in regard to activities which writer believes may be assumed by Dept. of Labor in addition to its present work.

Nova Scotia Collieries

Industrial Relations at the Collieries in Nova Scotia. F. W. Gray. Can. Min. Inst. Bul., no. 84, Apr. 1919, pp. 389-393. Attitude of workers towards proposed affiliation with United Mine Workers of America.

Repeaters

Is it Wise to Hire the Repeater? Leonard Blakey. Indus. Management, vol. 57, no. 5, May 1919, pp. 390-399, 10 figs. Study of turnover with reference to causes for leaving and duration of service on reëngagement.

Salaries

Classification of Salaries. J. L. Jacobs. Can. Engr., vol. 36, no. 13, Mar. 27, 1919, pp. 341-342. Principles and procedure in standardization of engineering salaries, particularly in regard to railroad positions. Address before Chicago R. R. Conference.

Soldiers and Sailors

Statement of Policy Relative to Employment of Returning Maryland Soldiers and Sailors. Baltimore, vol. 12, no. 7, Apr. 1919, pp. 15-16. Adopted by Employment Managers' Circle of Merchant & Mfrs. Assn. and other prepresentatives of industry.

Wage Rates

Cost of Living Studies as a Basis for Making Wage Rates. Royal Meeker. U. S. Dept. Labor, Bur. Labor Statistics, Bul. 247, Jan. 1919, pp. 43-50. Advocates this system in order to reduce dissatisfaction and bases estimates made on what is termed an adjustable basis.

The Different Systems of Wages (Les différents systèmes de salaires). Métallurgie, vol. 51, no. 13, Mar. 26, 1919, pp. 714-715, 2 figs. Taylor and Gantt systems. (Continuation of serial.)

Analyzing Bonus and Piece Work Systems—I. W. F. Rockwell. Am. Drop Forger, vol. 5, no. 4, Apr. 1919, pp. 162-166. Halsey, Rowan and Taylor plans.

Welfare Work

Developing Pride and Interest in the Job. W. R. Basset. Factory, vol. 22, no. 4, Apr. 1919, pp. 693-696, 4 figs. Suggests hiring welfare worker or personnel manager. Third article.

Modern Industrial Plants—VIa. George C. Nimmons. Architectural Rec., vol. 45, no. 4, Apr. 1919, pp. 343-355, 12 figs. Influence of employees' welfare work in reducing labor turnover.

Women

Women in Industry. H. E. Miles. U. S. Dept. Labor, Bur. Labor Statistics, Bul 247, Jan 1919, pp 119-129. Opinions of executives concerning efficiency of women and records obtained in countries where they have been engaged in industry.

Standards for Women Employees. Hugh Fullerton. U. S. Dept. Labor, Bur. Labor Statistics, Bul. 247, Jan. 1919, pp. 106-111. Advocates throwing around women in industry an unusual precaution by reason of greater social evils which result from their weakening.

Women in the Lead Industries. Alice Hamilton. U. S. Dept. of Labor, Bur. of Labor Statistics, no. 253, Feb 1919, 38 pp. Lead industries in U. S.; British records of lead poisoning of women in white lead industry; degree of susceptibility of women and men to poisoning; prevention of poisoning.

LIGHTING

Carbide Lamps

Illumination and the Safety Problem. Charles C. Phelps. Coal Indus., vol. 2, no. 4, Apr. 1919, pp. 153-156. Advocates use of carbide lamp as brightest and safest form of illumination.

Good Factory Lighting vs. Increased Production. H. Leveridge. Elec News, vol. 28, no. 7, Apr. 1, 1919, pp. 41-43. Discussion of provisions adopted in recent code of lighting for factories, mills and other work places, prepared by a Commission of Assn. Elec. Contractors and Dealers.

See also ELECTRICAL ENGINEERING, *Lighting and Lamp Manufacture;* MECHANICAL ENGINEERING, *Gas Engineering (Lightings, (Mantles).*

PUBLIC REGULATION

Municipal Ownership

Municipal Ownership Evils. Walton Clark. Gas Record, vol. 15, no. 8, Apr. 23, 1919, pp. 245-250. Holds that municipal ownership of gas plants is contrary to proper theories of democratic government. Paper read before Pa. Gas Assn.

RECONSTRUCTION

Construction Programs

A Post-War Construction Program—II, Charles C. May. Architectural Rec., vol. 45, no. 4, Apr. 1919, pp. 325-342, 16 figs. Organization and activities of Building Bur. of Int. Committee of Y. M. C. A.

Labor Relations

A Factor of Industrial Reconstruction. M. Webster Jenkinson. Machy. Market, nos. 961 & 962, Apr. 4 & 11, 1919, pp. 23-24 and 21. Recommends removing fear of workers that cost statistics will mean pressure put on them to work harder.

Machine Tools

Machine Tools. Alfred Herbert. Machy. Market, nos. 961 & 962, Apr. 4 & 11, 1919, pp. 19-20 and 17-18. Importation into England of American tools developed under conditions of expensive labor, has, in the writer's opinion, been of service in preparing that country to meet similar conditions. Paper read before North-East Coast Instn. Engrs. & Shipbuilders.

Telephone Booths

Market for Telephone Goods in Asia. Telephone Engr., vol. 21, no. 4, Apr. 1919, pp. 137-141, 3 figs. Extracts from Special Agent's series no. 172, Department of Commerce.

SAFETY ENGINEERING

Blasting, Quarry

Quarry Blasting with Electricity. A. S. Anderson. Cement & Eng. News, vol. 31, no. 4, Apr. 1919, pp. 32-34, 3 figs. Precautions to be observed.

Dust Inflammability

Inflammability of Carbonaceous Dusts in Air and in Atmospheres of Low Oxygen Content. H. H. Brown. Jl. Franklin Inst., vol. 187, no. 4, Apr. 1919, pp. 504-506, 1 fig. Research of Grain Dust Explosion Investigation Laboratory, Bur. of Chemistry.

Fire Prevention

Final Report of the Fire Prevention Section of the United States War Industries Board. Laboratories' Data, Underwriters' Laboratories, Nat. Board of Fire Underwriters, no. 1, Feb. 1919, pp. 11-16. Conditions existing in respect to fire hazard in privately owned property where machinery, material or supplies used for war purposes were manufactured, handled or stored.

See also Sprinklers and Dust Inflammability.

Gas Masks

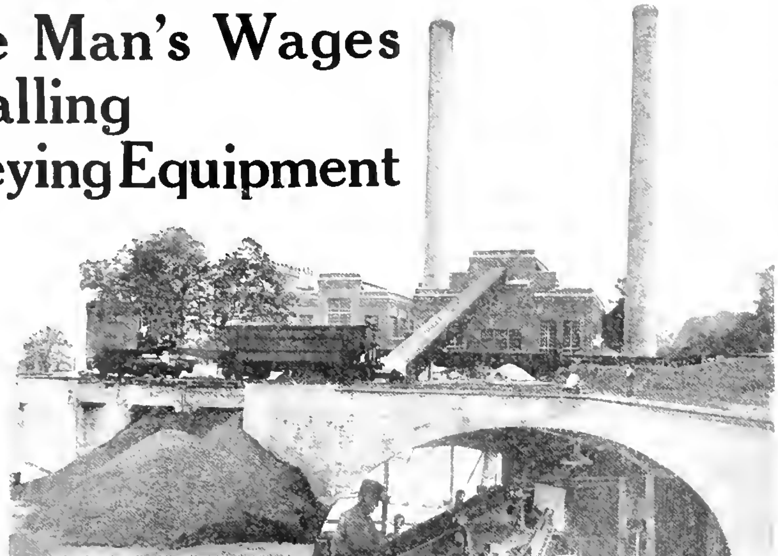
Army Gas Masks in Sulphur-Dioxide Atmospheres. A. C. Fieldner and S. H. Katz. Eng. & Min. Jl., vol. 107, no. 16, Apr. 19, 1919, pp. 693-695, 3 figs. Sectional diagrams of type adopted for use in smelters and sulphide roasters.

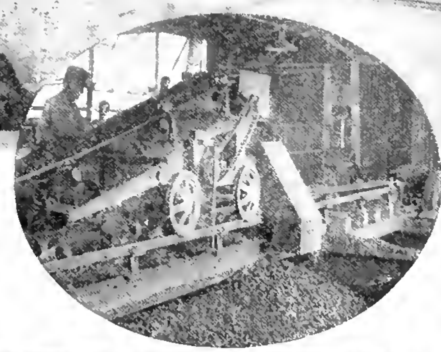
Respirators, Gas Masks and Oxygen Apparatus. Commercial America, vol. 15, no. 10, Apr. 1919, pp. 39-41. Work of Bureau of Mines in providing industrial workers with means of protection against gases incident to mining, fire, accident and various manufacturing processes.

Human Factor

The Human Factor in Accident Occurence. Eng. & Indus. Management, vol. 1, no. 9, Apr. 10, 1919, pp. 261-262. Inexperience and overwork in their relation to accident rates.

Handling Costs Reduced from $65 Daily to One Man's Wages by Installing Jeffrey Coal Conveying Equipment



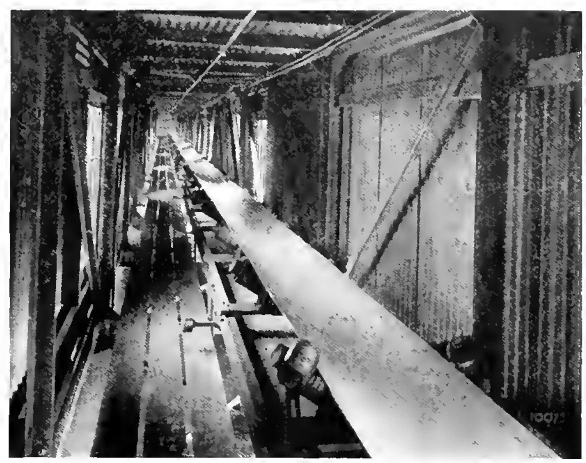


Showing interior view of head end of 20-in. Belt Conveyer over bunkers operated over a self-propelling belt tripper.

The new generating plant of the Mansfield Electric Light and Power Company, located at Melco, Ohio, 13 miles southeast of Mansfield, offers a striking example of the economies that can be effected by the substitution of modern equipment for old time methods. All equipment used is the last word in efficiency.

The coal for this plant is unloaded from railroad cars into a steel hopper, or dumped into a submerged storage into a 2000-ton concrete bin, which now stands where the coal pile is shown in top illustration.

From track hopper, a 30-in. Reciprocating Plate Feeder regulates the flow of coal to a Jeffrey 30 in. x 30 in. Single Roll Crusher, as shown in lower illustration, and a Jeffrey 20-in. Belt Conveyor carries the crushed coal to boiler house and distributes to bunkers.



20-in. Belt Conveyer in the inclined portion from Crusher to boiler house

The Conveyor proper consists of 736 ft. of 20-in., five-ply rubber belting. It is driven at a speed of 258 feet per minute and is supported by 80 standard 20-in., three-pulley troughing idlers, 36-20-in. return idlers and sufficient guide idlers.

The Jeffrey Equipment has a rated capacity of 50 tons of coal per hour, although the engineers in charge of this installation state that it is many times called upon to handle up to 70 tons per hour.

Write for Jeffrey Catalog No. 175-W, featuring this and numerous other Belt Conveyer Installations.

The Jeffrey Mfg. Co.

904 North Fourth Street
Columbus, Ohio

Handle it Mechanically

Showing Reciprocating Plate Feeder under Track Hopper and 30 in. x 30 in. Single Roll Crusher which discharges the coal on foot end of belt conveyer.

Respirators

See Gas Masks, page 20*a*.

Sprinklers

New Code for Automatic Sprinklers. Am. Architect, vol. 115, no. 2261, Apr. 23, 1919, pp. 588-595, 4 figs. Rules for fire extinguishing appliances (sprinkler system), adopted May 24, 1917, by Board of Standards and Appeals, as amended May 2, 1918, and Jan. 2, 1919, effective from Feb. 17, 1919.

Welding

Safety Rules for Oxy-Acetylene Welding. Machy. (N. Y.), vol. 25, no. 8, Apr. 1919, pp. 733-735, 3 figs. Adopted by Western Pennsylvania Division of Nat. Safety Council.

See also MINING ENGINEERING, Coal and Coke, Mines and Mining (Accidents), (Safety Lamps); CIVIL ENGINEERING, Building and Construction (Sprinklers).

SALVAGE

Sacks, Cement

The Proper Handling of Empty Cement Sacks. E. V. Aldridge. Ry. Maintenance Engr., vol. 15, no. 4, Apr. 1919, pp. 123-125, 1 fig. Practices of user and manufacturer which affect the salvage of cement sacks.

TRANSPORTATION

Truck Transportation

Ship-by-Truck Movement Invades South to Prove Great Benefits of Highway Transport. Commercial Vehicle, vol. 20, no. 6, Apr. 15, 1919, pp. 19-21 and 29, 6 figs. Georgia demonstration in which 37 trucks delivered 100 tons of goods to cities within 50-miles radius.

Economical Organization of Transport Trucks in a Large City (L'organisation économique des transports industriels automobiles dans une grande ville). Emile Belot. Journal des Usines à Gaz, vol. 43, no. 6, Mar. 20, 1919, pp. 93-95. Analytical determination of number of workmen, employed for loading and unloading, which will reduce transportation price per ton to a minimum. From Comptes rendus des séances de l'Académie des Sciences, no. 8, Feb. 24, 1919.

Tunnel, Vehicular, New York-New Jersey

The New York and New Jersey Vehicular Tunnel, Edward A. Byrne. Eng. World, vol. 14, no. 8, Apr. 15, 1919, pp. 33-37, 6 figs. Reasons for constructing it and plans of various proposed projects. Paper presented before N. Y. Branch Am. Soc. Civil Engrs.

Water Transportation

The Development of American River Traffic —I. Shipbuilding & Shipping Rec., vol. 13, no. 14, Apr. 3, 1919, pp. 406-408, 3 figs. Plans for towing steamers and steam barges on Mississippi and Black Warrior Rivers.

See also MINING ENGINEERING, Coal and Coke (Transportation); MUNITIONS AND MILITARY ENGINEERING (Railroad Transportation); AERONAUTICS, Aircraft (Transport Service).

Electrical Engineering

ELECTROCHEMISTRY

Electromotive Force of Metals

Electromotive Force of Metals (Force électromotrice des métaux). J. A. Montpellier. Industrie Electrique, vol. 28, no. 642, Mar. 25, 1919, pp. 103-104. Ionic phenomena in thermocouples and table of relative potentials of metallic elements.

Importance

Electrochemistry in its Human Relations. F. J. Tone. Chem. & Metallurgical Eng., vol. 20, no. 8, Apr. 15, 1919, pp. 413-415. Electrochemistry can contribute to human progress and raise standard of living by providing cheap fertilizer for increased crop yields, improve sanitation and produce new materials of construction.

Nelson Cell

The Nelson Electrolytic Chlorin Cell. C. F. Carrier, Jr. General Meeting Am. Electrochemical Soc., Apr. 3-5, 1919, paper no. 16, pp. 221-231, 3 figs. History, development, construction and operation of the Nelson cell, including particularly the life of its different parts, ampere efficiency and energy efficiency with which it works.

Sodium Permanganate

An Electrolytic Process for the Production of Sodium Permanganate from Ferromanganese, Robert E. Wilson and W. Grenville Horsch. General Meeting Am. Electrochemical Soc., Apr. 3-5, 1919, paper no. 15, pp. 207-220, 1 fig. Ferromanganese anodes were used in diaphragm cell in sodium carbonate solution, with production of an 8 to 12 per cent solution of sodium permanganate in anode compartment.

ELECTRODEPOSITION

Copper Plating on Iron

Electro-Plating on Iron from Copper Sulphate Solution, Oliver P. Watts. Brass World, vol. 15, no. 4, Apr. 1919, pp. 108-111. Shows that certain solutions of lead and antimony may be substituted for the arsenic dip, previous to direct-current plating of copper on iron from copper sulphate. Paper read before Am. Electrochem. Soc.

Plating Room Chemicals

Plating Room Chemicals. A. Schleimer. Brass World, vol. 15, no. 4, Apr. 1919, pp. 127-129. Appearance and properties of borax, charcoal, cobalt, copper acetate, copper sulphate, copper carbonate, corrosive sublimate, liver of sulphur, nickel salts, magnesium sulphate, lead acetate, caustic potash, sodium carbonate and cyanide.

ELECTROPHYSICS

Conservation of Electricity

Conservation of Electricity and the Electronic Theory (La conservation de l'électricité et la théorie électronique). L. Décombe. Revue Générale de l'Electricité, vol. 5, no. 12, Mar. 22, 1919, pp. 443-444. Admitting the electric constitution of matter, various experimental researches are presented in support of theory establishing conservation of electrical moment in a dielectric by assimilation of atoms to doublets of variable moment. Paper before la Société française de Physique.

Dielectric Phenomena

Dielectric Phenomena in Dielectric Substances (in Japanese). K. Kamibayashi. Denki Gakkwai Zasshi, no. 368, Mar. 10, 1919.

Electronic Emission

The Emission of Electricity from Incandescent Bodies (L'émission de l'électricité par les corps incandescents). A. Boutaric. Revue Générale des Sciences, vol. 30, no. 6, Mar. 30, 1919, pp. 171-183, 6 figs. Survey of experimental research by various investigators, notably O. W. Richardson. Theories offered in explanation of electronic emission. First article.

FURNACES

Crucibles

Morgan's Patent Electrically Heated Crucibles. Electrical Review, vol. 84, no. 2157, Mar. 28, 1919, pp. 342-344, 4 figs. Designed to prevent volatilization of non-ferrous alloys which takes place when arc is used on account of excessive heat.

Rennerfelt

Types of Electric Furnaces—I: the Rennerfelt, W. F. Sutherland. Can. Machy., vol. 21, no. 14, Apr. 3, 1919, pp. 328-330, 7 figs. Operating characteristics; tilting mechanism and control and wiring diagram of furnace.

Developments in the Rennerfelt Furnace. H. A. de Fries and Jonas Hertenius. Eng. & Indus. Management, vol. 1, no. 8, Apr. 3, 1919, pp. 238-239, 1 fig. Side electrodes tilt and shape of shell is round in new design.

Resistance Type

Electric Furnaces of the Resistance Type Used in the Production of Essential War Materials, T. F. Baily. General Meeting, Am. Electrochemical Soc., Apr. 3-5, 1919, paper no. 19, pp. 257-260, 1 fig. Heat-treating equipment intended for automatical and continuous hardening and tempering of cast-steel anchor chains. Heating is by an electrical resistor of granular carbon confined in carborundum firesand walls, machinery being controlled by pyrometers which allow of hardening and tempering at definite temperatures.

Steel Foundry

The Electric Foundry: Its Introduction into Foundry Practice. W. E. Moore. General Meeting Am. Electrochemical Soc., Apr. 3-5, 1919, paper no. 12, pp. 181-186. Comparison of electric furnace in steel foundry work with open-hearth furnace and small bessemer converter. Writer concludes that it is superior to both, in regard to cheapness of raw material, conservation of alloying metals, waste of lining, temperature obtainable, control of chemical composition and quality of steel produced.

Vom Baur

The Vom Baur Electric Steel Furnace. Iron Age, vol. 103, no. 17, Apr. 24, 1919, pp. 1071-1073, 2 figs. Electrode holders are so constructed that by means of fillers either graphite or carbon electrodes can be used. Tilting mechanism allows furnace to tilt backward 7 deg. so that slag can be taken off at this door instead of from the spout.

GENERATING STATIONS

Automatic Generating Plants

Automatic Induction Generator Plants. E. A. Quinn. Jl. Electricity, vol. 42, no. 8, Apr. 15, 1919, pp. 342-344, 7 figs. Description of two small power plants which make use of water normally used in larger plants of a light and power corporation under heads which existed in the flow line but had hitherto not been utilized. Plants are said to be operated without attendants.

Bus and Switches

Modern Bus and Switch Structures, C. D. Gray and M. M. Samuels. Elec. World, vol. 73, nos. 16 & 17, Apr. 19 & 26, 1919, pp. 788-792 and 831-833, 16 figs. Masonry, material, compartment doors and general arrangement. Types of circuit breakers and support of buses used with large generating units.

Canada

Central Electric Power Station Statistics. Can. Engr., vol. 36, no. 6, Feb. 6, 1919, pp. 203-205. Data gathered by Dominion Water Power Branch and Bureau of Statistics.

Electric Generation in Canada. Can. Engr., vol. 36, no. 9, Feb. 27, 1919, pp. 255-256. Table of central electric generating plants in Canada, showing capacity, ownership and prime movers.

The Present Electric Outlook in Canada, A. S. L. Barnes. Electrical Review, vol. 84, no. 2158, Apr. 4, 1919, pp. 389-390. Figures indicating total amount of power capable of developing and amount of power already developed. (Continuation of serial.)

Condenser, Static

Economic Use of Static Condenser—I & II, Waldo V. Lyon. Elec. World, vol. 73, nos. 15 & 16, Apr. 12 & 19, 1919, pp. 724-726 and 776-778, 6 figs. Increasing capacity of a generating plant by using static condensers to correct power factor; feasibility of putting less generating equipment in new plant by using condensers. Problems of power-factor correction by static condensers are analyzed for purposes of improving voltage regulation and reducing copper losses.

Prohibition

Effect of Prohibition on Lighting Revenue, Elec. World, vol. 73, no 15, Apr. 12, pp. 736-739. Conditions following prohibition as reported by 75 central stations.

Smethwick

Electricity Supply at Smethwick. Electrical Review, vol. 84, no. 2158, Apr. 4, 1919, pp. 368-371, 5 figs. Capacity of plant which was 12,475 kw. before the war has been increased to total of 36,325 kw. by installation of B. T. H. turbo-generators.

So. Philadelphia Works

Power System of South Philadelphia Works, Graham Bright. Elec. Jl., vol. 16, no. 4, Apr. 1919, pp. 126-131, 15 figs. Showing lighting arresters, disconnecting switches, etc.

Theft of Current

Detection and Remedy of Current Theft from Central Stations. Thomas Robson Hay. Elec. Rev., vol. 74, no. 15, Apr. 12, 1919, pp. 588-589. Methods employed by Duquesne Light Co. of Pittsburgh.

GENERATORS AND MOTORS

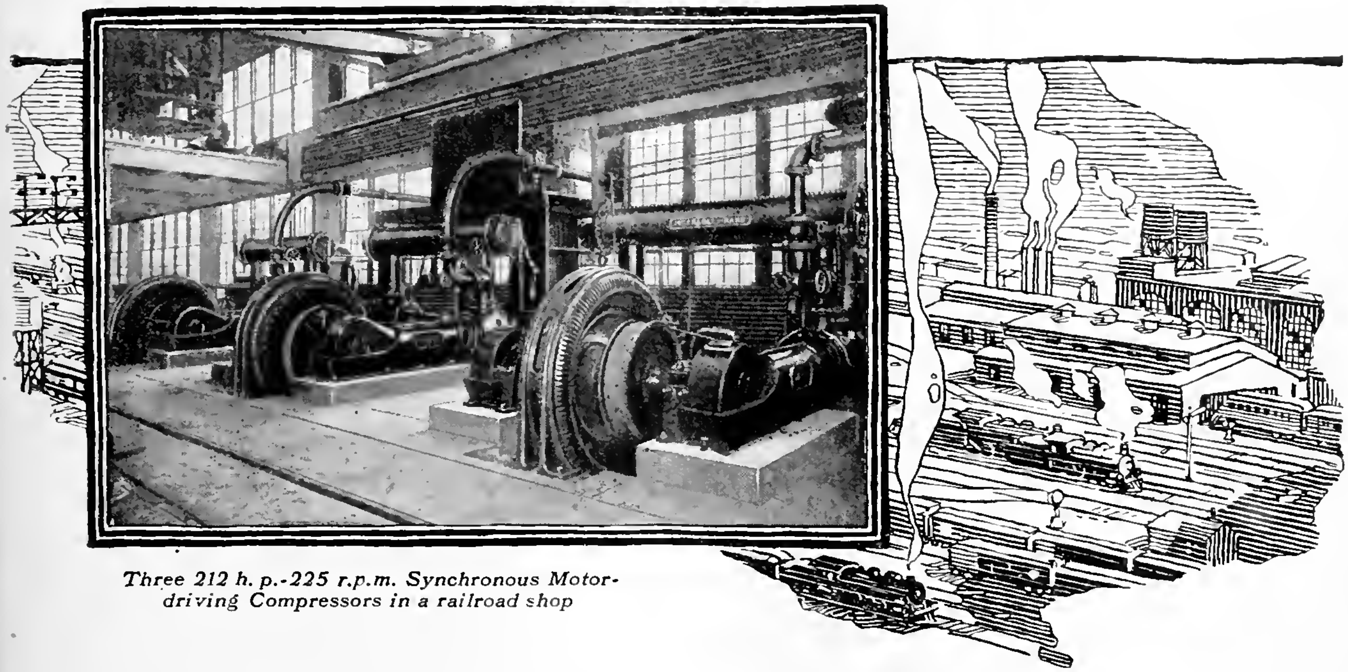
Alternators

Free Oscillations of Alternators in a Constant-Voltage System (Oscillations libres des alternateurs sur réseau a tension constante). André Blondel. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 9, Mar. 3, 1919, pp. 439-444. Values of K and e which make Δ a minimum, determined by taking advantage of the fact that changes in rI during oscillations are negligible by comparison to vector $(u - rI)$ when I is constant.

Asynchronous Machines

Theory of Elliptic-Field Asynchronous Machines (Sur la théorie des machines asynchrones à champ elliptique). W. Genkin. Revue Générale de l'Electricité, vol. 5, no. 15, Apr. 12, 1919, pp. 539-548, 15 figs. General equations derived from Fynn's theory. Equivalent circuit worked out for revolving-field motor, single-phase motor, phase converter and induction meter.

The high efficiency and dependability of G-E Synchronous Motors are relied upon in many industries today.



Three 212 h. p.-225 r.p.m. Synchronous Motor-driving Compressors in a railroad shop

88,000 h.p. of synchronous motors supplied in 1918 for air compressor drive

FOR a quarter century the General Electric Company has supplied synchronous motors designed for the particular work to be done. The first ones furnished are still in continuous service requiring maximum dependability.

For industrial drives these motors are furnished from 25 to 2000 h. p. capacity with speeds from 80 to 1800 r. p. m. and are designed to start any load met with in commercial practice without excessive current demands upon the power circuit.

The very high efficiency and dependability of these motors are due to their excellent design which is based on thorough testing of both raw materials and finished motors.

Our engineers will be pleased to supply additional information on these motors.

43-163

General Electric Company

General Office Schenectady, N.Y.

Application of the Diagram of Asynchronous Motors (Applications du diagramme des moteurs asynchrones), L. Lagron. Revue Générale de l'Electricité, vol. 5, no. 14, Apr. 5, 1919, pp. 507-510, 4 figs. How to use writer's diagram published in R. G. E., vol. 4, Dec. 7, 1918, p. 861, to modifying connection of coils, constructing characteristic curves and the starting of motor.

Heating

Maximum Power of Electrical Machines Limited by Permissible Heating of Parts (Etude analytique des conditions dans lesquelles, pour un échauffement determiné, la puissance de certaines catégories de machines électriques est maximum), H. Lajus. Revue Générale de l'Electricité, vol. 5, no. 13, Mar. 29, 1919, pp. 467-471, 1 fig. A d. c. generator or an alternator operating in constant cos ϕ theoretically assumed to be heated to the permissible limit can develop maximum power, according to the writer's investigations, when frequency is maximum and the sum of hysteresis and Foucault losses equals the Joule losses.

High-Frequency Generators

A High-Frequency Generator for Airplane Wireless Telegraph Sets, A. Nyman. Elec. Jl., vol. 16, no. 4, Apr. 1919, pp. 140-145, 16 figs. Scheme developed by Signal Corps for U. S. Army; requirements were lightness, compactness and reliability.

Lubrication

Lubrication of Electric Generators and Motors, Reginald Trautschold. Elec. Rev., vol. 74, no. 16, March 19, 1919, pp. 629-630. Influence of type of apparatus upon choice of lubricant.

Railway Motors

Manufacturers' Tests of Railway Motors, J. S. Dean. Elec. Ry. Jl., vol. 53, no. 16, Apr. 19, 1919, pp. 777-778, 9 figs. Chart presenting various detail parts with materials used in their manufacture. (First article of series.)

Rheostats

Starting Rheostats for Shunt Motors, Terrell Croft. Power House, vol. 13, no. 4, Apr. 5, 1919, pp. 90-91, 4 figs. Calculation of size of resistance to be placed in series with armature to prevent excessive current.

Single-Phase Generators

Armature Reaction and Wave Form of the Single Phase Generator (in Japanese), G. Shimizu. Denki Gakkwai Zasshi, no. 368, Mar. 10, 1919.

Switch-Gear, Starting and Controlling

Starting and Controlling Switchgear for Shipyard Machinery, A. P. Pyne. Elecn., vol. 82, no. 15, Apr. 11, 1919, pp. 413-420, 21 figs. Review of working conditions of various motors to be encountered in a shipyard and suggestions in regard to selecting starting and controlling apparatus.

Synchronous Motors

Synchronous Motor Characteristics—I, Theo. Schou. Elec. World, vol. 73, no. 17, Apr. 26, 1919, pp. 828-830, 6 figs. Heyland diagram for induction motor is applied to synchronous motors with squirrel-cage windings in order to investigate starting and pull-in torques. Comparison of brass and copper for rotor bars.

IGNITION APPARATUS

Contact Breakers, Splitdorf

The New Splitdorf Magneto. Aerial Age, vol. 9, no. 6, Apr. 21, 1919, p. 304, 2 figs. Details of contact breaker.

Generators, Motor-Car

Regulation of Automotive Generators, W. A. Dick. Elec. Jl., vol. 16, no. 4, Apr. 1919, pp. 148-151, 11 figs. Regulation characteristics of generators used for lighting and other purposes on automobiles and kindred machines. Only those types that have been developed and put into commercial use are dealt with.

Magnetos, Aluminum in

British Made Magnetos. Elecn., vol. 82, no. 13, Mar. 28, 1919, pp. 348-349, 6 figs. Uses of aluminum in their manufacture. (Concluded.)

Magnetos, Experiments

Experiments on the High-Tension Magneto—I, Norman Campbell. London, Edinburgh and Dublin Phil. Mag., vol. 37, no. 219, Mar. 1919, pp. 284-301, 6 figs. Work conducted at Nat. Physical Laboratory under direction of Advisory Committee for Aeronautics. Results were kept confidential during time of war.

See also ELECTRICAL ENGINEERING, Varia (Insulation, Mica).

LIGHTING AND LAMP MANUFACTURE

Design

Chart to Facilitate the Design of Lighting System. Elec. World, vol. 73, no. 16, Apr. 19, 1919, pp. 778-779, 1 fig. Curves are based on illuminating intensity 3 ft. above floor; portion of diagram determining size of lamps necessary to produce intensified illumination: a depreciation of 30 per cent in light intensity due to dirt in reflector of lamp or deterioration of filament is assumed. From Indus. Lighting Code of Indus. Commission of Wisconsin.

Laboratories

Some Special Problems in the Lighting of Laboratories and Technical Institutions. Illuminating Engr., vol. 12, no. 1, Jan. 1919, pp. 13-16. Concerning lighting of blackboards and chemical, electrical and physical laboratories.

Office Lighting

Modern Practice in Office Lighting, A. Wise. Illuminating Engr., vol. 12, no. 2, Feb. 1919, pp. 27-39, 17 figs. Choice of methods for lighting and how these can be applied to various types of offices; importance of periodical cleansing of lamps and lighting units; illumination required for various classes of work; typical examples of installations.

Searchlights

The Searchlight Projector as Used in the Mercantile Marine, R. C. Harris. Elecn., vol. 82, no. 15, Apr. 11, 1919, pp. 444-449, 15 figs. Types of lamps, mirrors and lenses and also methods of remote control, both mechanical and electrical.

Snellens Types

Report on Standard Illumination of Snellens Types Used in Testing the Vision of Candidates for Public Service. Illuminating Engr., vol. 12, no. 1, Jan. 1919, pp. 5-7, 2 figs. Report issued by Council of British Ophthalmologists. From British Jl. of Ophthalmology.

Street Lighting

Simple Lamp-Record System for Street Lighting Circuits, T. D. McDowell. Elec. Rev., vol. 74, no. 17, Apr. 26, 1919, pp. 668-669, 3 figs. Card records for noting type and history of lamps in use on large systems for street, boulevard or park lighting.

MEASUREMENTS AND TESTS

Fault Localizing

Fault Localizing: A Few Hints, H. Bujama. Electrical Review, vol. 84, no. 2160, Apr. 18, 1919, pp. 432-433, 5 figs. Double-slide wire bridge for use in connection with Murray loop and Varley loop tests.

Fuses

Short-Circuit Tests of Cartridge Fuses at the New York Office. Laboratories' Data, Underwriters' Laboratories, Nat. Board of Fire Underwriters, no. 1, Feb. 1919, pp. 16-19, 2 figs. Fuses were placed in cutout base, covered with thin layer of dry absorbent cotton and enclosed by strongly made protective cage; circuit breaker which was set so that it would not open automatically, but only by the cord, was then closed, and finally circuit was closed by switch at back of test frame.

Results of Factory Inspection of Standard Cartridge Enclosed Fuses. Laboratories' Data, Underwriters' Laboratories, Nat. Board of Fire Underwriters, no. 1, Feb. 1919, pp. 20-22, 1 fig. Graphs drawn from results of quarterly inspections.

Galvanometers, Differential

Zero Error in Differential Galvanometers (Über ein Differentialgalvanometer nebst einer Untersuchung über Nullpunktsfehler bei Drehspulengalvanometern), Helmer Bäckström. Zeitschrift für Instrumentenkunde, vol. 38, nos. 11 and 12, Nov. and Dec. 1918, pp. 173-179 and 189-195, 8 figs. Magnitude of after effect on zero position as affected by length of time during which deflection is maintained, damping of movement, and variations of current. Bibliography on moving-coil galvanometers covering period 1880-1916.

Ground and Short-Circuit Detection

Phase and Fault Testing by Means of Lamp Signals, Frank Gillooley. Elec. Rev., vol. 74, no. 16, Mar. 1919, pp. 617-619, 4 figs. Methods of using lamps in testing for grounds, short circuits and continuity of underground cables; methods of checking up phases and identification.

Hydrogen Overvoltage, Measurement of

Hydrogen Overvoltage, Duncan A. MacInnes and Leon Adler. Jl. Am. Chem. Soc., vol. 41, no. 2, Feb. 1919, pp. 194-207, 5 figs. Apparatus and method of measurement. It is concluded that hydrogen overvoltage is due primarily to a layer of supersaturated dissolved hydrogen in the electrolyte surrounding an electrode.

Insulator Testing

Pacific Coast Practice in Insulator Testing. Jl Electricity, vol. 42, no. 8, Apr. 15, 1919, pp. 345-347. Report of Insulator Committee of convention of Pac. Coast Section N. E. L. A.

Peak Potential, Measurement of

Note on the Measurement of the Peak Potential of an Alternating Source, Clifford C. Paterson and Norman Campbell. London, Edinburgh, and Dublin Phil. Mag., vol. 37, no. 219, Mar. 1919, pp. 301-303, 1 fig. Conditions which are considered necessary for accuracy in measuring peak potential by means of a thermionic valve.

Temperature, Body, Measurement

Some Notes on Electrical Methods of Measuring Body Temperatures, Robert S. Whipple. Electrical Review, vol. 84, no. 2158, Apr. 4, 1919, pp. 392-393, 5 figs. Adaptation of thermoelectric couples for measuring body temperatures; results of experiments. Paper read before Roy. Soc. of Medicine & Instn. of Elec. Engrs.

Temperature Determination by Weighing

Weighing High Temperatures in an Electric Balance, J. M. Bird. Sci. Am., vol. 120, no. 17, Apr. 26, 1919, pp. 430-431, 442 & 444, 5 figs. Curves for transformation points of two different steels, showing in each case the heating curve and the cooling curve. System of pyrometry based on use of thermocouples for controlling heat-treating furnaces in steel mills.

Timing

Accurate Timing in Electrical Tests, F. A. Kartak. Elec. World, vol. 73, no. 14, Apr. 5, 1919, pp. 672-675, 9 figs. Tuning-fork timing device found very satisfactory in practice, consists essentially of heavy iron base casting in head block of which are mounted two steel fork legs actuated by magnet; adjustment for rate of vigration is obtained by counterweights. Design was put into operation at Bur. Standard Laboratory.

Voltage Test Equipment

A Voltage Test Equipment. Laboratories' Data, Underwriters' Laboratories, Nat. Board of Fire Underwriters, no. 1, Feb. 1919, pp. 26-28, 1 fig. Outfit consists of transformer, the terminals of which are enclosed in glass case large enough to cover the device or sample under test.

Voltmeter, Electrostatic, Ayrton-Mather

New Measuring Instruments (Quelques nouveaux instruments de mesure), A. Tobler and K. Tchild. Journal Télégraphique, vol. 43, no. 3, Mar. 25, 1919, pp. 33-36, 7 figs. Ayrton-Mather electrostatic voltmeter as perfected by R. W. Paul. (To be continued.)

POWER APPLICATIONS

Cooking

Electric Cooking in Hotels, Clubs and Restaurants, C. O. Hard. Nat. Elec. Light Assn. Bul., vol. 6, no. 4, Apr. 1919, pp. 206-208, 3 figs. Section range with connected load of 30 kw.; 30-in. broiler connected load and other electrical features.

Mill Drive

Electrically Driven Plate Mills, G. E. Stoltz. Engrs.' Club of Philadelphia, vol. 36-1, no. 170, Jan. 1919, pp. 7-13, 10 figs. Considerations in selection of size and type of motor, control and flywheel, based on examination of performances of existing mills.

Electric Equipment in Blooming Mill of Steel Company of Canada, Hamilton. Elec. News, vol. 28, no. 8, Apr. 15, 1919, pp. 24-25, 2 figs. Generator set consists of 1800-hp., 2200-volt 3-phase wound rotor induction motor, a 50-ton flywheel and two 1200-kw., 600-volt d. c. generators all mounted on a common shaft.

Mine Service

Selection of the Electrical System, Voltage and Frequency for Mine Service, Terrell Croft. Coal Age, vol. 15, no. 15, Apr. 10, 1919, pp. 658-659. Believes that 500 volts is not an advisable tension to use at a coal mine, and advocates adhering to 250 volts as a standard.

See also MARINE ENGINEERING, Ships (Electric Propulsion), Yards (Electrical Equipment).

POWER GENERATION

Hydroelectric Plants

See items under Power Generation, Mechanical Engineering.

TELEGRAPHY AND TELEPHONY, RADIO

Detector, Radio-Frequency Oscillations

A Magnetic Detector of Radio Frequency Oscillations. Wireless Age, vol. 6, no. 8, May 1919, pp. 11-12, 4 figs. Based upon reputed principle that super-position of a high-frequency current upon iron core already excited by low-frequency current reduces hysteresis loop of low-frequency current.

Modulator, Mercury Vapor, Langmuir's

Langmuir's Mercury Vapor Modulator for Wireless Telephony. Wireless Age, vol. 6, no. 8, May 1919, pp. 15-16, 6 figs. Method of controlling output of radio frequency alternator at speech frequencies for radio telephony. Device comprises a glass or quartz envelope containing a body of mercury (constituting the cathode) and main anodes which may be made of graphite, tungsten, molybdenum or other highly refractory material.

Musical Radio-Sending

Notes on a Problem of Musical Radio-sending (in Japanese), T. Minohara. Denki Gakkwai Zasshi, no. 368, Mar. 10, 1919.

Progress Since 1914

Wireless Telegraphy and Telephony, J. A. Fleming. Times Eng. Supp., vol. 15, no 533, Mar. 1919, pp. 97-98. Progress since 1914.

Receivers, Bridge and Barrage

Simultaneous Sending and Receiving, E. F. W. Alexanderson. Wireless Age, vol. 6, no. 8, May 1919, pp. 23-26, 5 figs. Fundamental characteristics of the "bridge receiver" and the "barrage receiver." Paper read before Inst. Radio Engrs.

Regulations

Wireless Telegraphy and the Safety of Transoceanic Navigation (La télégraphie sans fil et la sécurité de la navigation maritime). Journal Télégraphique, vol. 43, no. 3, Mar. 25, 1919, pp. 36-38. Regulations of International Conference held at London on Nov. 12, 1913. (Concluded.)

Vacuum Tube

Negative Resistance Vacuum Tube as an Amplifier and a Beat Receiver. Wireless Age, vol. 6, no. 8, May 1919, pp. 12-13, 2 figs. Scheme using heterodyne principle to secure increased amplification and selectivity in receiving.

TELEGRAPHY AND TELEPHONY, WIRE

European Telephone Practice

European Telephone Practice, Fred W. Scholz. Telephone Engr., vol. 21, no. 4, Apr. 1919, pp. 159-163, 2 figs. Adaptation of telephone exchanges to telephone traffic. From Telegraphen-Versuchsamt. (To be continued.)

Telephone Receiver, Theory

Electromagnetic Theory of the Telephone Receiver with Special Reference to Motional Impedance, A. E. Kennelly and H. Nukiyama. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 4, Apr. 1919, pp. 491-539, 32 figs. Theory, which is stated under definite limitations, takes into account the m.m.f. produced by vibrations of diaphragm in permanent magnetic field; thus motional power is shown to be derived partly from testing alternating current and partly from changes in power of magnetic circuit.

See also ELECTRICAL ENGINEERING, *Generators and Motors (High-Frequency Generators).*

TRANSFORMERS, CONVERTERS, FREQUENCY CHANGERS

Instrument Voltage Transformers

Instrument Voltage Transformers, W. R. Woodward. Power, vol. 49, no. 15, Apr. 15, 1919, pp. 562-564, 11 figs. Westinghouse types.

Rectifiers

Transformation of Direct into Alternating Current, and Vice Versa, without a Commutator (Sur un système de transformation de courant continu en courant alternatif, et vice versa sans commutateur divisé), O. Li Gotti. Revue Générale de l'Electricité, vol. 5, no. 13, Mar. 29, 1919, pp. 471-484, 10 figs. Louis Magnini patented in 1905 (see Industrie Electrique, May 25, 1905, p. 217) an apparatus for rectifying an alternating current by the periodic alteration of the inductance coils mounted in two groups. In present article writer makes general study of possible transforming devices operating on induction phenomena.

Transformer Practice

Essentials of Transformer Practice—XXI, E. G. Reed. Elec. Jl., vol. 16, no. 4, Apr. 1919, pp. 145-147, 7 figs. Voltage transformations with auto-transformers.

TRANSMISSION, DISTRIBUTION, CONTROL

Control

The Control of Large Amounts of Power—III, L. B. Wedmore. Power House, vol. 13, no. 4, Apr. 5, 1919, pp. 97-101, 12 figs. Current-limiting by use of busbar reactance; heating and stresses due to heavy currents; combinations of machines requiring maximum transfer capacity; influence of power factor of machine on output of engine. Paper read before Inst. Elec. Engrs., England.

Cutout Bases

Effect of Cutout Base Design upon Plug Fuse Performance. Laboratories' Data, Underwriters' Laboratories, Nat. Board of Fire Underwriters, no. 1, Feb. 1919, pp. 23-25, 1 fig. Effect differences in cross-section have upon heating and consequently upon performance of plug fuses used in cutout bases.

Distribution, Flexibility

Flexible Distribution for Industrial Plants, L. F. Leurey. Elec. World, vol. 73, no. 17, Apr. 26, 1919, pp. 835-838, 7 figs. Design for meeting changing demands for power. Safety and low operating costs are said to be secured by employment of bus-bar feeders of uniform size.

Interconnection

Emergency Interchange of Power, G. R. Kenny. Jl. Electricity, vol. 42, no. 8, Apr. 15, 1919, pp. 347-349, 1 fig. Interconnection of two 60-cycle with one 50-cycle system. Paper presented by Eng. Committee for Pac. Coast Section N. E. L. A. convention.

Polyphase-Motor Protection

Protecting Polyphase Induction Motors from Single-Phase Operation, B. W. Jones. Power, vol. 49, no. 16, Apr. 22, 1919, pp. 604-606, 3 figs. Comparison of different means generally employed to prevent polyphase induction motors from operating single-phase and also from overheating.

Relays

Alternating-Current Plunger-Type Relays, Victor H. Todd. Power, vol. 49, no. 17, Apr. 29, 1919, pp. 636-639, 14 figs. Schematic diagram and characteristics of overload relay which obtains time limit by means of air bellows.

Relay Protective Systems, G. E. Armstrong. Jl. Electricity, vol. 42, no. 8, Apr. 15, 1919, pp. 349-353, 1 fig. Methods used on system of Southern Cal. Edison Co. From Eng. Report for spring convention of Pac. Coast Section N. E. L. A.

Synchronous Alternators

Stability of Synchronous Alternators in Constant-Potential System (Conditions de stabilité de la marche synchronique des alternateurs accouplés sur réseau à tension constante), A. Blondel. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 12, Mar. 24, 1919, pp. 587-593. Equation not taking into account oscillations induced in circuits of inductors is modified so as to include effect of these oscillations, and conditions necessary and sufficient for stability are obtained by application of Hurwitz' determinant.

Substation

Columbus Railway, Light & Power Co.'s Canal Street Substation, E. W. Clark. Elec. Rev., vol. 74, no. 17, Apr. 26, 1919, pp. 670-671, 6 figs. Switching arrangements and provision for voltage changeover.

Transformer Station, High-Tension

Transmission of Electrical Energy from Bourges to the American Arsenal at Beauvoir (Transmission d'énergie électrique de Bourges à l'Arsenal Américain de Beauvoir), Michel Berthon. Revue Générale de l'Electricité, vol. 5, no. 12, Mar. 22, 1919, pp 445-449, 3 figs. High-tension (70,000 volts) transforming station presented as example of rapidly established economic installation.

WIRING

City Hall Wiring

The Electrical Installation in San Francisco's City Hall. Elec. Rev., vol. 74, no 17, Apr. 26, 1919, pp 661-667, 7 figs. Features of conduit and wiring system for light, power, communication and signaling.

STORAGE BATTERIES

Barium Sulphate Action

Function of Barium Sulphate in Lead Accumulators (Sulla funzione del solfato di bario negli accumulatori a piombo), O. Scarpa. Elettrotecnica, vol. 6, no. 9, Mar. 25, 1919, pp. 176-179, 3 figs. Experimental research believed to have demonstrated that barium sulphate acts as negative catalyzer to transformation of lead.

Charging Plant

New Haven Installs Model Charging Plant. Ry. Elec. Engr., vol. 10, no. 4, Apr. 1919, pp. 103-106, 9 figs. Plant is equipped for charging, cleaning and repairing both lead and alkaline batteries and equipment and both 30- and 60-volt systems are taken care of.

Lead Acid Batteries

Characteristics of Starting and Lighting Batteries of the Lead Acid Type, O. W. A. Oetting. Elec. Jl., vol. 16, no. 4, Apr. 1919, pp. 134-139, 15 figs. Considerations in selecting size of starting battery.

Trickling Charge

The "Trickling Charge" as Applied to Lead-Acid Storage Batteries of the Naval Service, Lucius C. Dunn. U. S. Naval Inst. Proc., vol. 45, no. 193, Mar. 1919, pp. 339-343, 2 figs. Methods of applying to a charged storage battery a current just large enough to counteract local action and thus maintain it in a charged condition.

Civil Engineering

BRIDGES

Concrete Overhead Arch Bridges

Four Concrete Overhead Arch Bridges on Toronto-Hamilton Highway. Contract Rec., vol. 33, no. 14, Apr. 2, 1919, pp. 301-306, 6 figs. Governing factor in design of bridges has been long clearances by using parabolic overhead arch ribs braced together by horizontal bracing members.

Canada's Longest Reinforced Concrete Trusses. Can. Engr., vol. 36, no. 14, Apr. 3, 1919, pp. 345-348, 6 figs. Bridges carrying Toronto-Hamilton highway across Etobicoke river and Bronte creek. Each is 119 ft. clear span, with 20-ft. roadway and 16-ft. overhead clearance.

Canadian Reinforced Concrete Arch Bridges, Frank Barber. Can. Engr., vol. 36, no. 11, Mar. 13, 1919, pp. 289-293, 6 figs. Historical review and lists of open spandrel and earth-filled arches with clear span of over 100 ft. or total bridge length of over 200 ft.

Concrete-Pile Trestle Construction

Concrete Pile Trestle Construction, Albert M. Wolf. Eng. World, vol. 14, no. 8, Apr. 15, 1919, pp. 25-27, 6 figs. Economy of concrete pile process is argued by the fact that piles and slabs can be cast in central yard, and then transported to site and erected with comparatively small portable plants in the form of combined derrick and piledriver cars.

Construction

Railway Bridges in the Dutch Indies (Mededeelingen omtrent de verzwaring van den bovenbouw der bruggen in de lijn Goendih-Soerabajader Nederlandsch-Indische Spoorweg-Maatschappij), E. C. P. Hartman. De Ingenieur, vol. 34, no. 9, Mar. 1, 1919, pp. 148-161, 35 figs. Dismantling of old bridges and erection of new with aid of portable auxiliary bridges placed under existing structures on temporary pile foundation.

The Construction of Culverts and Small Bridges, Charles D. Snead. American City, Town & County Edition, vol. 20, no. 4, Apr. 1919, pp. 323-326, 2 figs. Methods suggested at Kentucky Road School.

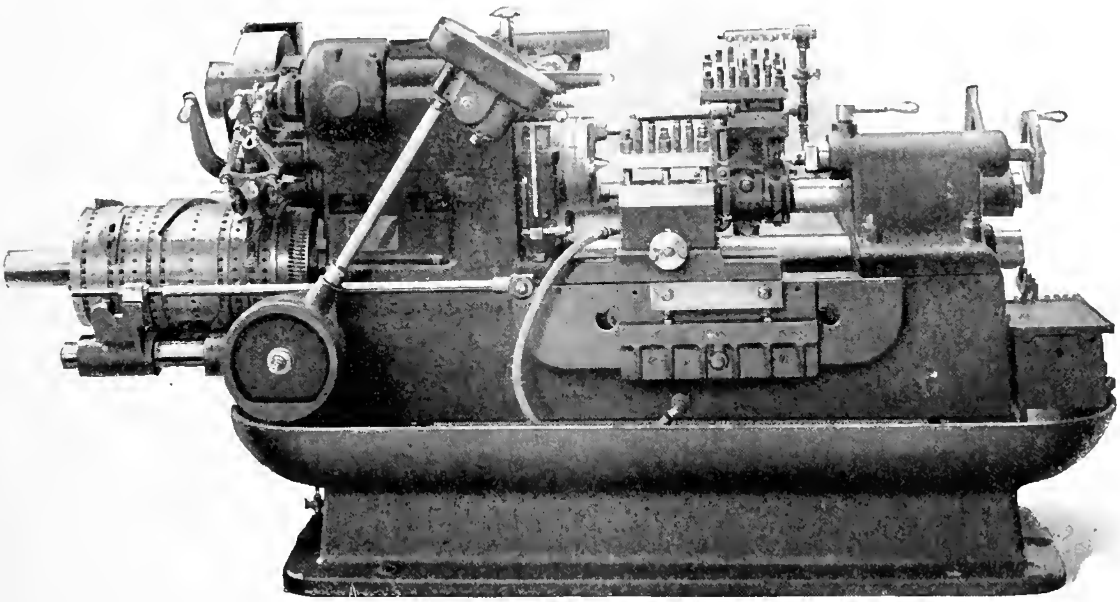
Failures

Are Our Highway Bridges Safe? Mun. Jl. & Public Works, vol 46, no 16, Apr. 19, 1919, pp. 276-279. Instances of failures of bridges. County highway officials quoted as saying that 30 per cent of bridges of the country are unsafe for heavy vehicles.

India

Adam's Bridge. Indian Eng., vol. 65, no. 1, Jan. 4, 1919, pp. 10-11, 1 fig. Project for connecting India and Ceylon by railway line.

The Fay Automatic Lathe



An automatic machine for simultaneous turning, facing and shouldering cuts on bar stock and centered forgings, such as pinion shafts, steering knuckles, cam shafts, etc.

An automatic machine for second operations on work held on centered arbors, such as spur and bevel gear blanks, hubs, pulleys, etc.

Designed with strength and driving power to carry all the tools, speed, and feed the work will stand under balanced cuts.

Jones & Lamson Machine Company

SPRINGFIELD, VERMONT, U. S. A.

109 Queen Victoria Street, London, E. C.

France, Spain and Belgium: F. Auberty & Co., 91 Rue de Maubeuge, Paris
Holland: Spliethoff, Beeuwkes & Co., Rotterdam

SEE OUR DATA IN 1918 A.S.M.E. CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT

Lift Bridges

Pretoria Avenue Lift Bridge, Ottawa, L. McLaren Hunter. Contract Record, vol 33, no. 16, Apr. 16, 1919, pp. 355-356, 3 figs. Two 52½-ft. fixed spans and a central 95-ft. electrically operated direct-lift span giving 30 ft. maximum clearance.

Relieving Arches

Relieving Arches in Subway Distribute Stress to Piers. Eng. News-Rec., vol. 82, no. 14, Apr. 3, 1919, pp. 667-669, 7 figs. Feature of design in three-span subway carrying street is said to be arched sidewalk spans seated on haunches of roadway span in order to insure desired distribution of stress.

Strengthening Bridges

Strengthening Bridges for Truck Traffic. Contract Rec., vol. 33, no. 14, Apr. 2, 1919, pp. 318-319, also Good Roads, vol. 17, no. 14, Apr. 5, 1919, pp. 149-151. Report of Committee of Am. Road Builders' Assn. on methods of reconstruction to carry heavy loads.

BUILDING AND CONSTRUCTION

Chimney, Demolition

Demolishing Tall Brick Chimney, Ralph B. Chandler. Can. Engr., vol. 36, no. 16, Apr. 17, 1919, pp. 383-384, 3 figs. Plans and elevations of chimney, showing preparations for demolition with dynamite.

Coal Bins

An Example of Coal Bin Reconstruction, Wm. Joshua Barney. Coal Trade Jl., vol. 50, no. 17, Apr. 23, 1919, pp. 448-451, 7 figs. Reinforced concrete structure built to enlarge capacity. Bins continued in operation while structure was being erected.

Concreting Plant

Efficient Concreting Plant. Am. Contractor, vol. 40, no. 17, Apr. 26, 1919, p. 30, 1 fig. Mechanical dumping and distribution in construction of Hotel Fort Des Moines the erection of which was demanded by the Government to be urgently terminated.

Dams

See Earthwork, Rock Excavation, etc., p. 28a.

Dome, Reinforced-Concrete

The Reinforced Concrete Dome at Hippodrome, Copenhagen. Eng. & Contracting, vol. 51, no. 18, Apr. 30, 1919, p. 445, 2 figs. Notes on methods of construction.

Earthquakes

Effect on Structures of Recent Porto Rico Earthquakes, M. L. Vicente and C. F. Joslin. Eng. News-Rec., vol. 82, no. 17, Apr. 24, 1919, pp. 806-808, 5 figs. Investigations are represented as indicating that wood frame proves safest for buildings, with well-built reinforced concrete next, and articulated construction last.

Floor, Girderless

Notes on the Test of a Girderless Floor, Peter Gillespie and T. D. Mylrea. Jl. Eng. Inst. of Canada, vol. 2, no. 4, Apr. 1919, pp. 300-317, 22 figs. Tests conducted on flat slabs in Toronto factory by City Architect's Dept. in conjunction with Dept. of Applied Mechanics, University of Toronto.

Foundations

Mathematical Study of Foundations on an Elastic Soil (Etude mathématique des fondations sur terrain élastique), Keiichi Hayashi. Memoirs of the Coll. of Eng. Kyushu Imp. University, Fukuoka, Japan, vol. 1, no. 4, 1919, pp. 225-267, 18 figs. Three cases are considered: mass is loaded symmetrically with uniformly distributed weight; when there are central elevations; symmetrical loading with two concentric weights.

Flues, Chimney

Notes on Chimney Flues, Henry N. Dix. Am. Architect, vol. 115, no. 2259, Apr. 9, 1919, pp. 530-534, 6 figs. Causes of poor draft.

Houses

Philippine Island Concrete House. Concrete, vol. 14, no. 4, Apr. 1919, pp. 146-149, 14 figs. House is of concrete and steel, the only wood in the structure being used in framing for kitchen roof, window and door frames, for doors and windows, stair rail cap, dumb-waiter box and shelving in closets.

Recommendations for Inexpensive Houses. Contract Rec., vol. 33, no. 14, Apr. 2, 1919, pp. 308-311. Recommendations of Ontario Housing Committee.

House-Building Machinery

Labor-saving Machinery Used in Building Houses, Samuel H. Lea. Eng. News-Rec., vol. 82, no. 16, Apr. 17, 1919, pp. 753-755, 8 figs. Tractors for dragging plows and hauling concrete carts from central mixing plant to all parts of extended job.

Masonry

Studying the Defects in Masonry Structures. Ry. Maintenance Engr., vol. 15, no. 5, May 1919, pp. 167-168, 2 figs. On defects resulting from instability, disintegration and weathering.

Roofs, Brick-Arch

Thin Tied Flat Brick Arch Roofs, E. W. Stoney. Indian Eng., vol. 65, no. 6, Feb. 8, 1919, pp. 80-81, 16 figs. Experiments to determine strength of various tied arch ribs of 10 to 30 ft. span, 2 ft 3 in. wide, having rise of one-eighth span.

Schools

Standardization of Plans for Schools, Clarence E. Dobbin. Contract Rec., vol. 33, no. 15, Apr. 9, 1919, pp. 339-340. Points out that uniform practice in preparation of designs reduces office work and produces economies in cost without sacrificing architecture.

Construction and Equipment of Portable School Buildings—II, John Howatt and Samuel R. Lewis. Heat. & Vent. Mag., vol. 16, no. 4, Apr. 1919, pp. 34-39, 7 figs. Double-ceiled construction with paper between.

Skylight

New Type Skylight Saves Maintenance Expense. Contract Rec., vol. 33, no. 17, Apr. 23, 1919, pp. 392-393, 2 figs. Construction designed to make provision for expansion and contraction. Used at Windsor Station, Montreal, Can. Pacific Ry.

Sprinklers

Sprinkler Devices for Building Protection, F. C. Broadfoot. Contract Record, vol. 33, no. 16, Apr. 16, 1919, pp. 363-365. Advises frequent inspection or central station control.

Stairways

The Double Stairway, its Design and Construction. Am. Architect, vol. 115, no. 2260, Apr. 16, 1919, pp. 557-561, 16 figs. Schematic arrangements, dimensions and types of details.

Storage Tanks

Storage Tanks of Reinforced Concrete for Ammoniacal Liquors, F. W. Frerichs. Concrete, vol. 14, no. 4, Apr. 1919, pp. 151-154, 3 figs. Tanks were made from cement concrete consisting of one part cement, two parts sand and four parts gravel. Account is given of tests to which tanks were subjected with a view of ascertaining permeability of concrete by water and ammoniacal liquors.

The Admiralty Oil Fuel Reservoir at Rosyth. Petroleum Times, vol. 1, no. 12, Mar. 29, 1919, pp. 245-246, 3 figs. Reservoir is built of concrete on a rock foundation. Oil is pumped in or out by means of cast-iron oil mains.

Superintendence

Systematic Building Superintendence, Charles F. Dingman. Concrete, vol. 14, no. 4, Apr. 1919, pp. 159-162, 4 figs. Scheduling details of building construction; Flynt Company's "Standard practice instructions" to superintendents. (Concluded.)

CEMENT AND CONCRETE

Beams

A Simple Method for Designing Concrete Beams Reinforced for Compression, Arthur Raymond. Eng. & Contracting, vol. 51, no. 17, Apr. 23, 1919, p. 410, 2 figs. Simplifications introduced in general theory by approximating on safe side of formulæ.

Blasting Concrete

Blasting Concrete, S. R. Russell. Du Pont Mag., vol. 10, no. 5, May 1919, pp. 8-10, 5 figs. Suggestions in regard to drilling of holes and locating blasting cap. It is claimed that explosives can be used for breaking concrete with great economy of time and money and with absolute safety.

Concrete Mixtures

Saturation of Concrete Reduces Strength and Elasticity, M. B. Haggard. Cement and Eng. News, vol. 31, no. 4, April 1919, pp. 23-25, 6 figs. Compression tests made in experimental laboratory of University of Minnesota.

The Design of Concrete Mixtures. Eng. & Contracting, vol. 51, no. 17, Apr. 23, 1919, pp. 421-426, 5 figs. Interrelation of consistency, size and grading of aggregates, and the proportion of cement. Experimental research at Structural Material Research Laboratory, Lewis Inst., Chicago.

How to Design Concrete Mixtures, D. A. Abrams. Eng. News-Rec., vol. 82, no. 16, Apr. 17, 1919, pp. 758-763, 7 figs. Theory developed from tests; main principles of theory are: With given concrete materials and conditions of tests the quantity of water used determines strength of concrete so long as mix is of workable plasticity; measurement of aggregate grading on a sieve is of greatest importance in proportioning a mixture.

Depositing in Water

Depositing Concrete in Water. Contract Record, vol. 33, no. 16, Apr. 16, 1919, pp. 374-375. Report of Sub-Committee of Committee on Masonry of Am. Ry. Eng. Assn., presenting its opinion on best practice to be followed.

Design

Use Minimum Steel for Economy in Concrete Design, Albert M. Wolf. Concrete, vol. 14, no. 4, Apr. 1919, pp. 139-142, 2 figs. Tables giving sizes, percentages of steel and cost per foot of height for various columns.

Electrolysis

Electrolysis and Concrete—II. Railway Engineer, vol. 40, no. 471, Apr. 1919, pp. 67-69, 2 figs. Tests made at Mass. Inst. of Technology. Points investigated were: Action of stray currents on unstressed embedded steel; rate of corrosion of steel under stress; and, effect of setting cement on paint films. (Continuation of serial.)

Preservation, Concrete

The Preservation of Concrete Structures, Maxmilian Toch. Chem. Engr., vol. 27, no. 3, Mar. 1919, pp. 69-71. Methods in use for protecting concrete against errosion, chemical action, disintegration and decomposition. Address delivered before Am. Inst. of Chemical Engineers.

Solubility of Portland Cement

Solubility of Portland Cement and Its Relation to Theories of Hydration, J. C. Witt and F. D. Reyes. Eng. World, vol. 14, no. 7, Apr. 1, 1919, pp. 39-41. Investigation to determine what constitnents of cement will go into solution and the proportion of the total amount of each present in the sample.

EARTHWORK, ROCK EXCAVATION, ETC.

Cofferdam

Notes on the Design of a Single-Wall Cofferdam, F. R. Sweeny. Eng. News-Rec., vol. 82, no. 15, Apr. 10, 1919, pp. 708-711, 3 figs. Theoretic and economic considerations in developing size and location of timber walls and braces and steel sheeting.

Dams

Recent Development of Marin Water District, H. M. Bowers. Jl. Electricity, vol. 42, no. 7, pp. 316-318, 4 figs. Dam making use of siphon type of spillway.

Swift Rapids Dam and Ship Lift Lock. Contract Rec., vol. 33, no. 15, Apr. 9, 1919, pp. 330-333, 7 figs. Generating plant supplies current to Orillia, Ont., lock; plant is part of Trent Valley system.

Constrnction Methods Used at Drummondville, James Dick. Can. Engr., vol. 36, no. 17, Apr. 24, 1919, pp. 397-400, 7 figs. Damming of river and erection of power house to develop 19,000 hp.

Excavator, Tunneling

The Tunnelling Excavator. Iron & Coal Trades Rev., vol. 98, no. 2667, Apr. 11, 1919, p. 440, 1 fig. It is reported that under actual working conditions this patented machines has cut a tunnel 7 ft. 2 in. in diameter at average rate of 60 ft. in 24 hours.

Subway

Solving Construction Problems in Canal Street Subway, A. J. Mayell. Eng. News-Rec. vol. 82, no. 14, Apr. 3, 1919, pp. 650-652, 4 figs. Pit and drift methods used in construction work under old subway in New York City

Trench Digging

Municipal Work in Detroit. Fire & Water Eng., vol. 65, no. 18, Apr. 30, 1919, pp. 977-979, 3 figs. Trench digging and pipe laying by Water Dept. of city.

HARBORS

Copenhagen

Extension of Copenhagen Harbor (Forskelligt Jernbetonarbejde i og ved Københavns Havn). Teknisk Tidsskrift, vol. 42, no. 5

The Taylor Stoker

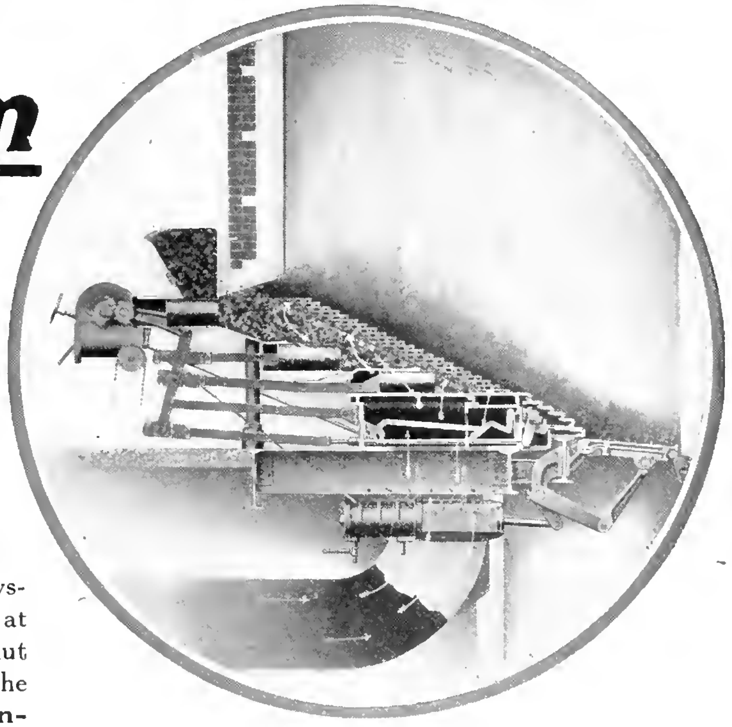
—more than a "Stoker"

A Complete SYSTEM of Scientific Combustion

How the

Taylor System

meets the 6 basic demands of boiler plant efficiency:



1-Continuous Steam Demand

The Taylor Stoker insures 24-hours-a-day, 365-days-a-year service. So long as you have the coal, at Taylor Stokered furnace need never be shut down except for periodical overhauling of the boiler. The fire is fed, sliced and cleaned **while running.** When you use a different grade of coal, you simply re-adjust tt e feed and the draft, accordingly—the operation goes on unceasingly. Clinker and ashes may be dumped by a mere lever movement. The "Fireman" never wearies, for he is freed from coal shoveling, from raking, slicing and battering at clinkers. And no matter whethe the steam demand jumps from 50% to 300% of the boiler capacity, the flexibility of the Taylor Stoker and the reserve power in the deep fuel bed make meeting it a matter of moments.

! Send for the new Taylor Stoker Catalog, Engineers' Edition

THE 6 DEMANDS

When the American Smelting and Refining Co. of Omaha, Neb., installed Taylor Stokers, these were their six boiler plant requirements:

1. Continuous operation
2. Minimum Labor
3. Utmost simplicity
4. Ready Accessibility
5. Maximum capacity
6. Provision for future plant growth

How Taylor Stokers meet these demands is told in this series of advertisements.

Æ CO

American Engineering Company

Philadelphia

Foreign Licensee: Babcock & Wilcox, Ltd., Oriel House, Farringdon Street, London, England

The TAYLOR System of Scientific Combustion

The Taylor Stoker

Dec. 18, 1918, pp. 6-7, 4 figs. Municipal electric power station adjoining harbor. Buildings and elevated railway for discharging coal to boiler house are of reinforced concrete. Part of quay wall consists of grooved reinforced-concrete piles and reinforced slabs.

Dock Gates

Reinforced Concrete Dock Gates. Engineer, vol. 127, no. 3299 Mar. 21 1919, pp. 289-290, 3 figs. Gates are constructed as stress line for uniform water pressure and are circular in shape; they have to stand a water pressure of 14 ft.

Montreal

Suggested Harbour Improvements for Greater Montreal. E. S. M Lovelace. Jl. Eng Inst of Canada, vol. 2, no. 4, Apr. 1919 pp. 318-327, 3 figs. To remedy strong current from canal basin to foot of island opposite Varennes; to provide sufficient depth at low water for larger ocean-going vessels; to prevent danger of floods during spring and fall.

Soerabaja, Java

New Harbor Works at Soerabaja, Java (Technische lessen en vraagstukken op het gebied van den Indischen havenbouw), Wouter Cool. De Ingenieur, vol. 34 no. 8, Feb. 22, 1919, pp. 121-141, 35 figs. Building of vertical reinforced-concrete quay walls on large caissons 22 ft. wide with 12 in. thick walls. Bases floated into position and sunk by being filled with concrete in bags.

Timber, Impregnated

Impregnated Timber for Harbors (Impraegnering af Havnetommer), A. Collstrop and Edv Bülow. Ingeniören, vol. 28, no. 11, Feb. 5, 1919, pp. 69-74, 17 figs. Results obtained in Denmark by impregnating pine and beech with tar oil.

Vancouver

Improvement of Vancouver Harbor. Contract Rec., vol. 33, no. 17, Apr. 23, 1919, pp. 381-386. Recommendations for development of port.

MATERIALS OF CONSTRUCTION

Clay

Experiments with Clay in its Relation to Piles, Alfred S. E. Ackerman. Surveyor, vol. 55, no. 1417, Mar. 14, 1919, pp. 213-224 and also Soc Engrs., Jl. & Trans., vol. 10, no. 2, 1919, pp 37-80 and (discussion), pp. 80-107, 17 figs. Results of 95 experiments, some extending over period of 40 hours each. Object was to determine relationship between horizontal pressure and depth at any given point in clay. Among other conclusions writer establishes that corrugating as well as tapering piles increases their resistance.

Tile

Strength of Hollow Building Tile. Eng. & Contracting, vol. 51, no. 17, Apr. 23, 1919, pp. 411-415, 6 figs. Tests conducted by Bureau of Standards. From Technologic Paper no. 120.

RECLAMATION AND IRRIGATION

Drainage Work

Moore Park Drainage System, Toronto, W. G. Cameron. Can. Engr., vol. 36, no. 9, Feb. 27, 1919, pp 251-255, 7 figs Storm-water outlet; district drained comprises area of 2375 acres.

Drainage Works on Railway Lands, G. A. McCubbin. Can Engr., vol. 36, no. 11, Mar. 13, 1919 pp. 295-298. Dominion laws in respect to drainage and examples of their application. Paper read at Annual Meeting of Assn. of Ontario Land Surveyors.

ROADS AND PAVEMENTS

Accounting

County Highway Books and Bookkeeping, Gordon F Daggett. American City, Town & County Edition, vol 20, no. 4, Apr. 1919, pp. 327-330, 3 figs. Forms for county highway departments.

Brick Pavements

Present Status of Brick Pavements Constructed with Sand Cushions, Cement Mortar Beds and Green Concrete Foundations, W M. Acheson. Good Roads, vol. 17, no. 14, Apr. 5, 1919, pp. 147-149, also Contract Record, vol. 33, no. 16, Apr. 16, 1919, pp. 370-371. Comparison of old and new methods of constructing brick pavements with reference to strength and durability.

Chicago Boulevards

The Michigan Avenue Improvement is the Most Important Addition to Chicago's Boulevard System, Hugh E. Young. Eng. World, vol. 14, no. 8, Apr. 15, 1919, pp. 15-24, 7 figs. Construction of work to remedy congestion in traffic which will involve expenditure of $7,700,000.

Concrete Roads

Machine Finishing Concrete Roads, E. G. Carr. Mun. & County Eng., vol. 56, no. 4, Apr. 1919, pp. 132-134, 5 figs. Benefit of using machine by reason of compactness resulting from action in concrete mass.

Drains

Segment Blocks have Advantages on Larger-Size Drains, D. L. Yarnell. Eng. News-Rec., vol. 82, no. 14, Apr. 3, 1919, pp. 663-664. Report prepared under direction of Bur. Public Roads and Rural Eng. Advantages of lightness, ease of handling and small breakage.

Financing

Methods of Financing Highway Improvements for States, Counties and Towns. Good Roads, vol. 17, no. 17, Apr. 26, 1919, pp. 177-179. Committee report presented at Convention of Am. Road Builders' Assn.

Grade Separation

General Problems and Aspects of Grade Separation. Eng. & Contracting, vol. 51, no. 16, Apr. 16, 1919, pp. 381-384. Report issued by Div. of Grade Separation and Bridges of city of Detroit. It comprises partly an account of progress and partly a study of general and special problems with which city is confronted as it looks forward to an extensive program of construction.

Guarantees

Pavement Guarantees. Can. Engr., vol. 36, no. 13, Mar. 27, 1919, pp. 337-339. Report of Committee on "Economic Status of Guarantees of Pavements on Roads and Streets," presented Feb. 28, at the Annual Convention of Am. Road Builders' Assn.

Indian Roads

Metalling Roads in the Punjab, Khan Bahadur M. Abdul Ahad. Indian Eng., vol. 65, no. 9, Mar. 1, 1919, pp. 124-125, 1 fig. Substitutes introduced by Punjab road engineers are: Sarai-Kala limestone, stone boulders, shingle and shale and overburnt brickbats.

Macadam

Considerations Affecting Designs of Heavy Traffic Highways in Ontario, W. A. McLean. Mun & County Eng., vol. 56, no. 4, Apr. 1919, pp. 157-158. Table indicating required thickness of macadam road crust to transmit at an angle of 30 deg. from the vertical safe bearing pressure to subgrade of various soils. From annual report of Ontario Dept. of Highways.

National Roads

National Roads, E. A. Kingsley. Mun. Jl. & Public Works, vol. 46, no. 16, Apr. 19, 1919, pp. 293-294. Argument in their favor based on success of Nat. Administration of French Roads.

Oil-Heating Plant

Road-Oil Heating Plant of Los Angeles County, E. Earl Glass. Eng News-Rec., vol. 82, no. 15, Apr. 10, 1919, pp. 728-730, 3 figs. Built plant from old equipment in stock. Installation is said to save county $20 per 1,000-gal. tank.

Relocations

Highway Relocations, Gordon F. Daggett. Wisconsin Engr., vol. 23, no. 7, Apr. 1919, pp. 235-243. In relation to securing a more economical road as regards construction and maintenance features.

Scarifier

A New Road Scarifier. Engineer, vol. 127, no. 3298, Mar. 14, 1919, p. 254, 4 figs. A quick-lift toggle action is fitted to frame carrying tines. This permits carrying out of tines to full depth on both sides of an obstruction.

Snow Removal

Efficient Methods of Snow Removal from Highways Outside of Urban Districts. Good Roads, vol. 17, no. 17, Apr. 26, 1919, pp. 180 & 187. Committee report presented at Convention of Am. Road Builders' Assn.

Truck Transportation

Hard Surface Roads and the Auto Truck, H. W. Eldridge. Cement & Eng. News, vol. 31, no. 4, Apr. 1919, pp. 28-29, 1 fig. Transportation of war supplies from point of production in interior states to points of shipping on Atlantic Coast.

Bituminous Surfaces under Truck Traffic, Prevost Hubbard. Contract Rec., vol. 33, no. 14, Apr. 2, 1919, pp. 314-315. Firm foundation essential to resist action of heavy motor trucks.

Wood-Block Pavements

Some Specific Suggestions on the Design and Construction on Modern Wood Block Pavements, E. A. Fisher. Mun. & County Eng., vol. 56, no. 4, Apr. 1919, pp. 129-130, 4 figs. Laying block on pitch cushion applied to smooth concrete base and filling in the remainder with sand.

See also MUNITIONS AND MILITARY ENGINEERING, Roads.

SANITARY ENGINEERING

New Orleans System

Unique Feature of Unified Operation of Water, Sewerage and Drainage Facilities at New Orleans, La., George G. Earl. Mun. & County Eng., vol. 56, no. 4, Apr. 1919, pp. 121-129, 3 figs. Developments which are said to have reduced death rate of city about one-third.

Refuse Collection

Efficiency in City Scavenging. Mun. Jl. & Public Works, vol. 46, no. 17, Apr. 26, 1919, pp. 309-311, 3 figs. Suggestions for planning a system of refuse collection.

Refuse Disposal

Refuse Disposal in London. Mun. Jl. & Public Works, vol. 46, no. 15, Apr. 12, 1919, pp. 263-264. Borough of 120,000 population reported to have screened its refuse, recovered paper and other salable materials and used a clay pit for dumping.

Sewage Disposal

Design Features of Sewage Disposal Plant at Industrial Housing Development of the Alan Wood Iron and Steel Co., at Swedeland, Pa., George L. Robinson. Mun. & County Eng., vol. 56, no. 4, Apr. 1919, pp. 135-136, 1 fig. Sections of sliding tanks.

Sewage Disposal in North Dakota, Elwyn F. Chandler. Quarterly Jl. of the Univ. of North Dakota, vol. 9, no. 3, Apr. 1919, pp. 220-230. Lists for North Dakota and the Red River Valley those towns that are on the banks of rivers and that already have (or will shortly have) sewerage systems, and formulates conclusions concerning the population that each may reach before its sewer outfall will transform the stream into a possible nuisance.

Regulating Chlorine Doses. Mun. Jul. & Public Works, vol. 46, no. 15, April 12, 1919, pp. 264-265. Conclusions from experiments by Maryland Health Dept. Five-minute absorption test recommended.

The Disposal of Sewage by Treatment with Acid, Edgar S. Dorr and Robert Spurr Weston. Boston Soc. Civil Engrs., vol. 6, no. 4, Apr. 1919, pp. 145-166 and (discussion) pp. 166-175. Concludes from results of various experiments and studies that the Miles process will produce a well disinfected effluent from which 90 per cent of the settleable solids have been removed.

Sewage Disposal by Dilution, Including Chlorination of Sewage Effluent and Treatment of Sludge, W. C. Easdale. Surveyor, vol. 55, nos. 1418 and 1419, Mar. 21 and 28, 1919, pp. 227-229 and 244-246, 2 figs. also Eng. & Contracting, vol. 51, no. 18, Apr. 30, 1919, pp. 456-459, 2 figs. Concerning removal of maximum percentage of solids in suspension; maintenance of sewage in fresh condition while passing through tanks; treatment of sludge in such a manner as to facilitate its disposal without causing fouling of tank effluent.

Sewage, Measuring Devices for

Sewage System for Essex Border Cities. Contract Record, vol. 33, no. 16, Apr. 16, 1919, pp. 358-362, 3 figs. Regulating chambers and measuring devices.

Sewage Pumping

Milwaukee Sewage Pumping Station, T. Chalkely Hatton. Fire & Water Eng., vol. 65, no. 17, Apr. 23, 1919, p. 938, 3 figs. Automatically controlled system for disposing of maximum combined daily flow of 231,000,000 gal.

Sewage Screening

Grit Chamber and Fine Screens for Part of New York Sewage, Charles E. Gregory. Eng. News-Rec., vol. 82, no. 14, Apr. 3, 1919, pp. 672-674, 5 figs. Screens of revolving-disk type. Plant serves an area of 345 acres of which about 17 per cent is built up with apartment houses.

Sewers

Equipment and Methods Employed in Building Sewers in San Francisco, Cal., H. W. Shimer. Mun. & County Eng., vol. 56, no. 4, Apr. 1919, pp. 136-140, 18 figs. Disposal scheme adopted is to discharge sewerage only at points were there are strong tidal currents.

Storm Sewer Extension at Toronto Harbor, George T. Clark. Can. Engr., vol. 36, no. 6, Feb. 6, 1919, pp. 193-195, 4 figs. Drainage problems arising from waterfront improvements and how they are being solved.

Town Planning

Town Planning in Canada, James White. Can. Engr., vol. 36, no. 6, Feb. 6, 1919, pp. 199-200. Outline of work of Commission of Conservation in relation to housing and land problems

SURVEYING

Azimuth Line

Drawing the Azimuth Line (Tracciamento della retta d'azimut), E. Modena. Revista Maritima, vol. 52, no. 2, Feb. 1919, pp. 169-173, 1 fig. Method is similar to St. Hilaire's for altitude line.

Geometric Leveling

Geometric Leveling by the Method of Dr. Wilhelm Seibt (Nivelacion geométrica par el metodo del Dr. Wilhelm Seibt), Tomas González Roura. La Ingenieria, vol. 23, no. 6, Mar. 16, 1919, pp. 379-388. Probable error of an isolated observation. (Continuation of serial.)

Transit

Variations of the Optical Axis of a Transit (Sur l'étude des perturbations de l'axe optique d'une lunette méridienne en direction), Maurice Hamy. Comptes Rendus des Séances de l'Académie des Sciences, vol. 168, nos. 9 and 10, Mar. 3 and 10, 1919, pp. 429-435 and 484-489, 4 figs. Adjustment of telescope by means of collimator placed in line of axis of rotation and two double-reflection prisms placed near ends of collimator and telescope which permit illuminated opening of collimator to be viewed through eyepiece of telescope. Formulæ for corrections. Determination of coefficients entering in equations given in first part of article (Comptes rendus, vol. 168, Feb. 24, 1919.)

WATER SUPPLY

Dry Feeding

The Dry Feeding of Chemicals Used in Water Purification, F. B. Leopold. Mun. & County Eng., vol. 56, no. 4, Apr. 1919, pp. 134-135, 1 fig. Main feature of dry-feed apparatus is cast-iron housing, into which is fitted a drum wheel carrying material forward through an adjustable orifice.

Earthquake Protection

San Francisco's High-Pressure Water Supply, Charles W. Geiger. Eng. World, vol. 14, no. 8, Apr. 15, 1919, pp. 29-32, 6 figs. Safeguards to protect system from damage by earthquakes or accidents.

Factory Water Supply

What it Pays to Know About Factory Water Supply—II, Charles L. Hubbard. Factory, vol. 22, no. 4, Apr. 1919, pp. 689-692, 4 figs. Bringing water to the plant.

Filter Plant

Dundas Has New Filter Plant on Gravity Supply, E. H. Darling. Can. Engr., vol. 36, no. 16, Apr. 17, 1919, pp. 379-382, 6 figs. Concrete dam forms conservation reservoir. Plant has capacity of 700,000 imp. gal. a day.

Manzanares River

Embankment and Hygienic Treatment of the Manzanares River (Encauzamiento y saneamiento del rio Manzanares), Edwardo Fungairino. Revista de Obras Públicas, vol. 67, no. 2268, Mar. 13, 1919, pp. 121-126, 10 figs. Reinforced-concrete structures being erected.

Montana

Treating Montana Waters, C. Herschel Koyl. Ry. Maintenance Engr., vol. 15, no. 5, May 1919, pp. 154-157, 2 figs. Results yielded by installation of Great Northern Railway for treating waters on 1100 miles of main lines.

Purification

Water Purification. Times Eng. Supp., vol. 15, no. 533, Mar. 1919, pp. 104-105. Methods and aims

Softening

Lime Softening of Water and the Use of Sludge as an Aid, W. A. Sperry. Can. Engr., vol. 36, no. 16, Apr. 17, 1919, pp. 384-386 also Eng. & Contracting, vol. 51, no. 15, Apr. 9, 1919, pp. 364-365. Experience at Grand Rapids with changing seasons and illustrating the relations of time and temperature. Paper read before Illinois Section Am. Waterworks Assn.

Treating Water Reduces Boiler Troubles, C. Herschel Koyl. Ry. Age., vol. 66, no. 17, Apr. 25, 1919, pp. 1053-1056, 2 figs. Great Northern experiences with installation on 1100 miles of main lines.

Water Softening: Investigation; Features of Plant; and Special Problems of Large Installations, M. F. Stein. Eng. & Contracting, vol. 51, no. 15, Apr. 9, 1919, pp. 353-356, 5 figs. Results of investigation for softening Lake Erie water. A diagram shows ultimate composition of water after treatment with various amounts of lime. Paper read before Illinois Section of Am. Waterworks Assn.

Under-Water Mains

Water Main Under Copenhagen Harbor (Vandledning nnder Havnen til Sundbyerne). Ingeniören, vol. 27, no. 101, Dec. 18, 1918, p. 634. Project for increasing water supply to suburb where rapid growth has made present supply insufficient.

Wells

Methods of Drilling and Test Results of Large Capacity Well. Eng. & Contracting, vol. 51, no. 15, Apr. 9, 1919, pp. 362-363, 3 figs. Data secured at University of Illinois Wells.

WATERWAYS

Flood Control

Flood Control Work in Washington, W. A. Scott. Eng. World, vol. 14, no. 7, Apr. 1, 1919, pp. 23-28, 12 figs. Project involving expenditure of $1,500,000.

Hell Gate Channel

Industrial Influence of Waterways, Harry Chapin Plummer. Indus. Management, vol. 57, no. 5, May 1919, pp. 353-358, 5 figs. How improvement of Hell Gate Channel and Harlem River will affect eastern manufacturers.

Rivers

Formation of Sinuosites in Water Courses (Recherches sur la formation des sinuosités des cours d'eau), C. Hoc. Génie Civil, vol. 74, no. 12, Mar. 22, 1919, pp. 233-234, 7 figs. Theory of meander of rivers developed from study of dynamic condition of moving point in liquid, considered as subjected to system of elastic forces defined by ellipsoid of elasticity. (Concluded.)

Mining Engineering

BASE MATERIALS

Asbestos

Famous Mineral Localities: The Pelham Asbestos Mine, Massachusetts, Earl V. Shannon. Am. Mineralogist, vol. 4, no. 4, Apr. 1919, pp. 37-39. Characteristical feature is granular material, olivine colored dark by magnetite or chromite dust, containing scattered square phenocrysts of bronzy enstatite up to 3 cm. in length, the whole forming a typical fresh saxonite.

Building Rock

Mineral Deposits and Building Rock Beds of the Argentine Republic (Los yacimientos de minerales y rocas de aplicación en la República Argentina), Ricardo Stappenbeck, Ministerio de Agricultura de la Nación, Direction General de Minas, Geologia e Hidrologia, boletin no. 19, series B, 1918, 107 pp. 1 fig. Summary of notes gathered by various explorers, particularly on genetic formation of ore deposits.

Graphite

Preliminary Report of an Investigation into the Concentration of Graphite from Some Ontario Ores. Can. Min. Jl., vol. 40, no. 12, Mar. 26, 1919, pp. 189-197, 11 figs. Account of experimental work conducted by staff of Dept. of Min. Eng., University of Toronto. From results of tests a system of concentration was outlined.

Lime

The Lime Industry in 1918. Cement & Eng. News, vol. 31, no. 4, Apr. 1919, pp. 35-38. General condition and statistics of production.

COAL AND COKE

Accidents

Reducing Accidents in Coal Mining, Charles P. McGregor. Coal Indus., vol. 2, no. 4, Apr. 1919, pp. 149-150. Duties of officials with reference to inspections, visits, discipline and machinery.

By-Product Plants

Some Striking Features of a Byproduct Coke Plant. Coal Age, vol. 15, no. 15, Apr. 10, 1919, pp. 654-657, 7 figs. Boosters are used to increase pressure of coke-oven gas after by-products are extracted.

Going In for the Production of By-Products Linked with many Important Considerations, L. W. Alwyn-Schmidt. Am. Gas Eng. Jl., vol. 110, no. 15, Apr. 12, 1919, pp. 309-311. Observes that production of by-products can not be neglected by small gas works.

Research and Progress in By-Product Coking in Great Britain—IV, John B. C. Kershaw. Coal Age, vol. 15, no. 17, Apr. 24, 1919, pp. 752-756, 6 figs. Coals are usually crushed and mixed before coking. Arrangement of coke oven plant at Newton Chambers & Co. collieries is given as example of practice followed.

Canada

Coal Resources of Western Canada—I, James White. Coal Age, vol. 15, no. 17, Apr. 24, 1919, pp. 744-748, 3 figs. Distribution: analysis of coal samples; production of coal in Alberta during 1917. (To be concluded.)

Classification

The German System of Coal Classification and the Future Economic War—III. Colliery Guardian, vol. 117, no. 3038, Mar. 21, 1919, pp. 660-661. It is presumed that future economic war will involve restriction of freedom of mine owner in respect of winning and treatment of coal, by introduction of methods based on communal economics.

Coke-Oven Gas

Coke-Oven Gas. Colliery Guardian, vol. 117, nos. 30-40, Apr. 4, 1919, pp. 773-774. Future development of coking industry will take place, writer believes, in two main directions: coke-oven plants becoming large heat, light and power producers, or becoming large centers of chemical activity.

Cutter

Coal-Cutter Invented by a Working Miner. Iron & Coal Trades Rev., vol. 98, no. 2666, Apr. 4, 1919, p. 415, 2 figs. Sketch plan showing details.

Gas

Bumps and Outbursts of Gas in the Crewsnest Pass Coal Field. Coal Age, vol. 15, no. 15, Apr. 10, 1919, pp. 660-665, 5 figs. Field covers 230 square miles and is estimated to contain 845 billion tons of coal. From Bul. 2, 1918, British Columbia Department of Mines.

Kent Coalfield

The Evolution and Development of the Kent Coalfield, A. E. Ritchie. Iron & Coal Trades Rev., vol. 98, nos. 2661, 2664, 2665, 2666, 2667, Feb. 28, Mar. 21, 28, Apr. 4, 11, 1919, pp. 257-258, 356, 381, 414, and 447-448, 3 figs. From 1897 to 1900. Mar. 21: Nationalization of Westphalian Coal Syndicate from accounts in German newspapers. Mar. 28: from 1912 to 1918. Apr. 4: from 1901-1905. Apr. 11: Diagram of borings put down by Kent Coal Concessions, Ltd., up to Dec. 1906.

Spanish Industry

Geological History of Coal and Its Present Value. II. Actual Conditions of Spanish Coal Industry; Its Future (La hulla en el pasado geológico y en el presento histórico. II Estado actual de la industria hullera española; su porvenir), D. Pablo Fábrega. Revista Minera, vol. 70, no. 2680, Mar. 16, 1919, pp. 129-135. Presentation of various theories concerning origin of coal; comparison of activities in coal industries of various nations. Conference given before Instituto de Ingenieros Civiles.

Stripping

Coal Stripping in the United States—IV, Wilbur Greeley Burroughs. Coal Indus., vol. 2, no. 4, Apr. 1919, pp. 143-146, 6 figs. Features of stripping and loading shovels and dragline excavators.

Methods of Mining Coal. W. C. Boehert. Pahasapa Quarterly, vol. 8, no. 2, Feb. 1919, pp. 41-52, 7 figs. Practices followed in U. S. A. in connection with stripping or open-cut mining, and mining under ground or under cover.

Surface Support

The Effect of Coal Mining on the Overlying Rocks and on the Surface, W. D. Lloyd. Colliery Guardian, vol. 117, no. 3041, Apr. 11, 1919, pp. 837-839 and (discussion) p. 842. Writer indicates lines on which he believes further observations should be made on the effect mining operations will have on the support of the surface. Paper read before Midland Inst. Min., Civil & Mech. Engrs.

Transportation

The Carriage of Coal by Rail in India. H. Kelway-Bamber. Ry. Gaz., vol. 30, no. 14, Apr. 4, 1919, pp. 603-605, 6 figs. Development in Indian coal output and forecast of future coal consumption. (To be continued.) Paper read before Indian Section, Roy. Soc. of Arts.

See also INDUSTRIAL TECHNOLOGY, By-Products, Coal By-Products.

GEOLOGY AND MINES

Adirondack Region

Pegmatite, Silextite, and Aplite of Northern New York. William J. Miller. Jl. Geology, vol. 27, no. 1, Jan-Feb. 1919, pp. 28-54, 8 figs. Examination of accepted genetic theories in view of phenomena presented by occurrences in Adirondack region.

Alaska

The Nelchina-Susitna Region, Alaska, Theodore Chapin. Dept. of the Interior, U. S. Geol. Survey, bul. 668, 1919, 67 pp., 14 figs. Location, area and geology of drainage basins of Copper and Susitna Rivers.

American Geology, Bibliography of

Bibliography of North American Geology for 1915 with subject index, John M. Nickles. Dept. of Interior, U. S. Geol. Survey. Bul. 645, 1916, 144 pp. Includes publications bearing on the geology of the Continent of North America and adjoining islands; also Panama and the Hawaiian Islands. Textbooks and papers general in character by American authors are included; those by foreign authors are excluded unless they appear in American publications.

Argentina

Geological and Hydrogeological Studies in the Region between the Mouth of the Rio Negro, San Antonio, and Choele-Choel (Estudios geológicos e hidrologicos en la región comprendida entre Boca del Rio Negro, San Antonio y Choele-Choel), Ricardo Wichmann. República Argentina, Anales del Ministerio de Agricultura de la Nación, Seccion Geológica, Mineralogia y Mineria, vol. 13, no. 3, 1919, 44 pp., 5 figs. Data secured in survey of region.

Contribution to the Geology of the Argentine Republic (Contribución al conocimiento geológico de la República Argentina), Ricardo Wichmann and Franco Pastore. Anales del Ministerio de Agricultura de la Nación, Sección Geologia, Mineralogia y Mineria, vol. 13, no. 4, 1919, 45 pp. 8 figs. Geology of region between Rio Negro and Arroga Valcheta, with petrographic description of volcanic and metamorphic rocks.

British Columbia

Was there a "Cordilleran Glacier" in British Columbia? J. B. Tyrell. Jl. Geology, vol. 27, no. 1, Jan.-Feb. 1919, pp. 55-60. Writer's observations have led him to deny possibility of existence of a great longitudinally moving Cordilleran glacier in latitude 54 deg., and he believes that it was absent as far south as Quesnel in latitude 53 deg.

Crystallography

Crystallography of Some Canadian Minerals: 8 Axinite. Eugene Poitevin. Am. Mineralogist, vol. 4, no. 4, Apr. 1919, pp. 32-36. Analyses made by Geol. Survey of Canada. Gives table showing combination of forms on nine measured crystals.

Dakota, North

The Geology of North Dakota, A. G. Leonard. Jl. Geology, vol. 27, no. 1, Jan.-Feb. 1919, pp. 1-27, 2 figs. Rocks are classified as being chiefly clays, shales and sandstones belonging to the Cretaceous and Tertiary periods, overlain in most places by the drift deposits of the Pleistocene.

Economic Geology

Contributions to Economic Geology (Short papers and preliminary reports), part II, Mineral Fuels, M. R. Campbell and David White. Dept. of Interior, U. S. Geol. Survey, Bul. 621, 1916, 375 pp., 42 figs. Descriptions of occurrences that have economic interest but are not considered of sufficient importance to warrant an extended account; preliminary reports on economic investigations, the results of which are to be published later in more detailed form; apparatus for determining percentage of ash and coal and instructions for its use.

Idaho

A Preliminary Report on the Mining Districts of Idaho, Thomas Varley, Clarence A. Wright, Edgar K. Soper and Douglas C. Livingston. Dept. of Interior, Bur. of Mines, Bul. 166, 113 pp., 6 figs. Gives localities of mining districts, and nature of present operations and those that have been carried on in the past; geology is discussed in reference to types of ore deposits and character of ores.

Lava

Dacites and Dacitoides, With Reference to Lavas of Martinique (Dacites et dacitöides, à propos des laves de la Martinique), A. Lacroix. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 6, Feb. 10, 1919, pp. 297-302. Composition of volcanic rocks found in Martinique is adduced in support of theory that a number of lavas, which are considered as andesites, are in reality heteromorphic dacites.

Metalliferous Deposits

Original Formation of Metalliferous Deposits (Sur la formation originelle des gisements métallifères). Notes Provençales (Notes de géophysique), no. 7, Feb. 1919, pp. 18-21. On the genesis of exogenous deposits. Remarks on Stephen Tabor's paper, The Mechanics of Vein Formation, before Am. Inst. Min. Engrs. See Trans., A. I. M. E., Sept. 1918, pp 1189-1222.

Nevada

The Yerington District, Nevada, Adolph Knopf. Min. & Sci. Press, vol. 18, no. 14, Apr. 5, 1919, pp. 455-458, 2 figs. Geological records; analysis of limestone sample taken in district. From Professional Paper 114, U. S. Geol. Survey.

Texas

Geology of North Central Texas Field, Wallace E. Pratt. Oil & Gas Jl., vol. 17, no. 44, Apr. 4, 1919, pp. 54-56. Structure of surface beds; surface relation to subsurface; occurrences of water, oil and gas. Paper before Am. Assn. of Geologists.

Vancouver Island

Sooke and Duncan Map-Areas, Vancouver Island, C. H. Clapp. Can Dept. of Mines, Geol. Survey, memoir 96, 445 pp., 19 figs. Topography, geology and natural resources.

IRON

Mesabi Range

Iron-Ore Concentration on the Mesabi Range, F. A. Kennedy. Eng. & Min. Jl., vol. 107, no. 16, Apr. 19, 1919, pp. 683-688, 5 figs. Tables and curves relating to performances of washers; suggestions for betterment of present methods.

LEAD, ZINC, TIN

Tin Mining

Tin-Mining in the Dutch Indies (Van het handgrondwerk naar het spuit-en pompbaggerbedrijf), J. C. Mollema. De Ingenieur, vol. 34, no. 5, Feb. 1, 1919, pp. 68-79, 14 figs. Particulars of a number of installations.

Zinc-Ore Distillation

Refractories for the Zinc Industry, M. Grover Babcock. Jl. Am. Ceramic Soc., vol. 2, no. 2, Feb. 1919, pp. 81-95. Requirements of clay retorts used in distillation of zinc ores.

Zinc-Ore Mining

Operations at the Zinc Camp, Arkansas, Tom Shiras. Eng. & Min. Jl., vol. 107, no. 14, Apr. 5, 1919, pp. 607-608, 2 figs. Mining confined to removal of siliceous ores.

MAJOR INDUSTRIAL MATERIALS

Manganese

Chrome and Manganese Ores in Cuba. Boletin de Minas, no. 5, 1918, pp. 57-70. Despite handicaps, it is believed that the outlook for a steadily increasing production in 1918 and 1919 is good. Reserves of manganese are estimated at 700,000 to 800,000 tons. The Spanish text for this article appears in pp. 41-56. From U. S. Geol. Survey, bul. 380, Sept. 1918.

Report on the Manganese Deposits of Georgia (Second Report on Manganese), J. P. D. Hull, Lawrence la Forge and W. R. Crane. Geol. Survey of Georgia, bul. 35, 295 pp., 39 figs. Divided into three parts. (1) relation of ore deposits to structural geology, (2) description of individual properties and mode of occurrence of ore, and (3) methods of mining and cleaning ore. Prepared in cooperation with U. S. Geol. Survey and U. S. Bur. of Mines.

The Mining and Preparation of Manganese Ores in Tennessee, W. R. Crane and E. R. Eaton. Mining Jl., vol. 125, no. 4363, Apr. 5, 1919, pp. 213-214. Minerals found are pyrolusite, psilomelane, and manganite. (To be continued.) From Mag. of Tennessee Geol. Soc.

Manganese, T. G. Trevor, South African Jl. Industries, vol. 2, no. 1, Jan. 1919, pp. 35-43. Occurrence and appearance of ores; metallurgical and chemical uses of manganese oxides; statistics of manganese production of the world for 1913 and 1916.

MINES AND MINING

Accidents

Quarry Accidents in the United States During the Calendar Year 1917, Albert H. Fay. Dept. of the Interior, Bur. of Mines, tech. paper 213, 62 pp. Tables indicating causes of accidents; safety rules promulgated by Nat. Lime Mfrs. Assn.

Africa, South

The Mineral Industry of South Africa and its Future—IV, V & VI. P. A. Wagner. S. A. Min. & Eng. Jl., vol. 28, parts I & II, nos. 1429, 1430 and 1432, Feb. 15, 22 and Mar. 8, 1919, p. 572, 597 and 27. Feb. 15: Iron, kaloin and lead mining. Feb. 22: Zinc, arsenic, magnesite, manganese, mica, soda, talc, tungsten. Mar. 8: Lime, rock phosphate, chert, gypsum, kieselguhr, salt, cement, clay products, and structural material. Presidential address read before S. A. Assn. for the Advancement of Science. (To be continued.)

British Columbia

History of Mining and Metallurgical Development in British Columbia. Min. & Eng. Rec., vol. 24, no. 1, Jan. 1919, pp. 6-11, 9 figs. From the discovery of gold in 1851 to construction of mill at Allenby, B. C.

Cuba

Historical Sketch of the Mining Industry in Oriente, Cuba (Resena historica sobre la mineria en Oriente, Cuba). Boletin de Minas, no. 5, 1918, pp. 26-40. Iron mining on northern coast. (Continued.)

Doors, Separation

Separation Doors at the Bottom of the Upcast Pit, Worked Automaticaly by Tubs Attached to Endless-Rope (Under-Tub) Haulage, Clement Fletcher. Trans. Manchester Geol. & Min. Soc., vol. 36, part 11, Mar. 1919, pp. 31-33, & 4 figs. on plate between p. 64 and cover. Doors work vertically in machined gun-metal grooves and are operated by two Hans Renold roller chains.

Drainage

Tapping and Draining a Deep Shaft, J. Fox. Colliery Guardian, vol. 117, no. 3038, Mar. 21, 1919, pp. 659-660, 3 figs. Sketches showing erosive action of water on borehole.

Drilling and Stripping

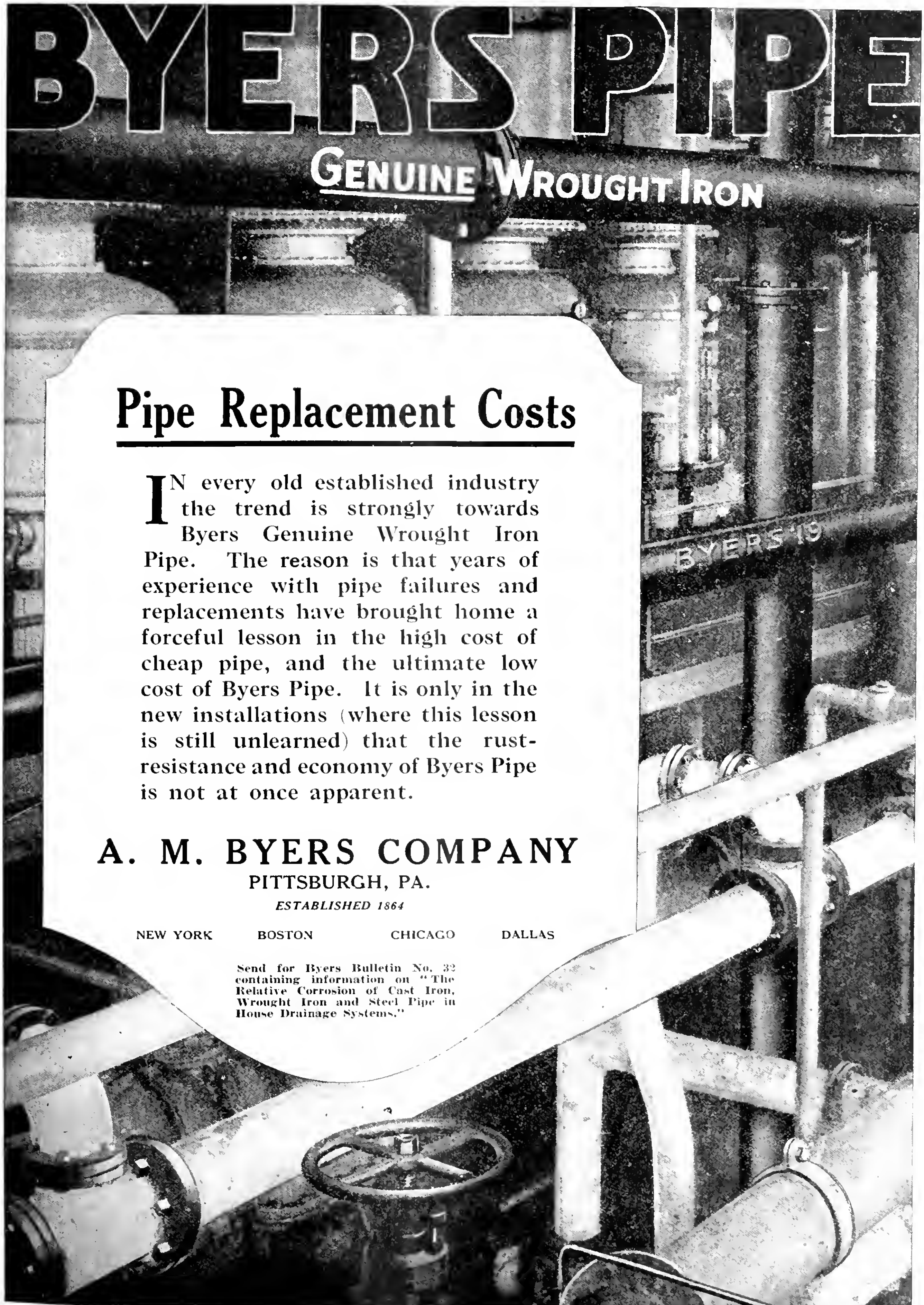
The Blow of the Drill Bit, Sharp or Dull, Frank Richards. Eng. & Min. Jl., vol. 107, no. 17, Apr. 26, 1919, pp. 735-736, 1 fig. Explanation of failure of steel to stand up under action is found in consideration of forces which act and react in drill-striking operation.

Heavy Drilling at Sacramento Hill, Robert T. Banks. Eng. & Min. Jl., vol. 107, no. 16, Apr. 19, 1919, pp. 690-691, 2 figs. Method adopted provides for series of benches which are operated simultaneously, steam shovels being used to load rock into cars after it has been drilled and blasted.

Stripping and Drilling Methods at the Sacramento Hill Copper Mines. Eng. & Contracting, vol. 51, no. 16, Apr. 16, 1919, pp. 389-390, 4 figs. Hill laid off in benches and drilling is effected by Sullivan "Hyspeed" pistol drill with $^3/_4$-in. cylinder diameter.

Hoisting Machinery

Electric Cables at Mines, Iron & Coal Trades Rev., vol. 98, no. 2666, Apr. 4, 1919, pp. 405-407, 5 figs. Regulations proposed by various mining engineers in the light of their experience. Discussion of paper published in Iron & Coal Trades Rev., Feb. 21.


BYERS PIPE
GENUINE WROUGHT IRON
BYERS 19
Pipe Replacement Costs
IN every old established industry the trend is strongly towards Byers Genuine Wrought Iron Pipe. The reason is that years of experience with pipe failures and replacements have brought home a forceful lesson in the high cost of cheap pipe, and the ultimate low cost of Byers Pipe. It is only in the new installations (where this lesson is still unlearned) that the rust-resistance and economy of Byers Pipe is not at once apparent.
A. M. BYERS COMPANY
PITTSBURGH, PA.
ESTABLISHED 1864
NEW YORK BOSTON CHICAGO DALLAS
Send for Byers Bulletin No. 32 containing information on "The Relative Corrosion of Cast Iron, Wrought Iron and Steel Pipe in House Drainage Systems."

Laws

A Uniform Mining Law for North America, T. A. Godson. Can. Min. Inst. Bul., no. 84, Apr. 1919, pp. 399-405. Considers that present mining laws of Canada are not sufficiently adaptable to mining needs.

Revision of Mining Law of April 21, 1810 (Projet de revision de la loi des mines du 21 avril 1810). M. Couriot. Génie Civil, vol. 74, no. 12, Mar. 22, 1919, pp. 228-232. Modifications in regard to duration of concessions and sharing of profits with the state. Comparisons of French mining law with those of other nations.

Ore Handling

Unloading, Crushing, and Screening at the Arthur Mill of the Utah Copper Company, F. G. Janney. Min. & Sci. Press, vol. 118, no. 14, Apr. 5, 1919, pp. 464-470, 8 figs. Ore comes from mine in trains of 40 cars, which descend on 0.4 per cent grade over 150-ton Strait scale, equipped with Streeter-Amet automatic weighing and recording device, on which ore is weighed while train is moving at rate of two miles per hour.

Ore Reserves

Application of the Theory of Probability in the Determination of Ore Reserves, G. A. Watermeyer. Jl. Chem., Metallurgical & Min. Soc. of South Africa, vol. 19, no. 7, Jan. 1919, pp. 97-107 and (discussion) pp. 107-108, 5 figs. Studies whether there is a law governing distribution of values in determination of ore reserves. Object is to ascertain probability of predicting nature of ore penetrating to various depths from points sampled.

Pillar Supports

Pillar Supports in Fortuna Mines of Braden Copper Co., Chile (Método de explotación en las minas Fortuna de la Braden Copper Co. de Chile Dejando columnas de sostenimiento), Charles Hollister. Ingenieria Internacional, vol. 1, no. 1, Apr. 1919, pp. 13-15, 2 figs. Results obtained by application of method used in Arizona of Ray Consolidated Copper Co.

Rand

Rand Mining in 1918, A. Cooper Key. Eng. & Min. Jl., vol. 107, no. 16, Apr. 19, 1919, pp. 702-703, 1 fig. Data showing past and present position of gold-mining industry.

Safety

Mine Officials and the Safety Problem, Edwin C. Curtis. Coal Indus., vol. 2, no. 4, Apr. 1919, pp. 141-142. Advises that an official be judged by good accident record rather than by his record of production.

Safety Lamps

Safety Lamp Gauzes—IV, T. J. Thomas. Colliery Guardian, vol. 117, no. 3039, Mar. 28, 1919, pp. 714-716, 3 figs. Velocities established in explosive mixtures; composition of air rendered extinctive by addition of dioxide and nitrogen; influence of inert gases on properties of firedamp mixtures; results of exposing methane and air mixtures to high temperatures without sparking.

Screening

Estimating Screen Efficiency, W. O. Borcherdt. Eng. & Min. Jl., vol. 107, no. 15, Apr. 12, 1919, pp. 651-653, 2 figs. Diagram of screen analysis on feed, undersize and oversize samples made on hand screen clothed with identical screening medium used on a mill screen.

Statistics

Mineral Statistics of Peru in 1917 (Estadistica Minera del Perú en 1917), Carlos P. Jimenez. Boletin del Cuerpo de Ingenieros de Minas del Peru, no. 95, 326 pp. Production of coal, oil, gold, silver, copper, lead, zinc, mercury, antimony, vanadium, molybdenum, tungsten, bismuth and natural salts.

Stripping

See Drilling and Stripping above.

Timbering

Safe and Efficient Mine Timbering—IV, R. Z. Virgin. Coal Indus., vol. 2, no. 4, Apr. 1919, pp. 138-141, 4 figs. Cribbing, forepoling under soft roof, timbering high places, inclined seams and using round, notched timber.

Ventilation

Mine Ventilation in the Coeur d'Alenes, Robert N. Bell. Eng. & Min. Jl., vol. 107, no. 14, April 5, 1919, pp. 603-604. Problem presented by air circulation at depth.

See also ELECTRICAL ENGINEERING, Power Applications (Mine Service).

MINOR INDUSTRIAL MATERIALS

Barytes

Barytes, Percy A. Wagner. South African Jl. Industries, vol. 2, no. 2, Feb. 1919, pp. 143-146. Mode of occurrence and sources of supply; commercial uses; dressing and preparation; valuation and prices.

Magnesite

Magnesite on the Island of Margarita, Charles F. Z. Caracristi. Eng. & Min. Jl., vol. 107, no. 1, Apr. 12, 1919, pp. 645-647, 1 fig. Geological examination has led writers to believe that there are important magnesite deposits on Venezuelan island.

Mercury

Quicksilver in 1917, F. L. Ransome. Dept. of Interior, U. S. Geol. Survey, Mineral Resources of U. S. A., 1917—Part I, pp. 367-455, Mar. 18, 1919. Statistics of production, including general review of important quicksilver deposits of the world, section on mining of quicksilver ores, and bibliography.

Salpeter

Economics of Chile (Chile Economico), Pedro Luis Gonzalez. Boletin de la Sociedad de Fomento Fabril, vol. 35, no. 12, Dec. 1918, pp. 811-821. Special reference is made to mineralogy, metallurgy and salpeter deposits.

Tungsten

Wolfram Mining in Bolivia, G. F. J. Preumont. Eng. & Min. Jl., vol. 107, no. 14, Apr. 5, 1919, pp. 597-600. Development of industry in recent years. Bolivia is considered by writer as second in importance to Malay States in production.

Cobalt, Molybdenum, Nickel, Titanium, Tungsten, Radium, Uranium, and Vanadium in 1916, Frank L. Hess. Dept. of Interior, U. S. Geol. Survey, Mineral Resources of the U. S. A., 1916—Part I, pp. 775-807, Feb. 25, 1919. Statistics of production, importation and mining conditions.

OIL AND GAS

California

Structure and Oil Resources of the Simi Valley, Southern California, William S. W. Kew. Dept. of Interior, U. S. Geol. Survey, Bul. 691-M, Contributions to economic geology, 1918, part II, Apr. 3, 1919, pp. 323-347. Geology of oil fields.

Drilling

The Percussion System of Drilling Oil Wells, Maurice A. Ockenden and Ashley Carter. Petroleum Times, vol. 1, no. 2, Mar. 22, 1919, pp. 219-222, 2 figs. Plant used in connection therewith. (To be concluded.) Paper read before Instn. Petroleum Technologists.

Gas Testing

Testing Natural Gas for Gasolene Content, G. A. Burrell. Water & Gas Rev., vol. 29, no. 10, Apr. 1919, pp. 12-13, 2 figs. Apparatus which condenses gasoline vapor out of gas and measures yield.

Gas Traps

Traps for Saving Gas at Oil Wells, W. R. Hamilton. Dept. of the Interior, Bur. of Mines, tech. paper 209, petroleum technology 49, 34 pp. 19 figs. Types of traps. Their use is represented as advantageous in increasing gasoline content of gas and eliminating part of storage losses.

Geological Surveying

How a Petroliferous Region is Studied (Come si studia un giacimento petrolifero). Ingegneria Italiana, vol. 3, no. 63, Mar. 13, 1919, pp. 174-177. General examination, geological survey and financial study as preliminary steps before prospecting.

Montana

Anticlines in a Part of the Musselshell Valley, Musselshell, Meagher, and Sweetgrass Counties, Montana, C. F. Bowen. Dept. of Interior, U. S. Geol. Survey, Bul. 691-F, Contributions to economic geology, 1918, part II, Nov. 22, 1918, pp. 185-209, 1 fig. Previous investigators have asserted that there is an area in this region where the rocks have undergone considerable folding. On basis of this information work was conducted to determine measure and extent of folds and to examine possible occurrence of accumulations of oil and gas in them.

Oil and Gas Geology of the Birch Creek-Sun River Area, Northwestern Montana, Eugene Stebinger. Dept. of Interior, U. S. Geol. Survey, Bul. 691-E, Contributions to economic geology, 1918, part II, Aug. 13, 1919, pp. 149-184, 4 figs. Presentation of unquestionable evidence having bearing on oil and gas prospects in specified area, including descriptions of broader features of geology and account of local structural characteristics which have been accounted as possible sources of oil and gas.

Oklahoma

New Development for Oil and Gas in Oklahoma during the past Year and Its Geological Significance, Geo. E. Burton. Bul. Am. Assn. Petroleum Geologists, vol. 2, pp. 53-59. From data submitted it is believed that the Pennsylvanian shales are much nearer the surface than it has been supposed.

Petroleum Structure

Petroleum Under the Miscroscope. No. 21, Spontaneous Ignition of Oil, James Scott. Petroleum World, vol. 16, no. 222, Mar. 1919, pp. 108-110, 3 figs. Showing formation of pyrites capable of inducing spontaneous ignition, owing to the comparatively large amount of space filled with gas.

Shales

Oil Shales of the Great Uintah Basin, Utah, Don Maguire. Salt Lake Min. Rev., vol. 21, no. 1, Apr. 15, 1919, pp. 21-26, 4 figs. Report of Mineralogical Survey. From Mineralogist & Metallurgist.

Storage

The Fireproof Storage of Petrol. Petroleum World, vol. 16, no. 222, Mar. 1919, pp. 128-132, 3 figs. Description of Martini and Hüneke pressure-type pumping plant. (To be continued.)

Texas

Natural Gas Resources of Parts of North Texas. Dept. of Interior, U. S. Geol. Survey, Bul. 629, 1916, 129 pp., 20 figs. Estimates of gas remaining in development pool.

Water

Water in Oil and Gas Wells, F. B. Tough, Petroleum Times, vol. 1, no. 2, Mar. 22, 1919, pp. 229-231. Formulæ for computing probable collapsing pressure for commercial sizes of casing.

PRECIOUS MINERALS

Arizona

Gold, Silver, Copper, Lead, and Zinc in Arizona in 1917, V. C. Heikes. Dept. of Interior, U. S. Geol. Survey, Mines Report, Mineral Resources of U. S. A., 1917—Part I, pp. 509-548, Apr. 1, 1919. Figures of output in marketable form as obtained from smelters, refineries and mints; review of industries of entire country; production in terms of recoverable metal in ores and other material sold or treated during calendar year. Information relative to mining industry in respective states, counties and mining districts.

Colombia

The Guamoco District of the Republic of Colombia—II, S. Ford Eaton. Eng. & Min. Jl., vol. 107, no. 14, Apr. 5, 1919, pp. 609-613, 2 figs. Peculiar transportation difficulties in gold mines.

Idaho and Washington

Gold, Silver, Copper, Lead and Zinc in Idaho and Washington in 1917, C. N. Gerry. Dept. of Interior, U. S. Geol. Survey, Mineral Resources of the U. S. A., 1917, part I, pp. 457-507, Apr. 3, 1919. Statistics of production.

Ontario

The Gold-Quartz Lodes of Porcupine, Ontario, Ellsworth Y. Dougherty. Min. & Sci. Press, vol. 118, no. 16, Apr. 19, 1919, pp. 532-536, 8 figs. Occurrence of tourmaline and feldspar with coarsely crystalline and fluid-enclosing ore-quartz led to classification of orebodies as high-temperature deposits, formed under great depth and pressure through the agency of igneous activity.

Platinum

An Investigation of Certain Canadian Platinum and Manganese Resources, G. C. Mackenzie. Can. Min. Inst. Bul., no. 84, Apr. 1919, pp. 425-434. Recovery from refining of Sudbury copper-nickel matte; report of examination of platinum occurrences in Alberta, British Columbia, undertaken by Canadian Munition Resources Commission.

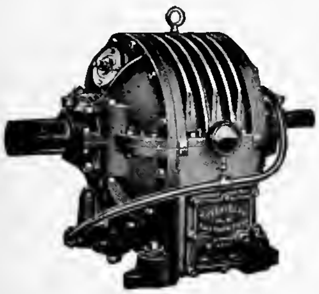
Washington

See Idaho and Washington above.

TURBOGEAR

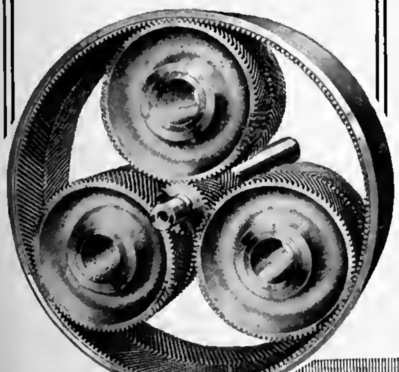
FAST PATENTS

The
IDEAL
DRIVE



The
MODERN
WAY
TO
CONNECT
DRIVING AND
DRIVEN
UNITS

CAPACITIES
1 to 20,000 H. P.



Men YOU Know are Boosters for Turbo-Gear

Engineers, power transmission experts, plant operators and owners of the leading industries—men you know or know about—are turning more and more to "Turbo-Gear" as the one practical, economical power transformer.

For "Turbo-Gear", low in first cost, free from up-keep expense, economically abolishes the big item of repairing and replacing power transmission equipment.

Cheaper first—and in the end

"Turbo-Gear" is moderate in price in comparison with other power transmission costs—and first cost is the only cost.

The Use of "Turbo-Gear" Means:

1. Greater over-all efficiency
2. Greater safety
3. Continuous operation
4. Positive transmission of power—no slip
5. Less floor space used therefore lower overhead

By the way of pointing out what "Turbo-Gear" can do for you let us tell you what it is doing for others.

Begin today by sending for Bulletin No. 101.

POOLE ENGINEERING AND MACHINE COMPANY

Manufacturers of Gears and Power Transmission Machinery Since 1843

BALTIMORE, MD., U. S. A.

General Sales Office: 50 Church St., New York, N. Y.

CHARLOTTE, N. C., Realty Building.
CHICAGO, Old Colony Bldg.
DALLAS, 1405 Southwestern Life Bldg.
DETROIT, 423 Dime Bank Bldg.
DENVER, First National Bank Bldg.
ST. LOUIS, 2211 Olive St.
SALT LAKE CITY, 914 Boston Bldg.
SAN FRANCISCO, 1067 Mills Bldg.
SEATTLE, 2012 L. C. Smith Bldg.
WILKES BARRE, Second National Bank Bldg.
PITTSBURGH, 781 Union Arcade Bldg.
EL PASO, 615 Mills Bldg.
MILWAUKEE, Wells Bldg.
PHILADELPHIA, 215 Drexel Bldg.

Sole Canadian Representatives { **The Canadian Fairbanks Morse Co., Ltd.** Branches in every large Canadian city

Metallurgy

ALUMINUM

Micrography

The Micrography of Aluminum and its Alloys, D. Hanson and S. L. Archbutt. Engineering, vol. 107, no. 2779, Apr. 4, 1919, pp. 450-453, 13 figs. Different microstructural constituents met with in aluminum alloys, and methods by which these may be etched for microscopic examination. Paper read before Inst. of Metals.

Metallography

The Metallography of Aluminum—I & II, Robert J. Anderson. Metal Industry, vol. 14, nos. 12 & 13, Mar. 21 & 28, 1919, pp. 223-228 and 245-247, 20 figs. Discussion of amorphous theory and plastic deformation witb remarks on grain growth phenomena; microstructure of various forms of aluminum; annealing and recrystallization of aluminum which has had plastic deformation; polishing and etching of aluminum microsections preparatory to microscopic examination.

COPPER AND NICKEL

Nickel Refining

Some Features of Nickel Refinery. Can. Manufacturer, vol. 39, no. 4, Apr. 1919, pp. 21-24, 8 figs. Features of Int. Nickel Co. of Canada refinery. Plant was erected at cost of \$5,000,000.

FERROUS ALLOYS

Chromium-Nickel Steel

Critical Points, L. A. Danse. Proc. Steel Treating Research Soc., vol. 2, no. 3, 1919, pp. 32-38. Discussion of mechanical and thermal treatment of chromium-nickel steel, particularly as used in aircraft production.

FLOTATION

Flotation Experiments

A Device for Flotation Experiments, Will H. Coghill. Min. & Sci. Press, vol. 118, no. 15, Apr. 12, 1919, pp. 495-496, 1 fig. Device consists of two pyrex flasks, one of 250 cc. and the other of 500 cc., fitting in same rubber nipple; to prepare a test, smaller flask is filled with mixture of ore and water of desired consistency and emptied into larger one; flotation reagents are added and test is accomplished by hand agitation.

FURNACES

Air-Volume Regulation

Air-Volume Regulation in Smelting and Refining Furnaces, C. H. Smoot. Eng. & Min. Jl., vol. 107, no. 15, Apr. 12, 1919, pp. 654-656, 3 figs. Type of constant-volume regulator developed by Ratean Rattn-Smoot Eng. Corp.

Gas Heating

Heating of Metallurgical Furnaces (Le chauffage des fours métallurgiques), Louis Lecocq. Chimie & Industrie, vol. 2, no. 3, Mar. 1, 1919, pp. 260-270. Figures indicating advantage of utilizing gas from coke furnaces.

Greene Arc Furnace

The Greene Rolling Cylinder Arc Furnace. Iron Age, vol. 103, no. 16, April 17, 1919, pp. 1005-1007, 3 figs. Principal features are tilting arrangement by use of hydraulic cylinder connected to back of furnace shell, and removable roof.

Pulverized Coal

Pulverized Coal in Canadian Steel Plant, C. F. Herington. Iron Age, vol. 103, no. 17, Apr. 24, 1919, pp. 1065-1069, 7 figs. Air distributing system supplies powdered fuel for boilers and furnaces at Canadian branch of Armstrong Whitworth Co.

See also MECHANICAL ENGINEERING, *Furnaces*; ELECTRICAL ENGINEERING, *Furnaces*.

IRON AND STEEL

Gray Iron

Improving the Quality of Gray Iron by the Electric Furnace, George K. Elliott. General Meeting Am. Electrochemical Soc., Apr. 3-5, 1919, paper no. 11, pp. 173-179. Proposes to use a basic-lined arc electric furnace for refining and superheating gray iron. Cupola is said to be strong on heating and melting, but weak in superheating, carbon regulation, waste of alloying metals, and impossibility of refining; consequently, duplex process, using electric furnace in tandem with cupola, is believed will correct and supplement deficiencies of cupola.

Hot Deformation

Hot Deformation and the Quality of Steel, Georges Charpy. Iron Age, vol. 103, no. 17, Apr. 24, 1919, pp. 1079-1081, 3 figs. Experiments determining effect on tensile strength and impact values; gun and hard basic steel were used. Paper presented before Iron & Steel Inst., London.

Liquid Steel

Paper on "The Solid and Liquid States of Steel," Cosmo Johns. Jl. West of Scotland Iron & Steel Inst., vol. 26, part 3, 1918-1919, pp. 36-41. Properties of an optically clean surface of liquid steel and its similarity to that of a polished metallic surface with a vitreous film. Preservation of surface of liquid steel is attributed to presence of iron-vapor atmosphere.

Malleable Iron

Malleable Iron, What it is, and How it is Made, F. H. Bell. Can. Foundryman, vol. 10, no. 4, Apr. 1919, pp. 85-88, 7 figs. Organization in operation of foundry works.

Manganese

Manganese Alloys in Open-Hearth Steel Practice, Samuel L. Hoyt. Sci. Am. Supp., vol. 87, no. 2261, May 3, 1919, pp. 282-283. Conditions in open-hearth practice that affect conservation of manganese, both during the working of the heat and in making final additions; metallurgical conditions for use of manganese in the form of low-grade or special alloys; effect on finished steel both as to quality and condition of various methods and processes.

Ore Smelting

A New Method for the Smelting of Iron Ores, J. W. Moffat. Can. Machy., vol. 21, no. 14, Apr. 3, 1919, pp. 325-327. Duplex process for making of steel from ores not suitable for blast furnace.

Phosphorus in Steel

The Determination of Phosphorus in Vanadium Steels, Ferro-Vanadium, Non-Vanadium Steels and Pig Iron, Chas. Morris Johnson. Chemical News, vol. 118, no. 3073, Mar. 7, 1919, pp. 113-115. Method for steel containing vanadium up to 2.6 per cent; table showing effect of increasing amounts of nitric acid on phosphorus recovery.

Refractories

See Refractories, under MECHANICAL ENGINEERING.

Rolling Mills

See Mechanical Processes (Steel Mills), under MECHANICAL ENGINEERING.

Tempering Velocity, Critical

Influence of Various Factors on the Critical Velocity of Tempering of the Carbon Steels (Influence de divers facteurs sur la vitesse critique de tremps des aciers au carbone), I. M. Portevin. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 7, Feb. 17, 1919, pp. 346-348. Duration of temper was determined in the experimental work as the time in seconds for cooling of metal from 700 to 200 deg. cent.

Toronto Electric Steel Plant

World's Largest Electric Steel Plant in Toronto, George T. Clark and Frederick Phillips. Can. Engr., vol. 36, no. 13, Mar. 27, 1919, pp. 327-331, 10 figs. Plant occupies 127.65 acres, and 5000 lin. ft. of concrete docks, accommodating vessels of 24 ft. draft. It was built for manufacture of 6-in. and 9.2 in. forgings from raw material.

NON-FERROUS ALLOYS

Aluminum Alloys

Alloys of Aluminum with Rare or Special Alloys, Jean Escard. Metal Industry, vol. 13, no. 20, Nov. 15, 1918, pp. 333-335. Constitution, properties and preparation of aluminum and manganese, aluminum and chromium, aluminum and tungsten, aluminum and vanadium, and aluminum and titanium alloys.

Aluminum Bronzes

Study and Graphical Representation of the Properties of Aluminum Bronzes (L'étude et la représentation graphique des propriétés des bronzes d'aluminum), R. de Fleury. Génie Civil, vol 74, no. 13, Mar. 29, 1919, pp. 254-256, 9 figs. Triangular diagrams of resistance to rupture and ultimate elongation of bars.

Brass

Notes on Alloys Used in Brass Rolling Mills, A. J. Franklin. Metal Industry, vol. 14, no. 12, Mar. 28, 1919, pp. 241-244, 3 figs. Effect of impurities, casting difficulties, hints on annealing and composition of some of the alloys used in sheet-rolling mill.

Decomposition

Decomposition of Metals—II, A. I. Krynitzky. Chem. & Metallurgical Eng. vol. 20, no. 8, Apr. 15, 1919, pp. 421-424, 6 figs. Application of theory to commercial problem of manufacturing durable alloys containing tin and aluminum, with outline of recommended melting, drawing and annealing practice for certain munitions.

Metallography

Metallography Applied to Nonferrous Metals—II, Ernest J. Davis. Foundry, vol. 47, no. 5, Apr. 15, 1919, pp. 215-218, 15 figs. Predicting microstructure of series of alloys by equilibrium diagram.

OCCLUDED GASES

Occlusion

Occlusion of Gases by Metals (L'occlusion des gaz par les métaux), A. Delesne. Revue Générale des Sciences, vol. 30, no. 1, Jan. 15, 1919, pp. 17-19. Synopsis of discussion at conference of Faraday Soc., London.

VARIA

Etching Solutions

Etching Solutions and their Uses, Ernest G. Jarvis and McNab and Harlin Mfg. Co. Metal Indus., vol. 17, no. 4, Apr. 1919, pp. 170-171. Preparation and uses of seventeen different solutions.

Manganese-Silver Problem

The Manganese-Silver Problem—I, Harry J. Wolf. Colorado School of Mines Mag., vol. 9, no. 4, Apr. 1919, pp. 73-77. Metallurgical experiments performed to determine reason for insolubility in cyanide of silver in certain ores where it is accompanied by manganese oxides.

Aeronautics

AIRCRAFT

Airship Developments

The Case for the Airship, Ladislas d'Orcy. Jl. So. Automotive Engrs., vol. 4, no. 4, Apr. 1919, pp. 303-307, 10 figs. Progress made since 1914.

The Development of Airship Construction, C. I. R. Campbell. Engineering, vol. 107, no. 2780, Apr. 11, 1919, pp. 469-472, 3 figs. General particulars of non-rigid, semi-rigid and rigid airships. Paper read before Insta. Naval Architects.

Ballooning

Free Ballooning, a Notable Factor in the Royal Air Force, Lance Rushbrooke. Flight, vol. 11, no. 13, Mar. 27, 1919, pp. 394-396, 7 figs. Use of free balloons in reconnaissance, transmission of messages, photography and other military purposes.

Commercial Use

The Commercial Use of Airships. Nature, vol. 103, no. 2575, Mar. 6, 1919, pp. 4-5. Discusses possibilities of use of airships in immediate future, and compares between large airplane and rigid airship.

Design

Lighter-than-Air Craft, T. R. Cave-Browne-Cave. Flight, vol. 11, no. 13, Mar. 27, 1919, pp. 410-416, 1 fig. Matters which influence lift and behavior of airship. Paper read before Roy. Aeronautical Soc.

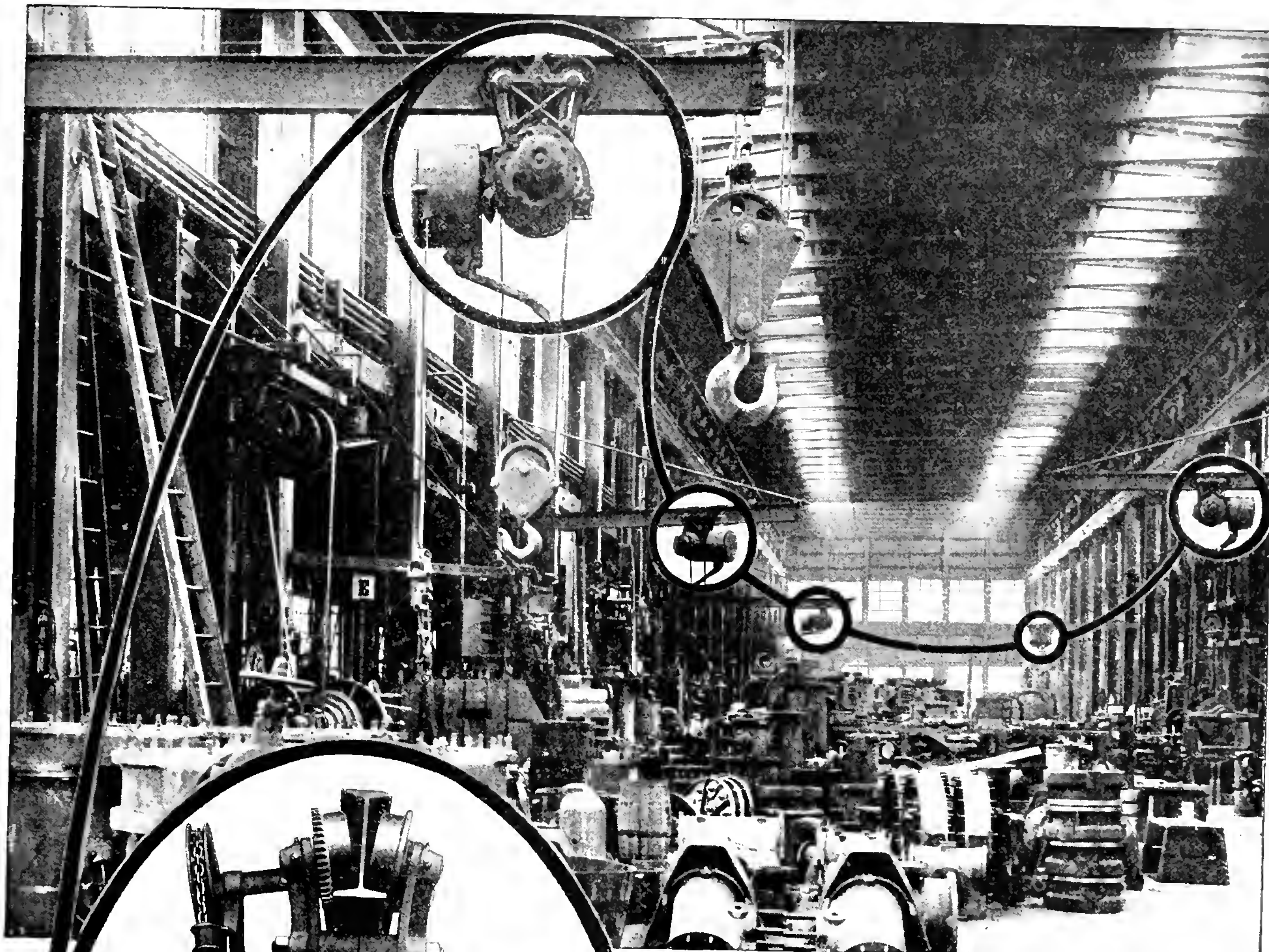
Aerial Greyhounds of To-Morrow. Sci. Am. vol. 120, no. 16, Apr. 19, 1919, pp. 400-401 and 418, 3 figs. Constructural features of air ships for future transatlantic service.

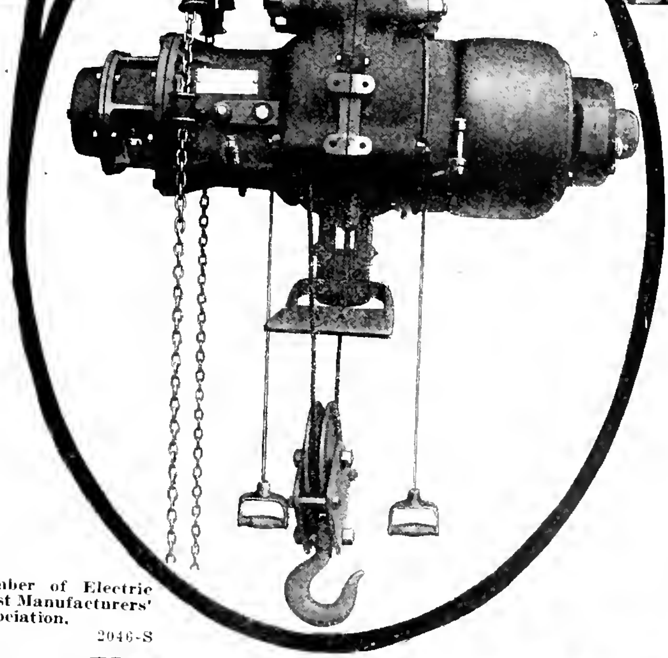
Helium

The Use of Helium for Aircraft Purposes Nature, vol. 102, no. 2573, Feb. 20, 1919, pp 487-488. On increasing buoyancy of airshi by heating gas electrically or otherwise.

Transport Service

The Possibilities of Airship Transport Service. Flight, vol. 11, no. 8, Feb. 20, 1919, pp 230-232, 1 fig. Estimated cost of running Atlantic airship service, London-New York financial and working arrangements and Government subsidy; general specifications of proposed airship for transport service. (Continuation of serial.)





"Shepards"— all over the shop

Where you find Shepard Hoists there you find work is carried on with the highest degree of efficiency, for each "Shepard" represents a saving in time and labor—one man can operate a "Shepard" and handle a piece it would take a gang to lift, and in half the time.

Give a "Shepard" consistent, steady, "day in, day out" work—it's sturdy and built for that kind of service.

It's unaffected by dirt, dust or dampness—because all electrical and mechanical parts are protected by the "closed in" unit construction.

The Shepard Line includes electric traveling cranes, monorail cranes and hoists, with either plain or motor operated trolleys, ½ to 30 tons. Our engineers will be glad to serve you.

Shepard Electric Crane & Hoist Co.

370 Schuyler Avenue, Montour Falls, N. Y.

New York, Philadelphia, Chicago, Pittsburgh, Boston, Baltimore, Cleveland, San Francisco, Montreal, Melbourne, London.

Member of Electric Hoist Manufacturers' Association.

2046-S

REG. U.S. PAT.OFF.

SHEPARD

ELECTRIC CRANES & HOISTS

APPLICATIONS

Buenos Aires-Pernambuco Service

The Buenos Aires-Pernambuco Aerial Service (El servicio aero Buenos Aires-Pernambuco). La Ingenieria, vol. 23, no. 6, Mar. 16, 1919, pp. 389-398, 5 figs. Project contemplates making total distance of 2700 miles in 38¼ hr. actual flying time. Handley Page, Rolls-Royce and Sunbeam machines will be used.

Landings, Marking

The Future of the Airplanes in Business, C. B. Merrick. Jl. Electricity, vol. 42, no. 7, pp. 309-310, 3 figs. Marking landing places and guide posts by electricity.

Regulations

Regulations for Air Navigation. Automotive Industries, vol. 40, no. 15, Apr. 10, 1919, pp. 782-785. Project of Int. Convention regarding air navigation.

DESIGN

Landing

Commercial Feature of Airplanes from an Engineer's Standpoint, G. H. Day. Jl. Soc. Automotive Engrs., vol. 4, no. 4, Apr. 1919, pp. 290-292. Sees as most important development of future that which will enable aeroplanes to land in small field, this to be obtained without too great a sacrifice of high speed.

Types, Characteristics

Airplane and Seaplane Engineering, H. C. Richardson. Jl. Soc. Automotive Engrs., vol. 4, no. 4, Apr. 1919, pp. 273-285, 12 figs. Characteristics of types devolved and discussion of factors affecting their performance.

DYNAMICS

Curvilinear Flight

The Aeroplane in Curvilinear Flight. Aeronautical Jl., vol. 23, no. 97, Jan. 1919, pp. 23-24. Expressions for determining approximately the relation between B and other quantities. From Schweiz. Aero Club Bul. nos. 8 and 9.

Stresses in Landing Gear

A Theoretical Investigation into the Stresses Arising in the Landing Gear of an Aeroplane, H. B. Thomas. Flight, vol. 11, no. 15, Apr. 10, 1919, pp. 483-484. In relation to probability of machine landing automatically.

Tests on Models

From Model to Full Scale in Aeronautics, H. Levy. Aeronautics, vol. 16, no. 284, Mar. 27, 1919, pp. 348-352. Technical analysis of following problem: Flying machine or part of one is in motion through the air with a given speed in the region of normal speed of flight; is there a corresponding experiment on a model from which the forces originated on the full scale may be deduced?

ENGINES

A. B. C.

The British A. B. C. Aero Engines. Aerial Age, vol. 9, no. 7, Apr. 28, 1919, p. 335, 4 figs. Outstanding feature of these models is copper coating on cooling fins.

Basse-Selve

The 270 H. P. Basse-Selve Aero-Engine. Engineer, vol. 127, no. 3298, Mar. 14, 1919, pp. 246-248, 11 figs. also Aerial Age, vol. 9, no. 5, Apr. 14, 1919, pp. 247-248, 253-255 and 262, 26 figs. Report on design based on examination of engine taken from remains of a German Rumpler two-seater biplane shot down and destroyed in France on May 31, 1918.

British

Current Types of British Aero Engines. Aeronautics, vol. 16, no. 284, Mar. 27, 1919, pp. 329-342, 20 figs. Siddeley-Deasy, (Puma) Napier Lion, Mercury, Lucifer, Hercules, Jupiter, Gnat I, Dragon Fly, "Manitou" Sunbeam-Coatalen, Maori IV, B.R.1 and B.R.2 types.

Crankshafts

The Design of Aeroplane Engines—XXI, John Wallace. Aeronautics, vol. 16, no. 282, Mar. 12, 1919, pp. 272-276, 7 figs. Points on crankshaft design; polar curve of crankpin load.

Dusenberg

The World's Largest Airplane Engine. Gas Engine, vol. 21, no. 5, May 1919, pp. 162-164, 10 figs. Dusenberg 850-hp. 1575-lb. engine.

Hall-Scott

Hall-Scott Type L-6a Aero Engine. Aerial Age, vol. 9, no. 7, Apr. 28, 1919, pp. 346-347, 5 figs. Characteristics of six-cylinder, 495-lb., 200-hp. engine.

King-Bugatti

King-Bugatti 16-Cylinder Aero Engine. Automotive Industries, vol. 40, no. 17, Apr. 24, 1919, pp. 906-910, 7 figs. Consists of two 8-cyl. all-in-line engines, mounted on common crankcase and geared to common propeller shaft. Designed to permit 37-mm. cannon to shoot through hollow propeller shaft. (To be continued.)

Mercedes

200 H.P. Compression Mercedes Engine. Flight, vol. 11, no. 8, Feb. 20, 1919, pp. 233-236, 9 figs. Report on running performance. Issued by Technical Dept. (Aircraft Production) Ministry of Munitions.

Napier Lion

The Napier Lion Aeromotor. Flight, vol. 11, no. 13, Mar. 27, 1919, pp. 397-402, 12 figs. Twelve-cylinder 450 hp. engine with record of 30,500-ft. altitude.

Siddeley

The Siddeley Aero Engines—"Puma" and "Tiger." Flight, vol. 11, no. 14, Apr. 3, 1919, pp. 429-433, 4 figs. Puma engine has 6 vertical cylinders, 145 mm. bore by 190 mm. stroke; valves are in cylinder heads and are worked by overhead camshaft. Tiger engine has two lines of 6 cylinders inclined at an angle of 60 deg.; valves are worked by two overhead camshafts. These engines were intended for use in areoplanes making long-distance journeys into Germany.

Supercharging

Maintaining Constant Pressure Before the Carburetors of Aero Engines Regardless of the Altitude, Leslie V. Spencer. Aerial Age, vol. 9, nos. 5 and 7, Apr. 14 and 28, 1919, pp. 244-246 and 264, and pp. 336-337 and 356, 10 figs. Arrangement of Sherbondy turbo-compression as laid out for Liberty 12-cyl. engine. (To be continued.)

MODELS

Slotted Armature

Localization of the Transformation of Energy in a Slotted Armature (Localización de la transformación de la energía en un inducido dentado), Konrad Simons. Boletin de la Asociación Argentina de Electro Técnicos, vol. 4, no. 11, Nov. 1918, pp. 874-876, 1 fig. Model to demonstrate that forces of magnetic field actuate more on teeth than on conductors.

Motors

Elementary Aeronautics and Model Notes, John F. McMahon. Aerial Age, vol. 9, no. 4, Apr. 7, 1919, p. 213. Motorcycle driven aeroplane.

Elementary Aeronautics and Model Notes, John F. McMahon. Aerial Age, vol. 9, no. 5, Apr. 14, 1919, p. 259, 2 figs. Ford motor rebuilt for aeroplane work.

PLANES

Armstrong-Whitworth

The Armstrong-Whitworth Machines. Flight, vol. 11, no. 14, Apr. 3, 1919, pp. 438, 21 figs. History, development and characteristics of the various types.

Caproni

The Caproni E-3 Night Bomber. Aviation, vol. 6, no. 6, Apr. 15, 1919, pp. 322-325, 3 figs. Outline drawings.

The Caproni Triplane. Aerial Age, vol. 9, no. 5, Apr. 14, 1919, pp. 242-243, 5 figs. Specifications of type CA-4 triple-motored Caproni triplane.

Georges Levy

The Georges Levy Type R Flying Boat. Aerial Age, vol. 9, no. 6, Apr. 21, 1919, pp. 286-288, 3 figs. Directions for rigging and mounting as applied by Georges Levy Co.

Grahame-White

An Interesting Grahame-White Sporting model. Flight, vol. 11, no. 15, Apr. 10, 1919, pp. 468-473, 19 figs. Span is only 20 ft. and overall length 16 ft. 6 in. Machine, however, is said to be capable of making 102 m.p.h. at low altitudes and 93 m.p.h. at 10,000 ft. It is fitted with 80-hp. le Rhone engine.

Navy

F-5-L Navy Flying Boat—IV, S. T. Williams. Automotive Industries, vol. 40, no. 15, Apr. 10, 1919, pp. 809-811, 2 figs. Flying controls and methods of hook-up; weight and percentage of weight of every component.

The Navy HS-1L and 2L Flying Boats. Aerial Age, vol. 9, no. 7, Apr. 28, 1919, pp. 338-340 and 357, 6 figs. General dimensions and data.

TESTING

Sand Testing

Sand Testing of Aeroplanes, Albert S. Heinrich. Aerial Age, vol. 9, no. 4, Apr. 7, 1919, pp. 200-202, 10 figs. Test of tail surfaces. (Continued.)

TRANSATLANTIC FLIGHT

British Machines

The Transatlantic Race. Flight, vol. 11, no. 15, Apr. 10, 1919, pp. 476-480, 5 figs. British machines intended to be used for the projected flight.

Marine Engineering

AUXILIARY MACHINERY

Compasses

The Gyroscopic Compass. Pac. Mar. Rev., vol. 16, no. 4, Apr. 1919, pp. 105-106, 1 fig. Sperry gyroscopic compass equipment for merchant vessels.

SHIPS

Concrete Ships

Economic Size of Concrete Ships, E. O. Williams. Eng. & Contracting, vol. 51, no. 18, Apr. 30, 1919, pp. 463-465, 1 fig. Curves showing various comparisons between concrete ships and steel.

Diesel Engine

Diesel Engine or Steam Engine. Shipbuilding & Shipping Rec., vol. 13, no. 13, Mar. 27, 1919, pp. 381-382. Discussion of relative economies in marine-engine practice.

Electric Propulsion

Electric Propulsion as Developed on Battleship New Mexico. Elec. Rev., vol. 74, no. 15, Apr. 12, 1919, pp. 579-584, 6 figs. Electrical features of propelling equipment, specially the two turbine-generators and four induction motors direct-connected to propellers.

Electrical Propulsion of Ships, J. F. Nielson. Elecn., vol. 82, no. 15, Apr. 11, 1919, pp. 432-437. Electrical transmission gears compared with mechanical gears. Emphasis is laid upon greater immunity from total breakdown possessed by electrical method, due to possibility of utilizing a plurality of motor and generator units.

Electric Drive of the U. S. S. New Mexico. Elec. World, vol. 73, no. 16, Apr. 19, 1919, pp. 780-783, 5 figs. Machinery is divided into two parts and ship is said to be able to make 17 knots with half of machinery disabled.

Electrical Equipment

Generating Machinery for Merchant Ships, F. P. Fenton. Elecn., vol. 82, no. 15, Apr. 11, 1919, pp. 451-453, 4 figs. Considered in various aspects, such as pressure of supply and type of current, character of primer mover and generator, type of coupling, position of plant in the ship and requirements of various classes of vessels.

Electric Light and Power Circuits on Board Ship, O. H. Kennedy. Elecn., vol. 82, no. 15, Apr. 11, 1919, pp. 438-443, 8 figs. Diagrams showing system and methods of control.

Propellers

Experimental Research of the Turning Action of a Propeller in a Ship (Richerche sperimentali interno all azione evolutiva esercitata dalle eliche). N. Pecoraro. Revista Maritima, vol. 52, no. 2, Feb. 1919, pp. 175-192, 3 figs. Formula for angle to which rudder has to be inclined in order for the ship to maintain a straight course when only one propeller is operated; experimental confirmation of theoretical results.

Graphic Solution of Propeller Formulae, J. S. Redshaw. Shipbuilding & Shipping Rec., vol. 13, no. 15, Apr. 10, 1919, pp. 436-437, 2 figs. Charts for determining diameters for three-bladed propellers by solution of Taylor's formula and Taylor's ρ value.

"Certified"

Every foot of Plastic-Arc Certified Welding Metal (patented) carries our guarantee that it can be depended upon to do exactly what it was made for and that it is uniformed throughout

These certified metals give maximum results when used with a welder employing low voltage and a constant, automatically regulated current, the fundamentals of Plastic-Arc Welding. They will, however, give more satisfactory results with any system of welding that can be obtained with ordinary welding metals.

There are eight grades of Plastic-Arc Certified Welding Metals, and each grade has been carefully developed to give maximum results in a definite line of work, as follows:

GRADE NO. 6

For work where ductility and high tensile strength is required.

GRADE NO. 8

Useful for building up worn places where high tensile strength is not required. Can be **readily machined.**

GRADE NO. 9

For use on all cast steel parts requiring high strength in the weld. Standard with many railroads and shipyards for this purpose.

GRADE NO. 17

For use in filling in blowholes in steel and gray iron castings and all work where parts are not subject to undue strains or where tensile strength is not an important factor.

GRADE NO. 20

Bronze alloy for bells and all brass, copper and bronze work.

GRADE NO. 30

This is an exceptionally easy and fast flowing electrode and lays relatively flat where deposited; of medium tensile strength; specially designed for welding thin cast iron.

GRADE NO. 31

High tensile strength and conductivity combined with very smooth flowing specially designed for overhead welding with deep penetration.

GRADE NO. 33

Exceptionally smooth flowing qualities. Specially designed for overhead welding, deep penetration.

Prices and samples of any grade will be furnished upon request

WILSON WELDER AND METALS CO., INC.

2 Rector Street, New York

Smokebox Locks

"Sturdun" Patent Smokebox Locks. Steamship, vol. 30, no. 358, Apr. 1919, pp. 234-235. 2 figs. Invention devised for locking smokebox door.

Standardized Ships

The "Standardized" Ship Schenectady. Am. Mar. Engr., vol. 14, no. 4, Apr. 1919, pp. 5-7, 3 figs. Vessel is designed for deadweight capacity of 7500 tons, total displacement loaded being estimated at 11,200 tons.

Typical U. S. Turbine Driven Carrier. Shipping, vol. 7, no. 4, Apr. 26, 1919, pp. 15-16 and 18, 4 figs. Mechanical equipment of geared-turbine-driven ship "Schenectady."

TERMINALS

Canadian Terminals

The Canadian Government's Ocean Terminals. Mar. Eng. of Canada, vol. 9, no. 3, Mar. 1919, pp. 112-114, 4 figs. Progress on project involving expenditure of $30,000,000.

Charleston

See Wood Construction below.

Coaling

Coaling Ships Mechanically—1, Wilbur M. Stone. Coal Trade Jl., vol. 50, no. 18, Apr. 30, 1919, pp. 479-483, 5 figs. Michener coaling ap-1919, pp. 110 111. Description of harbor and paratus. Elevator automatically frees itself in case of overload without interrupting operations.

Electrical Equipment

Electrical Service at Great Seaboard Terminal. Elec. World, vol. 73, no. 16, Apr. 19, 1919, pp. 784-787, 4 figs. Electrical agencies include elevators, cranes and industrial tractors and trailers.

Elevators

Concrete Shipside Elevator and Warehouse. Concrete Age, vol. 29, no. 6, Mar. 1919, pp. 10-11, 3 figs. Dimensions and operating equipment.

Mechanical Equipment

The Port of Seattle, G. F. Nicholson. Eng. World, vol. 14, no. 8, Apr. 15, 1919, pp. 11-14, 3 figs. Mechanical equipment for handling miscellaneous freight.

New Orleans

New Orleans Army Base Improves Facilities of the Port, George H. Davis. Eng. News-Rec., vol. 82, no. 17, Apr. 24, 1919, pp. 823-826, 5 figs. Three concrete warehouses tied to 2000-ft. wharfhouse on river by bridges permitting access to all floors.

St. John, N. B.

Wooden Shipbuilding Activities at St. John, N. B. Mar. Eng. of Canada, vol. 9, no. 3, Mar. 1919, pp. 110-111. Description of harbor and port.

San Francisco

Port Facilities and Freight Handling. Jl. Electricity, vol. 42, no. 7, Apr. 1, 1919, pp. 294-297, 5 figs. Plans for the improvement of San Francisco Harbor through the adoption of mechanical freight-handling devices.

Seattle

See Mechanical Equipment above.

Wood Construction

Wood Construction Feature of Charleston Port Terminal, Hunley Abbott. Eng. News-Rec., vol. 82, no. 15, Apr 10, 1919, pp. 702-706, 6 figs. Particulars of quartermaster depot for storage and shipment of materials.

See also MECHANICAL ENGINEERING, Handling of Materials (Ship Loading).

YARDS

Castings

Castings Used in Ship Construction, Ben Shaw and James Edgar. Foundry Trade Jl., vol. 21, no. 207, Mar. 1919, pp. 151-156, 17 figs. Preparation of molds for stem pieces.

Concrete Car Floats

Hudson River Shipyard Layout to Build Concrete Car Floats, H. W. Eldridge. Eng News-Rec., vol. 82, no. 15, Apr. 10, 1919, pp. 732-734, 5 figs. Concrete placed for 1600-ton vessels from stiff leg chute tower.

Cranes

Modern Shipyard Cranes, Claude M. Toplis. Elecn., vol. 82, no. 15, Apr. 11, 1919, pp. 408-412, 4 figs. Comparison of crane systems; double cantilever crane running on high gantry, overhead bridge traveling crane, jib crane running on high gantry and tower crane system.

Davey Plant at Lauzon, Can.

The Davey Shipbuilding Plant at Lauzon. Mar. Eng. of Canada, vol. 9, no. 3, Mar. 1919, pp. 105-107, 6 figs. Installation for building wooden steamers, steel trawlers and large steel steamers.

Electrical Equipment

Electrical Equipment of a Modern Shipyard, A. Henderson. Elecn., vol. 82, no. 15, Apr. 11, 1919, pp. 400-407, 14 figs. Central station containing four 450-kw. Westinghouse rotary converters, which convert the 3300-volt, 3-phase, 50-cycle supply to 240 volts continuous current for disribution throughout works.

Ford Method

Ford Methods in Ship Manufacture—V, Fred E. Rogers. Indus. Management, vol. 57, no. 5, May 1919, pp. 367-372, 12 figs. Electric rivet heating and welding, flame cutting and boring propeller-shaft bearings.

Ford Shipbuilding Plant, River Rouge, Mich. Am. Architect, vol. 115, no. 2259, Apr. 9, 1919, pp. 526-529, 9 figs. Operation in assembled shop. Boats are assembled on a line of trucks moving on standard-gage railroad tracks.

Framing, Millar System

SS. "Clan MacWilliam." Shipbuilding & Shipping Rec., vol. 13, no. 13, Mar. 27, 1919, pp. 375-376, 3 figs. Construction on Millar's patent system of framing. Deadweight 10,250 tons, on 26 ft. $10\frac{1}{2}$ in. draft.

German Shipbuilding

German Shipbuilding and the Revolution. Shipbuilding & Shipping Rec., vol. 13, no. 13, Mar. 27, 1919, pp. 373-374. Competition with foreign yards deemed impossible.

Halifax Shipyards

Halifax Shipyards Embraces Old and New Industry. Mar. Eng. of Canada, vol. 9, no. 3, Mar. 1919, pp. 97-99, 3 figs. Plant equipped with graving dock and deep-water wharf, also marine railway.

Vickers, Canadian Plant

Canadian Vickers have Well-Equipped Plant. Mar. Eng. of Canada, vol. 9, no. 3, Mar. 1919, pp. 89-93, 5 figs. Growth of shipbuilding industry on banks of St. Lawrence.

Welding

Electric Welding as Applied to Ship Construction, H. Jasper Cox. Mech. Eng., vol. 41, no. 5, May 1919, pp. 439-444, 11 figs. Variables which affect efficiency of weld. Investigations to determine possibility of application of electric welding to shipbuilding. General scope of experiments included principally determination of modulus of elasticity and approximate elastic limit; ultimate strength and ultimate elongation; application of alternating stresses with (a) rotating specimens, (b) stationary test pieces. Paper presented before Soc. Naval Architects and Mar. Engrs.

Electric Welding Applied to Shipbuilding, J. H. Collie. Elecn., vol. 82, no. 15, Apr. 11, 1919, pp. 421-427, 22 figs. After reference to general systems of welding that are available, writer describes particular systems now mostly in use and then passes on to the question of testing electric welds.

Wooden Ships

Building Wooden Ships for French Government. Mar. Eng. of Canada, vol. 9, no. 3, Mar. 1919, pp. 94-96, 7 figs. General layout of Montreal plant.

See also MECHANICAL ENGINEERING, Hoisting and Conveying (Cranes).

Industrial Technology

Acetylene Products

Principal Organic Compounds Derived from Acetylene (Les principaux composés organiques dérivés de l'acétylène), D. Florentin. Génie Civil, vol. 74, no. 12, Mar. 22, 1919, pp. 235-236. Industrial synthesis of alcohol, acetic acid, acetic anhydride and the acetic ethers. (Concluded).

Ammonium Nitrate

Effecting and Controlling Crystallization of Ammonium Nitrate, J. Esten Bolling. Chem. & Metallurgical Eng., vol. 20, no. 8, Apr. 15, 1919, pp. 401-405, 9 figs. Crystallizing process employed at U. S. Ammonium Nitrate Plant. Survey of air conditioning features involved and their relation to entire process of refrigeration.

Ammonium Sulphate

Manufacture of Ammonium Sulphate from Cyanamide (La fabrication du sulfate d'ammoniaque en partant de la cyanamide). Journal du Four Electrique, vol. 28, no. 6, Mar. 15, 1919, pp. 44-46. Cyanamide is decomposed by water under pressure; the ammonia gas is then brought in contact with dilute sulphuric acid.

Benzol

Manufacture of Benzol in Sestao Iron Works (Fabricaion de benzol en la fabrica de hierro de Sestao). Revista Minera, vol. 70, no. 2678, Mar. 1, 1919, pp. 105-107. Process followed, with remarks on adaptation of installation to coke furnaces.

By-Products

Importance of By-Products During the War, C. G. Atwater. Gas Age, vol. 43, no. 7, Apr. 1, 1919, pp. 339-343, 5 figs. Light oil stills and accessory plant of Barrett Co.

Coal By-Products

Coal: Its Value as a Raw Material for Distillation Products—II, J. A. Wilkinson. South African Jl. Industries, vol. 2, nos. 1 and 2, Jan. and Feb. 1919, pp. 74-85 and 178-185. Liquid distillation products of coal and processes by which they are obtained. Feb. Distillation of coal tar, oils and pitch.

Coal and Gas-Tar Derivatives of Growing Importance, C. W. Botkin. Colorado School of Mines, Mag. vol. 9, no. 4, Apr. 1919, pp. 78-80, 3 figs. Chart indicating from whence these materials are derived, with description of their nature, properties and method of manufacture.

Carbonizing Processes and Coal Utilization and Conservation, W. A. Bone. Gas Journal, vol. 145, no. 2915, Mar. 25, 1919, pp. 632-635. Uses of coal in the United Kingdom in 1913. Works in which writer believes complete by-products recovery is possible; commercial prospects for low temperature carbonization. Address delivered before Roy. Soc. of Arts.

Coated Paper

Casein and Coating Mixtures, E. Sutermeister. Paper, vol. 24, no. 7, Apr. 23, 1919, pp. 15-80 & 50. Suggestions for overcoming brush marks and froth pits in manufacture of coated paper.

Decolorizing Carbons

Investigations on Vegetable Decolorizing Carbons, using "Carboraffin," Vl. Stanek. Int. Sugar Jl., vol. 21, no. 244, Apr. 1919, pp. 168-171, 1 fig. Preparation of vegetable carbons from cellulose according to Austrian patent and their use in sugar refineries. "Carboraffin" is said to be so powerful that its effect equals that obtained with 8-15 per cent of annual charcoal. From Tijdschrift der Vereeniging van Beetwortelsuikkerfabrikantem no. 8, 1919, pp. 116-122.

Ethylene

Ethylene, William Malisoff and Gustav Egloff. Jl. Phys. Chem., vol. 23, no. 2, Feb 1919, pp. 65-138. Collection of data on ethylene, covering physical and chemical properties; formation in chemical reactions by decomposition; decomposition; catalysis; analytical and biological data; research possibilities.

France

France's Chemical Industries as they are, Camille Matignon. Chem. Engr., vol. 27, no. 3, Mar. 1919, pp. 55-58. France is said to be fully equipped with series of chemical industries competent to supply the most of the republic's chemical needs.

Fulminate of Mercury

Determination of Impurities in Fulminate of Mercury (Recherches sur le fulminate de mercure et quelques-unes de ses impurités), Paul Nicolardot and Jean Boudet. Bul. Société Chimique de France, vols. 25-26, no. 3, Mar. 1919, pp. 119-122. Results of utilizing sodium hyposulphite in treatment of residues in manufacture of fulminate.

Gallium

The Purification of Gallium by Electrolysis, and the Compressibility and Density of Gallium, Theodore W. Richards and Sylvester Boyer. Jl. Am. Chem. Soc., vol. 41, no. 2, Feb. 1919, pp. 133-134. Examination of methods recommended by various writers.

Glass

Optical Glass. Nature, vol. 103, no. 2578, Mar. 27, 1919, pp. 65-67, 3 figs. Developments in manufacture of homogeneous glass, particularly during time of war.

The Technique of Optical Glass Melting, Clarence N. Fenner. Jl. Am. Ceramic Soc.,

vol. 2, no. 2, Feb. 1919, pp. 102-145, 7 figs. Activities of Geophysical Laboratory in its work of coöperation with manufacturers of optical glass.

An Improved Method of Optical Glass Manufacture, George W. Morey. Jl. Am. Ceramic Soc., vol. 2, Feb. 1919, pp. 146-150. Modification of filling operation to prevent surface becoming high in silica.

Light, Ultra-Violet

Ultra-Violet Light in the Chemical Arts XXIII, Carleton Ellis and A. A. Wells. Chem. Engr., vol. 27, no. 3, Mar. 1919, pp. 73-74. Further conclusions regarding absorption spectra of some of primary alcohols, and of confectionary colors and dyes.

Light Oils

What Can Be Done with Light Oil Plants, W. H. Fulweiler. Gas Age, vol. 43, no. 8, Apr. 15, 1919, pp. 415-417, 1 fig. Fifty plants for recovery of toluene from illuminating gas were built during war. Article discusses possibility of utilizing these plants for recovery of light oils from illuminating gas in competition with gasoline for motor fuel. Paper read before Am. Gas. Assn.

Nitric Acid

The Theory of Absorption Towers for Nitric Acid Manufacture, J. R. Partington and L. H. Parker. Jl. Soc. Chem. Indus., vol. 38, no. 6, Mar. 31, 1919, pp. 75T-80T, 2 figs. Efficiency of a tower system said to depend on two factors, rapidity and completeness of absorption and concentration of solution produced.

Pitch

The Softening Point of Pitch, Percy E. Spielmann and G. Campbell Petrie. Jl. Soc. Chem. Indus., vol. 38, no. 6, Mar. 31, 1919, pp. 68T-70T, 2 figs. Attempt to characterize it by numerical value. Recourse was had to biting test, change of appearance, twisting test, bending and sagging dropping tests.

Rubber, Synthetic

Development of Artificial Rubber During the War (Die Entwicklung des Künstlichen Gummis im Kriege), Dr. Duisberg. Kunststoffe, vol. 8, no. 11, June 1, 1918, pp. 121-122. The carbide process: Acetylene obtained from calcium carbide and water is changed into acetaldehyde and this is oxidized into acetic acid; this latter, when blown over a contact substance, yields acetone, carbonic acid being split off during the process.

Salt

The Recovery of Salt from Sea-Water, F. H. Mason. Min. & Sci. Press, vol. 118, no. 16, Apr. 19, 1919, pp. 528-530, 4 figs. Process followed by Western Salt Co. at San Diego, Cal.

Sampling (Pulp)

Sampling Practice at Independence Mill, Claude T Rice. Eng. & Min. Jl., vol. 107, no. 15, Apr. 12, 1919, pp. 641-644, 6 figs. Some of features are mechanical bucking apparatus and sample mixer and divider, both of which devices are said to have proven satisfactory for final handling of pulp.

Selenium

Selenium and Its Present Uses (Le Sélénium et ses applications actuelles), Louis Ancel. Chimie & Industrie, vol. 2, no. 3, Mar. 1, 1919, pp. 245-259, 14 figs. Occurrences and properties of selenium in various allotropic states; its utilization in biological chemistry, glass and caoutchouc industries, electrical apparatus and electrochemistry.

Silicon Tetrachloride

Silicon Tetrachloride, Otis Hutchins. General Meeting Am. Electrochemical Soc., Apr. 3-5, 1919, paper no. 18, pp. 245-256. Experimental work undertaken by electrochemical plant in developing commercial process for preparing silicon tetrachloride.

The Role Played by Silicon and Titanium Tetrachlorides During the Past War, G. A. Richter. General Meeting Am. Electrochemical Soc., Apr. 3-5, 1919, paper no. 13, pp. 187-195. Physical properties of these chlorides and study of their reaction with moisture, or with ammonia gas, or with both, to produce smoke clouds; ship apparatus and trench apparatus used for producing smoke clouds.

Sugar

The Loss of Moisture from Sugar Samples Under Different Methods of Preservation, C. A. Browne and G. H. Hardin. La. Planter & Sugar Mfr., vol. 62, no. 15, Apr. 12, 1919, pp. 233-234. Table of changes in moisture and polarization of sugar samples in unsealed tin cans; compiled from data obtained in N. Y. Sugar Trade Laboratory. Paper before Am. Chem. Soc.

Sulphuric Acid

The Sulphuric Acid Industry, M. Rindl. South African Jl. Industries, vol. 2, no. 2, Feb. 1919, pp. 125-134. Production, uses, grades, prices, manufacture in Union of South Africa.

Erection of Huge Sulphuric, Nitric, Mixed Acid and Denitrating Plant under War Pressure, H. E. and C. E. Hollister. Chem. & Metallurgical Eng., vol. 20, no. 8, Apr. 15, 1919, pp. 406-412, 11 figs. Construction of one of the largest acid plants in the country, under adverse climatic conditions and insufficient transportation facilities.

Tanning Materials

Notes on Australian Tanning Materials and the Manufacture of Sole-Leather, F. A. Coombs. Jl. Soc., Chem. Indus., vol. 38, no. 6, Mar. 31, 1919, pp. 70T-74T. Comparative tests conducted at Sydney Technical College to ascertain value of tannins in barks of E sideraphloia.

Tar Distillation

Tar Distilleries (Les distilleries de goudron), W. Solton. Journal des Usines à Gaz, vol. 43, no. 7, Apr. 5, 1919, pp. 97-104, 13 figs. Machines and process of distillation followed by Sulzer Frères of Winterthur. From Bulletin Technique de la Suisse Romande, no. 16, Aug. 11, 1917.

Water Gas

Bituminous Generator Fuel, R. G. Krumrey. Gas Rec., vol. 15, no. 7, Apr. 9, 1919, pp. 217-220, 1 fig. Comparison of operating data and results for coke and coal as generator fuel in a water-gas machine. Paper read at Wis Gas Convention.

Railroad Engineering

BRAKES

Straight Air Brake, Automatic

The Automatic Straight Air Brake. Ry. Mech. Engr., vol. 93, no. 4, Apr. 1919, pp. 195-198. Series of tests conducted by Bur. of Safety of the air-brake system of Automatic Straight Air Brake Co. of N. Y.

ELECTRIC RAILROADS

Electropneumatic Driving Mechanism

Westinghouse Electro-Pneumatic Driving Mechanism of the Suburban Locomotives Used by the State Railways (Equipment Westinghouse pour la commande électro-pneumatique des automotrices de banlieue des chemins de fer de l'Etat), L. Pahin. Industrie Electrique, vol. 28, no. 643, Apr. 10, 1919, pp. 128-131, 6 figs. Scheme of connections and diagram indicating closing order of the thirteen contacts. (To be continued.)

Relays

A. C. Accessories, A. E. Tattersall. Railway Engineer, vol. 40, no. 471, Apr. 1919, pp. 77-80, 7 figs. . Radial polyphase relays. (Concluded).

See also ELECTRICAL ENGINEERING, *Generators and Motors (Railway Motors).*

ELECTRIFICATION

Argentina

Electrification of the Central Railway of Argentina (Electrificacion del ferrocarril central argentino). Ingenieria Internacional, vol. 1, no. 1, Apr. 1919, pp. 9-13, 4 figs. Details of power house.

Economics

Steam Railroad Electrification, Calvert Townley. Can. Engr., vol. 36, no. 16, Apr. 17, 1919, pp. 387-388. Possibilities of electrification as affecting future railroading policies. Also in Proc. Am. Inst. Elec. Engrs., vol. 38, no. 4, Apr. 1919, pp. 541-547; Ry. Rev., vol. 64, no. 17, Apr. 26, 1919, pp. 615-616.

Railroad Electrification, F. H. Shepard. Southwestern Elecn., vol. 15, no. 2, Apr. 1919, pp. 18-19. Urgency of steam-railroad electrification is argued from viewpoints of economy and service of electrical equipment. Paper presented at Annual Meeting of Eng. Inst. of Canada.

Pantagraph Frames

Railroad Electrification Facts and Factors, A. J. Manson. Ry. Elec. Engr., vol. 10, no. 4, Apr. 1919, pp. 115-117, 6 figs. Construction details of pantagraph frames as determined by operating conditions.

Washington

Railway Electrification in Washington. Jl. Electricity, vol. 42, no. 7, pp. 311-313. Review of present status with description of equipment and construction work.

FOREIGN

Argentina

The Railroad Development of the Argentine—I. Ry. Age, vol. 66, nos. 16 and 17, Apr. 18 and 25, 1919, pp. 1001-1005 and 1047-1050, 8 figs. Difficulties railways have been confronted with in the way of Government regulation, labor and taxation. Possible trend of future developments; figure of imports of railway material and discussion of possible markets for such supplies. Apr. 25: Problems in regulation, labor, and taxation. Article sets forth that largest market for railway equipment is in South America.

Australia

Australian Railways. Indus. Australian & Min. Standard, vol. 61, nos. 1582, 1583 and 1584, Mar. 6, 13 and 20, 1919, pp. 420-421 and 509, 463, 7 figs. General dimensions of Tasmanian and Western Australian types. Mar. 13: Queensland types of locomotives.

English Channel Tunnel

The English Channel Tunnel. Sci. Am., vol. 120, no. 16, Apr. 19, 1919, pp. 398-399 and pp 416-417, 5 figs. Plans for tunnel, showing its course, geological strata and system of drainage; also plans for tubes and a bridge.

The Channel Tunnel Scheme, A. E. Ritchie. Iron & Coal Trades Rev., vol. 98, no. 2666, Apr. 4, 1919, pp. 403-404, 4 figs. Details of proposed scheme.

Europe

European Train Speeds. Ry. Gaz., vol. 30, no. 14, Apr. 4, 1919, pp. 607-609, 3 figs. Survey of highest, longest and fastest non-stop runs, speed of trains between two places and geographical distribution of important services. (Continuation of serial.)

Foreign Developments

Railway Developments in Foreign Countries. Ry. Age, vol. 66, no. 15, Apr. 11, 1919, pp. 957-962, 2 figs. Problem of unification of railways in China; shortage of railway equipment in Germany; electric railway projected from Stockholm to Goteborg; cross-section of proposed English Channel tunnel.

Railway Developments in Foreign Countries. Ry. Age, vol. 66, no. 17, Apr. 25, 1919, pp. 1056-1059. In Chile, Uruguay and China.

Spain

An Important Development in the Railways of Spain—III, F. Lavis. Ry. Age, vol. 66, no. 15, Apr. 11, 1919, pp. 945-949, 3 figs. Proposed direct line from France to Gibraltar through Madrid and its relation to other railways of Europe and those of South America.

Uruguay

The Railways of Uruguay, William A. Reid. Ry. Rev., vol. 64, no. 16, Apr. 19, 1919, pp. 583-586, 7 figs. Agricultural interests served by three main systems.

LOCOMOTIVES

Boiler Power and Tractive Power

Boiler Power Versus Tractive Power—I, William N. Allman. Boiler Maker, vol. 19, no. 4, Apr. 1919, pp. 106-108. Expressions for deriving tractive power for single-expansion locomotives.

Electric Locomotives

See Electric Railroads.

Feedwater Heaters

Feed Water Heaters and Their Development—H. J. Snowden Bell. Railroad Herald, vol. 23, no. 5, Apr. 1919, pp. 109-112. From 1825-1840. (Continuation of serial.) Paper read before Am. Ry. Master Mechanics' Assn.

Firing

Modern Locomotive Engine Design and Construction—XLVII. Railway Engineer, vol. 40, no. 471, Apr. 1919, pp. 69-77, 15 figs. Special methods of boiler firing: Liquid fuel; pulverized fuel.

Flues

Flues, George L. Price. Boiler Maker, vol. 19, no. 4, Apr. 1919, pp. 98-99. Methods employed in installing flues in stationary and locomotive boilers.

Gasoline-Electric Locomotive

Locomotive Notes and News, C. S. Lake. Model Engr. & Elecn., vol. 40, no. 936, Apr. 3, 1919, pp. 225-227, 3 figs. Gasoline-electric

They Can Be SEALED!

"ADJUSTABLE in the toolroom — SOLID in the hands of operators and inspectors." That's ohansson Limit Snap Gages.

For when a Johansson Snap has been set, it can also be SEALED.

Just melt sealing wax into the heads of the screws and stamp the seale:'s mark—it's just as much a solid gage then as though made of a single piece. Cannot be changed or tampered with in any way without breaking the seal. And then you know who's who.

Johansson Snaps are made to be used SEALED.

And with thousands of them in use every day on all kinds of big production and inspection, we never hear of work being spoiled because the gage changed size. he fact is, they don't change size. They can't; they are adjusted, set and sealed by responsible hands and when sent out in the shop they retain their size.

When worn, they are quickly *reset* and *resealed* and are put back on the job with a minimum of time lost.

Twenty-one sizes give all dimensions up to 12 ins. Revised price list (No. 3) now ready.

Johansson

C. E. JOHANSSON, INC., 245 West 55th Street, New York City

SUCCESSOR TO SWEDISH GAGE COMPANY, Inc.

Canadian Address: 72 Queen St., West, Toronto

locomotive designed to haul 100 tons on the level, and built to run on 2-ft. gage. It is equipped with a 45-hp. four-cylinder gasoline engine, which drives through a flexible coupling, a 30-kw. ventilated-type direct-current generator.

Hanger Levers

General Observations of the Design of Hanger Levers for Locomotives, Victor M. Summa. Ry. & Locomotive Eng., vol. 32, no. 4, Apr. 1919, pp. 103-105, 5 figs. Stresses in a plain flat-bar lever subjected to forces lying in plane of bar.

Mallet

Latest Mallet Type of Locomotive for the Southern Railway—Baldwin's Fifty-Thousandth Engine. Ry. & Locomotive Eng., vol. 32, no. 4, Apr. 1919, pp. 97-99, 2 figs. Articulated type with 2-8-8-2 wheel arrangement in operation on Southern railway. Also in Ry. Jl., vol. 25, no. 5, May 1919, pp. 17-21, 4 figs.

P. & R. 2-8-2

P. & R. Large 2-8-2 Type Locomotive. Ry. Mech. Engr., vol. 93, no. 4, Apr. 1919, pp. 175-177, 5 figs. Tractive effort is 61,260 lb.; boiler has combustion chamber and 2-in. tubes 13 ft. 6 in. long.

French Express Locomotives

The Development of Express Locomotives in France, M. Herdner. Engineer, vol. 127, no. 3299, Mar. 21, 1919, pp. 270-272, 9 figs. From 1878-1918. Presidential address before Société des Ingénieurs Civils de France.

Standard Locomotives

Light and Heavy Standard Pacific Type Locomotives. Ry. Age, vol. 66, no. 15, Apr. 11, 1919, pp. 950-954, 10 figs. Railroad Administration Standard designs having details interchangeable with other types.

Standard 2-8-8-2 Type Locomotives. Ry. Mech. Engr., vol. 93, no. 4, Apr. 1919, pp. 187-190, 5 figs. Locomotive is 6000 lb. heavier than that built by the Norfolk & Western; working steam pressure is 240 lb. per sq. in. tractive effort, compound, is 106,000 lb.

OPERATION AND MANAGEMENT

Accounting

Railway Accounting of Carriage Paid Goods Train Traffic, L. C. Webber Reed. Ry. Gaz., vol. 30, no. 13, Mar. 28, 1919, pp. 564-565. Arguments in favor of economies which writer claims would be effected if it were made compulsory that all freight-train traffic should be consigned carriage paid.

Car Equipment, Inspection and Maintenance

Unification of Inspection and Maintenance of Car Equipment, J. J. Tatum. Official Proc. Central Ry. Club, vol. 27, no. 2, Mar. 1919, pp. 575-579 and (discussion) pp. 579-606. Selection of inspectors; their duties and responsibilities.

Lighting

Railway Lighting and Its Maintenance, A. Cunnington. Ry. Gaz., vol. 30, no. 12, Mar. 21, 1919, pp. 525-527. Standardization of lamps; illumination measurements; system of distance control. Paper read before Illuminating Eng. Soc.

Road Motor Vehicle Department

Organization of a Railway Company's Road Motor Vehicle Department. Ry. Gaz., vol. 30, no. 15, Apr. 11, 1919, pp. 639-645, 16 figs. Practice of Great Western R.R.

San Diego & Arizona Railway

Heavy Railway Construction Along Mexican Border. Ry. Age, vol. 66, no. 15, Apr. 11, 1919, pp. 931-934, 5 figs. Construction of San Diego & Arizona Ry.; seventeen tunnels are being driven in 11-mile gap.

Train Loading

Securing the Maximum Efficiency in Train Loading, T. H. Williams. Ry. Age, vol. 66, no. 17, Apr. 25, 1919, pp. 1051-1053. High ratio of actual tonnage moved to rating of engines. Heavy loading promotes fuel economy. Paper presented before Pac. Ry. Club.

Train and Engine Loading, T. H. Williams. Ry. Rev., vol. 64, no. 14, Apr. 5, 1919, pp. 507-508. Discussion of subject in regard to means for keeping up practice of loading engines up to full rating and losses accruing when such practice is not followed closely.

PERMANENT WAY AND BUILDINGS

Curvature

Effect of Curvature on Railway Maintenance of Way. Eng. & Contracting, vol. 51, no. 16, Apr. 16, 1919, p. 397, 1 fig. Graph indicating relation between wear of rail on straight line as compared with that on curves.

Slip

The Slip at Wembley Cutting, Great Central Railway. Ry. Gaz., vol. 30, no. 12, Mar. 21, 1919, pp. 528-534, 17 figs. Measures for reconstructing embankment and restoring traffic through cutting. Slip occurred in portion of cutting where maximum depth is about 60 ft.

Ties

Zinc Chloride Treatment for Railroad Ties. Eng. & Contracting, vol. 51, no. 16, Apr. 16, 1919, pp. 394-395. Influence of conditions of wood before treatment; leaching of zinc salt. From report of Committee on Wood Preservation of Am. Ry. Eng. Assn.

The Preservation of Railway Ties, H. K. Wicksteed. Can. Ry. & Mar. World, no. 254, Apr. 1919, pp. 174-176. Process based on coating to exclude moisture.

Track Reclamation

The Reclamation of Electric Railway Track by Welding and Grinding, H. Jackson Tippett. Elec. Ry. Jl., vol. 53, no. 16, Apr. 19, 1919, pp. 773-776, 9 figs. Adaptability of various types of welding and grinding equipment to prevent rapid deterioration of rail joints, particularly of those in paved streets. Paper read before Conn. Soc. Civil Engrs.

Tunnel, Mount Royal

The Mount Royal Tunnel, J. L. Busfield. Jl. Eng. Inst. of Canada, vol. 2, no. 4, Apr. 1919, pp. 267-298, 40 figs. Construction of tunnel and terminal for Canadian railway at Montreal; tunnel is 16,315 ft. long and its construction required the excavation of 422,358 cu. yd. of rock.

RAILS

Stresses in Rails

Stresses in Rails (Détermination des efforts développés dans le métal des rails des voies ferrées), T. Godard and M. Pigeaud. Annales des Ponts et Chaussées, partie technique, vol. 47, no. 6, Nov.-Dec. 1918, pp. 273-327, 8 figs. Formulæ for determining stresses due to supports not being on same level. Expressions are applicable when loads acting are or may be considered as static. A criticism is offered on Cuard's conclusions in this direction.

ROLLING STOCK

Coal-Hopper Cars

Broad Gauge Steel Coal Hopper Cars Built in Canada for Bengal-Nagpur Railway. Can. Ry. & Mar. World, no. 254, Apr. 1919, pp. 169-170. Some of general dimensions are: Length over buffers, 41 ft. 3 in.; length over end sill, 37 ft. 1 in.; length of body inside, 35 ft.; capacity 100,000 lb.

Concrete Gondola Cars

Reinforced Concrete Gondola Cars. Eng. World, vol. 14, no. 7, Apr. 1, 1919, pp. 45-46, 2 figs. Design in accordance with U. S. R. R. Administration standards as a 100,000-lb. capacity coal car, plus 10 per cent for overload. Also in Ry. Mech. Engr., vol. 93, no. 4, Apr. 1919, pp. 193-195, 3 figs.

Lumber for Freight Cars

Treated Lumber for Freight Cars. Ry. Mech. Engr., vol. 93, no. 4, Apr. 1919, pp. 198-200. Method of treating wooden parts of car construction.

SAFETY AND SIGNALING SYSTEMS

Automatic Train Control

Automatic Train Control on the Chesapeake & Ohio R.R. Ry. Rev., vol. 64, no. 14, Apr. 5, 1919, pp. 541-546, 9 figs. System installed is that of Am. Train Control Co. of Baltimore. Description of system and account of tests performed. Also in Ry. Signal Engr., vol. 12, no. 4, Apr. 1919, pp. 131-134, 7 figs.

Signal Failure

I. C. C. Report on the Collision on the Frisco. Ry. Signal Engr., vol. 12, no. 4, Apr. 1919, pp. 126-129, 4 figs. Accident reported to have been caused by dispatcher failing to transmit train order and engineman to obey signal indication.

Specifications

Specification for Electric Motor, Switch Operating and Locking Mechanism. Ry. Signal Engr., vol. 12, no. 4, Apr. 1919, p. 113. Concerns operating requirements, general design, dielectric tests, bearings and paint. Prepared by Committee of Am. R. R. Assn.

Specifications for Power Interlocking Machine. Ry. Signal Engr., vol. 12, no. 4, Apr. 1919, pp. 114-115. Prepared by Committee of Am. R. R. Assn.

SHOPS

Columbus Roundhouse

A Complete Modern Engine Terminal Installation. Ry. Age, vol. 66, no. 16, Apr. 18, 1919, pp. 994-997, 8 figs. Reinforced-concrete 20-stall roundhouse of Toledo & Ohio Central at Columbus.

Re-Boilering of Locomotives

The Re-Boilering of Locomotives. Ry. Gaz., vol. 30, no. 13, Mar. 28, 1919, pp. 575-576, 2 figs. Work done in shops of London & N. W. R.R.

Torrance Shops

New Car Shops at Torrance, Clifford A. Elliot. Elec. Traction, vol. 15, no. 4, Apr. 15, 1919, pp. 234-238, 3 figs. For the repairing and overhauling of equipment and the building of box cars.

Welding

Oxy-Acetylene Welding in Railroad Shops, W. L. Bean. Ry. Jl., vol. 25, no. 5, May 1919, pp. 21-23. Concerning ease and efficiency of operation. Also in Ry. Rev., vol. 64, no. 14, Apr. 5, 1919, pp. 513-515.

Spot Welding Applied to Railroad Tinware. Ry. Elec. Engr., vol. 10, no. 4, Apr. 1919, pp. 127-128, 3 figs. Process followed by Illinois Central.

SPECIAL LINES

Rack Railways

Rack Railways (Ferrocarriles de cremallera), Fabio González Tavera. Anales de Ingenieria, vol. 26, nos. 309 and 310, Dec. 1918 and Jan. 1919, pp. 137-147. Weight of locomotive in terms of total weight of train to be pulled up a given slope. Riggenbach, Bissinger, Abt, Strub, and Locher types of rack.

STREET RAILWAYS

Concrete Stations

Shelters and Stations on Pacific Electric's Interurban Lines, Clifford A. Elliott. Elec. Ry. Jl., vol. 53, no. 15, Apr. 12, 1919, pp. 733-734, 5 figs. Unit-slab concrete structure.

Subway Stations

Philadelphia City Hall Subway Station, Harry Gardner. Eng. World, vol. 14, no. 7, Apr. 1, 1919, pp. 15-22, 12 figs. Details of supports showing series of I-beams, girders and concrete construction.

Zone Fares

Zone Tickets Adopted for Portland. Elec Ry. Jl., vol. 53, no. 15, Apr. 12, 1919, pp. 728-731, 2 figs. Fare system is based on central zone from 2.5 to 4 miles in radius and subdivision of all exterior lines into zones of varying length.

The Zone Fare in Practice—Aberdeen, Walter Jackson. Elec. Ry. Jl., vol. 53, no. 17, Apr. 26, 1919, pp. 814-822, 17 figs. Combination zone and universal fare in city of 165,000 is claimed to stimulate both short-haul and long-haul riding.

See also ELECTRICAL ENGINEERING, Generators and Motors (Railway Motors).

TERMINALS

Chicago

The Chicago Railway Terminals, E. J. Noonan. Eng. World, vol. 14, no. 7, Apr. 1, 1919, pp. 29-35, 4 figs. Report of Chicago Railway Terminal Commission, and work of commission on yards and terminals of Am. Ry. Assn. Problem of transportation in Chicago is presented with illustrations of amount of work it involves.

San Francisco

Railway Terminal Improvements on the San Francisco Water Front, Charles W. Geiger. Ry. Rev., vol. 64, no. 16, Apr. 19, 1919, pp. 571-576, 9 figs. Spur track connections from piers to state-owned belt line behind waterfront.

Sewell's Point Virginian Railway

The Virginian Ry. Co.'s Pier, Sewell's Point—I. Coal Trade Jl., vol. 50, no. 16 and 17, Apr. 16 and 23, 1919, pp. 404-406, 445-447, 7 figs. Plant includes double car dumper capable of handling two 60-ton railroad cars at the same time, completing cycle in 2 min. Apr. 23: Coal from the mines is dumped into self-cleaning and self-propelling transfer cars of 120 tons capacity for dumping, cars are raised to required level by transfer-car elevator.

Spring Meeting of the A. S. M. E.

This Meeting, Held at Detroit, June 16-19, Was Featured by a Large Attendance, Extended Discussion on Aims and Organization, and Sessions on Research, Industrial Relations and Pulverized Fuel. Many Entertainment Features

WERE it not that the phrase is devoid of any idea of superlatives, the expression "a well-balanced meeting" would correctly characterize the Detroit meeting of The American Society of Mechanical Engineers, held June 16 to 19. The meeting was remarkably well balanced, both in respect to variety of subjects discussed and in the relation which these features bore to the entertainment provided by Detroit's hospitable citizens. It was, however, also a meeting of big things and peak loads. Whenever a high point was registered in one direction, it was immediately followed by an event of corresponding magnitude in some other direction, and so throughout the four days of the meeting there was a rapid succession of occurrences of the greatest interest.

The meeting started on high gear, full speed, on the very first day, over 250 arrivals having been registered on Sunday night and many more the next morning for the Business Meeting which was held on Monday afternoon. Somewhere in the impelling force there was a "hot spot" (this does not refer to the weather, although it might properly do so), which kept up a rapid acceleration of events and produced smooth running throughout the whole period. Every indication pointed to this as being located in the vicinity of the City Hall.

The total registration was 1180, the largest of any Spring Meeting, of which 638 were members and 542 were guests. In 1895, when the Society first met in Detroit, the registration was 132; and again in 1908, 265. This is indicative both of the growth of the Society and the interest of its membership, and of the growth and popularity of Detroit itself, which one of the soldiers returning from France has said he found, when in Europe, to be "the most-talked-of American city." It was obviously a city that the members of the Society desired to visit, and to say that all left immeasurably pleased with the opportunities afforded them for pleasure or profit is but to summarize the sentiments freely expressed by those in attendance.

Features of the Meeting

The dominating feature of the meeting was the discussion of the Report of the Aims and Organization Committee summarized in this number. This began on Monday afternoon and continued on Tuesday and Wednesday. It was a new thing in the annals of an engineering society to have so many members eager to discuss the professional work and opportunities of the Society itself and for its members in general in relation to their profession and the public at large.

Three of the professional sessions also drew large audiences, one of these, the opening session, being on the subject of Research and lasting all day. This again shows the awakening interest of engineers in conditions resulting from the war and an appreciation by them of the need for research work in the development of American industries. A session on Industrial Relations, in which the human side of industrial management was developed, evoked so much enthusiasm that a resolution was passed at its conclusion calling for a continuance of the discussion at the Annual Meeting. On Thursday morning, at the conclusion of the meeting, one of the largest audiences gathered for a discussion on pulverized fuel, although several important excursions, which also were largely attended, were scheduled at the same hour.

Headquarters of the American Society of Mechanical Engineers, Detroit Meeting, June 16-19, 1919

Business Meeting

Unlike previous years, the business meeting was held on the opening day, occurring this year on Monday afternoon. Pres. Mortimer E. Cooley presided, and, after expressing his pleasure at the choice of Detroit as a meeting place, called for the report of the tellers of election. This report, which was presented by Secretary Calvin W. Rice, embodied the following amendment to the constitution:

C48 There shall be a Nominating Committee, whose duty shall be to select candidates for the elective offices to be filled at each election. This Committee shall be elected annually by the voting membership of the Society. Other Nominating Committees having the same powers may be constituted by the voting membership. The number of members, the selection, organization and procedure of all Nominating Committees shall be as the By-Laws shall provide.

This amendment had already been voted upon by the membership, and the chairman accordingly declared it to be a law of the Society.

The report of the Boiler Code Committee was next presented by John A. Stevens, Chairman. This report, which was presented by title only, is a preliminary one covering the rules for the construction of boilers of locomotives which are not subject to Federal inspection and control. It is intended to form Section III of Part I of the present well-known Boiler Code, and was accepted without any discussion.

Progress reports were then presented by the Sub-Committee on Bearing Metals, and the Sub-Committee on Lubrication. These were also presented by title only, as they were available in printed form and had been accepted by the Council. C. H. Bierbaum is chairman of the Sub-Committee on Bearing Metals and Albert Kingsbury chairman of the Sub-Committee on Lubrication.

The meeting next proceeded with what the chairman characterized as "perhaps the most important business this Society has had for consideration in many years." This was the report of the Committee on Aims and Organization, of which Louis C. Marburg is chairman.

Before presenting his report, Mr. Marburg called attention to the fact that a joint committee of the four national engineering societies on Aims and Organization had been created, and that a meeting of this committee was to be held in New York on July 2. "The coöperation among the various committees of development is very close," said Mr. Marburg. "We are in continual contact, and it is remarkable how closely the lines of thinking in the different development committees agree."

Address by Frazer S. Keith, Secretary of the Engineering Institute of Canada

Preceding the discussion of the report of the Aims and Organization Committee, the Society had the pleasure of listening to Frazer S. Keith, who together with Mr. John A. Brown and Mr. Riddell were delegated by the Engineering Institute of Canada to attend the convention. Mr. Keith first conveyed the personal regrets of Sir Alexander Bertram and Mr. H. H. Bond, two prominent mechanical engineers of Canada and members of the Canadian Institute, at their inability to accept an invitation to be present, and then spoke of the work of the professional engineering society.

Mr. Keith voiced his belief in the adoption of activities whereby there will be aroused a fervent sense of loyalty on the part of every man who is a member of the profession. "Loyalty," he said, "combined with enthusiasm, is a prime necessity to any cause, and before the engineering profession can become a powerful national organization, its members must be intensely loyal to the profession itself. To the average engineer the national society of which he is a member embodies all that the profession represents to him. Whatever may be the aims and objects of that society, such constitute the engineering profession. If their aims be narrow, likewise will their viewpoint be circumscribed. Now, to create that loyalty there seems to be one sure method, that is, the loyalty combined with an intense professional spirit, which we must all admit, is required, and to accomplish that the promotion of the personal welfare of the members to a greater extent than has been customary in the past, seems to be necessary. When mention is made of one of these methods, that is, assisting to raise the salaries of the rank and file of the engineering profession, by means of adopting a schedule, we immediately hear the cry "Trade Unionism," but it is nothing of the sort.

In Canada we have broadened our vision. We have become cognizant of the fact and have taken it on ourselves to recognize that we have a definite responsibility to the individual member in assisting him in his material welfare, and this, combined with the fact that one of our objects is to enhance the usefulness of the profession to the public, is arousing a professional consciousness and a sense of loyalty greater than ever existed before. It is believed that in direct proportion to the attention which we have given to the material welfare of the members and the endeavor to make the profession useful to the public has loyalty to, and interest in, the profession increased. And, further, as the interest in the profession has increased, so has the influence of the profession developed.

There is another subject which is quite prominent in all engineering bodies. I refer to the question of capital and labor. This is the greatest problem confronting this continent today. Capital cannot solve this problem, and labor cannot solve it, because each is biased. The lawyer cannot solve this problem because his mind is not sufficiently instructed; and the politician cannot solve it because he lacks prospective. To whom, then, must we look for the solution? The mind that can design and construct and place in operation a Panama Canal, a battleship, a big bridge, a power plant, or a modern industrial organization; the mind that goes back to first principles in the solution of any problem—this, gentlemen, is the mind that must be brought to bear upon this important problem, and I believe that here lies one of the greatest opportunities which the engineering profession has ever had presented to it.

Research Session

A session in which deep interest was exhibited due to a realization of the pressing need for advancing the work with which it dealt, was that planned for the morning of Tuesday, June 17, by the Research Committee of the Society, but to which it was found necessary to devote the entire day. Four papers and an address dealing with various phases of the subject were presented: namely, The Present Condition of Research in the United States, by Arthur M. Greene, Jr., Chairman of the Research Committee and who also presided; The Organization and Conduct of an Industrial Laboratory, by A. D. Little and H. E. Howe, of Cambridge, Mass.; Organization and Conduct of a Research Laboratory, by Dr. C. K. Mees, of the Eastman Kodak Co., Rochester, N. Y.; Research Work on Malleable Iron, by Enrique Touceda, of Troy, N. Y.; and an address by Dr. G. H. Clevenger, acting chairman of the National Research Council, on its work in organizing the research activities of the country and especially on the work of its Engineering Division.

In the discussion, which occupied the greater part of the afternoon, H. S. Coleman gave particulars of the organization and work of the Mellon Institute of Industrial Research at Pittsburgh, Dean John R. Allen, director of the research laboratory of the Heating and Ventilating Engineers, outlined briefly its proposed activities. Dr. Z. A. Y. Jeffers dealt with the industrial research work of the Aluminum Castings Co., and Deans Richards, Benjamin and Potter spoke regarding research work carried on at the various state engineering experiment stations. J. R. Bibbins presented a resolution proposed by the Chicago Committee which declared it to be the sense of the meeting that Engineering Council be encouraged to undertake active support of a comprehensive plan and organization of scientific and industrial research, one feature of which calls for the passage of an act and the voting of an appropriation by the present Congress. This resolution, after extended discussion, was carried.

The papers by Professor Greene and Mr. Touceda are published in this issue of Mechanical Engineering. The other

will appear in the August issue, together with a more extended report of the discussion.

Session on Industrial Relations

On Tuesday afternoon there was a very full discussion of certain phases of labor problems which are confronting manufacturers at the present time. The basic paper of the meeting was a report prepared by L. P. Alford on The Status of Industrial Relations, which gave a historical summary of the progressive stages in the development of industrial relations since the period immediately following the Civil War, with emphasis on the new aspects of the question which have arisen as a result of the economic disturbance that has followed the recent world war.

The meeting was opened by an address by Arthur H. Young, Director of the Industrial Relations Department of the International Harvester Company of Chicago, in which he described the successful experience of his company with a shop council whereby the employees participate in certain phases of the management with which they are most concerned. Mr. Young's strong personality and appealing presentation deeply impressed the large audience, and the address opened the way for a strong discussion by several members who gave excellent talks on the topics in which they were particularly interested. The first discussion was by Dr. Otto P. Geier, Director of the Service Department of the Cincinnati Milling Machine Company, who gave a very acceptable address at the Spring Meeting at Cincinnati two years ago on the work of the physician among the employees of a company.

The full report of the Industrial Relations Session is given in this number of Mechanical Engineering.

Sections Session

In accordance with the policy of the Meetings and Program Committee to secure papers characteristic of the engineering work done in the part of the country where the meeting is held, a Sections Session was arranged for Wednesday morning with papers contributed by the Society's sections of the Mid-West.

D. Robert Yarnall, Chairman of the Sections Committee, presided, and the first paper was J. H. Walker, of Detroit, on Central-Station Heating in Detroit. This was followed by a paper on The Production of Liberty Motor Parts at the Ford Plant, by W. F. Verner, also of Detroit. Mr. Verner's paper was illustrated with lantern slides, and these clearly showed the method of manufacturing Liberty motor cylinders and connecting-rod bearings.

The third paper on the program was Fire Engines and the Essentials of Fire Fighting, by Charles H. Fox, of Cincinnati, Ohio. Mr. Fox was unable to be present and his paper was read by the Secretary.

J. M. Spitzglass, of Chicago, presented the final paper on An Electric Device for Measuring the Flow of Fluids in Pipes, which called forth a considerable amount of discussion. There has always been widespread interest in papers on the measurement of the flow of fluids, on which the Society has had numerous contributions, as evidence of which a member—a paper-mill engineer—drove 300 miles to attend this meeting in order to secure the latest data on fluid flow which might be applicable in paper-mill work.

Gas Power Session

The Gas Power Session was held on Wednesday morning with Prof. W. T. Magruder, Chairman of the Sub-Committee on Gas Power, presiding. Three papers were presented, the first being one by J. W. Morton, of Philadelphia, Pa., on Crude-Oil Motors vs. Steam Engines in Marine Practice, which, in the absence of the author, was outlined by F. E. Cardullo.

The second paper, A Suggested Formula for Rating Kerosene Engines, by D. L. Arnold, of Chicago, was presented by title only, but it nevertheless furnished a topic for considerable discussion. Some took exception to Mr. Arnold's suggestion, but others were of the opinion that sooner or later a formula must be adopted which will be intelligible to the average man who is unfamiliar with machinery and mechanics.

The third and last paper of the session, Standards of Carburetor Performance, was presented by its author, Prof. O. C. Berry, of Purdue University. The discussion which followed was concerned chiefly with methods of testing and actual operating conditions. Abstracts of these papers will appear later in Mechanical Engineering, together with a fuller report of the discussions.

Fuel Session

The Fuel Session, which was held on Thursday morning, was practically devoted to a consideration of pulverized coal as a fuel, as two of the three papers presented dealt with that subject. John A. Stevens, a Vice-President of the Society, presided at the meeting. The first paper, Pulverized Coal as a Fuel, was contributed by N. C. Harrison, of Atlanta, Ga. and the second, Pulverized Coal for Stationary Boilers, by F. A. Scheffler and H. G. Barnhurst, both of the Fuller Engineering Company of Allentown, Pa. Mr. Harrison had made an investigation of the pulverized-fuel problem in different parts of the country for his company, the Atlantic Steel Company, and his paper constituted his report to his company.

The latter paper was accompanied by a series of lantern slides showing the different-sized meshes used to screen the fuel, the crushers, magnetic separators, washers, dryers, feeders, etc., and

WHERE THEY CAME FROM

The registration of 1,180 guests and members at the Detroit meeting of The American Society of Mechanical Engineers was the largest at any Spring Meeting in the history of the Society. The registrations at the meetings in Cincinnati and Worcester, which were the largest previous meetings, were 863 and 986 respectively. The representative character of the Detroit meeting, at which there were members or guests present from 29 states and the District of Columbia, besides from Canada and Sweden, is shown by the following summary of the number in attendance from the various states and countries.

	Members	Guests
Alabama	2	1
California	4	...
Connecticut	14	5
Delaware	6	3
District of Columbia	4	1
Georgia	2	1
Illinois	50	22
Indiana	15	16
Iowa	1	...
Kansas	1	...
Louisiana	2	1
Maine	1	1
Maryland	7	4
Massachusetts	38	17
Michigan	184	252
Minnesota	5	...
Missouri	7	4
New Jersey	17	4
New York	119	55
North Dakota	1	...
Ohio	83	82
Oklahoma	1	...
Oregon	1	...
Pennsylvania	45	25
Rhode Island	5	5
Texas	1	2
Utah	1	1
Vermont	5	5
Virginia	1	...
Wisconsin	7	5
Canada	8	14
Sweden	...	3
No Address Given	...	13
	638	542

installations of pulverized-fuel equipment used in connection with boilers of various sizes and designs.

The subject of pulverized coal is unquestionably a timely one and the fourteen men who took part in the discussion which followed the presentation of the two papers made evident the fact that this type of fuel is rapidly becoming more generally adopted in metallurgical work and to a considerable extent in power plants and locomotives, although it has not as yet been proved to be the solution of the many problems arising as a result of a steady decrease in the quality of fuel available. Much of the discussion was naturally of a technical nature and related particularly to the papers presented; and since these will be published later in Mechanical Engineering, further reference to the discussion will be deferred until that time.

The session closed with the presentation by title only of C. R. Weymouth's paper on Economy of Certain Arizona Steam-Electric Power Plants Using Oil Fuel. This paper appeared in abstract form in the June issue (p. 523).

General Session

The General Session was held on Thursday morning, with President Cooley in the chair. Five papers were presented, two, however, by title only. Professor Alphonse A. Adler, of Brooklyn, N. Y., presented the first of these, on The Design of Riveted Butt Joints, and Lieut. J. F. Robbins, U. S. N. R. F., the second, on Mechanical Lifts, Past and Present, and A New Method for Their Balancing.

Walter C. Durfee, of Boston, Mass., next presented his paper on Elements of a General Theory of Airplane-Wing Design, and following the discussion of these three papers the chairman announced the titles of the other two: Air Fans for Driving Electric Generators on Airplanes, by Capt. G. Francis Gray, U. S. A.; Lieut. John W. Reed, U. S. A.; and P. N. Elderkin; and Economical Section of Water Conduit for Power Development, by Cary T. Hutchinson. The first of these papers appeared in abstract form in the April issue of Mechanical Engineering (p. 369) and the second, also abstracted, in the June issue (p. 527).

Excursion to Detroit

About two hundred and fifty members joined in an excursion en route to the Spring Meeting, there being representatives from the principal cities between New England, on the north, and Birmingham and St. Louis on the south. About two-thirds of these gathered at Buffalo on Saturday morning, June 14, where they were met at the train by members of the Buffalo Section who devoted the day to entertaining the visitors, taking them from place to place by automobile. The plants visited included the Lackawanna Steel Company, Larkin Brothers, Lumen Bearing Company, the steam power plant of the Buffalo General Electric Company, the Pierce Arrow Motor Car Company and the National Aniline & Chemical Company.

It is the desire of all those in attendance at the Spring Meeting of the A. S. M. E. at Detroit to express their appreciation to the Detroit Committee for the splendid reception accorded and for the complete and satisfactory way in which the local features of the convention were handled. To the Committee on Meetings and Program, on whom the final responsibility for the program rested, great credit is due; and to the Aims and Organization Committee, the Research Committee, the sub-Committee on Gas Power and the various Local Sections, particularly Detroit, Chicago and Cincinnati, appreciation is due for their contributions to the success of the professional sessions.

In the afternoon special cars were furnished to take the party to Niagara Falls and over the Gorge Route. A few of the members visited some of the hydroelectric plants in preference to taking the scenic ride.

The Buffalo contingent left on the Steamer *City of Erie* arriving at Cleveland Sunday morning, where the group of members who had gathered there the previous day boarded the vessel.

Simultaneously with the visit to Buffalo these other members were being entertained at Cleveland by the members of the Cleveland Engineering Society and the Cleveland Section of the A. S. M. E.

The plants visited at Cleveland included the Pennsylvania Ore Docks, where special arrangements had been made to have a vessel in process of being unloaded; the Upson Bolt & Nut Company, and the Wellman-Seaver-Morgan plant.

On Saturday afternoon, owing to the plants being closed, the party were taken by automobile for a ride through the beautiful park system of Cleveland, arriving at the Cleveland Yacht Club in time for dinner, which was followed by dancing and other entertainment.

The thanks of the Society and the members participating are due to the members at both Buffalo and Cleveland for the painstaking effort and attention which they gave to making both groups feel at home and enjoy their brief stay. These members met the incoming parties at seven o'clock in the morning, and stayed with them throughout the day and evening, and no effort was spared to arrange for their comfort.

Leaving Cleveland the *City of Erie* proceeded to Cedar Point, where a special dinner was served at the Hotel Breakers and opportunity was had for bathing and other recreation. After a rest of four hours at Cedar Point the party boarded the steamer *Put-In-Bay* and proceeded to Detroit, where the boat arrived shortly after 10 p. m. A stop was made at Put-In-Bay, where Commodore Perry fought and won the Battle of Lake Erie. Here was seen the beautiful memorial monument erected in his honor.

Council and Local Sections Luncheon

Sixty Council members and Sections delegates had the opportunity of meeting together at luncheon on Tuesday. Mr. D. Robert Yarnall, Chairman of the Committee on Local Sections, presided, and called upon President Cooley, Past-President Hollis and Lieut.-Col. E. H. Whitlock, the first chairman of the Committee on Local Sections, to make short addresses.

These addresses were of an inspirational character, Dr. Hollis pointing out that the nobility of the engineering profession was dependent upon the degree to which that profession promotes the common good and emphasizing that every engineer should pursue his profession to the end that the world will be just a little bit better for his having lived in it.

Colonel Whitlock gave a brief resume of his experiences in France with the 24th Engineers.

In his opening remarks Mr. Yarnall called attention to the fact that there are now 32 cities where meetings of the Society are being held regularly, seven Sections having been added during the current fiscal year. These are located at Cleveland, Washington, Eastern New York (including Albany, Troy, Schenectady and Watervliet), Rochester, the Mid-Continent Section (with headquarters at Tulsa, Okla.) Virginia Section (with headquarters at Richmond) and a Colorado Section (with headquarters at Denver). The last mentioned was authorized at the Council meeting held in Detroit on June 16. This is an increase of $33\frac{1}{3}$ per cent in the number of Sections, and indicates the extent to which the Section movement is taking hold.

During the convention plans were made to hold during the coming fall a Joint Mid-Sections Meeting at Indianapolis. This was to have been held there last October, but it was interrupted by the epidemic of influenza. The date has not yet been decided, but there will be in addition to a meeting under the auspices of several Sections, a meeting of the Council, and, probably, a dinner and excursions. The meeting will probably be held on October 17 and 18, and should attract a large gathering of members because of the central location of Indianapolis.

Local Sections Committee Meeting

During the course of the meeting the Committee on Local Sections held a five-hour session during which plans for the forthcoming year were discussed, at considerable length. Among other things the Committee will make a comprehensive analysis of the membership by Sections during the summer, and keep closely in touch with a number of localities where the members are contemplating the formation of Sections. A statement is being prepared showing the methods of procedure in the formation of a Section; and the various advantages accruing to the members of the Society and also to the local engineering organizations which may already be established.

Members of any locality interested in holding meetings are encouraged to correspond with the Secretary, and every assistance will be given them in planning an organization meeting.

Entertainment Features

On Monday evening the Local Committee arranged an informal reception in the ballroom of the hotel, with a brief address of welcome by Mayor James Couzens, to which President Cooley replied. The reception was followed by dancing and refreshments, and it may be said here that on all occasions when opportunity afforded, the evident desire of the members to be festive was shown in this way under the leadership of the Chairman of the Local Committee, H. H. Esselstyn, who proved as capable a director of dancing as of other and more weighty affairs.

On Tuesday evening all gathered at the Arena Gardens, the large convention hall at Detroit, which was beautifully decorated. An enjoyable concert was given by the Burroughs Band, and every one felt impelled to join in the dancing which followed. The large floor was well filled until a late hour. Refreshments were served during the evening.

On Wednesday was the crowning event, consisting of the sail on Detroit River and Lake St. Clair and through the St. Clair Flats, the picturesqueness of which delighted everybody. This trip, which lasted throughout the afternoon and evening, gave a rare opportunity for meeting members and friends from all sections of the country. Both the Council and the Sections Committee held meetings during the trip. Dinner was served on the boat, and although the number was large and facilities necessarily restricted, the dinner was excellent and well served.

Many ladies were in attendance at the meeting and the Ladies' Entertainment Committee of Detroit were alert to every possible attention to their guests. Automobile trips were provided, there was a drive around beautiful Belle Isle, luncheon at the Detroit Boat Club, Tea at Red Run Golf Club, and opportunity was offered to inspect many points of interest, including the United States General Hospital, the Art Museum, and Priscilla Inn.

Local and General Committees

The following is a list of the Chairmen of the various local committees which each helped to make the meeting a success and to all of whom the Society desires to express, for the membership, its thanks and appreciation as embodied in the vote of appreciation taken at the closing session. The faithfulness and efficient service rendered by the local members will be long remembered. General Committee, H. H. Esselstyn; Reception, James Couzens; Printing and Publication, John C. McCabe; Transportation and Information, W. E. Cann; Hotel, Thurlow E. Coon, Entertainment, M. W. Taber; Ladies' Entertainment, Mrs. F. G. Ray. The Detroit Local Section committee, E. C. Fisher, chairman, contributed two excellent papers to the meeting.

The work involved in directing the entertainment for so large a convention as this is necessarily very great. The committee members, however, had their work so well organized that every feature was carried through in an admirable manner, without confusion or delay.

The general plan of the meeting as a whole, and the details of the professional program, were under the direction of the Committee on Meetings and Program, Dexter S. Kimball, Chairman.

Trips to Industrial Plants

Unquestionably one of the appealing attractions of Detroit as a place of meeting for engineers is the opportunity for visiting the various industrial plants which have so much of interest.

The first of the regular trips was on Tuesday morning, to the well-known plant of the Burroughs Adding Machine Company, where luncheon was served for the visitors. In the afternoon trips were made to the plant of the Anderson Forge and Machine Company and the calorizing plant of the Diamond Power Specialty Company. On Wednesday morning a large party went to the Connors Creek plant of the Detroit Edison Company, where luncheon was also served. This plant has a number of unusual features, particularly in relation to the operation of the auxiliaries.

On Thursday a large number visited the Ford Eagle plant, where they witnessed the launching of one of these boats. In the afternoon trips were made to the Ford and the Packard plants.

Automotive Engineers See Work Ahead

President Charles W. Manley, in opening the summer meeting of the Society of Automotive Engineers, held at Ottawa Beach, Mich., June 23 to 27, declared that to those having to do with matters of automotive engineering, which includes the designing and building of automobiles, tractors, boats, aircraft and engines, as well as the planning and organization of their operation, the opportunities and obligations knocking at their doors demanded the acceleration of minds and energies to the highest degree. "The real work of the automotive engineer in these fields," President Manley emphasized, "has hardly yet begun. For instance, in the case of the motor truck, these vehicles are daily hauling thousands of tons of merchandize, but the careful study and collection of data for accurately predetermining best operating equipment, organization, and personnel to meet given conditions at a predetermined cost, has hardly been started. This single phase of automotive engineering presents the problems that the determination of freight rates would if all our records and data of railroad transportation were suddenly swept away and it became necessary to reëstablish them."

Professional features of the convention comprised a truck and fuel session, at which were brought out the trend of truck design, and the motor-fuel problem; a passenger-car session devoted mainly to a consideration of the probable characteristics of the car we will be riding in ten years from now; an engine and tractor section, including a paper on the relation of tractor to implement; and an Army and Navy session, divided between a description of the N C Boats and future relations between the automotive industry and various army departments.

The professional sessions were all held in the mornings, the afternoons were left free for sports and recreation, and the evenings were devoted to general meetings and entertainments. The general meetings included a lecture on Wireless Telephony by E. H. Colpitts, Assistant Chief Engineer, Western Electric Company, with a striking demonstration of conversation between the meeting room and the city of Chicago across Lake Michigan.

Dr. John Johnston, formerly secretary of the National Research Council, gave a talk to the Society on Gas Warfare, and Lieut.-Col. A. J. Slade, U. S. A., related experiences with the A. E. F. and the Armistice Commission.

Other distinguished speakers were Major-General C. C. Williams, Chief of Ordnance, Col. L. B. Moody, Chief of the Truck, Trailer and Tractor Division of the Ordnance Department, and Lieut.-Col. B. F. Miller, of the Motor Transport Division.

There were over 600 at the convention, the large Hotel Ottawa being filled to capacity and the overflow accommodated in hotels at Macatawa and Waukasoo, both across the beautiful Black Lake. The selection of the place of meeting was a happy one, and undoubtedly the desire of the Meetings Committee to make the meeting an opportunity not only for real accomplishment but also for plenty of fun was fully realized. A complete account of all features is being published in the forthcoming number of the Journal of the Society of Automotive Engineers.

W. E. B.

Discussion on Industrial Relations

At the largely-attended session on Industrial Relations, held at the Spring Meeting, there was presented the report on The Status of Industrial Relations, by L. P. Alford, an abstract of which was published in MECHANICAL ENGINEERING for June; and an initial, or opening address on Industrial Personnel Relations by Arthur H. Young, Manager of the Industrial Relations Department of the International Harvester Company, Chicago, which is given nearly in full elsewhere in this number. Mr. Young's address and Mr. Alford's report were followed by a general discussion, of which an account follows. A large amount of written discussion was also offered, from which extracts have been made for publication. Because of lack of room it has been impossible to give this discussion in complete form, but it is believed what is here presented correctly records the most essential points that were brought out.

Major Fred J. Miller[1] was of the opinion that the industrial problem resolved itself mainly into the establishment of a business relation between employer and employee of such a character as usually exists between any other classes of people who do business together—relations which must be mutually and permanently satisfactory to each side involved.

The employee must feel that he is doing at least as well as he could do with another employer in the same line, and the employer must feel that he is doing about as well as he could with any other body of employees.

A business relation implies, also, the right of either party to present a proposition at any time for a change in the terms of that relation. It should be agreed that in any negotiations regarding the terms of employment, either side may have the right to be represented by a representative of its own choosing. In these days of large corporations, the owners of a business have chosen, under the name of officers, superintendents, foremen, and so on, men who represent them in all negotiations concerning the business relation that should exist between employer and employee. Nobody disputes the rights of the owners to select such representatives of their own choosing, and if a business relation between employer and employee is to exist, the employees should have exactly the same right to choose their representatives. These may constitute a committee of their own number or they may be union representatives; but so long as they are chosen by the employees they should be treated as their representatives and allowed to state their case.

When an employer has sat down for a discussion across the table with representatives of that sort, whether they be employees of his own or union representatives, or what, and views have been expressed candidly and freely as man to man, it will often be found, as I have actually found, that many of the difficulties which may have been anticipated will disappear; in fact, that thereafter there is no difficulty whatsoever.

An impressive example of this occurred in two factories of which I was at the time general manager, where there was a movement for shorter hours and more pay, although we were already paying about the highest wages that were going. We voluntarily went to the shorter day and gave the men to understand that there could be the utmost freedom in discussing matters relating to the situation but suggested that it would be better if they were to appoint committees of their own number to discuss these matters with us and to present their side, we giving every assurance that no man serving on such a committee should be discriminated against in any way by reason of such service.

There were three classes of employees concerned, tool makers, automatic-screw-machine men and the polishers. The two former appointed committees of their own number of our employees, but the polishers preferred to send a union employee who was not a member of our labor force. He was, however, received just as the committees had been and invited to state his case which he did freely and fully. We stated our case and told him what we could do and what we could not do and why.

When the time for the strike arrived, the tool makers and the automatic-screw-machine men, who had appointed committees of their own, joined the strike, but the polishers did not, although everyone who has had experience with polishers knows that there is likely to be more difficulty in dealing with them than with men of the type of tool makers or screw-machine men. We learned afterward that after his interview this union representative stated at a meeting of the polishers that as a result of considerable experience in adjusting labor matters he had never met those who were quite so ready to hear the other side fairly, squarely and patiently as we had been, and he thought if they knew when they were well off they would hang on to their jobs and refuse to join the strike.

It is safe to say that such a result would not have been prophesied by most people who have had industrial experience; but it is only one of many instances I could relate to show that many of our difficulties which we think are serious in the management of men will disappear if we regard the relation that should exist between employer and employee as one which must be a mutually satisfactory business relation, not a patriarchal relation.

[1] Center Bridge, Bucks Co., Pa.

Forrest E. Cardullo. We have at the present time two conflicting ideas of what constitutes industry. One of these is based on the old idea of competition between all men for the good things of life. It falls back on the proposition that the primary purpose of industry is to make money for the capitalist or owner. Incidently it furnishes a means of livelihood to the worker and in doing so affords the capitalist or owner an opportunity to secure a commodity which he desires, namely, service in exchange for wages. The owner has the primary rights and privileges and the entire control, while the worker is put in the position of competing with his fellow workers in order to dispose of a perishable commodity, service, susceptible only to the operation of the laws of supply and demand.

Now we are coming to a point of view which regards the primary purpose of industry as service to the community and contributory to the general welfare of the nation; while the general welfare of the capitalists, owners, managers and employees who are engaged in the industry becomes secondary.

Our present-day attitude of mind on questions of capital and labor is such that we regard industry as passing from the competitive to the coöperative basis; from the idea of the entire and exclusive control by the owner to the idea of joint control, primarily in the interests of the community. In this we base our ideas on the theory of a democratic government which demands equal rights and privileges for all men. We have the Irishman's fundamental definition of democracy that it is "a form of government where every man is as good as every other man and a damn sight better;" but the trouble in working out the proposition of democracies is that we do not stop at the proper point in the definition, but put in the last clause, which destroys the effectiveness of coöperation and the workability of the definition.

All will admit that every man in the community, no matter what his position, is entitled to certain things such as a normal and healthy physical development; hygienic and sanitary living and working conditions; at least a minimum education which will enable him to discharge intelligently his duties as a citizen; and an equal voice in the control of every activity in which his essential interests are concerned.

Industry is not a war. It is a joint enterprise to be conducted in the spirit of coöperation for the joint benefit of all concerned, whether they be capitalists, managers or workmen.

The defects of the competitive system we have all seen and will continue to see as long as it remains such, which it is liable to do for some time to come. They are (1) that labor is under no moral obligation either to the community or to the employer to give its best, or to coöperate for a joint benefit: and (2) labor believes that it is compelled to adopt forms of organization and

methods of procedure which emphasizes the fighting power of the union and which develop inefficiency rather than efficiency and a spirit of antagonism rather than a spirit of coöperation. The men in charge of the activities of the union are dependent for their support upon fostering, at least, a reasonable amount of friction, so that they may have something to do and may point with pride to their achievements. Before we can do away with this spirit we must substitute not something which will assure to the workmen a larger measure of the good things of life and larger measure of control in the things in which he is interested.

This can only come about gradually and as the result of economic education of the workingman who must understand what he is to strive for, what kind of men he must elect to take care of his interests, and that efficiency must be the basis for any increase in his material welfare.

Dr. Otto P. Geier.[1] There is great need today for trained industrial physicians who will not be satisfied simply to be physicians called in as specialists, but who will actually make a contribution to the solution of some of the very difficult problems that are facing industry today. When we take into account that there is, perhaps, a billion dollars' worth of loss in this country per year, at least half of which is preventable by proper medical supervision in industry, then the problem that looms up for solution by the industrial physician, and by engineers and managers, is worth talking about.

The difficulty that I usually find in discussing this question with managers and industrial engineers is that they have such a poor idea of what contributions industrial physicians can make in the plant. If you hire an industrial physician—a man who is simply a finger wrapper, who sees nothing beyond the mere attempt to repair that injured part, then of course we cannot understand each other. If you have a man who is like a machine making medical examinations for purposes of admission to the plant, or who is only serving part time and is giving his thought to developing his outside practice and merely using industry as a stepping stone, then of course we cannot be talking the same language. Again, if you are talking about a cheap man—and I must confess that I have seen very few high-priced men in industry who are serving as physicians—he is not going to have the large industrial outlook, nor the necessary social outlook. He will have none of the training that comes from broad experience of living and working with people and the result will be what you would get in your engineering department if you hired a cheap man.

Industrial Relations means to me that feeling of responsibility which the farseeing management has; that in having large units of society, such as industry, in its charge it has all the responsibilities that a community has toward large groups; that it must exercise all the care in regard to the matters of health and sanitation and safety, and all the things that naturally come up, and perhaps the thing that has not been stressed today sufficiently is the matter of housing—the matter of living conditions.

Many of you know a man out in the field today, who is a personal service man, who is in overalls, and going from plant to plant in this country trying to find out what workmen are thinking about. I recently spent about five or six hours with him to find out, if possible, what his reaction had been as a result of about four months in overalls, working in coal mines, in steel mills, and doing the things that other men do who earn their money by the sweat of their brow.

Perhaps the thing that he stressed more than anything else was the fact that in spite of all the talk that we have had about sanitation, safety and medical examinations, we haven't even scraped the surface. We are not getting this message across to the workmen, and we haven't begun to realize how much we can do for them by actually caring for their health. Living conditions are the things that are making men start this unrest, and they are coming to the factory in the morning tired and miserable and ill at ease with everybody and the world at large.

[1] Director Employees' Service Department, Cincinnati Milling Machine Co., Cincinnati, Ohio.

Boyd Fisher[2] said that he was interested in presenting the social and economic justification for such a plan as Mr. Young had described, whereby the struggle for control in industry might to some extent be compromised.

The problem of the maladjustment of capital and labor is of interest because such maladjustment reduces production. The public is interested because lessened production increases the cost of commodities; and the manager, engineer and capitalist alike are interested because profits depend on rate of output.

As to labor, the speaker said that it had occurred to him (and he had been held to his viewpoint by Professor Jones of Ann Arbor) that one of the reasons why labor willfully restricts and limits output, although it is one of the partners of production, is because it is the one holding the least advantageous position in the apportionment of the production, and in formulating the rules by which that apportionment is made.

This is due to the fact that those who undertake industry pay off all of the other factors of industry before paying labor. They pay rent and interest, they pay the makers of the tools and suppliers of material, they pay the managers and they pay labor, and then they keep what is left.

These factors, other than labor, are mostly beyond the control of those who undertake industry. The manufacturer cannot control rent, for example, and even his paid managers have a bargaining power fixed in part by market conditions and in part by their ability to stay out of the market if the price offered does not suit them. Labor, on the other hand, has no such advantage and has to come into the market without sufficient resources and reserves and take what the market conditions provide. So it has been, at least, in the past.

Inasmuch, therefore, as capital has to pay off all of the other factors at prices over which it has no full control, at figures that must be satisfactory to the other factors before the bargain is made, and does not have to pay off labor in accordance with a bargain that is satisfactory to labor, capital is often able to derive an advantage at the expense of the workers in industry.

Mr. Young has proposed a method whereby labor can advantage itself equally with the other factors, so that, in a sense, it can say whether it will or will not stay out of the market. It can protect itself and get a fundamentally right bargain, which is the first step toward the fundamental need of the public in relation to industry, namely, to increase production. For with such protection labor has no just grounds for attempting to restrict output.

"I have often felt," said the speaker, "that the measure of our success with the labor problem would be the degree to which we could persuade labor to coöperate in the program of scientific management, which has as its aim, the increase of production. A week ago I was privileged to meet with the presidents of three trade unions to consider a proposal whereby I would be employed to assist in the installation of scientific management in three factories that have for 30 years been in relation with the unions.

"I set up the principle that I would not enter that situation unless the union assented and unless the union would help pay me for the job. The union in question brought in the presidents of two other unions to secure their point of view. I presented the point that hitherto trade unions had opposed scientific management and every other means designed to increase output and that therefore employers who had established relations with trade unions were at a disadvantage in open competition with open shop employers. I presented the point of view, on the other hand, that when the Soviets of Russia took control of industries there, they felt that now that they were in control of industries and were going to reap the benefits of increased output it was up to them to adopt scientific management to increase the output. I said I believed that the unions which the three presidents represented would join in a program for increased output if assured that the gains would be permanent and that the division would be on a permanent basis.

"Those officers unanimously agreed that on that basis they were for scientific management, and that they would employ a firm

[2] Consulting Engineer in Management, 3020 W. Grand Blvd., Detroit, Mich.

of consulting engineers to install scientific management jointly with their employers.

"I mention this incident because it represents an important step forward in the development of scientific management and shows that there is nothing inherent in the philosophy of the workers which restricts output and compels them to limit production to the disadvantage of society, managers and capitalists. The inherent difficulty lies in the fact that capital has the ability to pay off labor and the other factors without labor having an adequate protection of its interest in the bargain."

L. W. WALLACE[1] said that labor problems have always existed and are likely to continue to arise as long as humanity is constituted as it is. He therefore wanted to sound this warning:

"I do not anticipate that at this time or at any future period there will be evolved a panacea that will forever solve any and all problems that may arise between employer and employee. This is no more possible than that a plan can be evolved whereby there will be no more wars between nations. Some form of industrial democracy on the one hand and a league of nations on the other will unquestionably be an agency of great value and influence, but these agencies within themselves will not eliminate labor troubles nor make impossible future wars. In fact, no instrumentality or agency will accomplish much unless there be behind them and disseminated throughout every fiber and thread the spirit of fairness, honesty and justice.

"In all sincerity the principle of the 'Golden Rule' must obtain: do unto your employee as you would have him do unto you. I believe it is the duty of the employer to first demonstrate that he is operating on this principle. It is his responsibility to engender into the minds of the employees perfect confidence, absolute warmheartedness and cordial respect for him.

"It is also my conviction that no man will ever succeed as a leader of men and solve the industrial problems, unless he has a large store of human sympathy in his heart. Unless we are sympathetic, we are cold and indifferent to those matters that are nearest and dearest to men. We are apt to be impatient with human weaknesses, we are apt to make demands that are unfair and unreasonable, and we are apt to be cruel in our decisions and rash in our actions. Unless the principles enunciated are carried out, no satisfactory results will be obtained, whether the plan is a committee system, an industrial democracy system, or a House and Senate plan. The plan or the machinery whereby you are to operate is not nearly so important as the motive that prompts the ideals and the sincerity that obtains."

SAM H. LIBBY[2] stated that they had had a coöperative committee in operation at the Sprague Electric Works since last December. Ninety per cent of the 2000 employees voted to try the plan, which is much like that described by Mr. Young. In the Sprague committee, however, the elected members number about two to the hundred, with chairman, vice-chairman and secretary. Three members were elected to each of six sub-committees and on the sub-committees the management appointed three other members, making six members each. These sub-committees each selected a chairman, which in every case proved to be an appointed representative, showing the confidence of the men in the proposition. Mr. Libby described at length some of the practical workings of the committee, two examples of which follow:

"One of the committees, which we supposed would be the hardest-worked committee, was that on the adjustment of wages and working conditions. Since December that committee has had but 14 cases to review and the last case, No. 14, was the only one during the month of May, and had simply to do with the question of the men ringing out at 12 o'clock noon. They said they didn't think it was necessary that they ring out when they left the works; they were all in, they couldn't get out of the plant without a pass anyway. They presented a very good argument, the committee went over the details, investigated it as thoroughly as possible, and finally decided that the men were right. So what we thought was going to result in a grievance committee, with questions of wages and shorter hours, did not materialize as such.

"Another evidence of confidence was found in the coöperative committee. One month after the committee was started we voluntarily reduced the working day to eight hours and maintained the same weekly pay. We asked for a vote as to what would be done with regard to piece rates, explaining that it would be a large undertaking to go through all the piece rates of the plant in an effort to change them. It was proposed that the piece rates should remain as they were; and when one was found that was not to the advantage of the operator that it come up to the committee in the regular way or that it be adjusted before it reached the committee. The men had enough confidence in the proposition so that they voted 95 per cent in favor of taking the reduced time, the increased day rate, and allow the piece rates to remain exactly as they were."

RICHARD A. FEISS[1], as the result of a discussion introduced by Mr. Young as to the extent to which the question of management is an engineering problem, contended strongly that it is strictly such and that one's views should be big enough to make engineering stand for the things with which the engineer has to deal today rather than for the mere word "engineering" as defined in the old dictionaries. He contended that primarily mechanical engineering is production. The purpose of a machine is to produce and the machine itself must be produced in the process of manufacture. Many times an engineer has seen the best theoretically designed machine go to pieces in the hands of the average workman, because it had been forgotten that a man had to control the machine and its production, and that its successful operation could not be determined solely by the working drawings on which it is based. How, then, can one say that a problem affecting the man whose labor is assisting in production, or perhaps being replaced by a machine which is designed, does not present what is distinctly and directly an engineering problem? Again, we note that the running of two or three machines in a group is much more complicated than the running of one. It must be evident that the questions of the man and the machine cannot be separated and that their relationship is so essential in securing production that the question of labor and its management is distinctly an engineering problem.

H. F. J. PORTER[2] (written). In his admirable paper Mr. Alford gives excerpts from my article in the *Engineering Magazine* for August 1905, which presents a fairly clear idea of my installation of a factory committee in the plant of the Nernst Lamp Company, in Pittsburgh, in the winter of 1903-4, which I understand was the pioneer installation of its kind in this country. In 1905 I presented a paper before The American Society of Mechanical Engineers entitled The Realization of Ideals in Industrial Engineering, in which I referred to the merits inherent in enlisting the interest of the human element regarding matters affecting it in the management of an industrial plant. The basis for this paper was the experience obtained with my shop committee in the Nernst Lamp Company.

When I took charge of that plant it had failed twice and my study of conditions there assured me that one of the reasons for the failures was the autocratic management under which it had suffered. I had for a number of years kept in close touch with several Western plants, particularly the National Cash Register Company, in which welfare work had been carried to a very high degree of perfection, but I never liked the phrase "welfare work" nor the method of application of its principles.

When I took charge at the Nernst plant I decided to install the suggestion system used successfully by the National Cash Register Company, but disliking the method of handling all such features for the management, I determined to have the suggestions passed on first by a committee of the employees themselves and therefore requested the latter to elect by secret ballot a representa-

[1] Director of Industrial Education, Red Cross Institute for the Blind, Baltimore, Md.

[2] Managing Engineer, Hoist Dept., Sprague Elec. Works, Bloomfield, N. J. Mem. Am. Soc. M. E.

[1] Genl. Mgr., The Joseph & Feiss Co., 2149 W. 53d St., Cleveland, Ohio. Mem. Am. Soc. M. E.

[2] Industrial Engineer, 200 Fifth Ave., New York. Life Mem. Am. Soc. M. E.

tive to it from each department. The committee so formed elected its own chairman and secretary and all suggestions were collected from the boxes by the secretary and prepared by him for the committee.

Among the questions considered by the committee were the following:

Wage Payment, the premium system being finally adopted.

Permanency of Employment. The committee considered the taking on and laying off of all employees and succeeded in stabilizing the working organization, developing functions now accorded to an employment manager. As far as I know it was the first time that "labor turnover" was seriously considered. As Mr. Alford states, my ideas on this subject were reported to the Society in the discussion of Mr. M. W. Alexander's paper on A Plan to Provide for a Supply of Skilled Workmen, at the Annual Meeting of the Society in 1907.

Sickness and Accident Prevention, resulting in suggestions for safety and the appointment of a nurse in charge of an emergency hospital and a visiting physician.

Fire Drill. There had been a panic due to a false alarm of fire in the factory before I took charge, which led to the development of a factory fire drill. I found to my surprise after a canvass of representative factories of the country that further than developing a fire-fighting brigade for handling the hose, etc., no such thing as a fire drill existed anywhere. The fire drill at the Nernst plant was the first established anywhere, which at a given signal would take the employees out of a factory building in quick time. A further study of the problem showed that all factories were deficient in exit facilities and when the Ash Building fire occurred in New York in 1911 I was able to bring to the attention of the authorities the necessity for establishing factory fire drills generally, so that laws were passed in New York State making them compulsory and limiting the number of people in a factory to the capacity of the exit facilities, and these laws have since been adopted in practically all the states of the Union.

Mr. Alford refers to the fact that my shop committee was composed of workmen and foremen and that the superintendent presided. The first committee was formed wholly of working men and women, but as they were advanced to positions in the management and the employees reëlected, some of them to office, some foremen were on the committee and the superintendent was made chairman.

The second shop committee which I installed was in the Nelson Valve Company's plant in Philadelphia in 1907. Here we had a shop committee of workers only and an advisory board composed of foremen and the superintendent. I think this arrangement will be found to give the greatest satisfaction.

Mr. Alford mentioned in his paper that it does not seem pertinent to devote space to certain activities that classify under the definition of industrial relations. I feel that he minimizes the importance of some of these features, particularly the suggestion system, benefit associations and pensions, which seem to me to be of as vital importance as profit sharing, methods of wage payment, the safety first movement, employment management, mutual or joint control, etc.

Take, for instance, the suggestion system. It is a factor absolutely vital to the successful operation of a committee system of employees' representation in management, for there is no other means of bringing to the attention of the committee in a satisfactory way grievances or suggestions for improvement, or any other matters which the employees desire to have discussed. All these matters should be put down in writing at the time when they are fresh in the mind of the writer and signed by him. If they are postponed until letters can be written, or if they are left to be verbally transmitted to a sub-committeeman they rarely reach the committee in the way the authors intend, and sometimes not at all, which leads to dissatisfaction.

In the past when the foreman was the autocrat of the shop, the suggestion system was considered by him to be a reflection upon his capability and he worked against it and practically killed it, and it is now seldom heard of. Even the men who have introduced committee systems do not seem to know its value and have not installed it. When properly installed the suggestion system is a wonderful source of improvement in any factory. Many matters which I found had been installed previously by the management and had been dropped as failures were later suggested by the employees, installed and succeeded.

Scientific Management, always difficult to install in a factory under autocratic management, goes in as a matter of course under committee management.

CYRUS MCCORMICK, JR.[1] (written). Employee representation is the first consideration today, because however much emphasis is being placed by workingmen on shorter hours, higher wages, and better working conditions, their underlying motive is really an expressed desire to share in the management of a business as it affects their own interests. Employees and employers are both finding that it is necessary to develop a new foundation for their mutual relations which shall be founded upon something more than a cash basis.

Employee representation is the practical application of the theory of democratic industry, because it permits employees to speak their minds through chosen representatives and to make their collective will effective. The recent war has proved that democracies—however slow they may be to act—are capable of generating a momentum based upon popular sanction which is not to be found in any autocratic system. This momentum is due principally to the good-will resulting from the self-expression which constituents of a democracy are capable of producing. It is the newest application of the old Roman fable of the "bundle of sticks."

I disagree profoundly with Mr. Alford's statement that "students of the present condition of unrest have pointed out that the fundamental is a struggle for control, the opposite forces being the owners and the workers." The idea underlying employee representation is not a question of class struggle, but rather of removing class distinction. It is a constructive endeavor to secure added benefits which are not granted by our present system, rather than a restrictive effort to prevent the spread of ills incident to industrial warfare. It may, it is true, prevent the spread of these ills, but if it can not at the same time ameliorate conditions, it must philosophically be regarded as a failure. The first two principles of employee representation hereinafter described prove these points.

Employee representation must be characterized by one application or another of the following fundamental principles:

1 There must be full representation for employees concerning working conditions, protection of health, safety, wages, hours of labor, recreation, education, and the like. This statement, of course, involves a recognition of the right of collective bargaining. It assumes that the workers, individually and as a group, are intellectually capable of maintaining their share in the joint discussion with chosen representatives of the management.

2 Joint conference between men and management. It is not sufficient to grant the employees merely the right to discuss their own affairs. This discussion must take place with the management or its representatives. If any subject can be brought out into the open where it can be tested by the clash of men's minds and where honest opinions are exchanged in free and frank discussion, a happy solution of any debated point can not be long delayed. The fundamental point is to get together; to talk things over; to debate them; and so to understand each other's opinions and points of view.

3 Shop committees differ only in the basis of representation. The great point is to secure a sufficient representation to build the plan upon an essentially democratic foundation.

4 Employee representation must include an easy channel of approach from the lowest workmen to the highest official in the company whereby the former can appeal to the justice of big minds. In this way it is to be hoped that personality can be reintroduced into industry without depriving industry of the efficiency of broad organization.

5 There must be no discrimination on account of race, sex, political or religious affiliation, or membership in any labor or

[1] Works Manager, International Harvester Co., Chicago, Ill.

other organization. This is an essential tenet of democracy, and if it is not included in the groundwork of any plan of committee representation, that committee can not succeed.

6 Finally, there must be executive supervision for the plan. In this way the experience gained from day to day can be collected and coded into a working principle for the future. The handling of labor problems is becoming the work of specialists, and as the years progress the specialist in labor matters will be more and more important even than he is at present. Quoting from Dr. Thurston, Mr. Alford is not clear as to whether he would set up a special labor department in a corporation or would consider Industrial Relations as merely one of the by-products of an industry. Certainly this is not an engineering problem in the narrow use of the word "engineering," nor is it a problem for psychologists or sociologists. It is rather an attempt to translate humanity into the language of modern industry. The whole problem must be looked at, not merely on ethical, but also on economic grounds, and the future development of Industrial Relations will, it is believed, depend upon a satisfactory solution of this dual view of the problem.

Mack Gordon[1] (written). Although the shop committee and collective bargaining outside of trade-union control are comparatively new and untried methods in management, some conclusions can be drawn from the limited experience at hand.

If the worker does not understand clearly what are the functions of the shop committee, and what his part is to be, it will not have his confidence, which is essential.

How is this confidence to be built up? The management must make up its mind absolutely to turn over to the workers the right of bargaining with it on any matter whatsoever that pertains to the workers' interests, such as:

1 Wages. The quantity to be produced for those wages. The method of determining what the quantity to be produced shall be, such as time study. Individual requests for increase in pay
2 Hours of work
3 Any rules or regulations affecting the conduct of the worker
4 His right to a hearing in case of discharge.

More than five years' experience has proved that the workers are reasonable. As long as there is confidence in the committee and in the honesty of the management, they will remain so. They do not ask for impossible things and when they do it is only because of lack of knowledge as to conditions. A frank and honest discussion will soon dissipate the misunderstanding.

However, the mere existence of a shop committee that can present grievances, ask for increases in pay, changes in hours, review of discharges, etc., is not enough. When the committee finds something wrong and asks that it can be remedied, in the most important cases, the conditions can only be remedied by a change of manufacturing policy, or of methods of management. The management must be willing and able to make these improvements. If it cannot, the mutual confidence that is so necessary will be dissipated, due to the lack of ability to satisfy the workers. It is in this phase of the situation that scientific management can help to solve the problem.

Willard G. Aborn[2] (written). In the first place the employer must be entirely convinced that the employee committees can and shall work out to the mutual benefit of all concerned. Fair-mindedness on the part of the employer and a willingness at the beginning to go more than half way to convince his employees that he is earnestly endeavoring to bring about a mutually beneficial condition is a necessary preliminary to the successful inauguration of such a scheme.

There have been and always will be dissatisfied radical workers in every plant, whose influence increases or decreases in proportion as the fairness of the employer decreases or increases. Therefore, by all means, in instituting these committees, reduce the influence of these radicals by giving the rationals, who are about 80 per cent, entire freedom in the selection of their representatives; in other words, remove all possible suspicion of undue influence at the elections by arranging that they shall be directly under the supervision of the workers themselves or their representatives. Do not permit any official or foreman to in any way dominate, interfere, or even suggest, except as they may be called upon by the workers for advice.

Elections without nominations seem desirable and have worked out extremely successfully where used, in that conservative employees of long service in the plant have almost invariably been elected. Also the time required is much less and result is really more democratic.

Department committees of three are also recommended for the reasons that three are more constructive than one and when representing their own department only have intimate personal knowledge on any subject affecting their constituents.

Welcome joint discussion on any matter pertaining to the plant —in fact, if necessary or desired, originate matters for discussion so that the committees may function and the workers interest in the plant welfare be stimulated. Those who have had dealings with committees know that there is nothing much more dead than a non-working committee. Joint meetings of employer and employees' committee should be held frequently enough to keep up a live interest. Allowing the committeemen to honestly feel that they are originating and inaugurating matters for common good will tend to keep their enthusiasm alive and working.

[1] Consultant, 226 Marion Bldg., Cleveland, Ohio.
[2] 619 West 113th St., New York City.

Guy P. Miller[1] (written). Although the plan of Industrial Relations adopted by the Bridgeport Brass Co. has been in operation only nine months the results have been far greater than anticipated. About 100 meetings of committees have been held during this time, at 25 per cent of which hours and wages have been discussed, and in no case has the conclusion reached been other than unanimous and entirely satisfactory to the employees and the management. Every employee has an opportunity to be heard whenever he has a grievance, which enables the company to adjust little things which cause annoyance and to explain other things to the satisfaction of the men. In order to get the greatest benefit out of these committees, the safety and sanitation work, as well as the work of the sick-benefit association with the insurance features, have been turned over to them. Joint committees are also handling recreational and athletic activities in all plants of the company.

Every three or four months an evening meeting of all the committees is held with a dinner in our cafeteria, and I explain the general condition of the business and ask for expressions from the men, which has helped cement the spirit of confidence which has been established. No plan will be successful which fails to instill confidence, but as soon as the men are confident that the management will give them a square deal they will go half way.

Many feel that agitators may gain control of the committees and organize them as union representatives, but I am convinced that this danger is not to be feared as long as the management has the confidence of the employees, and when this is gone no plan can be successful.

P. J. Reilly[2] in a written discussion emphasized the change in conditions since the time about two decades ago when the general manager of a plant erected buildings, engaged help, bought materials and determined costs. He was unhampered by any restrictions as long as he made profits for his company. Now the old-type general manager would find himself unable personally to cope with the new problems which arise and he must be assisted by a staff of officers, purchasing agents, efficiency engineers, master mechanics and employment managers. He pointed out, however, that such staff services fall pitiably short in their appraisals of the worker and of the job as compared to that which was reached when the owner was present in the shop. This is because many good principles of personal management which are developed by the industrial engineer or the employment manager lose much of their effectiveness because they are applied by foremen who have not been trained for efficient foremanship. In

[1] General Manager, Bridgeport Brass Co., Bridgeport, Conn.
[2] Employment Manager, Dennison Mfg. Co., Framingham, Mass.

many factories the foreman is the only representative of the manager that an employee gets to know well. It is important, therefore, that foremen represent an employer in a creditable manner.

The work of industrial engineers and employment managers must be supplemented by a new type of foreman—one who has been trained for his foremanship. The manager of a large New England factory recently stated, "When the science of human relations is as carefully organized as the science of product and quality of product; when the human relations of the foreman in the large factory unit equal the human relations of the manager of the small shop, the managers will have established their credit as fitting leaders and true spokesmen." Information that will assist foremen to administer their departments more effectively should be organized and presented to them in a form that will make the material readily available. The philosophy behind any rules of organization which foremen are expected to enforce should be explained so that they can enforce such rules without appearing arbitrary. Regular meetings for foremen should be held for the discussion of problems affecting the planning of work, the quality, quantity, and economy of production, the handling of new workers and the promotion of deserving older workers. Such meetings are effective in the enlightenment of foremen so that they are in entire accord with the management's policies in each of these fields. Much can be done in the development of foremen by relieving them from duty in their department for short periods so that they can work under the direction of the employment manager, the industrial engineer, or the master mechanic.

Opportunity should be given to foremen to attend special courses on industrial management, or to visit other factories that they may get the broadening which so many of our foremen badly need.

If the industrial leaders will give them the chance, the foremen will learn to treat help with a degree of human sympathy that will result in better team work. They will develop more patience, judgment and tact, and will eventually realize that men under them will produce best when their heads and hearts are in their work as well as their hands.

D. G. Stanbrough[1] (written). In the last analysis, our difficulties are those of human relations rather than industrial relations, and if we pass from human relations to industrial relations unquestionably some of the specific remedies which Mr. Alford has recommended must be applied. It should be realized, however, that the growth of the factory system does not necessarily mean (*a*) the loss of personal contact; (*b*) the loss of personal knowledge of the work to be done; (*c*) the loss of personal knowledge of the tools and equipment necessary for production, or (*d*) loss due to lack of conservation of effort.

I believe that a wise system of management conserves these relations, and that they will be found to be developed to a higher degree today in many of our industries, than at any time in our industrial history. In fact, I believe that success in meeting present-day conditions prescribes their levelopment, and if this is the case, the natural question is, "How can that development be brought about?" and the answer: "Through education."

With reference to the development of the personal relations, this is a matter of organization. The foreman, in the minds of the workmen, represents the management, and consequently, if we are to be successful in maintaining personal relations, it becomes necessary that we develop a high class of foremanship, and this instruction work must be done by executives familiar with the broad policies of the business and who have had the necessary practical experience to enable them to talk to the foreman from the foreman's viewpoint.

The foreman must be a man of the proper amount of personal kindness and should be able to understand the psychology of management. Such foremen will be found among every class of workers, or at least potential foremen of this caliber, and to develop such men it goes without saying that the factory executive must have the proper viewpoint.

[1] Gen. Supt., Packard Motor Car Co., Detroit, Mich., Mem. Am. Soc. M. E.

I want to take particular issue with the closing paragraphs in the paper. I do not think that we can ever hope for any real measure of success if we are to consider workers in groups or masses. You cannot build morale by appeal to masses. I believe that the appeal must be made to the individual, through the organization line. The spirit of organization can be strongly built up if each individual worker feels that the management is conscious of his efforts and that the appeal is to him personally. Even in a large organization much can be done by the executive in knowing his men. At least he can know a few men in each department, and through them the spirit can be communicated to the organization.

John L. Henning[1] (written). During the past five years hundreds of thousands of potential business men have been added to our population and practically no new unorganized labor has been added to our supply with which to carry on the work created by this additional ambitious army of business makers.

There is every indication that immigration will be practically stopped for the next four or five years, perhaps longer, and an entirely new situation will be presented: viz., the machinery already in existence supplemented by additional but limited output will be called upon to operate much more continuously (and therefore efficiently) than ever before.

Even with greatly increased efficiency there will not be enough labor to meet requirements, and this is where the engineer will come into action. It is strictly up to him to create new machines and new methods of utilizing old machines to accomplish the required result with whatever labor is available.

With the door closed to disorganized labor from Europe, we will soon become really American and instead of being apprehensive about higher wages, I believe all real Americans will soon be proud of the wages and standard of living afforded our workers in this country.

Those classes which have been rather thoroughly organized for a number of years are doing very well, but there are a large number of classes, such as clerks, stenographers, and responsible employees of banks and industrial institutions that are having great difficulty in providing only the real necessities of life. Many engineers are among the classes that are having trouble in making both ends meet. Large industries cannot do anything that will help them through their present and future difficulties as much as to recognize the wonderful opportunity of the engineer and *voluntarily* place more responsibility on him, at the same time not forgetting to make him comfortable.

As Mr. Alford states, the loss of personal contact is one of the contributing causes of present unrest; but if employers will use the engineer to the fullest extent and permit him to take some responsibility in handling labor questions he will, I believe, demonstrate that his so-called fault of dealing with labor from an individualistic viewpoint may be turned to a very good account. He will use a little more human sympathy in dealing with labor, which after all is simply a collection of human beings who inherently have the same "rights, needs and aspirations" as the employer and those dependent upon their product of industry.

Referring to Mr. Alford's conclusions as to the reasons for the apparent failure of remedies heretofore applied, I have proved to my own satisfaction, in a small way, that reasonable assurance of a permanent job is the greatest single weapon against unrest and Bolshevism. The moment uncertainty as to tenure of job and rates of pay is introduced into a workman's mind he is ready to believe almost anything, and you cannot expect a worker in any class to save for a home when he has none or only small assurances of the regularity and permanency of his work.

William M. Leiserson[2] wrote saying that the tendency of the engineers is to consider workers only as individuals, while the "industrial psychologist" holds that they must be dealt with in the mass. On the other hand, the economist, who has been studying labor problems and industrial relations for more than a hun-

[1] Consulting Engineer, 525 Kirby St., Lake Charles, La. Mem. Am. Soc. M. E.

[2] Working Conditions Service, U. S. Dept. of Labor, Washington, D. C.

dred years, takes a broader view based on a study of the labor problem, its history, and its causes and manifestations under different systems of industry.

The economist, he continued, analyzes industrial relations and finds not one problem requiring individualistic or collective handling, but two sets of problems, one requiring dealing with each worker as an individual, the other necessitating dealing with wage-earners as a class. The first of these may be called the personal relations in industry, the second, the economic or governmental relations. The personal relations include such subjects as recruiting, selecting, hiring, training, placing and promoting workers, looking after their health, safety, comfort and welfare. These problems require individual problems or they are technical questions that must be decided by technical experts like the engineer or the physician. The second set of relations, however, have to do with bargaining, wages, hours, shop government and discipline. These questions are essentially controversial. They cannot be decided by technical experts. They are matters of opinion requiring decision by a democratic majority.

Failing to catch the economist's fundamental analysis of the problem, engineers, employment experts and industrial managers are wont to group all industrial relations together and to include the fixing of just rates of pay in the managers' function. Accurate records of individual production and fairness and square dealing with employees, they think, will assure justice to the workers. This may be true as far as injustices between individuals within a plant are concerned under a general scale of remuneration that is already fixed, but it overlooks entirely what President Wilson has called the progressive improvement in the condition of the wage earner, the raising of the scale of all so that labor may receive a very much larger share of the product of industry than it gets today.

The other day the waiters of the city of Toledo adopted a scale of wages and presented it to the hotels of the city, saying, in effect, "This is what we consider it fair and just to charge you for our labor," and they resented it when one of the employers did not want to pay them what they thought they were worth. They say, "Why should management place the price on labor? It does not set the price on the materials and machinery it buys, why should it on the labor? Why should not the workers set their own price? They know best what it costs to live and to produce the energy we call labor."

Yet from the national point of view neither the one side nor the other ought to be permitted to fix the scale of wages, according to its own ideas of what constitutes a square deal. The national welfare requires that it be set by negotiation and bargaining and mutual compromises and concessions, which cannot be done without the right of employees to bargain collectively with their employers.

H. L. Gardner[1] wrote outlining in detail the personal qualifications of the employment manager, his duties and the functions of the employment department. He said that the manager should be a broad-gage man, preferably a high executive or an officer of the concern, for which he preferred the title "service manager." He should be of sufficiently large caliber to "sit in" with the officers or a committee responsible for all relations between employer and employee; and being thus constantly apprised of general problems and accepted policies he can then organize and direct his department to coördinate with all other service departments and activities.

Interviewing is perhaps the keynote of his work, and with the right viewpoint and with practical knowledge of plant operations and conditions he can be of tremendous influence in building the right kind of working force. Continuing, Mr. Gardner wrote:

"One of the more abstract functions of Employment Management deserves detailed attention. If we are to offer a satisfactory substitute for the decreased personal contact in industry, the foremen are the channels through which we must work. To the workmen, the foremen are the personification of the manager and the company; it seems vital that such representation should harmonize with the general policies of the concern, yet too little has been done to develop this contact and to insure the desired results. To my mind, one of the most important services which employment management can render, and one which has a most important influence on industrial relations, lies in securing real coöperation of foremen through understanding of, and sympathy with employment methods of attack on the common problems of personnel and production. This may sound too theoretical, but it is, in fact, a tangible problem, and quite possible of surprisingly satisfactory solution.

"At the risk of repeating certain thoughts which I emphasized at the National Association of Employment Managers Convention in Cleveland, I would criticize the average employment department as too selfish. We too frequently devise theoretical solutions for the existing problems and impose them on the plant without sufficient sympathy for the other fellow's opinions and troubles. Complete success demands that the employment department thoroughly acquire the general plant viewpoint and merge its individual activities into the broader service program.

"Several vital changes in the status of employment management have taken place in recent months. War pressure for 'quantity production' has been relieved and the opportunity for intensive personnel work is much brighter. Changing social and economic conditions are making more important the necessity for the right relationships, and, to use Mr. Alford's words, focusing attention on the 'interacting human rights, needs and aspirations in productive industry.'"

[1] Manager Personal Relations Sec., E. I. DuPont de Nemours Co., Wilmington, Del.

Mark M. Jones[1] (written). Functions in industry can be arranged according to many very interesting classifications. The five M's—men, money, methods, materials and machines—have appealed to me as a simple classification. Engineers will recognize that in our progress on the fifth M—men, we have from an administrative standpoint reached a point of about 30 in case we consider progress on the other four M's—money, methods, materials, and machines, as being at 70, with 100 the ideal.

Employment management as a part of Industrial Relations has as its object the administration of recruiting, selecting, placing, transferring, promoting, and releasing workers on an engineering basis. It seeks to apply the labor policy of the enterprise so far as it may affect those functions named. Its effectiveness is only limited by the strength of the belief of the management in the value and possibilities of such a service.

Employment management is distinctly a "service" function. It is an aid to production and a department for the purpose must always be operated with the proper understanding of the important part it plays in turning out the finished product.

A well-organized employment department surrounds the initial contact of the worker with those activities which influence him favorably and contribute definitely toward the final object of production. It provides a proper reception place and courteous treatment while the applicant is being studied. It studies him from mental, moral, physical, financial and social standpoints with the object of placing him where he can work to his own best interests. The employment manager knows definitely that an individual cannot work to the best interests of the enterprise unless he is working to his own best interests. The interests of worker and business are identical. From the standpoint of placement there is no divergence. From the standpoint of effectiveness, however, men must be weighed more carefully and a more exact method of so doing remains to be developed.

The whole field is rich in opportunities for pioneering work. During the coming months and years there must be worked out and applied:

More exact methods for measuring men
Better coördination of personnel and production functions
More definite methods for recording meritorious services
More exact methods of promoting workers
A more careful observance of the relationship between cost of living and wages paid
Provisions for care during old age and sickness.

[1] Director of Personnel, Thomas A. Edison Industries, Orange, N. J.

There are also many other problems, each step in which creates more problems in the great game of employing large numbers of men as intelligently in our great organizations as would be the case if but 40 or 50 men were the total number.

If during the coming months engineers will have in mind just one need of this field, namely, the same recognition and study of the fifth M—Men—as of the other factors in production, they can do much in assisting American industry toward the great ideal of industrial nations, which is that of "increasing individual production."

Mr. Alford's Status of Industrial Relations is a timely summary of past and present, full of valuable data and epitomized in a warning to be heeded.

Harrington Emerson[1] (written). I have been requested to contribute to the discussion by notes on Wage-Payment Plans as one of the problems of modern industry.

Wages are but a phase of a much deeper problem. What is the starting point? I paid a man recently $10 for a half hour's work and I received an equivalent in return. When in Alaska I paid day laborers $15 a day and felt lucky to find the workers. I have personally worked for $0.10 for a long day's work and was grateful for the opportunity.

On the one side are the necessities of life: to live morally, to have health, time to study, time for industrial improvement, and to have opportunity; on the other, what the earnings will afford, and again also the market rate for similar services. An empirical equilibrium is struck. Not as high wages as an ideal life would require, but often more than the earnings justify.

But what I recognize is that three conditions enter into work and wages: (1) The basic hourly wage, however determined; (2) the equivalent in output for the hourly wage; and (3) the special excellence of the worker. Of these the third, the individual excellence of the worker, is the most important.

The great truth, as yet only partially recognized, is that the superior worker is worth so much more than the average or inferior worker that any amount of care and supervision and all the extra pay required to secure him is a good and paying investment.

From this conviction it is evident that I am wholly out of sympathy with so-called profit-sharing, which repudiates individuality and makes of business a kind of providence that rains on the just and the unjust alike.

There is no connection between profit and skill and effort. The product of the highest skill may be sold at a loss, the product of malingerers may be sold at high profit.

The extra wage paid for individual competence is not a dole, a gratuity, a present. It should be a measured and full equitable compensation for a measured delivery.

There are current wages so low as to be dishonest. There are also current wages so high as to be dishonest.

Starting with a basic hourly rate, increased yield should command higher pay as long as unit costs drop. An increase in wages that increases unit costs (unless money is falling in value) is robbing the three other divisions of the community.

The problem always is to so lower costs as to increase output, to lower unit costs yet to pay more per hour, to give greater security and volume of investment yet to lower interest and dividend rates, to so compensate executives as to stimulate them to secure the best combinations of men, materials and machines, thus again lowering unit costs and adding to the common fund.

Out of the common gain from reduced unit costs only four classes can make a gain:

1 The buyers, who are entitled to a permanently lower price if they continuously buy either more or more regularly or in standardized form
2 The provider of equipment, whose temporary risk must be temporarily covered not only by interest but by insurance against loss
3 The worker, whose only claim to higher compensation rests on a reduction in labor unit costs
4 The administrator, organizer, inventor, man of original and creative personality, who is entitled to the worm the early bird catches.

Fundamentals, not expedients, underlie all real solutions of the wage problem.

[1] Director, The Emerson Engineers, 30 Church St., New York City.

R. G. A. Phillips[1] (written) To my mind industrial relations problems came into being along with the "Big Business" idea and I think it well and timely that we give these various problems serious thought and study.

In our industrial relations work at the works of the American Multigraph Company the biggest topic of the day is our industrial democracy. Therefore, although it comes last in point of things done, it ranks first in order of importance.

In our case Industrial Democracy was no "spur-of-the-moment idea." It is a subject we have been studying almost as long as we have been in business. Our active interest dates back about five years—we have been all that time progressing toward our goal. It took about a year and a half of constant study before the final plan with its constitution became a fact. It took definite shape toward the end of February, 1919, and finally on March 1 the plan was put up to the employees.

The plan of putting it up was interesting—I don't recall having heard of it being done our way before. We mailed a letter, over President Osborn's signature, enclosed with it a book describing the plan and the constitution, and sent it all to the employees' home addresses. The letters were so timed in the mailing that they should reach the homes Saturday morning. We wanted them to be part of the Sunday reading program, and had a "hunch" that they would also be part of the Sunday conversation program. We figured that the more a person had to talk about the plan, the more thorough would be his understanding. We also figured that inasmuch as the envelopes bore the return card of the American Multigraph Company, by the time Mr. Man got home there would have been quite a bit of curiosity aroused. We figured strongly on the question, "John, there's a letter come for you from the company—what are they writing to you about?" Later developments proved that we were right in our judgment.

Along with the letter went a pledge card. The employees were asked in the letter to read the plan over; talk it over, and come in the following Monday to President Osborn's office and tell him frankly what they thought of the idea. If they liked it and were in favor of it they were asked to sign the pledge card. If they were not in favor of it or distrusted it they were asked to tell Mr. Osborn what they thought and he tried to "sell" them on the real purpose of the plan.

About 95 per cent of the people accepted the plan with the greatest enthusiasm. About one per cent prophesied dire failure. About four per cent thought it was some sort of a trick. This last class was most amusing. Its members admitted that so far as they knew the company had never gone back on its word to the men. It had never played any tricks on them, had always been square and all that—and then they would hesitate, and the silence would speak volumes for the broken pledges that had made up their experiences before they came to us. I don't blame men for being suspicious. Some of the stories we have heard would break the faith of the strongest of us. There must be no more of it. A square deal must be what it says.

Perhaps, in telling of the steps leading up to our installation of Industrial Democracy, it may be thought I am laying too much stress upon a detail. I am not. The success of the whole plan depends upon the introductory steps.

Well, we had our elections—lots of competition between rival candidates; lots of campaign speeches; lots of real old-time election enthusiasm—even one case of election fraud! Immediately upon taking office the congress turned its attention to that one case of election fraud, with the result that those concerned were eliminated,—three of them. That bit of serious-minded justice was startling, a true index of the seriousness with which the men took their new jobs.

Since then we have had many incidents that have made us wish

[1] Vice-President, The American Multigraph Co., Cleveland, Ohio.

we had started sooner. For instance, I will refer to some of the minutes of the congress meetings and pick out suggestions that were approved by the senate as being wise and necessary.

Educational Committee: Suggestion that certain employees be taught what the Multigraph does so they might do their work with greater understanding. (Assemblers and final inspectors)

Production Control Committee: Suggested rearrangements of departments that will produce greater results

Suggestion Committee: Presented about fifty new ideas, the principal one of which will result in considerable saving in handling of tools, etc.

Sales Coöperation Committee: Working all the time with Sales Department. Pushing manufacturing and keeping up standards. Latest job the reduction of time taken to fill and ship foreign orders about 80 per cent

Sanitation and Safety Committee: Always at work. Producing great results. Total suggestions adopted to date, about 65

Recreation Committee: Managed several dances, an indoor baseball league, bowling league and all gymnasium classes

Spoiled-Work Committee: Very active. Reported last week on correcting a condition that reduced scrap and increased production on a certain part about 150 per cent

Shop Training: Manages all class work during season just finished. Promoted mathematics classes (two each week after hours) and a big general shop efficiency class that met every Friday night, having an average attendance of 150.

Industry has got to begin to get all the effort it is buying. It should no longer be satisfied with the services of the hands of its workers—the brains, too, must be induced to participate. This matter of brain and hand cannot be commanded either—it must be more of a pull-together effort. We think we are headed that way through our Industrial Democracy.

C. B. Auel[1] (written). Both capital and labor have within their ranks elements of sufficiently radical tendencies and proportions to cover them at times with opprobrium in the estimation of the public at large, and it is these two elements, which might be termed the arrogant and the ignorant, in their own midst, that each must get rid of, if they are to make the most headway in their common progress.

It seems almost certain that the six lines of development listed by Mr. Alford will go a long way, if fairly universally adopted, toward lessening industrial unrest; but, they will hardly eliminate it since the fundamental cause for this unrest as admitted by the author is fear of unemployment, and methods of overcoming it have not been included. Some persons may point out in opposition to this statement that during the recent period of tremendous industrial activity, labor unrest was perhaps at a maximum; but, in answer to this it may be said this unrest was quite abnormal, due very largely to war conditions, and was moreover aggravated by employers practically bidding against one another in the labor market, with the very natural consequence that labor tended to oscillate to and fro, wherever wages were highest, or in the contrary event to insist on wages being brought to the high level.

One very important item the author has omitted from his list is "Americanization," which has been carried on by many corporations for a number of years past, principally through the medium of schools for their employees; but, fine as is the work already done by them, the task is so huge that it needs to be supplemented by greater efforts on the part of the various states if real headway is to be made. In Pennsylvania, for example, one authority has announced that with a population of 8,000,000, there are 1,500,000 foreigners over the age of 10 years and of these half a million cannot read or write English, while a third of a million cannot read or write any language, but what is worse than these statements is the further fact that the half-million that cannot read or write English increased to this figure from a quarter-million in the short space of 10 years. Illiteracy is a fertile field for the propagation of every kind of "ism" and it seems astonishing that a condition like this should exist in any state in our Union, and doubtless a similar situation exists in certain other states.

[1] Director of Standards, Processes and Materials, Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa. Mem. Am. Soc. M. E.

Dwight T. Farnham[1] (written). At the close of the paper Mr. Alford opens a question whose just solution will, I believe, within the next ten years tax to the utmost the ability and resourcefulness of our financial, economic, ethical and engineering minds. The fact that the International Harvester Company had hardly installed their "industrial democracy" plan before they were deluged with recommendations for rate raises illustrates this trend. When their committeemen, however, were taken to the company's books and shown that the business could not continue if their demands were granted, unreasonable demands for the most part ceased. From the standpoint of human relations, then, the first general principle necessary in order to establish a sincere industrial democracy would seem to be the possession of profits which will survive the light of public opinion.

The fair division of the rewards is the question which we face, and it will call for the development of the general principles under which controversies may be adjudicated. The first step is perhaps the establishment of a fair return upon capital which is so invested as to be reasonably secure. The next step in logical order to insure stability would then be the determination of adequate sinking funds to make reasonably certain steady dividends from each sort of business. Setting up such reserves would take investment in industrials out of the gambling class and would make them attractive at a 6 or 7 per cent return instead of having to offer chances of 15 to 20 per cent in order to sell stock.

One of the rocks upon which profit sharing has in the past gone to pieces has been its call upon the workers to share in the sacrifice during dividendless periods. The other has been the determination of the share to which labor is entitled. The solution of such questions requires first the scientific analysis which the engineering mind is best qualified to make.

What Mr. Alford describes as the second great tendency in the development of industrial relations,—the willingness to consider the workers in groups—I interpret as not so much a plea for an understanding of mass psychology as a plea for that knowledge which brought the ancient Greeks to the belief that he who understood life was all-powerful. Every age has had its interpreter of motives which actuate humanity. Today the human psychologist is an industrial psychologist. We applied the mind of the engineer first to materials, then to machines. Now we have reached labor.

C. E. Knoeppel[2] (written). Through organization and specialization in industry, relationships have each year become more and more complex, so that today this great problem of human contact is by far the most important confronting us, and my prediction is that from now on Industrial Relations will be considered the keystone of the industrial structure.

I am therefore pleased indeed to see that The American Society of Mechanical Engineers is giving this matter of Industrial Relations the prominent place it occupies. If the engineering world does not give the subject attention, where will the initiative come from? From the workers? No. From the employers? No. I say "no" in both cases advisedly, because in the last analysis each side is generally suspicious of the other's motives when suggesting improvements having to do with human relationships.

The world-wide tendency toward socialism and revolution in ideas, if not in acts, is due not so much to desire for political changes as to a demand for economic changes. What the great masses of people want are homes, food, farms, clothes, jobs, wages which balance cost of living, participation, representation in affairs, opportunity for self-expression and development.

The gigantic convulsion the world is now going through seems to me to be a protest against the way modern society is organized, against much in the present plan of man-to-man contact. The purpose of the coming era, as I see it, is to find the right basis, and this the people the world over will do, regardless of the strife and bloodshed necessary to its accomplishment.

[1] Cons. Industrial Engr., 3rd Natl. Bank Bldg., St. Louis, Mo. Mem. Am. Soc. M. E.

[2] Pres., C. E. Knoeppel & Co., Inc., Industrial Engineers, 6 East 39th St., New York City. Assoc.-Mem. Am. Soc. M. E.

Industrial Personnel Relations

By Arthur H. Young[1], Chicago, Ill.

The present focusing of attention on personnel relations, I think, will result in a new era in industry—as much an epochal change as we have had through various fundamental causes heretofore; such as the change from the original craftmanship to larger shop organization, made possible by power development, power transmission, changes wrought by methods of communication, and refinement of the methods of transportation, the era of consolidation of interests, and so on, and one has to stop and wonder why at last we have come to the consideration of the human factor.

We have probably had as great a refinement as would produce any revolutionary changes in machinery and methods and practices in everything except that relating to the human factor. All of us here have witnessed the birth and the growth and the final development of the safety movement, and more recently, too, employment management.

I refer to those, particularly, as factors in personnel relations of today, and illustrating how rapidly changes are coming about. I think it was only back in 1906 that the first organized effort in safety was made. It is generally credited to the South Chicago plant of the Illinois Steel Company, under the leadership of Mr. R. J. Young. He was a sort of genius who suddenly discovered that accidents were preventable—that it was no longer necessary to kill and maim men as a part of the making of steel.

Development of the Safety Movement

At first not much attention was paid to his proposition, but it rapidly gained support, due to its humanitarian appeal, its evangelical aspect. The first attack was naturally very largely along mechanical lines—the removal of projecting set screws and other parts of revolving machinery, the railing of platforms, the guarding of gears, changes in construction, marking of aisle spaces, and all such things.

A very disappointing result was had, because at the end of two or three years, after several hundred thousand dollars had been spent, at that particular plant accidents had not been reduced over 20 per cent, and generally speaking, today safety engineers rate the mechanical factor or the correction of engineering practices as not contributing more than 20 per cent to the possible efficiency of the safety movement.

It was immediately discovered that the real problem was psychologically to teach a naturally careless man to become habitually careful, and that more than 75 per cent of our accidents were preventable by a correction of habits of thought—of thinking safety all the time. To illustrate: It is perfectly natural to cross a street just exactly as a chicken does—to look neither to the right nor the left, but step right out from the curb; and it is only by a process of education that we learn to pause at the curb and look up and down the street and then walk into the middle of the street and then glance again, and finally to cross the street. That is a process of education which will prevent accidents, and it was what was immediately arrived at in industrial safety engineering.

The shaping up of that problem brought its immediate solution, and brought into play a most interesting development from the laboratory of safety engineers. We had movies, bulletin boards, mass meetings, and finally the formation of public safety councils, the introduction of the study of safety in the schools. Its serious considerations by civic police departments and other parts of society is really the product of the industrial safety engineer, because he realized that in order to make a man think safety all the time it was necessary to work on him not only while he was in the shop, but at home as well. And he carried his message to the man in the shop through his children whom he encountered at school, and during the hours that he was walking to and from the plant or riding to and from the plant by public safety bulletins and so had a continuous propaganda working 24 hours a day in order to make him think safety.

Immediate results were achieved. Taking again, for example, the South Chicago plant of the Illinois Steel Company, with which I happen to be familiar, back in 1906 the frequency of fatal accidents in that plant was 47 during the year, or about one a week. By 1913 that rate had dropped to 7, and it has since stayed at about that figure.

As in fatal accidents, so in the less serious accidents, the frequency rate dropped in the same proportion; and in the Illinois Steel Company there has been a reduction in the frequency of accidents to employees on duty of over 85 per cent since the 1906 rate. That was duplicated in nearly every plant of the United States Steel Corporation, and in thousands of other industrial concerns as well.

There have been a number of by-product results which have directly contributed to the growth of personnel movements and industrial relations, as we term them today, growing out of this safety movement. In the first place, it was found that not only did this human interest conserve lives, but that it was a paying proposition; originally it was an interest in the cause of humanitarian principles, and safety was regarded as somewhat of a fad by a great many employers.

After a sufficient period of experience on which to establish definite figures, it was found that safety was really "good business." The Steel Corporation has published the most interesting figures along this line, showing a net saving almost exactly equal to the cost of the safety work, or 100 per cent on the investment.

There is a striking unanimity in the form of organization for efficient safety work. The original movement in 1906 resulted in the formation of shop committees; as soon as it was realized that the problem was one of education of the workman and that his interest must be aroused, means were sought to turn the problem over directly to him, and I believe the first safety committees were organized at the South Chicago plant of the Illinois Steel Company.

Shop committees—the workmen themselves—were given charge of the safety work. It was their duty to investigate the cause of each accident, fix its responsibility, and make recommendations for a prevention of its recurrence. In addition, they were to make regular inspections of the plants, and by their foresight, and recommendations were to prevent, as far as possible, the recurrence of accidents.

That form, possibly modified, is almost unanimously used by safety workers today in all industrial establishments of any size—some form of a shop committee. It may be of the workmen themselves, it may be workmen in one committee reporting also to a committee of foremen, or it may be a joint committee, or it may be a joint committee of workmen, foremen and officers of the company, but the successful safety program of today includes shop committees.

In addition to the definite return on a cash basis of the safety work, there have been several interesting by-products. The first is the reduction of labor turnover. The Steel Corporation's reports recently published, show that since 1906 they prevented, roughly, 25,000 fatal or serious accidents. They rate as serious any accident which disables a man more than 35 days, or results in a permanent disability, such as the loss of a thumb, or an eye, or other member of the body.

Now, it is reasonable to assume that such an injury would require the replacement of the trained worker, and Captain

[1] Manager, Industrial Relations Department, International Harvester Company.

Address, slightly condensed, delivered at the Industrial Relations Session of the Spring Meeting, Detroit, Mich., June 17, 1919, of The American Society of Mechanical Engineers.

Fisher and other writers on the subject have given us some interesting figures as to the cost of replacement of trained workers. They vary anywhere from $10 to $200, depending somewhat on the way it is figured, and somewhat on the worker. Of course it is a fair statement to say that steel-mill workers are fairly well trained, and probably $100 as the cost of replacing a trained man with an inexperienced man is not an over-estimate.

If we multiply 25,000 prevented replacements of trained workers, because of the efficiency of a safety movement, by $100, we have a neat little by-product, due to reduced labor turnover through efficient safety work.

And then, too, there was another manifestation. As is generally known, the Steel Corporation has been facing a suit for dismemberment. While the hearings were on several years ago there appeared voluntarily a number of old employees who petitioned that the corporation be not dissolved, because that would mean a return to the days of ruthless competition when they did not have standardized safety programs. Of course, no one knows what effect that action had on the decision, but it presented concrete evidence of the boosting of the morale of the workers through safety work.

The Question of Employment Management

Turning for a moment to employment management, and asking your pardon for a bit of personal reference to illustrate exactly what has been the change in employment methods, I will cite the circumstances of my first employment. I went to work in a steel mill during vacation time when I was thirteen years old. I reported to the engineer and he turned me over to his assistant. The assistant said, "Do you know anything about oiling?" I have said that I was thirteen years old; naturally I knew everything about anything. He said, "All right, here is the cylinder oil, and there is the beeswax and some sand. Here is a ladder. Go to it!" And that was the extent of my instruction in oiling.

The third day I was on the job we had a fire caused by an overheated bearing. I discovered the fire when it first started, threw a bucket of sand on it, and put it out, and by the time the boss got there I had the oil cup in securely, had it full of oil, and was working away with a wire. I told him the oil cup was plugged up. I got away with it. (Laughter.) Quick thinking once in a while will save you your job, you know.

The day following the State Factory Inspector came through and asked me my age. I told him I would be fourteen the next December, and he said "There is a state law that says no one shall be employed until he is fourteen," so I had my first experience of being fired. But I still have distinctly a feeling of horror as I think of the days that I climbed on a rickety ladder, unsafe as unsafe could be, up to a high-speed shaft. In those days we oiled while the machinery was in motion, and the high-speed pulley on one side of me without any protection whatsoever, and couplings and collars on the shaft, had projecting set screws and bolts galore. There was absolutely no thought given to safety.

I well remember the first day I was on the job. An emery-wheel explosion occurred. It was frequent in those days, just as frequent as crane runway accidents were, and those things that you don't hear of any more.

And I also think of the possibility of a great financial loss through the neglect properly to educate a new man in a rather important and dangerous job. If that fire hadn't been discovered within the first five minutes it would have swept through the shop.

Procedure of a Present-Day Employment Manager

Contrast that with the employment program in effect in many shops today. In every well-managed institution there is an employment manager, not necessarily known by that title, but functioning as such anyhow, to whom a request to fill the vacancy of oiler would be referred. In my own case my reception at the gate was somewhat individual, because my father was employed at the plant, but if there had been a vacancy, and no one who was known personally was available, the assistant engineer would have gone to the gate and picked a man from the waiting crowd, and a crook of a finger would have put that fellow on the pay roll. The paymaster would have been informed that this man was oiling.

Today there would be a process of selection. Instead of the group hanging around at the gate, there would be a well furnished employment office with a waiting room, and when the request for an oiler was received by the employment manager, he would go out and seek a man who had some experience or who was adaptable for that position, and he would also know in full the duties and just what specifications he would have to meet in getting the right man for that job.

If the man whom he chose were a foreigner that man would be interviewed across a desk by a man who could talk in his own language, and be invited to tell in full his past experience. If he lied about it, that would show up in the replies to the letters of investigation that are sent out as a rule.

I am not one of those who believe that the employment manager is the final judge of the fitness of a man for the job, I think that rests wholly in his performance on the job, and the foreman is probably the final judge there, but certainly the employment manager can by intelligent first sifting, by coarse sifting, get rid of many palpably undesirable applicants. The applicant who seems after that sifting to be the man for the position would then be given a complete physical examination, not necessarily to reject him if physically impaired, but to make sure that he would not be assigned to a job that would further injure him if he had any physical disability.

If he were acceptable after that physical examination he would probably be told something of the policies of the company; be given an introduction to his employer—the corporation—and be told of its safety program and handed a book of rules of conduct. He would probably be told that this rule book was made up by the Safety Committee, employees in the shop, and that if he didn't fully understand it and wanted to quiz anybody on it he had only to seek the nearest old-timer who had been concerned in the revision of the book, and he would be given full and complete information. Undoubtedly, he would have greater respect for the rules when he learned that they were made by the men themselves.

Then he would be told of the promotional opportunities,—that it was the policy of the company to promote from the ranks, not to hire anybody at a given wage unless they were satisfied that nobody then in their employ at a lower wage could be promoted to fill that vacancy. He would be quizzed particularly as to his ambition. What did he want to be? He would not necessarily be put upon the job as an oiler permanently, but in an efficient filing system for recording applications his ambition would be registered. If he aspired to be a machinist and had stated that he had had certain experience as a bench hand and was attending night school, that would be recorded; and later, when a machinist was desired, preference would be given those applications from employees already in the service. Probably at that time the employment manager would send for this chap and say to him, "When you first went to work here six months ago you were put on as oiler. I understand you are still doing it, and you said you were going to night school to learn to read blueprints and take up manual training, and so on. Just how proficient are you as a machinist? Now I have a vacancy and you might be of use." And possibly he would be fitted into that job.

When he was hired there would be entered on his employee's record card a pretty complete history of him, his social condition, whether married or single, how many children he had, just how many dependents he had, where he was born, his age, his schooling, his military service, if any, whom to notify in case of sickness, result of physical examination and so on, for statistical purposes and then he would be sent to the job on sort of a personally conducted tour. He would be taken by an agent of the employment office, watchman, or special guide, and first shown the gate nearest his work so that any unnecessary hazard of

traveling through a long plant might be avoided in coming to work.

In the meantime, if he were a single man he would be assisted in getting a proper boarding house. If he were a married man, temporarily located in a boarding house, the employment agency would probably show him a map of the vicinity of the plant and the desirable residential districts for his type, and give him a list of reputable real estate men as an assistance to him in locating permanently, and show him the street-car lines whereby he might best get to work. Finally, when delivered to the foreman for whom he was to work, he would be introduced by his own name and learn the name of his foreman. Nowadays, the worker, whether he be foreigner or American born, is introduced to his foreman by name and the guide makes sure that they understand each other.

The foreman probably repeats "John Sobrinski—did I get it right? Well, my name is John Smith. I am your foreman." And the last word of the personal guide is, "The labor supervisor particularly requests you, Mr. Foreman, to give this man any special introductions necessary in the particular hazards of his job." And then and there the foreman, either himself or through a fellow-workman, tells this man something about his job, and introduces him by name also to one or two of his neighboring workmen, so they will know each other, and the man can go to his fellow-workmen and seek and get information.

I know all of us here have probably been on a new job at least once in our lives, and I don't care how brazen we may have appeared then or how brazen the foreign workman or laborer may appear when he first goes on the job, yet down in his heart there is a certain shyness and a certain craving for fellowship, a desire to have somebody that he may know by name, that he could go and ask a few questions of. This feeling exists just as much in the heart of the laborer, be he foreign or American born, as it did in our hearts when we went to work in a strange place.

Some employment agents go still further, and during the process of hiring a worker give him a movie show picturing the complete operation of the plant—taking it from the receipt of the raw material, through the various manufacturing processes, on through shipping, just as general as it may be or just as complete as it may be in the space of time available, and increasingly that time available is lengthening.

We used to brag in employment management about hiring a man in a minute, or half a minute, or in a number of seconds, or about the number we could put to work in a year. But that has changed; now we are beginning to boast of taking an hour and a half, and even a week and a half to put a man properly on his job.

Now, it doesn't need anything more than an appreciation of that contrast to bring to your mind how well sold a man may be on his job, how much he may be made to feel that he is a constructive part of that establishment, if he is put to work by the modern method, as contrasted with the former. If when he is put on the job the foreman calls his attention to the movie pictures of the particular operation that he is engaged in, and if it only be wheeling cinders away from the central boiler plant—if he is told at the time that that is the central boiler plant that furnishes the power to run the plant that does the things that he saw in the movies and that these cinders are the refuse from the boiler that generates all that power—then and there he links himself to the plant as a constructive force, as an important part of that machine, and that is very necessary if we are going to settle this unrest that we now feel.

The unrest in industry today is evidence of a social, a political unrest that must be met freely and frankly and squarely and corrected. In fact, it is manifested as Bolshevism in its ultra-radical form. It is no less than that. Probably when the history of the Bolshevik movement in Russia is finally written, and we know just what its causes were, it may be found that a large contributing cause was the fact that the citizens of that country had no part whatever in their government. Things were done *at* them and *for* them, but never *by* them. They were never taken "in on the know."

And while it is possible that their condition as citizens of that country under despotism was as good, their living conditions and all other conditions just as fine as they themselves might have done through democracy, they never had that feeling because they had not been consulted. It is simply a statement of basic psychology to say that we are only mildly interested in the things that other people are doing for us, but we are intensely interested in the things that we are doing for ourselves.

Going just a little further, if we have seen, as in the safety movement, the efficiency that may be gained through consulting the workmen themselves on such a matter of common interest, isn't it perfectly logical to go to the men themselves for consultation on other problems of mutual interest—recreation, sanitation, health, and then the controversial matters of hours and wages?

It has been stated by Professor Hoxie that naturally the aims and purposes of employee and employer are antagonistic; that the employer seeks long hours and low wages as a means to a low cost of output, and that conversely the employee is constantly seeking shorter hours and higher wages, which must necessarily mean a decreased output.

There is abundant experience in the industrial world today to show that the reduction from twelve hours to ten hours in the length of time employees are working has not decreased production—that the reduction from ten to eight hours has been accomplished in factories without any decrease in the output, and that today reductions are being made from nine to eight hours without any decrease in the output. Shorter hours do not necessarily mean reduced output. Neither do higher wages necessarily mean increased cost, if they mean a higher standard of living, a better mental and physical development. I firmly believe that there is a common ground upon which employer and employee can meet for the consideration of their problem, and it need not be a controversial affair either in the consideration of wages and hours any more than any consideration of safety or health or recreation or plant canteens or anything of the kind.

The International Harvester Company's Plan of Employee Representation

Our plan is known as the Harvester Industrial Council plan of employee representation, and was offered to the employees of the company on March 12 of this year. It was a frank invitation to them to participate in the determination of the policy of the company on all matters of mutual interest, including wages and hours, on an equal basis. They were invited to elect, by secret ballot, one-half of the membership of a works council whose function was to determine the policy of the company on the various items I have enumerated. The management appointed the other half of the membership. A guarantee of equal participation was had by the adoption of a unit ballot system. There are only two ballots cast. A majority of the employees' section determines their attitude and casts a unit ballot, as also does the majority of the management representatives.

These unit ballots have the same value, regardless of the number present on each side. The employees are guaranteed the right to a free performance and a free action in all of their activities as employee representatives. If there is any question of discrimination on their part, they may appeal directly to the president, and if not satisfied with his adjudication of the matter, it may then be arbitrated upon the selection of an arbitrator, mutually agreeable, whose decision would be binding upon both parties.

The plan was not put into effect at any plant which did not vote by considerable majority for it. It was first offered at the seventeen American and three Canadian plants. It was adopted at seventeen and failed of adoption at three. The day after the failure to adopt at these three plants petitions were circulated asking for another ballot and an opportunity of coming under the plan. The statement was made that the employees did not fully understand the plan on the previous day because it was written only in English. We have since published it in foreign languages because the employee representatives find it exceedingly difficult to convince foreign-born employees of the exact meaning of a certain clause if they themselves have to translate it.

We also made an error in the form of ballot. We use a ballot

stating "For adoption. Against adoption." We had some very good friends on the outside of the plant who were working against that plan and they told many employees, many foreigners, to vote on the bottom line, and when they saw the phrase "Against adoption" it did not mean anything to them and they voted according to instructions on the bottom line.

There was no positive effort on the part of the company to "sell" the plan. It was simply a dignified announcement. Each employee was furnished with a copy of the plan with a short résumé of a facsimile of the ballot, and asked to indicate, after three days of consideration, his wish for or against it. At the present time we are operating in nineteen of the twenty plants of the Harvester Company under this plan.

Another fundamental included in the plan is the guarantee of the protection of the employee against any discrimination because of race or sex or membership in any religious body or labor organization.

Function of the Works Council

The function of the works council is limited to the determination of the policy of the company with reference to wages, hours, recreation, health, sanitation, restaurants, and other matters of mutual interest. A policy having been determined, its execution lies wholly with the management. But the manner of execution being open to question at any time, it may be brought up through the works council. In other words, we have given to the employees equality in participation in the legislative and judicial functions, but not with reference to the executive. That, we believe, still lies wholly with the superintendent and foreman, and it is further accented in the procedure in bringing matters before the works council.

The plan states that any employee desiring to bring a matter before the works council shall present it first to the secretary, who shall ascertain whether it has been presented to the superintendent through the regular channels. If this has not been done, he shall see that it is done promptly. If the adjudication of the matter by the superintendent is not satisfactory to the employee or employee representatives, it then and then only comes before the works council. It must be presented in writing by the secretary to all members of the council at least three days before a regular meeting. The decision of the works council is final and binding.

When it agrees upon a matter—and it can only function through an agreement because the two ballots cast in opposition to each other completely deadlock the decision of the works council—it is forwarded to the superintendent for execution. In case the council deadlocks, it is then in order to reopen a discussion or propose an alternative or compromise resolution. If the deadlock still continues the matter is then referred to the president of the company, the highest executive officer, who is given ten days in which to propose a settlement acceptable to the majority of the employee representatives.

The General Council

If he fails to do that within the following five days he may elect to put it into arbitration direct, and arbitration is by mutual consent before a disinterested and non-partisan arbitrator, if one can be chosen. If not, each side selects one. If they agree, the matter is settled and their decision is binding and retroactive. If they cannot agree and choose a third arbitrator, a majority of the three is binding on both parties; or the president may elect to throw it before a general council—provisions being made that by such a reference, or in the event that a matter is introduced into a works council which is common to more than one other plant, the president may indicate the other plants which are interested, and call a general council of those plants, whereupon the works council originating the proposition ceases its consideration of the matter.

In a general council the employee representatives of each of the plants designated by the president send at least two of their representatives. For a general council they select one for each thousand employees or a major fraction thereof, but in no case less than two. The president names a number of management representatives, not greater than the total of employee representatives, and they function then exactly as the works council in regard to the method of ballot, etc.

Provision is made that either council may be recessed at any time and the employee representatives and management employees be privileged to withdraw and canvass their action. In a general council a recess may be taken to enable the plant representatives to consult with the other members of their works council. And provision is made, in order to do this, that the superintendent shall convene the works council in whole or any part of the employee representatives for conference with the representatives who have been elected to the general council. Their traveling, hotel and other expenses are paid while in the performance of this work.

After consultation with their plants upon a matter pending the general council may be reconvened, and decision is then binding upon all plants affected. Provision is made that all employees serving on the works councils shall be paid for the time they are so serving. They are privileged to call before them any employee of the plant to give testimony in a case under consideration, and the time of the employee so summoned is paid.

Provision is made, however, that in case it is not acceptable to the employee representatives to receive their money from the company, they are at liberty to arrange for a pro rata assessment of the employees directly. That was because of the objection which had been made by organized labor and other students of the subject to the general plan of paying employee representatives while serving as such.

Copies of the plan are available, and no less than 658 specific requests for them have come from other industrial establishments, from colleges and universities, from individuals, and from various sources.

Results Accomplished by Works Councils

We have been most agreeably surprised at the splendid results accomplished through these works councils since March 12, but surprised only at the rapidity with which they were accomplished, because there was no question in our minds as to what we would ultimately get.

There were elected by the employees 148 representatives in the 19 different plants. The average age of those employees is 38 years and 10 months. They are mature. A hundred and twenty-seven of them are married, and only 21 are single. Their average length of service is 7 years and 7 months, so they are relatively old-timers and mostly sedate married men. A hundred and two of them are native-born Americans, and 46 are foreign-born naturalized citizens.

Ninety-seven per cent of all of the employees who were present and eligible actually voted for or against the plan when it was proposed for adoption. The results at the various plants ranged from an almost unanimous vote for it to a vote of sixty to forty against it in two of the plants. One or two of the plants showed only a scant majority for the plan, considering the number of men involved, and we were somewhat puzzled at the time as to just what the result would be. For instance, at one plant the majority on the whole plan was only 200, and in one particular department—we will say the malleable foundry—the vote was 265 against the plan and 125 for it. And we thought that those 125 should be the only ones who would participate in the subsequent nominations and election, and we might then have a condition where only 65 of them would elect a representative for practically 400 men, which we could not feel was true representation. We were very much relieved, however, to learn that 98 per cent of all of the employees present and eligible actually voted at the nominations.

In the department just mentioned every man working on that day—nearly 400 of them—participated in the nominations, and again in the elections. On the final ballot for elections a nominating ballot was provided first in order that the elective representative might have at least a majority vote of his con-

stituents. It can easily be seen that if we had a department of 300 men and only one elective ballot and there were, say, 30 candidates running pretty evenly, possibly a man with only 25 or 30 votes would win the election. The nominating ballot makes it sure that at least a majority will be had by the successful candidate.

The average vote cast for the successful candidates at all plants was 68 per cent of the total, so that the winning candidates represented, or were elected, by more than two-thirds of their constituents. With a single exception, every local plant superintendent has written in response to an inquiry that if he had been permitted to select the employee representatives he would not have been able to choose a more satisfactory and more truly representative group than did the employees by their own secret ballot.

The Harvester Company has always operated under the open-shop principle, but a number of union men have been elected as employee representatives and are serving on works councils. Our experience shows that these men appreciate as readily as non-union employees the constructive possibilities of the plan and there is no indication that their participation in the co-operative activities of the council is not fully as satisfactory as that of the non-union representatives.

One of the first results under the plan was, naturally enough, a demand at several of the plants for shorter hours and increased wages. As one old-timer said, it looked very much as if the company was giving a sort of a Christmas party when it passed around those booklets saying that the works council would determine wages and hours.

With a single exception these requests were withdrawn voluntarily by the employee representatives upon presentation of the management's side of the case, which was to the effect that this was not an opportune time for such action—that the agricultural-implement business was a competitive industry. We were able to show that our wages and our rates were as high or higher than in similar industries in our own vicinity, and that only through constructive work in this council, through a greater efficiency in the reduction of the costs, would we be enabled to pay higher wages and still remain in a competitive market; and if they were willing to do their part we would do our part and exchange figures with them and show exactly what conditions were at any time, and when they felt that the time had come when we had better consider it again, we would do so.

In our experience thus far under the "Harvester Industrial Council" plan the works councils have been able to reach mutually satisfactory conclusions on all matters proposed with a single exception. That exception was in reference to a demand for a wages and hours revision, affecting about 25 per cent of the employees of one of the plants. The proposition as put up by the employee representatives did not meet the approval of the local management. After an extended discussion that was wholly friendly and frank, the ballot of the works council resulted in a tie. This was probably due to "an agreement to disagree," because both sides felt that the matter was one which could well be referred to the president for settlement and were entirely willing that this course should be followed.

Automatically the matter came before the president who was able to make a compromise offer to the employee representatives which met with their entire approval and at a special meeting, held four days after the original action had been taken in the works council, the proposal of the president had received the unanimous approval of the employee representatives and the matter was settled to the satisfaction of all concerned. In fact, it has resulted in a marked advance in the morale of the plant and the friendly attitude of the employees toward the council is doubtless more firmly established by the manner in which this matter was handled.

Probably 75 per cent of the actual business of the works council is translated outside of the regular meetings. Many suggestions or complaints have been brought to the attention of employee representatives and referred by them direct to the foreman or superintendent, who have promptly cared for the matter to the complete satisfaction of all concerned. This has been particularly true with reference to correction of ventilating equipment, improvement of shop practice, more convenient time of the weekly payday, occasional reviews of piece work rates and similar matters. This functioning of the council has been of especial value in acquainting the employees with the principles of time and motion studies, the reasons for adoption of certain shop rules, etc.

The employees have universally seemed appreciative of the opportunity to familiarize themselves with the facts as to any situation and have been exceptionally fair in passing judgment after complete discussion. They have displayed particular interest in production problems and seem to realize that the basis of larger returns to them for their labor lies in an increased production and more efficient operation of the shops.

Some of our plants are in the middle west side of Chicago, right in the heart of the radical district. Another in particular is out on the far south side, where probably you have read of race riots in Gary and Indiana Harbor and that vicinity.

I believe firmly that there is a well-organized propaganda on foot to start Soviet organizations in this country, and to play up the rebellious spirit in the foreign element in the vicinity of some of our shops.

The foreign members of one of our works councils desiring to meet this movement, asked for information which enabled them to get up a report showing the participation of the foreign-born employees in military service of this country. They drew parallel columns of the number of foreign-born employees per thousand of the men at the plant; and the number of each nationality per thousand who engaged in the military program. The average for the whole plant, of all the employees engaged who went into military service was 22 per cent. It was much higher at the other plants. The average of all the foreigners was 22.2 per cent, practically the same, but particularly the average of the Polish people against whom sentiment had been directed, and against whom a definite campaign was being waged in playing up their racial spirit, was 36 per cent.

The average participation of the Poles was greater than that of the Americans. And then they drew some conclusions: that the foreigner, while he was not a citizen, and therefore not bound by the same ties as the American, had contributed almost the same to the military program, and individual nationalities to a greater extent than had the Americans; that his contribution had really been much greater from the fact that he was not a citizen, not bound by those ties; and they drew the conclusion that the anti-foreign sentiment which was being engendered was all wrong and not justified by facts.

Now, that was done in the works council committee on publicity without any instigation by the management whatsoever. It was the thought of the men themselves as to how they might compete with this insidious and destructive propaganda.

Responsibilities Undertaken by Works Councils

We had a restaurant which was not very satisfactory. It was losing money for us and not getting the results which we wanted. We turned it over to the works council and the patronage has trebled since that time. It no longer shows a deficit. It was frankly and freely turned over to the men to manage. They hire their own manager, they make their own rules, they set their own prices, and they have learned something about the restaurant business that we wanted them to know, and something of its trials and tribulations, and we have "sold" the proposition entirely.

We have had one or two requests for reinstatement of discharged employees. We have functionalized employment bureaus and all recommendations for men on the part of foremen are reviewed at the employment office. There are no restrictions in our plan as to what may come before the works council. In two cases—the only cases thus far that have been presented—the works council by unanimous vote upheld the decision of the employment manager and refused to reinstate the employee who thought he had a just grievance.

The safety program has been rejuvenated. We thought we

were getting up efficient bulletins and we thought we were carrying our message all the way down the line. We thought that our safety program was satisfactory, and we couldn't go much farther with it. Since the inauguration of the works council, however, our accident-frequency rate has steadily fallen month by month. The character of the bulletins has changed somewhat. They are written in shop parlance, and by the men on the safety committees.

The sub-committee organization activities of the works council have been wonderfully well arranged by the employees themselves without any action of the management. They have unanimously said that they do not want a grievance committee. They do not want any committee on wages and hours. Those are subjects that they want to come out for a full discussion in the works council, and their reasoning was somewhat along these lines: They said, "If we had a grievance committee which only went to the boss on controversial matters, he couldn't help but get down on us a little bit, and believe that we never think of anything except how to make trouble. And we don't want to have that put up to just one or two men, we want the whole council to work on that; and then, too, we have this feeling that if a man comes to us with a grievance or a request for piece-work revision, or revision of prices or hours, we don't ourselves want to say to him, 'Well, you go over in the blacksmith department and see John Doe, because he is on that committee. We don't want to have anything to do with that.' Those are things they want us to get into, and if we do, we want to do it to our complete satisfaction."

The sub-committee activities, so far as grievances and hours and wages have been concerned, are always taken up by the council as a whole, and it has meant that no one or two individuals sat themselves up as business agents in the plant.

The question has been asked how much of this human relations problems lies within the field of the mechanical engineer. Engineering, to my mind, has been the consideration of an exact science, and these matters of personnel in the industrial sense are not reducible to stable factors at all. In the whole scale of industrial relations we are always dealing with the human being—a body with a mind, a creative force, and a soul, and therefore not reducible to any sort of stability as regards its valuation. You can't get up any sort of a formula which will solve a given condition, and repeat on it. And I don't believe the personnel problem ever should be treated as a science and coldly analyzed or formulated.

I believe that its direction and its constant progress should be made by men, not necessarily technical in their education, although we do need the assistance of every bit of science that can be brought to bear, but more particularly men who are given over to the idea of real service.

There are many employment managers functioning today in splendidly furnished, mahogany-lined offices, and who receive the requisitions from foremen for help and who analyze the jobs' specifications quite technically, and select by means of phrenology, and goodness knows how many other "ologies," applicants from the waiting line, if there is such a thing, or by scientific advertising, if the waiting line is not there, and possibly fill those jobs.

But I believe the work is best done by men who forsake the office and don't hire through an employment window but get out and interview a man across a desk, and look upon him as another human being, one who is coming into a strange land, into a strange company, and make him thoroughly at ease; who will sell him his job as a constituent part of a great assembly, who will look after him, not in an apparently disinterested way, but in an atmosphere of good-fellowship after he goes to work, and who will look upon his problems with a light of experience and know exactly, or nearly exactly, what his thoughts are, what his suspicions are—and those I do not think can be had by a science as well as by experience.

I think the employment engineer of today—the personnel manager of today—should first of all be chosen on personality. That is certainly more than fifty per cent of the necessary make-up. He should be of an engaging personality, a man who can converse with other men and get them in turn to converse with him; who has a sympathetic ear; who has a certain poise; and withal, who is a good, keen judge of human nature. And then on top of that, as much technical training as he may have.

The direction of the movement lies with all of us, for back of it all is this industrial unrest, a manifestation of political and social unrest, and it concerns every one of us as citizens that American industry shall do business on the square, that the structure of American industry shall be fundamentally sound, and that the correction of any improper practice and wages and accidents and conditions may be had through the instrumentality of collective bargaining and simply changing the conditions themselves that are causing the unrest, rather than by completely overthrowing the structure.

It is then, I believe, that we will have exercised an important reaction upon the community as a whole, and that that reaction will be manifest in keeping from our shores this menace of Bolshevism which now looms black on our horizon.

MOTOR GASOLINE

Information regarding the desirable properties of gasoline and the best methods of testing it are contained in the Bureau of Mines Technical Paper 214, written by E. W. Dean.

The desirable properties of gasoline are summarized as follows:

1 The gasoline should not contain too large a percentage of highly volatile products, which tend to cause large evaporation losses and excessive danger in handling and storage, but should have enough volatile constituents to permit starting an engine under reasonably unfavorable conditions, without preheating.

2 The gasoline should not contain any considerable percentages of heavy or non-volatile constituents, which after atomization into the engine cylinders cannot be completely vaporized and burned.

3 The gasoline should not contain material that after combustion leaves a residue that collects in the motor.

4 The gasoline should be free from substances that attack metal, either before or after combustion. Unremoved acid (used in refining) falls under this head.

5 Neither the gasoline nor its products of combustion should have a strong or markedly disagreeable odor, as this is objectionable to users of automobiles.

6 The gasoline should be free from non-combustible material such as water and sediment.

As already stated, the Bureau does not believe that one set of specifications is satisfactory for all needs. The following system is suggested, however, as a simple and satisfactory scheme for regulating the quality of ordinary automobile gasoline:

Color. Water-white—to be determined by inspection of the vertical column in a 4-oz. sample bottle or 100-cc. graduate.

Acidity. Total absence of free or combined acid—to be determined by testing with any satisfactory indicator, the water extract obtained by shaking thoroughly with 1 cc. of distilled water the residue in the flask after completion of an analytical distillation.

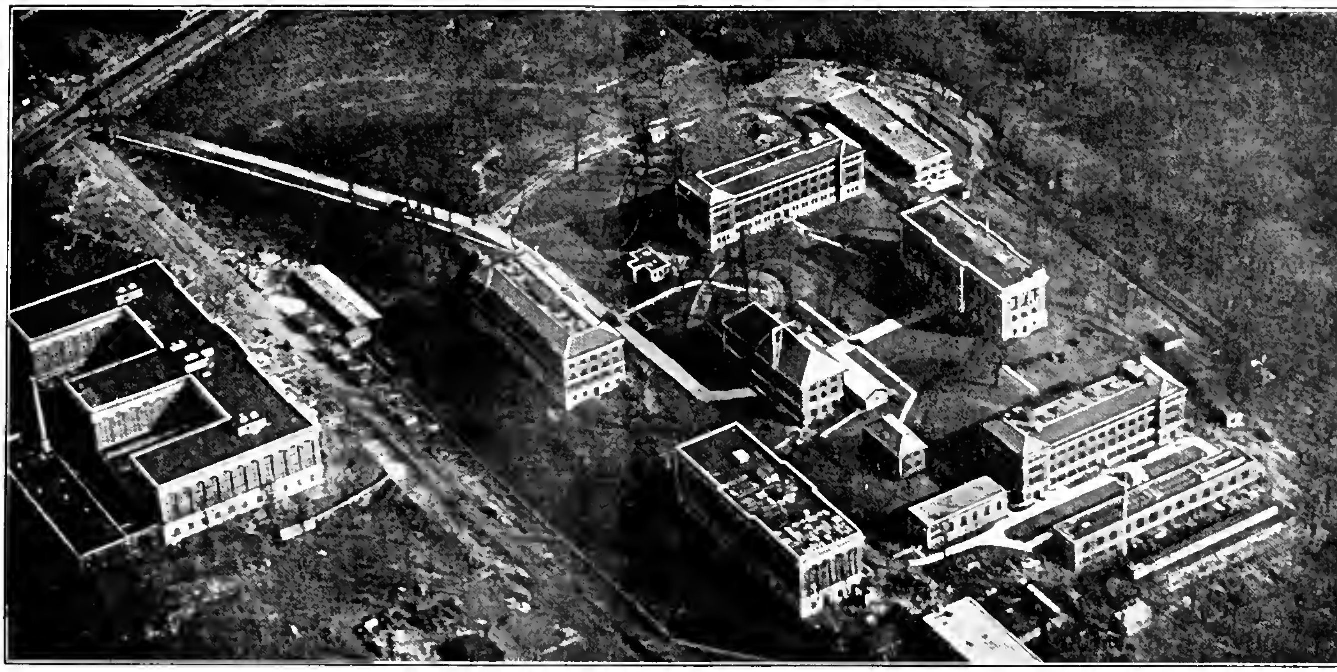
Volatility. The Bureau recommends a method of distillation similar to that adopted by Sub-Committee XI of Committee D1 of the American Society for Testing Materials (see A. S. T. M. Yearbook for 1915, pp. 568-569), the only two noticeable points of variation being the manner of reading temperatures against fixed percentage points and the use of a thermometer of lower range. The requirements for volatility are that when gasoline has been distilled by the bureau's method it should meet the following requirements:

a The temperature read on the thermometer when 20 per cent has distilled should not be below 70 deg. cent. (158 deg. fahr.), nor above whatever limit is fixed after due consideration of conditions of use.

b The temperature read when 90 per cent has distilled shall not be above another limit similarly chosen.

c The temperature read when 50 per cent has distilled shall not be higher than a mark halfway between the upper 20 per cent limit and the 90 per cent limit.

d The dry point shall not exceed the 90 per cent limit by more than 40 deg. cent. (72 deg. fahr.).



BUREAU OF STANDARDS, WASHINGTON, D. C., TAKEN FROM AN AIRPLANE

Condition of Research in the United States

BY ARTHUR M. GREENE,[1] JR., TROY, N. Y.

This paper, by the Chairman of the Research Committee of the A.S.M.E., deals with the conditions under which research is now being carried on in the United States. The author first discusses research in its relation to the technical school and engineering experiment stations. Cooperative research and the research activities of the Government are next presented and finally the author considers commercial and industrial research work. The complete paper contains lists of the educational institutions having mechanical engineering laboratories, of the private research laboratories and of manufacturing companies having their own research facilities.

HISTORY records the development of science from fortuitous observations and from systematic, careful and exhaustive research. The work of the Greeks as shown by Lucretius on the constitution of matter could only have been made after a careful and exhaustive study of the laws of nature. The work of Hippocrates certainly indicates a previous study of anatomy and the action of certain drugs. The studies of Galileo and Newton, of Kepler and Herschel, of Watt and Stephenson, tell of careful thought applied to the interpretation of facts which led to the establishment of laws. The story of Berzelius and his kitchen laboratory illustrates the spirit of adventure into the unknown which brought to us our early quantitative knowledge of the elements. The accidental observations of Galvani, Newton, Bell and Crookes by future development and study led to results of incalculable value to science, while the theoretical studies of Kepler, Maxwell and Hertz predicted results which in giving confirmation to theory gave also confirmation to the correctness of experimental observations.

Although all past ages have had men devoted to research, they are not numerous in any one period. If there is one thing, however, that marks the present epoch, it is the prevalence of this idea. In the past, research was carried on by the few, but today as a result of education and as a result of the success of research in many fields one can scarcely read a periodical of any branch of science without finding some article on this subject. For the last fifty years the commercial value of research has become more and more evident to industrial plants. This appreciation has been coincident with the growth of these plants and has made their development possible, while reciprocally the growth of the plants has made extensive research possible.

For many years our colleges and universities have had their laboratories where some research has been done, and with the development of our industries following the Civil War the necessity of commercial laboratories for examining or controlling products was evident. The search for knowledge by some of the investigators and the possibility of application of the results of their researches undoubtedly reacted, so that the laboratories of examination and control became laboratories for investigations in new and unknown fields.

Research work, quite general before the present war, became more extensive in overcoming the dastardly appliances of the Hun in devising new apparatus, products and manufacturing methods and in improving quality and production. The war has demonstrated, if demonstration was necessary, the value of research, and it is now the opinion of most of us that this stimulating viewpoint should not be lost and that the war-time interest should be continued.

Before discussing the matter of the physical condition of the various laboratories there are a few general considerations which should be mentioned. The cost of research in the past has been such that in many cases it could only be undertaken in an extensive way by large corporations. The necessity and value have been evident but the small plant has been unable to inaugurate that which it has known to be of value. In other instances there have been investigations which have been of such a nature that there would be no commercial gain from their results, although of great use to mankind. The necessity of such work has been clearly seen and appreciated by some, and in this country institutions and foundations have been established by public-spirited citizens to carry on investigations or to give grants to those who are

[1] Professor of Mechanical Engineering, Rensselaer Polytechnic Institute. Mem. Am. Soc. M. E.

Presented at the Spring Meeting, Detroit, Mich., June 16 to 19, 1919, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. The paper is here printed in abstract form and is subject to revision. Copies of the complete paper may be obtained at a nominal cost.

working on problems for the general good. The reference is to such organizations as the Rockefeller Institute for Medical Research, the Carnegie Institution of Washington, and the Sage Foundation.

A number of private commercial laboratories have been undertaking commissions for clients, but recently the plan worked out years ago by the Associated Factory Mutual Fire Insurance Companies of New England in their coöperative laboratory and the Insurance Engineering Experiment Station has been applied in the coöperative work of certain industries. These investigations have been undertaken by an industry as a whole or by group of manufacturers, and the results have been distributed among the contributors to the expense funds, or, in certain cases, the results of the experiments have been freely given to the world.

Research in Technical-School Laboratories

To turn now to the present research activities, let us consider first our universities and technical schools. The general equipment of the university laboratories is planned to give training to the undergraduate in methods and to illustrate certain laws. The engineering laboratories are equipped so that research work is possible, but in many cases the schedule for instruction work is so heavy that little or no research work can be done. Nevertheless, under these adverse conditions some work of great value has been produced during the last thirty years in the technical schools by faculty members, graduate students and even by undergraduates. The lack of time for experimentation has been cared for in the engineering experiment stations by the employment of full- or part-time investigators. In this way work can be carried on continuously to a conclusion. At present the disorganization of these laboratories by war activities has caused most of the work to cease. A return to normal conditions, however, is looked for within a year. The laboratories of chemistry, physics, biology and the other sciences have been doing much graduate research work. This has been of a theoretical nature rather than of the applied form of research more evident in our engineering laboratories. The small number of graduate students of engineering has partially accounted for the limited amount of research from the engineering schools.

The equipment of these technical schools is usually quite diversified and adapted for research work of a varied nature. The equipment has been planned in many cases for certain problems and in some instances contributions have been made by some associated industries for equipment to make investigations of problems of that industry. Thus, at Johns Hopkins University the gas interests in and around Baltimore donated a fund for the equipment of a laboratory to study gas manufacture and its by-products. At the Carnegie Institute of Technology at Pittsburgh a laboratory for rolling-mill research and instruction is being established from funds which are contributed by a number of steel manufacturers.[1]

One of the great needs of the present time as voiced by directors of a large Government laboratory and of a large commercial laboratory is the need for more research men. Research demands a man of clear vision, great imagination, tremendous resources, absolute honesty, good training and devotion to work. The love of the work will have to be the incentive as in many cases the monetary returns are small. If our colleges of engineering and science could by some means instill into more men the great desire for discovery through research, they would aid much in the contributions of this age to the future. Training is also necessary, and that should be done by men engaged in research.

Engineering Experiment Stations

To aid the work of research for the industries and manufacturers by supporting men on whole or part time to carry out investigations, engineering experiment stations have been established in many state universities. These have been active and the development of such institutions is considered by some to be of such national importance that several bills have been introduced in Congress for Government aid in establishing them throughout the United States.

The Engineering Experiment Station of the University of Illinois, organized in 1903, usually comes to mind when discussing this question, although there are fourteen such stations at other state universities. The Engineering Experiment Station of the University of Illinois up to January, 1919, has issued 110 bulletins and 10 circulars on its researches. Twenty-eight of these deal with structural problems, 28 with problems relating to fuel, its mining, storing, combustion and analysis, 10 with problems of mechanics, strength of materials and machine design, 14 with heat problems and 11 with problems of electricity and electrochemistry. These papers are sent free of cost to interested parties in some cases, and in other cases a nominal charge is made.[2]

Coöperative Research

While discussing the subject of the experiment station, the possibility of the coöperative research as shown by present conditions and the different methods of solving this problem should be mentioned. The problems of hot-air furnace heating have been solved by empirical rules which have had little if any scientific foundation. An association of builders of hot-air furnaces has granted the Engineering Experiment Station of the University of Illinois certain funds of money to finance an investigation of these problems, the results of the investigation to be made public at its conclusion.

The problems of metal rolling are complex and have been studied in the past with difficulty because investigations must not interfere with production. The coöperative plan of equipping a full-size rolling mill at the Carnegie Institute of Technology equipped with special apparatus for varying conditions and making quantitative determination of different data exemplifies what is being done by another industry.

The Mellon Institute of Research of the University of Pittsburgh is unique and illustrates a development of research by funds contributed to a laboratory by individuals, corporations or industries for the solution of problems confronting them. The Institute was organized about thirteen years ago by Dr. Robert Kennedy Duncan, and the contribution of funds for the support of the research was continued by each contributor for one or more years. The money so received served to pay the salary of the man or men on a special piece of research work and to pay for very special apparatus. The Institute houses the research, furnishes ordinary supplies and apparatus, affords library and consultation facilities and directs the work. The investigations are made for the donor and the results belong to him. At present the work is under the charge of a director, acting through two assistant directors in charge of the fellows on individual and multiple fellowships. In the Institute a method of developing complete unit experimental plants to study processes for certain donors has been used. In this way commercial processes have been developed from laboratory research in a way not done in many other research laboratories.

A list of coöperative efforts in research must mention the work of the laboratories of the Factory Mutual Fire Insurance Companies. The work of this association has covered many years, some of its bulletins being issued over thirty years ago. Many papers and discussions were contributed to the early Transactions of this Society from its staff.

Government Activities in Research

The Bureau of Standards at Washington and Pittsburgh, the laboratory of the United States Geological Survey at Pittsburgh, the Food Laboratory and Forest Products Laboratory of the Department of Agriculture and the Naval Experiment Station at Annapolis, are a few of the Government activities interested in research.

[1] A list of 78 educational institutions having mechanical engineering laboratories is given in the complete paper.

[2] A list of 14 universities having engineering experiment stations is given in the complete paper.

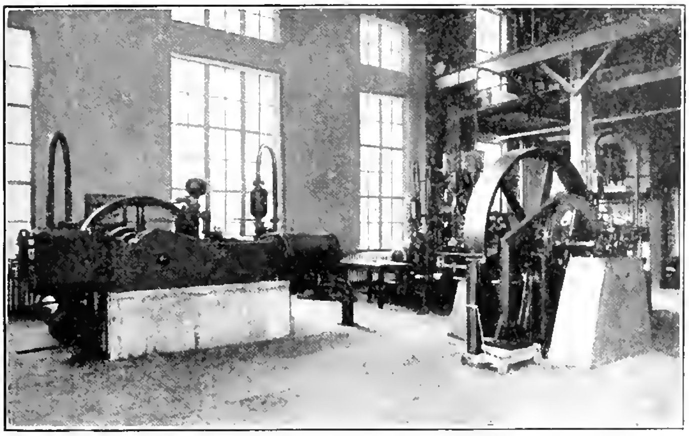
At the Bureau of Standards research work is being done in physics, chemistry, metallurgy, manufacturing and engineering. There is hardly a branch of human endeavor which is not touched by this enormous research laboratory. In 1917-1918 there were over 1400 employees connected with the Bureau, and accounts aggregating more than $3,400,000 were handled. During this year the Bureau issued fifty-three publications, and these may be obtained through correspondence.

The primary work of the Bureau is the definition and fixing of standards of measurements, standard constants, standards of quality, standards of performance and standards of practice, and to do this they have divided the scientific and technical staff into a division of weights and measures, a division of heat and thermometry, an electrical division, an optical division, a chemical division, a materials division, an engineering research division, a metallurgical division, and a ceramic division. Each division is under a Chief of Division, and under him there are numerous experts and assistants. The Bureau feels that its function is one of service to the nation, and it endeavors to aid all who apply for information or guidance.

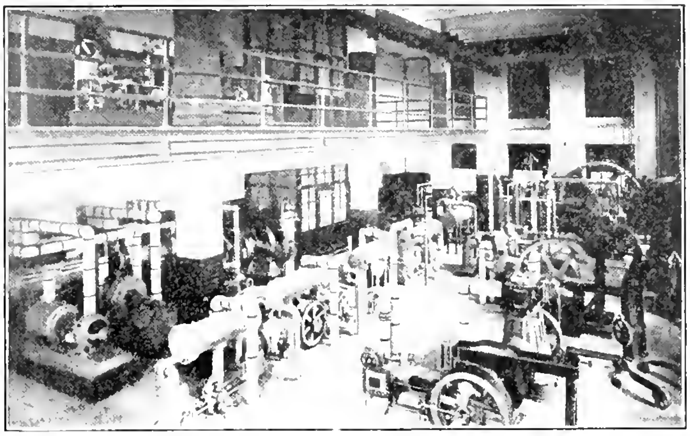
The work of the Gage Section of the Bureau of Standards during the recent war activities must be remembered as of the greatest importance. This department undertook to regulate the gages used in the various manufacturing plants through its headquarters in Washington and its branches in the East and the Middle West. The Section has developed instruments for testing screw-thread gages for profile and pitch, instruments for end measurements, and, in fact, it is prepared to test any commercial gage or templet for accuracy. The Section has studied the salvaging of gages and is vitally interested in the problems of duplicate production.

The activities of the laboratories of the Geological Survey and the Department of Agriculture are devoted to their special fields of endeavor, and in each case scientists of training and experience are in charge of the research.

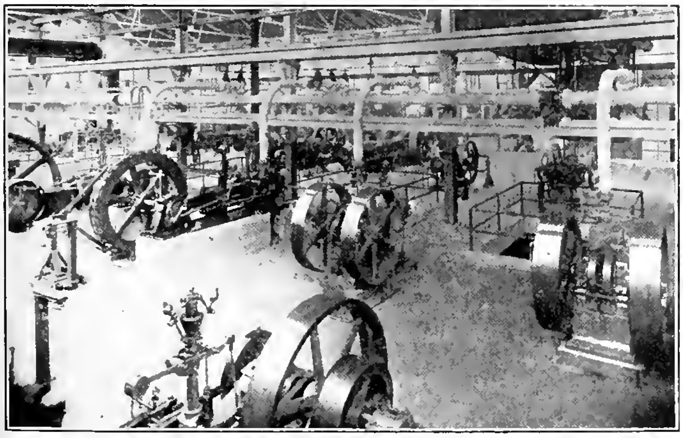
The U. S. Naval Experiment Station at Annapolis, Md., is used to study the apparatus and materials used by the U. S. Navy or certain Government bureaus. The work consists in making tests on these, and in addition researches regarding the general laws underlying the apparatus have been undertaken. The Station is well equipped with apparatus and an excellent staff. The work of the Station is for Government information, but frequent papers by members of the staff appear at times before various technical societies.



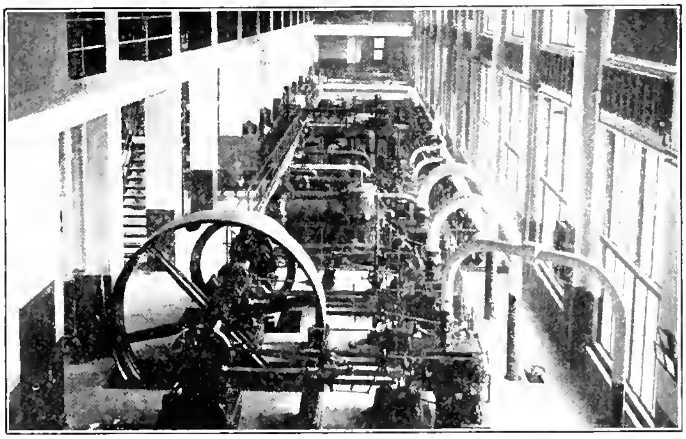
JOHNS HOPKINS UNIVERSITY



RENSSELAER POLYTECHNIC INSTITUTE



UNIVERSITY OF ILLINOIS



MASSACHUSETTS INSTITUTE OF TECHNOLOGY

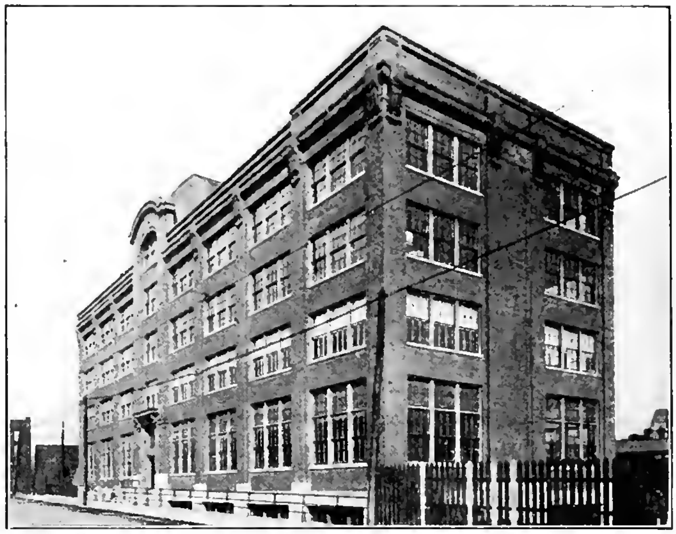
MECHANICAL ENGINEERING LABORATORIES OF TECHNICAL SCHOOLS

The Forest Products Laboratory of the United States Department of Agriculture at Madison, Wis., is devoted to problems relating to the applications of forest products.

The Watertown Arsenal is equipped for research in materials of engineering. The reports from this laboratory have been for years the source of many data on the strength of materials. The Philadelphia Navy Yard is equipped for research in fuel oils, while the Washington Navy Yard is equipped for testing ship models, propellers, airplanes and air propellers. The wind tunnels and testing basin are of special merit.

The research activities of the American Society of Heating and Ventilating Engineers in connection with the Pittsburgh Laboratory of the United States Geological Survey is important and illustrates the activities of certain groups of scientists and engineers. This society plans to make researches regarding problems arising in its field of endeavor for the benefit of the profession and the public. In this project the expenditure of $20,000 per year for a number of years is proposed.

Laboratory of the General Electric Company



Laboratory of the Pennsylvania Railroad

Commercial Research

The private research laboratories of the country are primarily devoted to investigations of materials for commercial purposes, to check products or raw materials or to improve the product. These are quite numerous, and the list of laboratories given in the complete paper shows in a partial way the private research resources of our country. Much of the work done by these laboratories is of the nature of inspection, but in many of them the commissions undertaken for clients have been of a true research nature, in finding the cause of defects, the methods of improving product and in some cases planning actual production methods or processes. Many of these laboratories have been in existence for almost a half a century; others have been developed in the last decade from a local need for such institutions.

The work of these private laboratories covers all fields of investigations and new equipment is obtained in many cases for special investigations. In some cases a laboratory has been specializing in problems of a definite character and its equipment for this work is expensive and complete.

Industrial Research

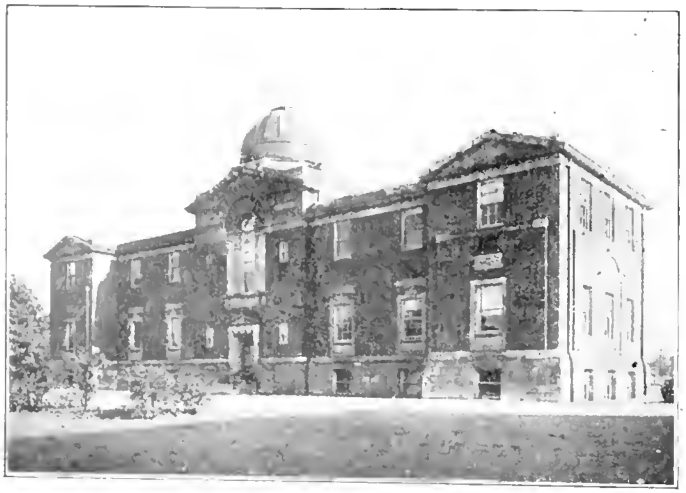
The last division of research activities is the one which undoubtedly represents the largest expenditure of money for operation, maintenance and equipment. It is the one including the various laboratories of the manufacturing plants of the country.

These laboratories occupy two fields, one the examination, inspection and testing of raw materials or finished products, in which the laboratory is called in many cases the test laboratory; the other concerned in determining physical and chemical properties and constants of materials, the investigation, development or invention of new methods, processes of manufacture, or even of products and the testing of these new schemes, in which case the laboratory is termed the research laboratory. In many instances the test laboratories are devoted to routine work, while in others researches of importance are carried out in the test department. In some organizations the laboratory combines both features under one head.

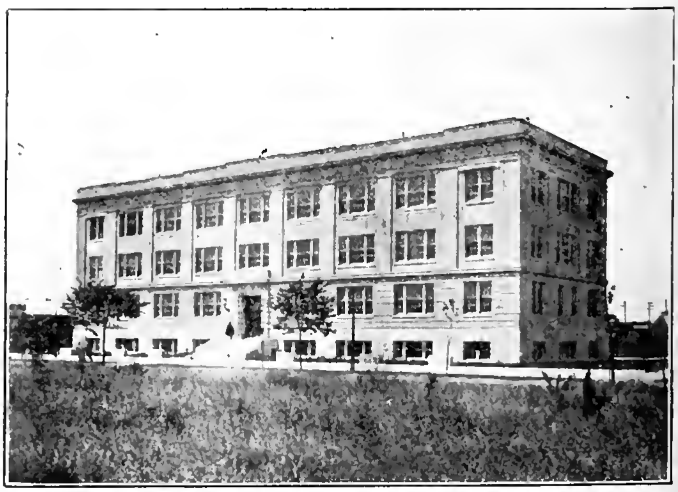
One of the oldest and largest of the laboratories of the corporations is that of the Pennsylvania Railroad at Altoona, Pa. It was established in 1874, and at present its staff of workers is over six hundred men, half of whom are engaged in inspection work. The expenses of this laboratory are about $500,000 per year, and the work of the department is the preparation of specifications for materials and supplies of the Pennsylvania System.

The locomotive testing plant, which was such a prominent part of the St. Louis Exposition, has been used at Altoona for further work in locomotive research. For studying problems on the road a dynamometer car is used by the laboratory. A unique part of their equipment is a laboratory car which may be sent to various parts of the system for the solution of local chemical problems or for other purposes.

The laboratories of the Westinghouse Electric and Manufacturing Company at Pittsburgh, Pa., and of the General Electric Company at Pittsfield, Harrison, Cleveland, Lynn and Schenectady, represent the large laboratories of the manufacturers of electric apparatus. In both of these companies the main research

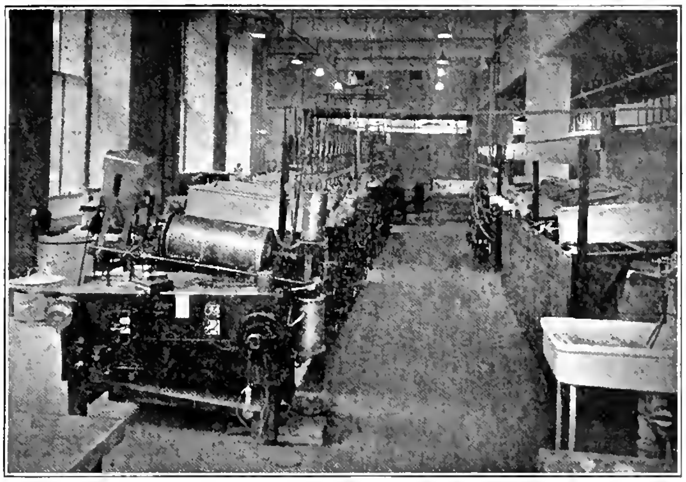


Laboratory of the National Lamp Works



Laboratory of Arthur D. Little, Inc.

Physical Laboratory of the Pennsylvania Railroad



Section of the General Electric Laboratory

laboratories have forces of more than one hundred men, and the budget of each amounts to $500,000 per year.

In the Schenectady plant of the General Electric Company the department of tests is independent of the research laboratory. The research laboratory is devoted to problems of the development of new materials, processes and apparatus, and, as its name indicates, its work is of a research nature.

Work in pure science, which at the inception has no commercial aim in view, is one of the activities of this laboratory and the publications of its results in the transactions of scientific societies gives evidence of such work. The results of these investigations in some cases have led to results of great commercial value—as in the case of the gas-filled lamp, which had its origin in a research on the laws governing the loss of heat from small wires coupled with an investigation on the evaporation of tungsten.

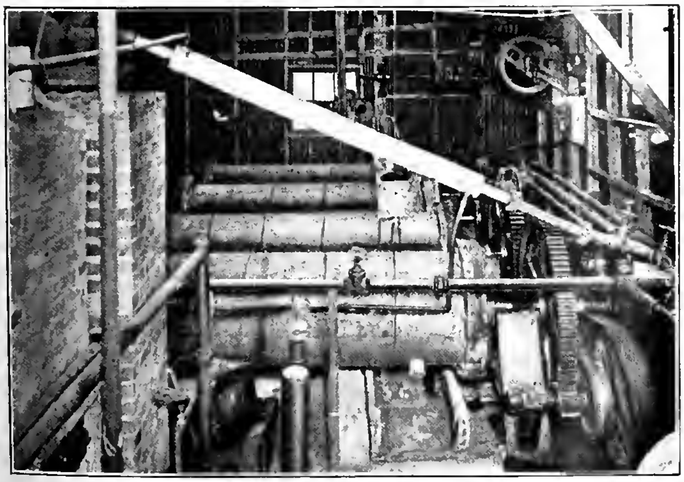
The research laboratory has as another of its functions the development of processes or of improved or new materials. The method of producing drawn tungsten wire, the production of insulating material, the improvement of transformer steel and the investigation of alloys represent certain of the problems of this laboratory. Here science has been applied for a definite commercial end. Another function of the laboratory is to make certain products for which there is but a limited demand. Thus the Coolidge X-ray tube, certain tungsten products and targets for X-ray tubes are manufactured in this laboratory.

The equipment of the laboratory is most complete for its activities. There are sixteen machines in its power plant giving power at different voltages and frequencies. Frequencies from 25 cycles to 2000 cycles may be had and by transformers voltages as high as 200,000 or currents of 12,000 amperes may be obtained. The building is piped with city water, river water, illuminating gas, high-pressure hydrogen, low-pressure hydrogen, oxygen, high-pressure steam, compressed air and vacuum suction and vacuum cleaning. Distilled water is supplied to any room by gravity, and liquid air may also be obtained. Various kinds of gas and electric vacuum and arc furnaces are installed in one part of the building. A furnace is installed for argon purification. Various crushers, grinders, rolls, punches and a 60-ton hydraulic press are installed.

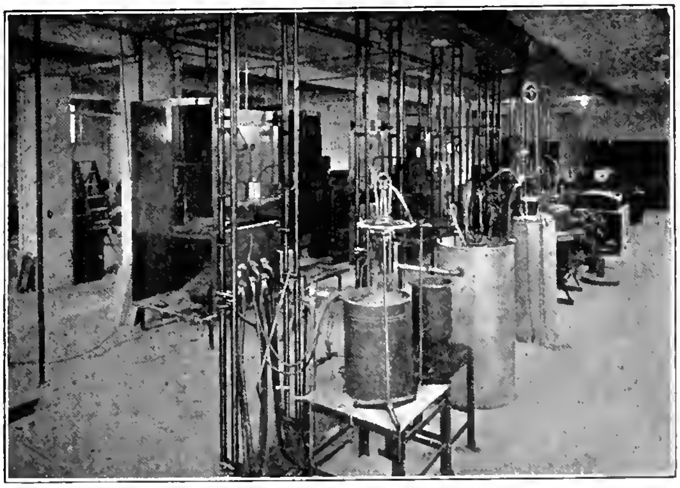
The illuminating laboratory, which is distinct from the research laboratory, is devoted to special problems in studying the best lighting units or methods of utilizing these units. The consulting engineering department laboratory, devoted to high-tension phenomena, the testing laboratory for materials, the standardization laboratory for instruments and the development of new instruments represent activities at Schenectady which are devoted to research in their commercial routine duties. Many engineering departments are constantly making investigations which are of a research nature.

The work at the laboratories at Lynn and Pittsfield is largely applied to the production problems of these plants, and at Harrison and Cleveland the problems of lamp production are studied. The problems of the Westinghouse Company are of a similar nature to those of the General Electric Company.

The research laboratory of the Eastman Kodak Company represents the research activity of another manufacturing corporation. The staff of this laboratory consists of about fifty men, some fifteen of whom are specialists. The budget amounts to more than $100,000. The work of the laboratory is devoted to physics, chemistry, to plant problems and new development. In



The Mellon Institute's Experimental Plant for the Treatment of Phosphate Rock



Metallurgical Laboratory of the Westinghouse Electric and Manufacturing Company

this laboratory full-size apparatus is used at times in making research. As shown by the equipment of many laboratories, the study of complete processes in the laboratory on a commercial scale is one of the features of the times. The problems of this laboratory are organic, inorganic and colloidal chemistry, optics, color photography, film products and applications of general photography, chemical products and emulsions.

The laboratory of the National Lamp Association, now the Nela Park Laboratory at the National Lamp Works of the General Electric Company at Cleveland, Ohio, represents one of the best-known research institutions of this country. The research work of this laboratory is devoted to the physics, physiology and psychology of light, the production, utilization and efficiency of luminous energy. In this laboratory, with a staff of eight investigators of the highest ability directing the work, all kinds of illuminating problems are studied from every angle. The laboratory has a policy of sending out its experts to study local conditions, and in many cases investigators from other institutions come to this laboratory to carry on research. During the first eight years of its existence from 1908 the laboratory has produced 125 high-grade papers. These are abstracted by the authors and the abstracts published at intervals. In having abstracts made by the authors the important points of the researches are sure to be covered.

The great extent of research facilities is disclosed by the list of laboratories used by the Research Committee. This list, comprising ninety-four manufacturing companies having research laboratories, will be found in the complete paper.

Still another agency which not only has been of utmost importance during the present war, but also in its continuance in the times of peace, will have a still greater influence on the developments in science and industry is the National Research Council, the purpose and work of which is best explained by the following executive order issued by the President of the United States, May 11, 1918:

The National Research Council was organized in 1916 at the request of the President by the National Academy of Sciences, under its Congressional charter, as a measure of national preparedness. The work accomplished by the Council in organizing research and in securing coöperation of military and civilian agencies in the solution of military problems demonstrates its capacity for larger service. The National Academy of Sciences is therefore requested to perpetuate the National Research Council, the duties of which shall be as follows:

1. In general, to stimulate research in the mathematical, physical and biological sciences, and in the application of these sciences to engineering, agriculture, medicine and other useful arts, with the object of increasing knowledge, of strengthening the national defense, and of contributing in other ways to the public welfare.

2. To survey the larger possibilities of science, to formulate comprehensive projects of research, and to develop effective means of utilizing the scientific and technical resources of the country for dealing with these projects.

3. To promote coöperation in research, at home and abroad, in order to secure concentration of effort, minimize duplication, and stimulate progress; but in all coöperative undertakings to give encouragement to individual initiative as fundamentally important to the advancement of science.

4. To serve as a means of bringing American and foreign investigators into active coöperation with the scientific and technical services of the War and Navy Departments and with those of the civil branches of the Government.

5. To direct the attention of scientific and technical investigators to the present importance of military and industrial problems in connection with the war, and to aid in the solution of these problems by organizing specific researches.

6. To gather and collate scientific and technical information at home and abroad, in coöperation with Governmental and other agencies and to render such information available to duly accredited persons.

Effective prosecution of the Council's work requires the cordial collaboration of the scientific and technical branches of the Government, both military and civil. To this end representatives of the Government, upon the nomination of the President of the National Academy of Sciences, will be designated by the President as members of the Council as heretofore, and the heads of the departments immediately concerned will continue to coöperate in every way that may be required.

The White House, May 11, 1918. (Signed) WOODROW WILSON.

The National Research Council was under the chairmanship of Dr. George E. Hale, with three vice-chairmen, an executive secretary, a treasurer and two assistant secretaries. The executive board, under the chairmanship of Dr. John J. Carty, consisted of the officers of the Council, the chairman and vice-chairman of divisions and the chairman of sections of the General Relations Divisions, together with six elected members. The Divisions of the Council were as follows:

1 The Division of General Relations
2 Military Division with its Research Information Service
3 Division of Engineering
4 Division of Physics, Mathematics, Astronomy and Geophysics
5 Division of Chemistry and Chemical Technology
6 Division of Geology and Geography
7 Division of Medicine and Related Sciences
8 Division of Agriculture, Botany, Forestry, Zoölogy and Fisheries.

Each division was divided into committees and sections, covering special features of the work. There were over one hundred scientists representing various technical and scientific societies, educational institutions, commercial laboratories and manufacturers.

The work accomplished by the Council during the war has been so important and many of the investigations and researches which were not completed gave so much promise for the future that the Council has been reorganized to continue its work for the furtherance of science and its applications.

Warping of Aircraft Propellers

During the war one of the greatest troubles experienced with airplane propellers was caused by the warping and twisting of the blades near the tips, and a large percentage of the propellers received at the front were rejected on this account. In order to determine the causes and to develop methods of preventing this trouble, a number of experimental propellers were manufactured for the War and Navy Departments by the Forest Products Laboratory of the U. S. Forest Service at Madison, Wisconsin. The propellers were made of Central American and African mahogany using carefully selected stock uniform in density and moisture content, and were stored under uniform atmospheric conditions for 30 days between the roughing out and final carving operations. After the standard finish, consisting of five coats of spar varnish, had been applied, they were again stored under the same conditions for observation as to warping and twisting.

These propellers were made up and handled much more carefully than the commercial product, and every possible effort made to produce perfect results. After exposure to a very damp or humid atmosphere for three or four months, it was found that every propeller had warped or twisted or otherwise changed shape to an extent that made them unacceptable for use. They had all absorbed about five per cent of moisture through the five coats of spar varnish, and this moisture caused all the trouble. The treatments to which these propellers were exposed, namely, being manufactured in a relatively dry condition and later exposed to moist atmosphere, is very similar to that which is normally received by propellers made in the United States and shipped to France. Frequently propellers are made in a relatively moist climate and shipped to a drier one, and trouble from change of shape due to drying out is almost sure to result.

These changes may be prevented either by applying a moisture-proof coating or by keeping the propellers under uniform atmospheric conditions throughout their life. At present, the aluminum leaf coating developed by the Forest Products Laboratory is the only practicable moisture-proof coating which has been successfully applied to propellers. It is not possible to keep propellers under absolutely uniform atmospheric conditions during manufacture and service, but these conditions can be approached by making up the propellers at the moisture content which they will normally reach in service. Propellers made up this way and coated with aluminum leaf have the best possible chance of giving high efficiency and long service.—*Technical Notes, Forest Products Laboratory, U. S. Forest Service.*

Research Work on Malleable Iron

By ENRIQUE TOUCEDA,[1] ALBANY, N. Y.

This paper contains an account of four years of research work undertaken for the American Malleable Castings Association as a plea for industrial research among manufacturers and as a striking example of what such research can accomplish. The author outlines the organization and purpose of the Association and shows how the quality of the product of its members has steadily increased since the beginning of the research work. Malleable-iron castings, due to lack of uniformity and dependability, were rapidly being replaced by other materials. There were many fallacious ideas and theories regarding the physical properties of such castings and the methods of annealing them. Records of tests of 1-in. bars from seven different concerns made by the author in 1911 showed that the average ultimate strength was 39,882 lb. and the elongation under 5 per cent. A report dated March, 1919, to the members of the Association, each of whom regularly submits test bars from some one heat of each day's run, showed that 44 per cent of the test bars submitted during that month had an ultimate strength over 52,000 lb. and an elongation of 14.67 per cent, indicating the progress made since research work was undertaken.

The records of tests also show that, contrary to generally accepted theory, the elongation increases with the ultimate strength. The purpose of the Association, however, is not to increase ultimate strength and elongation, but to increase the uniformity of a product upon which the engineer can rely, and this is being accomplished through exhaustive research and advice to members through the consulting engineer of the Association.

A description is also given of the process of manufacturing malleable iron, of the air furnace, and of the annealing ovens and the annealing process. In the complete paper there will be found a discussion of the structures of iron containing both free and combined carbon, and the metallurgy of cast iron, numerous micrographs of typical structures being given in connection therewith.

The effects of the time element in cooling through the critical temperature, and of successive anneals, are clearly described in the abstract and in the complete paper will be found a discussion of the value of varying percentages of carbon, sulphur, silicon, phosphorus and manganese and of subsequent heating to high temperatures. Picture-frame fractures are also discussed, and the author closes by exploding three popular theories with regard to malleable iron.

PRIOR to the time four years ago that research work was undertaken in the interests of the American Malleable Castings Association, the malleable-iron industry was in a more or less chaotic condition. There had been at least three years of serious business depression and ruinous competition as a consequence had been running its insensate course, but back of and beyond all this was the damning accusation of the engineer, that the material, except in the case of a limited number of concerns, was not only lacking in dependability, but of low strength when dependable. In railway-car fabrication particularly, the number of malleable-iron castings used had dwindled from a very large quantity per car to an almost insignificant number consisting mainly of unimportant details. Malleable cast iron was rapidly being replaced by the steel casting and in other directions as well the latter was encroaching on the legitimate field of the former and incidentally placing it in an exaggeratedly false position, for the reason that when substitutions were made the patterns were redesigned and made much heavier to accommodate the less fluid casting properties of that metal. When a steel casting failed, the attitude taken by the engineer was that the maker did not understand his business, that he was incompetent. On the other hand, if the broken casting proved to be made of malleable iron, the assumption in that case was not that the maker was incompetent, but that the material, *per se*, was unsuitable for the part. Under those rather distressing circumstances it was not strange that the malleable-iron founder stopped, looked and listened.

Formation of the American Malleable Castings Association

Among the various manufacturers of malleable-iron castings, at the time referred to were some twenty-five who were progressive enough to understand the benefits that accompany coöperation, and that one might better have an intimate friend with whom to compete than an enemy. These had formed an association that had been in existence some ten years and had as its objectives the exchange of ideas in the direction of business economy, improved works practice, the study of proposed foundry and factory enactments, the securing of more favorable insurance rates, the study of problems relating to cost, labor, housing and sanitation, and finally the forming of friendships that are the natural outcome of frequent and close personal contact. It is to these men that credit should be given for the renaissance of the industry. They decided to enlarge their field of action and, irrespective of cost, determined to go the full road along the lines of metallurgical research. They determined as well that every statement made as to progress would be conservative and accompanied by data that would be incontrovertible, which course they have followed to the letter.

When the research work was started, it was found that by far the majority of the members had no system of testing the quality of their product in order to ascertain its ductility, aside from the twisting and bending of a casting, or the bending over of test lugs attached to castings. Consequently there was no way in which the quality of product of one member could be compared with that of another. Mr. Benjamin Walker, who at the time was vice-president and general manager of the Erie Malleable Iron Company, of Erie, Pa., a number of years previous to this had devised for the purpose of testing the quality and uniformity of his product, what he called a test wedge. The wedge was 6 in. long by 1 in. wide, tapering from $\frac{1}{2}$ in. at its base to $\frac{1}{16}$ in. at its other end. His practice was to distribute a series of these wedges throughout the annealing oven, and at the conclusion of the anneal subject them to test—accomplished by holding the butt end of a wedge in a narrow-jawed tongs, placing it upright on an anvil, and striking its top end with a 6- or 8-lb. sledge. In this manner the thin end of the wedge would gradually curl up under these repeated blows, and it is apparent that the more blows the wedge would stand before fracture, the shorter would be the butt left in the jaws. The shortness of this butt he considered was a measure of the metal's ductility.

It was decided that an attempt would be made to standardize this test for adoption by the Association. With this end in view a machine was designed such that a weight of 21 lb. when raised to a height of 3.33 ft. above the top of the wedge (placed in position for test on the anvil of the machine) would be automatically tripped to deliver a fairly constant blow on the thin end of the wedge. The blows were counted, and for convenience the number delivered before rupture took place was recorded as the *blow efficiency* (assumed to be a measure of toughness), while the length of the butt (assumed to be a measure of ductility) was measured and expressed in terms of *butt efficiency*. These were arbitrary terms, understood by the members, and intended for their use only. Twenty blows has arbitrarily been chosen to correspond to a blow efficiency of 100 per cent, but at the present time we have numerous members whose wedges invariably test better than 30 blows. When a wedge fails to break at 30 blows without fracture, it is thrown aside, as it is obviously a waste of time to investigate it further.

[1] Consulting Engineer, Albany, N. Y.

Presented at the Spring Meeting, Detroit, Mich., June 16 to 19, 1919, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. The paper is here printed in abstract form, and is subject to revision. Copies of the complete paper may be obtained at a nominal cost.

Method of Submitting Test Bars and Reporting Tests

It was decided that tensile-test bars should be cast by all of the members, and that they be required to send to the consulting engineer one tensile-test bar and one test wedge from some one heat of each day's run. This made possible the ascertainment not only of the quality of each member's product, but furnished data through which a comparison could be made of the quality of the product of the membership as a whole. Equally important, it also served as a direct and positive measure of the progress that ensued from month to month. The dimensions of the tensile-test bar is exactly similar to that contained in the American Society for Testing Materials' specification for malleable cast iron. It is a round bar 12 in. long. The ends that go in the grips are each 3 in. long by $^3/_4$ in. in diameter, and gradually taper in a distance of 1 in. to the reduced section, which is $^5/_8$ in. in diameter and 4 in. long. At the end of each month a report is made of the results of the tests. This report is printed and distributed in the form of a bulletin. For convenience, and in order that the situation can be easily analyzed, the results are classified as shown in Table 1.

The members are classified into those who do railway work and those who do not. To the former is assigned a letter, and to the latter a number. Through this procedure each member can identify his record but not that of any other member, as all of the identification marks are known only to the consulting engineer.

In this manner it is possible to learn just how each member is progressing, and if it is considered by the Research Committee that his progress has not been as rapid as it should have been, the consulting engineer is requested to pay him a visit with the object of aiding him more quickly to better his condition.

Average Physical Properties Prior to Research

It is pertinent at this point to present in as fair and impartial a manner as possible a comparison of the physical properties of malleable iron manufactured within the past few years with that made in the period prior to 1913. Before entering into this matter the writer wishes to go on record as stating that any data in connection with the ultimate strength of malleable iron are valueless as far as serving to show its real worth, unless accompanied by information regarding the ductility of the metal as measured by the elongation. If one knows how, there is no difficulty whatsoever in making a metal of 85,000 lb. ultimate strength, provided ductility be sacrificed down to what would be represented by a 5 per cent elongation.

For many years the writer has had an unusual opportunity to learn either at first hand or on good authority what character of product most of the concerns made, and aside from one concern that had always enjoyed an enviable reputation for the uniformity and excellence of its product and another very large company whose plants were very painstaking in their methods of manufacture, the ordinary run of malleable iron was undoubtedly inferior. The tests made in this laboratory during the period mentioned do not number over three hundred. They do, however, represent the product of many different concerns. As some of the bars were of square section, some rectangular, and others round, it is plain that no uniformity existed in their dimensions. The latter vary anywhere from $^1/_2$ to 1 in. in diameter, while the former for the most part are 1 in. square and 1 in. by $^1/_2$ in. The great majority of these tests show that the ultimate strength was under [illegible] lb. per sq. in., while the elongations were for the most part under [illegible] per cent. There are instances of fairly high strength, slightly over 48,000 lb., while the highest elongations [illegible] 7 per cent in [illegible].

It happens that the writer has a record of tests made in 1911 on bars made by seven concerns that were deemed at the time to be unquestionably among the very best producers of malleable-iron castings. These founders were each asked to make 20 of the very best bars they could produce for test, 10 to be 1 in. in diameter, and 10 to be $^1/_2$ in. in diameter. In these tests the average ultimate strength of the 70 bars of 1 in. diameter is 39,882 lb., and the average elongation exactly 5 per cent. The lowest ultimate is 31,990 lb. and the highest 45,560 lb., the lowest elongation 1.7 and the highest 9.8 per cent. In the $^1/_2$-in. bars the average ultimate is 41,693 lb. and the average elongation is 5.5 per cent. The lowest ultimate is 33,600 lb. and the highest 47,430 lb., lowest elongation 1.2 and highest 6.3 per cent. Inasmuch as each of these seven concerns were informed that what was wanted was 20 test bars that would represent the very best product they could make, and inasmuch as these manufacturers were considered among the best of the producers, it would appear that the writer is warranted in assuming that the foregoing tests would represent a high rather than a low average.

Fallacious Theories of Malleable Iron

In Hatfield's Cast Iron in the Light of Recent Research, 1912, page 213, is a table containing the results of 14 tensile tests of bars 1 in. by $^3/_8$ in. in section. The bars run very uniformly and the material, while of low strength, is ductile. The latter should certainly be expected in bars that are but $^3/_8$ in. thick. The lowest ultimate strength is 38,820 lb. and the highest 45,700 lb., the lowest elongation 10 per cent and the highest 15.3 per cent. Under this table appears the following: "If attempts are made to increase the maximum stress obtained from such iron, the elongation would appear to have to be sacrificed, and to a considerable degree. In illustration of this the following records are given."

Maximum stress, tons per sq in.	Elongation, per cent in 2 in.	Reduction of area, per cent
18.9	12	9
21.1	13	8
24.0	9	8
26.5	7	5
27.8	5.5	3.5
29.0	5.0	4.2
34.3	3.0	2.5

Under this table the following words appear: "The cause of the increase in tonnage is the retention of increasing proportions of combined carbon. This combined carbon stiffens the material and incidentally reduces its ductility." The writer believes that he was the first to prove and furnish indisputable evidence as to the falsity of the statement that the ductility of malleable iron decreased as its ultimate strength increased. While Hatfield is correct in assuming that the ultimate strength is increased and the ductility decreased with an increase in combined carbon, the statements indicate clearly that he was, at the time at least, not familiar with the manner in which malleable iron can be obtained having the characteristics of high strength accompanied by high ductility. It can be stated, that in normal malleable iron as made today the higher the strength the higher will be the ductility, and in this particular this metal is unique.

In the Mechanical Engineers' Handbook, edited by Prof. Lionel S. Marks and published as late as 1916, appears the following by Dr. R. Moldenke: "These castings *should not be machined,* as the interior is not as strong as the metal at and near the surface. Tensile strength, 35,000 to 48,000 lb. per sq. in. European malleable cast iron, made by a somewhat different process, is not as sensitive to machining; the castings, which are thin only, are practically decarbonized in the annealing process; whereas in the American black-heart malleable iron only the skin is decarbonized, the metal adjacent for about $^1/_4$ in. partially so, and the central portions contain the full carbon percentage of the original hard white casting."

Improved Physical Properties Due to Research

Improvements have been made since the research work was started and Table 1 covers the physical tests for ultimate strength and elongation on bars received during the month of March 1919.

TABLE 1 ANALYTICAL EXAMINATION OF PHYSICAL TESTS FOR ULTIMATE STRENGTH AND ELONGATION ON TEST BARS SUBMITTED DURING MARCH, 1919

Limits of ultimate strength	Per cent of bars	Per cent elongation
Under 40,000 lb.	0.40	4.50
Between 40,000 and 42,000 lb.	0.88	6.86
Between 42,000 and 44,000 lb.	2.79	7.67
Between 44,000 and 46,000 lb.	6.47	8.13
Between 46,000 and 48,000 lb.	10.29	9.50
Between 48,000 and 50,000 lb.	17.16	10.09
Between 50,000 and 52,000 lb.	17.95	11.55
Over 52,000 lb.	44.06	14.67

It would be almost impossible to consider the figures in this record and fail to note that as the tensile strength increases, so does the elongation. These monthly records have been kept for four years and there is no exception to this rule. It will also be noted that only 0.40 per cent of the total bars received tested under 40,000 lb. per sq. in. As a matter of fact, only 10.54 per cent were under 46,000 lb., while 44.06 per cent stood over 52,000 lb. with an average elongation of 14.67 per cent. The best individual record showed an average of 59,681 lb. ultimate and 21.47 per cent elongation. The worst was 39,942 lb. ultimate and 4.20 per cent elongation. The latter record belongs to a member who but very recently joined the Association, and bears out quite well the thought that the writer has been endeavoring to convey.

The members who submitted bars classified under Railway Work were twenty-two in number. The average ultimate strength and elongation of test bars submitted by the eleven members having the highest averages are found to be 53,559 lb. and 15.56 per cent, respectively. Carrying through the same operation with the twenty-six members who are not thus classified, it is found that the average ultimate strength and elongation of these thirteen are respectively 52,327 lb. and 12.42 per cent. Taking the average of these twenty-four members, we find that the ultimate strength is 52,943 lb. and the elongation is 13.99 or practically 14 per cent. Lest our intention be misunderstood, it should be explained that our effort is not directed toward securing an increased ultimate strength and elongation so much as uniformity of product. The aim is to secure a product that the engineer will readily acknowledge possesses excellent physical properties, which vary but little from heat to heat. It may be of interest to state that from January 1, 1917, to March 31, 1919, the average ultimate strength of the test bars of the Association as a whole has been over 51,000 lb. ultimate and the elongation 12.50 per cent.

In considering the last statement the following facts should be taken into account. War conditions during 1917 and 1918 made it quite impossible to secure suitable pig iron and fuel, and it was solely and only through an intimate knowledge of the metallurgy of the process derived from the research work that made such a showing possible. It is therefore not unfair to assume that a still better showing could have been made had the times been normal.

At the beginning of our investigations an elongation of 10 per cent was considered to be an indication of a superior product. As our knowledge of the metallurgy of the process increased, accompanied by better air-furnace practice and annealing-oven conditions, the elongation particularly began to climb. An elongation of 20 per cent is not now looked upon as unusual; elongations of 25 per cent occur with considerable frequency, while we have had numerous bars that have run as high as 30 per cent and several of 31 per cent, which for an untreated cast-iron product we believe to be quite extraordinary.

Process of Making Malleable Castings

The process for making black-heart malleable castings involves two steps. The first step consists in making a casting in which the totality of the carbon will exist as carbide of iron, when the iron will have a structure shown in Fig. 1. (Air-furnace white iron has an average carbon content of but 2.40 per cent as against an average of 3.50 per cent in white pig iron.) The casting produced is white in fracture, hard and as brittle as glass. The second step consists in subjecting this white-iron casting to a heat treatment such as will serve to break up this hard carbide into its two original components, graphite and iron, both of which are very soft. Hence from a white-iron casting we can obtain through heat treatment one that possesses the properties of strength, toughness and ductility. Fig. 2 shows the structure of a normal well-annealed piece of malleable iron. The white ground mass is the carbonless iron (ferrite), while the dark continent is the carbon that precipitated out during the anneal. If Fig. 2 be compared with Fig. 1, an idea will be gained of the profound change effected in the structure during the annealing process.

The air furnace, in which the malleable iron is melted, consists essentially of a fire pot, hearth and stack. Some furnaces have a solid roof, the charge being "peeled in" through the charging door, but in the larger number of cases the roof is made up of bungs that can be removed during repairs and a sufficient number of them lifted off when necessary for the purpose of admitting the charge. While a few of the furnaces operate with natural draft, most of them use a forced draft of from 3 to 4 oz. pressure. Although oil is advantageously used for fuel in a few instances where its cost is not prohibitive, bituminous coal having a volatile combustible of from 25 to 35 per cent is the heating agent used by the majority. In order to burn the volatile products of the

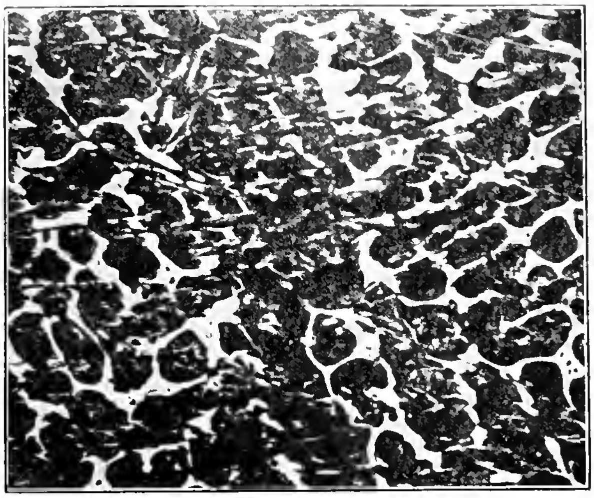


Fig. 1 Micrograph of Hard, White Cast Iron

coal, as well as the CO generated from it, when, as should be the case, a deep bed of coal is used, secondary air is admitted through a series of tuyeres or a continuous tuyere located far enough in front of the grate bridge wall and so inclined that the air will enter and be deflected about 15 in. from the base of the bridge. In this manner a maximum temperature of about 2800

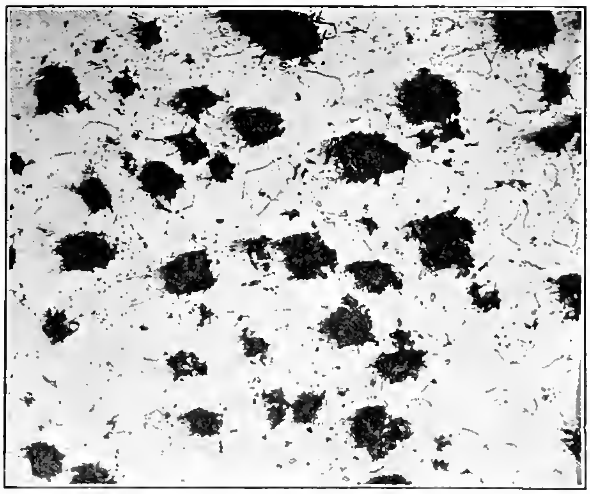


Fig. 2 Micrograph of Normal, Well-Annealed Malleable Iron

to 2950 deg. fahr. can be eventually obtained. Considerable time and thought have been expended in an endeavor to see if it would not be possible to regulate the amount of secondary air to just insure perfect combustion by the use of a CO_2 recorder, but it was found that the recorder would not act with sufficient promptness. The furnaces vary in capacity from about 7 tons to 35 tons. The best are very inefficient and in practice the fuel ratio is about three of iron to one of coal. The average practice does not exceed 2.5 to 1. In numerous cases waste-heat boilers are used and while this conserves heat, it obviously does not add to the furnace efficiency. The average furnace has a capacity of about 15 tons.

Annealing of Hard Iron

When a piece of air-furnace hard iron is gradually heated, many of its properties are changed. It will cease to be magnetic and the size of the crystals will be much finer than was the case under this particular temperature. It can be carburized beyond its original carbon content if packed in a carbonaceous material and held at this temperature for a sufficient length of time, while if packed in material that yields oxygen it can be decarbonized almost completely if the piece is thin. Also the carbide of iron can be broken up into its two soft constituents at this "critical temperature," or critical range, which for air-furnace hard-iron castings is in the vicinity of 1440 deg. fahr. It is the lowest temperature at which hard-iron castings may be successfully annealed. This statement must be modified by the further statement that in an oven under perfect control this temperature is the one that would be selected. In practice it would not be safe to adhere too closely to it, for the reason that should the castings while being held "at temperature" fall under the critical range, it would undo in large measure what had been accomplished above it. In the annealing of the castings one of the things to be avoided is oscillating temperatures, or temperatures alternating above and below the critical range. For this reason it is necessary to select a temperature some 100 to 150 deg. fahr. above the critical, say, 1550 deg. fahr., in which event, even if due to carelessness the temperature does drop a little, it will not be liable to fall to a dangerous point. There is another reason why this latitude is deemed essential and this has to do with the fact that in large ovens it requires considerable ingenuity to arrange flue openings, drafts, etc., in such a manner that the temperatures in all parts of the oven will be uniform, for which reason it is necessary to make sure that the temperature at the coldest corner is somewhat above the critical range, which will serve to safeguard oscillations in these locations.

Preparation of Castings for Annealing

In order to anneal the hard-iron castings that have previously been barreled or sand-blasted, chipped, gates ground off and inspected, they are packed in cast-iron pots where they are surrounded by an oxidizing packing. The packing has a dual function: to furnish oxygen through whose agency the castings will be decarbonized to the extent that is possible, and to avoid kiln warp—that is, prevent the castings from distorting. The usual packing consists of a predominating proportion of inert material, such as ground air- or blast-furnace slag, pulverized firebrick, etc., to which has been added iron oxide in some form, such as rolling-mill scale, hammer scale, etc. The pots, or stands are sectional and each comprises a casting which forms its bottom, upon which four or five sections are superimposed. Each section consists of a rectangular or circular "ring" about $1\frac{1}{4}$ in. thick and varying in size at different plants, depending upon the dimensions of the castings to be annealed, but averaging, if rectangular, about 14 in. by 24 in. by 14 in. high. In building up a stand a ring is placed on the stand bottom and then carefully filled with castings that are surrounded with packing. When the ring is completely filled it is hammered on the sides with a light sledge in order that the packing will run down and fill in all voids. The second ring is then placed upon the first one, and this is filled in the same manner, which procedure is followed until the stand of four rings is completed. The top ring is filled with castings only to about two-thirds of its height, for if they were brought to the top they would be exposed to the oven gases. Instead, the top third of the ring is filled with packing and this in turn is covered with an iron plate. The top, and all joints in the stand, are then mudded or luted in order to prevent the entrance of the oven gases, after which the stand is lifted up by the charging truck and placed in position in the oven.

The annealing ovens are usually of rectangular shape, and vary in capacity from 15 tons for a very small oven to 50 for the largest ones. Their average capacity is about 25 tons. The usual fuel is bituminous coal, but hard coal, powdered coal or oil are used. These ovens are being standardized and designed with a determination of securing uniformity of temperature throughout. The flues are not only being properly proportioned for the draft used, but the flue openings so dimensioned that the heat can be drawn to any part of the oven in amounts sufficient to equalize temperatures, while provision is made whereby they can be easily kept clean. In the plants of the Association practically all of the ovens are under pyrometer control, and equipped at a central station where it is possible at any moment to ascertain the temperature at the hottest and coldest part of any oven, while a master pyrometer is used as a check on those that are permanently located. Air-furnace and annealing-oven operations have also developed from extremely crude methods to intelligent control, and this in large measure accounts for the improvements in the uniformity of the product.

Length of Annealing Time and Temperature Limits

In annealing, the castings are brought "to temperature," that is, to 1550 deg. fahr. or as high as 1600 deg. fahr. if thought best, as rapidly as it is deemed they can absorb the heat. Too great a forcing of the heat during this period is avoided, for if it is done the rings expand much more rapidly than the material within them, which leaving a space between ring and contents will allow the packing to bleed down from the top toward the bottom of the stand, lessening the compactness in the upper rings. In average practice it takes about 48 hr. for the oven to arrive "at temperature." The temperature of anneal is then maintained for a minimum of 48 hr., the time recommended being 60 to 72 hr. Firing is then stopped and the oven sealed tight in order that the castings will not cool faster than from 8 to 10 deg. per hr. while passing through the critical range. To safeguard this very important detail, this rate of cooling is maintained until the pyrometers indicate that the oven temperature is less than 1100 deg., for on cooling, the castings are liable to be some 200 deg. higher than indicated by the pyrometer in the oven. After the temperature has been lowered to that point an opening is made in the front of the oven in order to allow it to cool more rapidly, for the reason that once the castings are at a temperature under the critical range no change can take place in their structural composition, so the only remaining precaution is to see that the castings do not cool so fast that internal strains can develop in them. From the foregoing, it can be readily seen that the average length of anneal occupies about seven days.

From theoretical as well as practical considerations the writer does not believe that there is a possibility of safely lessening the time for this operation by much more than one day without taking chances. He has designed an oven in which the temperature of 1600 deg. can be easily attained in 25 hr. and he is aware that when the composition of the hard-iron castings is such that the hard carbide is in its most unstable condition that even less than 48 hr. will suffice for the precipitation of the carbon, so that these two periods can be reduced somewhat, but danger is ever present if liberties are taken with the cooling through the critical range. In order then to safeguard the consumer as well as his own reputation, the manufacturer should make no serious attempt to shorten the anneal unduly. The annealing capacity should be such as to make the attempt unnecessary. If it is made, however, then the pyrometer element should be inserted directly into the center of the pot, placed for that purpose in contact with the side wall of the oven, in order better to determine when the castings have actually arrived "at temperature" and the moment when he can commence to record the time the temperature can be started on its downward course, which procedure will enable him to operate more closely and accurately.

From what has preceded it should be evident that the second step in the manufacture of these castings should not be known as an annealing process, but more appropriately as a conversion process. The dominant function of an anneal is to obliterate coarse crystallization or an unsuitable one, and replace it by the most suitable that it is possible to produce in the object treated and incidentally remove internal stresses. Annealing does not imply structural changes in the piece when cold, aside from grain size and grain refining. In the annealing of malleable-iron castings the dominant object is to convert white, hard iron, in whi

all of the carbon is combined, into a soft, tough, ductile iron in which no part of the carbon is in that state. In order to achieve this it is necessary to maintain for a sufficient length of time a temperature just in excess of the critical range, which, as has been pointed out, coincides closely with that at which grain refining occurs, so it happens that during the conversion both objects can be practically attained.

Appearance of Fracture of Test Pieces

It requires an extended experience before one can tell from the fracture of the iron what may have caused its abnormal condition, which is one direction in which great progress has been made. When a normal, well-annealed piece of malleable iron is subjected to a steady, direct pull in a testing machine, a point

Fig. 3 Fractures Showing Width of Decarbonized Rim

is reached at which the crystalline grains of which it consists are elongated permanently, the stretch continuing until fracture takes place. If the fracture is examined it will be seen that the grains have elongated into finely pointed spines which gives what is called a "tooth" to the fracture. When light falls obliquely on such a fracture, there is produced a play of colors that yields a sheen caused by a reflection from the points and sides of the spines and the shadows that fall between them. As the grains in

Fig. 4 Micrograph of Specimen with 0.33 per cent Silicon and 0.089 per cent Manganese

the decarbonized rim are more ductile than the rest of the metal in the section, they will elongate to a greater extent, and if the fracture is held in certain directions to the light, the width of the decarbonized rim can be seen by contrast, its color appearing under those conditions a little lighter than the rest of the section. (See Fig. 3.)

This explanation is made and entered into because such a rim or border must not be confused with and mistaken for the character of fracture that has a well-defined frame, that is, a border having not only a sharp line of demarcation between it and the core of metal which it surrounds, but an appearance wholly distinct from it. If the writer were asked to pass judgment as to the quality of a piece of malleable iron, based upon either the appearance of its fracture, or what would be shown by a polished and etched section under magnification, he is positive that he could render a more reliable opinion in the case of the former than would obtain in the case of the latter. The reason lies in the fact that even in a non-ductile product it is possible to have an absolutely normal structure, one which consists of a matrix of ferrite or carbonless iron; throughout which are uniformly distributed nodules of free carbon, such as shown in Fig. 1, while if the fracture is as has been described, a normal structure at least can be predicted. If the ferrite is not ductile, then the crystalline grains will not elongate, with the result that we obtain a structural appearance that would be interpreted by those not familiar with the facts as belonging to a piece that had been insufficiently annealed. It has already been stated that when the silicon is too low a steely fracture will result, and also that the metal is liable to be unsound. In making this statement the writer is assuming that the silicon is low, not because too little was used in the charge, but due to excessive elimination in the air furnace.

In such cases the low silicon will be accompanied by low carbon and manganese. In Fig. 4 can be seen the structure of a piece that had a silicon as low as 0.33 and a manganese of 0.089 per cent. The fracture of this piece was uniformly bright and coarsely crystalline. It had no frame. The structure consists of a matrix of pearlite and throughout it are distributed particles of undecomposed hard carbide (cementite) and small well-rounded nodules of graphite, or temper carbon, as that carbon is called

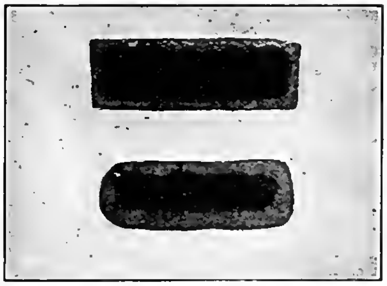


Fig. 5 Picture-Frame Fracture in Low-Silicon-Carbon-Manganese Specimen

which separates out during an anneal. The casting from which this piece was taken was in an oven in which castings of correct composition annealed perfectly, and the presence of the particles of undecomposed carbide simply means that the anneal was not carried on for a sufficiently long time for this character of product. The casting, however, would have been very inferior even if all of the carbide had been broken up.

Picture-Frame Fractures

Very frequently certain low-silicon-carbon-manganese compositions will yield what are known as picture-frame fractures, such as are shown in Fig. 5, which are typical and have the following composition: Silicon, 0.54; phosphorus, 0.162; sulphur, 0.053; manganese, 0.108; total carbon, 2.01. This piece when polished and etched showed the following characteristics: a decarbonized surface border, an inner ring of coarsely laminated pearlite, and within this a core corresponding in structure to that of normal malleable iron. Fig. 6 shows the decarbonized border surrounding the pearlite ring, Fig. 7 the structure of the pearlite ring, and Fig. 8 the core within the pearlite ring. It is the presence of this ring of pearlite whose ductility is so much less than that of the metal in either the decarbonized border or core that produces on fracture the sharp line of demarcation between frame and core. While in this particular fracture the frame is fiery bright and finely crystalline and the core black, there are picture-frame fractures that show various color characteristics of frame and core, but it will be found that invariably the frame has its pearlitic ring of greater or less breadth. The pearlite is not always coarsely laminated, but as a rule has the appearance and con-

sists of an amount of pearlite that would correspond to a 0.35 per cent or 0.45 per cent normalized carbon steel.

If the sulphur in the hard iron is unduly high and particularly if not well balanced by the manganese, the castings will almost invariably show a picture frame on the fracture, and especially is this true if the temperature of anneal is too high for such a composition. If the manganese is too high and not well balanced by the sulphur, the same result will follow.

While time is not available to enter into a full discussion of what has been discovered in regard to picture-frame fractures, there are some points that can be recorded. There are some compositions that unquestionably have frame-producing tendencies. These compositions will not produce a frame when annealed in an atmosphere that is not oxidizing. The surface structure of the hard iron has nothing to do with the problem as the writer has had 1/4 in. ground off of one side of hard-iron samples and upon annealing the frame was in evidence equally on all sides. It is believed that the following facts are pertinent to the situation: Not only do certain compositions affect the ductility of ferrite, but the same is the case with a pearlitic structure. We can have ferrite that will elongate into very long spines and ferrite that will fail to elongate at all. We can have a pearlitic grain that can be ductile and those that are not. The foregoing is stated because the writer believes that whether or not a frame will be produced in the fracture depends upon the breadth and ductility of the pearlitic ring, because a slight pearlitic ring can be present within a decarbonized border without a picture-frame fracture being produced. It is his belief that whether there will be a pearlitic ring or not depends upon the rate of surface decarbonization, as compared with the rate at which a dissociation of the cementite takes place. When conditions are such that there will exist a region between the decarbonized surface border and the core that will have a carbon content of about 0.90 per cent, equilibrium seems to be established in this region, and if any carbon passes from this region to the decarbonized border it is replenished by carbon from the core.

FIG. 6 MICROGRAPH OF DECARBONIZED BORDER

FIG. 7 MICROGRAPH OF PEARLITE RING

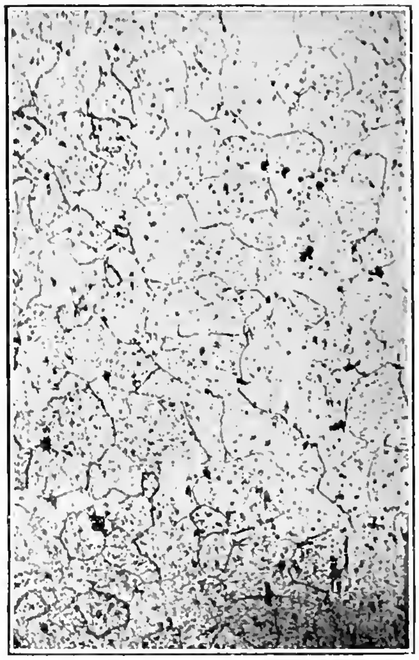


FIG. 8 MICROGRAPH OF CORE WITHIN PEARLITE RING

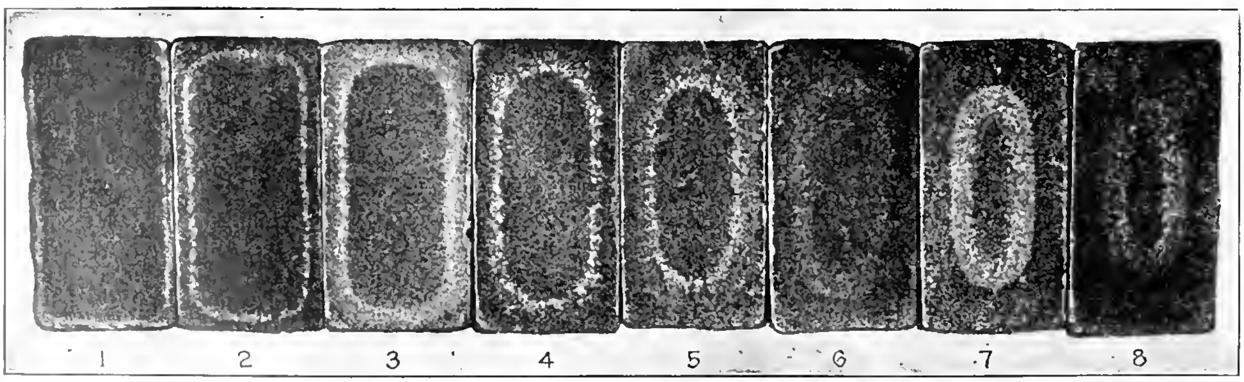


FIG. 9 THE PEARLITIC RING IN SUCCESSIVE STAGES OF ANNEALING

THE PEARLITIC RING

The writer believes that such is the case, and is of the opinion that perhaps the samples shown in Fig. 9 may have a bearing on the case. A well-annealed bar was cut into eight pieces. A section from the first piece was polished and etched, and the other pieces all packed together and given another anneal. The second specimen was then prepared like the first. The remaining six were then given a third anneal, and the third piece polished. As this procedure was continued, it follows that the eighth bar had

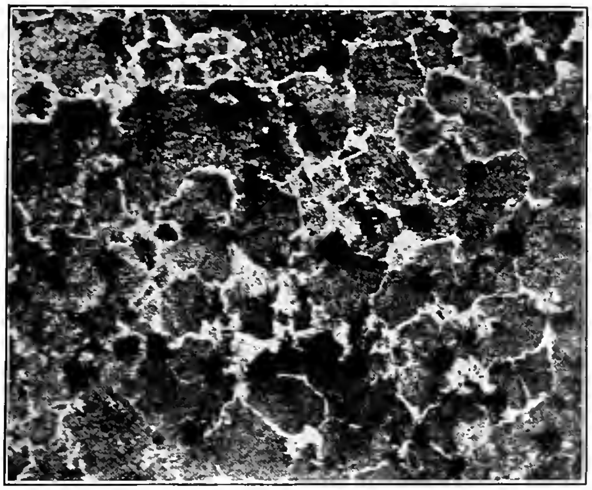


Fig. 10 Micrograph of Malleable Iron of High Ultimate Strength

eight separate and complete anneals. It will be noted that its very faint pearlitic ring which shows whitish and very faint in the once-annealed bar, is very distinct and well defined in the second and that it is wider and further in toward the center. It will be seen that with each anneal the pearlitic ring has widened and has a smaller periphery. As it was found that with each anneal the total carbon content decreased, it is plain that once the pearlitic ring has formed, it does not act as a seal for the passage of carbon from core to surface and that the width of the pearlitic ring is built up and added to more quickly from the core than it is robbed of carbon by the decarbonized border. The matter can be summed up as follows: If conditions are such that a region containing about 0.90 per cent or less carbon is formed, this region while permitting carbon to migrate or diffuse through it will at the same time be incapable of having its carbon precipitated. Under proper conditions the region can alter its position and increase in extent. For such a region to have a start it is essential that there be a very substantial difference in carbon content in two parts of the section.

Structure of High-Strength Malleable Iron

Malleable iron of very high strength accompanied by a ductility that can be considered good enough for certain purposes, has already been mentioned. While no effort has been made to exploit this product as yet, it would appear to the writer that there is a very large field in which it could be used to advantage. In Fig. 10 can be seen the structure of a sample that stood an ultimate strength of 84,000 lb. and had an elongation of 5.20 per cent. This material can be made with uniformity and it is believed from experiments that have been under way for some time that a 90,000 lb. ultimate and a 10 per cent elongation might be uniformly maintained. It will be noted that the structure consists of a ground mass of pearlite, in which are more or less uniformly distributed nodules of temper carbon. The structure readily explains why the product is of high strength.

Effects of Heating Malleable Iron

As it is frequently necessary to heat the finished product for the purpose of straightening it, for galvanizing and other purposes, it may prove instructive to see what happens when an annealed piece of malleable iron is heated up to and beyond the critical range. Ten pieces were cut from a normal, well-annealed malleable-iron bar. Fig. 11 shows the structure of this bar at 200 diameters. The pieces were then placed in an annealing oven that could be controlled with great accuracy. When the pyro-

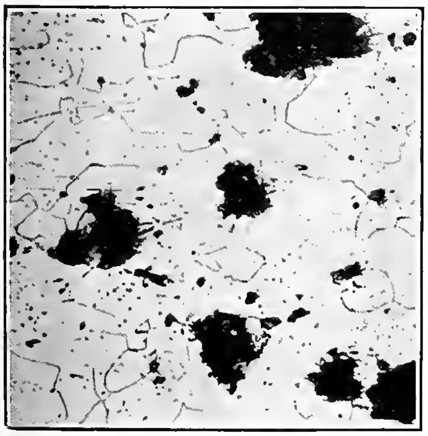


Fig. 11, Unheated

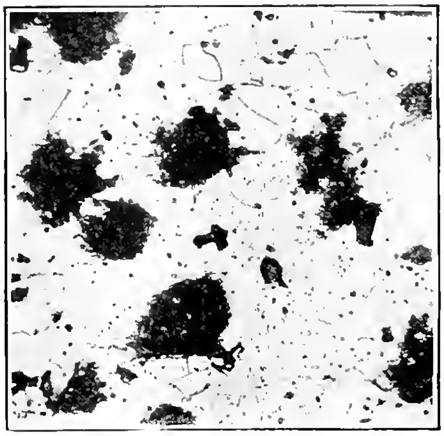


Fig. 12, 1400 deg.

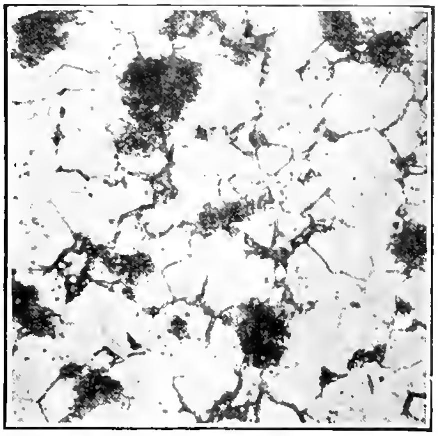


Fig. 13, 1450 deg.

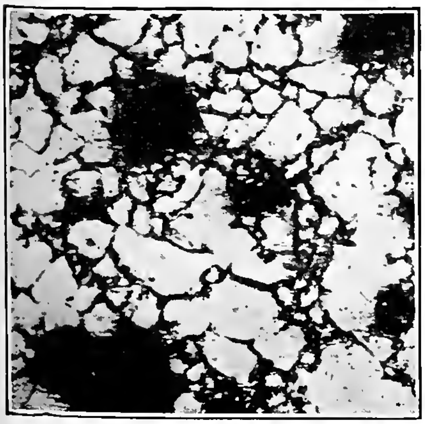


Fig. 14, 1475 deg.

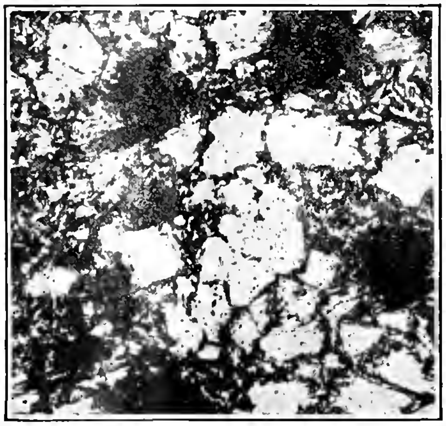


Fig. 15, 1500 deg.

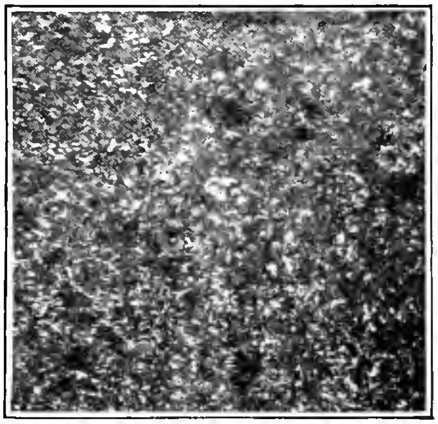


Fig. 16, 1675 deg.

Figs. 11 to 16 Micrographs Showing Effect on Structure of Heating to Various Temperatures

meter registered 1250 deg. fahr., one piece was withdrawn and allowed to cool in the air. When the temperature reached 1300 deg. fahr. another piece was withdrawn. The other pieces were withdrawn at temperatures of 1350, 1400, 1450, 1475, 1500, 1550, 1600 and 1675 deg., respectively. Fig. 12 shows the structure at 1400 deg., Fig. 13 at 1450 deg., Fig. 14 at 1475 deg., Fig. 15 at 1500 and Fig. 16 at 1675 deg. All of these micrographs were taken at a magnification of 200 diameters. It is apparent that no change has taken place in the structure up to 1400 deg., but that somewhere between 1400 and 1450 deg. the structure starts to alter in appearance. An examination of Figs. 13 to 16 shows that increased amounts of pearlite result as the temperature is increased, and that in Fig. 16 nearly all of the temper carbon has been dissolved. It follows that for straightening, brazing and other operations that necessitate the heating of a malleable-iron casting, the temperature used should be well under 1400 deg. fahr.

Common Fallacies

The fallacies that have been handed down and accepted by many of the engineers and consumers as true are numerous, but the following only will be touched upon as they are the most important:

a The strength of malleable iron lies in the skin. When it has been removed the remainder of the metal is found to be very inferior and not dependable.

b During the anneal, the elimination of the carbon is confined to the surface, and the amount removed from the rest of the section is inconsequential.

c When the section of a casting exceeds 5/8 in. in thickness, it cannot be annealed throughout.

Concerning item *a*, the data in Table 2 will prove of value.

TABLE 2 TESTS OF MALLEABLE-IRON BARS WITH DECARBONIZED SKIN REMOVED

Mark	Ultimate strength, lb. per sq. in.	Per cent elongation in 2 in.
12-2-1	52,084	17.50
12-3-1	47,182	10.00
12-3-2	51,107	17.50
12-4-1	56,732	14.00
12-5-1	46,482	7.00
12-5-2	52,246	23.00
12-6-1	47,889	19.00
12-7-1	48,080	18 00
12-7-2	49,640	18.00

Nine regular test bars were machined until the decarbonized surface was removed. These bars were all from different heats and marked as indicated in the table.

As the writer did not have duplicates of these bars, he was unable to make a comparison between the machined and the bars as cast and lacked time to run through a set for illustration, but the experiment should be unnecessary in any event in view of the above. It is obvious and must be acknowledged that the metal in the decarbonized skin is more ductile than the core, so when a bar fails it must be conceded that it is the core that has parted first, for the reason that the metal in the skin has not at the instant of fracture reached its maximum elongation. Aside from the foregoing we have the practical evidence that presents itself in the case of the automobile industry in which thousands of tons of machined malleable-iron castings are used annually on parts that receive in service great abuse, such as wheel spindles, etc. On the other hand, the writer not only admits that when the skin is machined off some malleable-iron castings the remaining part is worthless, but admits as well that the castings would be such with the skin on. This, unfortunately, will continue to be the case until the purchasing agents cease to shop around and make contracts with price as the basis rather than quality.

Taking up item *b*, the writer can, without encumbering this paper with the large amount of data he has on the subject, prove the falsity of this contention. In the figures quoted in Table 3 of the complete paper for bars of over 52,000 lb. ultimate strength and over 20 per cent elongation, there will be noted two bars, one of which has a carbon content of 0.72 per cent and the other of 0.82 per cent. Aside from this there are fourteen with a carbon content of 1.50 and under. It has already been pointed out that the carbon in the hard iron must be kept up to a certain figure, failing which the castings will not only misrun, but contraction cracks will spoil them. If we assume, in the case of the first two bars referred to, that the carbon was reduced by one-half, then in the bar that had but 0.72 per cent carbon, the carbon in the hard iron from which it was cast must have been 1.44 per cent, and we all know that it would be almost impossible to run such work, say nothing about subsequently annealing it. In a 5/8-in.-diameter annealed bar such a low carbon content is unusual but it proves the point that is being made nevertheless. The writer has polished the section of two 5/8-in.-bars and has photographed them at about seven diameters. One of these is shown in Fig. 17 and will furnish a fairly good idea as to how the carbon is distributed throughout the section, and indicate that the carbon does not vary by uniform gradation from surface to center, but in one region can vary slightly from what it may be in another. This does not signify that in the regions of highest carbon content the carbon has not been lowered through diffusion into its contiguous region, for many investigations have shown that this is just what does happen.

Item *c* can be disproved in a few words. We know that in order to break up the hard carbide in white iron it is simply necessary that the casting be not only heated until the iron is in an austenitic condition, but maintained at that temperature for a certain interval of time. To state that thick castings of white iron cannot be annealed is to state that they cannot be brought to a uniform temperature throughout and maintained at that temperature. Such a claim would be an absurdity.

Fig. 17 Bar Magnified Seven Diameters to Show Carbon Distribution

For the benefit of those who labor under the impression that malleable iron is a product unsuited for any but small castings, the writer would say that he has a photograph of a casting 5 ft. long, 23 in. high with some of its sections 3 in. thick. The metal when well made, can also withstand great abuse. Irrespective of how good the metal may be, as shown by physical tests on bars and wedges, patterns are often furnished so outrageously out of proportion that the good qualities of the metal can easily be destroyed and too frequently the metal is blamed when the design is at fault. These troubles are overcome as far as possible by a thorough study of the best method of gating the casting, in order that no evidence of shrink will be present in any part. Research has made considerable advance in this direction and well-placed, well-proportioned shrink heads are now generally used. Not infrequently, in the case of such castings as the ones referred to, the sprue, runners and heads weigh about as much as the casting.

Committee on Aims and Organization

Tentative Report of the A. S. M. E. Committee, Dealing with Society and Professional Activities and Relations of the Engineer to the Community

FOLLOWING the business meeting at the Spring Meeting of The American Society of Mechanical Engineers on Monday, June 16, the report of the Aims and Organization Committee was presented by its chairman, Louis C. Marburg. This report evoked so much interest that sessions for its discussion were required on three different days. The report is published herewith both in its original form and with the resolutions as amended at the meeting. The report was discussed section by section, and the synopsis of discussion herewith reported is grouped under the several headings to which it belongs.

In presenting the report, Mr. Marburg stated that the committee considered it as tentative and in making its recommendations felt very strongly that it should avoid giving too many details but should state, instead, its views along lines of broad principles. The chairman of the meeting, President Cooley, then called upon Prof. Dexter S. Kimball who said the committee desired it to be understood that the report was not the work of a small body of men anxious to tear down something simply because it existed as a committee; nor did they want to introduce radical ideas into the report simply because of their own points of view.

As nearly as he could place his finger on the origin of the documents, it started with the Committee on Meetings and Program of which he had been a member for some years. In the work of that committee it was necessary to arrange for papers and it had been difficult to get unanimity of opinion as to what the aims of the Society really were and what kind of papers should be presented.

He called attention, however, to the fact that the A. S. M. E. was not alone in the matter and that every society of note in the country is now wrestling with the same problem, every university is wrestling with it and every technical school. The work of the Aims and Organization Committee had been sub-divided in the way noted in the report, with the committee split into three groups and a chairman appointed for each; the work had been conducted by sending out questionnaires from which a great mass of information, criticisms and suggestions had been received. That matter was boiled down and so arranged that the committee as a whole could pass upon it, and constituted, in effect, a composite opinion of a large number of members. A great deal of the work was done by correspondence and recently the three sub-committees met in conjunction and each framed recommendations which were then submitted to the committee as a whole and endorsed by the committee.

RECOMMENDATIONS OF THE COMMITTEE ON AIMS AND ORGANIZATION

Text of the Report as Modified by Vote of the Meeting, Together with the Committee's Wording Where Changes Were Made

The Professional Activities of the Society

OUR discussion of the professional activities of the Society undertaken for the benefit of mechanical engineers led to the opinion that this work can well be strengthened in practically all its branches. The specific recommendations for the development of professional activities follow:

Adoption of Standards

2. RESOLVED: that it is the sense of this meeting that Section C-49 of the Constitution of The American Society of Mechanical Engineers be amended so that the Society may approve and adopt such professional reports and standards as shall from time to time be presented to it. [The foregoing resolution was adopted in place of the resolution printed by the Committee, which was the same except that it did not include the words "That it is the sense of the meeting."]

3. The purpose of this change is to permit the Society to adopt an active progressive policy in place of the present passive policy.

Professional Features of General Meetings

4. RESOLVED: that continuous tenure of membership on the Sub-committees of the Meetings and Program Committee be discontinued, that the classification of engineering activities be retained and extended, and that the means and methods of collecting information under this classification be enlarged and improved.

5. The purpose of these changes is to get better papers of broader scope.

6. RESOLVED: that all Sub-Committees of the Committee on Meetings and Program be appointed for limited terms, all memberships to expire automatically at the end of said terms, but a sufficient number of experienced members should be selected, when reconstituting any such committee, to secure continuity of policy.

Research and Standardization

7. RESOLVED: that the Society, in addition to the work it is now doing in aiding, recording and publishing matters pertaining to research take a more active interest in this field by the following methods:

a. By increasing the appropriations made from its own funds to further research and by obtaining from other sources funds to conduct research.

b. By determining and formulating problems requiring investigation, and by securing men and facilities to solve these problems.

8. RECOMMENDED: that the Society establish the policy of formulating and adopting engineering standards, but that, in general, these be limited to elements, and that the standardization of combinations be left to organizations devoted to special industries.

9. RECOMMENDED further: that all such standards be considered as progressive standards and not as ultimate ones.

Industrial Engineering

10. RESOLVED: that Industrial Engineering is a major subject for consideration by the Society, and should be placed on a par with all major technical subjects.

Education and Special Training

11. RESOLVED: that the Committee heartily approves the work now being done in connection with the Student Branches and technical schools of higher grade in general, and recommends that this work be strengthened as much as possible.

12. RESOLVED: that in the opinion of the Committee, the Society is not realizing its opportunities in connection with industrial education below the grade of college work, and recommends the formation of a strong committee to take up this activity vigorously.

13. The reason for this recommendation is found in the need of the engineer for trained subordinates and industrial workers.

14. *Professional Groups.* The By-Laws of the Society provide for professional sections, under a clause of the Constitution (C52). Several requests for such sections, including an Ordnance

Section, a Power-Plant Section, an Automotive Section and a Petroleum Section, have recently been received.

15. Recommended: that a standing committee on Professional sections be constituted, analogous to that on Local Sections.

Development of the Society's Publications

16. Resolved: that the Committee on Publications and Papers be encouraged to publish in Mechanical Engineering (The Journal) matter of broader scope, including papers and articles that have not been presented at any meeting of this Society, news items of engineering interest, and the information of general interest now presented in Bulletins.

[In the resolution before amendment the resolution read: Resolved: that Mechanical Engineering (The Journal) be made a weekly publication at the earliest possible date, and that the Committee on Publications and Papers be encouraged to publish matter of broader scope, etc. (as continued above).]

17. Resolved: that the Committee on Publications and Papers be requested to study the possibility of a substitute for the present expensive method of publishing the Transactions, reporting any plan developed at the Annual Meeting.

[In the resolution before amendment, the last clause read "presenting any plan developed to the members of the Society for letter ballot.]

18. Resolved: that the Society publish, as soon as practicable a Handbook of Mechanical Engineering Data.

Absence from Committee Work

19. Resolved: that the Council formulate and put into force such rules as will cause membership on any Council or Committee of the Society to terminate automatically on account of absence or neglect, either willful or due to force of circumstances.

Engineering Societies' Employment Office

20. Recommended: that the present Joint Employment Bureau in New York be retained and its activities be expanded and made more efficient.

21. Recommended further: that the name of employment officials be secured especially through the local sections, and that these officials be supplied with lists of men.

Code of Ethics

22. Resolved: that it is the sense of this meeting that a short Code of Ethics of broad scope, general character and positive rather than negative injunction, be prepared and that the same be enforced vigorously.

22*a*. Resolved: that a committee of five or Code of Ethics be nominated by the President and confirmed by the Council, who shall report back to the Society at the Annual Meeting.

[The foregoing resolution was adopted in place of the following resolution presented by the Committee:

22. Resolved: that the present code of ethics of our Society be abolished as unnecessary and unenforceable.]

Relations of the Mechanical Engineer to the Community

(Note. In order to avoid confusion, the term "technical societies" will be used to refer to the four Founder Societies and such others as confine their activities to specific professional or technical phases of Engineering. The term "general engineering societies" will be used to cover the federation—local, state or national—on such basis as may develop, of the various technical societies, their sections and others concerned with engineering.)

23. In the opinion of the Committee, the relations of the engineer to municipalities can best be cultivated through group activity, proper groups being the local general engineering societies which should include engineers of all classes. In state affairs, these relations may be developed through a coalition of such local groups into state associations, while matters of general and national interest may be handled by a national organization of such local, district and state societies. Such a system of societies is considered below.

24. The entity of the various local sections of the technical societies should be preserved, but they should form part of the local general engineering societies. In dealing with public affairs, their members should act as members of the general engineering society and *not* of the technical section.

25. Distinctly technical work such as the formulating and publication of safety codes, the fixing of standards, etc., should be done by those technical societies which, jointly or severally, are concerned with the particular subject: e. g., the Boiler Code by The American Society of Mechanical Engineers, wiring standards by the American Institute of Electrical Engineers, etc. But the agencies for bringing about their general adoption and legalization should be the general engineering societies local, district, state and national.

26. As embodying the above, the Committee presents the following resolutions:

27. *Whereas:* The Committee on Local Sections has been engaged in promoting coöperation between Local Sections of the American Society of Mechanical Engineers and other local engineering organizations, and

28. *Whereas:* it is desirable that this coöperation be encouraged and further vigorously developed not only among local but also among national engineering organizations, and

29. *Whereas:* engineering solidarity should be established to enable the profession to more effectively serve the community at large, therefore be it

30. Resolved: that the policy heretofore pursued by the Committee on Local Sections is heartily endorsed, and be it

31. Resolved: that the Council of the Society should actively encourage further development of coöperation both in local organizations under the leadership of local engineering societies, and in state or territorial groups, which can effectively handle state or territorial problems. This coöperation to take such form as will most readily lend itself to national coöperation, and be it

[In the resolution before amendment the words "as in Philadelphia or Cleveland" followed "local engineering societies," and the words "as in Minnesota or Ohio" the words "territorial problems."]

32. Resolved: that there should be created some agency of a national character through which the coöperation of local groups, state groups and national societies can be secured for purposes of national scope. This agency to be composed of representatives of the members of local groups, state groups and national societies. It should be an organization capable of speaking in the name of the profession, and be it

[The last sentence of the foregoing resolution before amendment read: "It should be an independent organization, fully empowered to act and capable of speaking in the name of the profession, and be it"]

33. Resolved: that The American Society of Mechanical Engineers should collect and publish in pamphlet form the various modes of coöperative organizations used in different localities, thus enabling each group of organizations contemplating coöperation, to more readily select the method best adapted to their local conditions.

34. Acting through the organizations above suggested, service to the community may best be promulgated along the following lines:

35. *Legislation.* Protection of Health, Life and Comfort—By securing the introduction of safety codes, of which the Boiler Code is an example, by securing the adoption and enforcement of measures for smoke prevention, the inspection of elevators, and the use of safety methods and appliances in the industries, etc.

36. Production, Distribution and Sale of Commodities—By the establishment of standards of size, strength and quality of manufacture of products, of standards of material, and standard methods of testing materials and performances.

37. Industries, Utilities and National Resources owned or controlled by Communities—By initiating and guiding legislation for their operation, development and conservation, and particularly by developing and securing the adoption of uniform systems of accounts and reports for public utilities, *both* privately and publicly owned.

38. Legislation for Protecting the Public in Engineering Affairs—By action to secure uniform State and Federal laws for the registration and certification of professional engineers whose work involves the public health, safety and well-being.

39. *Administration.* Placing Engineers in Public Positions requiring Engineering Training—By efforts to bring about the appointment rather than the election of engineering officials, and to secure the appointment and retention of the best grade of engineers in the public service; and also by cooperation with such civic bodies as the Civil Service Reform League.

40. Coöperation with Engineers in Public Positions—By encouraging such engineers to become members of the local general engineering societies, and by giving them the support of such societies when political or other influences seek to interfere with the proper exercise of their functions. The reports of such engineers may be made profitable and mutually helpful subjects of discussion and review by such societies.

41. Selection of Engineers to Meet Public Emergencies—The organization of the profession through general engineering societies seems to offer the best means for the prompt direction of the talent and efforts of engineers classifies as to their special abilities and experience, would be helpful in this connection.

42. *Enforcement of the Law.* By action in conjunction with other civic bodies rather than independently.

43. *Public Opinion.* By an active, but dignified program of education in the public press. This should be free from objectionable advertising and of a character which would broaden the public knowledge of, and its appreciation for, engineering achievements.

44. *Industrial Relations.* By active participation in the solution of the industrial problems now before us.

45. In his Presidential address before this Society in 1882, the second year of its existence, Dr. Thurston said:

> In singular and discreditable contrast with all the gain in recent and current practice in engineering, stands one feature of our work which has more importance to us and to the world, and which has a more direct and controlling influence upon the material prosperity and the happiness of the nation than any modern invention or than any discovery in science. I refer to the relations of the employers to the working classes, and to the mutual interests of labor and capital. It is from us, if from any body of men, that the world should expect a complete and satisfactory practical solution of the so-called Labor Problem. More is expected of us than even of our legislators. And how little has been accomplished?

46. Mr. Marburg in the progress report of this Committee in December last, said:

> Among all the educated classes, the engineers are the one group in closest touch with labor. It is the part of wisdom and our duty to Society to try to understand the strivings of the working classes for our own benefit and to interpret them to the rest of the community. If the British Labor Party has been able to frame a reconstruction program and to produce a document commanding the admiration of most thinking men, surely it behooves us, the engineers, the men of whom, on account of training and experience, industrial leadership might reasonably be expected, to discuss the mighty problems now before us.

47. The engineer was the first to attempt a definite solution of the problems involved. He has contributed most of the constructive work which has been done to date, and on him rests the principal burden of an adequate and constructive solution.

48. The political autocracies of the world have been overthrown, but industry remains to be democratized. Labor is not going to be contented with its present subservient and limited condition, and its discontent will not be ameliorated by welfare work or other manifestations of benevolent despotism. The engineer stands between opposing interests, frequently between extremists, the self satisfied obdurate employer who still regards labor as a chattel on the one hand, and on the other the radical laborite who would confiscate all forms of property. With his analytical habit of thought, his experience in estimating and directing physical and industrial forces, he must devise industrial methods which will insure greater and more efficient production and a more equitable distribution of it, and he must take the lead in their adoption.

49. As outlined above, action in public affairs should be through the general engineering societies, but discussion is distinctly within the province of our own Society. The Committee therefore presents the following resolution:

> 50. RESOLVED: that the Society should enlighten its membership in regard to all Federal, State and Local problems which should interest engineers, and in the solution of which their experience and training may be helpful.

Election of Officers

51. *Regular Nominating Committee for Elective Offices.* The Council referred the recommendations of the Committee on Local Sections and the Committee on Constitution and By-Laws on the manner of election of the Regular Nominating Committee by the voting membership to the Committee on Aims and Organization.

52. The plan of the Local Sections Committee was to utilize the organization of the local sections to affect this election, while that of the Committee on Constitution and By-Laws proposed dividing the country up into 15 districts of approximately equal membership and having one member on the Committee from each district.

53. The Committee on Aims and Organization carefully considered both the relative merits of the two plans and passed the following resolution:

> 54. RESOLVED: that it is the sense of the Committee on Aims and Organization that the regular nominating committee for the election of officers, as provided for in C48 of the Constitution, be composed of a member from each local section; provided that each voting member of the Society be assigned to some local section by the Committee on Local Sections exclusively for the purpose of electing a nominating committee member, and provided further that members of the Nominating Committee shall be elected annually for one year, and no member shall be eligible for more than two consecutive terms.

Time of Election

> 55. RESOLVED: that the Committee on Constitution and By-Laws be requested to prepare such changes in the procedure for the annual elections of officers as will permit the declaration of their election by a considerable time to be determined by the Council. [In the resolution before amendment the fourth line read "their election by November first."]

Information on Candidates

> 56. RESOLVED: that biographical sketches of all candidates for office in the American Society of Mechanical Engineers should be sent out with the ballot for election to office of the Society.

Respectfully submitted,

L. C. MARBURG, *Chairman*
D. S. KIMBALL
L. P. ALFORD
F. R. LOW
JAMES HARTNESS
W. F. M. GOSS
S. B. ELY

MEMBERS AT LARGE

	Section	
R. W. ANGUS	Ontario	SECTIONS DELEGATES
C. H. BIERBAUM	Buffalo	
L. P. BRECKENRIDGE	Connecticut	
E. S. CARMAN	Cleveland	
R. COLLAMORE	Detroit	
A. G. DUNCAN	Boston	
J. T. FAIG	Cincinnati	
H. P. FAIRFIELD	Worcester	
H. GASSMAN	Birmingham	
L. GUSTAFSON	St. Louis	
J. L. HENNING	New Orleans	
C. E. LORD	Chicago	
L. V. LUDY	Indianapolis	
T. C. MCBRIDE	Philadelphia	
G. K. PARSONS	New York	
C. H. REPATH	Los Angeles	
L. E. STROTHMAN	Milwaukee	
G. M. SPALDING	Erie	
E. F. SCOTT	Atlanta	
C. W. TUBBY	Minnesota	
A. E. WALDEN	Baltimore	
J. T. WHITTLESEY	San Francisco	
G. A. WESCHLER	Washington,	

DISCUSSION OF REPORT OF THE COMMITTEE ON AIMS AND ORGANIZATION

Adoption of Standards

The first resolution considered was as follows:

> 2. Resolved: that Section C-49 of the Constitution of The American Society of Mechanical Engineers be amended so that the Society may approve and adopt such professional reports and standards as shall from time to time be presented to it.

The section of the Constitution referred to (C-49) now reads: "Reports of such committees (Professional Committees) may be accepted by the Society and printed in the Transactions, but shall not be approved or adopted as the action of the Society."

The discussion of this resolution was mainly in the direction of clarifying ideas as to present procedure in passing upon reports, and as to the necessary changes in this practice in the event of the resolution going into effect. Secretary Rice explained that reports are now considered as recommended practice, ordered printed by the Council. The committee's names are affixed to each report so that a person reading a report can form his own opinion as to its authoritative character. Under the new conditions, instead of using the Society simply to give voice to the report, it would have the official approval and stamp of the Society.

Dexter S. Kimball said that the Aims and Organization Committee considered this one of the most important resolutions presented and that it reflected the suggestions received from a large number of members of the Society. If the Society believes in the Boiler Code, for example, why not say so and stand back of it? Alex Dow favored the present practice by which a standard is regarded as a gospel which may well be followed, rather than a creed which must be subscribed to. S. N. Castle held that an adopted report should be considered as carrying the minimum requirements rather than the maximum; an engineer could make his specifications as much better than called for by a report as he saw fit.

Major Fred J. Miller pointed out that the resolution as presented was in effect a proposition to amend the Constitution and that the vote should not be to that end, for which ample provision is made in the Constitution itself, but for the purpose of expressing approval or disapproval of the practice recommended. Past-President Jesse M. Smith accordingly proposed the following modification of the resolution, in which form it was adopted:

> Resolved: that it is the sense of this meeting that Section C-49 of the Constitution of The American Society of Mechanical Engineers be amended so that the Society may approve and adopt such professional reports and standards as shall from time to time be presented to it.

Professional Features of General Meetings

Arts. 4 and 6 of the report proposing that continuous tenure of membership on the Sub-Committees of the Meetings and Program Committee be discontinued and that such sub-committees be appointed for limited terms only, formed the subjects for discussion under this heading and were approved.

Dexter S. Kimball, Chairman of the Meetings and Program Committee, explained that the sub-committees referred to were intended to supply material for certain of the sessions at the Spring and Annual Meetings; and that sometimes they were effective and sometimes not. Instead of maintaining these as standing committees with continuous tenure of office, it was proposed to appoint committees for a fixed term as required, in order to carry out definite assignments, after which the members would go out of office automatically. By this means no committee could remain for several years on the list in the Year Book without accomplishing results.

President Cooley, referring to committee activities in general, said he had sent a letter to all members of committees and to all chairmen of Local Sections, requesting information as to the work of the committees in the first instance, and as to who were available for committee appointments in the second instance. In July he would go over the replies received and investigate the work of the various committees.

Research and Standardization

Arts. 7, 8 and 9 were next taken up. These proposed that the Society secure and appropriate funds for the conduct of research; formulate problems for investigation, and secure men and facilities for their solution; and that the Society establish the policy of formulating and adopting engineering standards (which, however, should be limited to elements), such standards being considered as progressive and not as ultimate. The resolutions as presented were approved.

W. E. Symons, Chairman of the Finance Committee, issued the warning that "we can't by resolution or legislation make one dollar into two," and stated that the appropriation for the Research Committee for the present year had been $4000, of which a considerable amount as yet remained unexpended. In response to his inquiry as to the desires of the Aims and Organization Committee with respect to funds and appropriations, Mr. Alford said that the committee was dealing with principles only and that there was no time limit whatever on the resolution. There was no thought of changing this year's appropriation, but that as the Society grew and its income increased it was believed that it should be the duty of the Society to secure and appropriate larger funds for research work.

Secretary Rice said that he hoped the Society, with an annual budget of $300,000, would appropriate more than $4000 for research. It should so spend at least one-tenth of its income, which, in good Bible terms, is considered a tithe of its income, for the benefit of others. The American Society of Heating and Ventilating Engineers, with a membership of about 1100, had collected a fund of $80,000 for the advancement of their art and science and Dean Allen of the University of Minnesota was to be the director of their research work at Pittsburgh. If necessary to accomplish the purpose, there could be a readjustment of our funds, certain committees receiving smaller appropriations and the Research Committee more. Past-President Oberlin Smith testified to the pressing need for research as shown by the discrepancies in the information given in our handbooks. C. H. Bierbaum, Chairman of the Sub-Committee on Bearing Metals, also emphasized the importance of research and standardization and said that it was a happy conclusion to the resolutions that they recommended simply the standardization of elements and not the combination of elements and that the work be not considered final at any time. During the discussion Frank B. Gilbreth, who had recently studied conditions in England, urged as an important subject for study and investigation, the fatigue of working men and women.

Industrial Engineering

The next resolution, Art. 10, recommending that Industrial Engineering be made a major topic of discussion, was introduced by Walter B. Snow, and at once brought a call from Alex Dow for a definition of Industrial Engineering, and from Charles E. Lord for an explanation of the distinction between the expression "Industrial Engineering" and that used later in the report, "Industrial Relations." Several tried their hand at definitions, a definition of industrial engineering. Mr. Snow said it was "engineering which has to do with industry." Professor Kimball said it was a well-understood term, difficult to define. It related more to the construction and operation of factories as distinguished from the design of clearly defined engineering construction. Robert T. Kent offered as a definition, "The application and use of the materials and machines of engineering in the industries; this to include problems of management and labor." Mr. Gilbreth gave a definition attributed to Mr. Kent's father, the late William Kent, who used to say, "Engineering is the

science of overcoming the resistance of nature, but industrial engineering is the science of overcoming the resistance of human nature." Professor Kimball explained that, assuming industrial engineering to have to do with the construction and management of plants, there exists a field still further away from design that has to do with the human element—the field of industrial relations between employer and employee, in which engineers can play a very large part.

Without further discussion the resolution of Art. 10 was adopted.

Education and Special Training

Arts. 11 and 12, introduced by Sumner B. Ely, approved the work now being done by the Society in connection with Student Branches and technical schools of higher grade and recommended that this work be strengthened; and that a strong committee should be formed to extend this work among the industrial school below the grade of colleges. Louis C. Marburg, Chairman of the Committee on Aims and Organization, expressed the belief that the field offered great opportunities of such importance to engineers that it should have thorough consideration by the Society. The resolutions were adopted.

Professional Sections

In view of the fact that there had been several requests for professional sections, as provided for by the Constitution, such as an ordnance section, power-plant section, etc., the resolution in Art. 15, introduced by S. N. Castle, was proposed, recommending a Standing Committee on Professional Sections. This resolution was approved after a brief discussion calculated to bring out the purport of the resolution. L. C. Marburg explained that as it was proposed to broaden the scope of the Society—with the attending danger that it might become superficial in dealing with technical subjects, it was desirable to have professional groups to which specific topics could be referred for treatment. In response to an inquiry, Mr. Marburg said that such groups would naturally form in the sections of the country where the industries which they represented were centered, but nevertheless, as further explained by Secretary Rice, they would represent horizontal divisions of the country rather than vertical and would be nationwide in their membership.

Development of the Society's Publications

Next in order were three resolutions introduced by G. K. Parsons, relating to the Society's publications, as follows:

16. Resolved: that Mechanical Engineering (The Journal) be made a weekly publication at the earliest possible date, and that the Committee on Publications and Papers be encouraged to publish matter of broader scope, including papers and articles that have not been presented at any meeting of this Society, news items of engineering interest, and the information of general interest now presented in Bulletins.
17. Resolved: that the Committee on Publications and Papers be requested to study the possibility of a substitute for the present expensive method of publishing the Transactions, presenting any plan developed to the members of the Society for letter ballot.
18. Resolved: that the Society publish, as soon as practicable a Handbook of Mechanical Engineering Data.

In introducing these resolutions, Mr. Parsons said they had been carefully worded to apply only "at the earliest possible date" and "as soon as practicable;" and as they were intended for the Council, and through them would be considered by the Publication and Finance Committees, their practicability would be determined by these bodies.

Discussion of Art. 16, Relating to the Development of "Mechanical Engineering" (the Journal). W. E. Symons, Chairman of the Finance Committee, opposed the more frequent publication of Mechanical Engineering on the grounds (1) that it would be regarded by other publications as a competitor and that their good-will which we now possessed would then be changed to opposition such as naturally results from commercial competition; and (2) that we would be in a position to suffer a heavy financial loss. He contended that it would be easy to lose a quarter of a million dollars in attempting weekly publication.

R. T. Kent testified to reading Mechanical Engineering thoroughly each month; but if issued in the weekly form he felt he would not have time to read it. He disapproved of soliciting contributions for publication except as presented at meetings, as he thought this would bring the Journal in direct competition with the technical press.

L. P. Alford called to the attention of the meeting that the Electrical Engineers had recently passed a resolution asking for the improvement and expansion of their journal and for an increase in its size to the standard 9 by 12 inches; and that a similar resolution was before the Mining Engineers, with prospect of adoption. He took exception to the suggestion that a weekly publication would earn the ill-will of other publishers. He spoke as an editor-publisher and would welcome the upbuilding of the Journal, since whatever was done to advance clean journalism would help his publication. Mr. Alford suggested that Major Fred J. Miller, who had had something to do with the establishment of the Society's Journal and had lately been investigating its possibilities for the future, should give his impressions.

Major Miller, in response, reminded the meeting that the resolutions of the Aims and Organization Committee were made by delegates representing the membership from all parts of the country; that they thought the Journal a good thing and wanted more of it. The qualification "at the earliest possible date," however, indicated that they did not expect the Society to bankrupt itself by making a weekly before it could be done advantageously. He said: "I believe the Journal occupies a field which is distinctive; that is a kind of a journal which no private publisher would probably want to undertake; and that it occupies a field which is not otherwise occupied. A journal either dies of dry rot or it goes ahead and progresses with the progressive ideas of the age and that is what the Mechanical Engineers' journal must do." He then outlined certain definite things which should be done in the development of the publication, such as the extension of the Engineering Survey, by which an engineer can keep in touch with the high lights of his profession without having to read 25 or 30 special journals; and by the strengthening and enlargement of the editorial staff, to permit the gradual enlargement of the Journal and to make it possible for one of the editors to travel and come into personal contact with the membership in different parts of the country.

Following these developments, if the Journal should have grown normally to the point where still more space was needed and the advertising income were sufficient, he could not see how it could become obnoxious to other publishers if it were made a semimonthly or a weekly, so long as its character were maintained, with the same kind of reading matter and under the same editorial direction. He was in favor of conservatism in the matter, as we were under obligation to be when handling the interests and the money of a professional society such as this. The whole thing could be summed up in so conducting the Journal that it would render the best possible service to the membership.

Mr. Symons, in reply to Major Miller's assertion that there were stages in the life of a journal where it might cease to progress and "die of dry rot," called attention to the marked growth of Mechanical Engineering during the past seven years, in circulation, advertising increase, money expended for production for the benefit of the membership, etc. Whereas the publication is very healthy now, he felt that if it were made a weekly it might become very unhealthy from a financial standpoint.

Alex Dow said that Mechanical Engineering was one of the few papers which he, a busy man, had time to go through "from cover to cover," and that it was one of the few papers whose make-up and advertising he admired. He wouldn't go through it if it came once a week, and so with many others. And herein, he thought, was a measure of its present advertising value. It is read by the very ones who do not read the weeklies. He therefore

took exception to the point in the resolutions relating to the weekly—it was an error in judgment—and he moved that the words "That Mechanical Engineering be made a weekly publication at the earliest possible date" be stricken out. The motion was seconded by W. O. Witherspoon, who said that he was a busy member of several societies and that what was needed was not so much more matter, but a stricter censorship of what was put in their journals.

During the debate on the question of the development of Mechanical Engineering the discussion drifted at times upon questions of practicability, in spite of Mr. Parsons' statement in introducing the resolutions that this was a question for the Council and the committees interested to determine. There was also considerable discussion as to expense involved and the utilization of the Society's reserve, details of which W. E. Symons, Chairman of the Finance Committee, contended should be made available so that "anybody who votes in the affirmative or negative on a question of such great and vital importance to the Society should know what he is voting on, expressed in dollars and cents." In the course of this discussion President Cooley, as chairman, asked to have the discussion confined to the general problems involved, as intended by the Committee, saying, "You needn't be afraid the Council will get you into trouble. The Publication Committee will have to come before us with figures, and if the Council is not sure of itself it will come to you again."

In justice to the Publication and Papers Committee, also, it should be told that the sentiment of the meeting with respect to the mission of Mechanical Engineering, the field which it is now filling, and its possibilities for development was most favorable. If the members of the Committee who were present were not embarrassed by the many good things which were said, the remarks at least must have been gratifying, as an expression of appreciation of their work.

The motion as amended by Mr. Dow was finally adopted.

Discussion of Article 17, Relating to a Substitute for Transactions. W. C. Brinton, in referring to Transactions, discussed also the procedure in handling papers in the Journal. In general, he proposed curtailment in the publication of papers, but that they be issued more completely in loose-leaf form, such copies being announced in the Journal and supplied to the membership as desired. Major Miller called attention to a similar proposal made several years ago, to do away with the bound volumes of Transactions and to substitute therefor papers printed in sections. Members would receive the sections of interest to them and not be burdened with the others. The plan had failed—members liked the looks of the bound volumes on their shelves—but it might be proposed again.

Secretary Rice said the Society was under obligations to supply Transactions, unless the membership should vote otherwise. In 1893 the membership dues were raised from $10 to $15 a year and it was agreed that if the members would stand for this they should receive Transactions in perpetuity. Mr. Rice, however, said the United States is the only country in the world where professional societies have to print the papers read at meetings in pamphlet form; then publish in the proceedings and later in a bound volume. The Society should consider whether it would not reduce this waste and put the money to a more useful purpose. R. T. Kent expressed a desire for the bound volumes, but believed the expense could be reduced, and advised the appointment of a committee to look into the matter. Jesse M. Smith contended that this was a function of the Publication Committee; and further, in respect to the wording of the resolution calling for a letter ballot on the subject, said that the matter could be more effectively handled by having the proper committee report to the Council, they in turn bringing up the report for discussion at a convention. Mr. Kent finally proposed an amendment to Art. 17, substituting for the words "letter ballot" the words "to report at the Annual Meeting." Mr. Smith seconded the motion, which, as modified, was later adopted.

Discussion of Art. 18 on the Publication of a Handbook of Engineering Data. In the discussion of this project it developed that the Committee had no definite plan to offer for a handbook, but that it believed it should be considered in its broad aspects with the possibility that a satisfactory plan would be developed. It was stated by Mr. Parsons, who introduced the resolution, that there was no intention of competing with any of the excellent handbooks now on the market. Following this statement, R. T. Kent said he felt free to discuss the resolution. If the Society were to publish a handbook which would not compete with any of the other handbooks, where is the field for it? What kind of data would it propose to put in? Had the Society considered the expense, which would run into thousands of dollars?

Major Max Toltz favored a handbook which should contain the data gathered by the Society. L. P. Alford said similar data were already published in Condensed Catalogues and thought that these data, with other material added, should go in a handbook. In reply to an inquiry as to the usefulness of Condensed Catalogues, Major Toltz said that in the West, where data readily available in New York are not accessible, the book was in constant use and that "we absolutely need it." Mr. Rice reported that an engineer in Salt Lake City had told him it was "the finest thing the Society gets out."

The resolution as offered was adopted, this and the two preceding as amended, being passed at the conclusion of the discussion.

Absence from Committee Work

Discussing Art. 19, dealing with absence from committee work, Major Toltz thought that the resolution if adopted and literally carried out would operate as a practical bar to western men serving on committees. Past-President Jesse M. Smith called attention to C-51 of the Constitution, which provides an effective means for removing inactive members from committees. Major Fred J. Miller stated that in his experience with the Society's work it had been very difficult to get action on any specific case of neglect of committee work, and the provision of the resolution therefore seemed to him eminently desirable. Carried.

The resolution in Arts. 20 and 21, on the Society's employment activities, were adopted without discussion.

Code of Ethics

Past-President Charles T. Main opposed the resolution in Art. 22 relating to abolishing the Society's Code of Ethics on the ground that many of the younger members found it of advantage to have a program outlined as a guide for their professional conduct. If it was imperfect it should be revised and amended. Past-President Oberlin Smith spoke in the same strain. Robert Sibley felt that the resolution should be defeated and spoke of the voluntary raising of $20,000 by engineers on the Pacific Coast to put forward a code and carry on education work among engineers in order that it might be put in practice.

Charles E. Lord called attention to the action taken at a recent meeting of the Committee on Development of the American Society of Civil Engineers in Minneapolis, which he attended as a representative of the Committee on Aims and Organization. In line with that action he proposed the following substitute resolution:

> Resolved: That it is the sense of this meeting that a short Code of Ethics of broad scope, general character and position rather than negative injunction, be proposed and that the same be enforced vigorously.

Jesse M. Smith approved of Mr. Lord's resolution with the exception of the clause regarding enforcement. There had been exceedingly few infringements on the codes of ethics of the national societies, and it seemed to him that the penalty for infringement should be in the sense of non-recognition by other members rather than expulsion or other forcible action.

Forrest E. Cardullo disagreed with the previous speakers and said that the Society did not need a code of ethics. All that was necessary was that members should be decent, honest men. Codes of ethics were heritages from an earlier day when the condition of the profession and the character of the men practicing them required such formulations.

Wm. T. Magruder then presented the following resolution

which embodied suggestions made by Messrs. Jesse M. Smith, Max Toltz and C. E. Lord:

> Resolved: That a committee of five on Code of Ethics be nominated by the President and confirmed by the Council, who shall report back to the Society at the Annual Meeting.

L. P. Alford, on behalf of the Committee on Aims and Organization, withdrew the original motion and those proposed by Messrs. Lord and Magruder were then unanimously adopted.

Relations of the Mechanical Engineer to the Community

Mr. Lord, chairman of the sub-committee that prepared the articles dealing with the relation of the mechanical engineer to the community (Arts. 23-50), at the suggestion of Mr. Alford read the first eleven articles. The resolutions offered, he said, were practically self-explanatory. The idea presented was one of federalization rather than amalgamation. It was to be clearly understood that there was no desire to change the status of existing engineering societies so far as any technical questions were concerned, but to develop some sort of coöperative agency for dealing more effectively and interestingly with economic, social and political matters. He then told briefly of similar activities on the part of the development committees of the Civil, Mining and Electrical Engineers and asked that Arts. 27-33 be approved.

Frederick H. Low offered the following as a substitute for Arts. 23-33:

> The Society commends the interest taken by its members as individual citizens in municipal, state and national affairs and recognizes that the local engineering societies are the natural and most effective exponents of engineering ideals as applied to public business.
>
> Therefore, the Society endorses the policy heretofore pursued by the Committee on Local Sections in conjoining the activities of our Sections with those of the local and state societies:
>
> Further, the Society looks with favor upon and will aid in the formation of a national organization of local societies whereby the voices of engineers as citizens of the United States may have their full value in the discussion of national and international questions.

Alex Dow stated that he believed in one keeping his different expressions of personality through his various affiliations separate. As a member of the Detroit Engineering Society he was not an engineer first but a citizen of Detroit. In the national societies he discussed engineering matters, but in the local society he discussed Detroit from the viewpoint of the engineers of Detroit. He entirely approved of the suggestion made that each member of the Society should be a member of a local society and express in that local body and in the affairs of the community the engineering ideals of truth which we must grow up with. The Society, however, should not undertake to embrace everything that was good, but should say that within its doors men are mechanical engineers first, leaving other matters to be taken up as personal duties in the churches, primaries, caucuses and other organizations of social and political life.

E. S. Carmen said that he could not see that Mr. Low's resolutions differed from the spirit or sentiments expressed in the remarks of Mr. Dow. Resolutions placed it entirely in the hands of the local and coöperating societies to unify the engineering professional work to and for the same high principles of citizenship.

Jesse M. Smith moved that the references to Cleveland, Philadelphia, Minnesota and Ohio in Art. 31 be stricken out, as he thought it was drawing an invidious comparison between the work done in those communities and that done in others. Carried.

Charles E. Gorton thought that the matter under consideration should be referred back to the Committee, to the end that similar committees of the other national engineering societies be consulted and something more tangible be evolved for presentation to the members for their approval.

L. C. Marburg, on behalf of the Committee, explained that the resolutions upon which a vote was asked would not be binding on the Society—they would simply be an expression of opinion as to the general plan. A joint committee had recently been created, consisting of representatives of the four Founder Societies, and at a meeting which it was proposed to hold in July in New York these matters would come up.

W. E. Snyder said it was becoming clearly apparent that the national societies wanted to do their utmost to meet the local societies in some sort of federation and that the resolutions before the meeting indicated a broad and liberal attitude and encouraged local members to attempt and continue the work. To him the original resolutions and Mr. Low's substitute were very similar. It made very little difference what phraseology was used—the spirit of the matter was the thing.

Jesse M. Smith said that he agreed with all that was stated in Arts. 31 and 32, with the exception of the word "independent" in Art. 32. This he thought to be a dangerous inclusion. He took a pardonable pride in recalling that the Local Sections of the Society were created in 1910 when he was its president. He had always stood for their development, but was fearful that it had been pushed too rapidly. Coöperation among the national societies was a most admirable thing and it pointed toward bringing all the societies together. He had outlined his views in this respect at the 1918 Annual Meeting, and in his address when installed as president in 1909 would be found the nucleus of what they were trying to bring about today. He was in hearty accord with Mr. Low's substitute resolutions, because they presented the substance of the Committee's views and yet avoided certain specific points which seemed to him dangerous.

W. E. Symons felt that the purpose of the resolutions as offered by the Committee was splendid. He was not, however, in accord with the method proposed for securing the objects sought, but was fully so with respect to Mr. Low's amendment. He could assure one of the previous speakers that any action taken on the resolutions before them would not be final, for a business meeting was not the Society's court of ultimate resort. The fundamental principles embodied in the Committee's resolutions were rather general in character and if later enacted into law and put into effect serious complications might arise. The cautions brought to their attention by Messrs. Smith and Dow and embodied in the amendment were timely, he thought, and should be heeded.

D. Robert Yarnall, while not sharing Mr. Smith's apprehension that the Sections were progressing too rapidly, felt nevertheless that in view of the fact that the resolutions offered by Mr. Low embodied the spirit of the Committee's presentment, the Committee might graciously accept them and thus avoid the dangers pointed out by Mr. Dow and Mr. Smith. He would therefore support Mr. Low's resolution.

Fred R. Low, who had earlier been called to the chair, took the floor and said that the idea of engineers coöperating was nothing new. The very plan referred to in the committee's resolutions had been in successful operation for years. One of the speakers who preceded him had said that there was a feeling in the Middle West that the national societies wanted to swallow up the local and state societies and that they were operated as a few men in the East wanted them to be operated. He did not believe that engineers in general had that feeling but that they had full confidence in the national headquarters of the Society. The Committee's proposal expressed from headquarters the sentiment that the Society wanted to encourage the local societies to incorporate all engineers within their local groups and devise some plan whereby a definite connection might be established between the locals, the large general local, and the national society, both technically and civically. There was nothing to fear, for at most, affirmative action on the committee's resolutions would be nothing more than a recommendation.

S. F. Jeter agreed with Mr. Smith that there was danger to be apprehended from the inclusion of the word "independent" in the resolution of Art. 32. An additional source of danger was the phrase "fully empowered to act." He could not see how a joint committee of all the societies in which mechanical engineers would have a one-to-three representation would be just and proper in the determination of questions strictly mechanical.

S. N. Castle said that there were at least 100,000 professional engineers in the country, 30 per cent of whom, barring duplications, are to be found in the national societies. The work of the

engineer, as he saw it, falls in two distant branches, his professional work and his work as a citizen, and to coördinate these two fundamental duties a working tool is needed. The spirit of the times was specifically for a formation from the ground up, comprising the purely local societies. From these a grouping into either state, geographical, social, economic or industrial divisions could be made. It seemed to him essential that with the present formation the highly desirable thing to do was to secure coordination between the local societies which handle primarily the community work, and the national societies which handle very largely professional work.

L. P. Alford, referring to Mr. Jeter's objection to the inclusion of the words "empowered to act" in Art. 32, said that the meeting the day before had definitely declared for an attitude of activity in indorsing the resolution in Art. 2 dealing with the adoption of standards.

In regard to coöperation, which, as he understood it, was the real meat of Mr. Low's resolution, it was not only the spirit of the times but, he believed, that of the majority of the Society's membership. Unwillingness to coöperate in the past had led in a number of instances to the withdrawal of members to form societies devoted to special branches of mechanical engineering, and many of the men thus lost were possessed of power and leadership. As he saw it, the issue was clean-cut. It was either to encourage the local organizations and reach out in the spirit of coöperation to other societies, or to stand pat and undoubtedly lose the advantages of other increases in membership which might have been had. He fully believed that the movement for coöperation was so strong that even rejection of the Committee's resolution could not kill it. The same movement was taking place in the other national societies and they were ready to go forward with the A. S. M. E. Was the latter to be the only society which would refuse to coöperate? Would it be the only one on the outside?

The Chairman then put to vote the motion to substitute the resolution offered by Mr. Low for Arts. 30-33 as submitted by the Committee, which was lost. The question of adopting the Committee's resolution was then taken up, but before a vote was taken, Jesse M. Smith moved to amend Art. 32 by striking from the last sentence the words "independent" and "fully empowered to act and." This motion being seconded, the amended resolution was adopted by vote.

Election of Officers

The resolution in Art. 50 was approved without discussion.

Art. 54 recommended that the Regular Nominating Committee, which as prescribed in the Constitution, is to be elected annually by the voting membership of the Society, should be composed of a member from each Local Section, each voting member of the Society being assigned to some Local Section by the Committee on Local Sections exclusively for the purpose of electing a Nominating Committee member. Robert Sibley criticized this resolution on the ground that a committee so composed would consist of too many members to be able to dispatch business adequately and secure harmonious results, and suggested reducing the membership of the Nominating Committee by dividing the country into a grouping of sections and that these groups nominate a committee of five. Such an arrangement, Jesse M. Smith argued, would create a condition whereby the Sections would be unequally represented because it would give the same representation to everyone of the Sections regardless of the number of members of the Society who might constitute it. To this objection Robert Sibley, and subsequently Louis C. Marburg, John J. Simmonds, Lawrence W. Wallace, H. John O. Hinchey and several other members, answered by observing that the Society being a national organization, it appeared to them more convenient to divide it into geographical groups for the purpose of representation in the Nominating Committee than to create the impression that its activities were being conducted principally for the benefit of those members who are residents in the localities where the greatest membership is at present found.

Secretary Rice observed that the provisions for selecting and organizing the nominating committees have not been written as yet in the By-Laws, and in this connection Jesse M. Smith said that the various views brought out during the discussion would enlighten the Committee on Constitution and By-Laws as to the sense of the membership in the manner of carrying out the constitutional amendments just adopted by letter ballot. No modification to the text of the resolution was proposed. President Cooley said in conclusion that although the subject had not been exhausted the discussion had been carried far enough so that the Committee on Aims and Organization could revise its recommendation to the Council.

The recommendation in Art. 55 requesting the Committee on Constitution and By-Laws to prepare such changes in the procedure for the annual election of officers as would permit the declaration of their election by November 1, was favorably commented upon by President Cooley, who expressed the opinion that such provision, if carried out, would permit a president to be coached in his duties before he actually assumed office, in which event the work could go on much more continuously and much more effectively. Jesse M. Smith spoke on the advisability of notifying the President of his nomination as early as possible, even at the Spring Meeting, and moved to substitute for "November 1" the words "a considerable time, to be determined by the Council." The motion was carried.

No changes were made in Art. 56, which was adopted in its original form as drafted by the Committee.

Following the acceptance of Art. 56 L. C. Marburg observed that as several of the resolutions which had been discussed and approved would call for constitutional amendments he would like to submit the following proposals. C-49 now reading:

C-49 Professional Committees:—The Council has the power to appoint, upon the recommendation of the Society at a general meeting, or upon its own initiative, such professional committees as it may deem desirable to investigate, consider and report upon subjects of engineering interests, but shall not be approved or adopted as the action of the Society. Any proposed expenses of such committees must be authorized by the Council before they are incurred.

To be amended to read as follows:

C-49 Professional Committees: The Council shall have power to appoint, upon recommendation of the Society at a general meeting or upon its own initiative, such professional committees as it may deem desirable to investigate, consider and report upon subjects of engineering interest. And proposed expenditures of this committee must be authorized by the Council before they are incurred. Reports of such committees may be accepted by the Society and printed in the Transactions.

C-50 The Society may approve or adopt any standard formula or engineering practice, but shall not approve any engineering or commercial enterprises. It shall not consent to the use of its name or initials in any commercial work or business, except to indicate conformity with its standards or recommend practices.

This proposed C-50 would supersede the present C-56.

C-45 *to be amended by adding* "Committee on Professional Sections" *and changing the sentence* "The Chairman of each Standing Committee of Administration shall have a seat in the Council......" so it would read: "The Chairman of all Standing Committees shall have a seat in the Council......"

C-50, reading at the present time as follows: "Each committee shall perform the duties required of it in the By-Laws or assigned to it by the Council; the Secretary of the Society shall be the Secretary of each of the standing committees," *to be amended by adding after the first sentence the following:* "Membership on the Council or any committee of the Society shall terminate automatically on account of absence of any member, either willful or due to force of circumstances, as provided in the By-Laws."

The last amendment elicited much discussion and some members considered its operation would deprive the Society of important and valuable membership on committees on the part of those whose names and prestige would make it desirable that they should serve even though their geographical position would not permit them to attend every meeting.

CRUDE-OIL MOTORS vs. STEAM ENGINES IN MARINE PRACTICE

BY J. W. MORTON[1], PHILADELPHIA, PA.

This paper is devoted to a discussion of the various factors to be considered in choosing the form of motive power for war vessels and cargo ships; also to a presentation of the advantages and disadvantages, as compared to steam engines, of crude-oil motors of the following types: constant-pressure, constant-volume, four-stroke cycle and two-stroke cycle. In the complete paper there will be found a description of some of the details of motor construction, dealing with lubricating systems, piston cooling and scavenging pumps.

THE number of articles which have appeared of late describing the performances of the so-called motorships would seem to indicate that for marine purposes the crude-oil motor is rapidly replacing the steam engine. The chief reason for this is not to be found, as might be expected, in the lower operating cost of the crude-oil motor but is rather due to other factors which when considered lead to the conclusions that it is probably the most economical prime mover of today.

Perhaps the correctness of this statement can best be shown by comparing a steamship with a motorship. In the case of a war vessel, for instance, there are eight factors which ought to be considered in choosing the form of motive power, namely, weight, space occupied, radius of operation, preparedness, crew necessary, fuel, auxiliary equipment, and cost.

The weight of the power plant is of great importance, for a saving therein can be utilized to increase the armor of the ship. If for example, a warship of 3500 tons displacement or equipped with crude-oil motors there would result a saving as indicated by Table 1 which is based on a single steam engine developing 4400 hp. and 3 units of 1600 hp. each of a standard make of crude oil motor.

TABLE 1 COMPARATIVE WEIGHTS OF POWER PLANTS IN STEAMSHIP AND MOTORSHIP

	Steamship		Motorship		Saving in Motorship	
					W'ight Tons	Per Cent
Engines, tons	335		264		71	
Per cent of displacement		9.6		7.5		2.1
Fuel, tons	246		86		160	
Per cent of displacement		7.0		2.5		4.5
Crew, Provision, Water, tons	91		82		9	
Per cent of displacement		2.6		2.3		.03
Totals	672		432		240	6.9

In the case cited about the same space would be required for both motor plant and steam plant, but the total horsepower could just as well be developed by two units of slightly larger size, and if this were done approximately one-third the space would be saved. Moreover if oil motors were used the space occupied by the coal bunkers could be partially released, as crude oil can be stored in tanks under the engine floor and below the protective line.

It is obvious that a warship must possess a great cruising radius and if weight for weight of engines be considered then the ratio R of the cruising radii of a steamship and a motorship be expressed by the formula:

$$R = \frac{V_c \times H_o \times W_c}{V_o \times H_c \times W_o}$$

where V_c = cu. ft. occupied per ton of coal = 45
V_o = cu. ft. occupied per ton of oil = 35
H_c = B.t.u. per lb. of coal = 12,500
H_o = B.t.u. per lb. of oil = 18,000
W_c = Lb. coal consumed per e.hp-hr.
W_o = Lb. fuel oil consumed per e.hp-hr.

In the case of the warship under consideration if W_c be taken as 2 and W_o as 0.5 then the ratio will be

$$R = \frac{45 \times 18000 \times 2}{34 \times 12500 \times 0.5} = 7.4$$

The cruising radius will of course vary according to the type of engine and ship, but nevertheless the average ratio as expressed above may be taken at least as 1 to 5 in favor of the crude-oil motor.

A motorship in sharp contrast to the steamship is always ready for action, as no time is lost in getting up steam. Moreover, fuel is consumed only when the motors are running, and the motorship is capable of maintaining full speed as long as there is a supply of fuel.

As there is no need for stokers on a motorship, the crew can be decreased about 10 per cent and this of course permits of a corresponding saving in provision, water storage and quarters.

In the case of a steam-driven warship the smoke from the stack frequently betrays the location of the ship, for it is well known that a vessel can be easily located by its smoke long before the masts or hulls are in sight. Another drawback to the steam-driven warship lies in the fact that the smoke covers the ship with a film of soot which, getting into vital parts of auxiliary machinery, necessitates frequent cleaning and unnecessary wear and tear. On the other hand, when oil is used there is no smoke, the handling of the oil is both cleaner and easier, and the life of machinery and equipment is greatly increased.

When a change is made from steam to oil the auxiliary machinery is usually electrically driven, as this has been found to be the most satisfactory. The dynamos are usually driven by separate oil engines. Hot water for heating and sanitary purposes is obtained from a small oil-fired boiler and while the first costs of such installations are high, they are in time offset by the lower operating costs.

Prior to the war the first cost of a crude-oil motor plant was approximately twice that of a steam plant. This was partly offset, however, by the savings in operating expenses, under which item comes cost of fuel, labor and supplies. The cost of fuel naturally depends upon the prevailing market for coal and oil. In regard to maintenance there is practically no information available as the crude-oil motor is still in its infancy so far as this country is concerned.

CARGO SHIPS

Many of the preceding statements concerning the installation of crude-oil motors on battleships can also be properly applied to cargo ships. During the last four years a number of such vessels have been equipped with crude-oil motors of both the two-stroke and four-stroke cycle type, and while engineers are not agreed as to the best type, the four-stroke cycle seems to be preferred.

One of the most successful installations of this kind is that found on the motorship *Suecia*. This ship has a length of 362 ft., a beam of 51 ft. 3 in., a depth of 25 ft. 6 in., and a capacity of 6550 deadweight tons, has twin screws driven by two 1000-hp. Diesel engines of the 8-cylinder 4-cycle type, and also two auxiliary engines of 200 hp. each. The vessel was built for service between Sweden and La Plata and its first run was a test made on December 4, 1913. The curves in Fig. 1 give some idea of the characteristics of the motors. The dotted curves are given for the sake of a comparison with the steamship *Princessan Ingeborg* built two years before the *Suecia* and for the same company. The

[1] Asst. Engineeer, Diesel Engine Unit, U. S. Shipping Board, Philadelphia, Pa.

Presented at the Spring Meeting, Detroit, June 16 to 19, 1919, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. The paper is here printed in abstract form. Copies of the complete paper may be obtained at a nominal cost. All papers are subject to revision.

Princessan Ingeborg has a length of 300 ft., a beam of 48 ft. 9 in., a depth of 22 ft. 4 in., and a capacity of 5895 deadweight tons. The coefficient for the *Suecia* is 0.78 and for the *Princessan Ingeborg* 0.794 and thus both vessels are about equal in size and excellence. A comparison will show that the same amount of power is necessary to obtain equal speeds when the displacement are equal. This would seem to indicate that there is no difference between transmitting power through two small comparatively fast-running screws as is done on the motorship and transmitting power through a single slow-running screw as in the case of the steamship. The propeller on the steamship has a diameter of 17 ft. while those of the motorship are only 10 ft. The ratio of indicated to effective horsepower is, therefore, the same for both ships and the total efficiency of engines and propellers is also about the same.

In order to correspond to the motorship in horsepower the

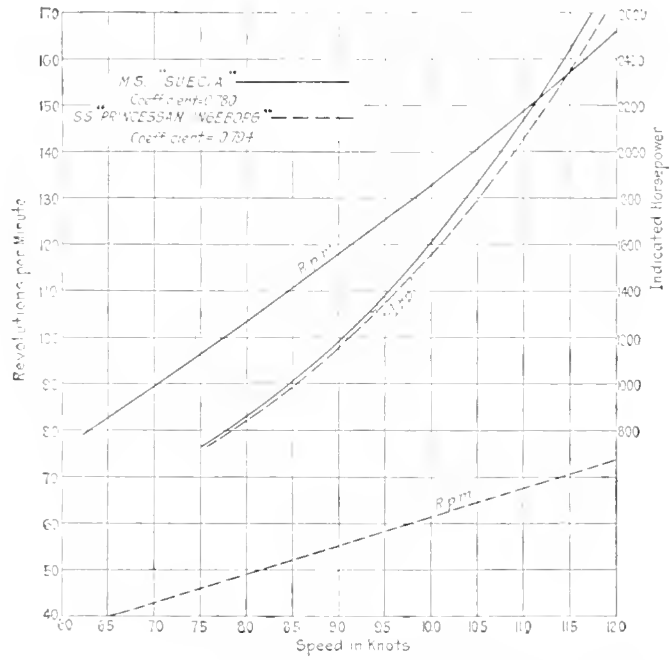


Fig. 1 Motor Performance Curves of Steamship and Motorship

steamship would be obliged to carry an extra boiler. This would increase its weight 570 tons whereas the weight of the machinery on the motorship is only 470 tons. The length of the engine room of the motorship is 41 ft. while the length of engine room and necessary boilers in the steamship is 66 ft. and this despite the fact that the steamship has less horsepower.

The fuel consumption during the trial trip of the *Suecia* was 0.2948 lb. per i.hp. or 0.3685 lb. taking the mechanical efficiency at 80 per cent, a very satisfactory value. Table 2 affords a comparison of this vessel with other motorships.

Motor Sizes and Types

The horsepower of a crude-oil motor, whether of the constant-volume or constant-pressure type, is somewhat limited by practical considerations of construction. At the present time the maximum size is 2500 hp. per shaft and from six to eight cylinders for the two- and four-stroke cycle constant-pressure type, although some experimental motors have been built as large as 6000 hp. This is in sharp contrast, however, to the power developed by steam, which runs as high as 15,000 hp. for the steam engine and 35,000 hp. for the steam turbine.

Crude-oil motors of small horsepower are usually of the high-pressure type, intermediate, so-called semi-Diesel or hot-bulb type and two-cycle constant-volume type. Prominent among such semi-Diesel motors are the Bolinder, Scandia, Abance, Alliance, Tuxhan, Gidion and Holm.

It has been proven both by experiment and practice that the constant-volume high-power single-cylinder type of motor is unsatisfactory, and chiefly because of the fact that the enormous heat generated at the pistons during the explosion must travel a great distance before it is transferred to the water jacket; and as a result the central part of the piston is heated to such an extent that preignition frequently occurs. Furthermore, the sudden rise in pressure sets up detrimental vibrating stresses in the material, and it is also exceedingly difficult to obtain a proper mixture of air and oil, rapid ignition and complete combustion and exhaust.

On the other hand, the constant-pressure oil motor of high power must have numerous cylinders all of the same size, and the high pressure, which lasts approximately 10 per cent of the stroke, necessitates a careful design of the crank mechanism. This applies especially to the crankshaft which is both difficult and costly to produce. Moreover, in motors with only a few cylinders the flywheel must be heavy, large and expensive if there is a great variation in speed. Difficulties have also been encountered in keeping the piston leakproof: if it fits too tightly the result is a large frictional loss, and if the clearance is too great there will be a loss of pressure. The greater the piston area the more effective must be the cooling system as the surface exposed per pound of working medium decreases as the cylinder dimensions increase. This accounts for the lower thermal efficiency and the horsepower available per unit of piston surface with large cylinder size.

Low-Power Motors

Advantages. The efficiency of an oil motor is greater than that of a steam engine, especially in small units, and furthermore it decreases less with increasing load. The fuel consumption of an oil motor is independent of the attendants' skill, as it shows the same value in daily work as on a test stand. With a steam engine, however, the fuel consumption is dependent upon the attendants, and especially the stokers, who must be experienced.

In steam plants the boilers and pipes must be able to withstand high pressures and temperatures, but with oil motors a high pressure exists only in the cylinder and a few small pipes. Moreover, the oil motor is simpler in construction and the weight and space occupied considerably less. It is of interest to note in this connection that the steam turbines in torpedo boats weigh about 45 lb. per b.hp. and aeroplane motors but little over 1 lb. per b.hp.

The small oil motor has other advantages over the steam engine and these can be briefly enumerated as follows: Starting takes only a few seconds; fuel is consumed only during operation; combustion in the motor cylinders can take place for a long period of time; the motors require little attention and the oil tanks can be refilled more easily than coal bunkers and without the dirt which accompanies the latter procedure.

Disadvantages. It must not be thought that oil motors have no disadvantages, for there are many, and chief among them may be mentioned the following: Fuel oil is more expensive than coal and is not available in all ports; furthermore, lubricating oil consumption is greater than in the case of steam engines as one must deal with higher temperatures and, as a rule, higher pressures. The operation of a crude-oil motor is also more irregular than that of a steam engine as oil motors cannot be run as slowly as is desirable when reversing from ahead to astern. The causes of interruptions (especially with electrical ignition) are often difficult to locate; the motor frequently works noisily with smoking and malodorous exhaust; the danger due to fire and explosion is greater, and the life of the machine is considerably less.

High-Power Motors

Advantages. The statements made in regard to the low-power crude-oil motor are also true to a certain extent in the case of the high-powered, but in addition the following items should be noted: With larger output the economy of a power plant becomes of greater importance. The low efficiency of most steam plants is due to the fact that the heat generated must travel through heavy boiler plates, and that there is a great loss of heat through exhaust, and condensation of steam. Furthermore, the steam plant operates with a small temperature difference which ought not to be increased because it is very desirable to work with

high temperature limits. With saturated steam the pressure soon increases beyond a practical value, and with superheated steam the walls of the superheater soon reach their limit as they should never be allowed to become red-hot. On the other hand, in the oil motor the heat formation and utilization take place in the working cylinders, and the high temperature limit is therefore the same as the temperature of combustion. The value of the lower temperature limit is greater than in a case of a steam plant, but the heat difference of the process is higher.

Another advantage of the oil motor is due to the ease with which the air supply necessary for complete combustion is regulated, and since the point of ignition is practically constant, there results complete combustion. On account of the great heat which exists in a boiler room it is very difficult for the stokers to maintain normal pressure; the coal consumption is accordingly increased but the speed of the vessel decreases. On the other hand, in the case of the motorship the reverse holds true. If the fuel oil becomes warmer it is more easily vaporized, with the result that fuel consumption decreases while the speed of the vessel increases.

Since fuel oil can be stored in tanks a considerable saving can be made in space, more oil can be carried and a greater cruising radius thus afforded. The weight of a slow-running four-cycle stroke oil motor for a cargo ship is about the same as that of a steam plant, but far less space is required. The horsepower and speed are about the same for a twin-screw motorship as for a single-screw steamship, but as the former's screw diameters are smaller its efficiency is greater and the vessel can thus be more easily maneuvered. The cylinders of a motorship are all similar, and since they work independent of each other, one or more of them can be put out of service and the motor still continue to operate.

Steam boilers and their fittings require as a rule a considerable outlay for repairs and maintenance; also the sides and bottom plates of the hull which are nearest to the coal bunkers are likely to corrode because of the sulphur content of the coal and in addition sea water in the ballast tanks may also cause corrosion of the plates. On the other hand, a motorship has no boilers and the fuel is stored in bottom tanks and this very fact is a great advantage since such tanks are protected by the oil.

Disadvantages. In a case of a single-cylinder oil motor the torque acting on a single shaft is limited but, everything else being equal, such as shape and line of hulls, propellers, r.p.m. and b.hp., the indicated hp. of the motorship will be greater than that of the steamship.

Since the reciprocating parts in a crude-oil motor weigh more than those of a steam engine the balancing of the masses is more difficult and the shifting forces greater. At light loads the pistons in a large motor are not tight enough to maintain high compression and since the combustion space is not sufficiently warm for positive self-ignition, large motors can only be run when under light loads at approximately one-third to one-fourth normal speed. Furthermore, the heat transmitted to the cooling water per unit area of the cylinder is about $2\frac{1}{2}$ times as great in a combustion chamber as in the cylinder walls, accordingly the heat drop in the cylinder wall is very considerable and tends to introduce stresses in the material, and if the limits of the elasticity are exceeded these stresses will be transmitted to distant parts. The material is also subjected to high stresses as a result of the rapidly repeated power impulses, the high temperatures, and great pressure in the cylinder.

TABLE 2 DATA ON VARIOUS CARGO MOTORSHIPS

(Number of main motors on each ship=2)

Name of Ship	Year placed in service	Owner	Hull					Machinery							
			Length ft.-in.	Beam, ft.-in.	Depth, ft.-in.	Capacity, deadweight tons	Speed in knots	Total i.hp.	No of cylinders in each motor	Bore, mm.	Stroke, mm.	R. p. m.	Ratio of Stroke to bore	Piston speed, meters per min.	M. e. p., kg. per sq. cm.
Suecia	1912	Nordstjernan	362-0	51-3	25-6	6550	$10\frac{3}{4}$	2000	8	500	660	140	1.32	185	6 2
Selandia*	1912	East Asiatic Co.	370-0	53-0	30-0	7400	12	2500	8	530	730	140	1 38	204	6 2
Pedro Christophersen	1913	Nordstjernan	362-0	51-3	25-6	6550	$10\frac{3}{4}$	2000	8	500	660	140	1 32	185	6 2
Siam	1913	East Asiatic Co.	410 0	55-0	30-6	9700	$11\frac{1}{4}$	3000	8	590	800	125	1.36	200	6 2
Annam	1913	East Asiatic Co.	410-0	55-0	30-6	9700	$11\frac{1}{4}$	3000	8	590	800	125	1 36	200	6 2
Kronprins Gust. Adolf	1914	Nordstjernan	362-0	51-3	25-6	6550	$10\frac{3}{4}$	2000	6	540	730	140	1 35	204	6 4
California	1913	United Steamship Co.	405-0	54-0	35-0	7250	$11\frac{1}{4}$	2600	8	540	730	140	1.35	204	6 2
Kronsan Margareta	1914	Nordstjernan	362-0	51-3	25-6	6550	$10\frac{3}{4}$	2000	6	540	730	140	1 35	204	6 4
Fionia*	1914	East Asiatic Co.	395-0	53-0	30-0	6700	$13\frac{1}{2}$	4000	6	740	1100	100	1 49	220	6 34
Malakka	1914	East Asiatic Co.	410-0	55-0	30-6	9200	$11\frac{1}{4}$	3100	6	630	960	125	1.525	240	6 2
Tongking	1914	East Asiatic Co.	410-0	55-0	30-6	9200	$11\frac{1}{4}$	3100	6	630	960	125	1 525	240	6 2
Pacific	1914	Nordstjernan	362-0	51-3	25-6	6550	$10\frac{3}{4}$	2000	6	540	730	140	1.35	204	6 4
San Francisco	1915	Nordstjernan	362-0	51-3	25-6	6550	$10\frac{3}{4}$	2000	6	540	730	140	1.35	204	6 4
Panama	1915	East Asiatic Co.	410-0	55-0	30-6	9200	$11\frac{1}{4}$	3100	6	630	960	125	1.525	240	6 2
Australien	1915	East Asiatic Co.	410-0	55-0	30-6	9200	$11\frac{1}{4}$	3100	6	630	960	125	1 525	240	6 2
Columbia	1915	East Asiatic Co.	425-0	55-0	30-6	9500	11 15	3100	6	630	960	125	1.525	240	6 2
Chile	1915	East Asiatic Co.	425-0	55-0	30-6	9500	11 15	3100	6	630	960	125	1.525	240	6 2
Oregon	1915	United Steamship Co.	405-0	54-0	36-6	8270	11 0	2800	6	590	900	140	1 525	252	6 1
Peru	1916	East Asiatic Co.	425-0	55-0	30-6	9500	11 15	3100	6	630	960	125	1 525	240	6 2
														(Avg.)	6 24

*Cargo and passenger vessel.

CONSTANT-PRESSURE MOTORS

Low-Pressure Types. The low-pressure oil motor is perhaps the simplest prime mover of its kind and is especially adapted for use in small boats where the operators are usually unskilled. The chief advantages of this type of motor are its low first cost and small operating expenses. Furthermore, the low temperature in the cylinder and the low explosion pressure together with its simplicity of operation make it a motor of great durability. This type, however, has some disadvantages and chief among them are its small power output, large cylinder dimensions, excessive weight and long time required for starting.

Hot-Bulb Type. The so-called hot-bulb motor operates at a medium pressure, with or without water injection. While the tendency today is to avoid water injection, if the hot-bulb motor be nevertheless operated with water injection its fuel consumption will be comparatively low; the temperature of inlet air low; overheating of cylinder and piston will seldom occur; the cylinder will

remain clean for a longer period and the piston rings will not gum or stick. The water tank, however, takes room, adds weight and considerably reduces cargo space. Furthermore, despite careful attention, corrosion and rust will rapidly destroy the motor, especially if sea water is used. The most serious objection, however, lies in the fact that the amount of water injected must be regulated according to load and this necessitates constant attention.

On the other hand, if the intermediate-pressure motor is operated without water injection, the cost of maintenance is low, the mechanism construction simple and little attention is necessary. Its chief operating difficulty lies in the inability to properly time the supply of fuel oil as its injection against the highly compressed air is exceedingly difficult in the short time allowed before ignition takes place.

High-Pressure Type. The advantages of high-pressure motors with self-ignition and injection of fuel oil during the high-compression cycle are practically the same as those of the intermediate-pressure motor without water injection. High-pressure motors, however, are usually operated with an oil chamber and such a type is very economical, has a high mean effective pressure, its cylinders are small, its weight low and it can be started without any preliminary operations. Furthermore, since the fuel oil is not injected against a high pressure the fuel-oil pumps can be of simple design and consequently easily maintained. Like all other motors, however, this type also has its disadvantages, chiefly the fault of design and construction rather than operation. If the size of the oil chambers or atomizer holes be improperly proportioned, fuel-oil consumption will greatly increase. Since this type of motor cannot be started by hand pressure air is therefore necessary and consequently the motor must be manufactured with great care. This of course means a higher initial cost. In operation, the ignition and combustion cannot always be controlled and especially if inefficiently operated preignition will occur.

Four-Stroke-Cycle Motors

Advantages. This type of motor is particularly well-adapted to high-speed work since it has a separate suction and exhaust stroke and thus the cylinder is filled each time with a full and new charge. Compared to a corresponding two-stroke motor it uses less fuel per brake horsepower. Furthermore, it does not employ a scavenging pump, receivers, etc., and the motor construction is therefore simplified and better adopted for continuous hard work.

Disadvantages. The chief objections to this type of motor are its increased weight and the greater space required. On account of the increased number of valves the valve gear is more complicated and noisy. Except with very large output the piston can act as a crosshead and unless the cylinder diameter be greater than 20 in., water cooling is unnecessary. The crank motion of this type of motor necessitates a heavy crankshaft and heavy flywheel if smooth running is to be obtained. Furthermore, the exhaust valves are subjected to high temperatures and occasionally give rise to considerable trouble. This type of motor is exclusively used for the Danish and Dutch merchant marine and also finds a large field in the automobile and aeroplane industry as gasoline and gas engines work as a rule in the four-stroke cycle.

Two-Stroke-Cycle Motors

Advantages. Compared with a four-stroke motor a two-stroke-cycle motor has a greater output per cylinder and everything else being equal, this will usually be about 75 per cent. On account of its greater pressure at the beginning of the compression stroke the weight of the charge can be increased if the stroke volumes are equal. On the other hand, the power is exerted only during three-quarters of the stroke as during the remaining portion exhaust takes place. Thus the total stroke volume is not completely filled at the beginning of compression with a fresh charge, and the result is that for the same cylinder dimensions the output is only 75 per cent greater than for a four-stroke motor. This difference, however, becomes even less for high-speed two-stroke motors since the mean effective pressure is lower. By forced scavenging through the valves the fresh air charge can, however, be made cleaner. In large units only the starting and fuel valves are subjected to high temperatures. In the open-type four-stroke motor, vapor from lubricating oil and exhaust gases can escape into the engine room, thereby causing impure air conditions. This, however, does not occur in a two-stroke motor which has a closed crankcase. Finally, the two-stroke engine is very smooth running because of its more uniform torque.

Disadvantages. The chief disadvantage of the two-stroke motor is its high operating cost. This is due to its higher loss of fresh air charge through exhaust parts and smaller utilization of the working fluid and higher heat loss due to cooling friction and increased pump work. The mean effective pressure is lower because during the working stroke exhaust also takes place. The mean temperature during the cycle is higher than in the four-stroke motor and consequently cooling of the piston is necessary. Furthermore, the piston can act as a crosshead only in small motors; lubricating-oil consumption is greater and the exhaust ports become overheated if not water-cooled. Finally, the stresses exerted on the moving parts are very large and therefore there must be ample sliding and bearing surface. The two-stroke type of motor is chiefly used in vessels where weight, space and first cost are the deciding factors. Its reliability and economy, however, have not been so marked as in the case of the four-stroke motor although in the Scandinavian countries, Germany and Italy it has been used to a considerable extent.

Notes

The exigencies of the war and the reconstruction period are forcing narrow-gage railways into engineering notice in England, where many productive areas are still isolated from the centers of consumption. It is urged that the available material for hundreds of miles of the light railway which was developed so effectively in the zone of communications at the front can now be put down in the remote districts of England by the experts who built similar lines in France, without the complicated legal and parliamentary procedure required to put through a standard-gage line and at much lower first cost and operating expense than main-line railways or highways.

An article describing the ventilation plant of the Simplon Tunnels, published in four recent issues of the *Schweizerische-Bauzeitung*, discloses some of the interesting questions which were considered in the determination of the position and the dimensions of the fans. There is only one ventilation plant for the two tunnels. The northern inlet at Brig was selected for the location of the plant, partly because meteorological conditions proved that the barometric pressure is in general higher at this entrance so that less power would be required for maintaining an air current from north to south than in the opposite direction, and partly also by the fact that the whole organization of the tunnel service was concentrated at that town.

The plan of having the current in each tunnel follow the direction of the train motion was not adopted because it had been observed that, when the air was taken in at Iselle, all the iron in the tunnel structure rusted badly. The reason was that the air at the southern entrance, being warmer and more humid, became cooled and deposited its moisture while traveling in the tunnel. In order to reduce the air resistance to a passing train and the power demand on the ventilation plant, the ventilation is shut down during the northward passage of the train.

Each of the two ventilators in the plant is a fan of $11\frac{1}{2}$ ft. external diameter and 5.13 ft. wide, with a central suction opening $8\frac{1}{2}$ ft. in diameter; six parallel rows of buckets, built of wrought-iron blades and partitions, take up 4.1 ft. of the width of the wheel; the hub is of cast iron. Each fan is directly coupled with an asynchronous three-phase motor which is fed with railway current at 3200 volts and a frequency of $16\frac{2}{3}$.

CORRESPONDENCE

Contributions to the Correspondence Departments of Mechanical Engineering by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in this journal, or brief articles of current interest to mechanical engineers.

How Can Engineers Be of the Greatest Use to Civilization?

To the Editor:

Engineering depends upon knowledge of facts and upon putting that knowledge into practice.

The exact form that the practice may take is guided by the conditions at the time and place concerned. There may be differences of opinion as to the exact value of those facts because of difficulty in getting perfect measurements, but as to the facts themselves, engineers are agreed.

It does not matter to the engineer whether these facts are found in a book on physics, or natural philosophy, or the first book of science, or whether they are found in an engineer's handbook.

Imagine, if you can, an engineer proposing that the law of gravity for a certain place be established by a vote of the people, or that delegates be appointed who should meet with delegates from other countries to come to a working understanding on a fair and just multiplication table, or that designers should get together and compromise their differences so that the mechanical properties of bodies should be the same in all countries!

There may have been a time when such an attempt could have been made, but if so, it was before there was any general knowledge of the principles upon which engineering is founded.

Many times statements come from engineering sources that engineers do not receive the recognition in the general affairs of the world to which their knowledge and training point. So general are the facts upon which such statements are based that they may be accepted as true, and if they are true there must be a reason for that truth.

Various reasons have been given for this state of affairs, but it has seemed to me that they do not go deep enough to get to the root of the matter.

No man who is educated to the point where he deserves to be called an engineer ever quarrels with the truths, or laws, upon which his profession is founded. In dealing with the circle, for instance, he knows that the diameter and the circumference have a fixed relationship to one another even though he cannot express in figures what this relationship is to absolute correctness, and he knows this, whether he uses 3 1/7 to 1 as the ratio of the circumference to the diameter as being accurate enough for the case in hand, or whether he uses figures which come nearer to the truth.

Even in matters in which the knowledge of the underlying laws is still very incomplete, as with wireless electricity, the engineer never doubts the existence of these laws, and his efforts are always directed to finding them and obeying them, for he is sure that only by so doing can he really succeed.

Knowing so much in his own particular part of the world, how can the engineer avoid the conclusion that the remainder of the universe is founded on just as fixed laws? If he does so conclude, why does he not act in harmony with his conclusions? If he is in doubt in the matter, why does he not investigate in a manner to find the truth?

Is there any evidence that engineers are clearer thinkers in every-day affairs outside of their line of engineering than those who are not engineers? If they are not, why should the public give them a larger part in its affairs? If they are, why does it not show in their position in the affairs in which we all are interested?

In matters such as taxation, one which affects every individual and every community, for instance; or the prohibition of the use of intoxicants; or the choice of candidates for public office; or the enforcement of laws in local affairs; or in the numbers of other things which no one of us can get away from, is the engineer guided by trained reasoning powers which seek out the truth, or is he controlled by his passions, his prejudices and his inherited superstitions, just as are the so-called uneducated?

Unless we, as engineers, can show that our education as engineers does fit us for leadership in these other things, why should the public have any more use for us than it now has?

Of course, it is much more pleasing to think that fault in the matter rests on the public and not on us, but the truth is the thing that will control in this matter, just as it does in engineering matters.

The activities of the members of this Society have gone far beyond our original aims; new boundaries are being thought of and need for a larger vision has been pointed out and a new code for our guidance has been urged. While we are thinking of these things, should we not recognize that all truths are comrades fighting the battles of civilization, whether these truths are religious, political, social or engineering truths, and that all untruth is on the other side, fighting against civilization?

Engineering developed because it sought out, found and accepted things that are the tools of the engineer, and if civilization is to grow and prosper and endure it must rest on a like foundation of truth in all matters that are the tools of civilization.

If the belief that truth of all kinds will finally prevail is not justified, the outlook for the future is surely a dark one. If the belief *is* justified, then honor belongs to those who find and practice truth, and we as a society and as individuals should always be on the side of truth in all of our human activities.

Engineers have numerous handbooks. Go to any of these that you will, and you find that there is perfect agreement in the fundamental principles. If there is any disagreement it is in regard to the best way to apply these principles, but as to the principles themselves there is no disagreement. If any member of any of these engineering societies were to try to start a movement to have a vote taken to adopt something else instead of these foundation principles, he would be expelled and perhaps shut up in an insane asylum; and certainly a person who did not believe in these principles would not be admitted to membership if his beliefs were known.

Why not have handbooks of civilization in which will appear the fundamental truths against which no agitation will be permitted, either under the guise of free speech or under any other form; and if any will persist in working against these truths, why not put him in an insane asylum or deny him the privilege of membership in the society of civilization?

The universe and every atom contained in it is built upon truths, and these truths cannot be altered by any action on our part, but all real progress must be in line with them. Have we vision enough to see this? Have we the courage to look it in the face?

W. O. Platt.

Oil City, Pa.

Regarding the Society's Employment Service

To the Editor:

I was greatly interested in reading the Society Affairs Section of Mechanical Engineering for May, and particularly in the subject, Some of Our Problems.

I note that under this subject mention is made of the Employment Department and the question raised, Shall we continue Employment Work? It is noted that about 7 per cent of the membership was directly benefited last year, and also that some of the members consider this phase of the Society's activities as undignified.

It occurs to me that the Employment Service Department of

the Society has performed a great service to the membership in the past, and the fact that 7 per cent of the large membership of the Society was actually benefited last year speaks well for this department, and, further, it does not occur to me that this service is in any way undignified.

There usually comes a time at some stage in every man's career when he needs assistance in securing proper and suitable employment connections, and it would appear that when the Society through its Employment Service Department has assisted a worthy and qualified engineer to make such a connection, the Society has performed a twofold service: it has assisted a member in securing employment and at the same time has rendered a service to the firm employing him.

C. T. BAKER.

Atlanta, Ga.

TO THE EDITOR:

I want to take this opportunity to express my appreciation of what the A.S.M.E. has done for me, especially in the last few months.

Through the efforts of the Engineering Societies Employment Bureau I have just obtained a position which looks very promising, and the advertisement which I inserted in the current number of MECHANICAL ENGINEERING has brought me a number of replies.

All this has been without extra charge, and it has occurred to me that this must put a heavy burden on the Society. In order that the efficiency and usefulness of the Society may be maintained at its present high standard, I would gladly pay an increase of 25 to 50 per cent in dues, if that should prove necessary.

R. E. NAUMBERG.

New York, N. Y.

WORK OF THE BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York City.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in MECHANICAL ENGINEERING, in order that any one interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee in Cases Nos. 236-239, inclusive, as formulated at the meeting of May 23, 1919, and approved by the Council. In this report, as previously, the names of inquirers have been omitted.

CASE No. 236

Inquiry: Is it permissible under the Rules of the Boiler Code to use commercial open-hearth steel pipe for the heating surface of a special small coil boiler, provided not over $\frac{3}{8}$ in. pipe is used? Also is it permissible to use wrought iron or steel lap-welded extra-heavy pipe for the shell of this boiler, provided the diameter does not exceed 12 in.?

Reply: It was not contemplated that the Boiler Code Rules would be applied to miniature boilers. It is the intention of the Code Committee to prepare a set of Rules for such boilers. Until these Rules are issued, the acceptance of miniature boilers for various classes of service will rest with the rulings of those authorities under whose jurisdiction they may come, without guidance by Code Rules.

CASE No. 237

Inquiry: Is the requirement in Par. 282 of the Boiler Code relative to a lifting device applicable to a $\frac{1}{4}$ in. safety valve designed for operation on miniature boilers? Such a lifting device may be worked out for such a design of small safety valve, but inasmuch as the Rules of the Boiler Code do not apply to valves less than 1 in. in size, it is thought that the lifting device would be unnecessary and undesirable.

Reply: It was not contemplated that the Boiler Code Rules would be applied to attachments for miniature boilers. It is the intention of the Committee to prepare a set of Rules for miniature boilers, and until these Rules are issued, the acceptance of attachments for miniature boilers for various classes of service will rest with the rulings of those authorities under whose jurisdiction they may come, without guidance by Code Rules.

CASE No. 238

Inquiry: Is it permissible under Par. 291 of the Boiler Code relative to water gage glasses, to use a double set of gage cocks? In other words, will a boiler equipped with two sets of gage cocks meet the requirements of the Code for use in saw mills and similar service in the open where there is no protection from injury to the water glass?

Reply: It is the opinion of the Committee that, while Par. 294 permits of omitting the gage cocks if two water glasses are used, a set of gage cocks may not be substituted for a water glass under the requirements of the Rules of the Boiler Code.

CASE No. 239

Inquiry: Is it permissible under the requirements of Par. 194 of the Boiler Code which states that for boilers over 48 in. in barrel diameter, a dome shall be placed on the barrel instead of over the firebox, to place the dome over the firebox on a boiler which has a 50 in. wagon top diameter and a 46 in. barrel diameter? Also, may the holding power of the staybolts be added to the strength of the riveting in the dome seam when figuring the factor of safety?

Reply: It is the opinion of the Committee that for a contracted waist type of boiler, where the barrel diameter is within the limits specified in Par. 194 of the Code, it will be permissible to locate the dome over the firebox. It is not permissible to add to the strength of the riveting in the dome seam the holding power of the stays in calculating the factor of safety.

The value of natural gas as an ideal fuel is now universally recognized and the prevention of fuel waste is of urgent importance to the welfare of the Nation. The Bureau of Mines Technical Paper 209, Traps for Saving Gas at Oil Wells, by W. R. Hamilton, pertinently calls the attention of oil operators to the advantages derived from the use of gas traps for separating and saving the gas from the flow and lead lines of oil wells.

The basic principle of gas-trap construction is to arrest the speed of flow in a chamber that separates the gas and oil. Oil and gas enter the top of a container through one bung, and the gas escapes through another at the top: oil flows out the bottom through a U-tube which provides an oil seal and prevents the escape of gas. This fundamental idea has been modified in various forms to provide for special conditions.

In general, traps might be grouped in three types, upright cylindrical, horizontal tubular, and special. Those of the first type are principally used on wells of small capacity; the second type is specially used for large wells of the gusher type; traps of the third type are used under certain special conditions. Mr. Hamilton describes various devices possessing the characteristics of each of these three general types, with a view to enabling the operator to choose one that will be likely to suit his particular need.

ENGINEERING SURVEY

A Review of Progress and Attainment in Mechanical Engineering and Related Fields, as Gathered from Current Technical Periodicals and Other Sources

AERONAUTICS (See also Internal-Combustion Engineering)

Largest Heavier-Than-Air Machine in the World

Tarrant Triplane. Tarrant triplanes, the largest heavier-than-air machines in the world built so far, have been constructed at the Royal Aircraft Establishment at Farnborough. They were designed as bombers and were expected to fly from England to Berlin with a load of sixteen 550-lb. bombs and have a large enough cruising radius to return to England. At present it is the intention to adapt them to commercial flying, as 100 passengers or an equivalent tonnage can be comfortably hoisted within them.

The most distinctive feature of the Tarrant machine is its fuselage, which is made up of a series of braced main rings with lighter rings or formers spaced between, the whole being connected together by a series of longerons running the whole length of the body. These longerons are built up on the Tarrant spar system at the parallel portion of the fuselage and taper down to a single longeron member at the reduced portion. The whole framework is covered by a skin of plywood made of two-ply and varying in thickness upon the different sections of the fuselage.

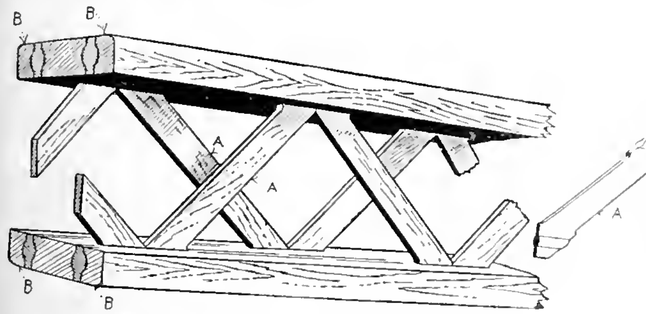


Fig. 1 Tarrant System of Spar Construction

The machine is fitted with six Napier "Lion" engines, each capable of developing 507 b.hp., and with full load a speed of over 90 m.p.h. can be obtained with two engines cut out.

The basic idea of the construction of the more important members of the Tarrant triplane is an adaptation of the braced girder as used in steel bridge work. Instead, however, of riveting the web bracing to the flanges, the construction shown in Fig. 1 has been adopted. The flanges *BB* consist of grooved pieces of wood which are glued on either side of a series of beaded bracing members *A*, the grooves registering with the beads. It is claimed that in this method of construction there is less chance of faulty timber being worked into the machine, for each piece of the girder is small and can be easily inspected. It is also claimed that the time required for seasoning in the Tarrant method of construction is less than usual, owing to the small size of the pieces. The tremendous size of the machine and the character of the mechanism are indicated by Fig. 2. On the left are shown the tanks, engineers' compartment and cockpit. The pilots, engineers and passengers all enter by the same door and are thus protected from risk of being struck by the propellers. In addition to the tanks shown in the figure there are other tanks arranged overhead, where there is also an exit through which the engineers may climb out so as to reach the engines in case of emergency.

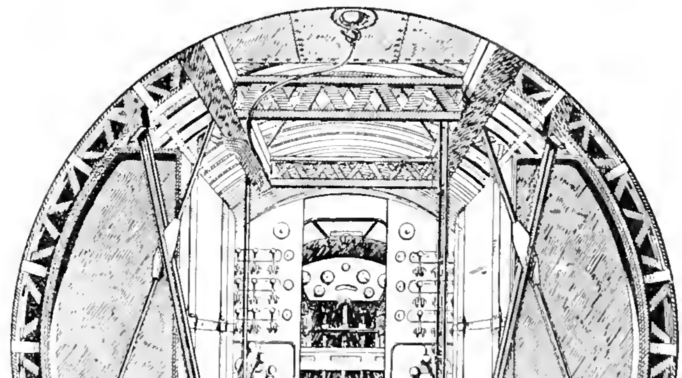


Fig. 2 Tanks, Engineers' Compartment and Cockpit

Fig. 3 shows the engineers' dashboard and entrance to cockpit. The two pilots sit side by side and operate duplicate interconnected controls, in addition to which they have a master control over the engines. For this there are provided a master switch controlling all the ignition circuits and six levers whereby the throttles can be separately adjusted. All other matters connected with the running of the engines are in the hands of the engineers.

The engines are arranged three on each side of the center line and are equipped with the Maybach starting system.

The total weight of the plane with crew, bombs, gasoline and oil is estimated at 44,672 lb. (*The Engineer,* vol. 127, no. 3306, May 9, 1919, pp. 452-454, 10 figs., *dA*)

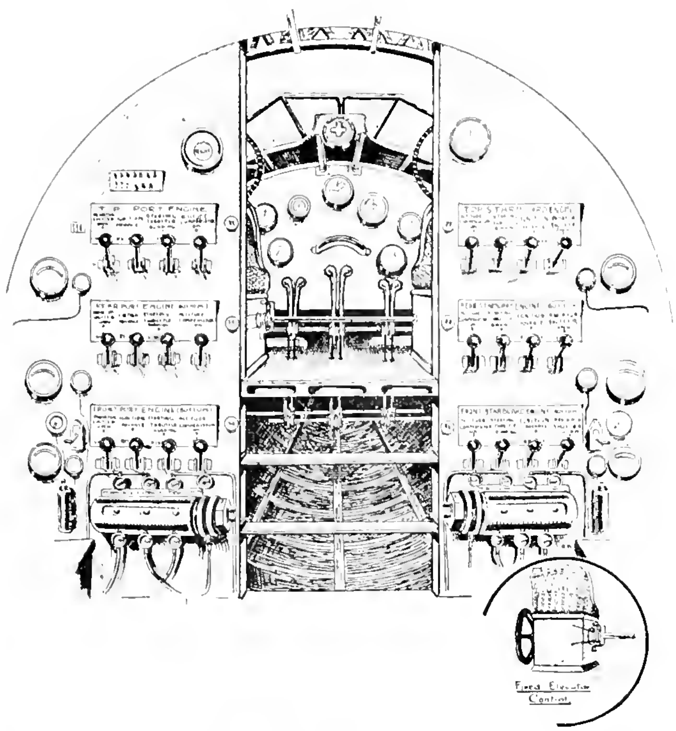


FIG. 3 ENGINEERS' DASHBOARD AND ENTRANCE TO COCKPIT

Moss Supercharger for Airplane Engines

MAINTAINING CONSTANT PRESSURE BEFORE THE CARBURETORS OF AERO ENGINES REGARDLESS OF THEIR ALTITUDE, Leslie V. Spencer. In a previous issue of MECHANICAL ENGINEERING (May, 1919, pp. 476-477) reference was made to superchargers, the aim of which is to maintain a constant content of oxygen in the engine charge regardless of the atmospheric pressure. The

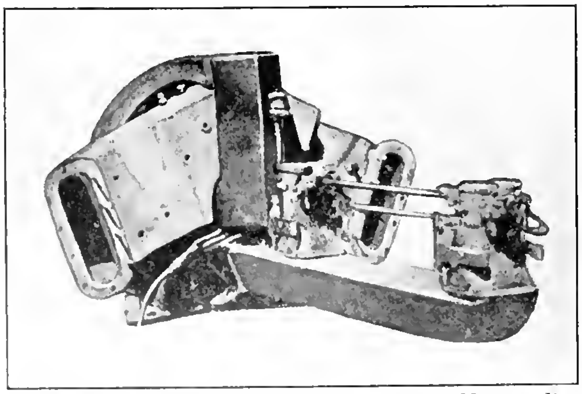


FIG. 4 REAR OF MOSS SUPERCHARGER SHOWING NOZZLE BOX AND INDUCTION SYSTEM

Moss supercharger designed by Dr. Sanford A. Moss, Mem. Am. Soc. M. E., and used on the Liberty-12 belongs to this class of machinery.

In this supercharger the turbine rotor, centrifugal compressor and air impeller are placed on the same shaft and the arrangement is such as to leave the Liberty engine carburetors in the center of the V, connected to the air discharge of the compressor by an induction pipe of generous proportions and rectangular in section.

The engine exhausts are on the outside and the gases are sent to the nozzle box of the turbine by means of substantial, specially designed exhaust headers which connect at their front ends to the flanges on the other side of the nozzle box.

In the Moss machine the nozzles are arranged in a semi-circular plate set into the front side of the nozzle box (compare Fig. 4). This is expected to help in keeping down the temperature of the rotor, since the intense exhaust-gas heat is not being directed to the entire rotor all the time, but to only about one-half of its circumference.

Because of the great fore-and-aft width of the Moss machine it cannot be installed on the Liberty engine with the propeller in its normal position and there has to be used a special propeller flange and hub construction.

A feature of the Moss machine is the water-cooled rear bearing (Fig. 5). A special water jacket surrounds the bearing proper and through it water is circulated from the regular water circulation system of the engine. The machine is also provided with self-aligning bearings to take care of any slight inaccuracy of the position of the rotative parts due to the high speeds and high temperatures encountered in operation.

In confirmation of the precautions taken in the design and the special features incorporated against overheating, the Moss apparatus has never given any appreciable overheating trouble in any operative tests yet conducted. The nozzles, which are subjected to the most severe heating conditions, have shown a slight red color after considerable running, but none of the other parts has become hot enough to reach a visible red. Undoubtedly the successful results obtained in this respect are due largely to the provision for free air circulation around the turbine and an equally free method of exhaust. In the writer's opinion Dr. Moss has been entirely justified in claiming slightly more room at the front of his machine than is allowed by the normal position of the propeller of the Liberty engine, for this permits the design of the apparatus in such a way as to get about as good cooling effects as is possible in the necessarily limited space available. The matter of the heat dissipation is of premier importance in any development work of this nature.

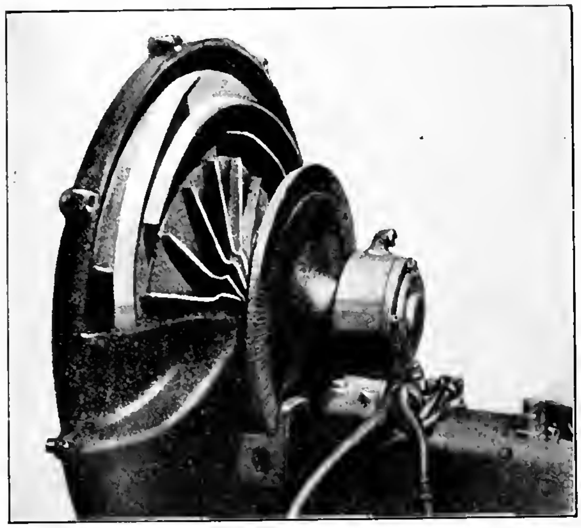


FIG. 5 MOSS TURBINE WHEEL AND WATER-COOLED REAR BEARING

In order to prevent the nozzle box and exhaust manifolds from getting out of shape due to the temperature and the pressure of the gas within, these chambers are internally braced by means of cross-stays which are welded to the casings. This was found necessary due to the fact that the nozzle box must not be allowed to distort to any extent, and in order to maintain a good joint between the nozzle box and the manifold on either side the manifold must be made quite rigid without being heavy. The cross-stays have proved a most satisfactory expedient. (*Aerial Age Weekly*, vol. 9, no. 8, May 5, 1919, pp. 387-389, 4 figs. *dA*)

AIR MACHINERY

Swiss Intercooler for Turbo-Compressors

B. B. C. AIR COOLERS FOR TURBO-COMPRESSORS (*B. B. C. Mitteilungen*, Nov. and Dec., 1918). The present article describes a new (patented) type of cooler for turbo-compressors, manufac-

tured by Brown, Boveri and Co., of Baden, Switzerland, and designed to meet the reduction in the number of cylinders used in the compressor to one. The new device is called an "intercooler," being fitted between the first, second and third groups of rotors of the compressor. The air enters and emerges through special coils so arranged over the groups as not to affect the rotor overall length of the compressor.

The cooling surface of each stage is distributed over two nests of coolers arranged in parallel, which are placed obliquely at both sides of the lower part of the cylinder. This arrangement facilitates cleaning.

The lower parts of the coolers are divided into two parts, which permits of cleaning them while the machine is running; the water chamber of one half can be opened while the other half remains in operation, thus preventing too great a rise in temperature of the successive groups of rotors.

The nests of tubes are generally round, though oval brass tubes are used for heavy loads, in the first and second stages, the tubes being brazed into solid bronze bottoms. The upper bottom plate, with its water chamber, is firmly screwed down to the cylinder, while the end piece of the lower bottom plate is freely movable in a round stuffing box, to allow for expansion of the tubes with temperature.

The cross-sectional area of the air passage between the tubes (the "air gap") is so selected that the heat transmission and pressure drop are at a convenient ratio to the efficiency of the compressor, and the cross-sectional area of the nest assumes a square shape which fills up the round openings in the cylinder as much as possible by omitting the tubes at the corners of the square. This form also permits of the use of round stuffing boxes of minimum diameter.

To compensate for the uneven thermal expansion of single tubes or groups which would give rise to deleterious stresses, the tubes are bent so that each one of them may expand outwards if necessary.

Special distance pieces are fitted to hold the long tubes together and prevent vibration, and other arrangements are provided to eliminate play and displacement of the tubes.

The air and water flow through the tubes on the counterflow principle, i. e., the air outlet and water inlet coincide, the article describing the flow of the two media in the various parts of the cooler.

The tube nests, water chambers and side plates form one unit which can be inserted in the cylinder openings.

The theoretical discussion in connection with the new type of cooler deals with: (1) the transmission of heat and the specific pressure drop; (2) influence of the cooler load on the efficiency of the compressor; (3) comparison of different methods of cooling compressors; and (4) the heat-transmission factors of various types of tubes.

The manufacturers claim that the cooling of their compressors may be said to be satisfactory in all respects, as it provides for the best utilization of the cooling surface by the arrangement of the tubes and by the air velocities and cooler factor obtained. (*Technical Supplement to the Review of the Foreign Press, vol.* 3, no. 10, May 13, 1919, no. 5008, pp. 349-350, *d*)

BUREAU OF STANDARDS

A Simplification of the Inverse-Rate Method for Thermal Analysis, Paul D. Merica. The use of stop watches in taking inverse-rate curves in thermal analysis is described, and it is shown that they may be substituted for the chronograph, which is often used without sacrificing accuracy or sensitivity. One operator is able to record the successive time intervals for the inverse-rate curve, with their aid, and no time is subsequently required for the reading and counting of the chronograph record; the intervals so recorded may be plotted directly. (Abstract from Scientific Paper No. 336)

Behavior of Graphite Eutectoid in White Cast Iron

Notes on the Graphitization of White Cast Iron upon Annealing, P. D. Merica and L. F. Gurevich. The annealing or graphitization ranges of temperature were determined for three different compositions used for car wheels. The temperature of initial precipitation of temper carbon for six hours of annealing was not noticeably affected by variation of sulphur content from 0.10 to 0.20 per cent, or by variation of total carbon content from 3.60 to 3.90 per cent, although the effect of greater carbon content is to narrow the temperature range within which graphitization is complete.

The temperature of beginning precipitation of temper carbon was about 830 deg. for the six-hour period of annealing, and about 725 deg. cent. for the 48-hour period. The maximum allowable temperature, therefore, for the annealing or "pitting" of car wheels is about 725 deg. cent.

After complete decomposition of all free cementite by annealing at from 1000 deg. to 1100 deg. cent. and cooling at equal rates in a laboratory electric furnace, less graphite is found in a specimen cooled from a 1100 deg. than in one of the same composition cooled from 1000 deg. cent. This indicates that graphite separates directly from solid solution upon cooling when its nuclei are already present.

The fact that only 0.20 per cent of combined carbon was found in some specimens after annealing at high temperatures, and cooling slowly in the furnace would indicate either that the graphite eutectoid lies at much lower values of carbon content than has been previously supposed; that there is at those rates of cooling a direct precipitation of graphite eutectoid, or that there is a formation of graphite from pearlite at temperatures directly below that of its formation. (Technologic Paper No. 129)

Results of Tests of Wire Rope

Strength and Other Properties of Wire Rope, J. H. Griffith and J. G. Bragg. The paper presents the results of tests on 275 wire ropes submitted by American manufacturers to fulfill the specifications framed by the Isthmian Canal Commission in 1912. The samples were selected by Government inspectors for acceptance tests of material to be used at the Canal Zone.

The ropes ranged in diameter from ¼ to 1½ in., a few being of larger diameters up to 3¼ in. Over half the specimens were plow and crucible cast-steel hoisting rope of 6 and 8 strands, 19 wires each. The remainder were galvanized steel guy rope and iron tiller ropes of 6 strands 7 wires, and 6 strands 42 wires, respectively.

The investigation was made primarily to determine the tensile strengths of the ropes. Much of the experimentation was of a supplementary character—to determine the general laws of construction of the rope as the basis of the interpretation of their physical behavior under stress. A comparative analysis was made of the chemical constituents of steel, rope fibers and lubricants of plow ropes submitted by different manufacturers.

The wires at the ends of specimens were "frayed out" to form a "broom." These were inserted into molds, into which molten zinc was poured so as to form conical sockets for connection to the testing machines. Most of the tensile tests were made on a 600,000-lb. Olsen testing machine, the ropes of large diameters being tested on the 1,200,000-lb. Emery machine. Stress-strain measurements were made on over half the specimens. Numerous tests of individual wires were conducted in tensile, bending and torsion machines. The strengths of the cables were studied in connection with their modes of construction, the strengths of their component wires, and the types of fractures which were presented.

The homologous linear dimensions of the strands, wires and fiber cores were found to vary in direct proportion to the diameters of the ropes. The diameters of the strands and fiber cores were generally ⅓ the diameter of the rope. The mean pitch or lay of the strands was 7½ diameters. The mean lay of the wires was 2¾ diameters. The mean diameter of the wires was expressed by the equation:

$$d = KD/(N+3)$$

where d = diameter of wires
D = diameter of rope
N = number of wires in outer ring of wires of a strand

$$K = \begin{cases} 1.0 \text{ for hoisting and guy rope} \\ 0.8 \text{ for extra flexible } 8 \times 19 \text{ hoisting rope} \\ 0.33 \text{ for tiller rope.} \end{cases}$$

The aggregate cross-sectional areas of the wires was expressed approximately by the equation:

$$A = CD^2$$

where C = 0.41 for 6 x 19 plow steel hoisting rope
= 0.38 for 6 x 19 crucible steel hoisting rope
= 0.38 for 6 x 7 guy rope
= 0.35 for x 17 plow-steel rope
= 0.26 for 6 x 42 iron tiller rope.

It was found when the maximum loads determined from tensile tests were platted as functions of the diameters of the ropes that the curves bounding the lower frontiers of each zone comprising the observed values were in close agreement with similar curves platted from the minimum strength stipulated in the specifications of the Isthmian Canal Commission of 1912. These strengths were also in approximate agreement with the standard strengths recommended in 1910 by the manufacturers from the results of their tests of cables similarly classified. The minimum strengths found from the present investigation are given by the following empirical equation:

$$\text{Load} = C \times 75{,}000D^2$$

where D = diameter of wire rope in inches

$$C = \begin{cases} 0.9 \text{ to } 1.1 \text{ (mean, about 1.0) for } 6 \times 19 \text{ plow-steel cables} \\ 0.8 \text{ to } 0.95 \text{ (mean, about 0.9) for } 8 \times 10 \text{ plow-steel and } 6 \times 19 \text{ crucible cast-steel cables} \\ 0.3 \text{ to } 0.4 \text{ (mean, about 0.35) for iron tiller and steel guy rope.} \end{cases}$$

The modulus of the rope calculated from stress-strain measurement was found to vary from 3,000,000 to 9,000,000 lb. per sq. in., depending upon the diameter and class of cable.

Plow-steel ropes were selected for comparative analyses of the constituent materials. In the chemical analyses the carbon content ranged from 64 to 96 per cent, with a mean of about 75 per cent. The manganese ranged from 25 to 68 per cent, the silicon from 11 to 24 per cent. The percentage of phosphorus and sulphur was relatively low. In certain cases the steel of the filler wires was softer than the main wires.

The fibers used in making the core of the rope were estimated as manila, jute, istle, mauritius, manila fiber alone being employed by certain manufacturers. The preservative and lubricants on the cores were composed of wood and vegetable tars, petroleum products, and fish oil, the practice varying somewhat.

There was a reasonable uniformity in the strengths and elongations of the wires from a particular cable, but a larger variation in the strengths of the wires from cables of different manufacturers. This was probably due to the fact that different grades of plow steel were used by the several manufacturers in meeting the provisions of the specifications.

The cables developed from 72 to 90 per cent of the aggregate strengths of the wires. The upper limit of the ratio of the strength of a rope to the strengths of its wires was found from theoretical considerations to be 89.2 per cent for 6 x 19 plow-steel cables. The differences between the results of the theoretical analysis and the practical tests were largely attributed to different strengths and degrees of ductility of the wires, this causing an unequal distribution of the load among the strands with overstressing of certain strands near the point of failure. (Technologic Paper No. 121)

The Effect of Rate of Temperature Change on the Transformations in an Alloy Steel, H. Scott. Cooling curves taken on an air-hardening steel of the high-speed tool-steel type show two critical points on cooling from 920 deg. cent., one occurring at about 750 deg. cent., accompanied by the precipitation of the hardening constituent, the carbide, and the other on fast cooling at about 400 deg. cent., under which condition the carbide remains in solution as martensite. On cooling at intermediate rates both transformations are observed, and the constituents, troostite and martensite, are detected by the microscope. A transformation is observed on the heating curves taken following a fast cooling, which is manifested by an evolution of heat ending at about 645 deg cent., and which represents the precipitation of the carbide held in solution as a result of the previous rapid cooling. The re-solution of the carbide under those conditions occurs at a temperature some 10 to 15 deg. cent. higher than after a slow cooling.

The conclusions drawn support the twenty-year-old theory of Le Chatelier that martensite is a solid solution of carbide in alpha iron. (Abstract from Scientific Paper No. 335)

ENGINEERING MATERIALS

Examination of Materials by X-Rays. Report of the general discussion at a joint meeting of the Faraday Society and the Roentgen Society, held April 29, 1919, Sir Robt. Hadfield, Mem. Am. Soc. M. E., presiding.

Prof. W. H. Bragg, of the University College, London, showed the extraordinary sensitiveness of the X-ray method of investigation. The transparency of a material to X-rays decreases as the atomic weight of the material increases. Heat has no influence, and a red-hot casting gives the same radiograph as a cold casting. Photographs of good and faulty castings and welds were exhibited, the tool marks showing quite distinctly. Considering how minute the difference in thickness due to tool marks is, this indicates the remarkable sensitiveness of the method. An attempt was made to explain this high sensitiveness. The question as to whether hard or soft X-rays should be used was next taken up by Professor Bragg. For penetrating through the material the rays should be hard, but in that case they also penetrated through the plate, which is not an advantage. That action was due to the liberation of electrons which darted to and fro among the surrounding atoms until their energy was spent. In the emulsion, electrons were set in motion mainly through absorption of X-rays by the silver and bromine, and that action might be reinforced by putting heavy atoms into the emulsion. Some experimenters placed a thin lead sheet on the film, so that the electrons generated in the lead struck back into the photographic plate. The variation in the absorption of rays of different wave lengths, studied by the Duc de Broglie and others, suggested a further consideration. As wave length increased the absorption by a given substance also increased: but at a certain value, critical for each substance, the absorption suddenly dropped, to rise again steadily afterwards. There was, therefore, a "step down" in the photograph—it should not be called a band—marking the critical wave length for silver. A similar "step up" on the side of short wave length would be obtained by interposing an absorbing screen, say of antimony or some other metal, in the path of the rays. That "antimony line" was so sharp that it might serve for a new method of spectroscopic examination of the constituents of a material. We might also put some special material in the emulsion and choose X-rays intermediate between the actual value of this material and of the casting under test; but this did not appear practicable.

A paper by E. Schneider on "The Industrial X-Ray Examination of Methods at the Laboratories of Messrs. Schneider & Co., Le Creusot, was read.

Two German papers have been translated and presented in abstract; one of these papers by Doctor Respondek of Hallensee, near Berlin, outlined the principles covering the penetration of metals by X-rays, and the other by F. Janus of Munich and M. Rettchen of Cologne explained the investigation of metals by means of X-rays. (*Engineering*, vol. 107, no. 2783, May 2, 1919, pp. 576-578, 1 fig., *e*)

HYDRAULIC ENGINEERING

Experimental Data on Conditions Covering Surge Pressures in Pipe Lines

Surge Pressures in Pipe Lines, Ralph Bennett. Description and data of tests made to determine the actual effect of varying the conditions on two pipes equipped with air chambers and of changing choke-gate areas. In these tests a simple apparatus was

used giving a time-pressure record of the variations which took place at shutdown in these pumping lines, the lines on the test being 18 in. and 24 in. in diameter. Further, the 18-in. line was equipped with the plain air chamber, while the 24-in. pipe was without any protection against shock.

In these tests the pencil mechanism of a steam indicator was so arranged that it made a record on a strip moved by the clockwork train taken from a high-speed recording voltmeter. The apparatus gave records sufficiently accurate for the purpose, though subject to the usual disadvantages of the steam indicator when used on water.

The indicator was connected at the base of the air chamber (Fig. 6), the reading being the pressure of the line. In one case the instrument was transferred to a point above the diaphragm to obtain a record of tank-pressure changes, and the curve was superimposed on the pipe-line curve secured from an otherwise similar test (Fig. 8*F*). Thus curve shows graphically the time and intensity relations of the internal and external pressures when an almost perfect damping is attained in a single swing.

The vertical scales shown on the curves are those corresponding

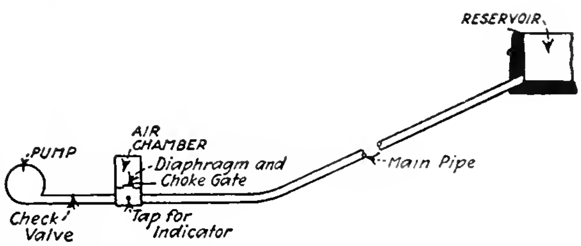


FIG. 6 TEST APPARATUS FOR RECORDING SURGE PRESSURES IN PIPE LINES

to the spring used. Owing to indicator friction and secondary pressure disturbances the curve peak values may vary considerable from actual values.

The horizontal scale of time must be averaged, as minor irregularities of drum movement affect the record. The time given for the waves is that of the half-wave after completion of shutdown when the column is vibrating as a free or loaded pendulum.

The 18-in. line was of riveted steel, average thickness 0.087 in., total length 3187 ft. The maximum head was 240 ft. (104 lb. per sq. in.) and the grade uniform without sharp bends or obstructions. The air chamber at the pump is 36 in. in diameter and 10.5 ft. long above the line, which passes directly through it. The pump delivering by test 954 gal. per min. gave a line velocity of 0.2 ft. per sec.

Shutdown tests were made on this line using varying quantities of air in the chamber. The results of some of these tests are given in Fig. 7 and in the original article in a table.

Further tests were made on the 24-in. pipe of a total length of 6791 ft. and with a maximum head of 160 ft. (70 lb. per sq. in. including friction) and uniform grade without sharp bends or obstructions.

The air chamber is 48 in. in diameter with 15 ft. effective height and a line velocity of 1.33 ft. per sec. is used.

The choke valve on the pump (two-stage centrifugal) was an

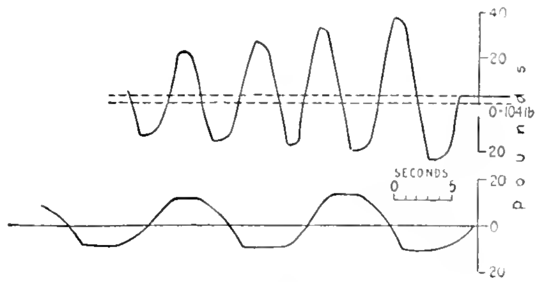


FIG. 7 GRAPHS FROM TESTS ON 18-IN. PIPE LINE

egg-shaped plunger controlled as to speed of closing by a bypassed plunger. The free actual was as rapid as that of a swing check.

On this line tests were made for numerous volumes of air and for different choke openings.

Fig. 8*A* shows the card obtained with 67 cu. ft. of air and a 25.87-sq. in. choke. Under this condition, the fall of pressure at shutdown is very severe, and the oscillations die down very quickly. The condition desired is one in which the greatest possible absorption of energy occurs across the choke from the instant of shutdown. The best condition occurs when the first half-wave (in this case negative) is the one in which the greatest loss occurs. The ability of the line to stand reduction in pressure will frequently limit the possible control.

Note on this curve the great distortion of the fundamental wave of the shock from the check valve. This superimposed pressure may at times become very serious, but, as stated above, any attempt to control it by slow valve action is a move in the wrong direction. Better results would be obtained by a loaded valve.

Fig. 8*B* was obtained with the same air content, 67 cu. ft., and a 32-sq. in. choke. The check-valve disturbance is much as before. The indicator was put on the line before the pump was started, and the entire cycle from standstill to standstill is shown. Note that the shock due to the rapid start of the pump is more severe than is that due to the shutdown surge.

The quantity of air and the closeness of the choke can be varied within limits with about the above results, but any considerable decrease in the amount of air reduces the ability of the tank to absorb energy and increases both the pressure peaks and the

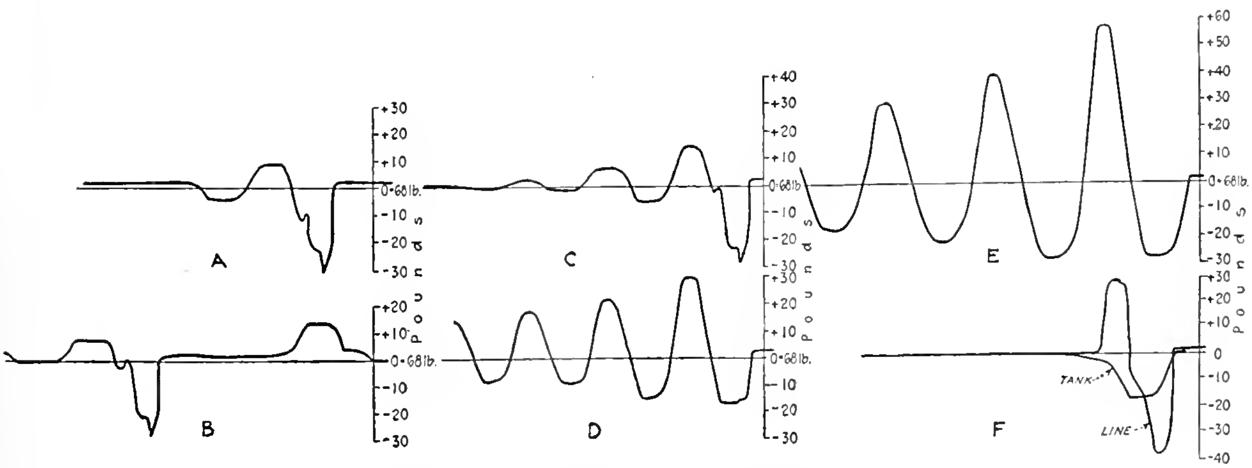


FIG. 8 GRAPHS FROM TESTS OF 24-IN. PIPE LINE

(Above—air, 14 cu. ft.; below—air, 118 cu. ft.)

(*A*—air, 67 cu. ft.; choke, 25.9 sq. in.; *B*—air, 67 cu. ft.; choke, 32.0 sq. in.; *C*—air, 35 cu. ft.; choke, 25.8 sq. in.; *D*—air, 35 cu. ft.; choke, 45.0 sq. in.; *E*—air, 90 cu. ft.; choke, 68.0 sq. in.; *F*—superimposed tank and line pressures.)

number of undulations required for full absorption of the energy in the water. Curves in Figs. 8C and 8D show these effects very clearly. Fig. 8C shows good control with 35 cu. ft. of air and a 25.8-sq. in. choke, while Fig. 8D, with the same volume, produces an excessive shock.

If the tank contains ample air but is too freely connected to the line, a condition results similar to that shown in Fig. 8E, which was taken when the air supply, 90 cu. ft., was more than ample for full pressure control but with no excessive opening, 68 sq. in. (*Engineering News Record,* vol. 82, no. 2, May 29, 1919, pp. 1048-1050, 9 figs., eA)

INTERNAL-COMBUSTION ENGINEERING (See also Aeronautics)

Oscillograph Tests of Various Types of Spark Plugs

SPARK-PLUG EFFICIENCY, Maj. A. M. Low. Data of tests on the intensity and duration of ignition sparks and conditions affecting them.

The writer states that pointed electrodes are ape to produce brushing, which may sometimes be so great as to prevent the engine being started.

There is a simple experiment of passing a spark through water by insulating the electrodes so thoroughly by means of glass that the spark has no other option.

In the case of the plain 2-point type of plug the current jumps

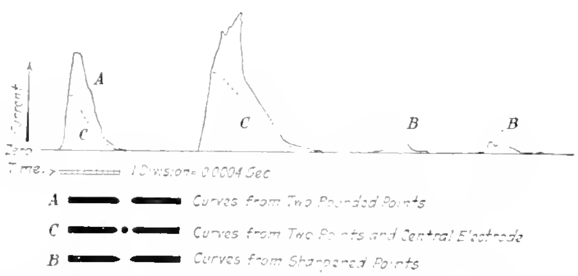


FIG. 9 OSCILLOGRAPH CURVES FROM SPARK PLUGS OF VARIOUS TYPES

the gap, but a very large proportion crosses as brush discharge and a great deal of efficiency is wasted. With the object of showing this, the author has taken a large number of photographs of the current passing, showing also the duration of the spark or spark and arc. These photographs have been reproduced in the form of diagrams, which are all drawn to scale in Fig. 9. At *A* the spark current is shown between two plain points, while in *B,* in which the plug points are sharpened, the duration and relative value of the current is much less. *C* shows the action of the plugs having a central plain electrode and two wings. The duration of the spark is the same as in *A,* but the current is slightly reduced, proving that two plain gaps in parallel are liable to waste current, as brushing occurs if the energy cannot get across the gaps with sufficient rapidity.

Fig. 10 is intended to show the fallacy of the plan if it is possible to obtain a ring of sparks. The author believes that under compression the current merely takes the path of least resistance, giving one spark at a time but at different places around the gap.

At *B* the current between the electrodes of the plate and point type of plug is shown to be high and of good duration. Fig. 11 shows the effect of two plates or two cups and points, while another figure represents the effect of three wings and one central electrode.

The plate type of plug will often give very good results if the body be not used to form one of the plates, as its large area leads to condensation and difficulty in starting, though for high-speed work it is good. In Fig. 10, *A,* the dotted line represents the current between a point and cup. If the cups are duplicated as in Fig. 11, *A,* the duration is slightly diminished and the current increased, proving that even a single cup and point waste current.

These curves have been obtained by means of a plug or gap connected in series with a Duddell oscillograph.

With almost any plug, the smaller the gap the higher is the amplitude of the current. The duration is also longer so that there is not much to be gained in having the points wide apart, though for high speed it is sometimes of advantage. While this suggests that a variable gap might be used, the author has made a good many tests with a variable-gap plug but the results obtained did not justify the increased complication.

Tests with the manograph on the engine and an oscillograph in circuit with the plug, indicated that more than two sparks per cylinder does not improve efficiency and that the temperature of the sparks which makes the first period of ignition rapid and avoids cooling of the heated particles is of much more importance than the distance between two sparks within the cylinder.

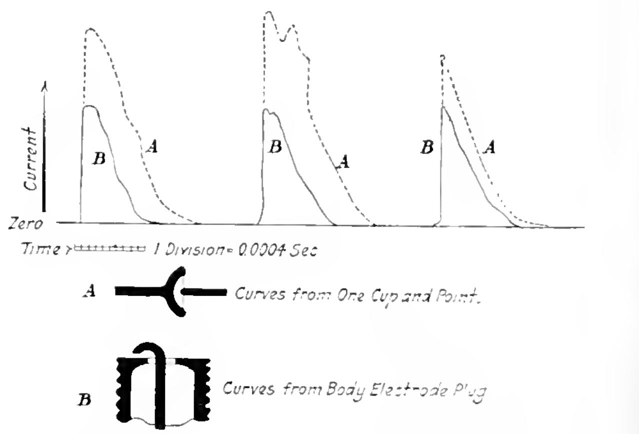


FIG. 10 OSCILLOGRAPH CURVES FROM SPARK PLUGS OF VARIOUS TYPES

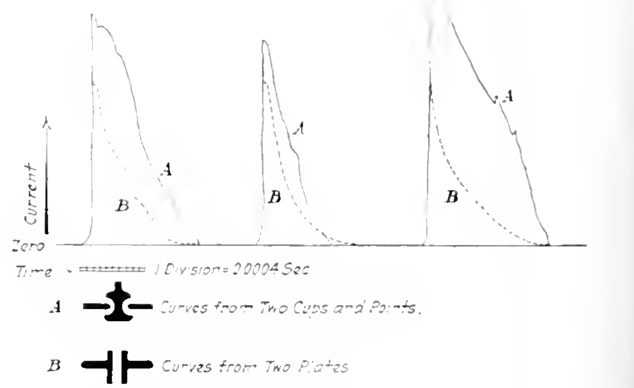


FIG. 11 OSCILLOGRAPH CURVES FROM SPARK PLUGS OF VARIOUS TYPES

It is only the very first production of the spark that is affected by the shape of electrodes, so that it is the first half of the spark that is of such importance. Different kinds of plugs may meet different requirements. The direction in which the current passes is extremely important and it was this that first led to the introduction of the cup system. (*The Autocar,* vol. 42, no. 1228, May 3, 1919, pp. 655-658, 6 figs., *e*)

STARTERS FOR LARGE MOTORS. Description of various starters, chiefly with reference to electric motors such as powder-cartridge type, auxiliary gas starters (like acetylene), compressed air, and electric starters.

An interesting type described is the Herzmark starter. Two cylinders of the engine are filled with carbureted air compressed to 5 kg. per sq. cm. (= 71 lb. per sq. in.). One of the cylinders is at the ignition point and the other in compression stroke, both being in equilibrium. Then by means of a very simple apparatus, ignition of the mixture in one of the cylinders is produced directly

by a magneto spark. The apparatus consists of a triple-action pump, taking from the carburetor a very rich mixture. A small distributor located behind this pump and carrying as many electric coils as there are cylinders indicates which of the cylinders is at the ignition point. An electric connection from a dry-cell circuit with the camshaft acts on the coil which corresponds to it. After a certain number of pump strokes which vary in accordance with the cylinder volume of the engine, all that is necessary is to bring the little movable handle of the distributor over the active coil and apply the catch in order to deliver automatically the mixture into the proper cylinders.

The pump is located right at the pilot's hand and is connected to the engine by two small tubes so that the engine may without any inconvenience be placed at a distance of 25 to 30 ft. from the pump.

It is stated that the starter is of simple construction, quite light (4 kg. or 8.8 lb.) and that it occupies little space (40 cm. by 12 cm. = 15.7 in. by 4.7 in.).

The original article has an illustration of this starter, too indistinct, however, to permit reproduction. (D. J., in *L'Aerophile*, vol. 27, no. 34, Feb. 1-15, 1919, pp. 45-46, 1 fig., *d*)

LUBRICATION (See also Air Machinery)

Practical Data on the Lubrication and Cleaning of Air Compressors

Proper Lubrication of Air Compressors, H. V. Conrad. To be satisfactory, lubrication of air-compressor cylinders should first reduce friction to a minimum, and, second, eliminate as far as possible carbonization of the oil.

The formation of excessive carbon deposits is apt to be due to use of improper oil such as oil of to great a viscosity; use of too great quantities of oil and failure to provide a proper screen over the air intake of the compressor, thus allowing free entrance of dust (coal dust being especially undesirable). Besides the usual objections to carbonization such as sticking of air valves and choking of air passages in the case of air-compressor cylinders, there is a further menace of fire. Carbon particles may become incandescent and cause a fire by coming in contact with oil vapor given off by lubricating oil.

The paper discusses the qualities of various lubricating oils and a basis for making a selection of the proper oil. In particular, data are given on the properties of paraffine-base and asphaltic-base lubricating oils.

As regards the question of quantity of lubricating oil, it is said that while it depends to a certain extent on the viscosity of the oil, heat of compression and size of cylinder in general, it may be stated that after the cylinders have acquired smooth and polished surfaces the quantity should be reduced to the lowest limit. Table 1 is given as a basis for determining the quantity of oil used. The resnlts in the last column are based upon the assumption that under average conditions of temperature and usual range of oil viscosities a pint of oil will contain an average of about 16,000 drops.

For cleaning the air-compressor system and removing carbon it is recommended to use only soap suds. A good cleansing solution is made of 1 part soft soap to 15 parts water. These suds should take the place of oil for a few hours and be fed into the air cylinders about once a week, either by means of a hand pump or through the regular lubricator at a rate about ten times as rapidly as that of the oil.

For cleaning the air receiver and piping a method is suggested, shown in Fig. 12, where a receptacle made of 6-in. pipe is set on top of the discharge pipe.

A cleansing liquid recommended consists of 1 lb. of Red Seal lye to 18 lb. of water. This mixture is passed into the discharge line at the rate of 60 or 70 drops per min. while the compressor is running.

To use the arrangement shown close cocks *A* and *G*, open valve *C* and fill compound through funnel *D;* when chamber *E* is filled, closed valve *C*, open cocks *G* and *A* and regulate feed by valve *B*.

TABLE 1 QUANTITY OF AIR-CYLINDER LUBRICANT REQUIRED PER 10-HOUR DAY

Diameter of Cylinder, in.	Size of cylinder, in.	Displacement per minute, cu. ft.	Piston speed, ft. per min.	Sq. ft. of cylinder wall swept by piston	Drops oil per min.	Drops oil per 10 hr.	Sq. ft. oiled per drop	Pints of oil required per 10 hr.
8	8 × 8	120	344	718	1	600	718	0.0375
12	12 × 12	320	408	1230	2	1200	613	0.0750
18	18 × 18	880	496	2340	4	2400	585	0.1500
24	24 × 24	1730	550	3450	6	3600	575	0.2250
30	30 × 30	2940	600	4700	8	4800	590	0.3000
36	36 × 36	4550	644	6070	10	6000	607	0.3750
42	42 × 42	6700	696	7600	12	7200	633	0.4500

Figures of last column are based upon estimated 16,000 drops per pint of oil at 75 deg. fahr.

The oil should be fed at the rate of about 70 drops per min. (*The Blast Furnace and Steel Plant*, vol. 7, no. 5, May 1919, pp. 224-226 and 242, 1 fig., *gp*)

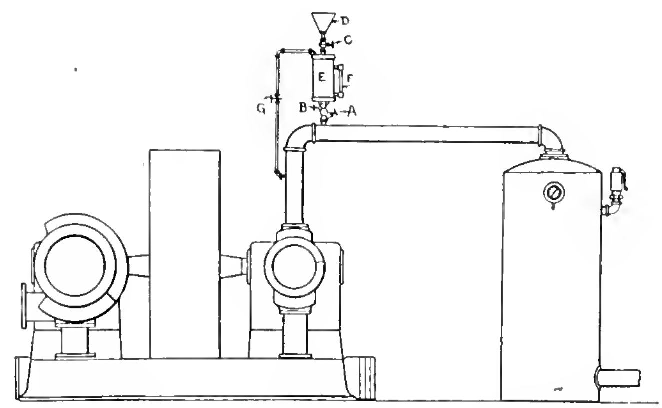


Fig. 12 Device for Removing Carbon in Air-Discharge Line and Receiver of Air Compressors

A—Pressure cock; *B*—Regulating valve; *C*—Filling Valve; *D*—Funnel; *E*—Compound chamber; *F*—Gage glass; *G*—Pressure cock.

MACHINE SHOP

Theory of Tolerances and Comparison of Symmetrical and Asymmetrical Systems

Tolerances in Mechanical Construction, A. C. An article based on a publication by Doctor D'Ailly of the C. E. Johansson Gage Company.

There are two kinds of tolerances, the theoretical and the practical. The theoretical tolerance comes from the imperfection of our instrnments and our senses and the more the appliances and processes for checking are improved the more the theoretical tolerance may be reduced, but it will probably never be entirely eliminated.

In manufacturing it is usually entirely unnecessary to strive to attain the limits of theoretical tolerance and a lesser precision known as practical tolerance is as a rule sufficient.

Graphically, the regions of tolerance may be shown in the following manner: Assume that a is the nominal value of the required dimension—for example, the theoretical diameter of a lot of shafts; $x_1, x_2, \ldots x_n$ are the real values of the diameters of these shafts; and that $y_1, y_2, \ldots y_n$ are the numbers of shafts which actually have the diameters $x_1, x_2 \ldots x_n$.

From the calculus of probabilities it is found that the relation between x and y is expressed by the function

$$y = ke^{-h^2(x - a)^2}$$

where e is the base of the Napierian system of logarithms and k

and h are coefficients depending on the perfection of the methods of machining employed in each instance. No matter, however, what the values may be, the representative curve for this equation tends to assume the form shown in Fig. 13; that is, the curve is always symmetrical with respect to the ordinate OY, for which $x = a$.

It is easy to show on this curve the region of theoretical tolerance. Let $\pm \varepsilon$ be the magnitude of theoretical tolerance expressed in the same units as a; the ordinates corresponding to the abscissæ $a + \varepsilon$ and $a - \varepsilon$ indicate the sectioned area in Fig. 13 symmetrical with respect to the ordinate of $x = a$, which represents the region of tolerance, so that all the shafts of which the diameter lies between $a + \varepsilon$ and $a - \varepsilon$ correspond to points of the curve comprised between A and B. The same graphical representation applies to practical tolerances. As a matter of fact, shafts accepted by the inspection are, by the very definition of practical tolerance, those of which the diameter does not differ from a by more than a certain predetermined tolerance.

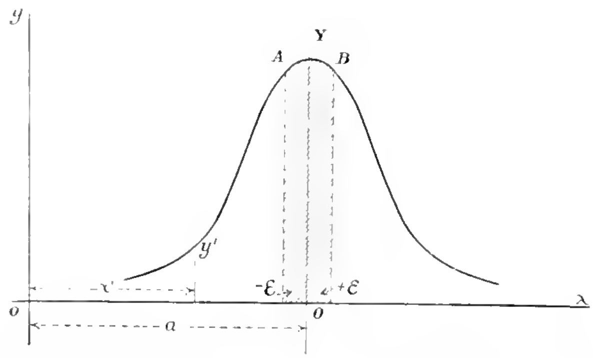


FIG. 13 GRAPHICAL REPRESENTATION OF REGIONS OF TOLERANCE, SYMMETRICAL SYSTEM

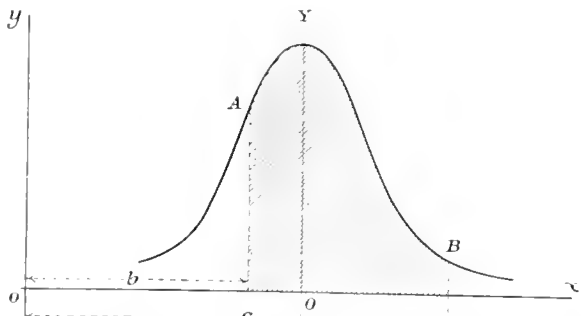


FIG. 14 GRAPHICAL REPRESENTATION OF REGIONS OF TOLERANCE, ASYMMETRICAL SYSTEM

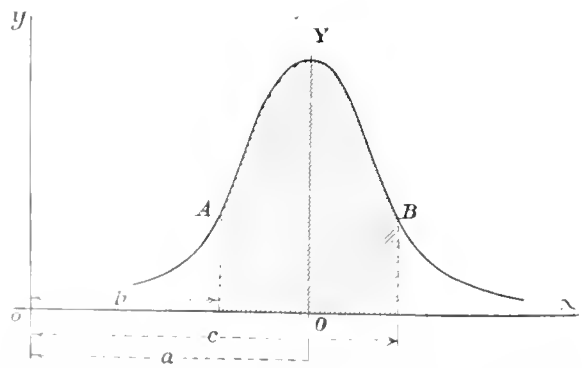


FIG. 15 RELATION BETWEEN THEORETICAL AND PRACTICAL TOLERANCES

Thus, let b be the minimum acceptable diameter and c the maximum (Fig. 14). The region of practical tolerance AB is here also represented by a cross-sectioned area comprised between $x = b$ and $x = c$. If a is the average between b and c the region of practical tolerance will be like that of theoretical tolerance, symmetrical with respect to the ordinate $x = a$. However, the designer may or may not adopt such a symmetry, and in what follows will be presented some of the advantages of symmetrical tolerances.

The whole purpose of tolerances is to permit a correct adjustment and good operation of assemblies constituting a machine. These assemblies may be such as to permit no play between the parts, or such as to require a certain greater or lesser amount of play. For example, in Fig. 16 is shown a rotating shaft and its journal, an assembly in which a certain predetermined amount of play is necessary.

Let us say that t_1 and t_2 are respectively the tolerances for the diameter D_1 of the shaft and the bore D_2 of the bearing. The shaft may then have a diameter which varies between D_1 and d_1 and the bearing may have bores varying from D_2 to d_2. In the first case the minimum play will be j; in the second case the maximum play will be j' and it is obvious that $j' - j = t_1 + t_2$. In other words,

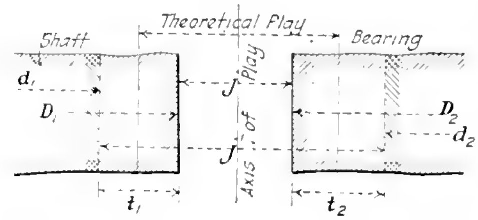


FIG. 16 REGION OF TOLERANCE AND PLAY BETWEEN THE SHAFT AND ITS BEARING

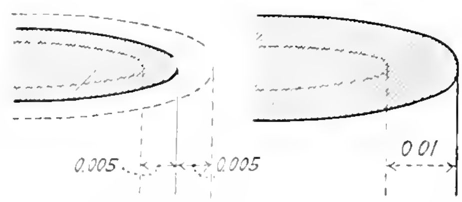


FIG. 17 SYMMETRICAL AND ASYMMETRICAL TOLERANCES

the total tolerance T or the play permitted is the same as the tolerances of the pieces which have to be assembled.

Symmetrical and Asymmetrical Tolerances. After the tolerance for a given piece has been selected it may be used either on the symmetrical or on the asymmetrical system. For example, let the nominal diameter of a shaft be 100 mm. with a tolerance of 0.01 mm. On the symmetrical system this tolerance will apply to the range from 99.995 mm. to 100.005 mm. In the second case there may be a difference in the permitted dimensions above and below 100 mm.; for example, 99.997 mm. to 100.007 mm. There may even be given a range from 99.990 mm. to 100.000 mm., in which case the entire tolerance will lie on one side of the given dimension.

The diagrams of Fig. 17 show at once that the symmetrical system, under equal conditions of manufacture, is more exact than the asymmetrical, because the permissible deviation of diameter is at most one-half of the tolerance, while in the asymmetrical system this deviation may be equal to the entire tolerance.

On the other hand, if, in an assembly such as, for example, a shaft and a bearing, it is desired to reduce the relative tolerance between the shaft and the bearing without varying the theoretical play, then (as apparent from Figs. 18 and 19) in the case of the symmetrical system (Fig. 18), the nominal diameter of the pieces is not altered by the change, and hence the nominal magnitudes on the drawings do not have to be changed when production with a

large tolerance (Case I) is changed to production with a smaller tolerance (Case II).

On the contrary, in the asymmetrical system the passage from Case I to Case II involves a change in the nominal diameter D equal to half the difference between tolerance t_1 and t_2, which can be seen by examining the left side of Fig. 19. In a shop this would involve remaking the drawings and indicating the nominal dimensions in complicated decimal fractions instead of in round figures.

Another case may be cited where the advantage of the symmetrical system is very appreciable. This is the case where it is desired in a lot of pieces, such as shafts, passed with the tolerance t, to carry out a new inspection and pass only the pieces satisfying a much smaller tolerance, for example, $t/2$. This may actually occur in course of production when the shop has a certain amount of completed stock on hand, and suddenly the market

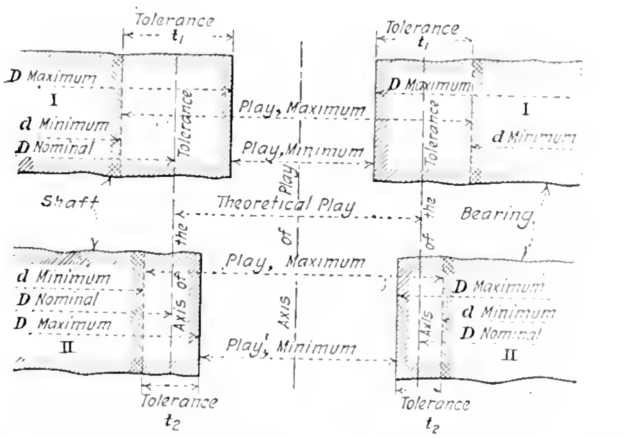


FIG. 18 VARIATION OF TOLERANCE WITH THE SYMMETRICAL SYSTEM

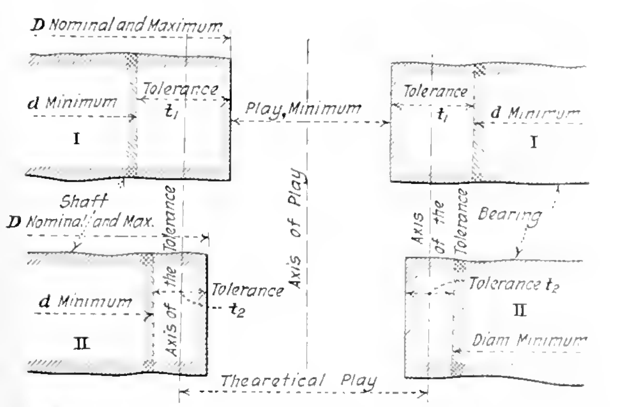


FIG. 19 VARIATION OF TOLERANCES WITH THE ASYMMETRICAL SYSTEM

begins to demand a smaller tolerance than the one which was current previously.

With this in mind the symmetrical and asymmetrical systems are compared, the tolerance being first t and then $t/2$ (Figs. 20 and 21).

The first to be considered (Fig. 21) is the scheme with the shaft adjusted on the basis of symmetrical tolerance. The different diameters which have been considered in this case are:

D, or nominal diameter corresponding to the axis of symmetry OY and the region of tolerances;

D_1, or maximum diameter, and d_1, or minimum diameter corresponding to a tolerance t;

D'_1 and d'_1, maximum and minimum diameters corresponding to a tolerance of $t/2$. The whole figure is symmetrical with respect to the axis OY.

The writer next plots the curve

$$y = ke^{-h^2(x-D)^2}$$

(the constant a of the general equation given above represents in this instance the nominal diameter D) of which the axis of symmetry is likewise OY since it corresponds to the nominal diameter D; the regions of tolerance corresponding respectively to t and $t/2$ and defined by the ordinates Aa and Bb for tolerance t and by Cc and Dd for the tolerance $t/2$. These two regions have in common the zone shaded by intersecting lines with the area $2S$.

The same operation (Fig. 21) may be carried out for the case of a shaft machined on the basis of asymmetrical tolerance. Here the tolerances t and $t/2$ are considerably below the nominal

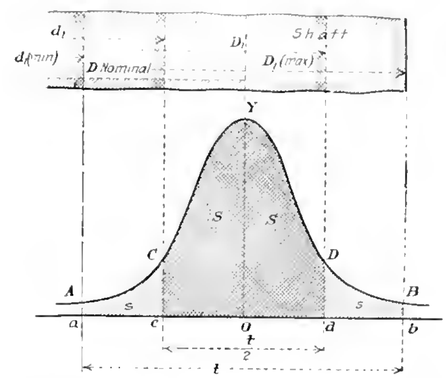


FIG. 20 GRAPHICAL REPRESENTATION OF THE REGIONS OF TOLERANCE WITH THE SYMMETRICAL SYSTEM

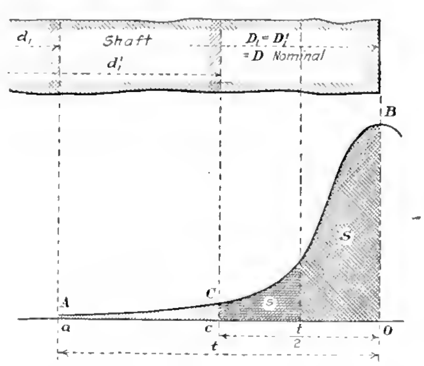


FIG. 21 GRAPHICAL REPRESENTATION OF THE REGIONS OF TOLERANCE WITH THE ASYMMETRICAL SYSTEM

diameter D, which may be easy to confuse with the maximum diameters D_1 and D'_1. The axis of symmetry of the curve

$$y = ke^{-h^2(x-D)^2}$$

is OY and the regions of tolerance are respectively defined by the ordinates Aa and BO for t and Cc and BO for $t/2$.

Here again the common part of the two regions of tolerance is represented by the shaded zone, but the area of this zone is equal to $s + S$ instead of $2S$.

If a regaging of the stock of shafts having the tolerance t be carried out and only those which have the tolerance $t/2$ be passed, the number of pieces to be kept will be represented by the cross-sectioned zone of area $2S$, where the symmetrical system of tolerances is in use, and by a zone of area $S + s$ in the case of the asymmetrical system, the difference in favor of the symmetrical system being represented by the difference between these two areas or by $S - s$. (Remarques sur le Système des Tolérances dans les Constructions Mécanique, A. C. *Le Génie Civil*, vol. 74, no. 11, May 3, 1919, pp. 353-355, 10 figs., *tp*)

MACHINE TOOLS, METAL-WORKING

CONTINUOUS MILLER. Description of a continuous milling tool designed by the Oesterlein Machine Co., Cincinnati, Ohio, which presents some novel features.

The body of the machine in general design resembles that of a punch press and is cast in one piece. It is claimed that the possibility of springing, due to working the machine to its maximum capacity, is avoided by the fact that the working surface of the platen and the cutter spindle are contained within the limits of the base casting.

The cutter can be held in a fixed position and the platen rotated continuously by means of an automatic feed, or the cutter may be reciprocated radially in combination with an intermittent motion of the table which is controlled by an indexing mechanism.

The spindle drive, Fig. 22, is taken from the driving pulley by means of miter gears to an intermediate shaft which connects with the first change-gear shaft in the speed box by means of a second pair of miter gears. The first and second change-gear shafts are connected by a single pair of change gears. The spindle speed is varied by means of pick-off gears on the two shafts.

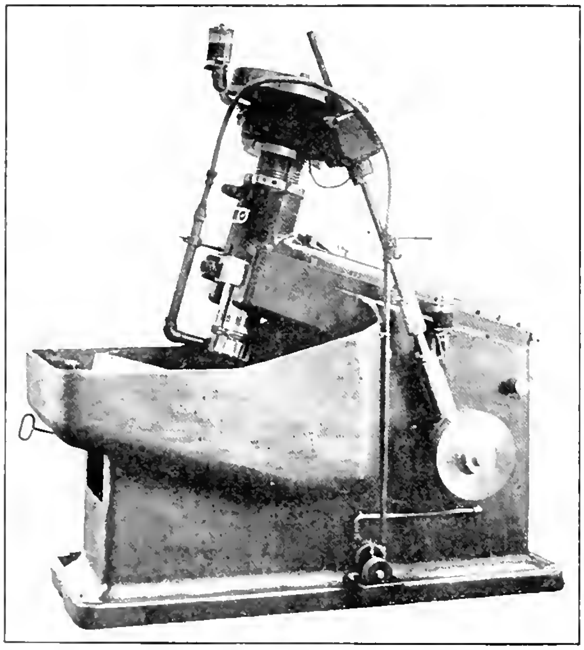


Fig. 22 Spindle-Drive Mechanism in the Oesterlein Continuous Miller

The spindle sleeve is provided with a vertical adjustment by means of a graduated collar which engages a coarse thread on the spindle sleeve. The spindle sleeve is clamped firmly in the split barrel of the ram after it is adjusted. The ram is fed radially over the surface of the platen by means of a cam which feeds the ram forward slowly during the cutting operation and permits it to drop back rapidly at the end of the stroke.

The relative travel of the ram is adjustable through the medium of a slide mounted under it. The slide is operated from the side of the ram by means of a bell-crank lever and is clamped with a knurled knob. The cam is driven by a worm and worm wheel in the feed box. A 4-gear feed-change mechanism regulates the platen feed when the continuous motion is in use. It also regulates the rate of speed of the cam when the indexing mechanism is employed. Thus the cutting feeds are established by the ratio of these change gears. The ratios are obtained by pick-off gears.

The rotary platen is set at a 15-deg. angle and is driven by a hardened worm and worm wheel. The worm is provided with ball thrust bearings and the box that carries the worm is gibbed to provide a means for compensating for the wear between the worm and worm wheel. (*Iron Trade Review*, vol. 64, no. 21, May 22, 1919, pp. 1359-1360, 3 figs. *d*)

MECHANICS

Application of Slope Deflection Method to Analysis of Statically Indeterminate Structures

Analysis of Statically Indeterminate Structures by the Slope Deflection Method, W. M. Wilson, F. E. Richart and Camillo Weiss. Frames composed of rectangular elements must in general be designed with stiff connections between the members at the joints, in order that loads may be carried. These connections must be capable of transferring not only direct axial tensile and compressive forces, but also bending moments. It follows that frames made up of rectangular elements are usually statically indeterminate; that is, the stresses in them can be found only by taking into account the relative stiffness and deformations of the various members. The common use of rectangular frames in engineering structures makes it highly desirable that the most convenient methods of analyzing their stresses should be developed. The stresses in a number of such rectangular frames have been analyzed by the writers and in their investigation they have made use of the so-called moment-area method given practically simultaneously in 1868 by O. Mohr in Germany and by C. E. Greene in lectures at the University of Michigan in this country.

The fundamental equations used in these investigations are expressed as follows:

1 When a member is subjected to flexure, the difference in the slope of the elastic curve between any two points is equal in magnitude to the area of the M/EI diagram for the portion of the member between the two points.

2 When a member is subjected to flexure, the distance of any point Q on the elastic curve, measured normal to initial position of member, from a tangent drawn to the elastic curve at any other point P is equal in magnitude to the first or statical moment of the area of the M/EI diagram between the two points, about the point Q.

The M/EI diagram is a graph in which the ordinate at any point is obtained by dividing the resisting moment, M, by the product of modulus of elasticity of material, E, and the moment of inertia of the section, I, at that point. If E and I are constant, the diagram will be similar in shape to the moment diagram for the member.

The fundamental equations are derived for moments at ends of members in flexure under various conditions of load and support, after which the writers proceed to the determination of stresses in statically indeterminate structures, to which by far the greater part of their discussion is devoted.

In this, two general methods of using the equations have been illustrated. In one case, after the equations have been written for each member of a frame by equating the sum of the moments at each joint to zero and employing one equation of statics, a number of equations are obtained which contain values of θ (angle between radii) and R $(= d/l)$ as the only unknowns. From these equations can be found the values of θ and R, which, when substituted in the original slope deflection equations, give values of the various moments. This method applies especially well to a frame in which a large number of members meet at each joint. Such a problem is generally best solved in numerical terms.

The procedure in the other case is more direct. The slope deflection equations for each member may be combined to eliminate values of θ and R, leaving equations involving the unknown moments, the properties of members and the given loading of the frame. These equations may be solved directly for the moments.

The following are some of the advantages of the slope deflection equations pointed out by the authors:

The general form of the fundamental equation is easily memorized, and the equations may be written for all members of a structure with little effort. The value of C or H for loaded members may be calculated by reference to two tables given by the writers. It is frequently possible to simplify the equations through noting where values of θ and R must be equal to zero from the conditions of the problem.

No integrations need be performed except possibly to find values of C and H, and there is little danger of the omission of

the effect of a single indeterminate quantity, as there is in methods involving the work of internal forces or moments.

The physical conception of a problem is easier than in the case where differentiation or integration is performed. When the slopes and deflections are determined, it is easy to visualize the approximate shape of the elastic curve of a member, whereas an expression involving the work of an indeterminate force or moment may have little physical meaning. Neither does the method of cutting a member and equating expressions for the linear and angular movement of the adjoining ends give so clear an idea of the actual deformation. To one unfamiliar with such a method the determination of the sign of the movement of the ends of the member cut is also more or less difficult.

Although the fact has not been brought out by the writers, these equations may be applied to many structures not composed of rectangular units. The determination of secondary stresses in bridge trusses is an example of such use which has been discussed in print for some time. With trapezoidal and triangular frames care must be taken in the use of the term R for adjoining members.

While the method is readily applicable to all the problems solved in this bulletin, its advantage over other methods is seen when applied to structures which are statically indeterminate to a high degree in which a number of members meet at each joint. (*University of Illinois Bulletin*, vol. 16, no. 10, Nov. 4, 1918, [Bulletin No. 108, Engineering Experiment Station], 214 pp., 112 figs., *tA*)

STEAM ENGINEERING

Is the Bucket Efficiency in Reaction Steam Turbines Materially Lower Than in Impulse Turbines?

Bucket Efficiency of Impulse and Reaction Steam Turbines, Prof. Tore G. E. Lindmark. First part of an extensive abstract of a paper in a Swedish periodical. In this paper the author claims that it is frequently stated that the bucket efficiency in a reaction steam turbine must necessarily be lower than the corresponding efficiency in an impulse steam turbine as long as the ratio between the peripheral velocity and heat drop for the reaction steam turbine does not exceed the most favorable values for the impulse steam turbine.

This means, in other words, that Σu^2, which is the sum of squares of peripheral velocities, must be greater in a reaction turbine than in an impulse turbine in order that, even apart from the influence of leakage losses, the former may attain the same degree of thermodynamic efficiency as the impulse turbine.

Professor Stodola, however, has shown that the reaction turbine with one-half degree of reaction has approximately the same ability for utilizing the relatively low peripheral velocities as an impulse turbine. The following considerations are presented by the author to combat the above expressed statement, which he considers to be incorrect.

The comparison between the efficiencies of impulse turbines and reaction turbines of various degrees of reaction is here limited by the author exclusively to the consideration of the bucket efficiencies, and by bucket efficiency is here understood the efficiency which relates only to losses in the guides and buckets, but not leakage losses, etc.

The author considers in this connection only one set of guides and buckets, and investigates the bucket efficiencies at various peripheral velocities in relation to a known heat drop. The so-called loss factor which originates in losses relating to thermodynamic efficiencies does not apply at all in this connection to the case of impulse turbines, since the investigation on this type of turbine has to do with but a single expansion. On the other hand, in the case of reaction turbine, even for a single guide and bucket set there is a certain loss factor, due to the fact that the steam expands not only in the guide, but also in the bucket. The losses in the first expansion raise the heat content of the steam, and therefore the expansion in the bucket starts from a somewhat higher heat content, and the heat drop in the bucket is somewhat increased thereby. At the same time this loss factor is so near unity that it can be neglected without creating thereby any very serious error.

If, for a start, all losses in the guides and buckets are neglected and the problem is simply considered as if the only loss were due to the absolute velocity of exit from the buckets, then the results obtained will be different from what has been indicated above. If it be assumed diagrammatically that all angles are equal to zero, then for the impulse turbine the following well-known formula will be obtained:

$$\eta_s = 1.0 \text{ if } u/c_0 = 0.5$$

where η_s = efficiency of bucket

u = peripheral velocity of bucket

c_0 = velocity of steam corresponding to the heat drop.

If the heat drop be denoted by W, then

$$A \times \frac{c_0^2}{2g} = W, \text{ where } A = \frac{1}{427}$$

In the case of a reaction turbine, 100 per cent bucket efficiency will not be obtained with the above indicated value of u/c_0. If the degree of reaction is, for example, 0.5, the heat drop will be divided into two equal parts between the guide and the bucket. Hence, the velocity of efflux of steam from the bucket will be

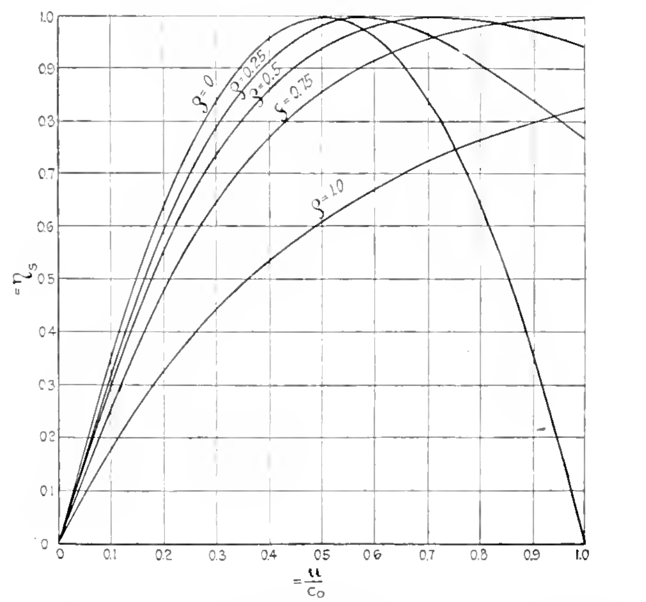


Fig. 23 Variation of Turbine Bucket Efficiency with the Peripheral Velocity for Various Degrees of Reaction

reduced to zero when the peripheral velocity is equal to the velocity of the steam, and therefore

$$\eta_s = 1.0, \text{ where } u/c_0 = \frac{1}{\sqrt{2}} = 0.708$$

If the degree of reaction lies between zero and 0.5, then $\eta_s = 1.0$ for u/c_0 having a magnitude between 0.5 and 0.708, and if the degree of reaction is greater than 0.5, then u/c_0 must have values greater than 0.708 in order that $\eta_s = 1.0$.

In the case of a complete reaction, the maximum bucket efficiency of unity is obtained only when $u/c_0 = \infty$.

It is of interest to see how the bucket efficiency under the above conditions varies with the peripheral velocity for various degrees of reaction.

Fig. 23 shows in the form of curves the variation of efficiencies with various u/c_0 values and five different degrees of reaction, viz., 0 (pure impulse turbine), 0.25, 0.50 (the usual so-called reaction turbine), 0.75 and 1.0 (pure reaction turbine). The curves illustrate the known fact that impulse turbines under the above conditions show greater ability for utilizing peripheral velocities than reaction turbines, and the situation with respect to the latter is the worse the greater the degree of reaction, and is at its worst for the pure reaction turbine. Nevertheless, it must be recognized that even under the above assumptions the difference of the bucket

efficiency between, for example, the pure impulse turbine and the reaction turbine with the degree of reaction = 0.5 is not excessively great. For example, with $u/c_0 = 0.4$ the reaction turbine operates with an efficiency only 10 per cent lower than an impulse turbine, and with $u/c_0 = 0.5$ with an efficiency only 6 per cent lower.

At the same time care must be taken not to draw from the foregoing considerations conclusions which are not justified by actual conditions. The curves mentioned have all been derived under the assumption that all the angles are equal to zero, and that there are no losses besides the absolute velocity of exit from the buckets, which is considered as being entirely lost. With the assumption of the presence of the usual angles the curves are somewhat displaced, although in the relative relations there are no material changes between the curves. Of more importance in this connection are the changes which are introduced by taking into consideration the losses in the guides and buckets due to friction, compression, etc., and also by considering the absolute velocity of exit from the buckets as not being entirely lost.

For a start the author continues to consider the absolute velocity of exit from the buckets as entirely lost, but introduces the usual angles in the guides and buckets, and takes into consideration the losses in flow through the guides and buckets. He uses the following notation in this connection:

A = amount of steam, kg. per hr.
c_0 = theoretical velocity of efflux of steam corresponding to the total adiabatic heat drop W for guide + bucket, meters per sec.
c_1 = actual velocity of efflux of steam from guides, meters per sec.
u = peripheral velocity of buckets, meters per sec.
ω_1 = relative inlet velocity of steam to bucket, meters per sec.
ω_2 = relative outflow velocity of steam from bucket, meters per sec.
c_2 = absolute outflow velocity of steam from bucket, meters per sec.
α = angle of guide
β_1 = entrance angle of bucket
β_2 = exit angle of bucket
φ = velocity coefficient for guides
ψ = velocity coefficient for buckets
N_s = actual bucket effect of velocity forces
N_t = theoretical bucket effect of velocity forces
$\eta_s = N_s/N_t$ = efficiency of bucket
ρ = degree of reaction

In all the calculations that follow it is assumed that β_1 is such that there is no shock at the velocity triangle in the inlet to the bucket.

For a pure impulse turbine, that is, one where $\rho = 0$, the following equations apply:

$$A \times \frac{c_0^2}{2g} = W$$

$$\text{hence } c_0 = \sqrt{\frac{1}{A} \times 2gW} = 91.5\sqrt{W}$$

$$c_1 = \varphi c_0$$
$$\omega_1^2 = c_1^2 + u^2 - 2\, c_1 u \cos \alpha$$
$$\omega_2 = \psi \times \omega_1$$
$$N_t = \frac{c_0^2}{2g} \times \frac{A}{3600 \times 75}$$
$$N_s = \frac{u \times A}{3600 \times 75 \times g} (\omega_1 \cos \beta_1 + \omega_2 \cos \beta_2)$$
$$\eta_s = \frac{2u}{c_0^2} (\omega_1 \cos \beta_1 + \omega_2 \cos \beta_2) \ldots\ldots\ldots\ldots [1]$$

When ϕ, ψ, α and β_2 are known, η_s can be calculated from Equation [1]. The author takes α = 18 deg. 10 min., and cos $\alpha = 0.95$; β_2 is taken to be equal to β_1.

For example, in turbines with guides, φ may with sufficient precision be taken to be equal to 0.95. It is more difficult to determine ψ. This coefficient appears naturally to be a function of the bending of the stream in the bucket and hence of the bucket angles β_1 and β_2. The greater $\beta_1 + \beta_2$ the less is the loss of velocity in the bucket and therefore the greater the magnitude of ψ. Professor Stodola tried to represent the function ψ/s of bucket angles in the form of a curve, but it is impossible to determine how far this curve approaches the actual conditions. It should, however, be borne in mind that the relative velocity when the stream bends in the bucket is not constant in all sections. Because of the difficulty of finding some satisfactory function determining the relations between ψ and $\beta_1 + \beta_2$ the author has assumed that ψ is not affected by the action of the angles and gives it a value 0.85, which is, roughly, a good value for multiple turbines of the

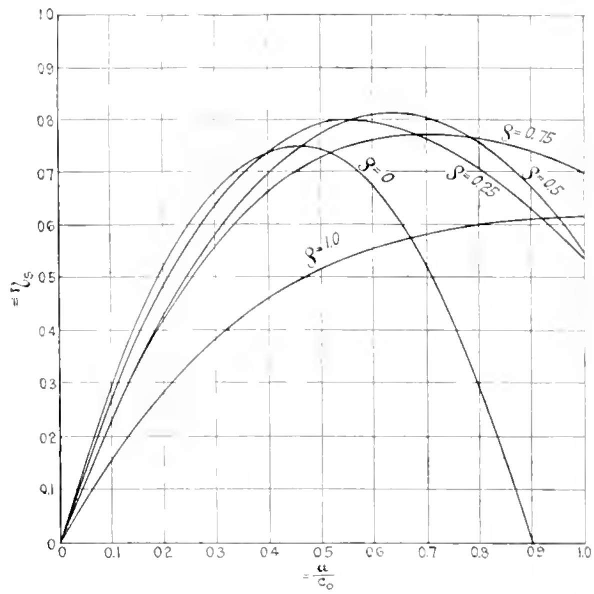


FIG. 24 VARIATION OF BUCKET EFFICIENCY OF PURE IMPULSE TURBINE WITH PERIPHERAL VELOCITY FOR VARIOUS DEGREES OF REACTION

impulse type with bucket angles of about 30 to 35 deg.

If the above numerical values be used the following equations are obtained:

$$c_1 = 0.95\, c_0 = 86.9\sqrt{W}$$
$$\omega_1^2 = c_1^2 + u^2 - 1.9 \times c_1 u$$
$$\omega_2 = 0.85\, \omega_1$$
$$\eta_s = \frac{2u}{c_0^2} \times 1.85\, \omega_1 \cos \beta_1$$

Since $\omega_1 \cos \beta_1 = c_1 \cos \alpha - u = 0.95\, c_1 - u = 0.9025\, c_0 - u$, we obtain

$$\eta_s = \frac{3.7u}{c_0^2}(0.9025\, c_0^2 - u) \ldots\ldots\ldots\ldots [2]$$

From Equation [2] are constructed the efficiency curves of Fig. 24 for the pure impulse turbine. From this the author proceeds to the consideration of combined impulse and reaction turbines with the degree of reaction ρ, which will be abstracted in the next issue. (Om Skevelverkningsgrader vid Aktions- och Reaktionsangturbiner, Professor Tore G. E. Lindmark, *Teknisk Tidskrift, Mekanik*, vol. 49, no. 24/3, March 12, 1919, pp. 37-41, 3 figs. *tA*, to be continued.)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

THE STILL ENGINE

Engineers who chanced to read the New York *Times* of May 28 had their curiosity aroused by a special cable dispatch from London under the heading, "New British Engine Surpasses the Diesel," giving a brief account of a paper read the previous day before the Royal Society of Arts on the Still engine, a combined internal-combustion and steam motor for which a thermal efficiency of 50 per cent was claimed. This paper, by Capt. F. E. D. Acland, was published in the *Journal of the Royal Society of Arts* of June 6, from which the following extracts and illustration, giving an idea of what it is claimed has been accomplished, have been taken.

The possibility of combining in one engine the superior thermal cycle at the high temperatures and pressures of the combustion engine with the low thermal cycle of steam to deal with its rejected heat, and in the same engine to add the superior working advantages of the steam engine, is the basis of work carried out by Mr. W. J. Still.

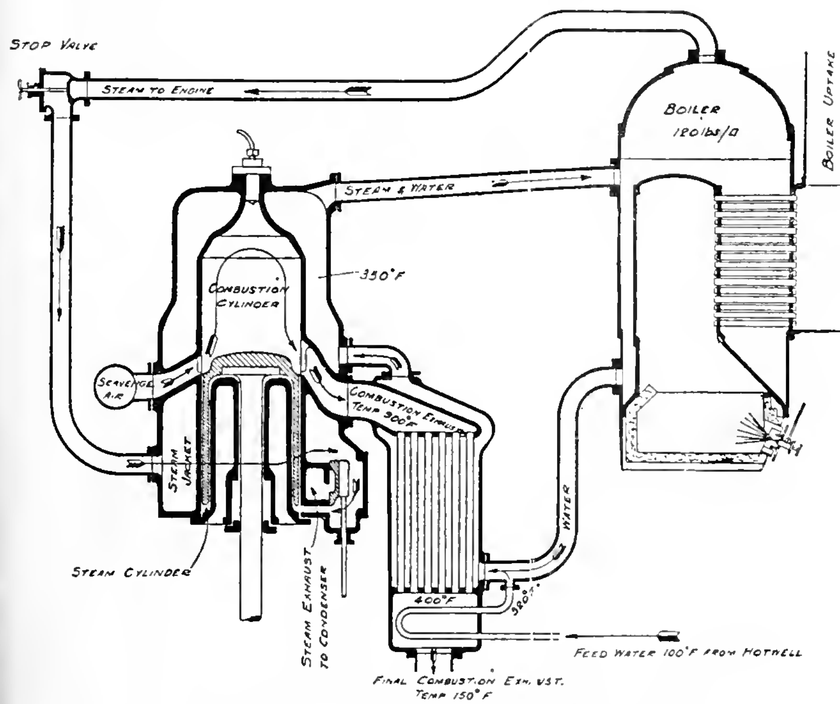


Diagram Showing Arrangement of Still Engine

The Still engine is an engine capable of using in its main working cylinder any form of liquid or gaseous fuel hitherto employed; it makes use of the recoverable heat which passes through the surfaces of the combustion cylinder, as well as into the exhaust gases, for the evaporation of steam, which steam is expanded in the combustion cylinder itself on one side of the main piston, the combustion stroke acting on the other side. It increases the power of the engine and reduces the consumption of the fuel per horsepower developed.

Its primary object is not to use the waste heat for raising steam, but first to use it in improving the thermal conditions of the working cylinder, and so insure the maximum efficiency from the fuel burnt within it, diminishing as a consequence the heat lost in that operation. Since the maximum efficiency is obtained by combustion of the fuel in the cylinder, and the minimum by the evaporation of the water in the steam generator, it is evident that the larger the quantity of steam which can be generated per horsepower developed by the combustion cycle, the lower must be the heat efficiency of the whole machine.

In the Still engine—see diagram—the jacket and cooling water form part of the circulating system of a steam generator, which may be an integral part of the engine, or external to it. The cooling water therefore enters and leaves the jacket at a constant temperature, regulated by the pressure of the steam, the cooling being effected by converting the water into steam without raising its temperature. Excluding the radiation losses, which are kept low by lagging, all the heat which passes through the walls is thus usefully recovered in the water as steam. The temperature of the cylinder wall is uniform over the whole of its exterior surface, and the heat lost to the cooling water at each stage of the cycle—compression, combustion and expansion—is diminished.

The exhaust gases after raising their quantum of steam are employed in preheating all the water required for the steam generated in the jacket water and the generator. Trials at full efficiency over long periods and steady loads show terminal stack temperatures as low as 150 deg. fahr.

The quantity of steam capable of being generated from "waste heat" depends on the efficiency of the combustion cycle and the load. Some years of experimental work prove that the weight of steam recovered may attain a maximum of about 7 lb. per b.hp-hr. developed by the combustion cycle of a four-stroke constant-volume engine at full load.

The first experimental engine constructed was a two-stroke engine capable of developing 500 b.hp. from three cylinders at 400 revolutions, bore 8 in. It was a high-speed engine, designed with special regard to obtaining data about the recovery of steam from waste heat (jacket and exhaust). It was first operated on town gas—540 B.t.u. per cu. ft., and subsequently converted for oil fuel. Its efficiency was not high, owing to its being a two-stroke engine with a short stroke, but its consumption per brake horsepower was 15 cu. ft. per hr. (31.3 per cent efficiency), a very promising result.

The outbreak of war prevented much progress being made in the design and construction of gas engines; but the results achieved give great promise of future development, for with a combustion indicated efficiency of 36 per cent, radiation 4 per cent, boiler loss 10 per cent, there remains 50 per cent for recovery; allowing 10 per cent efficiency for the steam cycle, a gain of 5 per cent is assured, and the total indicated efficiency of the engine will not be less than 41 per cent. If 20 per cent efficiency is obtained from the steam cycle, as appears possible, the total indicated efficiency will be 46 per cent.

A gas engine which can give a brake thermal efficiency 30 per cent better than its predecessors, and which, by governor control alone, can meet any demand up to and over 100 per cent overload, while maintaining a good efficiency at that increased output, cannot be neglected.

Four-stroke engines for petrol and similar fuels have been built and tested ashore and afloat. A special 13½ by 22-in. two-stroke-cycle heavy-oil engine with opposed pistons has been subjected to long and varied tests by representatives of various governments. The combustion takes place between the pistons, the steam acting on the return stroke at the back of both pistons. The best consumption of fuel—Admiralty shale oil—was as low as 0.302 lb. per b.hp. (scavenge pump not included) over a test of 1 hr. duration. This engine developed 330 b.hp. for 6 hr. at 360 r.p.m.—a single cylinder under waste-heat conditions. It will develop 400 b.hp. continuously with added steam—generated by fuel under the boiler—and has developed 540 b.hp. at 380 r.p.m. over short periods. (Combustion m.e.p., 128.2 lb.; steam m.e.p., 57.9 lb.; total m.e.p., 186.1 lb.) The thermal brake efficiency from below quarter load to full power is maintained at approximately 40 per cent over the whole range.

The application of the Still system to commercial marine work is being developed in this country and abroad, the two-stroke single-piston type, in powers of 100 hp. per cylinder and 400 hp. per cylinder, having been adopted. Engine of this type at 120 r.p.m., with a 22 by 36-in. cylinder, giving 4200 shaft hp. on two shafts, with all auxiliaries and water would approximate 600 tons. A geared turbine plant in a similar ship would weigh 20 per cent more and would consume approximately 2000 tons more fuel for a double journey lasting 1000 hours.

Bureau of Standards Publications

Circular 79, issued by the Bureau of Standards and prepared by G. W. Vinal and H. D. Holler, summarizes the available information on dry cells. A brief description is given of the materials and methods of construction, and an elementary theory of the operation of the cells. The various sizes and kinds of dry cells on the American market are described. The electrical characteristics of the cells and methods of testing them are discussed. In an appendix are given the proposed specifications for dry cells which have been prepared by the Bureau.

A second pamphlet, Technological Paper No. 109, gives practical suggestions for the conservation of tin in bearing metals, bronzes, and solders; much of the data having been obtained from questionnaires sent to representative manufacturers and users of these alloys. Tables are given showing the chemical composition and physical properties of many of the suggested alloys, and also for service tests of genuine babbitt and a high-lead bearing metal. Tentative recommendations for standard grades of bearing metal are also included.

MECHANICAL ENGINEERING

THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Published Monthly by the Society at
29 West Thirty-ninth Street, New York

M. E. Cooley, *President*
William H. Wiley, *Treasurer* Calvin W. Rice, *Secretary*

PUBLICATION COMMITTEE:
George A. Orrok, *Chairman* J. W. Roe
H. H. Esselstyn George J. Foran
Ralph E. Flanders

PUBLICATION STAFF:
Lester G. French, *Editor and Manager*
Leon Cammen, C. M. Sames, *Associate Editors*
W. E. Bullock, *Assistant Secretary Editor Society Affairs*
Frederick Lask, *Advertising Manager*
Walter B. Snow, *Circulation Manager*
136 Federal St., Boston

Yearly subscription $3.00, single copies 35 cents. Postage to Canada, 50 cents additional; to foreign countries $1.00 additional.

Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

The Detroit Meeting

The significant fact in connection with the Detroit meeting was the sustained interest in the professional and business sessions, from start to finish. The meeting opened on Monday, a day earlier than usual, and the business meeting was held on that day instead of the morning following, which virtually lengthened the period of the convention by one day. Nevertheless, a large number were on hand for business on Monday and stayed through the closing session on Thursday, which was one of the largest attended sessions of the meeting. The discussion at the various sessions was unprecedentedly large, that on Aims and Organization alone extending over a period of three days, and on Research for a full day. This number of Mechanical Engineering features reports of the Aims and Organization and the Industrial Relations sessions, while the August issue will report the Research and Pulverized Fuel sessions. In order to include the report, this number of Mechanical Engineering is issued one week later than usual, as announced on page 552 of the June number.

The Engineering Index

In this number of Mechanical Engineering an alphabetically-arranged index has been added to the items listed in the Engineering Index, in order to enhance its reference value.

When the Engineering Index was published by its former owners, the items were classified under the subject system. In taking over the Index, The American Society of Mechanical Engineers decided to retain the system of classification in order to test out the opinion of the membership as to its practicability. Experience has shown, however, that opinion is at least divided and that the alphabetical or dictionary arrangement of the items listed would be preferred by many members.

Because of the suggestions of the alphabetical arrangement which have come to us, it was decided to add the alphabetical index already mentioned until such time as a more decided preference can be expressed by our readers for the particular manner of arrangement for the Index items. The Editor of Mechanical Engineering will be glad to hear from members as to what they think is the relative desirability of the classified and alphabetical systems of listing items in the Index.

Report of the Nominating Committee

The following report has been received from the Nominating Committee appointed by President Cooley earlier in the year and which met at Detroit on June 16:

To the Secretary:

The Committee appointed by the President to nominate candidates to be balloted upon at the next annual election of the Society report a unanimous selection as follows:

For President:
Fred J. Miller, New York, N. Y.

For Vice-Presidents:
R. H. Fernald, Philadelphia, Pa.
E. C. Jones, San Francisco, Cal.
J. R. Allen, Pittsburgh, Pa.

For Managers:
D. S. Kimball, Ithaca, N. Y.
E. F. Scott, Atlanta, Ga. } Three-year term.
E. C. Fisher, Saginaw, Mich.
C. E. Lord, Chicago, Ill.: One-year term to complete term of Fred A. Geier—resigns December, 1919.

For Treasurer:
Wm. H. Wiley, New York, N. Y.

Respectfully submitted,
(signed) T. H. Hinchman,
John V. Martenis,
H. J. O. Hinchey,
Robert Sibley,
A. G. Christie,
Nominating Committee.

Detroit, June 17, 1919.

Anniversary Dinner for John A. Stevens

In celebration of the completion of a decade of successful business, an anniversary dinner was tendered to Mr. John A. Stevens, Engineer of Lowell, Mass., Vice-President of the A. S. M. E. and Chairman of its Boiler Code Committee, by his associate engineers and assistants at the Hotel Thorndike in Boston, Mass., on the evening of Saturday, May 17. About forty members of the organization were present and an informal reception was given to Mr. and Mrs. Stevens before the dinner.

The items on the menus, or "Fundamental Data" as they were called, were humorously couched in engineering terms, and the attractive front covers bore illustrations of one of the first plants built in 1909 and of a very large proposed super power house—recently designed in Mr. Stevens' office.

In the course of the evening the guest of honor was presented with a loving cup on behalf of the members of the organization, and received congratulatory letters and telegrams from many of his personal friends and clients. Mrs. Stevens was presented with a large bouquet of roses.

The associate engineers in Mr. Stevens' office are Messrs. Walter Slader, Clarence A. Bowen, Clarence Reeds, Francis Cunningham, Harry C. Lord, Carl J. Sittinger, George H. Thorpe and Marcus K. Bryan.

Services Acknowledged

At the request of the National Research Council, the Society, through its Standards and Technical Committee, has been privileged at various times during the past six months to furnish the French Government with information concerning American engineering and industrial standards. In all, nearly 200 publications have been transmitted (mostly in duplicate), embracing copies of engineering and safety standards and codes of the various engineering societies, publications of the American Pharmaceutical Association, chemical, mining and mechanical equip-

ment catalogs, and specifications and working drawings of United States standard locomotives and rolling stock. That the material thus collected and sent has been helpful, is evidenced by the letter reproduced below, which was recently received by the Society.

Office of the Scientific Attache to the American Embassy,
4, Place D'Iena

Paris, May 26, 1919

The American Society of Mechanical Engineers,
New York, N. Y.

Gentlemen:

The material collected by you for the French Government on the United States engineering and industrial standards has been received and transmitted to the services interested.

I wish to take this opportunity of thanking you in behalf of the French Ministry for the very comprehensive and valuable mass of material which you have assembled and put into convenient form for use. It will certainly be of great value here where standardization in the industries is in a very rudimentary state and where an organized attempt is now being made to introduce order into the engineering practice.

Very truly yours,
(Signed) H. M. Howe,
Scientific Attaché.

Honor for George Ellery Hale

George Ellery Hale, Director of the Mount Wilson Observatory and Foreign Secretary of the National Academy of Sciences, who has been for the last ten years a Correspondent of the Académie des Sciences, Institut de France, has received the unusual honor of election as Associé Étranger, taking the place of Adolph von Baeyer, declared vacant by the Academy. The Foreign Associates are limited to twelve, and the high distinction has been held by only two Americans—Simon Newcomb and Alexander Agassiz.

The National Research Council, upon the presentation and acceptance of Dr. Hale's resignation as its chairman and the election of James R. Angell as his successor, created and bestowed in perpetuity upon Dr. Hale the title of Honorary Chairman in recognition of his services to the National Research Council and to science and research by indefatigable efforts that have contributed so largely to the organization of science for the assistance of the Government during the war, and the augmentation of the resources of the United States through the newly intensive cultivation of research in the reconstruction and peace periods that are to follow.

Cleveland Engineering Society Honors A.S.M.E. Members

The Cleveland Engineering Society at its annual meeting on June 10 conferred Honorary Membership upon Dr. Charles F. Brush, Member A. S. M. E., and Worcester R. Warner, Past-President A. S. M. E. Dr. Brush was honored because of the important contributions he has made to the field of electrical engineering. He was the inventor of the arc lamp and many electrical devices.

Mr. Warner's connection with the machine-tool industry and his contributions to the science of astronomy are well known. In collaboration with Mr. Ambrose Swasey, his work represents the most notable development in the design and construction of telescopes and other instruments of precision for astronomical observation. The three great refracting telescopes, including the 36-in. Lick, the 40-in. Yerkes, and the 26-in. U. S. Naval, were all the products of his firm.

Summer School of Industrial Management

The fourth summer session in factory organization, cost accounting, employment and scientific management will be held at Pennsylvania State College, State College, Pa., August 11 to 23.

The mornings will be devoted to lectures and discussions on organization, cost accounting and employment management and will be conducted by Major Hugo Diemer, Mem. Am. Soc. M. E., formerly professor of industrial engineering at the college and now superintendent of personnel, Winchester Repeating Arms Co. During the war Major Diemer served in the Ordnance Department, where he was in charge of important munitions work at the U. S. Cartridge Co. and the Bethlehem Steel Co.

The afternoon practice work in making time and motion studies, routing, scheduling, etc., will be in charge of Lieut. J. C. Keller, Jun. Am. Soc. M. E., Major Diemer's first assistant in industrial engineering instruction at the college. A fee of $25 is charged for the course and equipment is available for a class of 30 students.

Labor and Scientific Research

Mention was made in the June number of Mechanical Engineering (page 558), of the organization of scientific and technical employees of the Government as a branch of the National Federation of Federal Employees, which is affiliated with the American Federation of Labor. Immediate cause for this movement was the action of the Joint Congressional Commission on Reclassification of Salaries of Federal Employees, this Commission preferring to deal with organizations rather than with independent groups. It is noteworthy that one of the first accomplishments of the new organization has been the securing of the adoption by the American Federation of Labor at its Atlantic City meeting of resolutions favoring scientific research as the basis for increased productivity in the industries and the promotion of the health and well-being of the employees—a recognition of fundamental principles, which, until recently, labor has seldom been willing to accept. The resolutions were introduced at the convention jointly by the National Federation of Federal Employees and by the American Federation of Teachers. The most important clauses embodied are given below:

The American Federation of Labor adopted the following resolution at its Atlantic City convention:

Whereas, Scientific research and the technical application of results of research form a fundamental basis upon which the development of our industries, manufacturing, agriculture, mining, and others, must rest; and

Whereas, The productivity of industry is greatly increased by the techincal application of the results of scientific research in physics, chemistry, biology, and geology, in engineering and agriculture, and in the related sciences; and the health and well-being not only of the workers but of the whole population as well, are dependent upon advances in medicine and sanitation; so that the value of scientific advancement to the welfare of the nation is many times greater than the cost of the necessary research; and

Whereas, The increased productivity of industry resulting from scientific research is a most potent factor in the ever-increasing struggle of the workers to raise their standards of living; and the importance of this factor must steadily increase since there is a limit beyond which the average standard of living of the whole population cannot progress by the usual methods of re-adjustment, which limit can only be raised by research and the utilization of the results of research in industry:

Resolved, By the American Federation of Labor in convention assembled, that a broad program of scientific and technical research is of major importance to the national welfare and should be fostered in every way by the Federal Government, and that the activities of the Government itself in such research should be adequately and generously supported in order that the work may be greatly strengthened and extended.

American Drop Forge Association

Progress in the establishment of standards for forgings was reported at the sixth annual convention of the American Drop Forge Association held at Pittsburgh, June 12-14, by the committee on standardization, which since the signing of the armistice has investigated the allowable limits for automobile crankshafts, gears, camshafts, connecting rods and axles. In his presidential address, E. J. Frost, Jackson, Mich., laid stress on this subject of standardization which, he observed, affords the greatest opportunity for eliminating waste and improving undesirable conditions.

W. O. Renkin, New York, read an interesting paper on Development in the Use of Powdered Coal in the Forging Industry, in which he claimed that the principal requirement of a furnace to burn powdered coal successfully is a relatively large combustion chamber of proper design. By proper design he

meant one which allowed the particles of coal to combine properly with the correct amount of air and burn at a minimum pressure above precipitation.

Earl E. Adams, Dayton, Ohio, spoke on Producer Gas as a Forge-Shop Fuel, and said that the gas must be cold to reduce the moisture and clean to prevent the clogging of the mains. He referred to a glass-wool tar extractor said to have an efficiency of from 99.95 to 99.98 per cent and made up of a mat of glass wool or spun-glass thread. A 20-in. mat, capable of handling 20,000 cu. ft. of gas an hour, contains 300 miles of this spun-glass thread. When made into a mat it is equivalent to 250 plies of 90-mesh screen.

Other technical topics were: Forge-Shop Profits, by F. A. Ingalls, Harvey, Ill.; Sand Blasting Versus Pickling, by R. R. Shuman, Chicago; Die Cost as a Factor in Selling Forgings, by R. T. Herdgen, Walkerville, Ont.; Heat-Treating Problems That Originate in the Forge Shop, by W. C. Peterson, Detroit, Mich., and Fusion Welding as Applied to Drop Forgings, by S. W. Miller, Rochester, N. Y.

A Word from Roberts College

The A.S.M.E. headquarters was recently favored by a call from Prof. Lynn A. Scipio, Mem.Am.Soc.M.E., Director of Engineering of Roberts College, Constantinople. Plans are under way for the expansion of the engineering school, and Professor Scipio is here to recruit a teaching staff.

Some one has said that the only good thing that has happened in Turkey is Roberts College; and certain it is that it has been the most potent civilizing and educational influence in that country and throughout the Balkan states.

In this work the engineering school is assuming an important place. The original plans for the school were made by Prof. John R. Allen, Mem.Am.Soc.M.E., in 1911 and 1912. He was followed by Professor Scipio, who went from the University of Nebraska to develop the school. Three courses have been offered in Civil, Mechanical and Electrical Engineering, and a course in Mining is contemplated. A shop building with limited equipment has been erected and a power plant at a cost of $100,000.

The college was able to remain open during the war, although its courses were curtailed. When diplomatic relations were broken off with Turkey, the United States Government ordered its citizens out of the country. A few remained at the college, however, and carried the work with the aid of native instructors. Frequent attempts were made both by the Germans and Turks to confiscate the buildings for other purposes, but these were thwarted through the diplomacy of the college president, Dr. C. F. Gates. The Germans dominated the situation and were in every office, and finally attempted to starve out the college by making flour contraband on the ground that it was needed by the army. The engineering department then proceeded to build a flour mill, which was successful in tiding over the situation.

Coal was bought for the power plant at $80 and $100 a ton, although much of it consisted only of earth scrapings from the bottoms of former coal piles, and was worthless. Money for the continuance of the college was secured mainly through personal contributions by Greeks and Armenians. Notes were sold at 2 per cent interest, which were readily disposed of, as it was felt that the college was sound and would be well supported financially, and many natives believed it provided a safer investment for their money than any other institution.

16 Hours, 12 Minutes

Since the NC-1 of the United States Navy has shown the way across the shorter part of the Atlantic there have been several highly significant developments.

The Sopwith biplane with Hawker and Grieve started from Newfoundland, but was not able to complete the crossing owing, as has been stated, to minor troubles in the water-circulation system of the engine. The plane had to land on the water after a flight of little in excess of 1000 miles, but the pilot and navigator were saved by a passing steamer.

Another attempt on Sunday, June 15, made by Capt. John Alcock and Lieut. Arthur W. Brown, British officers, in a Vimy biplane was successful and the two fliers crossed the Atlantic from Newfoundland to Clifden, Ireland, in 16 hours and 12 minutes.

The events of the last four weeks taken in their entirety point to several significant facts. In the first place, altogether five machines made this attempt—three in the shorter southern direction and two in the longer northern direction, and only two of the five have reached their goals, the other three landing on the water. Nevertheless, not a soul was lost in these flights, and even the dare-devil attempt of Hawker and Grieve has ended with all hands safe. This would indicate essentially that flying over an ocean upon which so many vessels are constantly plying as on the Atlantic along its trade routes is probably less dangerous than would appear at first sight.

The second lesson brought out by the flight of Alcock and Brown lies in the fact that they had to cross the ocean under unusually trying conditions, and succeeded in doing so, nevertheless. It would appear from this that even in the present state of long-distance aerial transportation a flight 1900 miles is practically achievable, and if the tremendous strides made in aerial navigation in the last years be considered, it will become fairly obvious that ere long the establishment of regular aerial transportation across the ocean may be expected.

It may well be pointed out here that these transoceanic flights represent really the first obviously important commercial application of aircraft. At present and for the first few years to come, there is no question but that air transportation will be considerably more expensive than all other existing means of transportation, not only because it necessitates the use of a heavier fuel but also because the depreciation of the machinery used per pound of weight carried is greater than in the case of motor trucks, railway trains, or steamboats.

The only point where air transportation is unquestionably superior to any other form of transportation is in its speed, but even in land transportation the superiority of aircraft speed is not great enough in a good many cases to compensate for its higher cost. Thus, taking such two points as New York and Chicago, air communication would only in comparatively few cases be fast enough to save even one business day between these cities.

The situation, however, is entirely different with transatlantic transportation. While there are one or two boats that can make the passage in five days and some hours, the average time from Liverpool to New York is between six and eight days, which means that all fast transportation of messages must depend upon the cables and wireless. With a 24-hour schedule between London and New York it would be perfectly possible to receive London papers in time for abstracting them in New York papers of the next day, while letters between London and New York would be delivered as promptly as they now can be between New York and Chicago.

In banking, important business transactions and especially in engineering enterprises the ability to send a draft or a blueprint from New York to London or back in 24 hours will not only be a great help to the growing American export trade but will also create an important source of business for the aerial navies of the near future.

Edwin J. Prindle, A. S. M. E. representative on the Patent Committee of the National Research Council and who presented a paper at the January 14 meeting of the New York Section dealing with the movement to increase the efficiency of the Patent Office and the patent system (see Mechanical Engineering, February 1919, p. 147), has just been appointed Chairman of the Patent and Related Legislation Committee of the American Chemical Society.

At the recent convention of the National Association of Manufacturers, addressed by Mr. Prindle on the subject, a resolution was passed approving the report of the Patent Committee of the National Research Council to that body and the enactment of its legislative program.

THE DIVISION OF ENGINEERING OF THE NATIONAL RESEARCH COUNCIL

At the Research Session of the Spring Meeting of the A. S. M. E., an address was given by Mr. Galen H. Clevenger, Acting Chairman of the Division of Engineering of the National Research Council, on the organization and work of the Council and of the Division of Engineering with which he is directly connected, at present in charge of the headquarters of the Division of Engineering in the Engineering Societies Building, New York.

Mr. Clevenger reviewed the organization of the National Academy of Sciences which came into being during the Civil War through the action of President Lincoln; and of the National Research Council which similarly was organized during the present war at the request of President Wilson. Lately, the National Research Council has been reorganized on a permanent basis for promoting research among the industries of the country.[1]

In his address Mr. Clevenger also reviewed the war organization and work of the Division of Engineering, followed by an account of the present activities and affiliations of the Division of Engineering, from which the following is taken:

War Organization of Division of Engineering

The Division of Engineering comprised four sections: A section on Metallurgy, a section on Mechanical Engineering, a section on Electrical Engineering and a section on Prime Movers. The work of each section was under a chairman, who was directly responsible to the chairman of the division.

The Section on Metallurgy had for its principal work the solving of metallurgical problems arising in connection with the conduct of the war, more particularly those brought to it by the military. This work was accomplished through the medium of committees, whose personnel included leading authorities upon metallurgy.

The Section on Mechanical Engineering established a drafting room in charge of a chief draftsman, at Research Council headquarters and through the generosity of the Carnegie Institute of Technology a machine shop at Pittsburgh under the direction of a foreman. These were used for the development of inventions referred to the Section by the Divisions of Engineering and Physics.

The Section on Electrical Engineering concentrated its efforts upon the problem of electric welding, more especially electric welding as applied to ship building. This section worked in very close coöperation with the Emergency Fleet Corporation, who financed its investigative work.

The Section on Prime Movers devoted its attention chiefly to the design and development of power plants for aircraft.

The efforts of each section were so directed as to be of the greatest service in the solving of the problems of greatest immediate need to winning the war; each has to its credit important achievements during the war period. (See Report of the Academy of Sciences for the Year 1918.)

Present Organization and Affiliations

The purpose of the National Research Council is to promote research in the mathematical, physical, and biological sciences, and in the application of these sciences to engineering, agriculture, medicine, and other useful arts, with the object of increasing knowledge, of strengthening the national defense, and of contributing in other ways to the public welfare. Affiliation with similar organizations abroad is rapidly bringing about an International Research Council.

The Division of Engineering consists of three representatives of each of the four founder engineering societies, the societies so represented being the American Society of Civil Engineers, the American Institute of Mining Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers. Further, there is one representative each from the four more important non-founder societies, the societies so represented being the American Society for Testing Materials, the American Society of Illuminating Engineers, the Western Society of Engineers, and the Society of Automotive Engineers. In addition to the representatives of the engineering societies there are 12 members at large, making a total membership in the division of 28. Eight members of the division are also members of Engineering Foundation.

The Engineering Foundation has from the beginning taken a very active and important part in furthering the work of the whole council; indeed in the earlier stages of the war organization, when the funds available for carrying on its work were very limited, Engineering Foundation gave the services of its secretary and substantially its whole income to the support of the Council, this arrangement continuing until support was secured from other sources.

Recently a plan of close affiliation of the Engineering Foundation and the Division of Engineering has been approved by the members of the Engineering Foundation and the Division of Engineering, and also by the Executive Board of the Council. In compliance with the terms of this agreement the Engineering Foundation has provided the Division of Engineering with an office in the Engineering Societies Building, New York, together with necessary clerical assistance. It further has agreed to make appropriations of its funds to aid specific undertakings of the division from time to time as may be later determined; and in fact at the present time an arrangement has been practically effected whereby the Engineering Foundation undertakes the financial support of the work of the Committee on Fatigue Phenomena in Metals.

The location of the Engineering Division in the same building with the headquarters of the national engineering societies and its close affiliation with the Engineering Foundation renders it a very potent factor in promoting engineering research.

The Engineering Division is not to be regarded as an instrument of research, but rather a stimulator and coördinator of research. It is not the master but the servant, eager to aid in the bringing together of research agencies and uniting them in larger projects of research than would be possible through individual effort. Its principal object is to get more and better research done in engineering, carefully avoiding the position of being a dictator, or of assuming credit for work which it has encouraged others to do.

The Engineering Division is at present carrying on its work largely through the medium of committees. Much thought has been devoted to developing a plan of organization of research committees which will render them most effective. It is clearly recognized that within every committee there should be an active group which is in a position to do the actual work of research. A chairman is provided who is thoroughly familiar with the subject in hand and who has sufficient time to devote to the work; furthermore, financial support necessary to carry on the work is provided so far as possible. When all of these conditions are provided for, effective work may be expected from the committee, even though the larger group of the committee may be busy men who can do little more than act in an advisory capacity.

The Engineering Division now has some 14 committees working upon a variety of subjects. These are in various stages of organization.

Every effort is being made to take up researches of broad general interest. At present 21 states, extending from the Atlantic to the Pacific, are represented on these committees and the number is rapidly increasing.

[1] For further references to the history and organization of the National Research Council see pamphlet copy of Mr. Clevenger's address; also the following references to Mechanical Engineering: May, 1919, p. 485; June, p. 559; and the present issue, p. 592.

ENGINEERING COUNCIL

Engineering Council[1] is an Organization of National Technical Societies of America, Created to Consider Matters of Common Concern to Engineers, as Well as Those of Public Welfare in Which the Profession is Interested

Classification and Compensation of Engineers

THE Committee on Classification and Compensation of Engineers, whose personnel was given in the May issue of MECHANICAL ENGINEERING (p. 488), is now actively engaged in securing data upon which to base its final report. This committee is divided into three sections, Federal, Railroad, and Municipal and State. Preliminary reports were recently rendered by each and in submitting them to Engineering Council the Committee outlined its method of procedure in attempting to formulate standard rates of compensation for professional engineers. The first task is to find what rates are actually in force, especially in those fields where attempts at standardization have been made, and the second is to inquire what adjustment should be made to correspond to the great change which has taken place in the cost of living. How great this change has been during the past 20 years is realized by few. Fortunately an accurate determination is available in the statistical records of average prices which for many years have been gathered and published by leading commercial organizations. A record of average prices of the necessaries of life kept by R. G. Dun & Co., shows that prices have increased continuously for 22 years. A certain quantity of staple necessaries which could have been purchased July 1, 1897, for $72.45, by January 1, 1905, cost $100.32. On January 1, 1914, before the outbreak of the war, the cost had risen to $124.53; May 1, 1917, to $208.43, and October 1, 1918, to the maximum of $233.23. This enormous increase in prices of the necessaries of life has been accompanied by an increase in wages, among workers organized in unions which had the power to compel attention to their demands, but no such increase has taken place in the compensation of salaried workers in the professions. It has been assumed that these workers, living in a different social environment, had a margin of compensation sufficient to enable them to meet the increased cost of living. This assumption, however, is not justified by the facts. Where salaries have been increased during the past three years, there are few cases in which the increase has been at all commensurate with the increase in prices of the necessaries of life, which the salaried worker, like the wage worker, has had to purchase.

There has been a general belief that with the coming of peace and the resumption of productive industries, a heavy fall in prices would occur. It has been assumed that the salaried worker would have to wait for this so that he could again live within his income. It now appears, however, to be the opinion of many financiers and economists that the present high prices of necessaries are likely to continue for a long time, probably for several years. If this is so, then surely the salaried worker, in a professional or any other occupation, has an equitable claim to have his compensation brought back in purchasing power to where it was fifteen years ago.

There is another aspect of the compensation of the professional worker which has been frequently misunderstood, but which with present knowledge ought no longer to deceive. The pay of professional engineers has for many years been influenced by the idea that a young man in the earlier years of his work should expect moderate compensation because of the future to which he might look forward. There was justification for this idea during the period when the development of engineering was so rapid that a large proportion of the men who were turned out from the few engineering schools or the engineering workshops were able eventually to rise to positions of large responsibility and importance, commanding high salaries. That condition has now been altered. Of the men who begin technical engineering work today, only a very few selected ones can rise to positions of responsibility commanding high salaries. The man of exceptional ability, indeed, may find it worth his while to work for low compensation because of the future awaiting him. But to hold up to the rank and file of technical workers the idea that they can afford to work for insufficient salaries for the sake of some future high position, is a gross deception.

The Committee believes, therefore, that in adopting standards for the compensation of workers in all technical fields due consideration should be given to the great increase in the cost of living. The dollar of salary must be considered with regard to what it will purchase today and is likely to purchase next year, and not with regard to the value of the dollar ten or fifteen years ago. This increase in compensation is necessary not merely as a matter of justice to the engineer, but in order that engineering work may be maintained on the plane that it must be to secure economical and efficient work. There is no economy in paying such men at rates inadequate for their support, for this leaves their minds burdened with anxieties, when they should be free to give their best efforts to the work in hand. Moreover, such a rate automatically tends to drive the abler men into other occupations and to leave in charge of the work only those of less ability. The Committee has therefore recommended that it be directed to formulate a definite classification for each of the services under consideration and a schedule of compensation which might reasonably be fixed for positions in each class.

Federal Government Section. A survey of Government activities shows that there are twenty-eight offices that employ Government engineers. A letter was sent to each departmental secretary outlining the work of the Committee and requesting assistance in furnishing a list of engineering bureaus in his department and in issuing instructions to the chiefs to furnish the needed data. Favorable responses from all departments were received, except the War Department, which stated it would be impracticable to furnish the information desired. But little work has been done, however, as an analysis of the data collected cannot be made until the majority of the reports have been received.

Railroad Section. The chairman of this section prepared a questionnaire to be sent to the chief engineers of the railroads under Federal control on the supposition that the salaries of all the men in the various departments of the Railroad Administration were a matter of public knowledge, and also requested recommendations on an unofficial basis from them. Before sending out this questionnaire, however, the chairman made a personal call on Director-General Hines and discussed with him the propriety of making such a request. Mr. Hines did not think that the matter should be approached in the manner suggested, nor that the employer should be called upon to furnish a list of salaries and to express in advance an opinion as to how these salaries should be changed; but did state that he did not see any objection to our getting the information from members of the Founder Societies. The chairman acquiesced in Mr. Hines' views, and has accordingly confined his questions to members of the Founder Societies.

Municipal and State Section. By reason of the wide variety of titles used for the municipal and state service, the Committee found it necessary to undertake the formulation of a standard classification of positions and duties, before attempting to investigate the question of compensation. The assistance of the Municipal Engineers of The City of New York was invoked in this particular, and after a painstaking investigation by a representative committee a schedule of suitable titles with corresponding qualifications and duties has been prepared. The fitness of this schedule for general use is now under consideration by the Committee. As soon as an agreement shall have been reached, it is proposed to incorporate it in a questionnaire for circulation among the engineers of all states and the more important cities with a view to determining present compensation and changes which should be made. It is hoped that the classification finally agreed upon will prove broad enough to cover all municipal and state engineering service, and that it will be accepted as a substitute for the variety of standards now in use.

[1] Officers of Engineering Council: J. Parke Channing, *Chairman;* Alfred D. Flinn, *Secretary,* Engineering Societies Building, 29 West 39th Street, New York.

NATIONAL SERVICE COMMITTEE

Contributed by the Washington Office [1]

National Department of Public Works

The proceedings of the conference held at Chicago, April 23 to 25, to consider the formation of a Department of Public Works were published in the June issue of Mechanical Engineering, p. 557. Since then the work in general has been divided into four parts:

Organization of Executive and Finance Committees
Drafting of a bill
Organization of a Campaign Committee
Review of public-works laws of other countries.

The Committee on Text of Bill has completed its labors. After approval by the Executive Committee it is the intention to consult leaders in Congress and secure advice as to its introduction. After it is introduced and has thereby gained official status, copies will be freely distributed among the various federated organizations. Suggestions concerning amendments will then be solicited.

The review and compilation of public-works laws of other countries is also practically completed, covering all the larger powers, three British dominions, four South American republics, and several small European kingdoms.

The organization of the Campaign Committee has been a huge task and is by no means completed. It was apparent at the outset that a committee would be required consisting of one or more members from each state in the Union. It is impossible to make such a committee function as a unit and therefore it was determined, subject to approval of the Executive Committee, to create separate state committees, all synchronizing with the Washington office. Campaign conditions vary widely in the several states and residents in each state are better qualified to determine details of campaign than any general committee. The Chairman has written several hundred original letters to men in the several states urging them to undertake the campaign work. Many replies, both favorable and unfavorable have been received, but from the majority of the states no responses have been returned. Formation of committees is now under way in New England, New York, Ohio, Michigan, Wisconsin, Minnesota, Illinois, Kentucky, Missouri, Kansas, West Virginia, Georgia, Florida, Louisiana, Texas, Nebraska, North Dakota, Arizona, California, Washington, Oregon, and Idaho.

It seems wise in the conduct of this campaign to avoid the outworn and objectionable methods that have been followed by practically everyone during the past generation. The very character of the project and the standing of those participating in it demand that the campaign shall be conducted on a high and dignified plane. It should be the duty of the several state camapign committees to select in each congressional district men qualified to give advice along such lines. The Washington office should supply the particular facts, instances and arguments that are apparent to everyone on detailed study, but which may or may not be familiar to those who approve the project on general principles.

It is not expected that a campaign of any kind can be immediately successful, but it is believed that the open and aboveboard procedure here outlined, steadily and progressively maintained, will result in the making of fast friends in official circles and in bringing a successful conclusion sooner and with less acrimony than any other method now apparent.

Relations with Congress

In order to introduce Engineering Council to members of Congress and to make known its purposes, the following letter has been addressed to the chairman of twenty-eight committees of the House and Senate. Appreciative acknowledgments have been received from a large number of them.

This is addressed to you on behalf of Engineering Council for the purpose of informing you concerning its aims and purposes, and of ways in which it may be useful to you in your official capacity.

Engineering Council is the central organization, made up of representatives appointed by the various national societies and institutions of engineers, including the American Society of Civil Engineers, American Institute of Mining Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers and American Society for Testing Materials. These national societies have focused their common aims and affiliations in Engineering Council, and said Council represents the highest type of engineering thought and experience in the United States.

One of the chief aims of the Council is that of national service. It proposes to lend its services to the Government when so invited, and to give counsel and advice on engineering matters. By this announcement it is desired to inform you that, if in your official capacity, you wish to secure the unprejudiced assistance of a body which comprises within its membership and affiliations the best qualified engineering authorities of the country, you have merely to make your desires known and Engineering Council will place at your disposal a group of men which will merit your entire confidence. Such service will naturally have to be confined to counsel and advice as to policies and plans.

It is hardly necessary to add that no compensation will be asked or expected for such service, the aim of Engineering Council being to give its services to the country and thereby contribute its appropriate part to the general well-being.

Government Contracts

The National Service Committee has placed before Engineering Council the matter of a uniform type of construction contract for use by Government agencies. At present there is a heterogeneous mixture of many kinds of contracts, from the old-fashioned lump-sum bid to the more complicated, so-called "cost-plus" contract. There is much discussion going on concerning these types of contract and many members of Congress are persuaded that either the one or the other kind is fundamentally wrong. It will be recalled that during the war a modified form of cost-plus contract was used by the Construction Division of the Army, which form was absolutely essential to the emergency work that was required. This form of contract has engendered much opposition and yet there are persons who advocate that it be adopted throughout all Government construction procedure whether in war or in peace. It is a subject quite unfamiliar to the legislator who has not given much study to it and there is always the danger that by riders to appropriation bills which go through in a hurry and without mature consideration, the construction work of the Government may be seriously hampered as it already has been in some instances in the Construction Division. Long before the war, there was need for reform, especially in the river and harbor work and that of the Reclamation Service. Under the lump sum process in vogue too many contractors failed, with the result that great losses were involved, not only on the part of the contractors, but also on the part of the Government. This subject, with especial reference to the cost-plus contract, has already been studied officially by one member of Council, who as chairman of a committee, during the early part of the war, rendered a report in favor of the cost-plus principle followed by the Construction Division. This is unquestionably a matter of great importance, and should receive thorough consideration by a qualified committee, and ultimately be made a subject of legislation.

Relations of Engineering Council to National, State and Local Societies

At the last session of the Chicago Conference, the chairman announced an opportunity for frank discussion of society relations which it was hoped would bring all engineers into harmony. The chairman of Engineering Council gave facts concerning Council and the methods and limitations under which engineering societies could become members. The discussion which followed gave clear indication that it was the desire of the delegates that some closer relation should be achieved. The remarks of W. H. Hoyt, delegate from the Minnesota Joint Engineering Board, conveyed the sentiments of those present as well as those of many others:

Engineering Council has done wonderful work in the few years it has been organized. They have shown to my mind simply the pos-

[1] Washington Office in charge of M. O. Leighton, *Chairman*, National Service Committee, McLachlen Building, 10th and G Streets.

sibilities. They have merely opened up the field. The appointment of their committees alone shows the enormous work that is to be done and can be done, but I believe, gentlemen, that it will not be a success until that Council is organized in some way so that it may feel the effect directly from the individual member at home, just exactly in the same way that your representative sits up and takes notice when he gets a letter from home—that represents personal and local interest. How that can be brought about, I don't know. It will be developed; there is no question about that. The men that are at the head of this question now are men capable of producing those results, and I can see it coming. As Mr. Channing has said, the question now is a live one. In my opinion, Council cannot be a success until it has a broader form of government, more personal backing and support from the individual societies throughout the country which give it its life and also the general support and backing which it will be able to obtain when they have such control over such an organization. In regard to financial backing, I believe there will be no question at all of obtaining all the finances necessary if it has the organization, shows the disposition and has the direct and immediate initiative to take hold of that work and the will to do it.

The National Budget

A national budget system, which engineers have long regarded as essential to the proper conduct of our fiscal affairs, is at last being seriously considered by Congress and seems likely to be adopted in some form. Several bills and joint resolutions have already been introduced but the measure which seems to attract the most attention is that introduced by Representative Good, Chairman of the House Committee on Appropriations. The origin of the bill is not without its significance because some of the strongest opposition to a budget system that has heretofore been developed in Congress has come from the members of this important committee.

The Good bill provides for the creation of a Bureau of the Budget in the office of the President, to which full information shall be furnished by all Departments and other Governmental agencies concerning powers, duties, financial transactions, business methods, etc. This Bureau is authorized to make investigation of all provisions of law dealing in any way with the preparation and transmission to Congress of estimates and other financial data, in order to determine what changes should be made, to the end that all the requirements shall be brought in harmony with an alternative budget which the President is authorized to submit to Congress. The President is further authorized to submit his recommendations as to how the needs of the Government should be met, and such further data regarding the financial affairs of the Government as he deems proper.

The bill abolishes the offices of Comptroller of the Treasury and all the Auditors for the several Departments, and substitutes therefor an Accounting Department, an establishment independent of the Executive Departments, under the direction of a newly created officer to be known as the "Comptroller General of the United States" whose powers shall comprise all those now conferred on the Comptroller of the Treasury and the several Auditors and, in addition, the investigation of all matters relating to the receipt or disbursement of public funds.

There is also created a joint committee of Congress to be known as "Joint Committee on Receipts and Expenditures of the Government," to consist of three members each of the Senate and House of Representatives, which committee shall investigate methods and procedure relating to the receipts and expenditures of the Government, recommend changes in laws and regulations, and accompany its recommendations by bill embodying same.

Engineering Research

The movement for Federal endowment of engineering and industrial research was revived early in the present Congress by the introduction of two bills into the Senate. The first, introduced by Senator Smith of Georgia, provides for the establishment of an engineering experiment station in each state, under the direction of and in connection with some university, engineering school, or land-grant college. The state legislature of each state is authorized to designate the institution best equipped to conduct the work but wherever the land-grant college has facilities approximately equal to those of the other institutions of the state, it shall be designated. All designations of institutions are made subject to the approval of the Secretary of Commerce.

The sums of $30,000, $40,000 and $50,000 for the first, second and third fiscal years respectively, and thereafter $50,000 annually, are appropriated to each state which by acts of its legislature assents to the provisions of this act The Secretary of Commerce is authorized to secure practical uniformity of methods by indicating such lines of work as shall be of importance from a military, naval, industrial or national standpoint, but responsibility for the conduct of the research shall rest with the individual experiment stations. Uniform standards of research are further provided for by making each experiment station a depository of the Department of Commerce and the Bureau of Standards, and the work of each station shall conform to the standards established by the U. S. Government.

The practical difficulty with the Smith bill is that it leaves open the question which has heretofore made it impossible to unite on any bill, namely, that the selection of the institution to receive the endowment is open to debate, and it will in too many cases depend on the influence each one may be able to muster in a state legislature. It opens up again the old contest between the state universities and the land-grant colleges by providing that the latter shall be selected if their facilities for conducting the work are equivalent to those of other institutions of the state. This again is a question leading to endless debate.

The second or Gronna bill sets up the Secretary of Commerce and the National Research Council as a "National Board on Engineering and Industrial Research" which shall appoint in each state and territory a state research board to consist of five engineers or scientists which shall have immediate supervision over the conduct of engineering and industrial research. Each state board shall utilize such laboratories, equipment and individuals as may be available in connection with any institution of learning within the state or territory, but before authorizing any investigations report shall be made to the Secretary of Commerce and authority to proceed shall be secured from the national board. The sum of $15,000 per annum is provided for expenditure in each state for the purposes aforesaid.

No statement can yet be made as to probabilities, but it is to be hoped that, in consideration of the matter that will soon take place, some opportunity will be afforded to present the real merits.

War Minerals Relief Commission

In Mechanical Engineering for May (p. 489) announcement was made of the appointment of a commission to review the claims of producers of manganese, chrome, pyrites and tungsten, who in their efforts to meet Government requirements during the war met with heavy losses. One thousand two hundred and eighty-seven claims with a total of over $18,000,000, were filed with the Commission prior to midnight, June 2, when the Act specified that the docket closed. An investigation, however, shows that a large number of the claims are subject to a material reduction, and the Commission believes that this reduction will permit the payment of all claims out of the $8,000,000, which was made available for this purpose.

The Commission is now making up a tour of mining centers at which hearings have been scheduled, and it is believed that the conduct of these hearings will require about three months. The Commission contemplates numerous difficult problems in administering the law. The most important, perhaps, is the interpretation of the "request or demand" of a Government agency which induced the claimant to undertake his venture. Important claims from various parts of the country and from the producers of different metals will be heard before the Commission makes its interpretation of this feature of the law. Since it is generally understood that this legislation was for the purpose of discharging moral obligations on the part of the Government, it is anticipated that the Commission will admit all claims in which it is shown that the claimant was responding to the general Government policy of stimulation.

NEWS OF THE ENGINEERING SOCIETIES

Reports of Meetings of Taylor Society, Heating and Ventilating Engineers, National Electric Light Association, Iron and Steel Institute, Engineering Society of Western Massachusetts, etc.

Taylor Society

IT was decided at a recent meeting of the Taylor Society to intensify and extend its activities, particularly along the following lines: The restoration of a recognized center of information and advice concerning scientific management; the classification and recording of data concerning the application of the principles of scientific management; the coördination of experiments and investigations; the publication of bulletins of standard practice and general pertinent information; the organization of machinery for lectures before industrial associations and educational institutions on the science and art of management; coöperation with educational institutions in determining the best methods of instruction in scientific management and in preparing material therefor; efforts to enlist the sympathy and coöperation of labor in the discovery and application of the best principles of management; and the development of a code of ethics to govern the practice of the consulting engineer in management and the administrator in both private and public service.

Provisions in the constitution were adopted to promote the increase of membership so as to include all who are seriously interested in scientific management. The affairs of the society have been placed in charge of Dr. H. S. Person who was elected Managing Director. The temporary New York headquarters of the society are in the Engineering Societies Building in space loaned by The American Society of Mechanical Engineers.

National Fire Protection Association

To promote the continued observance by the people of the United States and of Canada, both privately and in their occupations, of the measures for conservation of our natural resources adopted for the war emergency, was the import of the general resolutions adopted by the National Fire Protection Association at their twenty-third annual meeting in Ottawa, Ontario, May 6 to 8.

In its warfare against the needless sacrifice of human lives and property by fire, the association advocated the enactment of ordinances placing upon citizens who disregard fire-prevention orders the cost of extinguishing preventable fires, and a more general legal recognition of the common-law principle of personal liability for damage resulting from fires due to carelessness or neglect. Other measures recommended included the adoption by municipalities of the Standard Building Code of the National Board of Fire Underwriters; a wider general use of the automatic sprinkler as a fire-extinguishing agent, of the fire-division wall and of the life-saving exit facility; and the exclusive use of slow-burning motion-picture films, with national, provincial, state and local legislation to prevent the continued manufacture and distribution of material having the hazardous properties of the gun-cotton stock now commonly employed.

American Association of Engineers

Civic, social and legal problems affecting engineers were discussed at the fifth annual convention of the American Association of Engineers in Chicago, May 12 and 13. Of special importance was the report of the Compensation Committee of the Chicago Chapter, which contained detailed salary schedules submitted by the chapter to the national body with the suggestion that they utilize the data presented in a nation-wide and comprehensive study and seek to formulate a comprehensive schedule. This recommendation was approved by the convention, and the association is preparing to proceed with the work.

Changes made in the constitution were as follows: Junior members are given the right to vote; a new grade of membership called "candidate junior" is provided which requires but one year's education in a recognized technical college or one year of practical experience; a national practice committee is authorized, to report on questions of ethical policy and conduct; the latest past-president is to be a director; the board is authorized to make mutual agreements with other societies.

Dr. F. H. Newell, head of the department of civil engineering, College of Engineering, University of Illinois, was elected president of the association for the term 1919-1920. Dr. Newell is a member of the American Society of Civil Engineers, The American Society of Mechanical Engineers and the Western Society of Engineers, and is one of the original members of the Engineering Council.

Society of Heating and Ventilating Engineers

Among the various interesting committee reports presented at the semi-annual meeting of the American Society of Heating and Ventilating Engineers, held in Pittsburg, June 10 to 12, that of the Committee to Cooperate with the U. S. Navy Department is worthy of special mention on account of the researches undertaken by the committee in connection with the heating, ventilating and humidifying of battleships and submarines. The present system of heating submarines is by electricity. There are usually six electric heating units of two sizes, one taking 15 amperes and the other 25 amperes with a voltage varying from 110 to 115. These units draw energy from a storage battery. The committee, after investigating the characteristics of other systems of heating, such as combustion of smokeless powder, combustion of hydrogen and oxygen, combustion of acetylene and oxygen, and storage of heat in water and steam, have reached the conclusion that the system of heating by storage of heat in water can be advantageously substituted for the storage battery. They argue that a boiler of suitable capacity, capable of withstanding a pressure of about 300 lb. abs. per sq. in. could be installed in such a manner as to utilize the heat of the gases discharged by the engines when these are in operation. Such a boiler, containing about 3153 lb. of water, would store, they claim, about 1,135,000 B.t.u. which is equivalent to the number of heat units given out in 24 hours by the six electric heaters usually installed in a submarine boat. With an assumed total weight of 6000 lb. for the boiler and the water there would be a saving of 92.5 per cent of the weight required by a storage-battery equipment of equal heat-carrying capacity.

Some of the professional papers presented were: Classroom Ventilation, by Konrad Meier; Heating and Ventilating the Standard School House, by J. D. Cassell; Utilization of Sprinkler-System Piping for Heating, by A. W. Moulder; Heating and Ventilating Systems at the United States Government's Smokeless Powder Plant, at Nitro, W. Va., by G. W. Hubbard; Capacities of Reducing Valves for Steam-Heating Systems, by James A. Donnelly; and Cracking of Cast-Iron Sectional Hot-Water Boilers, by C. R. Honiball.

National Electric Light Association

The National Electric Light Association held its annual convention at Atlantic City, N. J., during the week beginning May 19. Municipal ownership, conservation of power resources and lamp production were the subjects discussed at the general sessions, the questions of prime movers, oil switches, underground construction and overhead lines being taken up at the technical sessions.

George Otis Smith, Director of the United States Geological

Survey, called attention to the difference in man power required by a steam plant and a hydroelectric plant, and cited the case of the Alabama Power Company, where the ratio was 84 to 1. The report of the lamp committee showed the total sales of incandescent lamps for domestic purposes, excluding miniatures, during 1918, to be 186,000,000, of which nearly 90 per cent were tungsten-filament lamps and the remainder carbon and "gem." The production of gem lamps, it was stated, has now been discontinued.

The committee on prime movers discussed in their report various phases of the problem of selecting turbines with proper regard to the size of the system as a whole, and included information as to the operating records of large-sized turbines, together with statements submitted by manufacturers reviewing progress during the past year. The development of power-station auxiliaries was treated at length and a wider use of boiler- and turbine-room instruments was recommended. Improvements in general design of hydroelectric installations were enumerated and the record of progress was noted.

The report of the committee on electrical apparatus covered particularly the control of fires in generators, some special phases of switchboard and transformer practice, substations with special reference to outdoor substations and automatic substations, power-factor correction, and apparatus for special fields, including electric furnaces, welding and the mining field.

In reference to underground distribution, the committee on this subject reported that a marked change had occurred in the load curve of central-station companies due to their taking on large blocks of load to serve industries working on a 24-hour basis. The result of thus obliging all classes of equipment to operate at a higher load factor than before, the committee asserted, has been an unusually large number of cable failures, with the resulting necessity for careful attention to the matter of rating cable capacities.

American Iron and Steel Institute

Optimism over the outlook in the iron and steel trades was expressed by Judge Elbert H. Gary in his opening address at the fifteenth general meeting of the American Iron and Steel Institute, held in New York on May 23.

Following Judge Gary's address several papers of technical interest were read. In a paper entitled Electrically-Heated Soaking Pits and Heating Furnaces, T. F. Baily, president of the Electric Furnace Co., Alliance, Ohio, considered the electric soaking pit for hot ingots as perhaps the most promising development of the electric furnace to the steel maker. Admitting that under ordinary circumstances when heating cold ingots electric pits could not compete in fuel economy with fuel-fired pits, he observed, however, that in the larger mills, when running at full capacity, features such as lack of uniformity in temperature of the heated ingot, excessive oxidation of the ingot and the like were often such as to quite outweigh the item of mere fuel. He said that the time was not far distant when substantially all modern mills rolling hot ingots would use electric pits for this part of steel-mill operation.

In a paper on the Present Status of Non-Metallic Impurities in Steel, Henry D. Hibbard, consulting engineer, Plainfield, N. J., discussed the occurrence and composition of solid non-metallic impurities or "sonims," and made reference to the experimental research so far completed by the committee on the elimination of sonims in steel instituted by the National Research Council, of which he is the chairman. In order to make steel as clean of sonims as practicable, the following rules were recommended:

1 Have the unfinished steel as free from oxides as possible at the end to diminish the work for the final additions to do and the quantity of sonims to be made by holding it without ore additions and with ample carbon and manganese in the bath. The manner and rate of boiling and the fracture of a slag sample will tell the furnaceman how his bath is in this respect. The "boil" must not be vigorous for the percentage of carbon in the metal.

2 Time must be allowed to elapse after the addition of the manganese for the sonims to be precipitated, or changed chemically as already noted, then to collect into globules or drops, and then to float to the top. Probably moderate agitation or stirring helps materially this gathering of sonims into drops of floatable size.

Other notable papers of technical interest were: Methods of Charging Raw Materials into the Blast Furnace, by J. A. Mohr, Superintendent, Currie Blast Furnaces, Carnegie Steel Co., Rankin, Pa.; Standardization of Shipbuilding Materials, by F. T. Llewellyn, Federal Shipbuilding Co., Kearney, N. J., and Chickasaw Shipbuilding Co., Mobile, Ala.; and Notes on Open-Hearth Practice, by H. M. Howe, professor emeritus, Columbia University, Bedford Hills, N. Y.

International Railway Fuel Association

Aspects of the fuel-conservation problem, both from the mechanical and operating standpoints, were extensively discussed at the eleventh annual meeting of the International Railway Fuel Association, which convened on May 19 in Chicago.

President L. R. Pyle drew a pertinent comparison between the service given by the railroads during the war and that which would be expected of them during the reconstruction period. To offset the increase in the cost of operation, he said, it is necessary to eliminate waste wherever it appears. All should bear in mind that practically everything done to save coal has a beneficial effect on all other angles of railroad operation.

The Committee on Pulverized Fuel reported that five American railroads—the Atchison, Topeka & Santa Fe, Chicago & Northwestern, Delaware & Hudson, Missouri, Kansas & Texas, and New York Central—have successfully operated during test periods individual locomotives equipped for and burning pulverized coal. The report quotes from some of the answers received by the committee to their request for information on results obtained from the tests made on locomotives. The following are notable instances:

a A carefully conducted test between two engines of the same class, one burning pulverized coal and the other hand-fired, showed that a saving of 23 per cent in fuel burned could be made by burning pulverized coal. The main difficulties encountered were the slagging over of the flue sheet and burning out of the brick arch. The former was largely overcome by an air jet to blow off the slag accumulations. A number of burner arrangements were tried, but it was found impossible to overcome the rapid burning out of the brick arch and the cost of replacing the arch brick practically equaled the saving in fuel. The delay to locomotives in replacing arch brick was also a decided drawback.

A comparison of total costs of hand firing versus pulverized-coal firing on the locomotives tested, which included cost of pulverizing, cost of handling, cost of arch manufacture, interest and depreciation, showed the hand firing to be most economical. In fairness to the pulverized coal, however, it was thought possible to design a firebox that would eliminate such troubles as burning out of the brick arch and show an advantage in favor of the pulverized coal.

b Burning pulverized fuel was very satisfactory; had all the steam that was wanted with splendid control all the time, burning 60 per cent anthracite and 40 per cent bituminous, the bituminous being necessary to increase the volatile. The question of economy is quite another thing and unless a poor or by-product coal can be purchased at a price that will absorb carrying charges, operation, etc., of a pulverizing plant and not exceed the price of a satisfactory lump coal, it should be given careful thought. There is no saving in the quantity of fuel used when pulverized, in fact, the difference is in favor of the lump coal. Pulverizing costs between 45 cents and 50 cents per ton.

From these and other answers received from pulverized-fuel installations operating on stationary engines, the Committee concluded that "the experimental work done and tests made, although still incomplete, have demonstrated the apparent soundness of the principle of burning coal in a finely divided form of suspension," but that "there are some things about pulverized coal" the Committee "are not satisfied with." They observe, for instance, that "it has not been clearly established that coal ground to the extreme fineness and dried to the extent recommended by most of the supporters of pulverized coal best meets the conditions of the practical user operating under widely diversified conditions," and that "the tendency of explosion and spontaneous combustion" has not been eliminated entirely.

Engineering Society of Western Massachusetts Organizes

The organization meeting of the newly formed Engineering Society of Western Massachusetts was held at Hotel Kimball, Springfield, on the evening of April 16. It was preceded by a dinner at which over 300 engineers representative of the various branches of the profession were present.

After dinner the meeting was called to order by George E. Williamson of the organization committee who briefly recited the history of the movement. The constitution and by-laws proposed and drawn up by the organization committee were then unanimously adopted as written and the following officers and directors unanimously elected:

President: Charles L. Newcomb, Manager, Am.Soc.M.E., Manager Deane Works, Worthington Pump and Machinery Corporation, Holyoke.

Vice-Presidents: C. C. Chesney, Fellow A. I. E. E., Manager General Electric Pittsfield Works; and George E. Williamson, Mem.Am.Soc.M.E., Chief Engineer, Strathmore Paper Co., Woronoco.

Secretary-Treasurer: Winfield E. Holmes, Mem.Am.Soc.M.E., Treasurer, Samuel M. Green Co., Springfield.

Directors: Dr. Herbert C. Emerson, Mem. Am. Chem. Soc., Springfield; Frank O. Wells, Manager Am.Soc.M.E., Greenfield; John C. Robinson, Springfield; E. E. Lochridge, Mem. Am. Soc. C. E., Springfield; Samuel M. Green, Mem.Am.Soc. M.E., Springfield; Geo. P. B. Alderman, Holyoke.

The meeting was then turned over to President Newcomb, who, in acknowledging the honor that had been conferred upon him, assured the society of his best efforts in the office to which he had been elected, and made a short address on the object and scope of the new organization, predicting for it an important and growing sphere in the community and the engineering world. It would have a purely engineering character, he said, but would embrace engineers of all branches. The American Society of Mechanical Engineers had thought well enough of the movement to have its Sections Committee present, and President Cooley would have attended but was unavoidably detained. Secretary Rice had also telegraphed from Denver expressing his regret at being unable to carry out his intentions of being present, and conveying his compliments to the new society. It was hoped to soon receive like recognition from all the national engineering societies.

Prof. L. P. Breckinridge of Yale University, who was then introduced, complimented the society upon its efforts to bring the various branches of engineering into one local organization, predicting that in the future the national organizations would get together in a great engineering body, and that it would then be pointed out that western Massachusetts had done the same thing in 1919.

William Spencer Murray, consulting engineer of New York, and who electrified the New Haven Railroad and the Hoosac Tunnel, spoke upon conservation and described a project he had been developing for the Secretary of the Interior which involved large-scale development of hydroelectric power and electric power at the pit mouth and the installation of a super-power distributing line from Washington to Boston. Mr. Murray submitted data upon the enormous consequent saving in coal and reduction of power cost in the region served by the proposed super-power line, and showed the gathering of engineers the entire feasibility of Secretary Lane's plan.

Dr. George Otis Smith, director of United States Geological Survey, followed Mr. Murray and furnished valuable data relating to the proposed super-power line, amplifying, substantiating, and further explaining his statements.

The meeting then adjourned with many additional applications for membership.

The objects of the society as stated in the constitution are—"The professional improvement of its members; the advancement of the arts and sciences connected with the various branches of engineering; the promotion of civic righteousness and truth and the participation in affairs of an engineering nature which affect the interest of the public." Headquarters will be in Springfield and regular meetings will be held in the various cities and communities of western Massachusetts.

The early history of the Engineering Society of Western Massachusetts really dates back to some two or three years ago, when it was proposed to organize a local section of The American Society of Mechanical Engineers in Springfield and vicinity. The matter was taken up again this year when Calvin W. Rice, Secretary of the A. S. M. E., and William G. Starkweather, Chairman of its Boston Section, conferred at the Hotel Kimball with Messrs. George E. Williamson, William J. A. London, C. W. Burges, and Winfield E. Holmes. After thoroughly canvassing the local situation Mr. Rice suggested that a regional engineering society be formed that would appeal to and embrace not only mechanical engineers but engineers of all branches.

This preliminary committee of four met again the following week and each was in agreement that the new engineering society

C. L. Newcomb
President

C. C. Chesney
Vice-President

G. E. Williamson
Vice-President

W. E. Holmes
Secretary-Treasurer

Officers of the Engineering Society of Western Massachusetts

should be inaugurated. Thereupon twenty other local engineers, architects, and chemists, were asked to participate in a conference on the subject, which was done January 21, 1919. At a later meeting, on February 17, the organization committee completed much of its preliminary work and made arrangements for the initial meeting on April 16.

Colorado Engineering Council

At a specially arranged meeting of the Colorado sections of the founder engineering societies and other local scientific organizations, held at Denver on May 16, the final form of the constitution of an association to be known as the Colorado Engineering Council was discussed and adopted. The purpose of this council is to coördinate the work of various technical, scientific and engineering organizations, to promote the welfare and professional standing of their members, and to foster a more general recognition of the engineer in civic matters. All local scientific associations are eligible for membership in the Council.

PROPOSED REORGANIZATION OF THE AMERICAN ENGINEERING STANDARDS COMMITTEE

At the present time many bodies are engaged in the formulation of standards. There is no uniformity in the rules for such procedure in the different organizations; in some cases the committees engaged in the work are not fully representative, and in a considerable proportion of cases they do not consult all the allied interests. The present custom results in a considerable duplication of work, and there are in some fields several "standards" proposed for the same thing that differ from each other only slightly and that often in unimportant details. It is very much more difficult to obtain agreement between proposers of overlapping standards after they have been published than it would be to get the proposers to agree before they had committed themselves publicly.

The American Society of Civil Engineers, the American Institute of Mining Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Society for Testing Materials, appointed a committee to consider the advisability of coöperating in engineering standardization, upon whose recommendation the American Engineering Standards Committee was formed, with a membership consisting of representatives of the five societies mentioned.

The American Engineering Standards Committee has held a series of meetings for the purpose of revising the constitution, and the following communication containing the proposed constitution is being sent to members of the Council of The American Society of Mechanical Engineers and to the governing boards of the other Founder Societies which were instrumental in organizing the American Engineering Standards Committee.

To the Council of

The American Society of Mechanical Engineers

Gentlemen:

At a regularly called meeting of the American Engineering Standards Committee held on May 17, 1919, a proposed revision of its constitution was approved by the committee. In submitting this revised constitution to your board for its approval, we desire to give the reasons and to offer some explanations for the proposed changes in the present constitution of this committee.

Soon after its formal organization on October 19, 1918, the committee began its work under the present constitution. But it became evident immediately that some organizations and societies were not willing to coöperate under the existing form of organization. This feeling was also expressed very freely and positively at a conference held in Washington on January 15, 1919. On this date representatives of more than one hundred organizations, including federal, state and municipal boards, who are interested, in the formulation of safety codes, met to consider how they might coöperate to develop these codes in an efficient and generally satisfactory manner. The objects of the five societies in organizing the American Engineering Standards Committee and the committee's method of procedure were very fully and carefully presented to this conference. The discussion which followed, however, indicated a feeling, especially among some large national organizations which have for some years been developing safety codes, that the present method of selecting representatives to this committee is not broad enough to permit them to coöperate completely.

Following this Washington conference a number of meetings and conferences between the American Engineering Standards Committee and other organizations interested in the development of standards were held. These meetings have convinced this committee that, if its work is to receive nation-wide, general, and immediate acceptance, some changes in its constitution are necessary.

The most important of these is contained in Sections 8 and 9. They state that the proposed Association starting with a membership consisting of representatives of the five Founder Societies and Government Departments may add representatives from other organizations or groups of organizations. To permit this enlarged committee or association to function easily, Article V provides for a Board of Directors of twelve members of the Association.

It should be stated here, however, that the objects for which the committee was originally organized, though restated in the proposed new constitution, are exactly the same. We desire especially to call your attention to Section 4. This is a definite declaration of the Association's policy of non-interference with the absolute autonomy of any group engaged in the development of a standard. The failure to recognize this is responsible for much of the misunderstanding and fear of interference that has found expression in the technical press, and even by well-meaning, but misinformed members of already affiliated organizations.

Article VII on the "Development and Approval of Standards" now states in no uncertain terms what has always been the intent of those instrumental in the organization of the Committee, viz., it will be entirely optional on the part of the organizations having representation on the new Association, to submit their existing standards and those developed in the future for the approval of the American Engineering Standards Association. But it is hoped that as the Association develops and its policies become well understood, the advantages of this approval will become so apparent that all societies and organizations producing standards will desire to submit their standards for approval. This article of the revised constitution further provides that full credit and recognition for its work in producing a standard will be given to the sponsor society or organization producing it, and the standard will be known by the name assigned to it by the sponsor society.

Trusting that you will consider carefully, and finally approve these proposed changes in our Constitution, we remain

Very respectfully,

American Engineering Standards Committee,

George C. Stone,

Vice-Chairman.

Proposed Changes in the Constitution of the American Engineering Standards Committee

The Constitution of the American Engineering Standards Committee shall be changed to read as follows:

Article I. Name

Sec. 1. The name of this association shall be the American Engineering Standards Association, hereinafter referred to as the Association.

Article II. Objects

The objects of the Association shall be:

Sec. 2. To unify and simplify the methods of arriving at engineering standards, to secure coöperation between various organizations, and to prevent duplication of standardization work;

Sec. 3. To promulgate rules for the development and approval of standards;

Sec. 4. To receive and pass upon recommendations for standards submitted as provided in the Rules of Procedure, but not to initiate, define, nor develop the details of any particular standard;

Sec. 5. To act as a means of intercommunication between organizations and individuals interested in the problems of standardization;

Sec. 6. To give an international status to American engineering standards.

Sec. 7. To coöperate with similar organizations in other countries and to promote international standardization.

Article III. Membership

Sec. 8. The Association shall be composed of not more than three representatives from the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Society for Testing Materials, the Government Departments of War, Navy, and Commerce, and from each of such other organizations or groups of organizations as may be approved as hereinafter provided. The vote of the Association shall lie with these representatives, who shall be termed members. Each member shall have one vote.

Sec. 9. The Association may, upon a majority vote, invite any organization or group of organizations to join in its work. This vote of the Association shall be by letter ballot.

Sec. 10. Any organization or group of organizations desiring representation in the Association shall make formal application therefor in writing, setting forth the scope of its standardization interests and activities and the number of its members. This application shall be considered at the next regular meeting of the Board of Directors and, upon a majority vote, shall be submitted to the Association. The Association shall vote on the application by letter ballot which shall be drawn upon the recommendations of the Board of Directors and shall state whether one, two, or three representatives are recommended. Upon a majority vote of the Association the organization or group of organizations making application shall be requested to appoint representatives not exceeding the specified number, who shall become members of the Association after properly qualifying.

Sec. 11. The number of representatives any organization or group of organizations is requested to appoint shall be determined by such considerations as: the volume, character, and importance of its standardization work, if any, together with its standing and total membership.

Sec. 12. Any organization or group of organizations appointing representatives to the Association shall agree to assume the financial obligations herein set forth and to abide by the Constitution, By-Laws, and Rules of the Association. In the case of members appointed by the Government, State or Municipal departments or bureaus, it is

understood that financial support is not expected until such time as proper authorization therefor can be obtained.

Sec. 13. Initially, each organization or group of organizations shall appoint its first representative to serve three years, the second to serve two years, and the third to serve one year. After the first year all appointments shall be for three years.

Sec. 14. A member whose term of office has expired may be reappointed. A vacancy shall be filled by the organization or group of organizations from which the retiring member was originally appointed, such appointment to be for the unexpired term.

Sec. 15. Any member may resign from the Association upon written notification to the Secretary. Any organization or group of organizations may withdraw its representatives from the Association upon notice in writing to the Secretary, provided the dues for the current calendar half-year have been paid.

Sec. 16. Any organization or group of organizations in arrears for dues for more than one year will thereby lose its right to representation in the Association.

ARTICLE IV. OFFICERS

Sec. 17. At its Annual Meeting the Association shall elect a Chairman and Vice-Chairman from its membership. Officers so elected shall serve for one year, or until their successors are elected. These officers shall not serve for more than three consecutive terms. Vacancies may be filled by election at any regular or special meeting, provided notice has been given in the call for the meeting.

Sec. 18. A Secretary shall be engaged by the Board of Directors.

Sec. 19. The Chairman shall be the executive officer of the Association, shall approve all expenditures and countersign all vouchers. He shall preside at all meetings of the Association. He shall be ex-officio member of all committees and Chairman of the Board of Directors. In the absence of the Chairman his duties shall be taken over by the Vice-Chairman, and in the absence of both, by a member of the Board of Directors.

Sec. 20. The Secretary shall perform all duties usual to the office of a secretary, shall maintain a file of information on and in connection with standards, a list of organizations interested in standardization work, and such other information as may be necessary for the work of the Association. He shall have sufficient authority to conduct the routine business of the Association under such instructions as may be from time to time given him by the Board of Directors.

ARTICLE V. BOARD OF DIRECTORS

Sec. 21. The affairs of the Association shall be managed by a Board of Directors elected from the membership of the Association at its Annual Meeting.

Sec. 22. The Board shall consist of not more than twelve members, and shall not include more than one representative from any one organization or group of organizations.

Sec. 23. The Board shall be the legal trustee of the property of the Association and shall have power to deal with all affairs of the Association except that of approving "Recommended Practices," "Tentative Standards" or "Standards of the American Engineering Standards Association."

Sec. 24. The Board may, by resolution, delegate any of its powers to committees or to any one or more of its members, but no act of such committee or delegates shall be binding upon the Association until it has been approved by the Board.

Sec. 25. All suggestions, inquiries, or complaints as to the purposes, objects, or methods of this Association shall be referred to and answered as directed by the Board of Directors.

Sec. 26. The Board shall submit a report at the Annual Meeting describing the work done in the past fiscal year and showing the financial condition of the Association. An abstract of this report shall be entered in the minutes of the meeting.

Sec. 27. A quorum of the Board of Directors shall be a majority of its membership.

ARTICLE VI. MEETINGS

Sec. 28. The Association shall hold the Annual Meeting in the month of November. It may hold additional meetings at any time either at the call of the Chairman or upon written request of not less than ten members. The call for a meeting shall be mailed to each member of the Association at least ten days before the date set for the meeting.

Sec. 29. A quorum of the Association shall consist of a majority of its members.

ARTICLE VII. DEVELOPMENT AND APPROVAL OF STANDARDS

Sec. 30. The Association shall formulate rules under which committees to create standards shall be constituted and organized.

Sec. 31. The Association shall receive and pass upon recommendations for standards which may be submitted by any competent body.

Sec. 32. Any proposed standard approved by the Association shall be known as a "Recommended Practice of the American Engineering Standards Association," or as a "Tentative Standard of the American Engineering Standards Association," and when in the opinion of this Association it has proved its suitability, it shall be known as a "Standard of the American Engineering Standards Association." In every case publication shall bear the title assigned to the standard by the Sponsor organization and the name of the Sponsor followed by the statement: "Approved as Recommended Practice, Tentative Standard, or Standard of the American Engineering Standards Association."

Sec. 33. The approval as "Recommended Practice" or as "Tentative Standard" of any standard submitted to the Association shall require the affirmative vote of three-fourths of the Association; the advance of status to "Standard" shall require an affirmative vote of 90 per cent. of the Association. Such votes shall be by letter ballot. Letter ballots may be ordered at any regular or special meeting of the Association, or at any meeting of the Board of Directors.

ARTICLE VIII. FINANCES

Sec. 34. Each organization appointing representatives to the Association shall pay annual dues of $500.00 for each representative. These dues shall be paid semi-annually.

Sec. 35. Other funds may be obtained in any manner approved by the Association.

Sec. 36. Funds of the Association shall be in the custody of the Secretary, who shall be placed under suitable bond, and they shall be disbursed by him upon vouchers countersigned by the Chairman or Vice-Chairman.

Sec. 37. The fiscal year of the Association shall terminate with the 31st day of December.

ARTICLE IX. AMENDMENTS

Sec. 38. Amendments to this Constitution must be proposed in writing at least thirty days before the meeting of the Association at which they are to be voted upon, this vote to be upon the amendment as originally proposed or as further amended at the meeting. If passed by a two-thirds majority of those present they shall be referred to the Governing Boards of all the organizations or groups of organizations represented in the Association, and shall become operative only when they have been approved by the organizations or groups of organizations appointing at least two-thirds of the membership of the Association.

HONORARY MEMBER OF A. S. M. E. RECEIVES JOHN FRITZ MEDAL

MAJOR-GENERAL GEORGE W. GOETHALS, upon whom was conferred Honorary Membership by The American Society of Mechanical Engineers at its 1917 Annual Meeting, was accorded on the evening of May 22 the further distinction of receiving the John Fritz Medal for his achievements in building the Panama Canal. The exercises were held in the auditorium of the Engineering Societies Building, New York City, Charles F. Rand, past-president of the American Institute of Mining and Metallurgical Engineers and Secretary of the Board of Award, presiding in the absence of Clemens Herschel, past-president of the American Society of Civil Engineers, Chairman of the Board. As is well known, this medal was established in 1902 in honor of the great American engineer, John Fritz, who was also the first recipient of the medal. A board representing the four national engineering societies—the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers—awards the medal not oftener than once a year for notable achievement along engineering lines. Other distinguished recipients of the John Fritz Medal have been: Lord Kelvin, George Westinghouse, Alexander Graham Bell, Thomas A. Edison, Charles T. Porter, Alfred Noble, Sir William H. White, Robert W. Hunt, John E. Sweet, James Douglas, Elihu Thomson, Henry M. Howe and J. Waldo Smith.

A fitting tribute was paid by William L. Saunders, past-president of the American Institute of Mining and Metallurgical Engineers, to the perseverance, skill, tenacious application and devotion to duty by which General Goethals brought to a successful termination the building of one of the greatest engineering works ever undertaken in history. After briefly reviewing the military career of General Goethals from the time he was appointed second lieutenant at West Point on June 12, 1880, and his later experience as instructor in civil and military engineering in the United States Military Academy, Mr. Saunders concluded with the following impressive remarks:

It has been said that fame comes to a man who is thinking about something else. The chief difference, it seems to me, between common men and big men is in the sense of self-effacement. When a man thinks of himself in his actions in life, he forgets the things that make men great. A thing done for the sake of self-glory or self-profit is only half done; it is only half-baked. It bears the savor of unripe fruit or the taint of decay. A thing to be well done must be well done;

and nothing is done well that does not carry with it the spirit of self-sacrifice in the material or human interests of others.

And so, in giving this token of our esteem tonight to General Goethals, do we honor the man as well as the engineer. We pay this tribute of our admiration and our tears to a great public servant, who, through a long period of inextinguishable devotion to public duty, a period of hard labor, has risen, rung by rung, up the ladder of St. Augustine.

"For the heights by great men reached and kept
Were not attained by sudden flight:
But they, while their companions slept,
Were toiling upward on the night."

Hon. Henry L. Stimson, Secretary of War for a considerable period of time during which the canal was under construction, spoke in part as follows:

The time when I began to have duties in regard to the canal, the period of my service, covered the years 1911 and 1912. At that time the work was in full swing, at its maximum capacity. The long delays and troubles which had marked the beginning had been overcome. The long discussion over the different types of canal, whether it should be a sea-level or a lock canal, had been settled before by the characteristic decision of Mr. Roosevelt. The dreaded scourge of the yellow fever, which had caused many delays in the early years, had been banished forever by the work of Colonel Gorgas and the Medical Corps. The organization of the working forces had been perfected, and the giant machinery was there and in full swing.

Of course, there were many problems meeting the Chief Engineer every day, but, nevertheless, the machine was then working at its fullest capacity; and for that very reason, perhaps, it was possible at that time to see, as at no other time, how the whole work depended and swung upon the character and the force of one man. . . .

By the inexorable necessity of events, there had been an evolution into one man control, and the result of that evolution was Goethals, and the Canal then represented throughout, in every part of its working force, the impress of his personality. The authority which he exercised there was comparable only to the authority of the commander of an expeditionary force in a foreign country; but even that was only a comparison, because he came into contact with his men in a direct, personal way which I have never seen exemplified in the commander of a combatant division.

Ambrose Swasey, past-president of The American Society of Mechanical Engineers, in making the formal presentation of the medal addressed General Goethals and said:

Sir, Major-General George Washington Goethals, Builder of the Panama Canal, we are gathered here to do honor to you, and in so doing we honor ourselves and all those whom we represent.

In a time of peace you went to war with the elements; and with the forces at your command you won for civilization one of the greatest victories of the age.

Whenever your country has called, that high standard of service has been your response—a service you have loyally and faithfully wrought into all your achievements as a soldier; as an engineer; as a man.

On behalf of the Board of Award I have the honor to present to you the John Fritz Medal.

In responding General Goethals paid a tribute to "others who should receive recognition and mention" in connection with the building of the Panama Canal, chief among them being the late Colonel Roosevelt, through whose "persistent efforts . . . the necessary legislation, authorizing the construction of the canal, was due," and who "had the far-sightedness and the courage, after convening an international board of engineers, to repudiate the recommendation of the majority, accept that of the minority and advocate to Congress the construction of a lock canal." General Goethals recalled the work of the doctors "who exhibited the highest type of moral courage when they demonstrated the fact that the mosquito was the transmitter of yellow fever" and who "laid down the principles which ultimately resulted in the eradication of yellow fever from the Canal Zone." He also referred to "the vast number of engineers, employed in this country, who gave the best that was in them in designing the various forms of machinery which were used in the construction work, and, subsequently, machinery employed for the operating of the locks, the lighting of the canal, the handling of our coal, and the operation of our dry-dock"; and to the 50,000 American workmen, every one of whom "was imbued with the idea that the particular part of the work on which he was engaged was absolutely necessary" to the success of the undertaking, and without which the canal would have been a failure.

NECROLOGY

CHARLES MILTON BALDWIN

Charles M. Baldwin, Lieutenant in the United States Navy, died at sea on March 12, 1919. Lieutenant Baldwin was born on March 26, 1876, in Mt. Vernon, Tex., and attended the Southwestern University at Georgetown. He was formerly connected as assistant marine engineer with the Mallory, Red D and Southern Pacific lines. For twelve years, 1903 to 1915, he served in the United States Navy, first as machinist and later as warrant machinist, with a chief engineer's unlimited ocean license. When the United States entered the war he again offered his services and was commissioned a lieutenant in the Navy. He had also served in the Spanish-American War and in the Philippine and Mexican campaigns.

Lieutenant Baldwin was a member of the National Marine Engineers' Beneficial Association, and belonged to a number of fraternal organizations. He became an associate-member of the Society in 1905.

LESTER WARREN COGSWELL

Lester W. Cogswell was born in January, 1880, at Charlestown, Mass. He was educated in the public schools of that city and was graduated from the Mechanics High School.

In 1898 Mr. Cogswell obtained employment in the engineering department of the B. F. Sturtevant Co., Jamaica Plain, Mass., where he served a two-year apprenticeship. Later he was associated with the following firms: the Mason Regulator Co., Dorchester; the Blake Pump Works, East Cambridge; the United Shoe Machinery Co.; the Sub-Target Gun Co.; the Walworth Manufacturing Co.; the Globe Ore Reduction Co., and the United Printing Machine Co., all in Boston.

In the latter part of 1916 Mr. Cogswell became connected with the Kinney Manufacturing Co., also in Boston, where he held the position of designer of engines and rotary pumps. He was with this concern at the time of his death, September 29, 1918.

Mr. Cogswell became an associate-member of the Society in 1917.

WILLIAM W. DINGEE

William W. Dingee was born on January 5, 1831, in Byberry, Pa. He was educated in the Maryland Institute and also attended the School of Mechanical Arts connected with the Institute.

For thirty years Mr. Dingee was the proprietor and superintendent of a foundry and machine business, where he designed, built and operated many machines for general and special purposes. For many years he was associated with the J. I. Case Threshing Co., Racine, Wis., as machine designer and constructor, and while with this concern was the inventor of many improvements for threshing machines.

Mr. Dingee retired from active business in 1906 and the last years of his life were spent in Chicago where he died on May 25, 1919. He was one of the early members of the Society, having joined in 1886.

WALTER ERLENKOTTER

Walter Erlenkotter, vice-president of the Secaw Chemical Co., Irvington, N. J., died on May 14, 1919. Mr. Erlenkotter was born on August 22, 1887, in Hoboken, N. J. He received his early education in the Hoboken Academy and was graduated from Stevens Institute of Technology in 1908. He was formerly connected with J. G. White & Co., New York City, in the design and construction of steam-engineering plants, etc., and later held the position of fuel-engineering chemist in charge of the Central Testing Laboratory, Bureau of Contract Supervision, New York City, where his work dealt with physical tests, sampling, coal analysis, the design of new apparatus, etc. In the latter part of 1916 he became chief engineer for the Secaw Chemical Co. and was subsequently advanced to the position of vice-president. Mr. Erlenkotter became a junior member of the Society in 1912 and in 1916 was promoted to the grade of associate-member.

JAMES J. FLYNN

James J. Flynn was born in April, 1893, in New York City. He was educated in the public schools of the city and was graduated from the Mechanics' Institute. In 1908 he started work for the Western Electric Co., taking their regular students' course and spending six months in their manufacturing department.

He was then transferred to the tool and gage-inspection department where he was located for about five years; he was then placed on construction work of telephone equipment on the road. After

seven years with this concern, Mr. Flynn became associated in 1915 with the Remington Arms Bridgeport Works as assistant low-tension engineer. The following year he was made foreman inspector of the barrel department and in 1918 he became chief inspector of ordnance for the U. S. Government in the same company.

Mr. Flynn became a junior member of the Society in 1918. He died on February 11, 1919.

RICHARD HUMPHREY HUGHES

Richard H. Hughes, vice-president and general manager of the Crescent Portland Cement Co., Wampum, Pa., and a member of the Board of Directors of the Portland Cement Association, died on April 12, 1919.

Mr. Hughes was born on September 16, 1862, in Lima, Ohio. He received his education in the schools of that city and also served there his appenticeship in railroad engineering. In 1901 he became connected with the Portland Cement Co. and took charge of the remodeling of their plant. During the year 1908 and 1909, in co-operation with Mr. W. B. Ruggles of the Ruggles-Coles Engineering Co., he had entire charge of the designing and building of the company's 3000-barrel plant and upon its completion, of its operation, alteration and additions.

Mr. Hughes belonged to a number of social and fraternal organizations. He became an associate-member of the Society in 1914.

THEODORE H. GUETHING

Theodore H. Guething, Lieutenant in the Ordnance Department of the Army, was born on October 15, 1891, in Winchester, Mass., where he received his early education. He attended Exeter Academy for three years and then entered the Massachusetts Institute of Technology, from which he was graduated in 1915 with the degree of B.S.

Theodore H. Guething

He was connected for short periods with the Haughton Elevator Co., Toledo, Ohio, and with the Anaconda Mining Co., Anaconda, Mont. In June 1916 he became associated with the John A. Stevens Engineering Co., Lowell, Mass., where he was assistant in the analysis of the power plant of the Stevens Manufacturing Co., Fall River, Mass., assistant superintendent of the construction of the power plant for the North & Judd Manufacturing Co., New Britain, Conn., and assistant engineer on motoring, Chelsea Fiber Mills, Brooklyn, N. Y.

When the United States entered the war he offered his services to the Government and was commissioned a first lieutenant in the Ordnance Department of the Army. He was assigned to the Picatinny Arsenal, Dover, N. J., as mechanical engineer in charge of the shops and as motor-transport officer, and was working in this capacity when he contracted influenza-pneumonia and died on October 16, 1918.

Lieutenant Guething became a junior member of the Society in 1917.

ERNEST G. MARBLE

Ernest G. Marble, who, until 1918, was general sales and works manager of the American Engineering Co., Philadelphia, died on May 6, 1919. Mr. Marble was born on September 19, 1876, in Methuen, Mass., and was graduated from Tufts College in 1899. Shortly after he became connected with the Otis Elevator Co. as superintendent of construction of their Philadelphia works, and from 1907 to 1912 was treasurer of the American Ship Windlass Co., with full charge of the manufacturing and financial interests of the concern.

Mr. Marble became associated with the American Engineering Co. in 1912, resigning in the spring of 1918 because of ill health. He became a member of the Society in 1909.

CHARLES W. PRARAY

Charles W. Praray was born on May 29, 1873, in Pawtucket, R. I., and was educated in the public schools of that city. He served an apprenticeship in one of the local cotton mills and for ten years was connected with the B. B. & R. Knight Cotton Manufacturing Co. as master mechanic and engineer. For several years he was master mechanic for the Manomet Mills in New Bedford, Mass., when he became associated with the Holmes Manufacturing Co., also in New Bedford, as superintendent and architect.

About twelve years ago he opened a mill engineer's and architect's office in New Bedford and proved highly successful in his work. He was the designer of some six or seven mills in New Bedford and of a great number of others throughout New England. He was actively connected with this work at the time of his death, March 22, 1919.

Mr. Praray held a first-class Massachusetts engineer's license. He was a member of the National Association of Cotton Manufacturers and of a number of social clubs. He became a member of the Society in 1918.

HENRY S. HAYWARD

Henry S. Hayward, Lieutenant, U. S. Naval Reserve Force, was born on December 25, 1876, in Elizabeth, N. J. He was a 1900 graduate of Stevens Institute of Technology.

Henry S. Hayward

His first position was in the drafting room of the Pennsylvania Railroad, Jersey City, N. J. He was next associated with the Franklin Air Compressor Co., Franklin, Pa., as chief engineer, his work consisting of designing and supervising the construction of their power plant. From 1902 to 1905 he was in business for himself as a mechanical engineer, handling mechanical mill supplies.

In 1906 he became assistant to the vice-president of the Franklin Railway Supply Co., manufacturing and promoting special mechanical devices for locomotives. Prior to his enlistment in 1918 he was president of the Roybel Packing Co., N. Y.

He was commissioned a lieutenant (j.g.) in the Naval Reserve Force and was stationed at the Charleston Navy Yard, Charleston, S. C. He was north on a twenty-day furlough when he contracted pneumonia and died on March 31, 1919.

Lieutenant Hayward became a member of the Society in 1900.

CHARLES JAMES REILLY

Charles James Reilly, Sergeant, Co. C, 21st Engineers, A. E. F., was killed in France, on September 1, 1918, by a bomb dropped from a German airplane, which, according to report, was flying low over the camp and bearing the Allies' colors.

Sergeant Reilly was born on September 10, 1887, in Louisville, Ky. He received his early education in the schools of that city and was graduated from the high school in 1905, when he entered Rose Polytechnic Institute, from which he received his B.S. degree in mechanical engineering in 1909. For three years he was connected with the Louisville & Nashville Railroad in Louisville, Ky., as a machinist in their locomotive-erecting shop. His next position was with the Vandalia Railroad, Terre Haute, Ind., as draftsman in the motive-power department, where he remained for a little over three years, resigning to become connected with the U. S. Division of Valuation of the Interstate Commerce Committee as junior mechanical engineer, where his work dealt with the valuation of the mechanical property of railroads. In April 1916 he became assistant to the superintendent of the Sandusky Cement Co., Bay Ridge, Ohio, where he was employed at the time of his enlistment, July 1917. He was sent to Camp Grant, Ill., for training and in January 1918 went to France as a member of Company C, 21st Engineers.

Sergeant Reilly became an associate-member of the Society in 1916.

AUGUST S. LINDEMANN

August S. Lindemann, secretary and treasurer of the Milwaukee-Waukesha Brewing Co., who died in the early part of 1919 was born in Milwaukee, Wis., in June 1866. He was graduated from the University of Wisconsin in 1885 with the degree of B.M.E. and in 1887 received his master's degree in mechanical engineering.

He served an apprenticeship as machinist with Filer & Stowell and with E. P. Allis & Co., both firms in Milwaukee. He was employed in the drafting room of Flanders & Bottum for one year when he became connected with the Pfister & Vogel Leather Co. as erecting engineer. From 1889 to 1898 he was associated with J. P. Lindemann, first as erecting engineer and later as designer and constructor of new stamping and metal-forming machinery. His next position was

with the Milwaukee-Waukesha Brewing Co., as manager and general superintendent, designing and developing machinery used in bottling works. His advancement was rapid and at the time of his death he held the position of secretary-treasurer of the company.

Mr. Lindemann became a member of the Society in 1913.

WILLIAM TRIMBLE WHEELER

William T. Wheeler, actively connected with the Trinity Engineering Co. and the Diamond Carbonating Co., both of New York City, died on April 27, 1919. Mr. Wheeler was born on August 22, 1862, in Calais, Me., and was educated in the public schools of that city and Pratt Institute, Brooklyn.

For the first twenty years of his business life he was associated with the Equitable Life Insurance Co., in charge of installing the steam, electrical and elevator plants in their buildings, both here and abroad. Later he was connected with the New York Life Insurance Co., as chief engineer of their building in New York City, and still later in charge of the installation of the elevator, electric-light and steam-heating plants for the H. O'Neil Co., New York.

Mr. Wheeler became a member of the Society in 1905.

ELIAS QUEREAU HORTON

Elias Q. Horton, Lieutenant (j.g.), U. S. Naval Reserve Force, died of influenza-pneumonia on March 4, 1919. Lieutenant Horton was born in Ossining, N. Y., on July 28, 1884. He was educated in the public schools of New York City, Stevens Preparatory School and Stevens Institute of Technology, from which he was graduated in 1905 with the degree of M.E.

Elias Q. Horton

Upon graduation he became associated with the Otis Elevator Co., New York, and gained his shop experience in their factory at Yonkers. He was then transferred to the estimating department and in 1908 he was made assistant chief estimator. In 1910 he was made assistant manager in Oklahoma City, in charge of all sales in the state. His advancement was continuous and rapid until, at the time of his enlistment in April 1917, he was in charge of the Washington office of the company.

He enlisted in the Naval Reserve Force and was assigned to active duty as coxswain in Newport, R. I. In June of that year he was sent to Annapolis for special training, and at the termination of the course was commissioned as ensign. He was ordered to duty on the U.S.S. *South Carolina*, where he served as junior watch officer, division officer and communicating officer, respectively. He was then promoted to the rank of lieutenant (j.g.). Shortly before his death he was ordered to the Receiving Ship *Philadelphia*, where he was to have been discharged and to have rejoined the staff of the Otis Elevator Co.

Lieutenant Horton was a member of the Sons of the Colonial Wars, the Sons of the Revolution and of a number of clubs. He became a junior member of the Society in 1912.

PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by July 15 in order to appear in the August issue.

CHANGES OF POSITION

E. A. Hitchcock has recently become connected with the Bailey Meter Company, of Cleveland, Ohio, as vice-president. He will supervise the training of technical graduates for the company's service and sales departments. During the past six years he has been associated with the E. W. Clark and Company Management Corporation, Columbus, Ohio, as advisory consulting and power sales engineer.

G. A. Trube, formerly associated with the Westinghouse Air Brake Company, Pittsburgh, Pa., as expert manager, has become connected with Gaston, Williams and Wigmore, of New York.

F. W. Teele has assumed the duties of general manager of the Mexican Light and Power Company, Mexican Tramways Company and allied interests at Mexico City, Mexico. He was, until recently, associated with the Southern Canada Power Company, Ltd., Montreal, Canada, in the capacity of vice-president and managing director.

Cleveland C. Soper has resigned his position of instructor of machine design, Wentworth Institute, Boston, Mass., and has accepted the position of engineer with the Kent Machine Company, Kent, Ohio.

Frederick C. Fladd's name was inadvertently omitted from the 1919 issue of the Year Book. Mr. Fladd is connected with the E. W. Bliss Company, of Brooklyn, N. Y., in the capacity of traveling and consulting engineer.

Arthur E. Anderson, formerly chief engineer, The Intermountain Railway, Light and Power Company, Denver, Colo., has assumed the position of general superintendent of The Grand Junction Electric, Gas and Manufacturing Company, and The Grand River Valley Railway Company, Grand Junction, Colo.

A. L. Roberts, formerly designing engineer with the Bethlehem Steel Company, has been elected president of The Roberts Company, Philadelphia, consulting and contracting mechanical engineers, and V. F. Signorelli, formerly secretary and treasurer of Southwark Foundry and Machine Company,, has been elected secretary and treasurer. The company has recently been incorporated under the laws of the State of Pennsylvania.

Charles E. Burgoon has completed his work with the Air Nitrates Corporation, New York and Muscle Shoals, Ala., and has accepted the position of senior examiner in the cancellation department of the Emergency Fleet Corporation, Philadelphia, Pa.

H. O. C. Isenberg has severed his connection with the Wright-Martin Aircraft Corporation, New Brunswick, N. J., as factory manager, and has accepted the position of general manager of factories at Ilion, Syracuse and Bridgeport, Conn., of the Remington Typewriter Company.

Frank D. Shumate who has been with the Worthington Pump and Machinery Corporation for a number of years, has assumed the duties of vice-president and sales manager of the Chalmers Pump and Manufacturing Company, which has recently been organized. Mr. Shumate and associates have purchased the entire pumping machinery business of the Canton-Hughes Pump Company, merging it with the Chalmers Manufacturing Company of Lima, Ohio, under the new name of the Chalmers Pump and Manufacturing Company, with general offices and works at Lima.

A. D. Stancliff has resigned as superintendent of the Western States Portland Cement Company, Independence, Kan., to accept a similar position with the Cuban Portland Cement Corporation of Havana, Cuba.

Frank G. Wheeler, until recently connected with the Miehle Printing Press and Manufacturing Company, Chicago, Ill., has become associated with the Chapman Engine Works, Marcellus, Mich.

ANNOUNCEMENTS

C. H. Stoddard has become consulting marine engineer for the Heiner Boiler Company.

Ray B. Whitman, formerly engaged in patent work in Chicago, has opened offices in New York, to engage in practice as a patent attorney and engineer, specializing on mechanical and marine inventions. Before entering the patent field, Mr. Whitman was a member of the firm of Whitman and Whitman, mechanical and electrical engineers of Chicago, and during the war was in shipbuilding work with the Emergency Fleet Corporation on the Great Lakes.

Hugh Pattison has accepted a position with the Westinghouse Electric and Manufacturing Company, New York.

Warren B. Hood, since receiving his discharge as Captain in the Ordnance Department, has become connected with the engineering department of the New York Shipbuilding Corporation, Camden, N. J.

P. C. Sanguinetti has assumed the direction of the research department of L. Bamberger and Company, Newark, N. J. He was affiliated, for several years, with Marwick, Mitchell, Peat and Company, public accountants and industrial engineers, and until recently was engaged in the cost accounting and production engineering field at various plants in the United States and Canada.

Lieut. Commander John L. Murrie, U. S. N. R. F., formerly of the New York Edison Company, who has been released from active duty in the government service, and Captain Edward F. McCrossin, U.S.A., announce the formation of a partnership under the firm name of

Murrie and Company, with offices in New York. The firm will conduct a general engineering practice, specializing in engineering, financial and operating reports, valuations and gas and electric rate cases.

William F. Walsh has accepted the position of representative of the Galena-Signal Oil Company, with headquarters in Chicago, Ill.

Earle W. Vinnedge, First Lieutenant, 7th U. S. Engineers Train, A. E. F., has been discharged from service and has become affiliated with the Worthington Pump and Machinery Corporation, Cincinnati, Ohio, in the capacity of sales engineer.

George C. Lewis has assumed the duties of manager of the Philadelphia office of Hersh and Brother. He was until recently assistant chief engineer of the company, at Allentown, Pa.

A. O. Hurxthal, Captain Ordnance Department, U. S. A., has received his discharge from service and has become associated with The Philadelphia Textile Machinery Company, Philadelphia, Pa.

F. W. Shumard, supervisor of the machine and small tools branch of the Motor Transport Corps, Maintenance Division, Washington, D. C., has left the Government service and is now superintendent of Arnold Hellmuth Manufacturing Company, Brooklyn, N. Y.

Major Paul Doty, Mem. Am. Soc. M. E., of the general staff, United States Army, came home to St. Paul on May 31 on a brief leave of absence after 21 months in the service. Major Doty was vice-president and general manager of the St. Paul Gas Light Company until September, 1917, when he was assigned to take charge of the utilities at Camp Grant, Ill., and became in effect "city manager" of that military city, directing the operation and maintenance of the large steam heating, electric lighting, water and sewage plants. He was later called to Washington and given general charge of the administration of the utilities of all camps and cantonments. In September, 1918, he was assigned to duty with the general staff.

Frank H. Clark has opened an office in New York, as consulting and inspecting engineer, and will handle reports on railway conditions and operations, plans and specifications for railway equipment and for shop and power-plant facilities and inspection of equipment and materials. Mr. Clark was formerly general superintendent of motive power of the B. and O. R. R., Baltimore, Md.

APPOINTMENTS

Ernest Gledhill has been appointed engineer representing the equipment division of the salvage sales section of the Remington Arms Union Metallic Cartridge Company, Bridgeport, Conn.

A. B. Russell, formerly works manager of the Ilion, N. Y. plant of Library Bureau, has been appointed general production manager in charge of the various manufacturing activities of Library Bureau.

William Knight, formerly assistant mechanical engineer of the Crocker-Wheeler Company, Ampere, N. J., and during the war a first lieutenant in the Air Service, U. S. A., has recently been appointed technical assistant to the National Advisory Committee for Aeronautics in Europe, with headquarters in Paris, France.

W. C. Tyler, formerly district manager at the New York office of the Poole Engineering and Machine Company, of Baltimore, Md., has been appointed general sales manager in charge of all the selling activities of the country. The general sales office of the company has been removed from Baltimore to New York.

H. R. Trotter, formerly chief engineer of the S K F Ball Bearing Company, has been appointed chief engineer of the S K F Industries, Inc., New York. The S K F Industries, Inc., has recently been organized to supervise the sales and engineering activities of the Hess-Bright Manufacturing Company, the Atlas Ball Company, the S K F Engineering Laboratories and the S K F Ball Bearing Company.

LIBRARY NOTES AND BOOK REVIEWS

The American Machinist Shop Note Book. A Collection of Articles Written for the *American Machinist* by Practical Men, Covering a Wide Variety of Machine Shop Activities and Giving the Solution of Problems that have Arisen in Machine Shops the World Over. Compiled by E. A. Suverkrop. First edition. Published by *American Machinist*, McGraw-Hill Book Co., Inc., sole selling agents, New York, 1919. Cloth, 6 x 9 in., 301 pp. 223 illus., $2.

Contents: Drafting and Design, Patterns and Foundry, Forge Shop, Hardening and Tempering, Drilling Machine, Engine Lathe, the Milling Machine, Planer and Shaper, Tool Making, Die and Press Work, Gages, Grinding, Boring, Gearing, Screw Machine, Shop Tools, Appliances and Expedients.

A collection of methods for dealing with difficult or unusual machine-shop jobs, compiled from the periodical mentioned, and classified under the above headings to facilitate ready reference. The articles show methods that have been successful and are suggestive to the machinist faced by similar difficulties.

Cutting Central Station Costs. Ways by which Central Station Managers, Operating Engineers and Sales Managers are Meeting High Costs. Compiled by S. B. Williams. First edition. Published by *Electrical World*, McGraw-Hill Book Co., Inc., sole selling agents, New York. 1919. Cloth, 6 x 9 in., 322 pp., illus. $2.

The commercial editor of the *Electrical World* has here collected the material contributed to that journal during the last nine months of the war, explaining methods adopted by various central stations. Economies in boiler and generating rooms, line construction, distribution methods, substation practice, commercial practice and administrative plans are discussed.

Efficient Railway Operation. By Henry S. Haines. The Macmillan Co., New York, 1919. Cloth, 6 x 9 in., 709 pp., tables, $4.50.

This volume is a description of the progressive development of efficiency in the operation of the railway system in the United States, as compared with similar progress in other countries; for the use of students, railway employees and general readers. Railway operation as distinguished from administration is the subject of the book; matters of finance, rates and labor questions are therefore not included. A bibliography and extensive statistical tables are given in the appendices.

Electricity and Magnetism for Engineers. Part II. Electrostatics and Alternating Currents. By Harold Pender. First edition. McGraw-Hill Book Co., Inc., New York, 1919. Cloth, 6 x 9 in., 221 pp., 172 illus., $2.

Gives from an engineering point of view, a description of the more important effects commonly described as electrical and magnetic phenomena, and the application of these laws to some of the simpler problems which arise in connection with the generation, transmission and utilization of electric currents. Intended for college instruction.

Handbook for Highway Engineers. Containing Information Ordinarily Used in the Design and Construction of Rural Highways. By Wilson G. Harger and Edmund A. Bonney. Third edition, entirely revised. McGraw-Hill Book Co., New York, 1919. Flexible cloth, 4 x 7 in., 986 pp., illus., tables, 1 map, $4.

This handbook is a compact volume, presenting in convenient form the information ordinarily required in the field and office practice of road design and construction, and is planned to meet the requirements of both experienced and inexperienced road men. In the present edition, approximately 350 pages of new material have been incorporated, covering mountain-road location and design, camp equipment, medical notes, photography, selected soil and gravel treatment of moderate-traffic roads and the recent development of hard-surface roads.

The Nomon. By Horace G. Deming. Miles and Parris, Champaign, Ill. 1918. General edition, $1.60 postpaid; Chemists edition, $1.60 postpaid; Sugar Technologists' edition, $1.60 postpaid.

The Nomon is a calculating chart, based on a new mathematical principle, that will multiply, divide, square and cube numbers, and extract square and cube roots, to four figures, with an average error of one part in four or five thousand. It is cheap and portable, more accurate in many cases than the slide rule and

quicker than the calculating machine. A particular advantage is the ease with which it solves special formulas of complex types. Any function of a single variable, such as $ax + b$ or $ax^2 + bx + c$, may be multiplied or used as a divisor as if it were a simple variable. An instruction manual accompanies the chart.

TRAINING FOR THE ELECTRIC RAILWAY BUSINESS. Written under the supervision of T. E. Mitten by B. B. Fairchild, Jr. J. B. Lippincott Co., Philadelphia, 1919. Cloth 5 x 8 in., 155 pp., 9 pl., 3 charts, $1.50.

Explains in non-technical language the business side of electric railroading, and gives an insight into the requirements, the opportunities and the training involved in the several departments. The various engineering and transportation problems are taken up and the recruiting and management of the army of laborers needed thoroughly discussed.

THE TURNOVER OF FACTORY LABOR. By Sumner H. Slichter, with an introduction by John R. Commons. D. Appleton & Co., New York, 1919. Cloth, 5 x 8 in., 460 pp., tables, $3.

Contents: General Analysis of the Turnover, the Cost of the Turnover, the Causes of the Turnover and Methods of Reducing the Turnover. The author intends his volume as a comprehensive study of methods of handling men, to supplement existing books on works management. It is founded on personal experience in large industrial plants, visits to factories, talks with employers and working men, schedules and questionnaires. As the study was begun in 1913 and most of the data were collected before the acute situation in 1916, the discussion is from the standpoint in peace times. The book deals with manual laborers generally, except out-of-door seasonal workers.

TRAUTWINE. The Civil Engineer's Pocket-Book. By John C. Trautwine. Revised by John C. Trautwine, Jr., and John C. Trautwine, 3d. Twentieth edition. Trautwine Co., Philadelphia, 1919. Flexible cloth, 4 x 7 in., 1528 pp., illus., tables, $6.

The present volume represents the fourth extensive revision of this well-known work of reference since its original appearance in 1872, and the first since the nineteenth edition as published in 1909. The present edition contains 271 more pages than the preceding one. In its preparation about 400 pages of material have been inserted, relating principally to matters connected with railways, on which subject about 250 pages of new matter have been added. Besides this inclusion of new data, the work has been revised and brought up to date throughout.

MARINE INSURANCE. Its Principles and Practice. By William D. Winter. First edition. McGraw-Hill Book Co., Inc., New York, 1919. Cloth, 6 x 8 in., 433 pp., $3.50.

In this treatise, the writer presents a thorough, simple exposition on marine insurance; suited to the needs of shipping men, merchants and others who require a general knowledge of the subject. Based on a course of lectures given at New York University.

PRACTICAL SHELL FORGING. And the Plastic Deformation of Steel and Its Heat Treatment. By Clifford O. Bower. Longmans, Green & Co., New York, 1919. Cloth, 6 x 10 in., 279 pp., 152 illus., 4 pl., 17 tables, $10.50.

This volume, by an experienced British forge master, is a detailed account of the processes of shell manufacture in which particular attention is given to the laws governing the plastic deformation of steel at high temperatures and the variations in its physical character to be obtained by thermal treatment. It will be useful indirectly, the author hopes, to all persons engaged in the manufacture of hydraulic forgings.

Accessions to the Library

AERONAUTICS IN THE UNITED STATES. By George Owen Squier. *1918.* Gift of author.

AMERICAN ENGINEERING STANDARDS COMMITTEE. Constitution and rules of procedure. *New York.* Gift of Committee.

THE CHEMISTS' POCKET MANUAL. By Richard K. Meade. 3d edit. Purchase.

THE DECLARATION OF THE RIGHTS AND DUTIES OF NATIONS ADOPTED BY THE AMERICAN INSTITUTE OF INTERNATIONAL LAW. By Hon. Elihu Root. *Washington, D. C., 1916.* Gift of Carnegie Endowment for International Peace.

THE DELAMETER IRON WORKS—THE CRADLE OF THE MODERN NAVY. A bit of forgotten Greenwich Village history. By H. F. J. Porter. Gift of the author.

DICTIONNAIRE TECHNIQUE DE L'AVIATION. By John Lyeett, Engineer. *Paris, 1918.* Purchase.

DRAWINGS OF OLD PENNSYLVANIA RAILROAD CARS. 26 plates. Gift of Geo. L. Fowler.

EFFICIENCY OF NATURAL GAS AT LOW PRESSURES. Abst. of testimony of Samuel S. Wyer before the Corporation Commission of Oklahoma, Feb. 4, 1919. Printed by Empire Gas & Fuel Co., Kansas City, Mo.

ELECTRIC SMELTING OF DOMESTIC MANGANESE ORES. By H. W. Gillett and C. E. Williams. Gift of the Manchester Steam Users' Association.

ENGINEERING DIRECTORY. No. 65, October, 1918. *London.* Gift from *Engineering.*

ENGINEERING INDEX ANNUAL, THE. 1918. *New York, 1919.*

ENGINEERING SOCIETY OF CHINA. Proceedings and Report of the Council. 1917-18. *Shanghai.* Purchase.

ENGINEMAN'S MANUAL—RICHMOND COMPOUND LOCOMOTIVES. Gift of George F. Fowler.

FEDERAL TAX LAWS AFFECTING INDIVIDUALS, PARTNERSHIPS AND CORPORATIONS. Practical questions and answers. Irving Trust Co. *New York, 1919.* Gift.

FIELD SANITATION. By C. G. Moor and E. A. Cooper. *London, 1918.* Purchase.

FUELS OF WESTERN CANADA AND THEIR EFFICIENT UTILIZATION. Jas. White. Commission of Conservation of Canada. *Ottawa, 1918.* Gift of author.

GASES USED IN WARFARE. By D. D. Berolzheimer. Reprint from Jour. Ind. & Engng. Chem. Vol. 2, No. 3, p. 256. March, 1919. Gift of author.

GAUGES AT A GLANCE. Fourth edition. By Thomas Taylor. *New York and London, 1918.* Purchase.

GOVERNMENT OWNERSHIP OF PUBLIC UTILITIES IN THE UNITED STATES. By Leon Cammen. *New York, 1919.* Gift of author.

HANDBOOK ON EMPLOYMENT MANAGEMENT IN THE SHIPYARD. Special Bulletin, Labor Loss. U. S. Shipping Board Emergency Fleet Corporation. *Philadelphia, 1918.* Gift.

HIGH EXPLOSIVES. By Capt. E. de W. S. Colver. *London, 1918.* Purchase.

A HISTORY OF THE BESSEMER MANUFACTURE IN AMERICA. The Evolution of American Rolling Mills. By Robert W. Hunt. Reprint. Gift of author.

HOURS AND HEALTH OF WOMEN WORKERS. Report of Illinois Industrial Survey. Dec., 1918. Gift of Louis L. Emmerson.

HUMANIZING INDUSTRY. By Irving Fisher. *1919.* Reprint. Gift of author.

THE HYDROGENATION OF OILS. Catalyzers and catalysis and the generation of hydrogen and oxygen. By Carleton Ellis. Second edition. *New York, 1919.* Purchase.

I FENOMENI ELETTRO-ATOMICI SOTTO L'AZIONE DEL MAGNETISMO. By Augusto Righi. *Bologna, 1919.* Purchase.

INDUSTRIAL ARTS INDEX. 1918, 3 vols. Purchase.

INFLUENCE OF THE GREAT WAR UPON SHIPPING. By J. Russell Smith. Preliminary Economic Studies of the War, edited by David Kingley. No. 9. *New York, 1919.* Gift.

QUICKSILVER RESOURCES OF CALIFORNIA. Bulletin 78. California State Mining Bureau. *1918.* Purchase.

RAILWAY STATISTICS OF THE UNITED STATES OF AMERICA—FOR YEAR ENDED DEC. 31, 1917. 15th year. By Slason Thompson. Bureau of Railway News and Statistics. *Chicago, Ill.* Gift of Slason Thompson.

THE RECOVERY AND RE-MANUFACTURE OF WASTE PAPER. By James Strachan. *Aberdeen, 1918.* Purchase.

REFRACTORY MATERIALS AS A FIELD FOR RESEARCH. A survey of the scientific aspects of the subject. By Edw. W. Washburn. Reprint from the Jour. of the Amer. Ceremic Soc., vol. 2, no. 1, Jan., *1919.*

THE RELATIVE DESIRABILITY OF SHIPS OPERATING IN FOUR TRADE ROUTES. U. S. Shipping Board, Washington, D. C. Division of Planning and Statistics. *Feb. 28, 1919.* Gift of Henry V. R. Scheel.

RELATIVE MERITS OF CAST-IRON, WROUGHT-IRON AND STEEL PIPE FOR HOUSE DRAINAGE PURPOSES. By Wm. P. Gerhard. *New York, 1918.* Gift of the author.

THE REPRODUCTION OF SOUND. By Henry Seymour. *London.* Purchase.

SHIP CONSTRUCTION AND CALCULATIONS. By George Nicol. *Glasgow and London, 1918* Purchase.

TAXATION OF FOREST LANDS IN WISCONSIN, THE By Alfred K. Chittenden, Forest Examiner and Harry Irion, Forest Service. Sept. 1910 Gift of Geo. F. Fowler.

TRAIN BRAKES AND THE MECHANICAL PRINCIPLE WHICH CONTROL THEIR CONSTRUCTION, WIT SPECIAL REFERENCE TO LOCOMOTIVE BRAKES The Beals Railway Brake Company. Nov. 1 1888. Gift of Geo. F. Fowler.

THE TRANSACTIONS OF THE CANADIAN MININ INSTITUTE. Vol. 21. *Montreal, Quebec, 19* Purchase.

TUNNEL CONSTRUCTION — AFFIDAVIT OF DANI E. MORAN. Equity Suit in United States D trict Court—Duncan D. McBean, Complainar vs. The City of New York. vols. I, II, I Gift of Arthur McMullen.

THE ENGINEERING INDEX

Published Monthly by The American Society of Mechanical Engineers

The Engineering Index was Founded in 1884 *by the Association of Engineering Societies; Published from* 1895 *to* 1919 *by The Engineering Magazine Company; and Acquired January* 1919 *by The American Society of Mechanical Engineers*

THE following pages form a descriptive Index to articles on engineering and related subjects in current periodicals. In its preparation the Society's engineering staff regularly examines all of the technical journals and society publications received by the Engineering Societies Library, which form one of the greatest and most complete collections of scientific periodicals in the world, comprising upward of 1100 distinct publications in some ten languages. Cross-references are freely introduced in the Index, and in all cases where the titles of articles are not sufficiently descriptive, explanatory sentences are appended. The main abbreviations used in the items are given at the bottom of this page.

PHOTOSTATIC COPIES OF ARTICLES LISTED

THE Society is prepared to supply photostatic copies (white printing on brown background) of any of the articles listed. Copies of the periodicals themselves, or clippings of articles, cannot be supplied.

Price of each print (up to 11 x 14 in. in size), 25 cents plus postage. A separate print is required for each page of the larger-size periodicals, but where possible two pages will be photographed together on the same print. Bill will be mailed with the prints.

Those holding coupon books for clippings formerly issued by The Engineering Magazine Company may use the coupons in payment for photostatic prints. In ordering, state plainly

(1) Page number of Index on which item appears
(2) Title of article
(3) Name of periodical.

Orders should be sent to

Harrison W. Craver, *Director,*
Engineering Societies Library,
29 West 39th Street, New York City.

DIVISIONS OF THE ENGINEERING INDEX

MECHANICAL ENGINEERING

Air Machinery
Corrosion
Forging
Foundries
Fuels and Firing
Handling of Materials
Heat Treating
Heating and Ventilation
Hoisting and Conveying
Hydraulic Machinery
Internal-Combustion Engines
Lubrication
Machine Elements and Design
Machine Shop
Machinery, Metal-Working
Machinery, Special
Machinery, Woodworking
Materials of Construction and Testing of Materials
Measurements and Measuring Apparatus
Mechanical Processes
Mechanics
Motor-Car Engineering
Pipe
Power Generation
Power Plants
Power Transmission
Producer Gas
Pumps
Refractories
Refrigeration
Research
Standards and Standardization
Steam Engineering
Textiles
Thermodynamics
Welding
Varia

ORGANIZATION AND MANAGEMENT

Accounting
Education
Export
Factory Management
Finance and Cost
Inspection
Labor
Legal
Lighting
Public Regulation
Reconstruction
Safety Engineering
Salvage
Transportation
Varia

ELECTRICAL ENGINEERING

Electrochemistry
Electrodeposition
Electrophysics
Furnaces
Generating Stations
Generators and Motors
Lighting and Lamp Manufacture
Measurements and Tests
Power Applications
Standards
Telegraphy and Telephony
Transformers, Converters, Frequency Changers
Transmission, Distribution, Control
Wiring
Varia

CIVIL ENGINEERING

Bridges
Building and Construction
Cement and Concrete
Earthwork, Rock Excavation, etc.
Harbors
Materials of Construction
Municipal Engineering
Roads and Pavements
Sanitary Engineering
Water Supply
Waterways

MINING ENGINEERING

Alloys, Ferrous
Base Materials
Coal and Coke
Copper
Explosives
Geology and Mineralogy
Iron
Lead
Major Industrial Materials
Mines and Mining
Minor Industrial Materials
Oil and Gas
Precious Minerals
Rare Minerals
Tin
Transportation
Varia

METALLURGY

Aluminum
Blast Furnaces
Copper
Flotation
Iron and Steel
Non-Ferrous Alloys
Occluded Gases
Waste Recuperation

AERONAUTICS

Aeroplane Parts
Aerostatics
Aircraft Production
Applications
Auxiliary Service
Design
Dynamics
Engines
Gliders
History
Instruments
Materials of Construction
Mechanics
Meteorology
Military Aircraft
Models
Planes
Propellers
Specifications, Aeroplane
Transatlantic Flight

MARINE ENGINEERING

Auxiliary Equipment
Salvage
Ships
Yards
Varia

INDUSTRIAL TECHNOLOGY

RAILROAD ENGINEERING

Electric Railroads
Electrification
Equipment
Foreign
Labor
Locomotive
Maintenance
New Construction
Operation and Management
Permanent Way and Buildings
Rails
Rolling Stock
Safety and Signaling Systems
Shops
Special Lines
Street Railways
Terminals

MUNITIONS AND MILITARY ENGINEERING

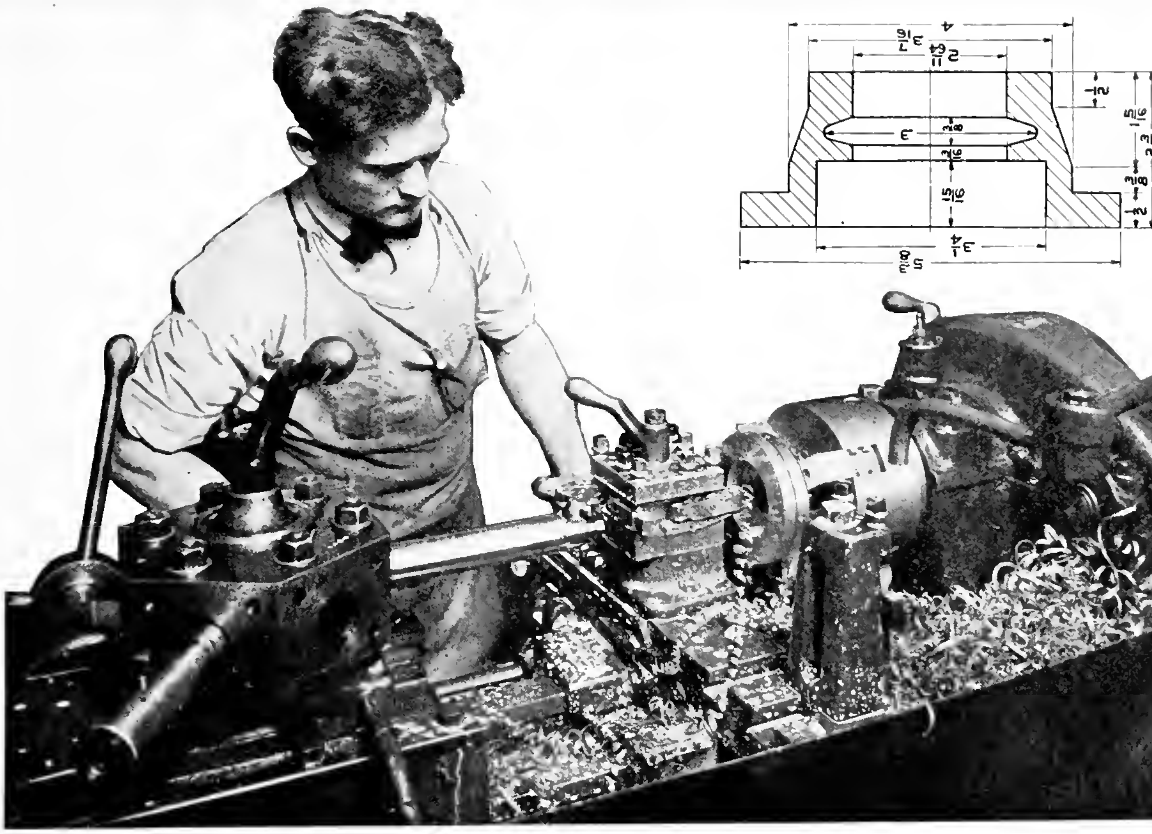
GENERAL SCIENCE

Chemistry
Mathematics
Physics

Note.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
New York (N. Y.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
Ventilating (Vent.)
Western (West.)

LIST OF TOPICS IN THE ENGINEERING INDEX

JULY, 1919



Value of the Square Turret

THIS shows the amount of material removed and how well the many operations on these tough power sprocket clutches were finished on the No. 4 Universal Screw Machine. The hexagon turret was used only for boring. The square turret, loaded to capacity with cutters, did the rest with the aid of its eight power cross and longitudinal feeds.

For Work Too Complicated for Ordinary Screw Machines

The special features of the No. 4 Universal (in this case the unusual use for the square turret) adapt them to a wide range of work too complicated for ordinary screw machines or turret lathes

SEND FOR DETAILS
Turret Lathes and Screw Machines
from 5/8 in. x 4 in. to 4½ in. x 44 in., Maximum Swing 21½ in.

THE WARNER & SWASEY COMPANY

CLEVELAND, OHIO, U. S. A.

NEW YORK Office—Singer Building. **Boston Office**—Oliver Building **Buffalo Office**—Iroquois Building. **Detroit Office**—Ford Building. **Chicago Office and Show Rooms**—618-622 Washington Blvd. **FOREIGN AGENTS:** Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. Allied Machinery Company, Paris and Turin. Van Rietschoten & Houwens, Rotterdam. Yamatake & Co., Tokio. Benson Brothers, Sydney and Melbourne. A. Asher Smith, Sydney. A. R. Williams Machinery Co., Ltd., Toronto, St. John, Winnipeg and Vancouver. Williams & Wilson, Ltd., Montreal.

Mechanical Engineering

CORROSION

Electrolytic Theory of Corrosion

The Effect of Air and Water on Materials Used in Engineering Work. H. E. Yerbury. Electrical Review, vol. 84, no. 2161, Apr. 25, 1919, pp. 484-486. Writer favors electrolytic theory of corrosion and quotes instances which, in his estimation, confirm it.

Rustproofing

Metallic Coating for Rust Proofing Iron and Steel—I. Henry S. Rawdon, M. A. Grossman and A. N. Finn. Chem. & Metallurgical Eng., vol. 20, no. 9, May 1, 1919, pp. 458-464, 1 fig. Recommendations in regard to rust-proofing metal coatings, with discussion of comparative values of different methods especially of zinc.

Wire Rope

The Internal Corrosion of Cables. Wm. Fleet Robertson. Min. & Sci. Press, vol. 118, no. 18, May 3, 1919, pp. 589-591, 1 fig. Lack of internal lubrication is believed to have been cause of rope failure at Nanaimo, B. C., Colliery, which resulted in 16 instant deaths.

See also MARINE ENGINEERING, Auxiliary Machinery (Propellers).

FOUNDRIES

Aluminum Casting

Progress in Aluminum Casting. Metal Indus., vol. 17, no. 5, May 1919, pp. 211-213, 4 figs. McAdamite Aluminum Co.'s plant at Detroit said to have been erected with a view to have all operations go in continuous process from unloading of raw material to shipment of finished castings.

Brass Foundry

Materials and Chemicals Used in Brass Foundry Practice—VI. Charles Vickers. Brass World, vol. 15, no. 5, May 1919, pp. 139-141, 1 fig. Patented processes for producing phosphorus and its compounds. Serial dealing with history, properties, appearance, physiological action and commercial use of substances commonly used in brass founding.

Chain, Steel Anchor

Molding and Casting Heavy Steel Anchor Chain. Foundry, vol. 47, no. 320, Apr. 1, 1919, pp. 141-147, 13 figs. Development of process; method of assembling individual links in molds preparatory to pouring connecting links.

Crucibles

Behavior Under Brass Foundry Practice of Crucibles Containing Ceylon, Canadian and Alabama Graphites. R. T. Stull. Jl. Am. Ceramic Soc., vol. 2, no. 3, Mar. 1919, pp. 208-226, 2 figs. Experimental research showed that substitution of Canadian graphite up to 25 per cent for Ceylon decreased life of crucible; the crucibles containing 100 per cent Canadian graphite are nearly as good as those containing 25 per cent Canadian and 75 per cent Ceylon, but that substitution of Alabama flake graphite for Ceylon improved crucible's life.

Die Castings

Die Castings and Their Application to the War Program. Charles Pack. Automotive Eng., vol. 4, no. 4, Apr. 1919, pp. 183-186, 9 figs. Development of industry, early machines and their work. Attempts to avoid blowholes and influence of this on machines. War castings produced.

Job Work

Diversified Output at Canton Plant. Foundry, vol. 47, no. 6, May 1, 1919, pp. 243-250, 11 figs. Organization of large foundry which produces castings weighing from 1 lb. up to 100 tons.

Pump Casing

How a Large Pump Casing was Molded and Cast. Foundry, vol. 47, no. 7, May 15, 1919, pp. 281-283, 6 figs. Green-sand, skin-dried mold used with dry-sand core made on floor with the mold and dried in an oven.

Research

Application of Physical and Chemical Research to Cast Iron Foundry Practice (Exemples d'utilisation dans la pratique industrielle de la fonderie de fonte des résultats d'essais physiques et chimiques). J. Seigle. Bulletin et comptes rendus mensuels de la Société de l'Industrie Minérale, series 5, vol. 15, first issue of 1919, pp. 127-143, 13 figs. Technical discussion. Reference is made to investigations outlined in Industrie Minérale, second issue, 1918.

Sand Blast

Application of the Sand-Blast. H. D. Gates. Iron Age, vol. 103, no. 18, May 1, 1919, pp. 1135-1138, 5 figs, also Metal Trades, vol. 10, no. 5, May 1919, pp. 203-206, 4 figs, second article. Relationship between air pressure and abrasion. Sand-blast air drier adopted by Emergency Fleet Corp. Barrel, cabinet and table types of sand-blast equipment. Paper read before Newark Foundrymen's Assn.

Sand Molding

Ferruginous and Other Bonds in Molding Sands. P. G. H. Boswell. Foundry, vol. 47, no. 320, Apr. 1, 1919, pp. 148-150. European practice; mechanical and chemical analyses of English sands.

Ship Work

Making Castings Used in Ship Construction—II. Ben Shaw and James Edgar. Foundry, vol. 47, no. 6-7, May 1-15, 1919, pp. 251-255 and 297-300, 41 figs. Details of making rudder pattern by two methods and description of core-box construction. Ramming, setting and pouring basins.

Steel Castings

Making Steel Castings by the Best Steel Casting Company. Metal Trades, vol. 10, no. 5, May 1919, pp. 199-201, 5 figs. Lebanon pig iron, to which is added a considerable amount of low-phosphorus and low-carbon plate scrap, is used.

Foundry With Diversified Output. Iron Trade Rev., vol. 64, no. 19, May 8, 1919, pp. 1211-1217, 11 figs. Facilities created for large scale production of steel castings.

Wheels, Truck

Making Quad Wheels in a Tractor Foundry. Foundry, vol. 47, no. 320, Apr. 1, 1919, pp. 157-161, 8 figs. Operation involved in manufacture of four-wheel drive army trucks.

See also MARINE ENGINEERING, Yards (Castings).

FUELS AND FIRING

Coal Storage

The Storage of Coal. Eugene McAuliffe. Ry. Rev., vol. 64, no. 20, May 17, 1919, pp. 712-714, 1 fig. Concerning methods of unloading. Fuel Conservation Circular no. 17 of U. S. Fuel Administration.

Gas and Oil Fuels

See Producer Gas, page 12a; items under INDUSTRIAL TECHNOLOGY; and Oil and Gas, under MINING ENGINEERING.

Peat

The Future of Peat as a Fuel—I. J. B. C. Kershaw. Coal Age, vol. 15, no. 20, May 15, 1919, pp. 898-901, 6 figs. Peat being considered as more widely distributed throughout the world than were the original beds of coal-forming materials, its utilization is considered advisable, and reference made to uses in various countries of drying and briquetting it. (To be continued.)

Pulverized Fuel

Instructions for Safe Use of Pulverized Fuel. Engineer, vol. 127, no. 3304, Apr. 25, 1919, pp. 398-399. Prepared by Pulverized Fuel Equipment Co., N. Y.

Use of Pulverized Coal, With Special Reference to Its Application in Metallurgy. L. C. Harvey. Iron & Steel Inst., Ann. Meeting, May 8 & 9, 1919, no. 8, 73 pp., 29 figs., also, slightly abridged, Iron & Coal Trades Rev., vol. 98, no. 2671, May 9, 1919, pp. 590-599, 17 figs., and Colliery Guardian, vol. 117, no. 3045, May 9, 1919, pp. 1081-1085, 5 figs. (To be continued.) Examples of installations, details of burners, curves showing results of operation and operating costs, and bibliography of recent articles on powdered coal.

Pulverized Coal and Its Bearing on the Fuel Situation. H. G. Barnhurst. Am. Fertilizer, vol. 50, no. 9, Apr. 26, 1919, pp. 48-49. Cost of pulverized coal equipment per boiler per rated boiler hp.

See also RAILROAD ENGINEERING, Operation and Management (Fuel Conservation, Oil Fuel Trials); MINING ENGINEERING, Coal and Coke; ELECTRICAL ENGINEERING, Generating Stations (Peat-Fired Central Stations); MECHANICAL ENGINEERING, Power Plants (Pulverized Coal Plants.)

FURNACES

See ELECTRICAL ENGINEERING, Furnaces; MECHANICAL ENGINEERING, Heat-Treating (Furnaces.)

GAGES

Errors

On Some Principles of Manufacturing Interchangeable Articles to Limit Gauges. G. Gerald Stoney and S. Lees. Engineering, vol. 107, no. 2777, Mar. 21, 1919, pp. 361-362, 1 fig. Analytical derivation of error, based on Gauss' theoretical law of distribution of errors.

Flush-Pin Sliding Bar

Flush-Pin Sliding Bar and Hole Gauges. Machy. (Lond.), vol. 14, no. 345, May 8, 1919, pp. 163-171, 34 figs. Principles involved and procedure followed by Pratt & Whitney Co. in developing gauging systems for interchangeable manufacture. (Fourth article.)

Johansson Gages

The Use of Gage Blocks in Inspection. Ernst Mentor. Inspector, vol. 1, no. 1, June 1919, pp. 5-11, 37 figs. Development and uses of Johansson gages.

Optical Testing of Flat Surfaces

U. S. Bureau of Standards' Method of Measuring in Millionths. H. S. Bean. Inspector, vol. 1, no. 1, June 1919, pp. 12-13 & 21, 3 figs. Optical testing of flat surfaces and comparison of size standards.

Tolerances

Notes on the System of Tolerance in Mechnical Construction (Remarques sur le système des tolérance dans les constructions mécaniques). Génie Civil, vol. 74, no. 18, May 3, 1919, pp. 353-355, 10 figs. Technical study of limitations, based on principles of symmetrical and unsymmetrical systems.

GAS ENGINEERING

Centralization of Gas Supply

Centralization in Public Gas Supply. J. H. Brearley. Gas World, vol. 70, no. 1812, Apr. 12, 1919, pp. 274-276, 1 fig. Discusses objections generally offered against centralization of gas supply. As example a scheme for Huddersfield (town adjacent to a number of small gas undertakings) is proposed.

Doors, Self-Sealing

Fifteen Ovens of Michigan Light Company at Kalamazoo Have Capacity of 1,250,000 Cu. Ft. of High-Grade Gas per Day. Louis Resnick. Am. Gas Eng. Jl., vol. 110, no. 18, May 3, 1919, pp. 373-380, 6 figs. Salient features of installation is self-sealing doors which are said to have given satisfaction throughout six months of operation.

Gas from Wood and Peat

Manufacture of Gas from Wood and Peat. Gas Jl., vol. 146, no. 2917, Aprl. 8, 1919, pp. 83-84. Swiss experience in commercial practice.

Gas Production, New Method of

New System of Gas Production (Et nyt system for gasfremfremstilling). Teknisk Ukeblad, vol. 66, no. 12, Mar. 21, 1919, pp. 174-175. Combination of present system of externally fixed retorts and water-gas producers, but combustion takes place inside retorts and is arrested when coal is changed to coke.

Water Gas

Water-Gas Operating Methods with Central District Bituminous Coals as Generator Fuel—Notes on Experiments on a Commercial Scale. W. A. Dunkley and W. W. Odell. State of Ill., Dept. Registration & Education, Div. State Geol. Survey, Coöperative Min. Ser., bul. 24, 1919, 27 pp. Summary of experiments on commercial scale.

HANDLING OF MATERIALS

Belt Conveyors

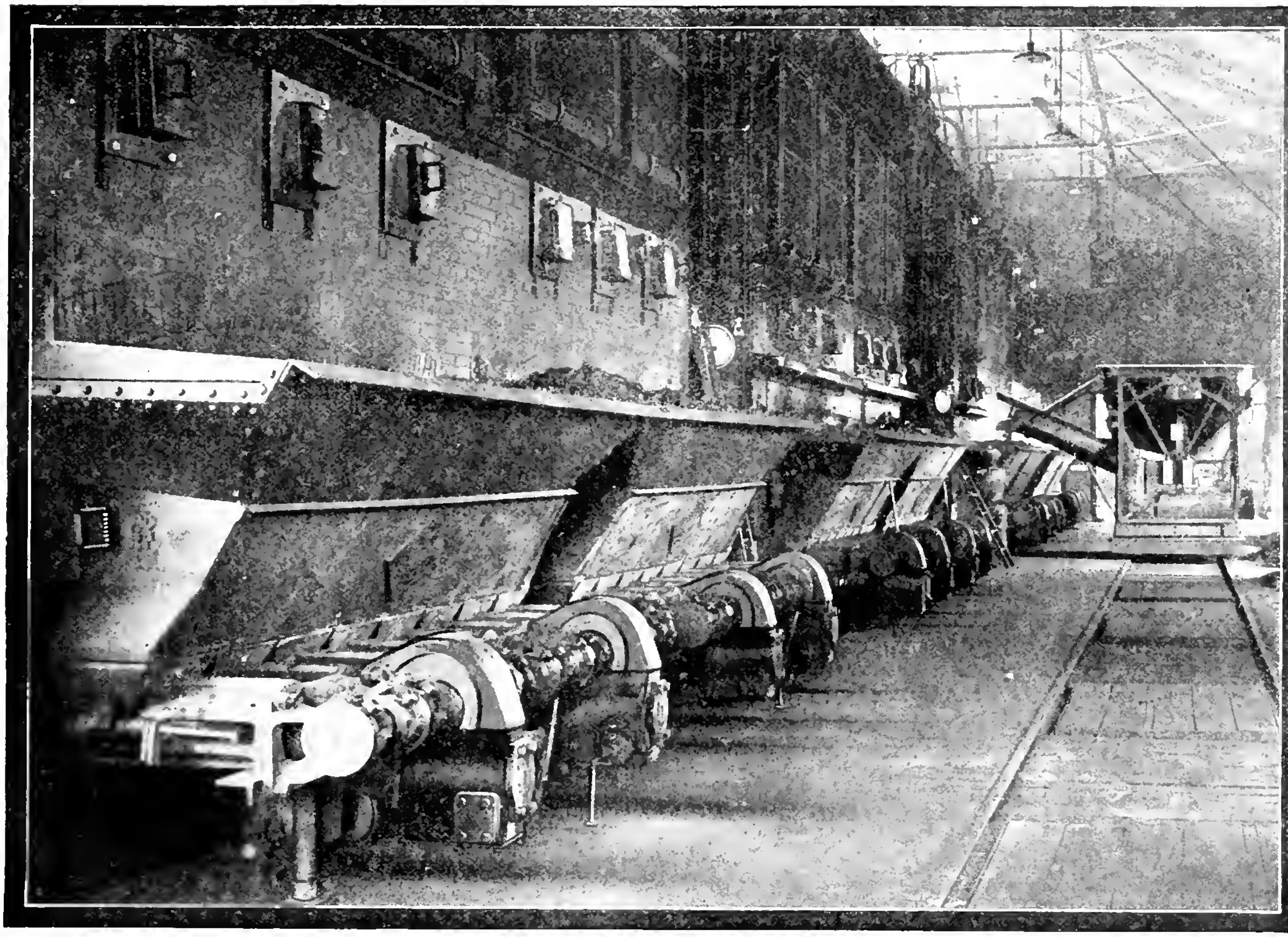
Coal and Ash Handling Equipment—III Robert June. Refrig. World, vol. 54, no. 5 May 1919, pp. 25-27, 4 figs. Requirements fo installing continuous belt conveyors.

Coal Tipples

New Coal Tipple at a Virginia Operation, C Sharon. Coal Age, vol. 15, no. 18, May 1 pp. 796-798, 7 figs. Described as compact an embodying means for obtaining various grade or mixtures of grades.

Iron and Steel Works

Some Notes on the Handling of Raw Ma terials for Iron and Steel Works. W. W. M Gosh. Jl. West of Scotland Iron & Ste Inst., vol. 26, parts 4 & 5, sessions 1918-191 January 1919, pp. 68-74 and (discussions) p 74-78, 18 figs. on supp. plates, also Iron Coal Trades Rev., vol. 98, no. 2670, May 1919, p. 532. Illustrating practice in vario Scottish plants.



300% Continuous Rating with Plenty of Reserve Capacity

High capacity is not only possible but highly economical. 300% continuous rating is EASY operation for the RILEY STOKERS at the Columbus Railway, Power & Light Company.

24-hour tests conducted on eight-retort stokers operating above 300% with 10,775 B. T. U. coal gave the following results:

Stoker & Boiler	Duration	% Rating Developed	% Efficiency with economizer
No. 3	24 Hours	305	72.2
No. 4	24 Hours	302	76.4

If your load calls for 300% of continuous rating or 400-500% of rating during peaks—write us.

Our engineers are ready to co-operate; possibly they can save you much time, money, men and material.

Our catalog explains the *live grate surface* and the *continuous, automatic, ash discharge*—two essentials for high efficiency and capacity.

SANFORD RILEY STOKER COMPANY ∴ WORCESTER, MASS.

British Licensees: Erith's Engineering Co., Ltd., London - - - French Licensees: Erith, Leroy & Cie., Paris

TRADE MARK Rx REGISTERED

RILEY UNDERFEED STOKERS

TRADE MARK Rx REGISTERED

Ore Handling

Automatic Ore Handling Plant. Iron & Coal Trades Rev., vol. 98, no. 2670, May 2, 1919, pp. 534-536, 15 figs., partly on supp. plate. Design for unloading railway wagons as they come into works with iron ore at a rate of 300 tons per hour.

Telpherage

Power Plant Management; Coal and Ash Handling—III, Robt. June. Power House, vol. 12, no. 6, May 5, 1919, pp. 154-156, 4 figs, also Brick & Clay Rec., vol. 54, no. 9, May 6, 1919, pp. 778-779, 3 figs. (Third article). Installation of Jeffrey telpherage system at plant of Scioto Traction Co. Contents are discharged directly into coal pit from which coal is removed by grab bucket and transferred either to overhead bunker or to storage.

HEAT-TREATING

Carburization at Low Temperatures

The Carburization of Iron at Low Temperatures, Andrew McCance. Iron & Steel Inst., Ann. Meet., May 8 & 9, 1919, no. 12, 5 pp., 1 fig. Consideration of variation of equilibrium conditions with temperature leads to assertion that above 550 deg. cent. ferrous oxide is more easily converted into carbide than pure iron.

Case-Hardening

Improvements in the Case-Hardening Process, D. Hanson and J. E. Hurst. Iron & Steel Inst., Ann. Meeting, May 8 & 9, 1919, no. 7, 19 pp., 6 figs., also Iron & Coal Trades Rev., vol. 98, no. 2671, May 9, 1919, pp. 573-575. Theoretical and experimental research leads to assertion that ordinary methods of case-hardening at or above 900 deg. cent. tend to formation of hypereutectoid layer in the case, which is a frequent source of flaking and grinding cracks.

Furnaces

Metallurgical Furnaces—II. Adolph Bregman. Metal Indus., vol. 17, no. 5, May 1919, pp. 218-220, 5 figs. Advises that in the design and operation of heat-treating plants, efficiency of furnace from standpoint of finished product be estimated from uniformity with which product is heated throughout its entire mass when heat chamber is filled to its full working capacity.

Low-Carbon Steel

Heat Treatment of Low-Carbon Steel, W. H. Wilkie. Jl. Am. Steel Treaters Soc., vol. 1, no. 6, Mar. 1919, pp. 194-206, 12 figs. Cautions against placing cold piece of steel into highly heated furnace, and recommends quenching piece with axis vertical in order to prevent excessive warping or cracks due to unequal contraction in cooling.

Men

Fundamental Principles to be Considered in the Heat Treatment of Steel, R. A. Hayard. Chem. & Metallurgical Eng., vol. 20, no. 10, May 15, 1919, pp. 519-523. Advises encouraging men to think about the work they are handling and exercising creative instinct whenever possible, and devolping sense of responsibility by allowing men to visualize their work by using charts and graphs.

Steel-Mill Practice

Relation of Steel Mill Practices to Subsequent Heat Treating, A. F. MacFarland. Jl. Am Steel Treaters Soc., vol. 1, no. 6, Mar. 1919, pp. 183-193, 10 figs. Quality of steel produced, and its ability to respond to heat treatment giving superior physical properties desired, said to depend entirely upon local conditions surrounding its manufacture.

HEATING AND VENTILATION

Central-Station Heating

Central Station Heating in Detroit, J. H. Walker. Mech. Eng., vol. 41, no. 6, June 1919, pp. 497-503, 8 figs. Complete utilization of heat ordinarily discharged to condensing water in central electric generating station for purpose of heating buildings is held responsible and difficulties in way of even its partial utilization are pointed out with particular reference to conditions existing in Detroit. Paper for Spring Meeting of A. S. M. E.

Equipment

Care of Heating and Ventilating Equipment—IX, Harold L. Alt. Power, vol. 49, no. 18, May 6, 1919, pp. 675-679, 9 figs. Several vapor systems are taken up and their characteristics explained, together with information regarding some of the special apparatus used with each.

Theater Ventilation

Theater Ventilation From a Health and Business Standpoint, E. Vernon Hill. Domestic Eng., vol. 87, no. 6, May 10, 1919, pp. 237-239 and 270. Mechanical equipment is judged necessary, and its installation profitable to contractor and owner.

HOISTING AND CONVEYING

Compressed-Air Hoisting Engine

Compressed Air Hoisting Engine for a Mine in India. Engineer, vol. 127, no. 3302, Apr. 11, 1919, pp. 356 & 363, 4 figs. Cylinders are 18 in. in diamater by 3-ft. stroke and work at pressure of 60 lb. per sq. in.

Conveyors, Portable

Cutting Conveying Costs in the Brick Plant. Brick and Clay Rec., vol. 54, no. 9, May 6, 1919, pp. 765-767, 6 figs. Installation of portable conveyor. Examples of its applications are illustrated.

Crane, Bridge, Transporters

Handling Devices in British Shell Shops—IV. Eng. & Indus. Management, vol. 1, no. 2, Apr. 24, 1919, pp. 349-355, 13 figs. Material is conveyed through shop by railways and two bridge crane transporters. (Concluded from p. 361.)

Cranes, Gantry

A New Way of Loading Ocean Freighters. Ry. Elec. Engr., vol. 10, no. 5, May 1919, pp. 153-156, 7 figs. Illustrating how electrically operated gantry cranes quickly transfer locomotives from cars to ship.

Elevator Control, Electromagnetic

Electro-Magnetic Electric Elevator Control, T. Schutter. Elec. Eng., vol. 52, no. 6, Dec. 1918, pp. 36-38, 4 figs. Otis elevator control.

Elevators, Mechanical

Mechanical Lifts—Past and Present, J. F. Robbins. Mech. Eng., vol. 41, no. 6, June 1919, pp. 507-512, 9 figs. A new type of lift described has the points of support of two counter-balancing loads so interconnected that movements of supporting elements of structure are synchronized and it is made impossible for supports to get out of level. Applicable to freight-car lifts, lift bridges, canal-lock lifts, etc.

Fordson Methods

Handling Parts in the Shop and on the Assembly Floor, J. Edward Schipper. Automotive Industries, vol. 40, no. 19, May 8, 1919, pp. 1009-1012, 5 figs. Conveying apparatus installed in tractor works of Henry Ford & Son plant.

Inclined Plane

Inclined Plane of the Union Mining Co., U. U. Carr. Coal Age, vol. 15, no. 19, May 8, 1919, pp. 856-857, 3 figs. Electrically driven hoist was installed in place of inclined-plane machine that proved inadequate to handle increased output.

Mechanical Handling Equipment

Seattle's Mechanical Handling Equipment, G. F. Nicholson. Pac. Mar. Rev., vol. 16, no. 5, May 1919, pp. 102-105, 4 figs. Consists partly of shear-leg derricks, gantry cranes, stiff-leg derricks, 12 miles of railway tracks and eight loading platforms; equipment is electrically operated.

Winding Equipment

An Electrically Driven Winding Equipment. Electrical Review, vol. 84, no. 2161, Apr. 25, 1919, pp. 460-461, 2 figs. Induction motor is geared to spur wheel on drum shaft, driving pinion being mounted on extension shaft supported by two bearings, connection to latter shaft being made through flexible coupling. Installed at Kilton Colliery in shaft 720 ft. deep.

HYDRAULIC MACHINERY

Big Chute Plant

Big Chute Generating Station, W. L. Amos. Can Engr., vol. 36, no. 19, May 8, 1919, pp. 436-438 4 figs. Evolution of present power plant at Big Chute on Severn river from 1909 to addition of four generating units in January 1919.

French Plant

Hydroelectric Plant of the Loire and Center Electric Co. at Ance (L'usine hydro-électrique de l'Ance de la Compagnie électrique de la Loire et du Centre), Jacques de Soucy. Revue Générale de l'Electricité, vol. 5, no. 18, May 3, 1919, pp. 659-670, 15 figs. Output is 30,000,000 kw-hr. per year. (To be continued.)

Governor, Hydraulic-Turbine

New Hydraulic Turbine Governor (Nouveau regulateur à action indirecte et à indication mixte), M. Barbillion and M. Cayere. Houille Blanche, vol. 18, no. 25-26, Jan.-Feb. 1919, pp. 23-25, 4 figs. Advantages claimed are: extra rapid regulation, disappearance of speed oscillations, easy setting, and sensitiveness.

Ice Troubles

Design of Hydro-Electric Plants for Combatting Ice Troubles, R. M. Wilson. Jl. Eng. Inst. Can., vol. 2, no. 5, May 1919, pp. 383-387 and (discussion) pp. 387-395, 2 figs. Classification and discussion of ice troubles. Remarks upon selection of site and design of head and tail-race channels with a view to eliminate trouble and damage both to the outside portion of development and to hydraulic equipment.

Water Hammer

Water Hammer in Conduits Made Up of Truncated Cones (Sur les coups de bélier dans les conduites de diamètre variable et formées de parties tronconiques), G. Guilliaumin. Comptes rendus des séances de l'Academie des Sciences, vol. 168, no. 14, Apr. 7, 1919, pp. 723-726. Analytical. Conclusion is reached that oscillation period is either smaller or greater than $2\ \theta = 4\ l/a$ according as conduit diverges or converges up the stream.

Pressures in Penstocks Caused by the Gradual Closing of Turbine Gates, Norman R. Gibson. Proc. Am. Soc. Civ. Engrs., Papers and discussions, vol. 45, no. 4, Apr. 1919, pp. 173-206, 9 figs. Determined from Professor Joukovsky's theory of maximum water hammer. Solution of problem by trial-and-error method is first given, and then formulæ are derived that cover governor time and relation between stroke and gate movement.

Western Canada Plant

The Plant of the Western Canada Power Company, F. C. Perkins. Power House, vol. 12, no. 6, May 5, 1919, pp. 145-146, 1 fig. Hydro-electric plant operating at 125-ft. head.

See also MECHANICAL ENGINEERING, *Pumps (Hydraulic Pumps.)*

INTERNAL-COMBUSTION ENGINES

Atmospheric Conditions

Atmospheric Conditions Affecting Power, A. Johnson. Automobile Engr., vol. 9, no. 123, Feb. 1919, pp. 37-38, 3 figs. Table for estimating probable power and consumption of engine at elevations above sea level. Mathematical reasoning on which it is based is included.

Diesel Engines

Diesel Engines Prove Economical at Lincoln, O. J. Shaw. Elec. Ry. Jl., vol. 53, no. 19, May 10, 1919, pp. 902-905, 9 figs., also Power, vol. 49, no. 19, May 13, 1919, pp. 734-736, 4 figs. Maintenance cost figures obtained at plant where three 350-kw. Diesel units have been in service for more than two years in combination with steam equipment.

War Developments in Marine Oil Engines. Mar. Eng. & Can. Merchant Service Guild Rev., vol. 9, no. 4, Apr. 1919, pp. 140-141, 3 figs. Schneider 2150-i.hp. submarine Diesel engine, as used in French navy.

Engine Experiments

Engine Experiments, L. H. Pomeroy. Automobile Engr., vol. 9, no. 123, Feb. 1919, pp. 44-50, 11 figs. Influence of valve area, revolution speed, and combustion chamber design upon horsepower and thermal efficiency. Experiments made by Vauxhall Motors, Ltd., upon two 4-cyl. engines identical in design, save in arrangement of valves, which were of side-by-side type in one engine and overhead in the other.

Gas Engines

Large Horizontal Gas Engines in Modern Industry, H. Pilling. Gas & Oil Power, vol. 14, no. 164, May 1, 1919, pp. 109-119. Their application and working. Paper read before Cleveland Instn. of Engrs.

Heavy-Duty Car Engine

New Golden, Belknap & Swartz Engine for Trucks. Commercial Vehicle, vol. 20, no. 8, May 15, 1919, pp. 32-33, 4 figs. Four-cylinder model, designed to handle low-grade fuel.

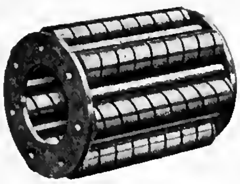
The 150 H. P. Ricardo Tank Engine, H. A. Hetherington. Automobile Engr., vol. 9, no. 126, May 1919, pp. 147-153, 27 figs. Cam details, governor arrangement, connecting-rod dismantling diagram, and table of general data. (Concluded.)

Oil Engine, Marine

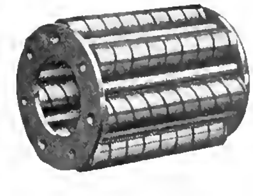
The Doxford Opposed-Piston Marine Oil Engine. Pac. Mar. Rev., vol. 16, no. 5, May 1919, pp. 106-108, 4 figs. Results obtained in tests on fuel economy and mechanical efficiency tried out under supervision of chief surveyor of Lloyds.

Rotary Engine

A Novel Rotary Engine. Autocar, vol. 42



ENGINEERING PRIDE



You, as an Engineer, feel a certain thrill in knowing that you are "utilizing the forces and materials of nature for the benefit of mankind."

You take pride in making things a little better than you found them—and in refining and improving existing designs—in producing better machines.

As an Engineer you owe it to yourself and to your profession to keep abreast of the times. Improvements in Engineering practice are constantly being made. Some of the principles learned at college must be revised in line with present day knowledge.

The modern trend in machine design is toward the universal use of anti-friction bearings. Are you still using the old style, power wasting, plain bearing? Are you penalizing a modern, carefully designed machine with old fashioned bearings?

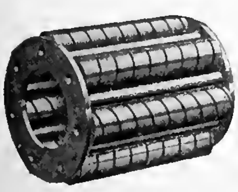
Hyatt Roller Bearings are anti-friction bearings that merit the careful consideration of every thinking Engineer, because they are designed and constructed according to sound, modern engineering principles and form a logical part of modern machinery.

Send for our latest engineering data.

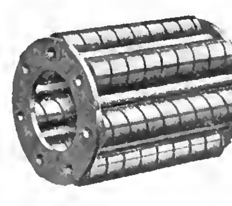
MOTOR BEARINGS DIVISION
DETROIT, MICH.

**HYATT ROLLER BEARING COMPANY
INDUSTRIAL BEARINGS DIVISION
METROPOLITAN TOWER, NEW YORK**

TRACTOR BEARINGS DIVISION
CHICAGO, ILL.



Manufacturers of Bearings for Mine Cars, Ore Cars, Steel Mill Cars, Roller Tables, Trolleys, Cranes, Hoists, Machine Tools, Line Shafts, Countershafts, Concrete Machinery, Textile Machinery, Conveyors, Lift Trucks, Industrial Trucks, Railway Service Cars, Storage Battery Locomotives, etc.



no. 1228, Apr. 1919, pp. 572-573, 2 figs. Power controlled by varying mass of charge and combustion space in invention of P. H. Gergasse, Sussex, England.

See also AERONAUTICS, Engines.

LUBRICATION

Submerged Governor Pins

Operation at Holtwood. Charles H. Bromley. Power, vol. 49, nos. 19 & 20, May 13 & 20, 1919, pp. 713-715, and pp. 770-776, 24 figs. Lubrication of submerged pins in governor operating mechanism. Record-keeping forms and follow-ups.

MACHINE ELEMENTS AND DESIGN

Ball Bearings

Ball Bearings and Haulage Economies. Arthur Hall. Iron & Coal Trade Rev., vol. 98, no. 2669, Apr. 25, 1919, p. 512, 2 figs. Test made at South African mines.

MACHINE SHOPS

Cylinder Grinding

Cylinder Grinding. Machy. (Lond.), vol. 14, no. 343, Apr. 24, 1919, pp. 93-99, 13 figs. Advantages of finishing cylinder bores by grinding; machines and auxiliary equipment used; practice in different plants manufacturing engines for automobiles and airplanes. (First article.)

Cylinder Machinery

Operations on the Liberty Motor Cylinders—II. H. A. Carhart. Am. Mach., vol. 50, no. 21, May 22, 1919, pp. 985-991, 14 figs. Information as to speeds, etc., in machining operations.

Jigs and Tools

Jigs, Tools, and Special Machines, with Their Relation to the Production of Standardised Parts. Herbert C. Armitage. Engineering, vol. 107, no. 2778, Mar. 28, 1919, pp. 402-406, 10 figs., also Eng. & Indus. Management, vol. 1, no. 10, Apr. 17, 1919, pp. 301-306, 11 figs. (2d article.) Advantages claimed are interchangeability of work, cheapening of production, ability to use less-skilled class of labor, elimination of fittings and introduction of assembling methods. (To be continued.)

Templets, Jigs and Fixtures. Joseph Horner. Engineering, vol. 107, nos. 2777 & 2781, Mar. 21 & Apr. 18, 1919, pp. 367-370 & 493-497, 39 figs. Fixtures for use on plain millers, made by Kempsmith Mfg. Co., Milwaukee, Wis. Multiple drilling machines constructed by Moline Tool Co., Moline, Ill. (Continuation of serial.)

Milling and Drilling Motor Parts

Machining a Six-Cylinder Motor—I & II. J. V. Hunter. Am. Mach., vol. 50, nos. 18 & 19, May 1 & 8, 1919, pp. 851-853 & 887-890, 17 figs. Milling and drilling operations followed by Falls Motor Corp. of Sheboygan Falls, Wis. Milling motor parts in multiple.

Threads, Metric

Metric Threads. Theodore Chaundy and T. H. Plummer. Engl. Mechanic & World of Sci., vol. 109, no. 2823, May 2, 1919, pp. 172-173. Rules for cutting them on English lathes. From Ministry of Munitions Jl.

Trays, Wrench Holders and Pans

Arranging Trays, Wrench Holders and Pans on Machine Tools. F. Scriber. Can. Machy., vol. 21, no. 20, May 15, 1919, pp. 487-489, 18 figs. Examples of various types and discussion of their advantages.

MACHINERY, METAL-WORKING

Cast Cutting Tools

Casting Cutting Tools from Crucible Steel. J. E. Johnson, Jr., Junior Foundry, vol. 47, no. 320, Apr. 1, 1919, pp. 162,164, 7 figs. Micro-photographs made by Davidson process.

Cylinder Boring and Reaming Tools

Cylinder Boring and Reaming Tools. Machy (Lond.), vol. 14, no. 342, Apr. 1919, pp. 61-68, 28 figs. Types and designs of cutter heads and reamers used for rough boring and reaming small engine cylinders.

Lathe Tools

Capstan Lathe Tools. I. E. W. Field and A. E. Simpson. Machy. (Lond.), vol. 14, no. 345, May 8, 1919, pp. 173-175, 10 figs. Deals with spring-collet or split-jaw type of chuck, particularly design of H. W. Ward & Co., Birmingham. Paper read before Coventry. Eng., Soc.

Some Fittings and Attachments to a 5-in. S. C. Lathe for Repetition Work. T. W. Averill. Model Engr & Elecn., vol. 40, no. 938, Apr. 17, 1919, pp. 275-282, 20 figs. Reduction gear and clutch for actuating lead screw to obtain self-acting sliding motion.

Lathes

The New Drummond Lathes. Machy. (Lond.), vol. 14, no. 345, May 8, 1919, pp. 153-158, 13 figs. Special reference is made to manner of testing, truth of fast headstock in relation to center axial line, relative height of center, cam action in chuck, cam action in lead screw and lead-screw pitch.

Machine Tools

Machine Tools. Alfred Herbert. Engineering, vol. 107, no. 2776, Mar. 14, 1919, pp. 355-358. Their development in recent years, with special reference to present tendencies to standardization. Paper before North East Coast Instn. of Engrs. & Shipbuilders.

Milling Machines

The Becker Model D-1 Vertical Milling Machine. Am. Mach., vol. 50, no. 18, May 1, 1919, pp. 825-827, 3 figs. Designed to permit pieces of work weighing up to 10 tons being carried and machined on work table.

The New Cincinnati No. 5, High Power Milling Machine. John H. Van Deventer. Am. Mach., vol. 50, no. 21, May 22, 1919, pp. 971-976, 14 figs. Tool specially designed for quantity production.

MACHINERY, SPECIAL

Coke-Quenching, Screening and Loading Machine

Coke Quenching, Screening and Loading Machine. Gas World, vol. 70, no. 1811, Apr. 5, 1919, pp. 12-13, 1 fig. Machine consists of water-jacketed steel receptable, slightly larger than the coke oven, and mounted on steel-framed traveling structure running on rails. Endless chain conveyor propels charge of incandescent coke into receptacle without exposure to air.

Rolls

Design of Rolls for Making Ship and Boiler Plates. Machy. (Lond.), vol. 14, no. 342, Apr. 17, 1919, pp. 68-71, 4 figs. Drafts of slabbing and plate-mill rolls; universal mill; surface speed of rolls; rolling tin plate.

Separators, Centrifugal

Continuous Centrifugal Separation Machines. Engineering, vol. 107, no. 2776, Mar. 14, 1919, pp. 354-355, 7 figs. South African type which consists essentially of two bottomless buckets or vertical cylinders, revolving rapidly in a frame, around an upright spindle, each having an independent revolution on its own axis.

The Mauss Centrifugal Separators. E. M. Weston. Eng. & Min. Jl., vol. 107, no. 20, May 17, 1919, pp. 862-863, 6 figs. Type used for separation of colloids from slimes, particularly tin-ore slimes, consists of two bottomless buckets or vertical cylinders revolving rapidly in a frame around an upright spindle at a rate, for treatment of tin slimes, of 700 to 800 r.p.m.

See also MARINE ENGINEERING, Ships (Turbine Machinery).

MATERIALS OF CONSTRUCTION AND TESTING OF MATERIAL

Brass

The Effect of Work on Metal and Alloys. Owen Wm. Ellis. Metal Industry, vol. 14, no. 14, Apr. 4, 1919, pp. 284-288, 13 figs. Effect of reduction by rolling on alpha-beta brass determined by subjecting to deformation in the rolls a casting of 61:39 brass containing traces of impurities and having had no prior treatment.

Cement

Why Materials of Construction Should Be Tested Prior to Their Use. Emmanuel Mavant. Mun. & County Eng., vol. 53, no. 5, May 1919, pp. 184-186. Argues that cement should not be considered as standard material because there is always a possibility, even though remote, of its coming out too fresh, too high in sulphuric anhydride, in magnesia or too low in specific gravity.

China and Semi-Porcelain

Impact Tests and Porosity Determinations on some American Hotel China and Semi-Porcelain Plates. Homer F. Staley and J. S. Hromatko. Jl. Am. Ceramic Soc. vol. 2, no. 3, Mar. 1919, pp. 227-240, 6 figs. Vitrified hotel china plates tested were not found superior as a class to semi-porcelain plates in resistance to heavy impact blows; however, they are said not to have chipped with light blows, while semi-porcelain did. No direct relation was believed to be discernible between porosity and resistance to impact.

Cloth

Notes on the Quantitative Testing of Rain-proof and Waterproof Cloth. Geoffrey Martin and James Wood. Jl. Soc. Chem. Indus., vol. 38, no. 7, Apr. 15, 1919, pp. 84T-87T, 2 figs. Six ways of waterproofing are mentioned, and methods of determining which of these has been applied to given cloth are indicated.

Copper

The Influence of Cold-Rolling upon the Mechanical Properties of Oxygen-Free Copper. F. Johnson. Metal Indus. (Lond.), vol. 14, no. 14, Apr. 11, 1919, pp. 297-302, 14 figs. Method adapted to obtain sound piece of pure copper was to melt copper in graphite crucible under layer of fine charcoal, adding further portions step by step until crucible was full of molten copper. When solidified, metal was heated to 900 deg. cent. and forged on anvil. Results of tensile tests are tabulated and figures of maximum breaking load. Paper read before Inst. Metals.

Deformation of Cast Iron in Bending

Observations of Elastic and Permanent Deformations in Testing Cast-Iron and Steel Bars (Observations de déformations élastiques et permanentes dans les essais de flexion sur barreaux en fonte et en acier). J. Seigle. Bulletin l'Industrie Minérale, series 5, vol. 15, first issue of 1919, pp. 87-126, 30 figs. Characteristics of elastic curves of various specimens. Curves were drawn from values obtained in tests.

Fatigue of Metals

The Fatigue of Metals. H. F. Moore. Jl. Engrs. Club, Philadelphia, vol. 36-4, no. 173, Apr. 1919, pp. 138-142, 19 figs. Photomicrographs of specimens before and after stressing; proposed formula for failure-stress calculations; test data of repeated-stress tests.

Fuel Oil

Physical Tests of Fuel Oil. John W. Newton and F. N. Williams. Petroleum Age, vol. 6, no 5, May 1919, pp. 189-191. Discussion of various tests and apparatus required in laboratory with reference to U. S. Navy specifications for fuel oil. Third article.

Galvanized Sheets

Selection of Galvanized Sheets. Raw Material, vol. 1, no. 2, Apr. 1919, pp. 144-146, 5 figs. Concludes that from results of experiments and work done in commercial mill operations, the factors that are active in producing small granular spangles in galvanizing have their origin in the open-hearth process; and these causes can be eliminated only when sufficient care is taken to produce a steel substantially free from oxide.

Impact Testing Machine

The Eden-Foster Repeated Impact Testing Machine. Machy. (Lond.), vol. 14, no. 343, Apr. 24, 1919, pp. 105-109, 11 figs. Machine attempts to combine effect of vibration test and impact test by subjecting specimen to both shock and reversal of stress.

Mica

Raw Materials Needed in the Electric Industry. Mica (De quelques matières premières nécessaires à l'industrie électrique. Le Mica). Desiré Pector. Revue Générale de l'Electricité, vol. 5, no. 18, May 3, 1919, pp. 673-678. Location of mica deposits in the world; crystallization of various kinds of mica. (Continuation of serial.) Preceding articles appeared in R. G. E., vol. 4, July 20 & 27, 1918, pp. 87 and 121.

Porcelain (see also China)

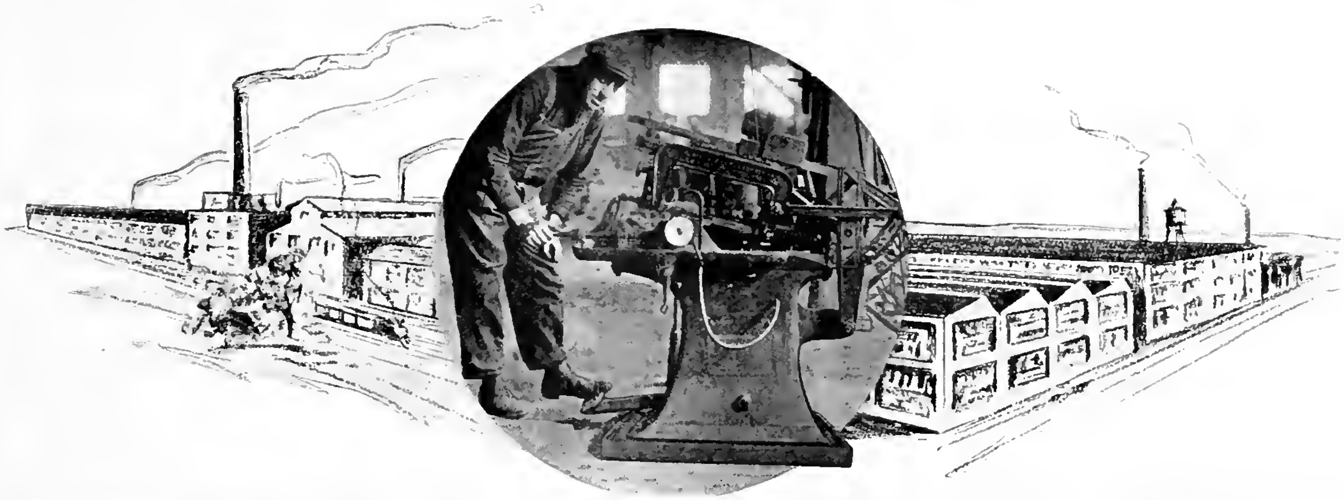
The Effect of Time and Temperature on the Microstructure of Porcelain. Albert B. Peck. Jl. Am. Ceramic Soc., vol. 2, no. 3, Mar. 1919, pp. 175-194, 15 figs. Petrographic microscopic examination reported as showing that quite dissimilar bodies can be produced by holding porcelain at a constant temperature for lengths of time which lie within variations of commercial practice, clay passing into amorphous silica and sillimanite which in turn passes into crystallized sillimanite.

Resistance of Materials

The Resistance of Materials—III. G. S. Chiles and R. G. Kelley. Ry. Mech. Engr., vol. 93, no. 5, May 1919, pp. 241-243, 7 figs. Effect of sudden or abrupt changes in section on the distribution of the unit stress. Rubber specimens having cross rulings in white ink were subjected to stresses; diagrams of resulting distortions in rulings are shown.

Rubber (see also Resistance of Materials)

The Tensile Strength of Rubber-Sulphur Mixtures. O. de Vries and H. J. Hellendoorn. Jl. Soc. Chem. Indus., vol. 38, no. 7, Apr. 15, 1919, pp. 91T-93T, 4 figs. Stress and strain curves on Schopper testing machine.



Starrett Hack Saws

are more than just hack saws—each blade is a cutting tool especially designed to cut one or more kinds and shapes of metal most economically.

It's only a small shop with a wide range of miscellaneous work and very frequent changes that can afford to use one hack saw blade to cut every kind of metal.

The big concerns, cutting quantities of metal, work the Starrett way. They standardize by specializing because they've found it cheaper in cost per cut.

Follow the Starrett Hack Saw Chart LD and watch your cutting costs go down.

The L. S. Starrett Co.

THE WORLD'S GREATEST TOOLMAKERS
MANUFACTURERS OF HACK SAWS UNEXCELLED

Athol, Mass.

NEW YORK LONDON CHICAGO

STARRETT HACK SAWS CUT QUICKER LAST LONGER

42-934

X-Ray Examination of Materials

The Examination of Materials by X-Rays. Engineering, vol. 107, no. 2783, May 2, 1919, pp. 576-578, 1 fig. General discussion held at joint meeting of Faraday Soc. and Rontgen Soc.

MEASUREMENTS AND MEASURING APPARATUS

Dilatations, Measurements of

The Use of the Interferometer in the Measurement of Small Dilatations or Differential Dilatations, C. G. Peters. Jl. Wash. Acad. Sciences, vol. 9, no. 10, May 19, 1919, pp. 281-284. Equations for determining changes in length observable with dilatometer originated by Fizeau.

Flow Meters

Petrol Flowmeters and the Calibration of Jets, G. Smith-Clarke. Automobile Engr., vol. 9, no. 126, May 1919, pp. 140-146, 19 figs., also Automotive Industries, vol. 40, no. 21, May 22, 1919, pp. 1110-1113, 2 figs. Instruments devolved under specifications of standardization, requiring all jets to be calibrated under constant head of 100 cm. and stamping number upon jets indicating quantity of gasoline in cubic centimeters passed through in 1 min.

Fluid Pressure and Velocity

The Measurement of Fluid Velocity and Pressure, J. R. Pannell. Engineering, vol. 107, nos. 2776, 2777, 2778, Mar. 14, 21 & 28, 1919, pp. 333-334, 364-366, and 394-398, 23 figs. Hot-wire anemometers. Direction and velocity meter. Manometers and hydrometers. (Concluded.)

Kata-Thermometer

On the Cooling and Evaporative Powers of the Atmosphere, as Determined by the Kata-thermometer, Leonard Hill and D. Hargood-Ash. Proc. Roy. Soc., Series B., vol. 90, no. B. 632, Apr. 1, 1919, pp. 438-444, 3 figs. In observations taken the kata-thermometer was heated in hot water in a thermos flask, being kept in water till the air space at top was about half full of alcohol. For theory and use of kata-thermometer see Phil. Trans. (B, vol. 207, 1916, pp. 183-220.)

Moisture and Gases

Device for Measuring Small Quantities of Moisture in Gases, A. J. Crockatt and R. B. Forster. Jl. Soc. Chem. Indus., vol. 38, no. 8, Apr. 30, 1919, Trans. pp. 95T-96T, 1 fig. Fiber principle; chardonnet silk used.

Optical Methods of Measurement

Measuring to the Millionth Part of an Inch, Robert L. Clegg. Iron Age, vol. 103, no. 21, May 22, 1919, pp. 1345-1348, 8 figs. Optical method used by U. S. Bureau of Standards and other similar optical methods.

Snow Samplers

The Measurement of Snow, Robert E. Horton. Can. Engr., vol. 36, no. 18, May 1, 1919, pp. 426-427, 5 figs. Description of various samplers.

Scales

The Effect of Distance Between the Knife Edges on the Errors of Scales, C. A. Briggs. Scale Jl., vol. 5, no. 8, May 10, 1919, pp. 7-9, 4 figs. Assuming distance between load knife edge and fulcrum knife edge is changed by circumstances of rust or wear, or by error of construction, the resulting error in indication of scale is considered to depend on distance between knife edges and not on nominal multiplication of levers.

Spherometry

Refinements in Spherometry, G. W. Moffitt. Physical Rev., vol. 13, no. 4, Apr. 1919, pp. 261-271, 8 figs. Precision in mechanical methods is asserted to decrease rapidly as radius becomes larger; by auto-collimating method, up to limit of slide on turntable, precision is said to be high and independent of radius; methods are found to possess high degree of precision of measurement for concave surfaces of any radius and for measurement of convex surfaces to decrease in precision with increase of radius.

Tintometer

Estimation of Cyanogen Compounds in Concentrated Ammonia Liquor, Percy E. Spielmann and Henry Wood. Chem. News, vol. 118, no. 3077, Apr. 4, 1919, pp. 157-159. Calorimetric method employing the Lovibond tintometer.

Viscosity of Gasoline

Viscosity of Gasoline, Winslow H. Herschel. Technol. Papers of Bur. Standards, no. 125, May 5, 1919, 18 pp., 4 figs. Method of judging volatility and viscosity of gasoline by density is considered as only a rough approximation and measurement of fluidity by Ubbelohde viscosimeter is estimated as a preferable criterion.

MECHANICS

Cables, Suspended

Laying Aerial Lines (La pose des lignes aériennes), Emile Piérard. Société Belge des Electriciens, vol. 33, Jan.-Mar. 1919, pp. 10-40, 10 figs. Cloeren and Barbaret formulæ for determining tension in suspended cable. Writer proposes stretching to one-fourth ultimate strength at — 15 deg. cent.

Columns

Strength of Various Long Columns, William Jackson. Can. Engr., vol. 36, no. 21, May 22, 1919, pp. 467-468, 1 fig. Formulæ said to have been derived from results of a large number of tests on columns.

Plates

Maximum Tension in Square Plate Carrying Load Concentrated at Center (Valeurs maxima de la tension près de la face inférieure d'une plaque carrée supportant une charge unique concentrée en son centre), M. Mesnager. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 8, Feb. 24, 1919, pp. 392-395. Mechanical theory of plate supported at its periphery, taking into account thickness of plate.

Stresses in Beams and Trusses

Ladders, Robt. T. Reddy. Fire & Water Eng., vol. 65, no. 21, May 21, 1919, pp. 1133-1135, 10 figs. On the manner of using a truss ladder of form used by fire departments. Remarks based on theory of stresses in beams and trusses.

Stresses in Machines

Stresses in Machines When Starting and Stopping—V. F. Hymans. Automotive Eng., vol. 4, no. 4, Apr. 1919, pp. 189-190, 6 figs. Energy equations and mathematical calculations developed from consideration of forces on machine-tool parts without assuming that they are either at rest or in motion.

Trajectories

Formulæ of Trajectories (Sur les formules représentatives des trajectoires), M. Risser. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 8, Feb. 24, 1919, pp. 390-392. Parameters of compensating hyperbola.

MECHANICAL PROCESSES

Barrels, Steel

Manufacture of Steel Barrels. Machy. (Lond.), vol. 14, no. 342, Apr. 17, 1919, pp. 72-76, 12 figs. Blanking barrel heads, bending sheets for bodies; welding, flanging, brazing, bilging, pickling and testing.

Boilers

How to Design and Lay Out a Boiler—VII, Wm. C. Strott. Boiler Maker, vol. 19, no. 5, May 1919, pp. 137-139, 3 figs. Calculations for design of girth seams; layout of tubes; location of fusible plug and water-gage glass. (To be continued.)

Flues—II, George L. Price. Boiler Maker, vol. 19, no. 5, May 1919, pp. 128-130, 8 figs. Kinds of tools used on flue work and reasons for using them.

Chuck Manufacture

Universal Chuck Manufacture. Machy. (Lond.), vol. 14, no. 343, Apr. 24, 1919, pp. 101-104, 16 figs. Methods employed by F. Pratt & Co., Ltd., Halifax.

Crankshafts

Manufacture of Crank-Shafts for Aeroplane Engines, Richard Vosbrink. Metal Trades, vol. 10, no. 5, May 1919, pp. 219-221, 10 figs. Specifications require that pins and journals must be to size within plus or minus 0.0005 in.; other similar examples are quoted to indicate accuracy required.

Drawing Steel

Making Cold-Drawn Screw and Shaft Stock, Robert E. Clegg. Iron Age, vol. 103, no. 18, May 1, 1919, pp. 1129-1131, 5 figs. Factory of New England Drawn Steel Co. at Mansfield, Mass. Product is 3/16 in. to 1½ in. shafting and screw stock, rounds, hexagons and other shapes in cold-drawn free-cutting material.

Files

Some Points in the Manufacture of Files, Geo. Taylor. Iron & Steel Inst., Ann. Meeting, May 8 & 9, 1919, no. 15, 34 pp., 29 figs., also abridged, Iron & Coal Trades Rev., vol. 98, no. 2671, May 9, 1919, pp. 584-588, 12 figs. Pleads for definite and organized system of working in manufacture of files, such as will insure reliable quality of steel and production of blanks of uniform size and quality.

Gears

Gear Plant Makes War Record. Iron Trade Rev., vol. 64, no. 15, Apr. 10, 1919, pp. 947-952, 12 figs. How Falk Co. of Milwaukee organized for mass production of reduction gear sets for destroyers and cargo boats.

Hosiery Machinery

Manufacturing Banner Hosiery Machine—IV, Robert Mawson. Can. Machy., vol. 21, no. 20, May 15, 1919, pp. 481-483, 6 figs. Manufacturing operations on frames.

Liberty Motor Parts, Production of

Production of Liberty Motor Parts at Ford Plant, W. F. Verner. Mech. Eng., vol. 41, no. 6, June 1919, pp. 517-522 & 556, 11 figs. Describes process of forging cylinders from high-carbon steel tubing; also the 21 machining operations on bronze babbitt-lined crankshaft bearings. Paper for Spring Meeting of A.S.M.E.

Marine Engines

Building Marine Engines on a Quantity Basis, F. B. Jacobs. Mar. Rev., vol. 49, no. 6, June 1919, pp. 273-282, 13 figs. Hooven, Owens, Rentschler Co. of Hamilton, O., said to be completing four 2800-hp. 3-cyl., triple-expansion, inverted-type marine engines per week. First article of a series, dealing with heavy units such as cylinders, crankshafts, bed plates, connecting rods, etc.

Milling-Machine Manufacture

Special Operations in Milling Machine Manufacture, F. B. Jacobs. Iron Trade Review, vol. 64, no. 14, Apr. 3, 1919, pp. 893-896, 13 figs. Seasoning of castings accomplished by exposing them to weather for a number of weeks, during which time they expand and contract with change in temperature from midday to midnight.

Rolling Mills

19,000-Hp. Electric Reversing Rolling Mill Equipment. Engineer, vol. 127, no. 3301, Apr. 4, 1919, pp. 334-336, 6 figs. Motor comprises three units rigidly coupled together and mounted on common bedplate.

New Steel Works Built in England, Joseph Horton. Iron Trade Review vol. 64, no. 14, Apr. 3, 1919, pp. 879-883, 5 figs. Arrangement of 36-in. blooming mill and 21- and 18-in. bar mills at Phoenix Special Steel Works, Sheffield.

Pointers on the Designing of Wire Rod Mills, W. S. Standiford. Can. Machy., vol. 21, no. 18, May 1, 1919, pp. 426-429, 4 figs. Design of roll passes developed for manufacture of wire used in entanglements in front of trenches.

Vise Manufacture

How the Reed Vise is Made, J. V. Hunter. Am. Mach., vol. 50, no. 20, May 15, 1919, pp. 923-926, 14 figs. Machining operations used by Reed Mfg. Co., Erie, Pa., especially in regard to obtaining interchangeability of parts.

MOTOR-CAR ENGINEERING

Daimler

The Daimler 2-3 Tonner. Motor Traction, vol. 28, no. 739, Apr. 30, 1919, pp. 373-375, 7 figs. Specifications: 22.4-hp., 4-cyl., sleeve-valve engine; gross loaded weight allowable, 5½ tons; four forward and one reverse speeds; overhead worm.

Gazelle

The 8-hp. Gazelle. Autocar, vol. 42, no. 1227, Apr. 26, 1919, pp. 616-618, 6 figs. Four-cyl. French car. Some of specifications are: forced lubrication, 3-speed gear box, and bevel-driven back axle.

Military Trucks

Military Transport Chassis—XI & XIV. Automobile Engr., vol. 9, nos. 123 & 126, Feb. 1919, and May 1919, pp. 39-42 & 137-139, 9 figs. Performance of Kelly Springfield K 40 (3½ ton) and Packard "4D" truck under war conditions.

Tractor Engines

Fuel Limitations of Tractor Engines, H. L. Horning. Automotive Industries, vol. 40, no. 19, May 8, 1919, pp. 1001-1003 and 1043. Hints on overcoming common troubles. Paper read before Soc. Automotive Engrs.

See also MUNITIONS AND MILITARY ENGINEERING *(Automobile Service, French)*; ORGANIZATION MANAGEMENT, *Factory Management (Repair Shop, Automobile.)*

POWER GENERATION

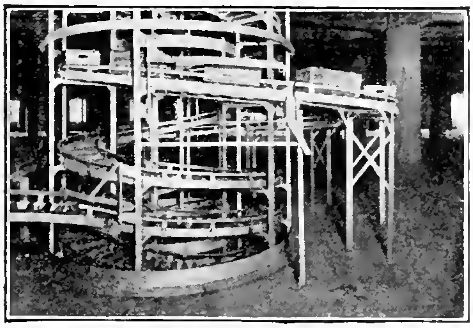
Delivery and Relative Fall Determination

Utilization of Hydraulic Energy (Programme d'étude pour l'aménagement des forces hydrauliques), R. de la Brosse. Houille Blanche, vol. 18, no. 25-26, Jan.-Feb. 1919, pp. 1-5. How to determine delivery and relative fall; their sig-

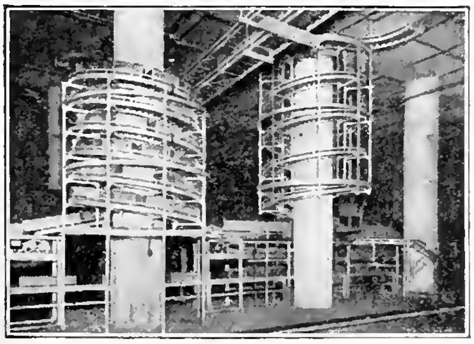
Lamson Conveyors

Flowing out of cars past inspectors

To upper floors via overhead space



Switched into storage on any floor



Flowing storage above car platform and direct distribution to cars

Human Hands Never Lift BEVO Cases

THE Lamson Conveying System installed in the Anheuser-Busch Bevo plant is a typical example of the way Lamson eliminates manhandling — trucking or carrying — throughout a factory.

In the Bevo plant, Lamson Conveyors set the pace for a continuous flow of production without aid by human hands. From the time Bevo cases are first placed on Lamson Conveyors until they flow to storage or freight cars, they are never lifted by human hands. While Bevo bottles are being washed, filled, capped, labeled, and inspected, Bevo cases are conveyed at a pace regulated to the capacity of each machine and each operator. No time is lost in waiting for cases to come along, in stooping, or in reaching. Lamson Conveyors see to it that Bevo cases always arrive on schedule time.

Lamson Conveying Systems are as varied as industry itself, yet each one is largely or wholly made up from a few standard units. Lamson Conveyors increase production and cut down costs; they save floor space, stop congestion and confusion; they bring about a new conception of "full capacity." With post-war labor and cost conditions they are economic necessities.

The Lamson Booklet on Conveying will be sent on request, or our nearest representative will be glad to call. It involves no obligation.

THE LAMSON COMPANY

100 BOYLSTON ST., BOSTON, MASS.

Boston	100 Boylston Street	Denver	1622 Arapahoe Street
New York	15 West 44th Street	St. Louis	709 Pine Street
Philadelphia	1200 Walnut Street	Seattle	215 Stewart Building
Pittsburgh	319 Third Avenue	San Francisco	617 Mission Street
Rochester	194 Main Street East	Los Angeles	627 South Broadway
Detroit	97 Woodward Avenue	Dallas	905½ Elm Street
Cleveland	2063 East 4th Street	Baltimore	Equitable Building
Cincinnati	119 East 5th Street	New Orleans	124 St. Charles Street
Indianapolis	Illinois & Washington Streets	Atlanta	30 Moore Building
Chicago	6 North Michigan Avenue	Toronto	136 Simcoe Street
Minneapolis	221 Tribune Annex	Montreal, Jones & Glassco, Reg'd., St. Nicholas Building	
Omaha	Brandeis Building, Room 678	Vancouver, B. C.	603 Hastings Street

LAMSON SERVICE

nificance in calculation of available energy. Reference is made by way of illustration to region of Pyrenées and central basin of France.

New England

War-Time Service Problems in New England. Elec. World, vol. 73, no. 20, May 17, 1919, pp. 1007-1019, 31 figs. Details of plant growth, connected load and enforced economies are presented as factors which have contributed to establish reliability of central station service.

New South Wales

White Bay Power Station of the New South Wales Railways, O. W. Brain. Tramway & Ry. World, vol. 45, no. 18, Apr. 10, 1919, pp. 177-186, 6 figs. Plant supplies traction current for Sydney's tramways and also furnishes electric power for railway and tramway workshops, and various auxiliary services of department throughout metropolis, including signaling system, elevators, conveyors, lifts, pumps, air compressors, etc. Paper read before Elec. Assn. of Australia.

New Zealand

Hydro-Electric Development of New Zealand, E. Parry. Elec. Times, vol. 55, no. 1436, Apr. 24, 1919, pp. 259-260, 1 fig. Report of chief electrical engineer to Minister of Public Works.

Niagara Falls

Niagara Falls a War-Load Center. Elec. World, vol. 73, no. 20, May 17, 1919, pp. 996-1000, 4 figs. How electrochemical and electrometallurgical loads were helped by interconnection of power.

Norway

Utilization of Water-Power in Norway (Statens forhold til vandkraften). Teknisk Ukeblad, vol 66, no. 11, Mar. 14, 1919, pp. 156-160. For domestic heating, lighting and power purposes in place of imported coal. Comparison of costs.

Pacific Coast

Pacific Coast Plants Fully Loaded. Elec. World, vol. 73, no. 20, May 17, 1919, pp. 1031-1037, 12 figs. Interconnection of system is claimed to have enabled Western companies to carry increased loads despite lack of hydroelectric development.

Southern States

How the South Handled War-Time Loads. Elec. World, vol. 73, no. 20, May 17, 1919, pp. 1022-1030, 12 figs. Extensions and interconnections of transmission lines, particularly installation of reserve steam plant by Alabama Power Co.

Tennessee

The Larger Undeveloped Water-Powers of Tennessee, J. A. Switzer. State of Tenn. Geol. Survey, bul. 20, 1918, 35 pp., 30 figs. Description of existing plants and scheme for the utilization of available energy. Paper presented before Am. Electrochemical Soc.

United States

The Question of Hydro-Electric Development, D. H. Colcord. Elec. Eng., vol. 53, no. 2, Feb. 1919, pp. 59-63, 4 figs. Estimate of undeveloped resources in the U. S. A. is considered as 60,000,000 hp. Economic and other causes affecting development in various sections are mentioned.

POWER PLANTS

Boiler Efficiency

Graphic Calculation of Boiler Efficiency, Ralph E. Turner. Power Plant Eng., vol. 23, no. 10, May 15, 1919, pp. 450-451, 4 figs. Chart for calculating combined boiler and furnace efficiency when feed water is measured in cubic feet or pounds.

Boiler Room, Air Supply for

The Air Supply to Boiler Rooms, Richard W. Allen. Tran Inst. Marine Engrs., vol. 30, no. 241, Mar. 1919, pp. 347-387, 38 figs. Report of investigation conducted in various vessels where closed stokehole systems had been adopted.

Boiler Supports

Reinforced Concrete Supports for Horizontal Tubular Boilers, H. E. Dart. Locomotive, Hartford Steam Boiler Inspection & Insurance Co., vol. 32, no. 5, Jan. 1919, pp. 130-142, 4 figs. Reinforced concrete is preferred for supporting suspended boilers because it is said that all of the material used (including reinforcing rods, lumber for forms, cement, sand, stone and water) are much more easily obtainable than structural-steel shapes and cast-iron columns and there is no delay in waiting for any of them to be fabricated.

Condensers

Notes on Surface Condensing Plants, with Special Reference to the Requirements of Large Power Stations, R. J. Kaula. Eng. & Indus Management, vol. 1, no. 2, Apr. 24, 1919, pp. 342-346, 4 figs., also Elecn., vol. 82, no. 17, Apr. 25, 1919, pp. 488-490, 3 figs., and Engineering, vol 107, no. 2781, Apr. 18, 1919, pp. 522-524, 5 figs. Deals with problem of tube erosion. Advantage to be derived on siphonic circulating water system by adopting parallel-flow principle. Paper presented before Instn. Elec. Engrs.

Hotel Plants

Plant of the Hotel Traymore. Power, vol. 49, no. 20, May 20, 1919, pp. 760-762, 5 figs. Plant comprises six 200-hp. water-tube boilers in three batteries. Building is heated with exhaust steam.

Electric and Elevator Equipment of the Hotel Pennsylvania, Chas. E. Knox. Power, vol. 49, no. 19, May 13, 1919, pp. 708-712, 8 figs. After studying possible methods of supply it was agreed upon to purchase steam and electricity from Pennsylvania R. R. and to install only a single engine-driven 500-kw. electric generator to be run during winter months, exhaust being used for heating and hot-water supply.

Oil-Fuel Plants

Economy of Arizona Power Plants Using Oil Fuel, C. R. Weymouth. Mech. Eng., vol. 41, no. 6, June 1919, pp. 523-526, 3 figs. Tables and curves of operating characteristics of three plants, embodying various similar features, but differing in methods of condensing, are presented. Paper for Spring Meeting of A. S. M. E.

Plants

Power Installation at the Old Hickory Powder Plant near Nashville, Tennessee. Power, vol. 49, no. 20, May 20, 1919, pp. 748-755, 8 figs. Equipment includes sixty-eight 823-hp. boilers, fifty-two 350-hp. engines, 17,500-kw. in turbo-generators and 13 ammonia compressors driven by uniflow engine.

Power Plant Installation of the Braden Copper Co. at Rio Pangal, Chile (Instalación de fuerza motriz para la Braden Copper Co. en Rio Pangal, Chile), H. L. Cooper. Ingeniería Internacional, vol. 1, no. 2, May 1919, pp. 77-80, 5 figs. Details of hydroelectric plant with special reference to conduits.

Prime-Mover Plants

Tendencies in Prime-Mover Practice. Elec. World, vol. 73, no. 21, May 24, 1919, pp. 1106-1109, 4 figs. Advises that continuous service be safeguarded as steam turbines of great size are adapted.

Pulverized-Coal Plant

Equipment for Using Pulverized Coal. Can. Mfr., vol. 39, no. 5, May 1919, pp. 40-42. Features of distributing system and waste-heat boilers at plant of Armstrong, Whitworth Co. of Canada, Ltd., at Longueuil, P. Q.

Steel-Mill Plants

Steel-Mill Electric Drive—Present Status and Recent Developments, Brent Wiley. Elec. Rev., vol. 74, no. 19, May 10, 1919, pp. 737-740, 6 figs. One of noteworthy features of recent practice described is selection of large-size turbine units and a more liberal policy to provide for general plant electrification; this is approved on the ground that water rate of large-size turbines is materially better than for size of units formerly selected for mill use.

Superheaters

Superheaters at Collieries, Edward Ingham. Colliery Guardian, vol. 117, no. 3045, May 9, 1919, pp. 1084-1085. In order to avoid unnecessary blowing off, writer believes superheater safety valve, which he recommends as a safety measure, should be loaded to pressure a few pounds in excess of that to which boiler safety valve is loaded.

Turbo Generators

A Big Turbine-Generator Equipment, J. P. Rigsby. Elec. Eng., vol. 53, no. 4, Apr. 1919, pp. 156-159, 1 fig. Westinghouse cross-compound double unit, 45,000 kw. type, installed in power station of Narragansett Electric Light Co., Providence, R. I.

Sixty Thousand-Kw. Turbine Installation, W. S. Finlay. Elec. Jl., vol. 16, no. 5, May 1919, pp. 172-182, 24 figs. Features specially proposed in design of scheme were concentration of auxiliary equipment and piping to provide ready access to machinery, valves, etc., placing auxiliaries within reach of cranes to facilitate dismantling and overhauling during off-peak hours, and avoiding right-and left hand arrangements in auxiliary units in order to reduce necessary stock of spare parts.

See also MINING ENGINEERING, Mines and Mining (Power Plants); MARINE ENGINEERING, Ships (Boilers).

POWER TRANSMISSION

Belting

Relative Efficiency of Different Kinds of Belting, E. W. Bowman. Wood-Worker, vol. 38, no. 3, May 1919, p. 40, 1 fig. Chart of horsepower slip curves obtained from comparative tests.

Motor Location

Effective Transmission Most Essential to Economy, J. H. Rodgers. Power House, vol. 12, no. 6, May 5, 1919, pp. 147-154, 18 figs. Location of motor drive about midway of shaft length claimed to minimize shaft torque.

PRODUCER GAS

Gas Producers

Practical Operation of Gas Producers, J. S. M'Climon. Blast Furnace & Steel Plant, vol. 7, no. 5, May 1919, pp. 230-233, 4 figs. Methods of measuring fire. Generating of hot and cold gas; steam requirements. Purpose of article is to offer method for systematizing operating conditions in ordinary plant.

PUMPS

Corrosive Liquors, Pumping

Pumping Corrosive Liquors. Engineering Review, vol. 32, no. 10, Apr. 15, 1919, pp. 296-297, 2 figs. Pumps made of "ceratherm." This material is an earthenware composition said to be insensible to sudden changes of temperature.

Hydraulic Pumps

Steel Works Machinery. Engineering, vol. 107, no. 2783, May 2, 1919, pp. 567-569, 5 figs. Typical battery of hydraulic pumps. Features taken up are driving motor, working pressure, single-reduction gear with double helical machine-cut teeth, valve chambers and pump barrels of forged steel with renewable bronze valves and seats arranged for quick removal. (To be continued.)

REFRIGERATION

Ethyl and Methyl Chloride

Properties of Ethyl and Methyl Chlorides, Charles H. Herter. Refrig. World, vol. 54, no. 5, May 1919, pp. 11-14 and 27-28. Attention is called to possibilities of methyl chloride as refrigerating agent.

Ice Plants

Deterioration of Ice Plants, Fred Ophuls. Refrig. World, vol. 54, no. 5, May 1919, pp. 21-22. Advises giving attention to repairs immediately defects are known as means to prevent rapid deterioration.

The Toronto Plant of the Wm. Davies Co., W. F. Sutherland. Power House, vol. 12, no. 5, Apr. 25, 1919, pp. 111-113, 7 figs. Ice plant.

Insulation, Cold-Storage

Cold Storage Insulation: Government Research. Cold Storage & Produce Rev., vol. 22, no. 253, Apr. 17, 1919, pp. 85-86, 1 fig. Report of tests at Nat. Physical Laboratory conducted by immersing large coil of piping in insulating material under test, and obtaining heat transmitted from the observed rise of temperature of the brine stream.

See also RAILROAD ENGINEERING, Rolling Stock (Refrigerator Cars); ELECTRICAL ENGINEERING, Generating Stations (Ice Making and Refrigeration); MECHANICAL ENGINEERING, Hydraulic Machinery (Ice Troubles).

RESEARCH

Bureau of Mines, Pittsburgh Station

The New Pittsburgh Station of the Bureau of Mines—III & IV, George W. Harris. Coal Age, vol. 15, nos. 19 & 20, May 8 and 15, 1919, pp. 852-855, and 907-911, 11 figs. Analytical apparatus used in analysis of coal. Researches on combustion of coal in furnaces and absorption of heat by boiler.

Industrial Research Laboratories

Industrial Physical and Mechanical Research Laboratories (Les laboratoires d'enseignement et de recherches de physique et mecanique industrielles), Jean Villey. Revue Générale des Sciences, vol. 30, no. 8, Apr. 30, 1919, pp. 233-240. Scheme of coöperation between universities and industries. Its adoption expected to be important factor in developing French industry.

The Relationship between the Laboratory and the Workshop, W. R. Barclay. Metal Indus. (Lond.), vol. 14, no. 14, Ap. 11, 1919, pp. 306-309. Likeness of principles of operation and objects of accomplishment in laboratory and in workshops.

Co-ordination of Research in Works and Laboratories, H. R. Constantine. Elecn., vol. 82, no. 16, Apr. 18, 1919, pp. 464-466. Scheme for establishing a self-supporting Board of Research. Board is to be treated in a similar way

to Boards of Trade and Education. Paper before Instn. Elec. Engrs.

Municipal Testing Laboratories

The Organization of a Standard Municipal Testing Laboratory, J. O. Preston. Can. Engr., vol. 36, no. 21, May 22, 1919, pp. 480-482. Installation of municipal laboratory for purpose of developing uniform standards and establishing fair basis for purchase of materials as well as securing proper usage of them.

Photography

Photography in Research, Arthur G. Eldredge. Chem. & Metallurgical Eng., vol. 20, no. 10, May 15, 1919, pp. 506-510, 14 figs. Examples of applications in industry and their considerations on opporunities of development.

Testing Equipment—Armour Inst. of Technology

Armour's Special Testing Equipment. Power, vol. 49, no. 18, May 6, 1919, pp. 670-673, 9 figs. Among other equipment which the Armour Inst. of Technology employs are apparatus for determining horsepower of automobile engines, influence of impact, bearing friction, belt slippage and heat flow through any material that can be prepared in flat slabs.

See also MARINE ENGINEERING, Ships (Model Experiments); RAILROAD ENGINEERING, Locomotives (Tests); AERONAUTICS, Testing.

SPECIFICATIONS

Steel

Specifications for Steel. Times Eng. Supp., vol. 15, no. 534, Apr. 1919, p. 130. Chemical specifications are not believed to be an expression of physical properties; it is said that much steel has been found serviceable which has been condemned on its chemical specification.

STANDARDS AND STANDARDIZATION

Sulphur Boiling Point

The Standardization of the Sulfur Boiling Point, E. F. Mueller and H. A. Burgess. Jl. Am. Chem. Soc., vol. 41, no. 5, May 1919, pp. 745-763, 4 figs. Importance of sufur boiling point as defining a standard temperature, and the necessity of obtaining further evidence upon certain questions concerning effect of experimental conditions upon the results obtained in its use, are considered.

See also RAILROAD ENGINEERING, Locomotives (Standard Locomotive.)

STEAM ENGINEERING

Boiler Power vs. Tractive Power

Boiler Power Versus Tractive Power—II, Wm. N. Allman. Boiler Maker, vol. 19, no. 5, May 1919, pp. 132-134, 2 figs. Graph showing percentage of boiler pressure for various piston speeds for both saturated and superheated steam, designed for use in calculating tractive power at any desired speed and to determine hp. (To be continued.)

Turbines, Large

The Large Steam Turbine, J. F. Johnson. Jl. Engrs. Club Philadelphia, vol. 36-5, no. 174, May 1919, pp. 174-183, 7 figs. Graph indicating relative steam consumption for units of various capacities designed for equal costs per kw. hour; records of performance of large turbine units; notes on design and construction. Paper read before Phila. Section Am. Soc. Mech. Engrs.

Three-Cylinder, 60,000-Kw. Turbine Installation, W. S. Finlay, Jr. Elec. World, vol. 73, no. 19, May 10, 1919, pp. 933-935, 4 figs. Operating details of three-element turbo-generator fitted with automatic control which enables any two elements to do the work of three in case of trouble.

Interborough Commission's 60,000 Kw, Turbo-Generator Unit, W. S. Finlay, Jr. Elec. Ry. Jl., vol. 53, no. 19, May 10, 1919, pp. 906-907, 3 figs. Attention is directed particularly to automatic control features of installation.

See also RAILROAD ENGINEERING, Locomotives (Comparative Efficiencies, Compound and Simple Locomotives.)

TEXTILES

Slashing of Cotton Warps

Slashing of Cotton Warps, Everett H. Hinckley. Textile World Jl., vol. 55, no. 19, May 10, 1919, pp. 61-63, 9 figs. Tests to determine influence of temperature on finer work.

Soaps, Scouring and Fulling

Properties of Scouring and Fulling Soaps, F. Albert Hayes. Textile World Jl., vol. 55, no. 21, May 24, 1919, pp. 21 and 33, 4 figs. Theories as to deterrent power and photomicrographs showing structure of wool fiber.

WELDING

Crankshaft Welding

Welding Broken Crankshafts, J. H. Deppeler. Iron Age, vol. 103, no. 19, May 8, 1919, p. 1217, 2 figs. Suggestions in regard to methods of lining up broken parts for thermit process.

Electric Welding

Electric Welding, W. H. Gard. Times Eng. Supp., vol. 15, no. 534, Apr. 1919, p. 137. Experiences in warships.

Electric Welding; Its Theory, Practice, Application and Economics, H. S. Marquand. Elecn., vol. 82 nos. 16, 17, 18 & 19, Apr. 18 & 25, May 2 & 9, 1919, pp, 468-469; 495-496; 515-517, and 541-543; 16 figs. Deals generally with Thomson process of resistance welding; describes plant used for spot welding, seam welding and butt welding; application of method to chain welding, tire and wire welding; spot-welding curves for equal thickness of sand-blasted plates and butt-welding curves for copper. (Continuation of serial.)

Electric Welding and Welding Appliances—VIII, IX, X, XI, XII. Engineer, vol. 127, nos. 3301, 3302, 3303, 3304, 3305, Apr. 4, 11, 18, 25, and May 2, 1919, pp. 319-322, 352-354, 375-378, 394-396 & 421-422, 36 figs. Resistance welders of Electric Welding Co. Holmes portable generating sets; plant consists of 4-cyl. gas engine of 28 b. hp. coupled to d. c. compound-wound dynamo having output of 250 amperes at 65 volts. Process followed by Steel Barrel Co., Ltd., in manufacture of steel drums.

The Technique of Arc Welding, F. A. Anderson. Jl. Electricity, vol. 42, no. 9, May 1, 1919, pp. 437-439, 23 figs. Methods of preparing work and detecting faults.

A Review of Some Modern Methods of Arc Welding, Thomas H. Heaton. Can. Machy., vol. 21, no. 19, May 8, 1919, pp. 463-465, 3 figs. Comparison of Benardos, Kjelberg and quasi-arc systems. (To be continued.)

Electric Welding, James Caldwell and Henry Bailey Sayers. Engineering, vol. 107, no. 2776, Mar. 14, 1919, pp. 350-351. Developments in Great Britain and U. S. A.; experiments on application of electric welding to large structures; application of electric welding in ship construction and repairs. Abstracts of papers read before Instn. Civ. Engrs.

Equipment Designed for Electric Arc Welding—III, E. Wanamaker and H. R. Pennington. Ry. Elec. Engr., vol. 10, no. 5, May 1919, pp. 141-146, 14 figs. Types used in different systems, operating characteristics and circuits.

Electric Arc Welding for Repairing of Steel Parts (Soldadura de piezas de acero por medio del arco electrico), O. H. Eschholz. Boletin de la Asociacion Argentina de Electro-Tecnicos, vol. 4, no. 12, Dec. 1918, pp. 902-905, 2 figs. Small arc and proper control of flame claimed to insure minimum oxidation of arc vapors and superficial deposits. (Concluded.)

Experiments on the Application of Electric Welding to Large Structures, Wescott Stile Abell. Steamship, vol. 30, no. 359, May 1919, p. 257. Account of experiments carried out on behalf of Lloyd's Register of Shipping, in order to determine possibility of application of electric arc welding to ship construction. Paper read before Instn. Civil Engrs.

Electric Welding and Its Applications, Walter Leonard Lorkin. Tramway & Ry. World, vol. 45, no. 18, Apr. 10, 1919, pp. 197-200, 9 figs. Endeavors to show that process is simple, that it can be carried out with ordinary labor and that the welds are efficient and effected at small cost. Paper read before Roy. Soc. Arts.

Gas Torches

Modern Welding and Cutting—XII, Ethan Viall. Am. Mach., vol. 50, no. 21, May 22, 1919, pp. 977-983, 21 figs. Description of various makes of gas torches.

Inspection of Welds

Inspection of Metallic Electrode Arc Welds. Elec. Traction, vol. 15, no. 5, May 1919, pp. 330-334, 7 figs. Graphs indicating approximate arc current and electrode diameter for welding steel plates of various thicknesses, also variation in weld strength with change in arc current.

Oxy-Acetylene Welding

Oxy-Acetylene Apparatus and Its Accomplishments in the M. C. T. Reconstruction Camp in France, George N. Sieger. Welding Engr., vol. 4, no. 5, May 1919, pp. 19-23, 7 figs. Work of salvage, repair and reconstruction. Personnel of welding shop. Installation of compression plant.

Safety Rules for Oxy-Acetylene Welding. Boiler Maker, vol. 19, no. 5, May 1919, pp. 134 and 136. Adopted by Western Pa. Div. of Nat. Safety Council.

Modern Welding and Cutting—X, Ethan Viall. Am. Mach., vol. 50, no. 18, May 1, 1919, pp. 833-838, 7 figs. Details regarding acetylene in cylinders and description of positive-pressure type of generator.

Sheet and Tube Welding (see Thin Plates)

Autogenous Welding at Albuquerque, H. Louis Hahn. Ry. Mech. Engr., vol. 93, no. 5, May 1919, pp. 271-272, 7 figs. Repairing burned or cracked sheets and tubes by gas or electric welding; welding of flue beads.

Steel Castings

The Welding of Steel Castings, J. F. Springer. Ry. & Locomotive Eng., vol. 32, no. 5, May 1919, pp. 142-143, 1 fig. Effect of carbon percentage in behavior of casting when being welded.

Testing Welds

A Review of Some Modern Methods of Arc Welding, Thomas H. Heaton. Can. Machy., vol. 21, no. 20, May 15, 1919, pp. 490-492, 9 figs. Application of petroleum is considered a good test of a weld because of its penetrating quality.

Thin Plates

The Gas Welding of Thin Plates—II, J. F. Springer. Ry. Mech. Engr., vol. 93, no. 5, May 1919, pp. 268-271, 2 figs. Requirements of thin work with and without use of rods; behavior of various metals.

See also MARINE ENGINEERING, Yards (Welding); RAILROAD ENGINEERING, Construction (Welding Outfits), Shops (Welding.)

WOOD

Creosote Treatment

Creosote Treatment of Car Timbers. Ry. Mech. Engr., vol. 93, no. 5, May 1919, pp. 255-257, 3 figs. Methods used by Marsh Refrigerator Service Co. Cost of work and estimates of increased life.

Forest Conservation

A Program of Forest Conservation for the South, J. G. Peters. Jl. Forestry, Soc. Am. Foresters, vol. 17, no. 4, Apr. 1919, pp. 364-370. Argues that since states and Federal Government disposed of Southern lands to such an extent as to make it impossible for the small population of these states to develop adequately and use the land, the states and the Federal Government have contracted obligation in the matter at least until owners can be expected to handle land properly. Paper read before Soc. Am. Foresters, Washington Section.

Tasmanian Hardwood

Use of Tasmanian Hardwood in Holland (Eene toepassing van Tasmanisch hardhut), S. Van Ravensteijn. De Ingenieur, vol. 34, no. 11, Mar. 15, 1919, pp. 197-200, 4 figs. Blue-gum wood has been used for 380 yd. of quays at Dordrecht, and while it has not yet proved its durability, it is not expected that it will equal that of oak.

Timber Estimating

A Formula Method for Estimating Timber, E. I. Terry. Jl. Forestry, Soc. Am. Foresters, vol. 17, no. 4, Apr. 1919, pp. 413-422, 1 fig. Worked out by using merchantable form factor and ratio between average cubic and board-foot contents of trees of each diameter class.

VARIA

Education of Engineers

Education and Training of the Engineer, A. P. M. Fleming. Tran. Inst. Mar. Engrs., vol. 31, no. 242, Apr. 1919, pp. 2-11 and (discussion) pp. 12-21. Considers as a matter of primary concern that a rigid selection be made among the larger supply of youths applying for entry into the engineering profession of only those boys who appear to have mental, moral, and physical capacity for availing themselves to the utmost of the course of training provided.

Engineering School Laboratories

Mechanical, Physical and Chemical Laboratory of the Engineering School of Lausanne University (Le laboratoire d'essais mécaniques, physiques et chimiques de l'école de l'Université à Lausanne). Bulletin Technique de la Suisse Romande, vol. 45, no. 8, Apr. 19, 1919, pp. 70-74, 8 figs. Description of 50-ton oil press.

Glass Vessel Marking

The Permanent Marking of Glass Vessels, Joseph C. Bock. Chem. News, vol. 118, no. 3077, Apr. 4, 1919, pp. 161-162. Proposes the use of glass color fused in the glass by means of ordinary burner. From Jl. Am. Chem. Soc.

Perpetual-Motion Machines

Perpetual Motion Machines, B. F. Jakob-

sen. Jl. Electricity, vol. 42, no. 9, May 1, 1919, pp. 426-427, 6 figs. Absurdity implied in their conception.

Telescope, 72-in. Canadian

The Dominion of Canada's 72-In. Telescope, J. S. Plaskett. Nature, vol. 103, no. 2580, Apr. 10, 1919, pp. 105-108, 3 figs. Reflecting type; article deals with optical parts, on work being done and proposed to be done with the instrument.

Organization and Management

ACCOUNTING

Army, U. S.

The Cost Accounting System of Construction Division, U. S. Army, C. W. Pinkerton. Eng. & Contracting, vol. 51, no. 21, May 21, 1919, pp. 548-551, 5 figs. Basis is foreman's daily report blank.

Factory Costs

New System Computes Factory Costs, W. A. Rutz. Iron Trade Rev., vol. 64, no. 16, Apr. 17, 1919, pp. 1023-1024. Method used by Am. Multigraph Co., Cleveland. System is based on principle that stock room is a bank.

Production Charges, Indirect

Fixing Indirect Production Charges, M. H. Potter. Iron Trade Rev., vol. 64, no. 18, May 1, 1919, pp. 1148-1149, 1 fig. Chart showing connection between various items offered as preliminary step in classifying indirect charges.

EDUCATION

Apprentices

Theoretical Training for Apprentices—Outline of the Educational Facilities Provided at the British Government Arsenal, E. G. Timbrell. Can. Engr., vol. 36, no. 18, May 1, 1919, pp. 423-425. Apprentices must be between 14-16 years of age. Course of four years covering mathematics, experimental mechanics, chemistry and engineering drawing, given three evenings per week, with addition of one-half day.

Home of the Canadian Ingersoll-Rand Co. Can. Machy., vol. 21, no. 19, May 8, 1919, pp. 451-455, 8 figs. Particular reference is made to apprenticeship systems and practices followed in forging department.

Women, Wireless Workers

Telephone and Wireless Transmission. Elec. Eng., vol. 53, no. 1, Jan. 1919, pp. 15-17. Training given women workers in Westinghouse plant.

FACTORY MANAGEMENT

Boiler Manufacturing

Modern Management in Boiler Manufacturing, Chas. M. Horton. Boiler Maker, vol. 19, no. 5, May 1919, pp. 122-123. Advises systematic continuity in turning out product.

Fordson Assembly Methods

Fordson Assembly Wholly on Progressive Plan—II, J. Edward Schipper. Automotive Industries, vol. 11, no. 18, May 1, 1919, pp. 960-966, 11 figs. Cylinder block and transmission housing assemblies travel along parallel lines until complete.

Haulage, Inter-Shop

Saving $200 a Day in Inter-Shop Haulage, R. M. Kinny. Factory, vol. 22, no. 5, May 1919, pp. 926-929, 9 figs. Minneapolis Steel & Machinery Co. have added a railroad despatching system to the use of ordinary industrial trucks with trailers.

Human Element

The Human Element in the Factory, Hugh K. Moore. Eng. & Indus. Management, vol. 1, no. 2, Apr. 24, 1919, pp. 327-331, 3 figs. Boiler performance curves for various forms are examined and conclusions are derived concerning influence of personal touch between employer and employee in creating research initiative in the latter.

Layout

Continental Plant Layout Facilities Production. Automotive Industries, vol. 40, no. 21, May 22, 1919, pp. 1122-1126, 10 figs., on supp. plate. Engine shipments go out on same tracks on which raw parts enter. (To be continued.)

The Designing of Factory Layouts for the Clay Industries, T. W. Garve. Jl. Am. Ceramic Soc., vol. 2, no. 3, Mar. 1919, pp. 195-207, 4 figs. Interior and selection of machinery as affected by kind and quantity of ware to be made, physical conditions of clay and local conditions and requirements.

Pattern Control

A Simple Pattern Control and Routing System. Foundry, vol. 47, no. 7, May 15, 1919, pp. 292-296, 11 figs. Method worked out at Canton Steel Foundry Co. It is based on five standard forms operated from central office.

Payroll Systems

Installing Accurate Payroll System, Clifford E. Lynn. Iron Trade Rev., vol. 64, no. 20, May 15, 1919, pp. 1289-1292, 9 figs. Maintenance of timekeeping and distribution method by co-operation of superintendent, foremen and workmen.

Production Control

Controlling Production in a Motor Plant, Charles Lundberg. Iron Age, vol. 103, no. 20, May 15, 1919, pp. 1279-1281, 10 figs. Obtainable from methods used by Mechanical Appliance Co., Milwaukee, are determination of comparative production, of labor costs, stage of manufacture each lot has reached at any time, quantity of each piece on hand or in process and deduction of faulty work.

Purchasing

Handling Orders in Steel Plants, Clifford E. Lynn. Iron Trade Rev., vol. 64, no. 15, Apr. 10, 1919, pp. 956-958, 3 figs. General forms by which purchase requirements are received, recorded and executed.

Repair Shop, Automobile

The Scientific Management of the Automobile Repair Shop (Application des principes de l'organisation scientifique à l'atelier central de réparations du service automobile). J. Compagnon. Bulletin de la Société d'Encouragement pour l'Industrie Nationale, vol. 131, no. 2, Mar.-Apr. 1919, pp. 299-328, 29 figs. Based on the Taylor system.

Weighing and Packing

Weighing and Packing by Machinery, Gilbert Balkan. Commercial America, vol. 15, no. 11, May 1919, pp. 41-45, 4 figs. Automatic weighing and packing illustrated by continuous operation applied to flour.

FINANCE AND COST

Appraisal

Advantages of the Engineering Appraisal, Charles W. McKay. Textile World Jl., vol. 55, no. 20, May 17, 1919, pp. 43-45. Discussion of federal tax problems of textile executives.

Appraising and Cost Finding, William F. Worcester. Concrete Age, vol. 30, no. 1, Apr. 1919, pp. 14-16. Address delivered before Am. Concrete Pipe Assn.

Costkeeping System

Manufacturing Non-Ferrous Metal Articles. Iron Age, vol. 103, no. 19, May 8, 1919, pp. 1209-1214, 10 figs. Annealing and pickling machinery and automatic safety devices in plant of Bridgeport Metal Goods Mfg. Co. also costkeeping system.

Costing as Applied to General Engineering, Chas. E. Lewton. Eng. & Indus. Management, vol. 1, no. 10, Apr. 17, 1919, pp. 310-317, 15 figs. Scheme in vogue at general engineering establishment is laid out with considerations on procedure adopted in commercial inspection, labor cost and allocation of predetermined establishment expenses to job; iron foundry costs; material costs and determining establishment expenses.

INSPECTION

Equipment, Inspection and Record

Demobilizing Equipment of Spruce Production Division. Eng. News-Rec., vol. 82, no. 20, May 15, 1919, pp. 967-968, 4 figs. System of inspecting and recording which is said to keep order among 4800 classifications.

Materials Before Acceptance

Inspection of Materials Before Acceptance, Emmanuel Mavaut. Contract Rec., vol. 33, no. 18, Apr. 30, 1919, pp. 417-419. Instances of failures caused by neglect to have concrete, sand and stone properly tested for quality before use.

LABOR

Convict Labor

Convict Labor on Highway Work; Organization, Administration, Camps and Cost Data. Good Roads, vol. 17, no. 18, May 3, 1919, pp. 189-190, 2 figs. Committee report presented at Convention of Am. Road Builders' Assn.

Fatigue, Industrial

Industrial Efficiency from the Psychological Standpoint—II, Chas. S. Myers. Eng. & Indus. Management, vol. 1, no. 12, May 1, 1919, pp. 359-360, 5 figs. Experiments with Kräpelin's ergograph. Distinction is established between muscular fatigue arising from excessive activity, producing clogging of physiological mechanism with products of that activity, and fatigue due to exhaustion of living substance of the muscles. Lecture delivered before Imperial College of Science & Technology.

Industrial Disputes

Organization in the Settlement of Industrial Disputes, V. Everit Macy. Eng. & Min. Jl., vol. 107, no. 19, May 10, 1919, pp. 825-828. Emphasizes that labor problem is merely a human problem and unless similar methods are employed in dealing with it as have been found effective with other human problems, maximum production and industrial peace can not be realized.

Industrial Relations

The Status of Industrial Relations, L. P. Alford. Mech. Eng., vol. 41, no. 6, June 1919, pp. 513-516 & 556. Present aspect of labor and employment problems is held to be similar to that presented by these problems immediately after civil war; situation, however, is considered as greatly amplified now. Suggestions to meet present emergency are made.

Industrial Efficiency from the Psychological Standpoint—I, Charles E. Myers. Eng. & Indus. Management, vol. 1, no. 2, Apr. 24, 1919, pp. 332-336, 6 figs. Improving mechanical conditions and sympathetic understanding of standpoint of others are considered far more important factors in determining industrial efficiency than capital or labor.

Industrial Co-operation, Charles P. Steinmetz. Am. Mach., vol. 50, no. 19, May 8, 1919, pp. 893-894. Merging capital and labor interests in one advocated as only way to meet present industrial requirements.

Labor Turnover

Reducing the Labor Turnover, W. C. Nisbet. Ry. Mech. Engr., vol. 93, no. 5, May 1919, pp. 265-268. Discusses advantages of applying employment department idea to railroad shops.

Modern Industrial Plants—VI-b, George C. Nimmons. Architectural Rec., vol. 45, no. 5, May 1919, pp. 450-470, 20 figs. Excessive turnover of labor and influence of employees' welfare work on reducing it. Conditions in various plants are quoted.

Night Work

Medical Argument Against Night Work, Especially for Women Employees, Emery R. Hayhurst. Am. Jl. of Public Health, vol. 9, no. 5, May 1919, pp. 367-368. How night work emphasizes intrinsic factors which bring about chronic fatigue.

Profit Sharing

Willys Profit-Sharing Plan on 50-50 Basis, J. Edward Schipper. Automotive Industries, vol. 11, no. 18, May 1, 1919, pp. 942-944. Provides for division of profits over and above amounts reserved for interest upon capital on a 50-50 basis between workers and employers.

How to Compass Industrial Coöperation, Charles P. Steinmetz. Coal Age, vol. 15, no. 20, May 15, 1919, pp. 904-906. Proposes to give labor dividends based on wages paid and on the amount of excess profits above a certain percentage, the gross returns to labor being made equal to the excess profits allotted capital.

Wages

Uniform Wages for Workmen. Contract Rec., vol. 33, no. 18, Apr. 30, 1919, pp. 403-406, 5 figs. Assn. of Montreal Building and Construction Industries reported attempting to secure fixed wages and eliminate sub-contract abuses.

Welfare Work

Welfare Work for Employees in Industrial Establishments in the United States. U. S. Dept. Labor, Bur. Labor Statistics, Bul. no. 250, Feb. 1919, 139 pp., 40 figs. Fieldwork of investigation extended over period of twelve months in 1916 and 1917 and 31 states were visited in connection with study.

Women

Female Labour on Line Construction Work J. B. Taylor. Post Office Elec. Engrs. Jl., vol 12, part 1, Apr. 1919, pp. 26-31, 6 figs. Although work was hard, and meant exposure to all kinds of weather, experiment is reported as successful.

Women in Electrical Work. Elec. Eng., vol 53, no. 1, Jan. 1919, pp. 11-13. British meth

Let us solve Your Problem

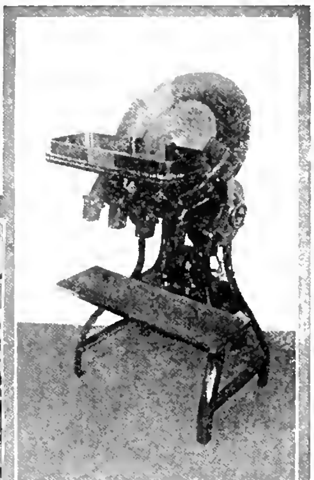
Our Model Room—

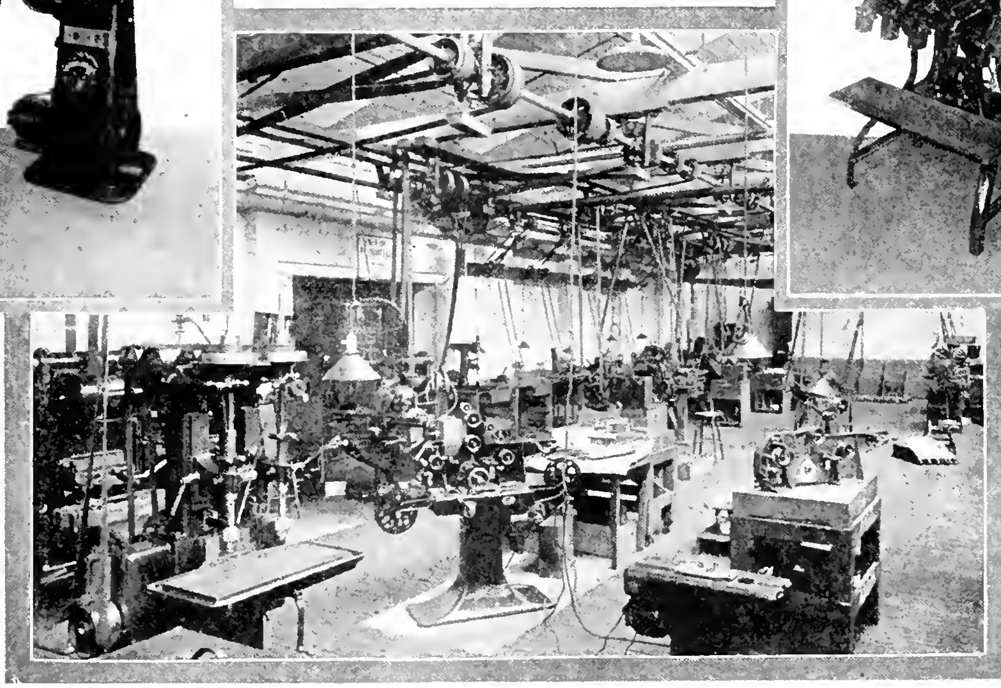
where *perfection* is assured and *accuracy* maintained.

Here is the department where all special machinery is tried out and perfected—here is where your special part is measured and tested—actual production begins here and assures perfection in the finished article. This is part of S. A. S. Service.

With our great facilities, thoroughly up-to-date equipment and our large force of skilled mechanics we are prepared to develop, perfect and produce your special intricate machine or unusual special part.

The two machines illustrated in the inserts are two of many that have been developed and perfected in our laboratories and are now being produced in our shops.





Get the benefit of this expert service

In knowledge of experience, completeness of equipment, superiority in service, and in everything that goes to form the basic foundation for developing, perfecting and producing your special work, we believe we can proclaim pre-eminence.

A complete service is offered—

to work with you and for you—from designing to finishing—whether you need a simple part of accurate measurement or an intricate mechanical device that must work accurately—we can do it and do it right—and deliver on time.

This is the fourth of a series of advertisements showing our plant, our methods and the work we are doing—Our tool room in the next issue.

We want to tell you more about the work we do and how we can help you. Better write us to-day.

SLOCUM, AVRAM & SLOCUM
LABORATORIES, Inc.

Production Plant: NEWARK, N.J. *New York Office*: Woolworth Bldg., N.Y.

Special Machinery QUANTITY PRODUCTION Jigs, Fixtures and Gages

SLOCUM-AVRAM-SLOCUM MANAGEMENT

ods for training workers in war industries. From bul. issued by U. S. Dept. Labor.

Women as Factory Inspectors. Eng. & Indus. Management, vol. 1, no. 12, May 1, 1919, pp. 368-369. Duties of women in the capacity of assistant factory inspectors in several German states, notably Bavaria and Baden. From Technik & Wirtschaft.

See also MARINE ENGINEERING, Ships (Merchant Shipbuilding.)

LEGAL

Compensation

Compensation for Occupational Diseases. Riley M. Little. U. S. Dept. Labor, Bur. Labor Statistics, bul. 248, Mar. 1919, pp. 251-257 and (discussion) pp. 258-268. Contends that hazards of industry ought to be borne by society as a whole and not by individual workingman.

LIGHTING

Shop Lighting

Improved Methods of Shop Lighting. Power Plant Engr., vol. 23, no. 10, May 15, 1919, pp. 457-459, 5 figs. Comparison of general and localized system of illumination.

Wall-Box Illumination

Lighting Without Hanging Ceiling Fixtures. J. L. Stair. Elec. Jl., vol. 16, no. 5, May 1919, pp. 183-187, 14 figs. Examples of wall box or wall pocket method of illumination.

See also ELECTRICAL ENGINEERING, Lighting and Lamp Manufacture (Lighting Codes.)

RECONSTRUCTION

Financial Conditions

Some of Our Post-War Problems. Francis B. Sisson. Am. Mach., vol. 50, no. 20, May 15, 1919, pp. 935-937. Concerning particularly financial conditions resulting from war. Address before Indus. Conference of N. Y. Business Publishers' Assn.

Foreign Trade

Reconstruction Days. Metal Indus., vol. 17, no. 5, May 1919, pp. 207-210. Analysis of present business conditions and forecast of future of foreign trade.

Problems of Our Foreign Trade. G. A. O'Reilly. Am. Mach., vol. 50, no. 19, May 8, 1919, pp. 891-893. Address before Editorial Conference of N. Y. Business Publishers' Assn.

Foreign Trade Policy

The Stabilizing Effect on American Industry of a Definite Foreign-Trade Policy. James W. Hook. Am. Mach., vol. 50, no. 20, May 15, 1919, pp. 938-939. Address delivered before Sixth Nat. Foreign Trade Convention.

Industrial Democracy

Industrial Democracy. Charles A. Eaton. Am. Mach., vol. 50, no. 20, May 15, 1919, pp. 933-935. Address before Indus. Conference of N. Y. Business Publishers' Assn.

Wage Problems

After War Problems. W. L. Hitchens. Machy. Market, nos. 964 & 965, Apr. 25 & May 2, 1919, pp. 19-20 and 19-20. Wage problem in industry. Paper read before Roy. Soc. Arts.

SAFETY ENGINEERING

Accident Prevention

Safety from the Standpoint of Industrial Efficiency. C. W. Price. Official Proc. Ry. Club of Pittsburgh, vol. 18, no. 3, Feb. 27, 1919, pp. 58-71 and (discussion) pp. 71-79. Accident prevention as common ground on which employers and employees can meet, with mutual benefit as result.

Accidents

Comparison of Industrial with Military Casualties. I. M. Rubinow. U. S. Dept. Labor, Bur. Labor Statistics, bul. 248, Mar. 1919, pp. 217-225. Concludes that in peaceful times industrial life creates as many handicapped persons as would an army of 1,000,000 soldiers fighting on the battlefields of Europe.

Some Showing from Accident Records. Lucian W. Chaney. U. S. Dept. Labor, Bur. Statistics, bul. 248, Mar. 1919, pp. 30-37. Statistics of Bur. of Labor including causes of accidents and nature of injuries described as indicating that 58 per cent of accidents could have been prevented by adequate engineering provisions.

Shipbuilding Accidents. Eng. & Indus. Management, vol. 1, no. 12, May 1, 1919, pp. 379-381. Dangers to which workmen are subjected in a shipyard and how these may be minimized or eliminated.

Fire Fighting

Fire Engines and Effective Fire Fighting. Charles H. Fox. Mech. Eng., vol. 41, no. 6, June 1919, pp. 503-505. Essentials of effective fire fighting and their relation to fire engines as viewed by writer who believes that importance of methods employed in fire fighting is often underestimated by both laymen and engineers.

Fire Prevention

Fire Prevention in the Metal Trades—I. R. E. Swearingen. Metal Trades, vol. 10, no. 5, May 1919, pp. 213-216. A clean, well-managed plant is considered not only a safer risk, but a healthier and more satisfactory place to work in and of wholesome effect on the working force.

The Saskatchewan Fire Prevention Act and the Methods of Its Administration. Arthur E. Fisher. Quarterly of the Nat. Fire Protection Assn., vol. 12, no. 4, Apr. 1919, pp. 334-342. One section appoints local assistants to Fire Commissioner in every place, with practically all powers granted to Commission.

Mechanical Safeguards

Mechanical Safeguards. David S. Beyer. U. S. Dept. Labor, Bur. Labor Statistics, bul. 248, Mar. 1919, pp. 16-26. Emphasizes importance of mechanical guarding in addition to safety education for prevention of accidents. Desirability of standardizing mechanical guards is advocated and an account of work done in this direction by Standardization Committee of Nat. Safety Organization is mentioned.

TRANSPORTATION

Electric Trucks and Tractors

The Field for Industrial Electric Trucks and Tractors. Elec. Rev., vol. 74, no. 20, May 17, 1919, pp. 791-795, 7 figs. Examples of their application in various industries. (First article.)

Electric Vehicles. C. Tunstill Opperman. Surveyor, vol. 55, no. 1421, Apr. 11, 1919, pp. 271-272. Their reliability and economy on short journeys.

Truck Delivery Costs

Cost of Highway Concrete Delivered Wet by Trucks. Eng. News-Rec., vol. 82, no. 18, May 1, 1919, pp. 870-872, 3 figs. Delivery of wet concrete from central crushing and mixing plant to road surface, by motor trucks, over hauls ranging from 1/4 mile to 4 miles reported as being satisfactorily accomplished by Maryland State Road Commission.

See also RAILROAD ENGINEERING, Operation and Management (Accident Prevention), Safety and Signaling Systems; AERONAUTICS, Production (Fire Hazard); MINING ENGINEERING, Mines and Mining (Cartridges, Safety; Lamps, Safety.)

Electrical Engineering

ELECTRODEPOSITION

Galvanizing Plant

Planning and Operating a Galvanizing Plant. E. P. Later. Foundry, vol. 47, no. 7, May 15, 1919, pp. 289-291, 5 figs. Analysis of temperature factors and difficulties; remarks on choice of kettles, tanks and cleaning equipment.

ELECTROPHYSICS

Cables, Aerial

General Property of Aerial Cables (Sur une propriété très générale des câbles servant aux transport aériens). G. Leinekugel le Cocq. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 15, Apr. 14, 1919, pp. 761-764, 1 fig. Portion of cable between two suspension points considered as beam and deflections at various points determined in terms of horizontal tension at extremities and integral of bending moments to left of section.

Current Rectification by Voltameter

Direct Current Generation by Applying Alternating Electromotive Force to Voltameter with Platinum Electrodes (Sur la production d'un courant continu par application d'une force électromotrice alternative à un voltamètre a électrodes de platine). P. Vaillant. Revue Générale de l'Electricité, vol. 5, no. 16, Apr. 1919, pp. 593-594. From Comptes rendus des séances de l'Académie des Sciences, vol. 168, Mar. 31, 1919, pp. 687-689.

Emission of Electricity from Incandescent Bodies

Emission of Electricity from Incandescent Bodies (L'émission d'électricité par les corps incandescents). A. Boutaric. Revue Générale des Sciences, vol. 30, no. 7, Apr. 15, 1919, pp. 198-211, 17 figs. Its application in construction of Fleming valve, audion and tubes acting by electronic discharges. The theory of operation of these apparatus is outlined and a mathematical theory of the operation of vacuum three-electrode tubes is presented. Second article.

Oscillations, Maintained

Electrotechnical Analogy of Maintained Oscillations (Sur une analogie électrotechnique des oscillations entretenues). Paul Janet. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 15, Apr. 14, 1919, pp. 764-766. Anology between maintained oscillations used in wireless telegraphy and reversing motion of separately excited motor when fed by series generator and running on no load.

FURNACES

Booth-Hall Electric Furnace

The Booth-Hall Electric Furnace. W. K. Booth. Iron & Coal Trades Rev., vol. 98, no. 2671, May 9, 1919, p. 617, 3 figs., also Can. Machy., vol. 21, no. 18, May 1, 1919, pp. 430-433, 7 figs. This conducting-hearth electric furnace has an auxiliary electrode for starting and automatic control. Paper read before Iron & Steel Inst., and Instn. Elec. Engrs. at joint meeting.

Control of Temperature

Metal Melting in Electric Furnaces. E. F. Collins. Metal Indus., vol. 17, no. 5, May 1919, pp. 221-224, 3 figs. Some characteristics of the furnace installation treated are control of temperature of heat-generating source and uniform distribution of heat generated.

Héroult Furnace

Work of the Electric Furnace. Elec. Eng., vol. 52, no. 5, Nov. 1918, pp. 12-13, 4 figs. Installation at plant of Driver-Harris Co., Harrison, N. J. Furnace is of Héroult arc type, featured with automatic regulation; it has capacity of two tons.

Non-Ferrous Metal Melting

Electric Furnace for Melting Nonferrous Metals—I. Edgar F. Collins. Foundry, vol. 47, no. 7, May 15, 1919, pp. 284-288, 6 figs. Diagram illustrating principles of carbon-electrode type of furnace. Notes on continuity and dependability of service in melting brass commercially.

Melting of Non-Ferrous Metals and Alloys. Elec. World, vol. 73, no. 21, May 24, 1919, pp. 1110-1114, 5 figs. Data presented to show that saving of 100 per cent or more may be expected from electrical method in brass-melting industry.

Sahlin Furnace

A New Type of Electric Furnace. Axel Sahlin. Iron & Coal Trades Rev., vol. 98, no. 2671, May 9, 1919, p. 618, 2 figs. Built as circular ladle with contracted top and dished bottom. Paper read at joint meeting of Iron & Steel Inst. and Instn. Elec. Engrs.

Steel-Furnace Practice

Pointers on Electric Steel Furnace Practice. H. E. Diller. Foundry, vol. 47, no. 6, May 1, 1919, pp. 239-242, 6 figs. Data on arc-type furnaces based on research work conducted by writer and his experience in various foundries.

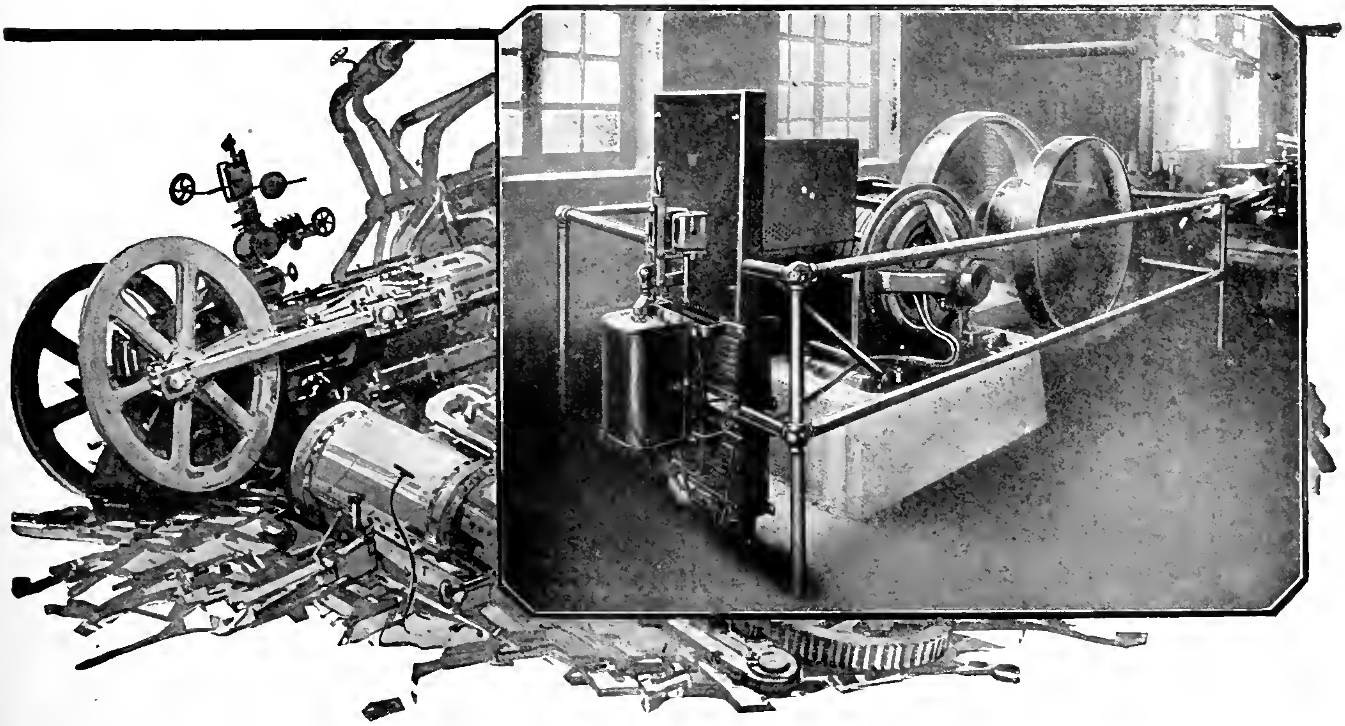
Steel-Furnace Progress

Electrical Apparatus Development. Elec. World, vol. 73, no. 21, May 24, 1919, pp. 1102-1105, 4 figs. Growth of electric steel furnace indicated by mentioning that while in July, 1913, there were only about 20 such furnaces in the U. S. A., at the end of 1918 there was a total of 287.

Electric Furnaces. W. E. Moore. Jl. Engrs. Club of St. Louis, vol. 4, no. 2, Mar.-Apr. 1919, pp. 166-183, 4 figs. History of development with remarks on quantity production. Arc-type furnace is considered as best suited type for foundry work.

Developments in Electric Iron & Steel Furnaces. J. Bibby. Iron & Coal Trades Rev., vol. 98, no. 2671, May 9, 1919, pp. 611-617, 23 figs. Remarks confined to development in manufacture of iron and steel by means of electric furnaces. It is emphasized that it is important for electrical engineers to grasp requirements of metallurgists and to be acquainted with working conditions of blast furnaces and steel foundries. Paper read at joint meeting of Iron & Steel Inst. and Instn. Elec. Engrs.

The present and future competitive conditions compel every manufacturer to seriously consider the wonderful advantages, efficiencies and economies possible with the use of electrical equipment.



One G-E Motor-Driven Compressor Supersedes Two Steam Engines

THIS one little 50 horsepower G-E motor is being used to drive an air compressor which is doing the work previously done by two steam-driven compressors. It furnishes full compression for every air tool in the quarry — at Penn Allen Cement Co.

This is just another example of where G-E engineering service has been of great value to the customer.

The next point is — is your mill completely electrified? If not, you are not realizing full value on your principal investment.

General Electric Company

General Office Schenectady, N.Y.

43-260

Steel Furnaces

Large Electric Steel-Melting Furnaces, Victor Stobie. Iron & Coal Trades Rev., vol. 98, no. 2671, May 2, 1919, pp. 618-621, 8 figs. Suggested connections for various sizes. Paper read at joint meeting of Iron & Steel Inst. and Instn. Elec. Engrs.

GENERATING STATIONS

Centralization of Electric Power

The Significance and the Opportunities of the Central Station Industry, R. F. Schuckardt. Elec. Jl., vol. 16, no. 5, May 1919, pp. 166-168. Believing centralization of electric power will come eventually writer urges planning present extensions so that in due time interconnection can be carried out most economically.

The Primaries of Today, the Secondaries of Tomorrow, W. S. Murray. Elec. Jl., vol. 16, no. 5, May 1919, pp. 168-170. Advantages of centralization of electric power illustrated by quoting comparative load factors of central plants and plants otherwise operated.

Eastern Companies

Promising Outlook for Eastern Companies. Elec. World, vol. 73, no. 20, May 17, 1919, pp. 984-991, 14 figs. Central-station situation outlined for several communities, notably Philadelphia, Baltimore, New Jersey and New York City.

Hydroelectric Plant, Small

Opportunities for and Data on Small Municipal Hydro-Electric Plants Wm. G. Fargo. Min. & County Eng., vol. 56, no. 5, May 1919, pp. 168-171 3 figs. Example of rating curve for determining intermediate stream flow based on several flow measurements.

Ice Making and Refrigeration

Central-Station Service for Ice Making and Refrigeration, C. J. Carlsen. Elec. Rev., vol. 74, no. 20, May 17, 1919, pp. 783-787, 6 figs. Status and growth of load in New York and Chicago indicating tendency to use synchronous motors.

Middle West

Central Station Progress in the Middle West. Elec. World, vol. 73, no. 20, May 17, 1919, pp. 1001-1006, 8 figs. Engineering development of last eighteen months.

Peat-Fired Central Station

Steam-Driven Central Station at Vasteras, Sweden (La station centrale thermo-électrique de Västerås), V. Forssblad. Génie Civil, vol. 74, no. 15, Apr 12, 1919, pp. 296-298, 3 figs. Designed to insure constant feeding of network served by hydroelectric plants. It utilizes peat available in region. From Teknisk Tidskrift.

Railway Power Station

New Railway Power Station. Southern Engr., vol. 31, no. 3, May 1919, pp. 36-39, 4 figs. Station generates 2,400 kw. at maximum rating; present equipment consists of horizontal cross-compound Nordberg-Corliss engines driving 1200 kw. direct-current generators.

Rotary Converters

An Interesting Rotary Converter Installation at Ilford. Electricity, vol. 33, no. 1185, Apr. 25, 1919, pp. 257-259, 4 figs. Inverted rotary converter with step-up transformer and rotary converter supplying continuous current at substation installed by General Electric Co., Ltd.

Totalization of Load

New Emergency Bus Feature in Brantford Hydro-Electric Station. Elec. News, vol. 28, no. 9, May 1, 1919, pp. 29-30, 3 figs. Scheme provides for totalizing load no matter which way current is fed.

Turbines

The Year's Electrical Development. Elec. Eng., vol. 53, no. 1, Jan. 1919, pp. 23-28, 2 figs. Concerning particularly turbine unit installations.

See also MARINE ENGINEERING, Ships (Electric Propulsion).

GENERATORS AND MOTORS

Converters

Adapting Automatic Control to Motor Started Converters, R. J. Wensley. Elec. Ry. Jl., vol. 53, no. 20, May 17, 1919, pp. 948-951, 6 figs. Control developed by Westinghouse Electric & Manufacturing Co. Principle is same as that of automatic control of self starting machines.

High-Frequency Machines

Regulation of High-Frequency Machines (Sur les machines à haute fréquence et leur réglage), J. Bethenod. Bulletin de la Société Française des Electriciens, vol. 9, no. 78, Mar. 1919, pp. 161-176, 2 figs. Technical study. Formulæ derived both in case of a single machine and when two machines are coupled.

Induction Motors

Three-Phase Currents in Mining Work. Elec. Eng., vol. 52, no. 6, Dec. 1918, pp. 18-20, 2 figs. Simplicity of squirrel cage for induction motor, absence of commutator in all forms of induction motors, and convenience with which large amounts of power can be transmitted over long distances, and their pressures converted to any figure that may be desired at the points of consumption, are believed to have given three-phase currents preference over continuous-current service.

Light-Weight Generators

Light Weight Electric Generating Sets. Engineering, vol. 107, no. 2782, Apr. 25, 1919, pp. 531-533, 9 figs. Sets made by A. Lyon & Wrench, Ltd., Willesden, London. These have been used by Admiralty, War Office and Air Ministry, supplying power for daylight signaling, X-ray apparatus, battery charging, landing lights for aerodromes and general lighting of huts, dugouts, etc.

Radiotelephony, Generators for

Dynamotors and Wind-Driven Generators for Radiotelephony, R. G. Thompson. Elec. Jl., vol. 16, no. 5, May 1919, pp. 205-210, 12 figs. Single-armature, double commutator, bipolar, ball-bearing, totally-enclosed direct-current machine, 5 in. in diameter and 8.5 in. long, weighing approximately 15 lb.

Synchronous Motors

Synchronous Motor Characteristics—II, Theo. Schou. Elec. World, vol. 73, no. 18, May 3, 1919, pp. 880-883, 12 figs. Compound squirrel-cage winding developed for pulling into step synchronous motors carrying full load.

Utilizing the Time Characteristics of Alternating Current, Henry E. Warren. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 5, May 1919, pp. 629-643, 10 figs. Small self-starting synchronous motor devised for driving timing devices such as clocks, graphic-instrument movements, time recorders, etc., directly from lighting circuits.

Winding

Rewinding 12,000 Kw. Turbo Generator Field. Elec. World, vol. 73, no. 18, May 3, 1919, pp. 893-894, 3 figs. Work performed on insulation and damaged coils.

See also MECHANICAL ENGINEERING, Power Plants (Turbo Generators).

IGNITION APPARATUS

Magnetos

Sparking Power of Magnetos, Harry F. Geist. Automotive Industries, vol. 11, no. 18, May 1, 1919, pp. 949-953, 8 figs. Oscillograms showing electromotive force across contact points of breaker and current flowing in ignition circuit for five different points of interruption.

Experiments on the High-Tension Magneto—II, Norman Campbell. Lond. Edinburgh, and Dublin Phil. Mag., vol. 37, no. 220, Apr. 1919, pp. 372-396, 16 figs. Object of experiments was to discover how far the relation between peak potential, primary capacity, and coupling of circuits, which is predicted by theory, is found in experiment. (Continued.)

Spark Plugs

The Operation and Design of Sparking Plugs, H. Warren. Automobile Engr., vol. 9, no. 123, Feb. 1919, pp. 53-63, 14 figs. Actual ignition of explosive charge in engine cylinder is particular case with which writer deals, attention being confined to physical conditions under which ignition is effected and operation and design of sparking plugs. (To be concluded.)

LIGHTING AND LAMP MANUFACTURE

Lighting Codes

Present Status of Industrial Lighting Codes, G. H. Stickney. Am. Architect, vol. 115, no. 2264, May 14, 1919, pp. 694-698. In four states and in several establishments industrial lighting codes have been adopted for the protection of workers from accidents and eye strain. Specifications deal with intensity, glare limits and distribution. Various texts are discussed and suggestions are offered. (To be continued.) Paper presented at joint meeting of Am. Inst. Elec. Engrs. and Illuminating Eng. Soc.

Motion-Picture Projection

Mazda C Lamps for Motion Picture Projection, A. R. Dennington. Elec. Jl., vol. 16, no. 5, May 1919, pp. 201-204, 6 figs. Westinghouse equipment.

See also ORGANIZATION AND MANAGEMENT, Lighting.

MEASUREMENTS AND TESTS

Capacity and Capacitance

Measuring Capacity in a Three-Phase Armored Cable and Evaluation of the Current of Capacitance (Mesure de la capacité dans les câbles armés triphasés en vue de l'évaluation du courant de capacitance) Raymond Bouzon. Revue Générale de l' Electricité, vol. 5, no. 18, May 3, 1919, pp. 651-653, 4 figs. Theory and formulæ.

Electrostatic Glow Meter

The Electrostatic Glow Meter, R. J. Wensley. Elec. Jl., vol. 16, no. 5, May 1919, p. 228, 4 figs. For indicating in high tension switching stations presence of potential, grounded phase or synchronism between two separate high-tension lines.

Insulator Testing

Western Practice in the Testing of Insulators. Elec. Rev., vol. 74, no. 19, May 10, 1919, pp. 741-743. Report of Insulator Committee presented before Pacific Coast Section N.E.L.A. Covers tests used and adopted by various operating companies of Pacific slope together with description of equipment and limitations of the various methods.

Insulating Materials, Dr. Bultemann. Elecn., vol. 82, no. 17, Apr. 25, 1919, pp. 491-492. Their uses, breakdown voltages and preparation. (To be concluded.) From Gummi Zeitung, nos. 43, 45, 46, 47, 48, 1918.

Methods of Measuring Conductivity of Insulating Materials at High Temperatures, F. B. Silsbee and R. K. Honaman. Jl. Wash. Acad. Sciences, vol. 9, no. 9, May 4, 1919, pp. 252-266, 4 figs. Results obtained by use of alternating-current method on a number of types of samples. Figures show variation in resistance but similarity in constant b, which is a measure of temperature coefficient of their resistance.

Magnets, Permanent

Note on the Testing of Permanent Magnets, J. D. Morgan. Engineering, vol. 107, no. 2782, Apr. 25, 1919, pp. 525-526, 5 figs. Writer feels that it is undesirable to depart from established practice of specifying in terms of B_{rem} and H_c, but he suggests additional test for determining maximum B H product.

Temperature Indicators for Alternators

Temperature Indicators for Alternators, S. L. Henderson. Elec. Jl., vol. 16, no. 5, May 1919, pp. 193-196 11 figs. Of exploring coil and thermo-couple methods while both are admitted to give satisfactory results still the latter is believed to give results nearer maximum measurable temperature because it is said it indicates temperature at a spot while exploring coil gives average temperature over its length.

Voltages, High

Electrastatic Apparatus for Measuring Very High Voltages (Technische elektrostatische Apparate zur Messung sehr hoher Spannungen) A. Imhof. Schweiz. Elektrotechnischer Verein, Bul. no. 3, vol. 10 Mar. 1919 pp. 47-52, 7 figs. Apparatus described by writer is based on principle whereby only part of the voltage passes through "measuring system" (2 electrodes, one stationary the other movable), the remainder of the voltage passing through a series condenser.

POWER APPLICATIONS

Filtration Plant

Electric Filtration Plant, R. U. Steelquist. Jl. Electricity, vol. 42, no. 9, May 1, 1919, pp. 427-438 5 figs. Electrically pumped, electrically filtered water supply of Albany, Ore.

Heat Treatment

How the Power House Aids the Forge, L. F. Johnson. Iron Trade Rev., vol. 64, no. 19, May 8, 1919, pp. 1221-1226, 12 figs. How electricity is used for heat-treating guns and other heavy forgings by Inland Ordnance Co.

Heating

Heating Liquids by Electricity—the Past, the Present and the Future, H. O. Swoboda. Proc. Engrs. Soc. Western Pa., vol. 34, no. 8, Nov. 1918, pp. 537-571 and (discussion) pp. 572-574, 26 figs. Examination of several electric circulation water heaters, notably in the West, leads writer to believe that with the establishment of high-power central stations electric heating devices offer sufficient advantages to predict their general adoption.

Plate Mills

Electrically-Driven Plate Mills, G. W. Haney. Elec. Jl., vol. 16, no. 5, May 1919, pp. 188-192, 14 figs. Of Brier Hill Steel Co. Two 66,000 volt lines connect to a main and auxiliary bus which is supported in structural work by suspension insulators; bus arrangement allows flexibility in switching to permit any piece of apparatus to be cut out of circuit.

Quarrying

Quarrying and Working Stone by Electricity. Elec. Eng., vol. 53, no. 3, March 1919, pp. 105-107. Applications in Belgium, U. S. A. and Great Britain.

POWER GENERATION

Hydroelectric Plants

See Power Generation, MECHANICAL ENGINEERING.

See also MARINE ENGINEERING, Auxiliary Machinery (Electrical Auxiliaries.)

STANDARDS

Motor Rating

The Continuous-Rated Motor and its Application. L. F. Adams. Elec. World, vol. 73, no. 19, May 10, 1919, pp. 936-939. Reasons for adopting 50 deg. temperature rise for motor rating. Efficiency of economical use of motor material as affected by development of motor design and amelioration of hot spots.

Voltage Standardization

Standardization of Voltage in Switzerland (Zur Frage der Vereinheitlichung der Betriebsspannungen in der Schweiz). H. Schweiz. Elektrotechnischer Verein, Bul. no. 3, vol. 10, Mar. 1919, pp. 43-47. Normal voltage to be fixed on basis of voltage most generally employed lately. Figures presented show that 90 per cent. of current systems used and motors installed in 1918 were of the three-phase alternating-current type.

STORAGE BATTERIES

Charging

Charging Storage Batteries under Constant Voltage (Charge des accumulateurs sous tension constante), Fernand T'sas. Société Belge des Electriciens, vol. 33, Jan.-Mar. 1919, pp. 41-43, 2 figs. Scheme of connections.

See also RAILROAD ENGINEERING, Electric Railroads (Battery Locomotives.)

TELEGRAPHY AND TELEPHONY, RADIO

Airplane Telephone Sets

Development of Airplane Radiotelephone Set. H. M. Stoller. Elec. Jl., vol. 16, no. 5, May 1919, pp. 211-214, 10 figs. Transmitting circuit consists of two three-element vacuum tubes connected to an input transformer operated by a microphone telephone transmitter. S C R-68 set.

Nomenclature

Nomenclature in Wireless Telegraphy—II. W. H. Eccles. Elecn., vol. 82, no. 17, Apr. 25, 1919, pp. 499-500. Ionic tubes used in radio work. (To be concluded.)

Static Interference

Static Interference and the Wireless. Roy A. Weagant. Elec. Eng., vol. 53, no. 3, Mar. 1919, pp. 117-119, 1 fig. Writer states that other investigators have considered characteristics of signal wave and static wave to be the same. He holds an opposite view and claims to have discovered the nature of the difference and on this knowledge to have based his invention for preventing static interference. Paper read before Joint Meeting of Inst. Radio Engrs. and N. Y. Elec. Soc.

Transatlantic Reception

Transatlantic Radio Reception. Charles A. Culver. Jl. Franklin Inst., vol. 187, no. 5, May 1919, pp. 525-579, 13 figs. In order to provide for transatlantic communication in event of failure of cables, representatives of Navy and War Departments decided to establish six experimental radio stations at Army posts. Conditions, personnel equipment and results are discussed.

Valves, Ionic

Three-Electrode Lamp Valve (La lampe-valve à trois électrodes), C. Gutton. Revue Générale de l'Electricité, vol. 5, no. 17, Apr. 26, 1919, pp. 629-640, 16 figs. Work undertaken in the laboratories of the Radiotélégraphie Militaire.

See also AERONAUTICS, Auxiliary Service (Telephone Apparatus, Radio.)

TELEGRAPHY AND TELEPHONY, WIRE

Field Telephones

Field Telephone of the German Army (L'appareil téléphonique de campagne de l'armée allemande). Annales des Postes, Télégraphes et Téléphones, vol. 8, no. 1, 1919, pp. 94-102, 6 figs. Electrical scheme and connection for apparatus serving two lines.

Fullerphone

The Fullerphone. A. C. Fuller. Elecn., vol. 82, no. 19, May 9, 1919, pp. 536-538, 5 figs.; also Engineer, vol. 127, no. 3301, Apr. 4, 1919, p. 435, 5 figs. Among advantages claimed for its application to civil telegraphy are saving of battery power, simplicity of wiring and manipulation of instruments, covering long distances without relaying and reduction to minimum of maintenance of lines. Paper read before Instn. Elec. Engrs.

Marine Telephone, Anti-Noise

A Successful "Anti-Noise" Marine Telephone. Pac. Mar. Rev., vol. 16, no. 5, May 1919, pp. 121-123, 3 figs. Use of both ears is permitted by special construction of hand set.

Protection of Lines

Systems of Protecting Telephone Lines against Falling on Trolley Wires (Los sistemas de protección contra la caída de los hilos telefónicos sobre las líneas aéreas de los tranvías eléctricos), Eug. Aigouy. Energía Eléctrica, vol. 21, no. 5, Mar. 10, 1919, pp. 58-61. Systems employed in Norway, Switzerland, Russia and Spain. (Concluded.)

Telephone Receivers

On the Determination of the Electrical and Acoustic Characteristics of Telephone Receivers. Louis V. King. Jl. Franklin Inst., vol. 187, no. 5, May 1919, pp. 611-625, 5 figs. Theoretical aspect presented from viewpoint of possible improvements.

Unification of Telegraph and Telephone Facilities

Unification of Telegraph and Telephone Facilities in the St. Louis-East St. Louis Terminal District. Frederick E. Bentley. Official Proc. St. Louis Ry. Club, vol. 23, no. 11, Mar. 14, 1919, pp. 236-246. Suggests unification plan.

TRANSFORMERS, CONVERTERS, FREQUENCY CHANGERS

Insulation

The Insulation of Distribution Transformers. A. C. Farmer. Elec. Jl., vol. 16, no. 5, May 1919, pp. 223-227, 15 figs. Advantages claimed for treatment at Westinghouse plant, which reduced windings to solid mass of copper and insulation.

Parallel Connections of Transformers

Parallel Connection of Transformers Fed by One System or by Two Systems (La pratique de la mise en parallèle des transformateurs alimentés par le même réseau ou par deux réseaux), B. Guerschinovitch. Industrie, Electrique, vol. 28, no. 644, Apr. 25, 1919, pp. 148-153, 13 figs. Possibility of realizing delta or star connection in cases when both primary and secondary windings are at high tension, conditions being assumed to be theoretically perfect as regards connection of phases, etc.

Phase Transformation

Essentials of Transformer Practice—XXII. E. G. Reed. Elec. Jl. vol. 16, no. 5, May 1919, pp. 216-218, 5 figs. Phase transformation with autotransformers.

Scott Transformer Connections

Intensity and Maximum Power of Scott System of Connecting Transformers (Le calcul des intensités dans les transformateurs disposés suivant le montage de Scott et ses conséquences au point de vue de la puissance maximum admissible), E. Baticle. Revue Générale de l'Electricité, vol. 5, no. 17, Apr. 26, 1919, pp. 619-621, 2 figs. The two transformers are found to work under notably different conditions; consequently taking of suitable precautions is recommended.

TRANSMISSION, DISTRIBUTION, CONTROL

Circuit Protecting Devices

Circuits and Their Protecting Devices (in Japanese), M. Shibuzawa. Denki Gakkwai Zasshi, no. 369, Apr. 10, 1919.

Inductive Interference

Inductive Effects of Power Lines on Communication (in Japanese), M. Shibuzawa. Denki Gakkwai Zasshi, no. 369, Apr. 10, 1919.

Line Construction, Medium-Voltage

Construction Developments for Medium-Voltage Lines. D. F. Parrott. Elec. Rev., vol. 74, no. 18, May 3, 1919, pp. 703-708, 9 figs. Data of cost on man-hour basis. Paper read before Minnesota Electrical Assn.

Overload Relays

Overload and Reverse Power Relays. A. E. Hester. Elec. Eng., vol. 53, no. 1, Jan. 1919, pp. 17-22, 9 figs. Induction-type overload relay.

Substations

Outdoor Substations for Intercounty Development. Elec. World, vol. 73, no. 18, May 3, 1919, pp. 884-887, 10 figs. Substation through which small groups of consumers are being served from 26,400-volt circuits.

A Modern Substation. Roy R. Kime. Power Plant Eng., vol. 23, no. 10, May 15, 1919, pp. 437-440, 5 figs. Substation serving congested district in New York City. Attention is called to limitations imposed upon construction by the necessity of placing substation near center of load, among residences, where real estate is high and where quiet operation and freedom from vibration are essential.

Largest Portable Substation. Elec. Eng., vol. 52, no. 6, Dec. 1918, pp. 11-12, 3 figs. Long Island R. R. Co. emergency substation having normal capacity of 1500 kw.

Voltage Regulation

Voltage Regulation. J. Humphrey. Iron & Coal Trades Rev., vol. 98, no. 2668, Apr. 18, 1919, pp. 472-473, 6 figs. Importance of regulating voltage in collieries and other industrial concerns. Methods for securing it and description of Westinghouse system of compounding alternators, invented by Prof. Miles Walker.

WELDING

See MECHANICAL ENGINEERING, Welding (Electric Welding).

WIRING

Hotel

Electric Service in World's Largest Hotel—I. Elec. World, vol. 73, no. 19, May 10, 1919, pp. 940-943, 8 figs. Schematic diagram of feeders in riser shafts extending from basement to roof.

VARIA

Leclanche Cells

Renovation of Leclanché Porous Pots and the Re-use of the Interiors of Spent Dry Cells. W. J. Thorrowgood. Ry. Gaz., vol. 30, no. 18, May 2, 1919, pp. 763-764. Reported that old porous pots were renovated by treatment with solution of one part hydrochloric acid and five parts water. Paper read before Instn. Ry. Signal Engrs.

Statistics

Statistics of the Electrical Industry. Gas Age, vol. 43, no. 9, May 1, 1919, pp. 474-475. Reports upon central stations and street railways issued by U. S. Census Bureau.

Civil Engineering

BRIDGES

Culverts and Small Bridges

Culverts and Small Bridges. Charles D. Snead. Better Roads & Streets, vol. 9, no. 3, Mar. 1919, pp. 86-88. Examines mixing practice throughout State of Kentucky and lists what he terms faults in procedure.

Maintenance

See Painting and Maintenance below.

Military

Military Bridges Built by the English Army (Les pont-routes militaires de l'armée anglaise), R. Mechin. Génie Civil, vol. 74, no. 15, Apr. 12, 1919, pp. 285-291, 18 figs. and 2 extra plates. Construction, and erection of Inglis, Portal, Dawit and Hopkins types. Organization of engineering corps.

Painting and Maintenance

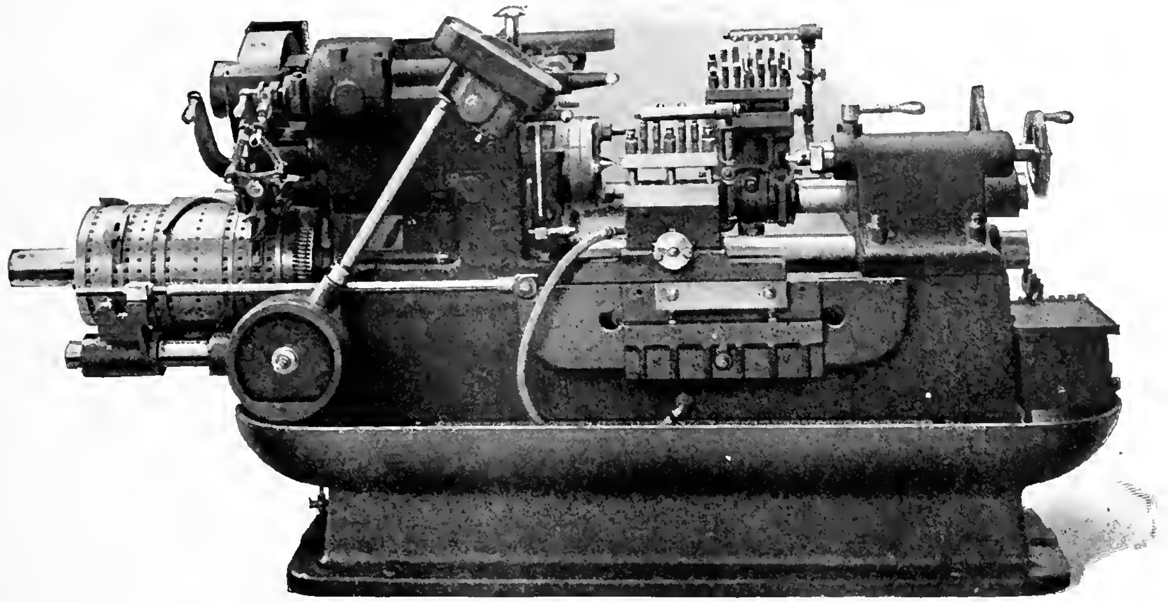
Recommended Procedure in the Painting and Maintenance of Highway Bridges. Charles D. Snead. Mun. & County Eng., vol. 56, no. 5, May 1919, pp. 171-172. Periodical inspection of structures, particularly of small culverts after very hard rain, is recommended as advisable practice.

A Survey of Electric Railway Bridge Maintenance. R. C. Cram. Elec. Ry. Jl., vol. 53, no. 20, May 17, 1919, pp. 952-959, 11 figs. Specifications of Massachusetts Public Service Commission.

Raising Bridge

Raising Allegheny River Bridge 13 Feet by Jacking. Eng. News-Rec., vol. 82, no. 18, May 1, 1919, pp 850-854, 9 figs. Increasing by 12.6 ft. the underclearance of a four-track, two-level steel structure at Pittsburgh without interruption of traffic.

The Fay Automatic Lathe



An automatic machine for simultaneous turning, facing and shouldering cuts on bar stock and centered forgings, such as pinion shafts, steering knuckles, cam shafts, etc.

An automatic machine for second operations on work held on centered arbors, such as spur and bevel gear blanks, hubs, pulleys, etc.

Designed with strength and driving power to carry all the tools, speed, and feed the work will stand under balanced cuts.

JONES & LAMSON MACHINE COMPANY

SPRINGFIELD, VERMONT, U. S. A.

109 Queen Victoria Street, London, E. C.

France, Spain and Belgium: F. Auberty & Co., 91 Rue de Maubeuge, Paris
Holland: Spliethoff, Beeuwkes & Co., Rotterdam

SEE OUR DATA IN 1918 A.S.M.E. CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT

Reinforcement

Reinforcement of Bridge by Means of an Eccentric Chord. Eng. News-Rec., vol. 82, no. 19, May 8, 1919, pp. 912-914, 4 figs. Strengthening steel bridge span in Chicago without infringing on underclearing and without using falsework.

Repairs

Repairs to Bridge at Kampen, Holland (Herstellingswerken aan de brug over den Ijssel te Kampen), J. C. Pannekoek. De Ingenieur, vol. 34, no. 12, Mar. 22, 1919, pp. 204-206, 8 figs. Collision of steamer with one of the girders damaged bottom flange, plates and angles being torn away. Damaged parts were removed and actual tension on girder determined by calculation and checked by spring balance temporarily inserted.

Small Bridges

See Culverts and Small Bridges above.

Superstructure

Design of New Superstructure of Louisville Bridge with 644-Foot Riveted Span. Eng. News-Rec., vol. 82, no. 21, May 22, 1919, pp. 1007-1011, 10 figs., partly on separate plate. Replacement of Pennsylvania's historic Fink-truss bridge over Ohio River at Louisville, Ky., said to have involved design and erection under exceptional conditions.

Wilson Bridge

Wilson Bridge Combines Stone and Concrete. Contract Rec., vol. 33, no. 20, May 14, 1919, pp. 451-453, 4 figs. Six-span arch structure over river Rhône has masonry arches, cut-stone trimmings and Hennebique type concrete deck.

BUILDING AND CONSTRUCTION

Army Construction Division

The World's Biggest Building Project, Arthur J. Widmer. Jl. Engrs. Club of St. Louis, vol. 4, no. 2, Mar.-Apr. 1919, pp. 125-141. Work of the Construction Division of the army said to have involved expenditure of $1,200,000,000 for period of 18 months.

Concrete Houses

Housing Project Construction Costs, Charles F. Willis. Concrete, vol. 14, no. 5, May 1919, pp. 185-190, 14 figs. Concrete houses in groups at Tyrone, N. M.

Cottage

The Perfect Double-Flatted Cottage Dwelling, Robert Thomson. Building News, vol. 116, no. 3353, Apr. 9, 1919, pp. 212-213, 1 fig. Structural arrangement of offices housing water-using appliances and their combination with entrance lobby makes each of them independently accessible therefrom.

Stucco-Coated English Type of House. Building Age, vol. 41, no. 5, May 1919, pp. 162-163, 4 figs. Plans, elevations and cross-sections of three-story 35-ft. x 31-ft. design.

Dams

See Earthwork, Rock Excavation, etc.

Factory Production of Building Parts

Reducing Construction Costs—II, Theodore F. Laist. Am. Contractor, vol. 40, no. 19, May 10, 1919, pp. 21-22 and 35. Suggests factory production of essential structural parts of dwellings as way to offset high cost of materials.

Floors

Reducing Construction Costs, Theodore F. Laist. Am. Contractor, vol. 40, no. 18, May 3, 1919, pp. 32-34, 10 figs. Reinforced-concrete floors in apartment buildings are suggested as means of decreasing depreciation charges and eliminating loss through obsolescence.

Halifax Ocean Terminals

Reinforced Concrete Building, J. J. Macdonald. Can. Engr., vol. 36, no. 18, May 1, 1919, pp. 427-429, 1 fig. General plan of part of Halifax ocean terminals showing coach cleaning and storage yard.

Housing Projects

Notes on Grading and Planting Plans for Government Housing Projects, H. V. Hubbard. Landscape Architecture, vol. 9, no. 3, Apr. 1919, pp. 131-140. Concerning projects executed by U. S. Housing Corporation.

Competition for the Design of a Housing Scheme at Bözingen, near Biel (Wettbewerb für eine Wohnkolonie im Fuchsenried in Bözingen bei Biel). Schweizerische Bauzeitung, vol. 73, no. 7, Feb. 15, 1919, pp. 67-72, 8 figs. Specifications required 60 per cent of dwellings should have 2 bedrooms, living room, kitchen, cellar and attic; 30 per cent 3 bedroms instead of 2; and 10 per cent 4 bedrooms and in addition a separate kitchen. Schemes of six competitors and report of assessors are given with criticisms and comments.

Industrial Housing

Industrial Housing, C. W. Ruth. Stone & Webster Jl., vol. 24, no. 5, May 1919, pp. 388-392, 2 figs. Believes that the most economical structure is the five to six-room house, because it allows family to take one or two roomers and boarders.

Reservoirs

Circular Concrete Reservoirs at Leamington, Ont., Edward M. Proctor. Can. Engr., vol. 36, no. 19, May 8, 1919, pp. 433-435, 8 figs. Provide storage of 1,000,000 imp. gal. Low unit stress has been used for steel and walls are entirely separate from floor.

Oil Fuel Reservoir of Rosyth. Engineer, vol. 127, no. 3301, Apr. 4, 1919, pp. 324-325, 2 figs. Concrete structure on rock foundation; walls built in form of retaining walls with average height of 35 ft., and reinforced with steel rods laid in direction of length of wall in layers 3 ft. apart in vertical direction, and spaced from 1 ft. to 4 ft. apart in horizontal direction.

Roofs

Erecting Long-Span Roof over Steel Mill by Rolling Trusses to Place. Eng. News-Rec., vol. 82, no. 19, May 8, 1919, pp. 898-902, 8 figs. Trusses rolled along craneway in groups weighing 800 tons.

School House

Standard School House Equipment and Details. Am. Architect, vol. 115, no. 2263, May 7, 1919, pp. 657-663, 11 figs. N. Y. City practice of forming folding partitions.

Vibrations

Vibrations in Buildings Due to Electrical Machinery, A. B. Eason. Post Office Elec. Engrs. Jl., vol. 12, part 1, Apr. 1919, pp. 32-40, 3 figs. Noise and vibration dealt with is that being due to telephone charging sets and ringing machines. Various reports dealing with conditions in post-office telephone exchanges are mentioned.

Warehouse

Eaton Mail Order Building, Moncton, N. B. Contract Rec., vol. 33, no. 20, May 14, 1919, pp. 449-450, 2 figs. Six-story flat-slab reinforced-concrete warehouse.

CEMENT AND CONCRETE

Car Floats

Construction of Concrete Car Floats for the Government. Concrete, vol. 14, no. 5, May 1919, pp. 181-183, 8 figs. Concrete is poured in three units: (1) bottom skin, keelsons and frames, and outside skin and frames; (2) bulkheads; (3) stanchions, deck beams, girders and deck slabs.

Concrete Mixes

Correct Proportioning of Concrete Mixes, Duff A. Abrams. Am. Architect, vol. 115, no. 2265, May 21, 1919, pp. 721-733, 9 figs. Report of investigations covering consistency (quantity of mixing water), size and grading of aggregates, and mix (proportion of cement) conducted during past three years at Structural Materials Research Laboratory, Lewis Institute, Chicago, with coöperation of Am. Inst. of Architects and Portland Cement Assn.

Design of Concrete Mixtures, Duff A. Abrams. Concrete, vol. 14, no. 5, May 1919, pp. 191-195, 4 figs. Results of investigations conducted at Lewis Institute, Chicago, covering relation between consistency, size and grading of aggregates and mix.

Iron Portland Cement

Iron Portland Cement in Reinforced Concrete, Edwin H. Lewis. Iron & Coal Trades Rev., vol. 98, no. 2669, Apr. 25, 1919, p. 510. Claims that in properly made iron portland cement there should be no difficulty in keeping sulphur percentage below requirements of British standard specification. Paper before West of Scotland Iron & Steel Inst.

Mortars and Concretes, Physical Properties of

Physical Properties of Mortars and Concretes, H. M. Thompson. Can. Eng., vol. 36, no. 18, May 1, 1919, pp. 415-422 and 429, 18 figs. Tests show that 1:2 mortar without addition of chemicals and cured in a moist closet resists attack by alkali solution, but is disintegrated when steam-cured; addition of soap and aluminum sulphate decreases strength of mortars and renders them more liable to disintegration.

Pneumatic Concreting

Pneumatic Method of Concreting, H. B. Kirkland. Cement & Eng. News, vol. 31, no. 5, May 1919, pp. 23-25, 3 figs. Consist in blowing batches of concrete through pipe from central point of supply to their place into concrete form.

Retaining Wall

New Type of Sectional Concrete Retaining Wall. Ry. Rev., vol. 64, no. 19, May 10, 1919, pp. 690-691, 4 figs. Material in form of 8-in. reinforced-concrete I-beams was secured and laid in form of cribbing or retaining wall.

Rodding

Improving Concrete by Rodding, F. E. Giesecke. Eng. News-Rec., vol. 82, no. 20, May 15, 1919, pp. 957-958, 2 figs. Tests are said to have shown that strength is increased materially by continuous agitation of wet concrete with rods.

Setting Time of Portland Cement

Notes on the Setting Time of Portland Cement, F. Esling. Jl. Soc. Chem. Indus., vol. 38, no. 7, Apr. 15, 1919, pp. 81T-82T. Advocates further revision of standard specification of cement testing in respect to water that should be used in gaging cement-setting-time tests, and for this purpose distilled water is suggested as most readily obtainable standard.

Slag Production

Largest Slag Producer in America. Cement Mill & Quarry, vol. 14, no. 9, May 5, 1919, pp. 11-13, 14 figs. Plant at Ensley designed to produce 4000 tons of basic slag, crushed and screened in seven standard sizes.

Trunking, Concrete

Construction and Use of Concrete Trunking, B. A. Lundy. Ry. Signal Engr., vol. 12, no. 5, May 1919, pp. 169-170, 2 figs. Scarcity of cypress and high cost of sizes required led to development of this type.

See also RAILROAD ENGINEERING, Permanent Way and Buildings (Abutments and Grade Crossings.)

EARTHWORK, ROCK EXCAVATION, ETC.

Dams

Sweetwater Dam Enlarged for the Third Time, H. N. Savage. Eng. News-Rec., vol. 82, no. 20, May 15, 1919, pp. 948-952, 6 figs. Construction of siphon spillways and enlargement of weir spillways to take care of maximum flood.

Dredging

Embankments of the Zuider Zee (De dijken in de Zuiderzee), K. dem Tex. De Ingenieur, vol. 34, no. 13, Mar. 29, 1919, pp. 227-228. Advantage claimed for suction dredges with pressure pipes is great output independent of wind and weather.

Filling

Computation of Time Required to Fill a Graving Dock, Eugene E. Halmos. Eng. News-Rec., vol. 82, no. 19, May 8, 1919, pp. 920-921, 1 fig. Based on method of filling from upper orifice or from usual gate openings at bottom of dock.

Inspection of Dredging

Inspection of Drainage Ditch Cross-Sections After Contract Dredging, E. S. Blaine. Eng. News-Rec., vol. 82, no. 21, May 22, 1919, pp. 1019-1022, 7 figs. Soundings made by level rod gave way to lead and line following along tape.

Sinking

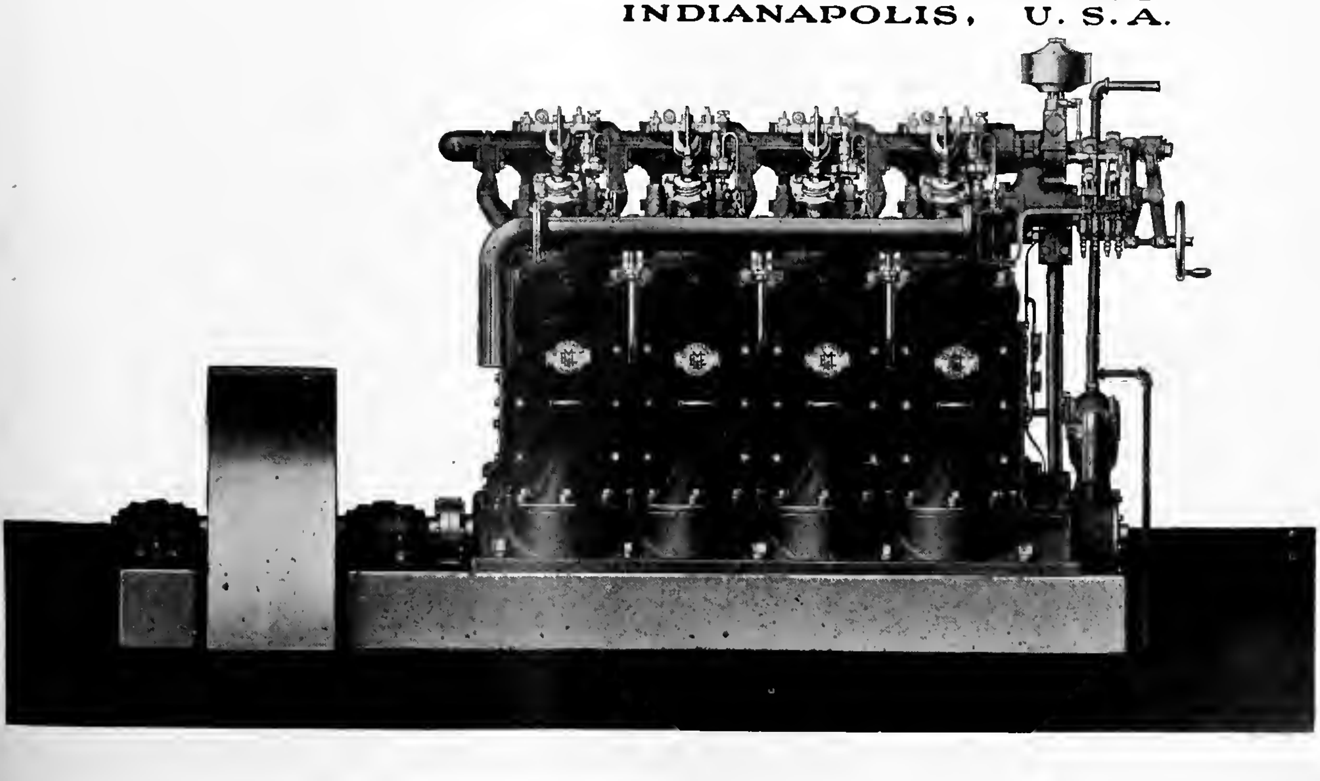
Sinking a Concrete Pumping Station in a River, Keith O. Guthrie. Eng. News-Rec., vol. 82, no. 21, May 22, 1919, pp. 1013-1016, 6 figs. House consisting of concrete cylinder 30 ft. in diameter lowered while being built from frame controlled by ratchet wrenches tied together for simultaneous movement.

Steam Shovel

A Review of Modern Steam Shovel Practice, with Recommended Procedure, Llewellyn N. Edwards. Mun. & County Eng., vol. 56, no. 5, May 1919, pp. 176-179, 3 figs. Economy and efficiency of shovel operation believed to be mainly dependent on properly proportioned combination of latent power of machine with skill and experience of operator.

Tunneling

Tunnel Between Denmark and Sweden (Om tunnelbanen København-Malm), Heinrich Obrt. Ingenioren, vol. 28, no. 15, Feb. 19, 1919, pp. 94-95. Project contemplates connection across harbor dam with Amagar Island. It is proposed to sink shafts at Saltohlm Island from which tunneling will be carried in two directions. Total length to be 31¼ miles of which 11 miles will be below sea level.



HARBORS

Philadelphia

Harbor Developments of the Port of Philadelphia in Progress and Contemplated, W. B. Ladue. Jl. Engrs. Club Philadelphia, vol. 36-5, no. 174, May 1919, pp. 188-193. Forecasts great future for this port, and suggests advertising its present possibilities.

MATERIALS OF CONSTRUCTION

Liquid Air for Blasting

Liquid Air as an Explosive (Het schieten met vloeibare lucht in de Nederlandsche Kolenmijnen), W. H. D. de Iongh. De Ingenieur, vol. 34, no. 10, Mar. 8, 1919, pp. 176-179, 2 figs. Experiments with cartridges containing finely powdered soot, charcoal, bituminous coal, paper, cork, reed and sawdust saturated with liquid air. This explosive is said to have been found equal to dynamite.

Roofing Materials

Bituminous Roofing Materials and Construction—II, George Landis Wilson. Chem. & Metallurgical Eng., vol. 20, no. 9, May 1, 1919, pp. 484-486, 4 figs. Comparative tests of thickness, tensile strength, absorption of moisture, pliability, volatility and fillers.

ROADS AND PAVEMENTS

Asphalt

Hot Mix Asphalt Pavements, Francis P. Smith. Can. Engr., vol. 36, no. 21, May 22, 1919, pp. 472-474 & 482. Determining character of drainage and on manner of utilizing existing pavements. Paper read before Sixth Can. Good Roads Congress.

Bituminous Pavements

Defects in Surface of Bituminous Pavement Due to Concrete Base, H. W. Skidmore. Eng. News-Rec., vol. 82, no. 18, May 1, 1919, pp 878-880. Data collected at Oak Park, Ill., interpreted as indicating that cracks and other objectionable features are a minimum where flexible foundations are used.

Efficiency of Bituminous Surfaces and Pavements Under Motor Truck Traffic, Prevost Hubbard. Am. City, City Edition, vol. 20, no. 5, May 1919, pp. 455-458.

Brick

Design and Construction of the Monolithic Brick Road South of Seneca, Ill., A. H. Hunter. Mun. & County Engr., vol. 56, no. 5, May 1919, pp. 161-163, 6 figs. Plans called for alteration of grade by reduction to maximum of 7 per cent, a specification which required heavy excavation on hill.

Brick Pavements in the Middle West, A. T. Goldbeck and F. H. Jackson. Public Roads, U. S. Dept. Agriculture, Bur. Public Roads, vol. 1, no. 10, Feb. 1919, pp. 3-18, 14 figs. Writers conclude from their survey that type and thickness of base should depend upon maximum load or weight to be carried and the bearing value, under all weather conditions, of the underlying soil. Further conclusions applying to special cases were also formed.

General Features of Brick Pavement Construction, A. T. Goldbeck and F. H. Jackson. Eng & Contracting, vol. 51, no. 19, May 7, 1919, pp. 479-481. From observations made during inspection trip of large number of brick roads in the Middle West. See note to preceding item.

Present Status of Brick Pavements Constructed with Sand Cushions, Cement Mortar Beds, and Green Concrete Foundation, Wm. M. Acheson. Better Roads & Streets, vol. 9, no. 3, Mar. 1919, pp 83-84. Paper before Am. Road Builders' Assn.

Concrete Highway Standards

Concrete Highway Construction Standards Raised. Eng. News-Rec., vol. 82, no. 20, May 15, 1919, pp. 955-956. Mississippi Valley State Road Officials recommend tamped concrete and heavier sections.

Concrete Sidewalks

Design of Concrete Sidewalks and Concrete Curb and Gutter at Street Intersections, W. Robert Paige. Mun. & County Eng., vol. 56, no. 5, May 1919, pp. 188-189, 3 figs. Examples of lines of walks and curves, intersected at angle of 78 deg. 14 min. on one side and 101 deg. 46 min. on other side.

Cost Charts

The Cost of a Mile of Road, George A. Duren. Eng & Contracting, vol. 51, no. 19, May 7, 1919, pp. 485-486, 3 figs. Charts based on prices assumed as averages. Paper presented before Engrs. & Road Builders' Congress.

Dixie Highway

Design and Construction of the Dixie Highway from Rockwood to Monroe, Mich. Leroy C. Smith. Mun. & County Eng., vol. 56, no. 5, May 1919, pp. 163-165, 2 figs. Metal top is 18 ft. wide with uniform thickness of 7 in. and 5-ft. shoulders. Grade is uniform, with no heavy cuts or fills, country being low and level and soil a heavy clay the entire length.

Easements and Superelevations

Superelevations and Easements, George Alden Curtis. Good Roads, vol. 17, no. 19, May 10, 1919, pp. 199-201, 5 figs. Field methods of constructing pavements with banked and easement curves.

Guarantees

Pavement Guarantees. Mun. Jl. & Public Works, vol. 46, no. 20, May 17, 1919, pp. 355-356. Practice of counties throughout U. S. A. as to requiring them and opinions of county officials as to their desirability.

Finishing Concrete Roads

The Finishing of Concrete Roads by Machine, E. G. Carr. Am. City, Town & County Edition, vol. 20, no. 5, May 1919, pp. 429-431, 2 figs. Illustrating how entrapped air is removed from concrete by alternating pressure.

Illinois

Illinois Adopts a Uniform Basis of Design for all Types of Rigid Pavement, Clifford Older. Eng. News-Rec., vol. 82, no. 19, May 8, 1919, pp. 905-907. State bond issue of \$60,000,000 together with about \$24,000,000 of Federal aid appropriation is to be expended for road building. It has been decided to use mainly concrete but brick or bituminous-concrete on concrete base have also been considered for main roads.

Macadam

Bituminous Macadam, A. W. Dean. Can. Engr., vol. 36, no. 21, May 22, 1919, pp. 469-470. Various rules are given for preventing unsatisfactory results with bituminous macadam.

Marker, Standardization

Uniform Markers for Our Highways, Roy E. Berg. Motor Age, vol. 35, no. 20, May 15, 1919, pp. 30-32, 14 figs. Road signs recommended for standardization.

Pavings for Electric-Railway Tracks

Investigation of Pavings for Electric Railway Tracks, H. S. Cooper. Elec. Traction, vol. 15, no. 5, May 1919, pp. 318-328. Advises that in comparing various types and kinds of paving it is well to consider that each has the type of base or foundation best suited to its stability as a whole and that such base or foundation is of ample strength of itself to relieve paving of any stresses or strains other than those which crush, roll or otherwise disintegrate or wear the actual body of the paving itself.

Road Oil

The Use of Road Oil. Am. City, Town & County Edition, vol. 20, no. 5, May 1919, pp. 423-427, 2 figs. Costs and tentative specifications prepared for highway engineers.

State Highway Management

State Highway Management, Control and Procedure, M. O. Eldridge, G. G. Clark and A. L. Luedke. Public Roads, U. S. Dept. Agriculture. Bur. Public Roads, vol. 1, no. 10, Feb. 1919, pp. 29-103, 28 figs. Schematic diagram of organization in state highway forces in 28 states.

Washington (State)

The Road Building Sands and Gravels of Washington, Morris M. Leighton. Wash. Geol. Survey, bul. 22, 1919, 307 pp., 45 figs. Studies covered (1) field examination to determinate nature, extent and manner of occurrence, and (2) laboratory tests to ascertain probably quality for gravel macadam and the various forms of pavement in which sand and gravel are used.

Wood-Block Pavement

Procedure in Constructing an Open Joint Wood Block Pavement at Toledo, Ohio, Raymond Pierce. Mun. & County Eng., vol. 56, no. 5, May 1919, pp. 174-175, 2 figs. Work carried on during winter months. Tractor was used to steam stone and sand and to furnish hot water for concrete mixer.

SANITARY ENGINEERING

Comfort Stations

Comfort Stations Are National Necessities. Domestic Eng., vol. 87, no. 5, May 3, 1919, pp. 186-188 and 223, 2 figs. Need of immediate erection of public conveniences believed to be important part of reconstruction program. Arrangement suggested.

Sewage Disposal

Results of Experiments With Miles Acid Process of Sewage Treatment, Edgar S. Dorr. Eng. & Contracting, vol. 51, no. 20, May 14, 1919, pp. 510-513. From experiments conducted at various institutions it is concluded that Miles process will produce a well-disinfected effluent from which 90 per cent. of settleable solids and 99 per cent. of the bacteria have been removed. From Jl. Boston Soc. Civil Engrs.

The Sewage Disposal Problem in Chicago, C. D. Hill. Mun. & County Eng., vol. 56, no. 5, May 1919, pp. 180-181. Dilution process used.

Sewage Screens

Operation of Fine Sewage Screens at Long Beach, California. Eng. News-Rec., vol. 82, no. 21, May 22, 1919, pp. 1012-1013. Tests reported to have indicated that screens remove 16.3 per cent. of solids.

Sludge Activation

Activated Sludge Experiments at Sheffield—Successful Results by Agitation, John Haworth. Contract Rec., vol. 33, no. 19, May 7, 1919, pp. 438-439, 1 fig. Analysis of samples from experimental aeration plant, Sheffield Sewage Works.

SURVEYING

Astronomical Meridian Determination

Polaris Observations for Azimuth in Northern Latitudes, J. Maughs Brown. Eng. Education, Bul. Soc. for Promotion of Eng. Education, vol. 9, no. 8, Apr. 1919, pp. 305-316, 4 figs. Suggestions intended to simplify field work and computations in determining astronomical meridian.

Magnetic Meridian Determination

A Method of Determining the Magnetic Meridian as a Basis for Mining Surveys, T. Lindsay Galloway. Trans. Instn. Min. Engrs., vol. 56, part 4, Apr. 1919, pp. 222-227 and (discussion) pp. 227-235, 3 figs. Describes theodolite and three tripods, and appliance termed "magnetic reflector," which consists of a small plate-glass mirror to which is cemented a flat magnetized bar, the whole being delicately suspended by a single fiber of unspun silk. These apparatus are introduced in writer's method for the purpose of correcting what he terms the deficiencies in Beanland's extension of astronomical methods to underground surveying.

Spirit Leveling

Spirit Leveling, R. B. Marshall. Dept. of the Interior, U. S. Geol. Survey, bulletins 632 to 636 and 638. In W. Va., Me., La., Ga., Ark.; and N. Mex. A separate bulletin for each state.

WATER SUPPLY

Factory Water Supply

What It Pays to Know About Factory Water Supply—III, Charles L. Hubbard. Factory, vol. 22, no. 5, May 1919, pp. 919-923, 7 figs. Contaminated drinking water supplied to workers said to have cost one company \$50,000 in death and sickness claims.

Filtering at High Rate

Reports on Detroit Waterworks. Mun. Jl. & Public Works, vol. 46, no. 19, May 10, 1919, pp. 334-337. Investigation conducted under auspices of Board of Water Commissioners concerning possibilities of filtering water at high rate.

Reservoirs

The High Service Reservoir of the St. Paul, Minn., Water Works, W. N. Jones. Mun. & County Eng., vol. 56, no. 5, May 1919, pp. 165-168, 6 figs. Investigation of proposition relative to securing entire city supply from artesian well and using Mississippi river as source of supply.

Improving Providence Water Supply, John Rositer Hess, Jr. Mun. Jl. & Public Works, vol. 46, no. 20, May 17, 1919, pp. 350-353. Temporary dam and regulating dam with spillway of horseshoe shape. Reservoir is expected to permit elimination of pumping.

Testing Stations, Water Purification

Testing Stations for Determining Critical Factors for Water Purification Plant Design, W. T. McClenahan and R. S. Rankin. Eng. & Contracting, vol. 51, no. 20, May 14, 1919, pp. 515-516. Purpose of station was to study (1) effect of aeration on odor and taste, (2) kind and amount of chemical to be used and its effect on odor and taste, (3) period of sedimentation and time of contact giving best results, and (4) peculiarities in treatment of water contaminated by oil.

VIEWS illustrating the quantity production of "Chicago Pneumatic" Compressors. The Franklin, Pa., plants, here partially illustrated, cover more than eight acres of ground.

The Production Efficiency Back of "Chicago Pneumatic" Air Compressors

—like their well-known operating efficiency, is an asset to users in this definite way:

Every "Chicago Pneumatic" Compressor built is comprised of parts made to an accurate system of jigs, fixtures and templates which, supplemented by careful inspection and tests, maintains a dimensional uniformity of parts so accurate that replacements for any of *300 distinct sizes and types of compressors* may be ordered with the assurance that they will be strictly interchangeable with the old. The uniform quality and performance of each machine is a standardized certainty.

The production in large quantities of air compressor equipment, justifies an elaborate manufacturing system of this kind. Its development by the builders of "Chicago Pneumatic" Compressors is another indication of the broad service and engineering policies of this Company; another reason, why "Chicago Pneumatic" Compressors being *built* for better service, *give* it!

Regardless of your requirements there is a "Chicago Pneumatic" Air Compressor available to best fulfill them.

Ask for Bulletins

Chicago Pneumatic
Tool Company
1010 Fisher Building
New York Chicago San Francisco
Sales offices all over the world
C-17

"Chicago Pneumatic"
Products

Pneumatic Tools
Electric Drills
Air Compressors
Oil, Gas and
Steam Engines
Vacuum Pumps
Rock Drills

"CHICAGO PNEUMATIC"

The Compressor with the Simplate Valve

Water Softening

Water Softening for Municipalities, Milton F. Stein. Jl. Am. Water Works Assn., vol. 6, no. 2, June 1919, pp. 202-214, 5 figs. Essential features of softening plants are held to be mixing chambers in which softening reagents are thoroughly dispersed through the raw water, either by mechanical devices or by baffling, large settling basins whose capacity is based upon reaction period as determined for conditions of minimum temperature and means for adding a coagulant solution either at entrance to or near exit from settling basins or at both points.

WATERWAYS

Canal, Adriatic to Switzerland

From the Adriatic to Switzerland by Canal Boat (Dall' adriatico alla Svizzera per canali navigabili), Guido Po. Rivista Marittima, vol. 52, no. 3, Mar. 1919, pp. 289-308, 11 figs. Venice-Brondola-Pizzighettones, up rivers Po and Adda and industrial canal to Milan. In process of construction.

Flood-Water Control

The Control of Flood Water in Southern California, Edw. N. Munns. Jl. Forestry, Soc. Am. Foresters, vol. 17, no. 4, Apr. 1919, pp. 423-429, 1 fig. Construction of stone check-dams so placed across channel that the water, although able to percolate through them to some extent, collects in a basin behind the dam and then falls vertically, or nearly so, over its front face.

Short-Circuiting Floods in the Big Sioux River, Francis C. Shenehon. Eng. News-Rec., vol. 82, no. 20, May 15, 1919, pp. 961-964, 5 figs. Plan of spillway to guard against flood water in Big Sioux River near Sioux Falls, S. D.

VARIA

Stump Removal

Methods and Costs of Stump Removal in Land Clearing, F. M. White and E. R. Jones. Eng. & Contracting, vol. 51, no. 21, May 21, 1919, pp. 535-537, 3 figs. Examples of dynamite charges in various cases and stumping records made by crews. Investigations by Agricultural Experiment Station, Univ. of Wisconsin. Pulling with horse puller and then cracking with dynamite said to have been found to be the most economical method of stump removal.

Mining Engineering

BASE MATERIALS

Clays

Ball Clays of West Tennessee, Rolf A. Schroeder. Resources of Tennessee, State Geol. Survey, vol. 9, no. 2, Apr. 1919, pp. 81-180, 13 figs. Investigation covered location, geological relations and economic importance. Laboratory tests were made at Ceramic Laboratory, University of Illinois.

Garnet

Garnet in North Carolina and the Market for Abrasive Garnet, Frank J. Katz. Eng. & Min. Jl., vol. 107, no. 21, May 24, 1919, pp. 903-906. Report of examination of deposits and of canvass of producers and consumers.

COAL AND COKE

Alaska

The Nenana Coal Field, Alaska, G. C. Martin. Dept. of the Interior, U. S. Geol. Survey, bul. 664, 1919, 54 pp., 12 figs. Geology, geography and general features. Coal is classified as lignite of good grade.

Belgium

The Coal Beds of Belgium (Les gisements houillers de la Belgique), Armand Renier. Annales des Mines de Belgique, vol. 20, first issue, 1919, pp. 227-258. Stratigraphy. (Continuation of serial.)

Canada

Coal Resources of Western Canada—II, James White. Coal Age, vol. 15, no. 19, May 8, 1919, pp. 858-862, 1 fig. Government is reported to favor plan to carbonize low-grade coals of Saskatchewan for the purpose of saving freight and by-products.

Carbonization

Some Features of Carbonisation and By-Product Recovery, J. Thorp. Colliery Guardian, vol. 117, no. 3044, May 2, 1919, pp. 1015-1016, Beehive vs. patent coke for steel smelting. Paper read before Coke Oven Managers' Assn. (Midland Section).

Carbonizing Process, Low Temperature

G-L Low-Temperature Carbonizing Process. Coal Age, vol. 15, no. 18, May 1, 1919, pp. 810-812, 5 figs. Gases, oil and tars are liberated from coal at maximum temperature within retort not exceeding 1200 deg. fahr.; oils are thus expelled as vapors without being broken down by heat into gases; after removal from retorts they are condensed into liquid oils.

Coal-Cutting Machinery

Comparative Working Costs of Electrical and Compressed-Air Coal-Cutting Machines (Longwall) with Increased Outputs over Hand Hewing, F. A. Hale. Iron & Coal Trades Rev., vol. 98, no. 2668, Apr. 18, 1919, p. 478. Series of tests is presented in substantiation of writer's objections to installation of longwall coal-cutting machines in collieries. Paper read before North of England Branch Assn. Min. Elec. Engrs.

Coal Gas

Coal: Its Value as a Raw Material for Distillation Products—IV, Coal Gas, J. A. Wilkinson. South African Jl. Industries, vol. 2, no. 3, Mar. 1919, pp. 239-246, 1 fig. Methods of producing coal gas. (Concluded.)

Coke Ovens

New Coke Ovens at the Providence Gas Works, Edward D. Bauer. Gas Age, vol. 43, nos. 9 & 10, May 1 & 15, 1919, pp. 461-465 & 516-520, 17 figs. Plant has nominal capacity of 7,500,000 cu. ft. of gas per day and consists of one battery of 40 by-product coke ovens equipped coal-handling conveyors, crushing and mixing apparatus and bins for preparing coal, 750-ton coal-storage bin, quenching station, coke-handling conveyors and both metallurgical and domestic coke-screening stations. Three reversing machines—one damper and air-valve reversing machine and two gas-coke machines (one for coke side and one for crusher side gas coke).

Modern Coke Oven and By-Product Plant, Drummond Paton. Iron & Coal Trades Rev., vol. 98, no. 2668, Apr. 18, 1919, pp. 470-471. In discussing schemes suitable for Lancashire coal, writer remarks on features of low temperature, high temperature or gasification as factors determining successful operation. Paper read before Manchester Geol. & Min Soc.

Coking Low-Grade Fuel

Utilization of Mine Waste and Low-Grade Fuels (Utilisation des déchets de mines et des mauvais combustibles), F. Blache. Bulletin et comptes rendus mensuels de la Société de l'Industrie Minérale, series 5, vol. 15, first issue of 1919, pp. 5-28, 2 figs. Scheme for coking fuel with recuperation of by-products and purifying coke.

Coking Output of Coals

Coking Output of Coals (Quelques notes sur le pouvoir cokéfiant des charbons). Annales des mines de Belgique, vol. 19, third issue, 1914, pp. 625-651. Experiments with English, Belgian and German samples to determine agglutinant power as index of quality.

Costs

Coal-Mining Costs and Output. Times Eng. Supp., vol. 15, no. 554, Apr. 1919, p. 129. Comparison with America.

Kent, England

The Evolution and Development of the Kent Coalfield, A. E. Ritchie. Iron & Coal Trades Rev., vol. 98, nos. 2662, 2668, 2669, and 2670, Mar. 7, Apr. 18 & 25, May 2, 1919, pp. 289-290, 476-477, 508-509, and 537-538, 6 figs. From 1901 to 1905; operations in the latter part of 1906 and during 1907; from 1909-1910; comparative sections of pits at Dover and Tilmanstone to show strata between Gault and coal measures are illustrated; from 1911 to 1912; diagramatic section showing general position of Tilmanstone pits. (Continuaton of serial.)

Methane Accumulations

Methane Accumulations from Interrupted Ventilation, H. I. Smith and R. J. Hamon. Colliery Guardian, vol. 117, no. 3042, Apr. 17, 1919, pp. 895-896, 2 figs. Tests conducted in three mines—two in Southern Illinois and one in Indiana—showed that methane may accumulate from (1) sudden liberation from seams, cracks or other feeders, (2) emission from inaccessible and abandoned workings, as a result of either an increase or decrease in pressure of ventilating current and, (3) local accumulations resulting from any interruption of normal ventilating current.

Pyrites

Pyrite Deposits in Ohio Coal, W. M. Tucker. Economic Geolog., vol. 14, no. 3, May 1919, pp. 198-219, 3 figs. Total possible production of pyrite estimated at 250,000 tons yearly.

Recovery of Pyrite from Washery Refuse, E. A. Holbrook. Coal Age, vol. 15, no. 19, May 8, 1919, pp. 848-851, 4 figs. Efficiency of recovery of about 70 per cent is said to be realized by installation and operation of crushing, screening, jigging and sometimes tabling apparatus.

Screening Plant

Thurcroft Main Colliery. Iron & Coal Trades Rev., vol. 98, no. 2662, Mar. 7, 1919, pp. 279-280, 2 figs. & supp. plates. Equipment for an output of 4000 tons daily. Screening plant comprises several units each capable of dealing with 120 tons per hour.

Stripping

Coal Stripping in the United States—V, Wilbur Greeley Burroughs. Coal Indus., vol. 2, no. 5, May 1919, pp. 177-182, 2 figs. Differences between systems followed in bituminous and anthracite fields.

Russia

At the Anthracite Mines, South Russia, in the Early Days of the War, A. L. Simon. Min. Mag., vol. 20, no. 4, Apr. 1919, pp. 203-211, 2 figs. Area over which mining rights extend approximates 10,000 acres. Mine water, boiler house, winding engines and labor conditions are discussed from viewpoint of adaptability to special requirements and susceptibility to improvements.

Tipple and Washeries

New Tipple of the Granby Consolidated Mining, Smelting & Power Co., F. E. Mueller. Coal Age, vol. 15, no. 18, May 1, 1919, pp. 804-805, 3 figs. General layout of tracks, tipple and proposed washery, and details of solid-body mine car.

See also RAILROAD ENGINEERING, (Locomotives) (Pulverized Coal.)

COPPER

Leaching Ores

Leaching of Oxidized Copper Ores with Ferric Chloride, R. W. Perry. Min. & Sci. Press, vol. 118, no. 20, May 17, 1919, pp. 669-674, 2 figs. Patented process based on: $3 Cu O + 2 Fe Cl_3 + 3 H_2 O = 3 Cu Cl_2 + 2 Fe (OH)_3$; $3 Cu Cl_2 + 3 Fe = 3 Cu + 3 Fe Cl_2$; and $3 Fe Cl_2$ + Electricity = $Fe + 2 Fe Cl_3$.

See also MECHANICAL ENGINEERING, Materials of Construction and Testing of Materials (Copper.)

GEOLOGY AND MINERALOGY

Australia

A Geological Reconnaissance of the Country Between Laverton and the South Australian Border (near South Latitude 26 deg.), Including part of the Mount Margaret Goldfield, H. W. B. Talbot and E. de C. Clarke. Geol. Survey, Western Australia, bul. no. 75, 1917, 207 pp., 72 figs.

Brazil

Notes on the Geology of the Diamond Region of Bahia, Brazil, Roderic Crandall. Economic Geology, vol. 14, no. 3, May 1919, pp. 220-244, 14 figs. Opinions expressed by various explorers.

Chisone Valley

Contribution to the Study of Minerals in the Chisone Valley (Contributo allo studio dei minerali della Valle del Chisone), E. Grill. Atti della Societé Toscana di Scienze Naturali, Memorie, vol. 31, 1917, pp. 140-167, 6 figs. Pyrite, albite magnetite, dolomite, apatite, tremolite, actimolite, tourmaline and ilmenite.

Crystallography

Crystallography of some Canadian Minerals: 9. Cerussite, Eugene Poitevin. Am. Mineralogist, vol. 4, no. 5, May 1919, pp. 56-58, 3 figs. Crystals show three habits: Tabular crystals with large brachypinacoid, pyramidal crystals with well-developed prisms and pyramids and limited domes, and pyramidal crystals having r (130) as twinning plane.

Artificial Coloration of Helicoid Spherolites as Means to Determine Polymorphous Modifications (Coloration artificielle des sphérolites à enroulement hélicoïdal et distinction des modifications polymorphes par la couleur acquise), P. Gaubert. Bulletin de la Société Française de Minéralogie, vol. 41, nos. 7-8, July-Dec. 1918, pp. 198-224, 6 figs. Account of experiments. Coloring matter and colorless substance group themselves so as to form mixed crystals. Asparagine, tartrates and bimalates considered.

Georgia

Report on the State Deposits of Georgia. H. K. Shearer. Geol. Survey of Ga., bul. 34, 1918, 192 pp., 24 figs. Geological formations of Appalachian Valley and Cumberland Plateau areas. Only along eastern border, near Cartersville, are shaly beds considered as commercially valuable slates.

New Minerals

Review of New Mineral Species (Revue des espèces minérales nouvelles). P. Gaubert. Bulletin de la Société Française de Minéralogie, vol. 41, nos. 7-8, July-Dec. 1918, pp. 224-226. Coleraininte, collbranite and gilpinite.

Oregon

The Salient Features of the Geology of Oregon. Warren Dupre Smith and Earl L. Packard. Jl. of Geology, vol. 27, no. 2, Feb.-Mar. 1919, pp. 79-120, 3 figs. Including bibliography of important articles.

Tasmania

The North Pieman and Huskisson and Sherling Valley Mining Fields. A. McIntosh Reid. Tasmania Dept. Mines, Geol. Survey bul. 28, no. B-82381, 1918, 132 pp., 13 figs. Geological data, location and area, and topographical details.

Tonopah Divide

The Divide District. Frank L. Sozer. Min. & Sci. Press, vol. 118, no. 19, May 10, 1919, pp. 631-633, 4 figs. Important geological features of the Tonopah Divide are the pronounced fissuring and the volcanic uplift.

Water in Rock Formations

Water Expectancy in Tunnels, Mines and Deep Wells in Homogeneous Rocks. Robert E. Horton. Jl. Am. Water Works Assn., vol. 6, no. 2, June, 1919, pp. 183-186. Proposes method and formulæ by which data obtained from surface wells can be applied. Method is limited to cases where bedrock is somewhat uniform in character throughout all depths from rock floor down to bottom of tunnel or other structure.

LEAD, ZINC, TIN

Lead from Vanadinite

A Proposed Metallurgical Process for the Treatment of Vanadinite for the Recovery of Lead and Vanadium. J. E. Conley. Chem. & Metallurgical Eng., vol. 20, no. 10, May 15, 1919, pp. 514-518, 2 figs. Vanadinite concentrate is fluxed and reduced with soda ash, caustic and carbon, giving metallic lead; slag is elutriated Si and Mo precipitated with lime; vanadium pentoxide precipitated by boiling in acid solution.

Sintering Zinc Residues

Sintering Zinc Residues. K. Stock. Chem. & Metallurgical Eng., vol. 20, no. 10, May 15, 1919, pp. 525-537, 16 figs. Methods used by Bartlesville Zinc Co. After roasting and retorting, all residues are subjected to additional treatment depending upon amount and nature of metals to be recovered.

MAJOR INDUSTRIAL MATERIALS

Nickel

Canada Controls Nickel Output of the World. W. P. Sutherland. Can. Machy., vol. 20, no. 26, Dec. 26, 1918, pp. 730-736, 13 figs. Plant of International Nickel Co. of Canada at Port Colborne. Reference is made to laboratory and refineries.

See also METALLURGY, Aluminum, Copper and Nickel, and Iron and Steel.

MINES AND MINING

Bore-Hole, Diamond

Some Difficulties met with in Putting Down Diamond Bore-Hole Underground. J. Walker Steele. Iron & Coal Trades Rev., vol. 98, no. 2662, Mar. 7, 1919, p. 292, 1 fig. Account of difficulties met and dealt with in putting down 2-in. diamond borehole for the proving of underlying seams in faulty and difficult ground.

Cartridges, Safety

Safety Cartridge (Etude d'une Cartouche de Sûreté). Emmanuel Lemaire. Annales des Mines de Belgique, vol. 19, third issue, 1914, pp. 587-590. Mixture of calcium fluoride, sodium chloride, iron sulphate and sand reported found from experimental research to insure safety and permit minimum cartridge diameter. First article.

Concentrate Treatment

New Process for the Mechanical Preparation of Minerals (Nouveaux procédés de préparation mécanique des minerals). Echo des Mines et de la Metallurgie, vol. 47, no. 2620, Apr. 6, 1919, pp. 217-218. Wolfram and cassiterite mixed concentrates treated in Rapid apparatus.

Concentration

Economies of Concentration. A. P. Watt. Eng. & Min. Jl., vol. 107, no. 18, May 3, 1919, pp. 775-776, 3 figs. Evidence offered in substantiation of suggested advisability for operating a separate heat-treatment plant.

Deep Mines, Cooling and Drying

Cooling and Drying in Deep Mines. Sidney F. Walker. Refrig. World, vol. 54, no. 5, May 1919, pp. 23-24. Recommends refrigeration and cold-storage methods to make coal more accessible.

Explosives, Storage

Storage of Powder and Explosives at Coal Mines. E. M. Kimball. Coal Age, vol. 15, no. 18, May 1, 1919, pp. 794-795, 1 fig. Example of magazine built on brick foundation.

Geophone

The Geophone. Eng. & Min. Jl., vol. 107, no. 20, May 17, 1919, pp. 872-873, 2 figs. Invented by French to detect enemy sapping and underground mining operations and for ascertaining position of enemy artillery.

Hoisting

Hoisting in Coal Mines. W. J. Heeley. Can. Min. Inst. bul. no. 85, May 1919, pp. 498-503, 1 fig. Lines which writer believes to be close approximation to economy, from viewpoint of rope, for relative positions of drum and pulley, for shafts from 100 to 600 yards winding depth.

Lamp, Safety

The Chance Acetylene Safety-Lamp. William Maurice. Trans. Instn. Min. Engrs., vol. 56, part 4, Apr. 1919, pp. 273-280 and (discussion) pp. 280-284, 9 figs. Combines American type of Wolf lamp with Mueseler principle. It is provided with roof reflector which distributes illumination sidewise, thus making it unnecessary to tilt lamp.

Safety Lamp Gauzes—V. T. J. Thomas. Colliery Guardian, vol. 117, no. 3042, Apr. 17, 1919, pp. 898-899. Compilation of data on uses of non-ferrous metals as recorded by various experimenters.

Loading Machinery, Underground

Underground Coal-Loading Machinery. E. N. Zern. Coal Age, vol. 15, no. 18, May 1, 1919, pp. 784-791, 10 figs. Remarks in reference to results obtained in some mines that it is manifestly unfair to put any coal-loading machinery to work unless mining, haulage and other conditions are made favorable to its operation.

Power Plants

Economies in a Mine Power Plant. J. A. Carruthers. Power, vol. 49, no. 19, May 13, 1919, pp. 720-722, 3 figs. Example is quoted where it is said that power plant effected reduction of 13 to 15 tons of coal per day as result of several changes in equipment.

Queensland Mining Industry

Queensland Mining Industry. Queensland Gov. Min. Jl., vol. 20, no. 226, Mar. 15, 1919, pp. 97-114, 1 fig. Annual report of Under Secretary for Mines for 1918. It includes inspection of mines, state mining and boring operations, geological survey and methods of mining gold, copper, tin, silver, lead, wolfram, bismuth, molybdenite and scheelite.

Rescue Apparatus

Digest of the First Report of the Mine Rescue Apparatus Research Committee. David Penman. Trans. Instn. Min. Engrs., vol. 56, part 4, Apr. 1919, pp. 236-260 & (discussion) pp. 260-272, 7 figs. Committee was appointed by Advisory Council to Committee of Privy Council for Scientific and Industrial Research, to inquire into types of breathing apparatus used in coal mines and by experiment to determine the advantages, limitations and defects of the several types of apparatus, their possible improvements and the advisability to standardizing.

Respirator

The Use of the Gas Mask as a Respirator. A. C. Fieldner and S. H. Katz. Chem. Engr., vol. 27, no. 4, Apr. 1919, pp. 79-83, 3 figs. Directions of uses in chemical and metallurgical industries. Warning is issued against indiscriminate use of gas masks for any and all purposes; it is observed that poisonous gases used in warfare are chemically active and therefore combine readily with absorbents of gas mask; some of the gases, however, immediately penetrate the mask when present in quantities of one or two per cent.

Ties, Steel

Steel Mine Ties. R. B. Woodworth. Coal Age, vol. 15, no. 18, May 1, 1919, pp. 814-816, 6 figs. Gain in headroom, endurance, fireproofness, scrap value, and simplicity are quoted as some of the advantages of steel tie over wood rest.

Timbering

Safe and Efficient Mine Timbering—V. R. Z. Virgin. Coal Indus., vol. 2, no. 5, May 1919, pp. 175-177, 3 figs. Removing timber from pillar workings, hanging canvas and timbering with wire rope.

See also MUNITIONS AND MILITARY ENGINEERING (Mining); MECHANICAL ENGINEERING, Handling of Materials (Ore Handling).

MINOR INDUSTRIAL MATERIALS

Antimony

Pure Antimony (Reines Antimon). E. Groschuff. Zeitschrift für anorganische & allgemeine Chemie, vol. 103, no. 3, June 21, 1918, pp. 164-188. Technical refining of metallic antimony; electrolytic refining of antimony; crystallization of metallic antimony; precipitation and purification of antimony sulfide; crystallization of antimony as tartar emetic; analytical examination of antimony; examination of commercial antimony as to impurities; analytical and physical characterization of nominally pure antimony.

Chrome

Maryland Sand Chrome Ore. Joseph T. Singewald, Jr. Economic Geology, vol. 14, no. 3, May 1919, pp. 189-197, 5 figs. Account of Chrome industry in Maryland State. Paper presented before Geological Soc. of America.

Quicksilver

The Anticlinal Theory and Some Quicksilver Deposits. William H. Emmons. Eng. & Min. Jl., vol. 107, no. 21, May 24, 1919, pp. 916-917, 2 figs. Considers theory as applicable to prospecting of areas where structure conditions are favorable.

Vanadium

Treatment of Cuprodescloizite for Extraction and Recovery of Vanadium, Lead and Copper. J. E. Conley. Chem. & Metallurgical Eng., vol. 20, no. 9, May 1, 1919, pp. 465-469. It is held that the niter cake-sulphuric acid extraction is most economical.

OIL AND GAS

Holbrook Area

Study of Oil and Gas Possibilities of the Holbrook Area. Dorsey Hager. Salt Lake Min. Rev., vol. 21, no. 3, May 15, 1919, pp. 21-25, 6 figs. Determined from examination of general stratigraphic conditions structural characteristics, notably presence or absence of folding or intrusions that might create adverse conditions for oil or gas accumulations. No positive indications of petroleum were found in this Arizona area.

Movement of Oil Through Gas

Movement of Oil and Gas Through Rocks. Victor Ziegler. Petroleum Times, vol. 1, no. 13, Apr. 5, 1919, pp. 275-277. Surface tension of water being greater than that of oil affords explanation for passage of water through smaller openings while oil occupies larger ones. (Concluded from p. 38.)

Natural Gas

Utilization and Conservation of Natural Gas. L. L. Graham. Gas Age, vol. 43, no. 9, May 1, 1919, pp. 477-478. How public-service commissions can control situation. Paper read at conference called by Public Service Commission of Pa.

Domestic and Industrial Use of Natural Gas. John Gates. Gas Age, vol. 43, no. 9, May 1, 1919, pp. 470-471. Conditions in Pittsburgh district.

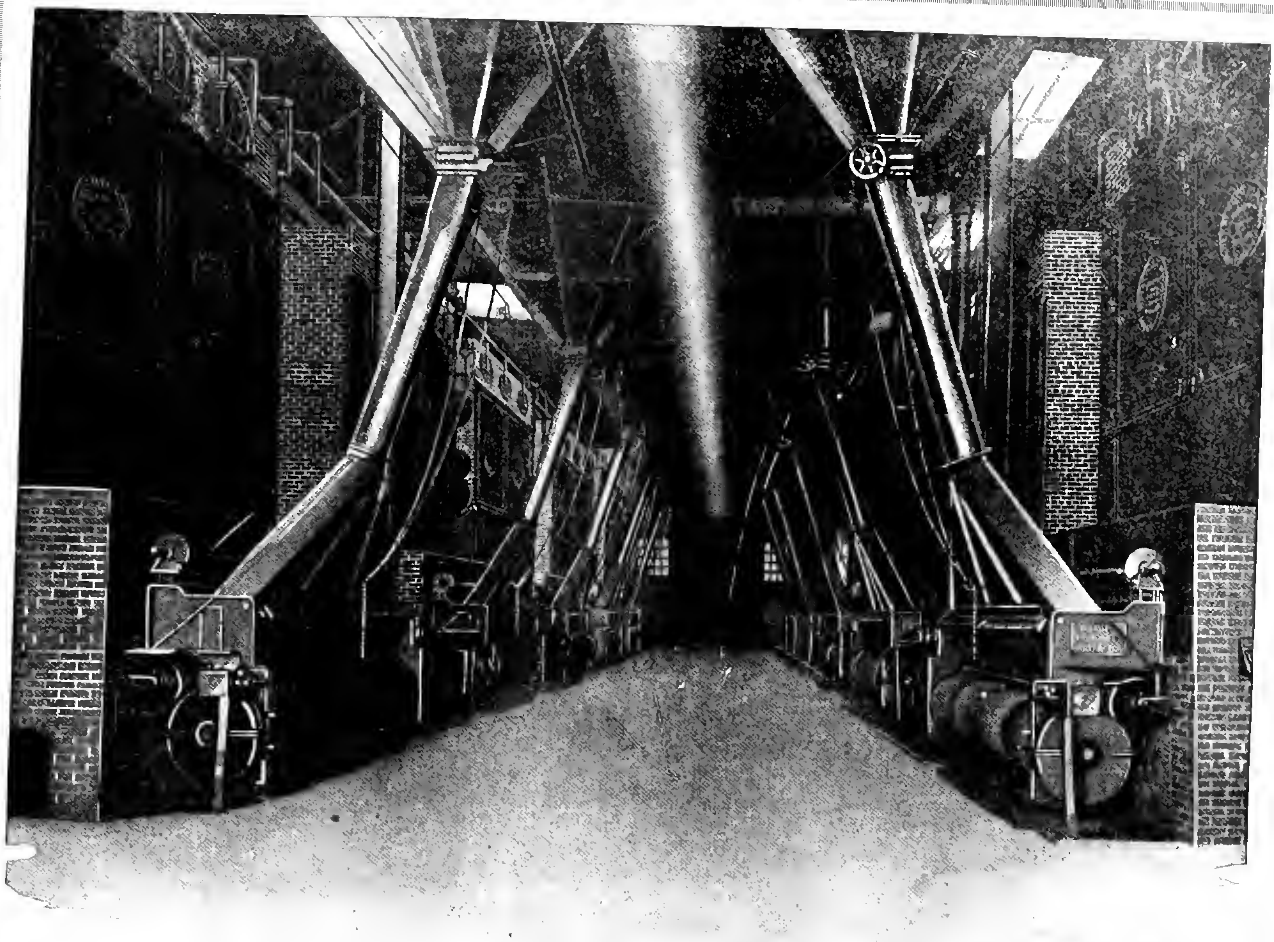
Texas

The Oil Fields of Northwestern Texas. W. L. Watts. Min. & Oil Bul., vol. 5, no. 5, Apr. 1919, pp. 255-258 and 269, 7 figs. Types of structures and petroleum geology in general. Third and concluding article. Second article appeared in Dec. 1918 issue.

PRECIOUS MINERALS

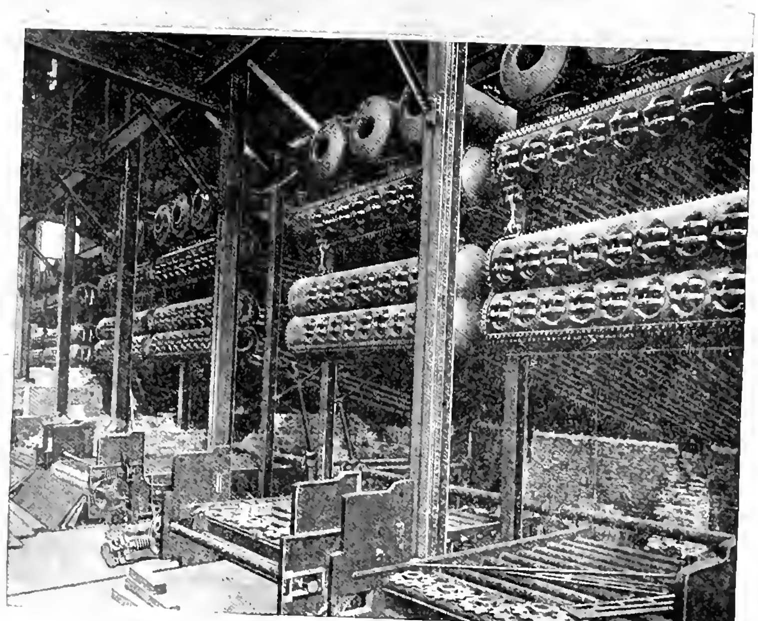
Gold Situation

Report of a Joint Committee Appointed from the Bureau of Mines and the United States Geological Survey by the Secretary of the Interior to Study the Gold Situation. Dept. of the Interior, Bur. of Mines, bul. 144, Oct. 30, 1918, 84 pp., 4 figs. Decline in gold



10,000 Horse Power
Vogt Water Tube
Boilers at Whiting
Indiana. ♦ ♦ ♦ ♦

Vogt



Let Us Figure on Your Requirements

HENRY VOGT MACHINE CO.

MANUFACTURERS

LOUISVILLE, KY.

mining is believed to be due to labor shortage and higher wages, lower efficiency of available labor and higher cost of power.

Santiago River

Gold Deposits of the Santiago River and its Zone (La riqueza aurifera del rio Santiago y de su zona), Luis Ulboa. Boletin de la Sociedad Geografica de Lima, vol. 34, Dec. 1918, pp. 94-106. Geographical history.

South Africa

Labor and Gold Mining in South Africa, Evelyn A. Walters. Eng. & Min. Jl., vol. 107, no. 21, May 24, 1919, pp. 918-922. Remedy for labor unrest lies, writer holds, in building, piece by piece, with persistence and patience, upon basis of steadily developing mutual understanding and desire to mutual good will between employer and employees.

TRANSPORTATION

India

The Carriage of Coal by Rail in India, H. Kelway-Bamber. Ry. Gaz., vol. 30, no. 16, Apr. 18, 1919, pp. 689-691, 3 figs. Gross earnings of train weighing 1400 tons and carrying coal a distance of 250 miles. (Continuation of serial.) Paper read before Indian Section Roy. Soc. Arts.

Mine Haulage

Efficiency in Mine Haulage Construction, George L. Yaste. Coal Indus., vol. 2, no. 5, May 1919, pp. 199-200. In choice of rails for roadway writer prefers to have them rather heavy than so light that it should become difficult to maintain track on account of low places between ties and at junction of rails.

Metallurgy

ALUMINUM

Alloys

Aluminum and Its Light Alloys. Dept. of Commerce, Circular of the Bur. of Standards, no. 76, Apr. 21, 1919, 120 pp., 27 figs. Deals primarily with physical properties of metal or alloy. Other features, except a few statistics of production and such as methods of manufacture, presence of impurities, etc., are discussed only in their relation to these physical properties.

Aluminum and Magnesium

The Metallurgy of Aluminum and Magnesium, H. B. Pulsifer. Salt Lake Min. Rev., vol. 21, no. 2, Apr. 30, 1919, pp. 21-25, 4 figs. Principles of electrolytic cell for producing magnesium; methods of manufacture.

Micrography

The Micrography of Aluminum and Its Alloys. D. Hanson and S. L. Archbutt. Metal Industry, vol. 14, no. 14, Apr. 4, 1919, pp. 277-283, 13 figs. Preparation of etchings, especially when metal has been cold-worked, when material is said to exhibit great readiness to become tarnished by formation of adhering coating of oxide of aluminum.

COPPER AND NICKEL

Alloys

The Properties of Some Copper Alloys, W. Rosenhain and D. Hanson. Metal Industry, vol. 14, no. 14, Apr. 4, 1919, pp. 269-272 and (discussion) pp. 272-274, 4 figs. Series prepared by Metallurgy Dept. of Nat. Physical Laboratory. Combination of high tensile strength with great ductility was aimed at in every case.

Brass and Silicon

Some Principles Involved in Melting Metals—V, Charles Vickers. Brass World, vol. 15, no. 5, May 1919, pp. 145-147, 2 figs. Adding silicon to yellow brass in order to increase fluidity of alloy so that it can be poured into thin castings.

Brass for Rolling

Notes on Alloys Used in British Brass-Rolling Mills, A. J. Franklin. Metal Indus., vol. 17, no. 5, May 1919, pp. 225-228, 1 fig. Effects of impurities, casting difficulties, hints on annealing and composition of some of the alloys.

Copper Rolling

The Metallurgy of Copper, Thomas H. A. Eastdick. Sci. Am. Supp., vol. 87, no. 2264, May 24, 1919, pp. 332-333 and pp. 335-336, 5 figs. Graphs showing effect of rolling on tensile strength and elongation under a given stress.

Slag

Copper-Smeltery Slag from the Microscopic and Chemical Point of View, C. G. Maier and G. D. Van Arsdale. Eng. & Min. Jl., vol. 107, no. 19, May 10, 1919, pp. 815-824, 40 figs. Combined misroscopical and chemical method pursued in investigations indicated that, in slags examined, copper existed in two physical forms chemically similar: (1) dissolved copper sulphide, in blast furnace and reverberatory slags and in converter or mixed slags, and (2) mechanically suspended particles of sulphide copper varying in composition from matte to Cu₂ S X Cu and in amount equal to total copper less dissolved copper.

See also MINING ENGINEERING, Copper.

FERROUS ALLOYS

Ferro-Manganese

Manganese Alloys in Open-Hearth Practice. Iron Age, vol. 103, no. 21, May 22, 1919, pp. 1363-1365. Use of silico-manganese recommended.

FLOTATION

Gold

Notes on Cyaniding, W. B. Blyth Min. Mag., vol. 20, no. 4, Apr. 1919, pp. 224-226. Effect of arsenic and antimony and position of flotation as regards gold metallurgy.

FURNACES

Heating and Annealing Furnaces

Heating Furnaces and Annealing Furnaces—V. W. Trinks. Blast Furnace & Steel Plant, vol. 7, no. 5, May 1919, pp. 215-217, 6 figs. Heat losses from tongue-hold, from openings around ingots, through roofs partly burned and through incomplete combusion. Examples derived from large furnaces.

IRON AND STEEL

Cast Iron

The Solubility and Stability of Iron Carbide in Cast Iron, J. A. Holden. Iron & Coal Trades Rev., vol. 98, no. 2668, Apr. 18, 1919, p. 479, 3 figs. Results of various experimenters compiled and compared.

Duplexing

Metallurgical Considerations of Duplexing—I, Richard S. McCaffery. Blast Furnace & Steel Plant, vol. 7, no. 5, May 1919, pp. 209-212. Operation of large and small Bessemer converters from viewpoint of metallurgical and physical chemistry.

Electric-Furnace Steel

Electric Furnace Steel, William K. Booth. Jl. Am. Steel Treaters Soc., vol. 1, no. 6, Mar. 1919, pp. 207-214, 6 figs. Characteristics of Booth-Hall electric furnace. General principle of design is hearth which becomes conductive of electricity when hot, and use of auxiliary electrode which acts as a return for the electric current until the hearth becomes heated and conductive.

Making Electric Steel for Roller Bearings. Machy. (Lond.), vol. 14, no. 344, May 1, 1919, pp. 131-137, 11 figs. Practice of Timken Roller Bearing Co., Canton, Ohio, in operating Héroult electric furnaces forging ingots, rolling billets and cold-drawing steel into solid bars and seamless tubing.

Flaky Fractures

Flaky Fractures and Their Possible Elimination, Haakon Styri. Chem. & Metallurgical Eng., vol. 20, no. 9, May 1, 1919, pp. 478-483, 1 fig. Review of literature bearing upon oxides and other inclusions in steel, together with application of principles of physical chemistry to conditions in a steel melt.

Graphitization

Graphitisation in Iron-Carbon Alloys, Kunii-chi Tawara and Genshichi Asahara. Iron & Steel Inst., Ann. Meeting, May 8 & 9, 1919, no. 14, 16 pp., 4 figs., also abstracted in Iron & Coal Trades Rev., vol. 98, no. 2671, May 9, 1919, pp. 578-579, 2 figs. View is held that in fluid alloys there exist atoms of free carbon; these free-carbon items may serve as nuclei for the graphitization when conditions are favorable.

Hardening

The Hardening of Steel, H. C. H. Carpenter. Engineering, vol. 107, nos. 2776 and 2777, Mar. 14 & 21, 1919, pp. 340-341 and 386-390, 18 figs. Exposition of various views as to scientific explanation of this property. Discourse delivered at Roy. Instn.

The Experimental Investigation of the Influence of the Rate of Cooling on the Hardening of Carbon Steels, A. M. Portevin and M. Garvin. Iron & Coal Trades Rev., vol. 98, no. 2671, May 9, 1919, pp. 599-607, 25 figs. (Abridged.) Reported that with temperature falling regularly formation of troostite corresponds with rapid transformation at high temperature (about 650 deg. cent.), and that of martensite with relatively slow transformation and at about 300 deg. cent. and under. Paper read before Iron & Steel Inst.

High-Speed Steel

The Manufacture and Working of High-Speed Steel, J. H. Andrew and G. W. Green. Iron & Steel Inst., Ann. Meeting, May 8 & 9, 1919, no. 1, 32 pp., 40 figs. Also abstracted in Iron & Coal Trades Rev., vol. 98, no. 2671, May 9, 1919, pp. 588-590, 2 figs. Investigation of various forging operations of cogging, rolling, etc., disclosed, in opinion of writers, that for efficient forging temperatures must be used which are appreciably higher than those which are generally accepted as correct. Also photomicrographs are interpreted as showing that whether reduction is effected by rolling or hammering, or a combination of both, no difference is produced in the microstructure of the steel.

The Molecular Constitutions of High-Speed Tool Steels and Their Correlations with Lathe Efficiencies, John Oliver Arnold. Iron & Steel Inst., Ann. Meeting, May 8 & 9, 1919, no. 2, 24 pp., 5 figs. Experiments to ascertain compositions of the carbides of chromium, vanadium, tungsten, and molybdenum and to examine electrolytic differential analyses of carbides and tungstide.

Ingot Production

Safeguarding Steel Ingot Production. Raw Material, vol. 1, no. 2, Apr. 1919, pp. 138-143, 6 figs. Indicates how some of methods of ingot production can be improved wherever steel price justifies expense of changing established practice. (To be continued.)

Lime in Open Hearth

Deoxidation, and the Influence of Lime on Equilibrium in the Acid Open-Hearth Furnace, B. Yaneske. Iron & Steel Inst., Ann. Meeting, May 8 & 9, 1919, no. 17, 16 pp. Also in Iron & Coal Trades Rev., vol. 98, no. 2671, May 9, 1919, pp. 576-578. While writer admits that for certain classes of steel such as that required for ship and similar plates it is unnecessary to obtain a very highly deoxidized bath, yet he considers that for special steel, particularly nickel-chrome, which has to undergo severe mechanical tests, forging and machining operations, it is essential that such a condition of the bath be obtained before the finishing alloys are added.

Liquidus

Note on the Liquidus in the Iron-Carbon Diagram, G. Cesaro. Iron & Steel Inst., Ann. Meeting, May 8 & 9, 1919, no. 4, 9 pp., 1 fig. Based on deduction from experiments by Carpenter and Keeling, writer endeavors to ascertain cause of curve joining points at which molten iron-carbon alloys commence to solidify.

Malleable Cast Iron

Effects of Phosphorus on Malleable Cast Iron, J. H. Teng. Foundry, vol. 47, no. 320, Apr. 1, 1919, pp. 151-156, 9 figs. Curves indicating effect of increasing phosphorus on tensile properties of both the pure-iron series and the common-iron series. From paper presented before Iron & Steel Inst.

Manganese in Open Hearth

The Use of Manganese Alloys in Open-Hearth Steel Practice, Samuel L. Hoyt. Metal Trades, vol. 10, no. 5, May 1919, pp. 227-230, 1 fig. Investigation to determine (1) condition in open-hearth practice that lead to conservation of manganese both during working of heat and in making final addition; (2) satisfactory metallurgical conditions for use of manganese in form of low-grade or special alloys, and (3) effect on finished steel, both as to quality and "condition" of various methods and processes studied. From Bul. no. 11 of War Minerals Investigation Series, U. S. Bur Mines.

Metallurgy

Modern Steel Metallurgy, Chas. H. F. Bagley. Iron & Steel Inst., Ann. Meeting, May 8 & 9, 1919, no. 3, 49 pp. Also Iron & Coal Trades Rev., vol. 98, no. 2671, May 9, 1919, pp. 565-571. Method of calculating consumption of materials and technical results in manufacture of steel from any kind of pig iron by any standard process.

Quenching

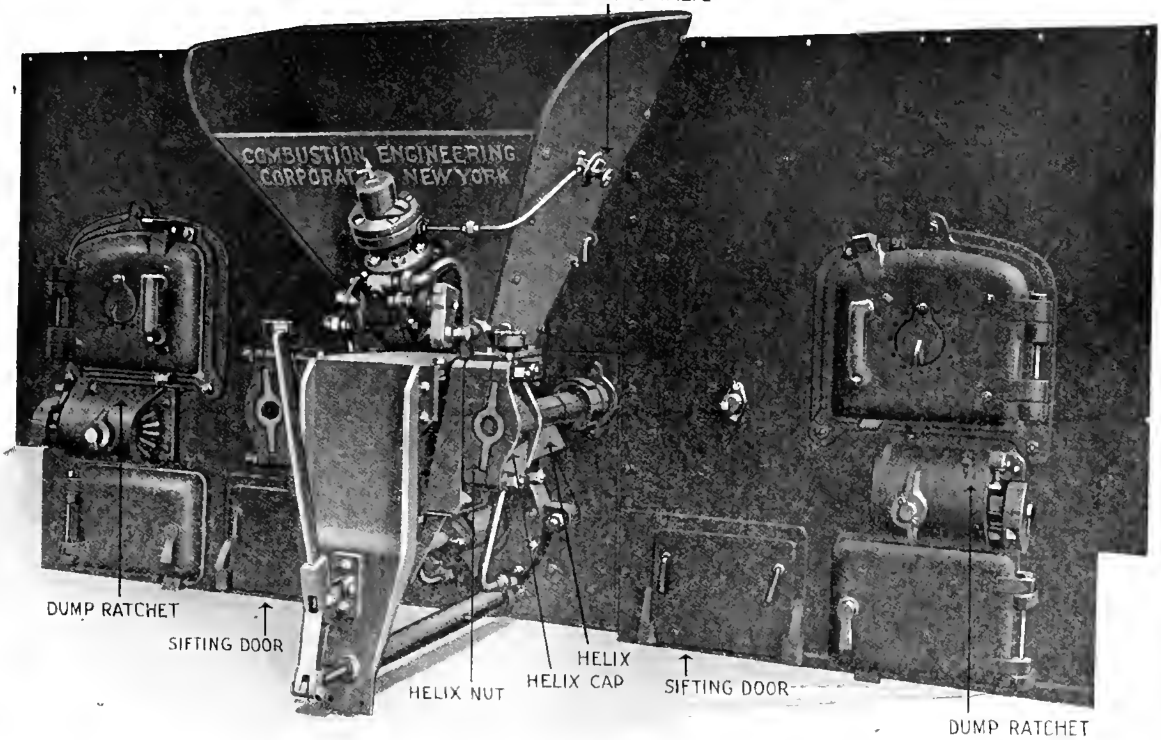
The formation of Troostite at Low Temperature in Carbon-Steels and the Influence of the Emersion Temperature in Double Quenching (La formation de la troostite à bassee température dans les aciers au carbone et l'Influ-

DUMPS

that operate from the side make the work of cleaning easier and keep the boiler on the line no matter how poor the fuel.

TYPE "E" STOKERS

DUMP FROM THE SIDE



Get in touch with us

Combustion Engineering Corporation

11 Broadway, New York City

Owners and manufacturers of

Type "E" Stokers—for Bituminous Coal **The Grieve Grate—Hand-Firing**
Coxe Stokers—Anthracite Coal and Coke Breeze

PHILADELPHIA, PA. PITTSBURGH, PA. MINNEAPOLIS, MINN.
BIRMINGHAM, ALA. HAZLETON, PA. BOSTON, MASS. CHICAGO, ILL.
SEATTLE, WASH. SALT LAKE CITY, UTAH ALBANY, N. Y.
OMAHA, NEB. TAYLOR ENGINEERING CO., VANCOUVER, B. C.

ence de la température d'émersion dans les trempes interrompues), M. Portevin and M. Garvin. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 14, Apr. 7, 1919, pp. 731-733. Concluded from experimental investigations that in vicinity of critical quenching velocity, troostite will form even after cooling to 450 deg. cent., such formation being always accompanied with a pronounced characteristic recalescence.

Refractories

See Refractories, under MECHANICAL ENGINEERING.

Rolling Mills

See Mechanical Processes, (Steel Mills), under MECHANICAL ENGINEERING.

Slag

The Acid Hearth and Slag, J. H. Whiteley and A. F. Hallimond. Iron & Steel Inst., Ann. Meeting, May 8 & 9, 1919, no. 16, 44 pp., 29 figs. Also abstracted in Iron & Coal Trades Rev., vol. 98, no. 2671, May 9, 1919, pp. 579-583, 3 figs. Microstructure of slags, structure of slowly cooled acid slags and reactions occurring in molten slag during process. From observations and experiments.

Transformations in Iron

On the Non-Allotropic Nature of the A2 Transformation in Iron, Kôtarô Honda. Iron & Steel Inst., Ann. Meeting, May 8 & 9, 1919, no. 9, 8 pp., 3 figs. Also abstracted in Iron & Coal Trades Rev., vol. 98, no. 2671, May 9, 1919, pp. 575-576. Reported experiments evidenced three transformations, A2, A3 and A4, in the case of pure iron; last two are said to be allotropic transformations, while the first cannot properly be so called.

MICROPHOTOGRAPHS

Macro-Etching and Printing

Macro-Etching and Macro-Printing, J. C. W. Humfrey. Iron & Steel Inst., Ann. Meeting, May 8 & 9, 1919, no. 10, 14 pp., 12 figs. Also abstracted in Iron & Coal Trades Rev., vol. 98, no. 2671, May 9, 1919, pp. 607-609, 4 figs. Writer's etching reagent used in course of investigation into flow of steel during process of punching and drawing a shell blank, was prepared by addition of hydrochloric acid to Heyn's reagent.

NON-FERROUS ALLOYS

Metallography

Metallography Applied to Nonferrous Metals—IV, Ernest J. Davis. Foundry, vol. 47, no. 6 & 7, May 1 & 15, 1919, pp. 263-266 & 304-307, 15 figs. Equilibrium diagram of copper-aluminum, aluminum-zinc and aluminum-magnesium series, and photomicrographs of various alloys.

OCCLUDED GASES

Hydrogen

The Occlusion of Hydrogen by the Metallic Elements and Its Relation to Magnetic Properties, Donald P. Smith. Jl. Physical Chemistry, vol. 23, no. 3, Mar. 1919, pp. 186-200, 1 fig. From review of literature it is deduced that resulting alloys are to be distinguished from other types of binary hydrogen compounds and that metals which form the alloys probably occupy a definite region in the periodic table of Werner.

Aeronautics

AIRCRAFT

Lift of Airships

Lighter-than-Air Craft, T. R. Cave-Browne-Cave. Aeronautics, vol. 16, no. 285, Apr. 3, 1919, pp. 365-371, 4 figs. Technical study of factors governing variation of lift of an airship and its significance in design of envelope. Paper read before Roy. Aeronautical Soc.

Non-Rigid Airships

The Development of Airship Construction, C. I. R. Campbell. Engineer, vol. 127, no. 3303, Apr. 18, 1919, pp. 384-386, 3 figs. General dimensions and dates of three typical non-rigid airships, Zodiac, Parseval and Astra types. Paper read before Instn. Naval Architects.

Rigid Airships

Rigid Airship Design: The Tension in the Diagonal Bracing Wires, E. H. Lewitt. Aeronautics, vol. 16, no. 287, Apr. 17, 1919, pp. 402-403, 2 figs. Formula based on assumption that ship bends about a neutral axis, that longitudinal girders take the bending stresses only, while diagonal bracing wires take all the shear, and that all loads are concentrated at transverse frames.

APPLICATIONS

Air Navigation Regulations

Air Navigation, H. E. Wimperis. Flight, vol. 11, no. 19, May 8, 1919, pp. 600-604, 10 figs. Technical problems in air navigation, similar to those presented by sea navigation and manner of solving same. Paper read before Roy. Aeronautical Soc.

Air Navigation Regulations. Flight, vol. 11, no. 19, May 8, 1919, pp. 608-615, 2 figs. Legislation concerning conditions of flying, aerodromes, safety provisions, licensing of personnel, lights and signals, registration and nationality marks.

Commercial Transportation

Commercial Transportation and High-Speed Services by Air, G. Holt Thomas. Aeronautics, vol. 16, no. 287, Apr. 17, 1919, pp. 404-405. Visualizes trade conditions when "there will be no place on the earth's surface more than four days' journey from London by air."

Air Transports (Aéro-Transports), Ernest Archdeacon. L'Aérophile, vol. 27, nos. 3-4, Feb. 1-15, 1919, pp. 33-37, 3 figs. Analysis of types developed during war which indicate possibilities of commercial utilization for air service.

Latin-American Republics

Aviation as a Solution of the Economic and Sociological Problems of Latin American Republics (Lo que puede hacer la aviacion en pro de la solucion de los problemas economicos y sociologicos de las republicas latinoamericanas), Henry Woodhouse. Flying, vol. 8, no. 4, May 1919, pp. 350-351 & 374. Argues that since lack of adequate means of transportation has prevented growth of Latin America, its development by establishing air routes will solve problem.

AUXILIARY SERVICE

Air Fans

Air Fans for Driving Generators on Airplanes, G. Francis Gray, John W. Reed and P. N. Elderkin. Mech. Eng., vol. 41, no. 6, June 1919, pp. 527-530, 11 figs. Difficulty of problem in designing is represented as having been the production of fan which was turned at constant speed in air streams of widely varying speeds set up by airplane in flight. Paper for June meeting of A.S.M.E.

Navigation Apparatus

Determining True Course in Aerial Navigation (Indicateur-jalonneur de route pour la navigation aérienne à l'estime), L. Dunoyer. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 14, Apr. 7, 1919, pp. 728-729. To simplify composition of triangle of velocities a system is suggested which involves placing on pilot's chart at place of departure an indicator having concentric circles whose radii are proportional to distances made under wind of 2, 4, 6 .... meters per sec., and at place terminus of voyage a similar indicator in which the radii of concentric circles are proportional to distances travelled by airplane in calm weather. Their operation is illustrated by examples.

Telephone Apparatus, Radio

Aeroplane Radio Telephone Apparatus, Edgar H. Felix. Aerial Age, vol. 9, no. 8, May 5, 1919, pp. 397-399, 10 figs. Types of microphones, headgear and generators developed by Signal Corps.

DESIGN

Aerofoil Design

Some Future Possibilities of Aerofoil Design, W. E. Astin. Flight, vol. 11, no. 16, Apr. 17, 1919, pp. 506-509, 7 figs. Considers possible that rigid wings will not persist, but will in time be replaced by wings which may be of variable area, of variable angle of incidence, variable camber, or again of any suitable combination of these variables.

Commercial Engines

Machines for Commerce and Pleasure. Aeronautics, vol. 16, no. 286, Apr. 10, 1919, pp. 380-381, 3 figs. Graham White Co., Ltd., has decided on seven types: instructional machine, Bantam sporting single-seater, express airmail machine, four-seater aero-limousine, five-seater aero-limousine, 24-seater passenger machine, and Dominions-type machine.

Radius of Action

Air Mileage of Aeroplanes Intended for Long Distances and for Transport, J. Dennis Coales. Engineering, vol. 107, no. 2783, May 2, 1919, pp. 557-560, 6 figs. Technical study of limitations with reference to problem of transatlantic flight. (To be continued.)

ENGINES

Cooling

The Cooling of Aero Engines. Autocar, vol. 42, no. 1227, Apr. 26, 1919, pp. 609-612, 9 figs. Physical conditions of the atmosphere to which engine must adapt itself. Discusses means being adopted for preventing overcooling of front valves.

Design

The Design of Airplane Engines—V, John Wallace. Automotive Eng., vol. 4, no. 4, Apr. 1919, pp. 166-168, 11 figs. Crank-effort diagram; calculation of inertia forces of reciprocating mass. (To be continued.)

Hispano-Suiza

Hispano-Suiza Motors (Les moteurs Hispano-Suiza). L'Aérophile, vol. 27, no. 5-6, Mar. 1-15, 1919, pp. 78-81, 8 figs. Five types considered are: 150 hp., 180 hp., 200 hp., 220 hp., and 300 hp. (To be continued.)

King-Bugatti Engine

King-Bugatti 16-Cylinder Aero Engine—II. Automotive Industries, vol. 11, no. 18, May 1, 1919, pp. 956-959, and 986, 7 figs. Consists virtually of two 8-cyl. all-in-line engines mounted on common crankcase and geared to common propeller shaft; designed to permit a 37-mm. cannon to shoot through hollow propeller shaft.

Liberty Engine

Mechanical Details of the Liberty Engine—III. Automotive Eng., vol. 4, no. 4, Apr. 1919, pp. 178-179 and 192. Specifications of both the cast-iron cylinder forms for tank use and the steel cylinder type with sheet-metal water jackets for airplane power plants.

Maybach Engine

Details of the 300-Horsepower Maybach Airplane Engine. Automotive Eng., vol. 4, no. 4, Apr. 1919, pp. 169-173, 10 figs. Mechanical construction and design features. Cylinders, crankcase and shaft, pistons and wrist pins. (To be continued.)

Puma Engine

The Siddeley-Deasy "Puma" Aero Engine. Aerial Age, vol. 9, no. 9, May 12, 1919, pp. 441-442 and 453, 4 figs. Engine has 6 cylinders; outstanding features claimed are special construction of cylinders and arrangement of mechanism actuating valves, these features being designed to facilitate dismantling and erection for repairs.

Superchargers

Maintaining Constant Pressure Before the Carburetors of Aero Engines Regardless of the Altitude, Leslie V. Spencer. Aerial Age vol. 9, no. 8, May 5, 1919, pp. 387-389, 7 figs. Mechanical features of Moss and Sherbondy turbo-superchargers. (Concluded.)

Zeitlin Engine

The Zeitlin Aero-Engine. Engineer, vol. 127 no. 3304, Apr. 25, 1919, pp. 408-410, 10 figs Nine-cylinder rotary 220-hp. engine. Differ fundamentally from other motors in that pis ton stroke is not of uniform length in eac of the four movements constituting a complet cycle.

See also MECHANICAL ENGINEERING Mechanical Processes (Liberty Motor Port Production of.)

INSTRUMENTS

Anemometers

Design of Pressure Plate Anemometers, H. Powell. Aviation, vol. 6, no. 7, May 1919, pp. 374-375, 3 figs. Technical points design. Writer takes up case of constructi instrument to give direct readings witho making it necessary to have recourse to tri and error methods.

MATERIALS OF CONSTRUCTION

Glues

The Manufacture and Use of Glues in Aer plane Construction, B. C. Boulton. Aer Age, vol. 9, nos. 8 & 9, May 5 & 12, 1919, 390 and 395-396, and 451-453, 2 figs. Bas upon technical reports prepared for Bur. A craft Production. Factors affecting quality casein; Bur. of Aircraft Production specific tion for glues.

Veneers

Veneer Body Construction. Aviation, vol. 6, no. 8, May 15, 1919, pp. 434-436, 3 figs. Results of investigations conducted at McCook Field in endeavor to develop satisfactory veneer bodies of USC-2 and USXB-1 combat planes. (To be continued.)

METEOROLOGY

Cyclone Compression

Examples of "Cyclone Compression" (Sur quelques exemples de "compression de cyclone"), Gabriel Guilbert. Comptes rendus des séances de l'Académie des Sciences, vol. 168 no. 13, Mar. 31, 1919, pp. 691-693. Cases quoted in substantiation of rule: Depressed region surrounded with converging strong winds shows maximum barometric compression in center.

MODELS

Aeroplanes

Model Aeroplanes—XXIII. F. J. Camm. Aeronautics, vol. 16, no. 285, Apr. 3, 1919, p. 363, 6 figs. Built-up plane: covered with proofed transparent silk. Illustrations indicate construction details.

Elementary Aeronautics and Model Notes. John F. McMahon. Aerial Age, vol. 9, no. 9, May 12, 1919, p. 457, 1 fig. Model in which regular tested wing curve is used.

Air Screws

Model Aeroplanes—XXIV. F. J. Camm. Aeronautics, vol. 16, no. 287, Apr. 17, 1919, p. 409, 4 figs. Carving model airscrews.

Speed Models

Elementary Aeronautics and Model Notes. John F. McMahon. Aerial Age, vol. 9, no. 8, May 5, 1919, p. 403, 2 figs. Speed model said to have developed speed of 55 miles per hour.

PLANES

B. A. T.

The B. A. T. Four-Seater Biplane. Flight, vol. 11, no. 16, Apr. 17, 1919, pp. 494-498, 11 figs. Designed for commercial work—either passengers or carrying mail; provides accommodation for four passengers besides pilot.

Curtis M-F Flying Boat

Curtiss M-F Flying Boat. Aerial Age, vol. 9, no. 8, May 5, 1919, pp. 384-385, 5 figs. Equipped with 8-cyl., 4-stroke cycle water-cooled V-type engine, rated at 100 hp. at 1400 r.p.m.; bore and stroke $4\frac{1}{2}$ in. by 5 in.

Halberstadt

The Halberstadt Two-Seater Fighter. Aviation, vol. 6, no. 7, May 1, 1919, pp. 384-386, 11 figs. Constructional features.

Lepere

The Lepere Two-Seater Fighter. Aviation, vol. 6, no. 8, May 15, 1919, pp. 426-429, 8 figs. Belongs to class of DeH.-4 and Bristol type. One peculiarity of design is that there are no incidence or stagger wires in the plane, these being replaced by a system of portal-framed struts.

Pfalz

The Pfalz (D XII) Single-Seater Fighter. Flight, vol. 11, no. 17, Apr. 24, 1919, pp. 528-533, 16 figs. This airplane was brought down near Dury on Sept. 15, 1918. Report covering design and details issued by Technical Dept. (Aircraft Production) Ministry of Munitions.

Tarrant Triplane

The Tarrant Giant Triplane. Flight, vol. 11, no. 19, May 8, 1919, pp. 592-593, 2 figs. Power plant consists of Napier "Lion" engines, four of which are mounted on bottom plane, the other two being placed between the middle and the top plane and driving tractor screws. Warren type of girder has been adapted in regard to wood construction.

Torpedoplane

The Torpedoplane, the New Weapon which Promises to Revolutionize Naval Tactics. Henry Woodhouse. U. S. Naval Inst., Proc., vol. 45, no. 5, May 1919, pp. 743-752. Constructed for dropping torpedoes from airplanes.

PROPELLERS

Variable Pitch Propeller

Pilot Motor Variable Pitch Propeller. Alfred Vischer, Jr. Aviation, vol. 6, no. 7, May 1, 1919, pp. 380-381, 3 figs. SCR-73 synchronous rotary-gap transmitter designed and developed to be adjustable to nine wave lengths supplemented by five notes obtained from interchangeable-gap rotors to prevent interference and to aid in identification.

PRODUCTION

Fire Hazard

Features of Fire Hazard in Airplane Manufacture. W. D. Milne. Quarterly of the Nat. Fire Protection Assn., vol. 12, no. 4, Apr. 1919, pp. 345-352. Notes on prominent fire hazards as observed by writer in various airplane factories; he advocates incorporating in plans for these plants measures necessary for their protection against fire.

National Aeroplane Factory, England

National Aeroplane Factory Near Manchester. Engineer, vol. 127, no. 3301, Apr. 4, 1919, pp. 422-424, 10 figs. on supp. plate. Factory covers area of 15 acres and comprises assembling and erection shop, woodworking shop, timber drying shed for spruce conditioning and two ash-drying plants.

Naval Aircraft Factory, Philadelphia

Aeroplane Construction, F. G. Coburn. Jl. Engrs. Club, Philadelphia, vol. 36-4, no. 175, Apr. 1919, pp. 121-126, 6 figs. Brief account of construction and development of Naval Aircraft Factory at Philadelphia Navy Yard.

TESTING

Engine Trials

The Analysis of Engine Trials. Automobile Engr., vol. 9, no. 126, May 1919, pp. 134-136, 9 figs. Empirical methods of calculation for analyzing results of aero-engine trials, particularly where tests have obviously been faulty or incomplete.

Full-Scale Experiments

Full Scale Aeroplane Experiments. W. S. Farren. Aeronautical Jl., vol. 23, no. 98, Feb. 1919, pp. 34-63, 14 figs. Formulæ derived from model experiments cannot be employed in designing calculations, it is stated, without first testing their validity in full-scale experiments.

TRANSATLANTIC FLIGHT

Navy (U. S.) Fliers

The Navy's Trans-Atlantic Fliers. Motor Boat, vol. 16, no. 10, May 25, 1919, pp. 5-7, 5 figs. Weights and principal dimensions.

Winds

Trans-Atlantic Flight and Meteorology. Willis Ray Gregg. Aviation, vol. 6, no. 7, May 1, 1919, pp. 370-372, 1 fig. Wind velocity and direction as affecting Newfoundland-Ireland and Newfoundland-Labrador-Greenland-Scotland routes. Paper read before Phil. Soc. of Washington.

VARIA

Aviators, Physiology

The Physiology of the Aviator. Yandell Henderson. Science, vol. 49, no. 1271, May 9, 1919, pp. 431-441. Development of this branch of science during the war and account of the principles laid down from experience.

Aviators, Tests of

Psycho-Physical Tests of Aviators. George M. Stratton. Sci. Monthly, vol. 8, no. 5, May 1919, pp. 421-426. Stress is laid upon two qualifications, viz.: coolness and power to make rapid decisions.

Camera, Aero

A New Aero Camera. Aeronautics, vol. 16, no. 286, Apr. 10, 1919, p. 389, 2 figs. Taking photograph, moving exposed plate out of position, resetting camera shutter and moving up of fresh plate into position performed by one movement.

Mapping, Aero

Methods Used in Aero-Photographic Mapping. Eng. News-Rec., vol. 82, no. 21, May 22, 1919, pp. 1000-1004, 8 figs. Outgrowth of experience in use of panoramic camera in Alaska with exposition of principles on transforming camera. From Geographical Rev.

Present Status of Photographic Mapping from the Air. J. B. Mertie, Jr. Eng. News-Rec., vol. 82, no. 21, May 22, 1919, pp. 996-999. Airplane mapping is considered possible and practicable, but it is observed that two great problems, horizontalization of camera and effects of surface relief, must be solved.

Marine Engineering

AUXILIARY MACHINERY

Anchors

New Type of Anchor. Iron Age, vol. 103, no. 19, May 8, 1919, pp. 1225-1226, 4 figs. Allison cast-steel product with spoon-shaped flukes.

Compasses

The Gyro Compass. An Essential Navigation Instrument. M. R. Lott. Monthly Jl., Utah Soc. of Engrs., vol. 5, no. 2, Feb. 1919, pp. 28-41, 8 figs. Points of difference between a gyro-compass and a magnetic compass.

Electrical Auxiliaries

Merchant Marine Electrical Auxiliaries. Walter E. Thau. Jl. Am. Soc. Marine Draftsmen, vol. 5, no. 4, Jan. 1919, pp. 55-59, 5 figs. Advantages claimed for electrical appliances over steam appliances are economy, flexibility, lessening of noise and greater reliability.

Propellers

Propeller Patterns. Machy. (Lond.), vol. 14, no. 344, May 1, 1919, pp. 125-129, 8 figs. Methods of laying out propeller patterns, assembling different sections and working blades to required form.

Investigations into the Causes of Corrosion or Erosion of Propellers. Charles A. Parsons and Stanley S. Cook. Engineering, vol. 107, no. 2781, Apr. 18, 1919, pp. 515-519, 21 figs., also Shipbuilding & Shipping Rec., vol. 13, no. 16, April 17, 1919, pp. 494-495, and Engineer, vol. 127, no. 3301, Apr. 4, 1919, pp. 427-428. Result of investigation on nature of surface and state of initial stresses in blades under working conditions; impingement of water at high velocity; cavitation; water hammer produced by vortex cavities. Paper read before Instn. Naval Architects.

See also MECHANICAL ENGINEERING, Internal-Combustion Engines (Oil Engine, Marine), Mechanical Processes (Marine Engines.)

SHIPS

Boilers

The Work of the British Marine Engineering Design and Construction Committee, A. E. Seaton. Engineering, vol. 107, no. 2781, Apr. 18, 1919, pp. 519-522, and Shipbuilding & Shipping Rec., vol. 13, no. 16, Apr. 17, 1919, pp. 483-484. Object of committee was unification of all rules which govern design and construction of all marine machinery, especially of that pertaining to boilers. Paper read before Instn. Naval Architects.

Cast-Steel Ship

The Cast-Steel Ship Development, Myron E. Hill. Iron Age, vol. 103, no. 21, May 22, 1919, pp. 1351-1352, 2 figs. Standard units cast in sand, assembled in position and automatically welded.

Coastal Motor Boats

Coastal Motor Boats for the Navy. Engineer, vol. 127, no. 3303, Apr. 18, 1919, pp. 369-371, 3 figs. Design aimed at smallest possible dimensions consistent with carrying of torpedo, speed of at least 30 knots and full capacity for wide radius of action.

The Mysterious "C. M. B.'s" Motor Boat, vol. 16, no. 10, May 25, 1919, pp. 8-9, 4 figs. British 55-ft. coastal motor boat designed to run at high speed and to withstand hard sea work, carries two torpedoes which are discharged over stern.

Compartment Designs of Hull

Italian Two-Floodable Compartment Cargo Steamers, Salvatore Orlando. Engineering, vol. 107, no. 2782, Apr. 25, 1919, pp. 533-537, 9 figs. Design to permit keeping ship afloat after torpedo explosion, according to specifications proposed by engineers and technical men assembled in Genoa on August 18, 1917, to examine from a technical standpoint the urgent question of reconstruction of mercantile fleet and conservation of remaining vessels. Paper read before Instn. Naval Architects.

Protection of Freight Steamers (Per una maggiore difesa del naviglio da carico), Mario Taddei. Rivista Marittima, vol. 51, no. 11, Nov. 1918, pp. 187-206, 2 figs. Technical remarks on compartment designs of hull.

Electric Propulsion

Electric Drive on Merchant Ships. W. L. R. Emmet. Instn. Mar. Eng., vol. 24, no. 5, May 1919, pp. 335-337. Electric propulsion of single-screw cargo vessel proposed.


DO YOU KNOW
what
BADGER SERVICE
means, when applied to the
Re-Cooling of
Condensing Water?
ASK US TODAY—and we will show you that we have the most economical and efficient system of cooling water by sprays, for condensers, water jackets or transformers.
WRITE FOR OUR BULLETIN NO. 101—and you will learn how the Badger System of Cooling Water with sprays will reduce power plant operating costs, save fuel, and meet the demands of any industry requiring an abundant supply of cold water.
WHY NOT ACCEPT OUR SUGGESTION—and consult with able specialists—men who have been real pioneers in the development of spray cooling systems and who are qualified to solve any water cooling problems.
All Badger Spray Cooling Equipment is constructed in our own shops with the same careful workmanship and best materials that have always been used for 77 years, in the establishment of our enviable reputation.
E. B. Badger & Sons Co.
American Spray Dept.
67 Pitts St.
Boston, Mass., U. S. A.

Electric Drive from a Military Point of View, S. M. Robinson. Mar. Eng. & Can. Merchant Service Guild Rev., vol. 9, no. 4, Apr. 1919, pp. 137-138. Based on technical considerations and performance of S. S. "New Mexico."

Merchant Shipbuilding

Some Recent Developments Towards a Simplification of Merchant Ship Construction, Eustace Tennyson d'Eycourt and Thomas Graham. Engineering, vol. 107, nos. 2781 & 2782, Apr. 18 & 25, 1919, pp. 503-505 and 554-556, 16 figs., also Shipbuilding & Shipping Rec., vol. 13, no. 16, Apr. 17, 1919, pp. 488-493, 17 figs. Design was intended to fulfill three conditions: (1) employment of labor unaccustomed to shipbuilding, (2) construction which would fully avail itself of such labor, and (3) process of obtaining parts of ship from various sources of supply and subsequently assembling such parts at the building berths. Paper read before Instn. Naval Architects.

Model Experiments

Some Experiments on Full Cargo Ship Models, James Semple. Shipbuilding & Shipping Rec., vol. 13, no. 16, Apr. 17, 1919, pp. 495-497, 5 figs. Results of experiments made in order to determine effect on performance (1) of fullness, and (2) of longitudinal distribution of displacement. Paper read before Instn. Naval Architects.

Model Experiments on the Effect of Beam on the Resistance of Mercantile Ship Forms, J. L. Kent. Engineering, vol. 107, no. 2782, Apr. 25, 1919, pp. 550-553, 11 figs., also Shipbuilding and Shipping Rec., vol. 13, no. 16, Apr. 17, 1919, pp. 501-503. Research on effect upon resistance of change in maximum beam, carried out at William Froude National Tank. Paper read before Instn. Naval Architects.

Speed, Cost of

On the Great Cost of High Speed, Sidney Graves Koon. Int. Mar. Eng., vol. 24, no. 5, May 1919, pp. 357-359, 1 fig. Analysis of relative costs in power for moderate increases in speed in slow- and high-speed vessels.

Stability of Ships

Stability of Ships, George Nicol. Shipbuilding & Shipping Rec., vol. 13, no. 18, May 1, 1919, pp. 562-564, 7 figs. Method of obtaining cross curves of stability by employment of longitudinal sections. Paper read before Instn. Engrs. & Shipbuilders in Scotland.

Submarine Chasers

The 110-Foot Submarine Chasers and Eagle Boats, J. A. Furer, U. S. Naval Instn. Proc., vol. 45, no. 5, May 1919, pp. 753-767. How British Admiralty solved problem of providing effective patrol boats for war zone and for combating activity of submarine.

United States 110-Foot Submarine Chasers, R. P. Sanborn. Int. Mar. Eng., vol. 24, no. 5, May 1919, pp. 337-343, 10 figs. Construction, equipment and engineering data, also part this type of naval vessel played in the war.

Submarines

Below Deck on a U-Boat, Warren O. Rogers. Power, vol. 49, no. 20, May 20, 1919, pp. 784-787, 5 figs. Notes on engine room and torpedo room.

Tankers

The World's Largest Oil Tanker. Petroleum Times, vol. 1, no. 14, Apr. 12, 1919, pp. 289-292, 5 figs. Vessel has d.w. carrying capacity of over 18,000 tons.

Tonnage

The Tonnage of Modern Steamships, A. T. Wall. Engineering, vol. 107, no. 2782, Apr. 25, 1919, pp. 549-550, also Shipbuilding & Shipping Rec., vol. 13, no. 16, Apr. 17, 1919, pp. 479-481. Effect of recent legislation on modern machinery on tonnage measurement. Paper read before Instn. Naval Architects.

Turbine Machinery

Turbine Machinery for Standard Ships. Engineer, vol. 127, no. 3303, Apr. 18, 1919, pp. 371-373, 11 figs., partly on supp. plate. Two Turbines driving one screw propeller through toothed reduction gearing considered as most economical design because it is said that by splitting up power between two units, turbines can be designed to utilize high vacuum without making machines unduly large or adopting inconveniently high speed.

Marine Geared Turbines Have Shown Great Economy and Efficiency, William H. Easton. Marine News, vol. 5, no. 12, May 1919, pp. 110-111, 5 figs. Discussion of relative advantages of turbines and reciprocating engines.

Modern Ships

3500-Ton D. W. Auxiliary Schooners Built for France. Rudder, vol. 35, no. 5, May 1919, pp. 244-247, 5 figs. Built of Oregon fir in long lengths. Machinery consists of two triple-expansion steam engines and two Roberts water-tube boilers with 1800 sq. ft. heating surface.

The Uses of Wood, Hu Maxwell. Am. Forestry, vol. 25, no. 304, Apr. 1919, pp. 973-983, 21 figs. Wooden boats and their manufacture. Twentieth article.

See also MUNITIONS AND MILITARY ENGINEERING (Battleships); MECHANICAL ENGINEERING, Foundries (Ship Work).

TERMINALS

Coaling

Coaling Ships Mechanically—II, Wilbur M. Stone. Coal Trade Jl., vol. 50, no. 19, May 7, 1919, pp. 527-529, 4 figs. Trimming mechanism, driving motor and reduction gearing. Concluding article.

Shanghai

The Port of Shanghai, Paul Page Whitman. Pac. Mar. Rev., vol. 16, no. 5, May 1919, pp. 71-77, 17 figs. General description. Maritime customs report for 1917 shows foreign trade of this port to be a little over one-half billion dollars.

Wharf Equipment

Wharf Equipment, Roy S. MacElwee. Professional Memoirs, Corps Engrs., U. S. Army & Engr. Dept., vol. 10, no. 54, Nov.-Dec., 1918, pp. 820-840, 12 figs. Determining size of transit shed. Reference is made to conditions in several of principal ports in the world.

See also CIVIL ENGINEERING, Harbors.

YARDS

British Columbia

British Columbia's Part in Ship Programme, A. F. Menzies. Can. Machy., vol. 20, no. 26, Dec. 26, 1918, pp. 722-729, 15 figs. Program undertaken by Imperial Munitions Board Wooden Shipbuilding Dept. report completed and to have resulted in addition of 27 wooden steamers of total d.w. capacity of over 75,000 tons.

Castings

Steel Foundry to Cast Ships, E. C. Kreutzberg. Mar. Rev., vol. 49, no. 6, June 1919, pp. 269-271, 4 figs. Methods of Cast Steel Ship Corp., New York, for casting component parts of ships. Parts are afterwards permanently joined by welding.

Concrete Car Floats

New Concrete Shipyard on Lake Erie. Int. Mar. Eng., vol. 24, no. 5, May 1919, pp. 352-356, 14 figs. Method of constructing concrete car floats.

Concrete Shipyards, British

British Concrete Shipyards, W. Noble Twelvetrees. Engineering, vol. 107, no. 2776, Mar. 14, 1919, pp. 334-338, 21 figs. partly on separate plates. Two yards are dealt with, (1) Brentford, of limited capacity, as only one vessel not exceeding 150 ft. can be built there at a time; and (2) Rochford, equipment of which provides for simultaneous construction of three vessels up to nearly 200 ft. in length.

Hog Island Shipyard

The Electrical Features of Hog Island Shipyard, H. W. Osgood. Jl Engrs. Club, Philadelphia, vol. 36-5, no. 174, May 1919, pp. 165-173, 8 figs. Problem was to anticipate where and in what amount electric service would be required in yard, which was expected to grow up in a few months, at a time when only partial plans were known. Paper read before Assn. Iron & Steel Elec. Engrs.

The Hog Island of Today. Pac. Mar. Rev., vol. 16, no. 5, May 1919, pp. 83-94, 21 figs. and supp. chart. Technical data of engineering features connected with design and construction of ships being built and construction and management of yard.

Welding

Some Experiences with Electric Welding in Warships, W. H. Gard. Shipbuilding & Shipping Rec., vol. 13, no. 16, Apr. 17, 1919, pp. 485-486. Repairing cast-steel stern post of battleship and similar work carried out during the war. Paper read before Instn. Naval Architects.

Electric Welding in Ship Construction. Elec. Eng., vol. 52, no. 5, Nov. 1918, pp. 14-15. Projects and some experimental results obtained by British Admiralty.

Electric Welding, Thomas T. Heaton. Steamship, vol. 30, no. 359, May 1919, pp. 252-253. Systems applied to welding of mild steel. Paper read before Instn. Mech. Engrs.

Industrial Technology

Ammonia Oxidation

The Oxidation of Ammonia, W. S. Landis. Chem. & Metallurgical Eng., vol. 20, no. 9, May 1, 1919, pp. 476-477, 5 figs. Review of early investigations beginning in 1839 with Kuhlman; Ostwald process and apparatus; improvements made in catalyst screens platinum activation to foreign gases such as acetylene and phosphine; cyanamide process at Muscle Shoals. Paper read before Am. Electrochemical Soc.

Boron

The Production of Amorphous Boron (Ueber die Darstellung des amorphen Bors), Wilhelm Kroll. Zeitschrift für anorganische & allgemeine Chemie, vol. 102, no. 1, Jan. 4, 1918, pp. 1-33, 4 figs. Writer describes experiments made and results obtained by reduction with aluminum, magnesium, calcium, natrium, and by electrolysis. Apparatus for quick distillation of boric acid with methylene alcohol is described.

Cements, Rubber

Notes on Cemented Seams and Rubber Cements, Junius David Edwards and Irwin L. Moore. India-Rubber Jl., vol. 57, no. 15, Apr. 12, 1919, pp. 1-6, 8 figs. Tests and examination of micro-sections. It is concluded that a good seam requires a good cement, smoothing and cleaning of surface.

Dust Elimination

Removal of Dust, Gases and Fumes in Metal-Working Plants, J. J. Rosedale. Metal Trades, vol. 10, no. 5, May 1919, pp. 223-226, 6 figs. Recommended specifications for design, construction and operation of exhaust systems. From Cal. Safety News.

Electrical Precipitation of Solids from Flue Gases, J. M. Wauchope. Elec. Rev., vol. 74, no. 19, May 10, 1919, pp. 744-747, 7 figs. Application of Cottrell process to waste gases of smelters. Article dwells particularly on apparatus used, operating conditions, and troubles.

Explosives

Modern Explosives, J. Young. Jl. & Trans. Soc. Engrs., vol. 10, no. 3, 1919, pp. 109-130. Historical sketch of development during last 50 years leads writer to assert that no epoch-making discovery has been made during this time, but he examines the work which has been accomplished in inventing mixtures of old materials and grading them in order to make them suitable for various purposes.

Fertilizers

Sodammonium Sulphate. A New Fertiliser. The Utilisation of Nitre Cake in the Fixation of Ammonia, H. M. Dawson. Jl. Soc. Chem. Indus., vol. 38, no. 8, Apr. 30, 1919, Trans. pp. 98T-101T, 1 fig. Diagram illustrating crystallization of solutions containing sodium and ammonium sulphate.

Gas Masks

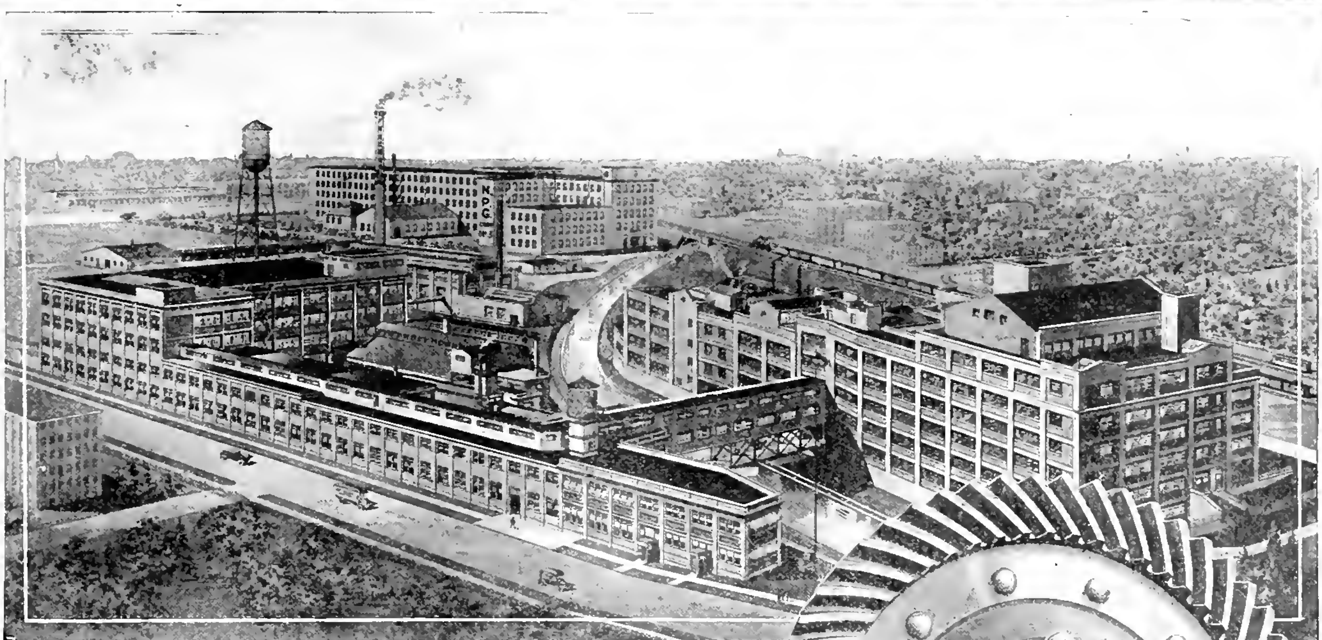
Effect of Exposure to Weather on Rubber Gas Mask Fabrics, G. St. J. Perrot and A. E. Plumb. Jl. Indus. & Eng. Chem., vol. 11, no. 5, May 1919, pp. 438-443, 6 figs. Investigation by Research Division, Chem. Warfare Service.

Gas Mask Absorbents, Arthur B. Lamb, Robert E. Wilson and N. K. Chaney. Jl. Indus. & Eng. Chem., vol. 11, no. 5, May 1919, pp. 420-438, 10 figs. Reasons underlying choice of mixtures used by Chemical Warfare Service. Mixture used in canisters contained 60 per cent 6 to 14 mesh coconut-shell charcoal and 40 per cent 8 to 14 mesh soda-lime-permanganate granites. Other combination selected was 75 per cent specially impregnated coconut charcoal and 25 per cent of soda-lime containing no permanganate.

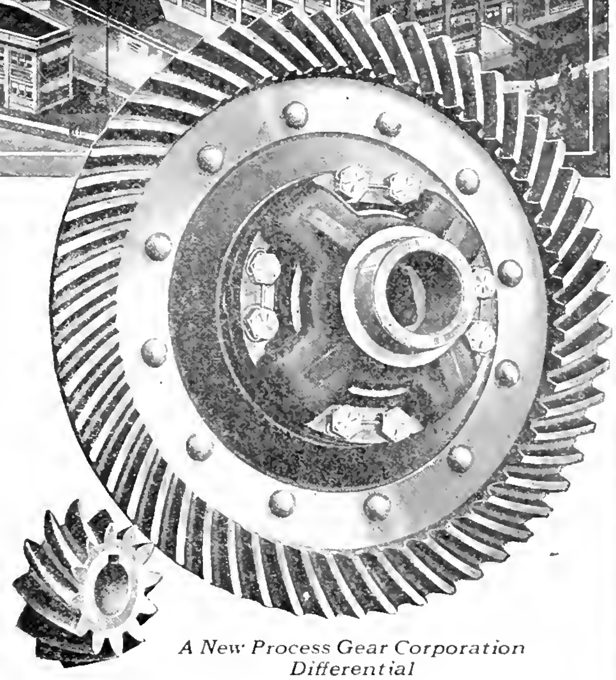
Nitrogen Fixation

The Present Status of Nitrogen Fixation, Alfred H. White. Sci. Am. Supp., vol. 87, no. 2264, May 24, 1919, pp. 330-331, 1 fig. Several processes contrasted on basis of recent experience. Address delivered at meeting of Am. Inst. of Chem. Engrs.

How the Nitrogen Problem Has Been Solved—III, Henry Jermain Maude Creighton. Jl. Franklin Inst., vol. 187, no. 5, May 1919, pp. 599-610, 2 figs. Outline of principles underlying formation of calcium cyanide from calcium carbide and atmospheric nitrogen. (To be concluded.)



The Ten-Acre Plant of the New Process Gear Corporation



A New Process Gear Corporation Differential

Six Acres of Manufacturing Space

in these buildings are devoted to the manufacture of *differentials* and *gears.*

Hearty co-operation of the gear specialists with the best of modern equipment combine to produce gears of quality.

New Process Gear Corporation
Syracuse New York

New Process Gears

Paints

The White Pigments, S. J. Cook. Can. Chem. Jl., vol. 3, no. 5, May 1919, pp. 145-147. Survey of present practice and magnitude of these paint industries. Address delivered before Ottawa Branch, Soc. Chem. Indus.

Salt

The Salt Industry and the Possibilities for the Future Development in Canada, L. Heber Cole. Can. Min. Jl., vol. 40, no. 19, May 14, 1919, pp. 346-366, 1 fig. Flow sheet indicating method employed in recovery of commercial salt from nature; deposits of British Columbian, Albertan, Manitoban, Ontario and Maritime provinces.

Seaweed Products

Industrial Uses of Seaweed (Sjotang som raastof for Sorindustri). Teknisk Ukeblad, vol. 66, no. 12, Mar. 21, 1919, pp. 172-174, 4 figs. "Norgin" manufactured from seaweed is used as dressing for cotton and linen fabrics and by painters for the preparation of inside walls and ceilings.

Soda Ash

Huge Industrial Development by Brunner Mond Co. at Amherstburg, Ont. Contract Rec., vol. 33, no. 18, Apr. 30, 1919, pp. 403-406, 5 figs. Process to be employed in manufacture of soda ash utilizes as two of principal raw materials limestone and salt.

Thallium

Note on Extraction of Thallium from Pyrites Flue Dust, George Sisson and J. S. Edmondson. Chem. News, vol. 118, no. 3078, Apr. 11, 1919, p. 75. Method depends upon solubility of chloride and sulphate, operation being to treat the dust with boiling water acidified with sulphuric acid.

Wood Pulp

The Chemistry of Wood Pulp Production. Arthur Klein. Paper, vol. 24, no. 10, May 14, 1919, pp. 15-19. Theories concerning constitution of cellulose. Paper read before German Assn. of Cellulose and Paper Chemists. (To be continued.)

Railroad Engineering

FOREIGN

European Train Speeds

European Train Speeds. Ry. Gaz., vol. 30, no. 16, Apr. 18, 1919, pp. 685-687, 2 figs. Survey of highest, longest and fastest non-stop runs, speed of trains between two places and geographical distribution of important services. Balkan States, Roumania, Germany. (Continuation of serial.)

Foreign Developments

Railway Developments in Foreign Countries. Ry. Age, vol. 66, no. 19, May 9, 1919, pp. 1163-1164. Proposed extension in Peru; suggestions for trading with Greece; South African news.

Norway

Transport Conditions on Norwegian Railways During the War (Vore jaernbaners transport forhold under Krigen), Chr. Platou. Teknisk Ukeblad, vol. 66, vo. 11, Mar. 14, 1919, pp. 147-156, 15 figs. Development and present conditions. Railways are state-owned. Figures indicating traffic during the war.

CONSTRUCTION

Welding Outfits

Local Building of Railway Special Work with the Aid of an Oxygen-Acetylene Cutting and Welding Outfit, Montelle C. Smith. Stone & Webster Jl., vol. 24, no. 5, May 1919, pp. 402-409, 4 figs. Experience in building frogs, switchmates and switches.

ELECTRIC RAILROADS

Battery Locomotives

Electric Battery Locomotives. Quarry, vol. 24, no. 267, May 1919, pp. 125-126, 1 fig. Consideration given to Brush type by Ministry of Munitions. These locomotives haul loads of three to four tons on level track.

Locomotive Design

The Progress of Electric Locomotive Design, W. B. Potter and S. T. Dodd. Ry. Age, vol. 66, no. 19, May 9, 1919, pp. 1157-1158. States that geared motors mounted directly on the axle will probably be continued for freight and slow-speed passenger work, while locomotives for high-speed passenger service will be preferably of gearless design.

Regenerative Braking

The Economics of Electric Operation of Railways, W. G. Gordon. Jl. Eng. Inst. Can., vol. 2, no. 5, May 1919, pp. 398-401. Costs of maintenance of electric locomotive for an average of five years for three railroads, an average of four years for two roads, an average of 2 years for C., M. & St. P. RR., with figures of saving effected by regenerative braking obtained by this road.

Substations, Railway Converter

Railway Converter Substations, C. E. Lloyd. Elec. Eng., vol. 53, no. 3, Mar. 1919, pp. 108-112, 3 figs. Plan of Taggart Street substation, Pittsburgh Railways Co.

Westinghouse Pneumatic Controller

Westinghouse Pneumatic Controller of French Suburban Locomotives (Equipment Westinghouse pour la commande électro-pneumatique des automotrices de banliene des chemins de fer de l'Etat), Lucien Pahin. Industrie Electrique, vol. 28, no. 644, Apr. 25, 1919, pp. 145-148, 1 fig. Scheme of connections and description of operation. (Concluded.)

ELECTRIFICATION

Electrification and Policies

Some Possibilities of Steam Railroad Electrification as Affecting Future Policies, Calvert Townley. RR Herald, vol. 23, no. 6, May 1919, pp. 133-135. Fundamental difference between electrification and steam propulsion. Emphasizes, among other features, practically unlimited power electricity can furnish as compared to strictly limited motive power of locomotives.

France

Partial Electrification of French Railways; Experiences Acquired in France and in Other Countries Concerning Electrification of Main-Line Roads (Programme d'électrification partielle des chemins de fer français; expérience actuellement acquise en France et à l'étranger dans l'électrification des grandes lignes), A. Mauduit. Bulletin de la Société Française des Electriciens, vol. 9, no. 78, Mar. 1919, pp. 127-160, 8 figs. Figures indicating fuel economy; types of locomotives, particularly three-phase designs used in Simplon tunnel; operating practice.

Iowa

Electrification of Steam Road Results in Service and Success. Elec. Traction, vol. 15, no. 5, May 1919, pp. 290-293, 9 figs. Iowa Southern Utilities Co.'s experience.

Limiting Factors

Main Line Railway Electrification. Times Eng. Supp., vol. 15, no. 534, Apr. 1919, p. 127. Some limiting factors.

Locomotive Characteristics

Railroad Electrification, F. H. Shepard. Jl. Eng. Inst. Can., vol. 2, no. 5, May 1919, pp. 402-406 and (discussion) pp. 406-409, 10 figs. Examples of track arrangement and details of locomotive design. Graphs indicating comparative steam- and electric-locomotive characteristics.

Pantagraph Shoe Design

Railroad Electrification Facts and Factors, A. J. Manson. Ry. Elec. Engr., vol. 10, no. 5, May 1919, pp. 147-149, 4 figs. Pantagraph shoe design is governed by class of service in which the locomotive operates.

Progress

Steam Railroad Electrification, Calvert Townley. Elec. Eng., vol. 53, no. 4, Apr. 1919, pp. 170-172. Blames electrical men for slow progress during last 20 years.

Swiss Railways

Electrification of Swiss Railways (Die Elektrifizierung der Schweiz. Bundesbahnen), E. Huber-Stockar. Schweizerische Bauzeitung, vol. 73, no. 15, Apr. 12, 1919, pp. 174-178, 4 figs. Difficulties encountered concerning supply of labor and material. Idea of electrification was suggested and work hastened by steadily increasing shortage of coal. Description of various power stations and single-phase a. c. 15,000 60,000-volt transformer for Riton power station. (To be concluded.) Paper read before Zürcher Ingenieur & Architekten Verein.

LOCOMOTIVES

Comparative Efficiencies, Compound and Simple Locomotives

Comparative Efficiency of a Compound and a Simple Locomotive Both Using Superheated Steam, C. J. Mellin. Loco, vol. 10, no. 1, May 1919, pp. 3-11, 4 figs. Diagrams worked out from investigation as to ranges in temperatures and expansion of superheated steam.

Electric Locomotives

See Electric Railroads.

Feedwater Heaters

Feed Water Heaters and Their Development, J. Snowden Bell. RR. Herald, vol. 23, no. 6, May 1919, pp. 143-148, 5 figs. Forms of feedwater heaters being applied in the U. S. A. by various locomotive works. (Continuation of serial.)

Pulverized Coal

Utilization of Pulverized Coal in Locomotives (L'emploi du charbon pulvérisé sur les locomotives), E. Lasseur. Génie Civil, vol. 74, no. 18, May 3, 1919, pp. 345-349, 7 figs. Present development of this application, notably as practiced by the Locomotive Pulverized Fuel Co., N. Y.

Pulverised Fuel Locomotive. Engineer, vol. 127, no. 330A, Apr. 25, 1919, pp. 400-402, 8 figs. on supp. plate. In order to make fire-box suitable for use of pulverized fuel, grate and ashpan were removed and two openings, each $7\frac{1}{2}$ in. in diameter, were made through the water space; through these openings pulverized fuel with a certain proportion of air is injected. Apparatus located on tender and steam-driven throughout.

Standard Locomotives

Standard 4-6-2 Type Locomotives. Ry. Mech. Engr., vol. 93, no. 5, May 1919, pp. 230-235, 14 figs. Locomotive is somewhat similar in its proportions to M., K. & T. locomotive, which, however, has more heating surface, but a considerably smaller grate and a smaller ratio of firebox heating surface to total heating surface.

The Administration Standard Light Mountain Type. Ry. Age, vol. 66, no. 20, May 16, 1919, pp. 1193-1196, 5 figs. Weight 327,000 lb., tractive effort 53,900 lb. with factor of adhesion of 4.2.

Swiss Locomotives

Brown-Boveri Locomotives for the Swiss Federal Railways, J. Buchli. Engineering, vol. 107, no. 2783, May 2, 1919, pp. 562-565, 12 figs., partly on supp. plate. Spur gearing and coupling rods transmit power from motor to driving axles. (To be continued.)

Tank Engines

2-6-4 Tank Engine, Class K, South Eastern and Chatham Railway. Ry. Engr., vol. 40, no. 472, May 1919, pp. 102-103, 2 figs. Design drawings with dimensions.

Tests

Locomotive Performance—IV, E. G. Young. Loco, vol. 10, no. 1, May 1919, pp. 12-17, 4 figs. Curves obtained in tests made on a Pacific-type locomotive at Pennsylvania laboratory, Altoona.

Uniflow

New Express Locomotive with "Uniflow" Cylinders, North Eastern Railway. Ry Gaz., vol. 30, no. 19, Ma .., 1919, pp. 801-803, 5 figs. Boiler has length of 15 ft. $10\frac{1}{2}$ in. and diameter of 5 ft. 6 in.; cylinders, $16\frac{3}{4}$ in. diameter by 26 in. stroke.

MAINTENANCE

Car Trucks

Problems in Design and Maintenance of Car Trucks in Relation to Maintenance of Roadway, W. J. Hyman. Official Proc. Can. Ry. Club, vol. 18, no. 4, Apr. 1919, pp. 15-22 and (discussion) pp. 23-35, 3 figs. Wheel-base trucks in relation to tracks and flat spots from viewpoint of Car Department.

Progress

Progress in Railroad Engineering and Maintenance, as Developed in the Annual Convention of the American Railway Engineering Association, Chicago, March, 1919, J. C. Irwin. New England RR. Club, Apr. 8, 1919, pp. 65-104. Following subjects are touched upon: Flat spots on wheels; economics of railway labor; war emergency yard improvements; umbrella vs. butterfly sheds; screw spikes.

BUNTING
BRONZE BUSHINGS AND BEARINGS
PATENTED

BIGNESS

Bunting Bushing Service is typically American—Big production, highly intensified.

Someone says we have the largest factory in the world devoted to Bushings exclusively—anyway we're BIG.

Specialized, exceptionally accurate, high speed machinery brings LOW PRICES and " INSTANT " SERVICE.

Long experience and an intense faith in the commercial value of a good article keeps Bunting Bushings a QUALITY PRODUCT.

Get Our Figures

Plain Bronze Bushings and Babbitted Bearings —pattern and tool equipment for over 10,000 standard designs or " specials " as ordered. 107 compositions on file—alloys compounded with absolute accuracy.

THE BUNTING BRASS AND BRONZE CO.

729 Spencer Street **TOLEDO, OHIO**

OPERATION AND MANAGEMENT

Accident Prevention

The Prevention of Accidents at Railroad Grade Crossings. Proc. Pac. Ry. Club, vol. 2, no. 12, Mar. 1919, pp. 12-22. Present methods for preventing accidents were discussed as practiced in various parts of the country by different members of the club.

Fuel Conservation

Reduction of Fuel Consumption on the Northern Pacific Railroad, M. A. Daly. Official Proc., N. Y. R. R. Club, vol. 29, no. 6, Apr. 18, 1919, pp. 5632-5636, also Ry. Mech. Engr., vol. 93, no. 5, May 1919, pp. 237-240, 21 figs. Fuel-instruction car employs laboratory demonstrations and moving pictures.

Oil-Fuel Trials

Oil Fuel Trials; North Western State Railway, India. Ry. Engr., vol. 40, no. 472, May 1919, pp. 90-92, 4 figs. Report of trials which have been in progress since 1913. Result is said to be that locomotives are to be fitted to burn 60,000 tons of oil per annum. Technical paper no. 193, Gov. Printing Dept., Calcutta.

PERMANENT WAY AND BUILDINGS

Abutments

Reinforced Concrete Framed Railway Abutments, Albert M. Wolf. Eng. World, vol. 14, no. 9, May 1, 1919, pp. 23-24, 3 figs. C., M. & St. P. R. R. abutments carry tracks over ends of high embankments, and instead of retaining the embankment, allow it to slope out between and around the abutment posts or piers.

Grade Crossings

Engineering Treatment of Necessary Railroad Grade Crossings, Rodman Wiley. Mun. & County Eng., vol. 56, no. 5, May 1919, pp. 191-193, 1 fig. Recommends that important crossing be well paved, paving to be level with top of rails, so as to prevent man killing his engine on track.

General Aspects of Grade Separation. Contract Rec., vol. 33, no. 19, May 7, 1919, pp. 440-443. Report issued by Division of Grade Separation and Bridges of city of Detroit. Question is viewed in its relation to city planning and cost of elevating railroads.

RAILS

Weight of Rail and Axle Load

Relation of Weight of Rail to Axle-Load, G. Richards. Ry. Gaz., vol. 30, no. 17, Apr. 25, 1919, pp. 715-716. Reasons for scales of axle loads prescribed in "Schedules of Maximum, Minimum and Recommended Dimensions to be observed on all 5-ft. 6-in., 2-ft. 6-in. and 1-metre gauge railways in India," for 1913 and limitations for spacing of sleepers. From Roy. Engrs. Jl.

ROLLING STOCK

Draft Gear

Freight Car Draft Gear Test Demonstrations. Ry. Age, vol. 66, no. 18, May 2, 1919, pp. 1097-1100, 6 figs, also Ry. Mech. Engr., vol. 93, no. 5, May 1919, pp. 249-252, 6 figs. Method of recording action under impact between cars devised by Inspection and Test Section of Division of Operation, U. S. R. R. Administration.

Perishable-Food Cars

On the Design of Railway Wagons for the Carriage of Perishable Foods. Dept. Sci. & Indus. Research, Food Investigation Board, special report no. 1, 1919, 8 pp. Among other suggestions it is advised that doors be laid in two portions, being divided horizontally.

Refrigerator Cars

Report on English Refrigerator Cars. Cold Storage & Produce Rev., vol. 22, no. 253, Apr. 17, 1919, pp. 87-90. Document from Government Research Sub-Committee. Urges, among other things, that special attention be directed to airtightness, especially as regards fitting of doors.

SAFETY AND SIGNALING SYSTEMS

Block-Signaling Practice

Block Signaling Practice on a British Railway. F. B. Holt and A. B. Wallis. Ry. Signal Engr., vol. 12, no. 5, May 1919, pp. 159-161, 3 figs. Electrical equipment used in signal tower on the Midland. First of series of three articles.

Low Frequency System

Supply and Transmission for Modern Railway Signalling, A. E. Tattersall. Ry. Engr., vol. 40, no. 472, May 1919, pp. 92-95, 2 figs. Advantages of low frequency are claimed to be possibility of using standard d. c. apparatus, economy in installation, improvement of power factor and greater variation in operating values of apparatus.

Reinforced-Concrete Appliances

Reinforced Concrete for Signal Work in England, A. C. Rose. Ry. Signal Engr., vol. 12, no. 5, May 1919, pp. 152-154, 6 figs. Types of reinforced-concrete signal and telegraph poles, stakes and other appliances.

SHOPS

Dipping and Baking

Insuring Electrical Equipment by Efficient Dipping and Baking, W. G. Lamb. Elec. Traction, vol. 15, no. 5, May 1919, pp. 307-309, 5 figs. Experience with dipping and baking process of Waterloo, Cedar Falls & Northern Railway.

Halifax Car Repair Shops

Car Repair Building for C. N. R. at Halifax, J. J. MacDonald. Contract Rec., vol. 33, no. 19, May 7, 1919, pp. 427-429, 5 figs. Shell of building consists of plain concrete base wall rising to level of window sills, a series of narrow wall piers between windows and reinforced-concrete entablature and parapet wall above window openings.

Omaha Car Barns

New and Modern Car Barn in Omaha. Elec. Traction, vol. 15, no. 5, May 1919, pp. 293-296, 5 figs. Structure of 100 cars capacity, including feature of single line of columns, giving maximum unobstructed floor space.

Roundhouse Design

Some Modern Tendencies in Roundhouse Design, Exum M. Haas. Ry. Age, vol. 66, no. 20, May 16, 1919, pp. 1199-1201. Economy in permanent construction. Paper read before Western Soc. of Engrs.

Welding

Welding Locomotive Drive Wheel. Welding Engr., vol. 4, no. 5, May 1919, p. 29, 2 figs. Pin was broken off flush with wheel; job was performed without removing wheel or preheating.

SPECIAL LINES

Narrow-Gage Repair Shop Trains

Repair Shop Train Used on Narrow Gage in Flanders, F. C. Coleman. Ry. Age, vol. 66, no. 19, May 9, 1919, pp. 1139-1140, 3 figs. Portable machine shop equipped with electric-motor-driven tools and gasoline generator sets.

See also MINING ENGINEERING, Transportation.

STREET RAILWAYS

New Orleans

Suggested Changes in the Operation of the Street Railway System of New Orleans, W. T. Hogg. Proc. Louisiana Eng. Soc., vol. 5, no. 1, Feb. 1919, pp. 25-78, 22 figs. Analysis of present routes from viewpoint of principles said to be scientifically based on geographic relations of commercial, industrial, residential and recreative centers. Present system found inadequate and modifications suggested.

New York

Six Years of Rapid-Transit Progress in New York, D. L. Turner. Eng. News-Rec., vol. 82, no. 18, May 1, 1919, pp. 865-869, 8 figs. Graphs showing cost of labor, comparison and work accomplished on old and new subway lines.

Rehabilitation Track Standards

Chicago Rehabilitation Track Standards Prove Successful. Elec. Ry. Jl., vol. 53, no. 18, May 3, 1919, pp. 865-869, 5 figs. Five standard types adopted in 1907 and 1909. Study made of rail corrugation as influenced by several types of construction.

Wheels and Axles

Steel-Tired Wheels and Axles, H. Vernon. Elec. Ry. Jl., vol. 53, no. 20, May 17, 1919, pp. 961-963, 7 figs. Practice at tramway sheds of Belfast, Ireland.

TERMINALS

Coaling Station, Lehigh Valley RR.

Modern Railroad Coaling Station, M. V. Bailliere. Coal Trade Jl., vol. 50, no. 19, May 17, 1919, pp. 519-520, 2 figs. Facilities provided for coaling on six different tracks in station built for Lehigh Valley R. R. at Manchester, N. Y.

D. & R. G. Freight Terminal

Novel Features in New D. & R. G. Freight Terminal. Ry. Age, vol. 66, no. 18, May 2, 1919, pp. 1083-1085, 7 figs. Facilities at Salt Lake City include two freight houses, transfer platforms and a team yard.

N. Y. C. Engine Terminal

New York Central R. R. Engine Terminal, Gardenville, N. Y. Ry. Rev., vol. 64, no. 19, May 10, 1919, pp. 677-681, 10 figs. Engine house is equipped with boiler-washing and filling apparatus, portable electric-welding equipment, hoists and trolleys for handling heavy locomotive parts, etc.

Munitions and Military Engineering

Airdromes

American Combat Airdromes, Charles C Loring. Architectural Rec., vol. 45, no. 4, Apr. 1919, pp. 311-324, 18 figs. Plans show characteristic irregular grouping necessary to render plants less vulnerable as targets.

Ammunition, Artillery

The Design of Artillery Ammunition and Some Recent Developments at Frankford Arsenal, J. Wallace Taylor. Jl. Engrs. Club Philadelphia, vol. 36-4, no. 173, Apr. 1919, pp. 127-137, 8 figs. Pressure-velocity curves of a medium-caliber gun; graphs showing travel of projectile against twist torque; table indicating atmospheric resistance to flight of projectile with ogival head of 2-caliber radius.

Artillery, Railway

Railway Artillery, E. D. Campbell. Jl. Engrs. Club of St. Louis, vol. 4, no. 2, Mar.-Apr. 1919, pp. 142-160, 9 figs. Historical sketch and forecast of future types.

Railway Mounted Artillery in the War. Ry. Age, vol. 66, no. 20, May 16, 1919, pp. 1205-1209. Development of mobile guns from 1863 to time of armistice with special reference to American types.

Automobile Service, French

French Military Automobile Service (Le service automobile militaire française), Robert Altermann. Génie Civil, vol. 74, no. 15, Apr. 12, 1919, pp. 291-294, 3 figs. Account of its operation during the war.

Battle Cruisers

The Battle Cruiser, E. F. Eggert. U. S. Naval Inst. Proc., vol. 45, no. 5, May 1919, pp. 719-728. Suggests a type which is said to combine high speed of cruiser and fighting ability of battleship. It is to be 650 ft. long with 28 ft. draft, 20,000 tons displacement, 32 knots speed and have power of 100,000 i. hp.

Battleships

United States Battleship New Mexico, S. M. Robinson. Int. Mar. Eng., vol. 24, no. 5, May 1919, pp. 323-334, 26 figs. Description of propelling machinery; trial data.

Camouflage

A System of Camouflage for Railway Mounts, John M. Goodwin. Jl. U. S. Artillery, vol. 50, no. 3, May 1919, pp. 253-267, 14 figs. Two systems: (1) five-color system for concealment of heavy railway mounts in which great mass of solid surface must be broken up into several separate masses and shadow cast by mount must also be hidden; (2) three-color system which consists principally in an endeavor to hide field piece by blending its form and shadow with landscape, this being accomplished by use of green, yellow and cream.

Camps

The Army's Utilization of Camp Wastes, F. C. Bamman. Mun. Jl. & Public Works, vol. 46, no. 17, Apr. 26, 1919, pp. 304-308, 2 figs. Results of changing from incineration to utilization. (To be concluded.)

Camp Wastes

The Army's Utilization of Camp Wastes, F. C. Bamman. Mun. Jl. & Public Works, vol. 46, no. 18, May 3, 1919, pp. 322-325. Form of contract said to secure great economy in use of food, more material from which glycerine can be derived, and larger revenue.

Engineering, Italian

Notes on the Operations of the Italian Engineers, James H. England. Prof. Memoirs, Corps Engrs., U. S. Army & Engr. Dept., vol. 11, no. 5, Jan.-Feb. 1919, pp. 128-133, 5 figs.

Deals with waterways and roads, the latter being designed and constructed with a view to accommodating 10-ton power trucks.

Fortifications

The Future of Permanent Fortifications, C. Beard. Prof. Memoirs, Corps of Engrs., U. S. Army & Engr. Dept., vol. 11, no. 55, Jan.-Feb., 1919, pp. 47-64. Author holds that by paying the price it will be possible in the future to construct fortifications capable of withstanding projectiles of large caliber, but remarks, quoting Napoleon, that "like cannon, fortresses are arms which alone cannot fulfill their missions."

Gas Masks

Gas Defense, Oscar E. Stevens. Stone & Webster Jl., vol. 24, no. 5, May 1919, pp. 365-371, 7 figs. Types of gas masks used by various belligerents during war.

Gun Emplacements

Notes on the Field Emplacement of a German Large Caliber Gun, G. P. Pillsbury. Professional Memoirs, Corp Engrs., U. S. Army & Engr. Dept., vol. 10, no. 54, Nov.-Dec., 1918, pp. 846-853, 3 figs. Foundation was wholly of structural steel and forged plates, no concrete being used. It had been prepared by excavating pit of required horizontal dimensions, about 7 ft. deep. No signs of overstrain were found in any part of foundation structure.

Gun Mounts

Making Naval Gun Mounts—III, Franklin D. Jones. Machy. (N. Y.), vol. 25, no. 8, Apr. 1919, pp. 745-749, 14 figs. Fixtures for broaching, milling and drilling operations, and testing methods. (Concluded.)

Gun, Photographic

The Photographic Gun, Edgar H. Felix. Aerial Age, vol. 9, no. 4, Apr. 7, 1919, pp. 198-199, 13 figs. Mechanism of gun camera showing Geneva movement and shutter mechanism, which automatically continues to take photos as long as trigger is depressed.

Gun Sights

Making Gun Sights for Anti-Aircraft Guns, Fred H. Colvin. Am. Mach., vol. 50, no. 15, Apr. 10, 1919, pp. 681-684, 10 figs. Mechanism consists primarily of a yoke attached to the recoil cyclinder which allows sight to be swung up and down on gun by means of curved rack governed by worm-actuated pinion in a case.

Guns

Making the U. S. 75-Millimeter Field Gun—II Erik Oberg. Machy. (N.Y.), vol. 25, no. 8, Apr. 1919, pp. 716-721, 27 figs. Methods developed by Wisconsin Gun Co., Milwaukee, Wis.

America's Great Effort in Ordnance—II. Sci. Am., vol. 120, no. 17, Apr. 26, 1919, pp. 432-433 and 444 and 446, 9 figs. Features of proving ground for testing army ordnance at Aberdeen, Md.

Guns, Location of

Listening for the Enemy. Sci. Am., vol. 120, no. 20, May 17, 1919, pp. 510-511, 8 figs. How a gun is located by timing its report as heard at three points.

Mine Protection

The Protection of Ships Against Mines II. Engineer, vol. 127, no. 3300, Mar. 28, 1919, pp. 293-294, 5 figs. Arrangements for towing projector-type paravanes on war ships and mercantile vessels.

Mining

The Work of the Miner on the Western Front, 1915-1918, H. Standish Ball. Bul. Instn. Min. & Metallurgy, no. 175, Apr. 1919, pp. 1-53, 32 figs., partly on 19 separate plates. Empirical formulæ by means of which fairly accurate calculations are said to have been made of the size and depth of the crater resulting from an explosion.

Mining in Chalk on the Western Front with Some Notes on the Explosion of Large Charges of High Explosives, L. B. Reynolds. Can. Min. Inst. Bul. no. 85, May 1919, pp. 483-493, 1 fig. Diagrammatic illustration of manner in which enemy works were located.

Motor-Transport Salvage Park

M. T. C. Salvage Park in France—I & II W. F. Bradley. Automotive Industries, vol. 40, nos. 16 & 17, Apr. 17 and 24, 1919, pp. 860-863 and 902-905, 19 figs. Reconstruction plant erected by Motor Transport Corps of U. S. army 120 miles behind front.

Munitions, Canada

Canada Made a Remarkable Record in Production of Munitions. T. M. Fraser. Can. [illegible], vol. 20, no. 26, Dec. 26, 1918, pp. 717-721. Imperial Munitions Board gives figures of total production in various plants.

Projectors

Projectors—British and German, Byron C. Goss. Nat. Service & Internat. Military Digest, vol. 5, no. 5, May 1919, pp. 276-280, 4 figs. Features of design and construction.

Railroad Transportation

Modern Armies and Modern Transport. Ry. Gaz., vol. 30, no. 14, Apr. 4, 1919, pp. 601-602. Work of North-Eastern Railway Co. during the war.

Roads

Military Roads as Constructed and Projected by the Construction Division, War Department, U. S. A., in 1918, Daniel B. Goodsell. Mun. & County Eng., vol. 56, no. 4, Apr. 1919, pp. 140-142, 10 figs. Typical cross-sections of cement concrete and bituminous pavements.

Submarine Detectors

The Wonderful Submarine Detector, Brewster S. Beach. Am. Mar. Engr., vol. 14, no. 4, Apr. 1919, pp. 8-14. Effort made by American scientists to perfect instrument for locating submarines while in a submerged condition.

Listening Devices in U-Boat War. Telephony, vol. 76, no. 15, Apr. 12, 1919, pp. 23 and 26-27. Development of submarine detecter by research laboratory experts of General Electric Co.

Stokes Gun

The Stokes Gun and Shell and Their Development, Wilfred Stokes. Professional Memoirs, Corps Engrs., U. S. Army & Engrs. Dept., vol. 10, no. 54, Nov.-Dec., 1918, pp. 765-788, 24 figs. Setting-up mechanism modified by introducing leg of heavier design and with only half the traverse. Similar improvements made in mechanism and accessories.

Supply Bases

Yard Tracks for Brooklyn Army Supply Base. Ry. Rev., vol. 64, no. 17, Apr. 26, 1919, pp. 609-611, 1 fig. Terminal arrangements and water-front development.

See also CIVIL ENGINEERING, *Bridges (Military), Building and Construction (Army Construction.)*

General Science

CHEMISTRY

Adsorption

Adsorption of Precipitates, Harry B. Weiser and J. L. Sherrick. Jl. Physical Chemistry, vol. 23, no. 4, Apr. 1919, pp. 205-252, 2 figs. Adsorption of following anions by precipitated barium sulphate said to have been determined: Chloride, bromide, iodide, chlorate, permanganate, nitrate, nitrite, cyanide, sulphocyanate, ferrocyanide and ferricyanide. Order of adsorption was not in accord with Schulze's law.

Analysis, Coke

Precautions Necessary in Grinding Samples of Coke for Analysis, A. E. Findley. Jl. Soc. Chem. Indus., vol. 38, no. 7, Apr. 15, 1919, pp. 93T-94T. Reports that samples of coke ground in an iron mill were found to be magnetic; consequently recommends placing coke in strong linen bag and grinding it to fine powder in agate mortar.

Analysis, Gas

An apparatus for the Automatic Estimation of Small Amounts of Oxygen in Combustible Gas Mixtures or of Combustible Gases in Air, H. C. Greenwood and A. T. S. Zealley. Jl. Soc. Chem. Indus., vol. 38, no. 7, Apr. 15, 1919, pp. 87T-90T, 3 figs. Principle involved is that of combustion of oxygen or impurity by means of intermittently heated platinum wire.

The Determination of Sulphites, and of Sulphur Dioxide in Gaseous Mixtures, Percy Heller. Jl. Soc. Chem. Indus., vol. 38, no. 5, Mar. 15, 1919, pp. 52T-56T. It is concluded from experimental research that the addition of 5 per cent glycerin to solutions or sulphites, or to caustic soda solutions used in absorbing sulphur dioxide, prevents any loss by spontaneous oxidation to sulphate.

Analysis, Phosphorus

The Estimation of Phorphorus in the Presence of Tungsten, G. Watson Gray and James Smith. Iron & Steel Inst., Ann. Meeting, May 8 & 9, 1919, no. 5, 4 pp. Method devised by writers.

Analysis, Steel

Determination of Uranium, Zirconium, Chromium, Vanadium and Aluminium in Steel—I, Charles Morris Johnson. Chem. & Metallurgical Eng., vol. 20, no. 10, May 15, 1919, pp. 523-524, 1 fig. Method based on fact that when ammonia is added to iron in the ferrous state the unoxidized iron is first converted to double sulphate of ferrous iron and ammonium and remains in solution. Addition of ammonia forms precipitate.

Colloids

The Colors of Colloids—III & IV, Wilder D. Bancroft. Jl. Physical Chemistry, vol. 23, nos. 3 & 4, Mar. & Apr. 1919, pp. 154-185 and 253-282. Rayleigh's discussion of visibility of polished surfaces; phenomena exhibiting invisibility due to uniform illumination; soap bubbles, oil or tar upon water, tempered steel, the brilliant colors of lead skimmings, Nobili's metallochrome, insects' wings, and other objects exhibiting colors of thin plates. Survey and analysis of various theories.

Rubber

Rubber as a Colloid, D. F. Twiss. Jl. Soc. Chem. Indus., vol. 38, no. 5, Mar. 15, 1919, pp. 47T-49T and (discussion) pp. 49T-50T. Suspensoid character of rubber is deduced from its behavior in electrolytic process of separating it from latex.

Solubility

Theory of Solubility (Théorie de la solubilité), Albert Colson. Comptes rendus des séances de l'Academie des Sciences, vol. 168, no. 13, Mar. 31, 1919, pp. 681-684. Thermodynamic interpretation of sense of phenomenon, eutectic concentrations, angular points, etc. A formula of solubility is developed from the chemical principle established by Chesneau that the concentration of a solution varies in the same sense as the osmotic pressure.

Solutions

Sulphur as a Cryoscopic Solvent (Schwefel als kryoskopisches Losungsmittel), E. Beckmann and C. Platzmann. Zeitschrift fur anorganische & allgemeine Chemie, vol. 102, no. 3, Apr. 9, 1918, pp. 201-214. Describes results of series of tests. Adjustment of "natural" melting point; determination of cryoscopic constant; catalytic influences; some applications of cryoscopic constant to anorganic substances.

On the Determination of Boiling Points of Solutions, F. G. Cottrell. Jl. Am. Chem. Soc., vol. 41, no. 5, May 1919, pp. 721-729, 1 fig. Particulars of method described consist in placing thermometed bulb in gas phase as in the case of a pure liquid and making the boiling of the liquid itself pump some of the latter mechanically in a thin film over it, thus duplicating as far as possible the same relations of gas, liquid and thermometer which ordinarily obtain in boiling-point determinations of pure substances.

Ultra-Violet Rays

Use of Ultra-Violet Rays—XXIV. Chem. Engr., vol. 27, no. 4, Apr. 1919, pp. 102 and 20 (adv.) Description of absorption spectra apparatus and ultra-violet light filters.

MATHEMATICS

Bessel-Clifford Function

The Bessel-Clifford Function, G. Greenhill. Engineering, vol. 107, no. 2776, Mar. 14, 1919, p. 334. Claims to simplify formula relating to stability, statistical and dynamical of a beam, strut or whirling shaft.

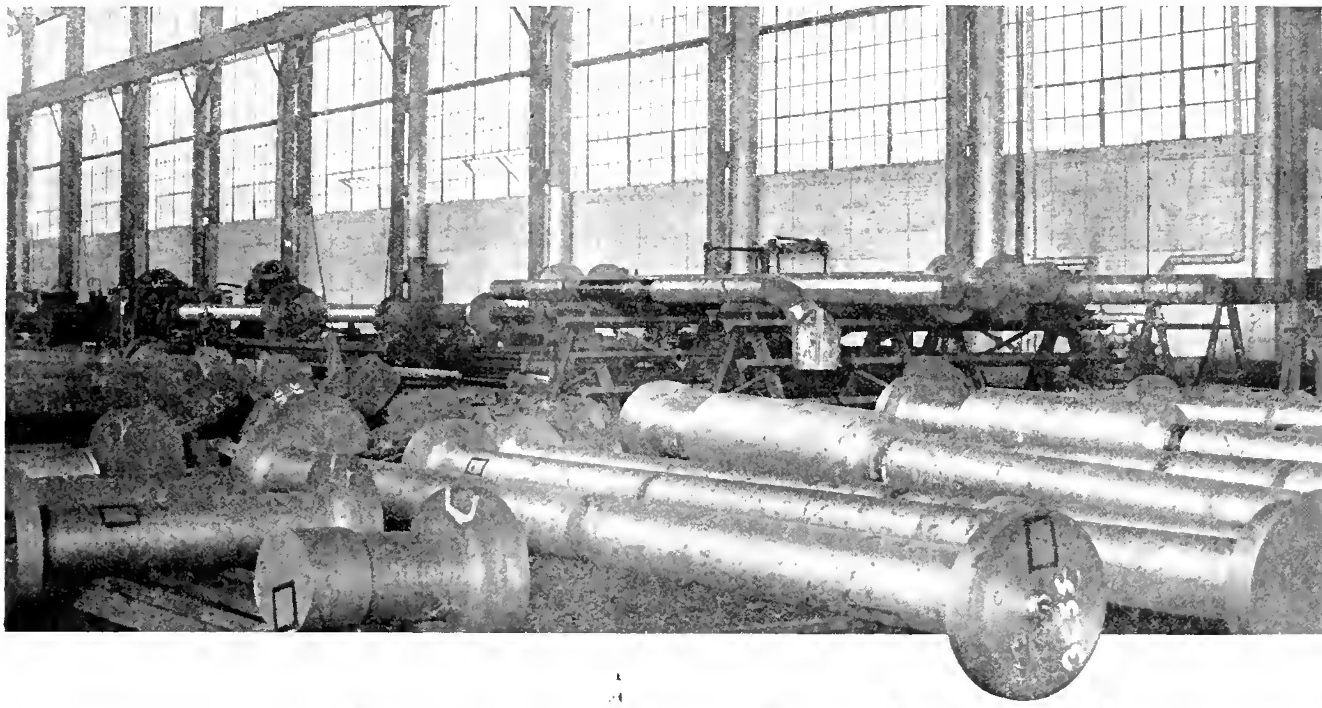
Equations

Linear Equations with Unsymmetric Systems of Coefficients, A. J. Pell. Trans. Am. Mathematical Soc., vol. 20, no. 1, Jan. 1919, pp. 23-29. Theory for linear equations in infinitely many unknowns. Method followed consists in reduction, by means of biorthogenal system, to system of linear equations with limited symmetric matrix of coefficients.

Solution of Simultaneous Linear Differential Equations and Certain Problems in Mechanics by means of D Symbol (Applications du calcul symbolique a l'integration des éguations différentielles linéaires simultanées et à la résolution de certains proldèmes de mécanique), H. Vogt. Revue Générale de l'Electricité, vol. 5, no. 16, Apr. 1919, pp. 581-589. In R. G. E., vol. 2, Sept. 29 and Oct. 13, 1917, pp. 483 and 563, writer applied this system of solution to single differential equations occurring in electrotechnics; in present note application is extended to simultaneous equations and exemplified in various cases of vibratory motion and gyroscopic action.

The General Solution of the Indeterminate Equation: $Ax + By + Cz + \ldots = r$, D. N. Lehmer. Proc. Nat. Acad. Sciences, vol. [illegible] no. 4, Apr. 1919, pp. 111-114. Treats equation in same non-tentative way that is found in continued fraction solution for two variables.

CAMDEN



DON'T STOP

to wonder whether we can make your forgings.

CAMDEN FORGINGS

are made for innumerable purposes.

We are interested in knowing of your forging requirements. We know that we can interest you in our plant and its product.

Let these considerations lead to our receipt of your forging inquiries.

BUYERS' MEMO

High and Low Carbon Bars
Press Columns and Rams
Pull Back Cylinders
Water Cylinders
Valve Bodies
Plungers
Weldless Steel Rings
Lathe Spindles, solid and hollow bored
Long Feed Screws
Power Press Crank Shafts
Rudder Arms

Rudder Stocks
Cam Shafts
Eccentric Shafts
Crusher Shafts
Gear and Pinion Blanks
Locomotives: Side and Main Rods; Crank Pins; Axles; Rod Straps; Guides; Parts of frame both in iron and steel

Hammered Iron Bars for locomotive repairs
Marine Shafts
Marine Connecting and Eccentric Rods
Rolls: Bending; Feed; Straighten'ng; *Embossing*
Large Wrenches
Saw Arbors

Steam Engine Forgings
Pump Crank Shafts
Pump Connecting Rods
Large Nuts
Turbine Shafts
Mill Shafting
Trolley Car Axles
Electric Motor Axles
Any forging to your print, and specifications, in either iron or steel

CAMDEN FORGE CO.
CAMDEN, N.J., U.S.A.

Functions

Approximation Polynomials and the Existence of Derivatives (Sur les polynomes d'approximation et l'existence des dérivées), Paul Montel. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 4, Jan. 27, 1919, pp. 215-217. Theorem establishing relation between differential properties of function to order of nearest approximation $u(n)$ of this function by polynomial of degree inferior or equal to n.

Fundamental Geometric Magnitudes

Fundamental Geometric Magnitudes of Euclidian Space (Les géométries fondamentales de l'espace euclidien), René de Saussure. Archives des Sciences Physiques et Naturelles, year 124, vol. 1, Jan.-Feb. 1919, pp. 29-47. Study of figures possible in one-dimensional space and of quanta of two and three paramaters. (To be continued.)

Implicit Functions

Implicit Functions (Sur les fonctions de lignes implicites), Paul Lévy. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 3, Jan. 20, 1919, pp. 149-152. Conditions under which inversion of point transformation is constant and uniform.

Integration

On the Analytical Extension of the Integrals of Certain Systems of Equations to the Linear Partial Derivatives (Sur le prolongement analytique des intégrales de certains systemes d'equations aux derivées partielles linéares), M. Riquier. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 3, Jan. 20, 1919, pp. 144-147. Considers as illustrative example case of five independent variables in seven arbitrary functions.

Isomorph

A Partial Isomorph of Trigonometry, E. T. Bell. Bul. Am. Mathematical Soc., vol. 25, no. 7, Apr. 1919, pp. 311-321. Isomorph considered as the algebra of sets and parities, and the related properties of functions $f(\epsilon_1, \epsilon_2 \ldots \epsilon_r; \eta_1, \eta_2, \ldots \eta_s)$.

Orthogonal Projection, Model

A New Geometrical Model for the Orthogonal Projection of the Cosines and Sines of Complex Angles, A. E. Kennelly. Proc. Am. Academy of Arts & Sciences, vol. 54, no. 5, Apr. 1919, pp. 371-378, 4 figs. on separate plates. Three-dimensional structure constructed to permit verification of sines and cosines of complex angles by two successive orthogonal projections on to X-Y plane, one projection being made from a rectangular hyperbola, and the other from a circle selected among a theoretically infinite number of non-coplanar circles, all concentric at origin.

Quadrics

On the Deformation of Quadrics (Sur la déformation des quadriques), C. Guichard. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 4, Jan. 27, 1919, pp. 200-204. Homographic transformation of parametric functional quantic. Determination of integral systems by Laplace's method.

Ruled Surfaces

Trajectories and Flat Points on Ruled Surfaces, J. K. Whittemore. Bul. Am. Math. Soc., vol. 25, no. 5, Feb. 1919, pp. 223-229. Determination of points of ruled surface, with real rulings, where curvature of every normal section is zero.

Spiral Minimal Surfaces

Spiral Minimal Surfaces, J. K. Whittemore. Tran. Am. Math. Soc., vol. 19, no. 4, Oct. 1918, pp. 315-330. Study of Minding parallels and meridians of minimal surfaces with reference to Z axis.

Triad System Trains

The Trains for the 36 Groupless Triad Systems on 15 Elements, Louise D. Cummings. Bul. Am. Mathematical Soc., vol. 25, no. 7, April 1919, pp. 321-324. Triad system being regarded as an operator, covariants of that operator are deduced. These covariants are called trains or systems.

PHYSICS

Acoustics

New Value of Velocity of Sound in Open Air (Sur une nouvele determination de la vitesse du son à l'air libre), Ernest Esclangon. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 3, Jan. 20, 1919, pp. 165-167. From various outside measurements under different conditions writer's value reduced to 15 deg. cent. in dry air becomes 339.9 m. per sec., 1115.15 ft. per sec.

Tables of the Zonal Spherical Hermonic of the Second Kind $Q_n(z)$ and $Q_n'(z)$, A. G. Webster and Willard Fisher. Proc. Natl. Acad. Sciences, vol. 5, no. 3, Mar. 15, 1919, pp. 79-82. Tables prepared in connection with investigations in regard to submarines.

Aggregation

Investigations Dealing with the State of Aggregation. Part IV.—The Flocculation of Colloids by Salts Containing Univalent Organic Ions, S. B. Schryver and Nita E. Speer. Proc. Roy. Soc., vol. 90, no. B631, Feb. 17, 1919, pp. 400-414. Deals with surface tension of solution and relationship between this property and capacity of salts for flocculating colloids.

Alcohol-Water Mixtures

The Determination of the Freezing-Point Curves and Densities of Denatured Alcohol-Water Mixtures, Clarke E. Davis and Mortimer T. Harvey. Jl. Indus. & Eng. Chem., vol. 11, no. 5, May 1919, pp. 443-448, 10 figs. A "zone of safety" is proclaimed for several concentrations. Tests were conducted at Chem. Eng. Lab., Columbia Univ., for the purpose of determining means of protecting radiator and cooling system of automobiles, airplanes and trucks from freezing.

Critical Phenomena

Critical Phenomena, William R. Fielding. Chem. News, vol. 117, no. 3063, Dec. 20, 1918, pp. 379-383. Attempt to obtain general formula connecting critical temperature of a gas and its critical pressure.

Crystallography

Molecular Orientations in Physics and in Crystallography, Albert Perrier. Sci. Am. Supp., vol. 87, nos. 2245 and 2246, Jan. 11 and 18, 1919, pp. 18-19 and 46-48, 1 fig. Investigations of matter based on fundamental concepts of anisotropy. Address before Helvetian Soc. Nat. Sciences, Zurich. From Minutes of Swiss Soc. Sci. Research, vol. 2, 1917.

Structure of Crystals in Thin Layers: New Experimental Determination of Molecular Magnitudes (Structure des cristaux en lames très minces: nouvelle détermination expérimentale des grandeurs moléculaires), René Marcelin. Annales de Physique, series 9, vol. 10, Nov.-Dec. 1918, pp. 185-194. Principle of measures is as follows: crystalline film is compared, in white parallel light, with quartz birefringent plate placed between two nicols; thickness of quartz plate is modified until it presents same appearance as first crystal.

Diffraction Figures

On the Diffraction-Figures Due to an Elliptic Aperture, C. V. Raman. Physical Rev., vol. 13, no. 4, Apr. 1919, pp. 259-260, 2 figs. on supp. page. Transition from Fresnel to Fraunhofer class of diffraction figure is traced and attention drawn to geometric law to which pattern conforms.

Diamond, Dispersion of

On the Dispersion of Diamond, L. Silberstein. Lond., Edinburgh, and Dublin Phil. Mag., vol. 37, no. 220, Apr. 1919, pp. 396-406, 2 figs. Applies concept of electrical intersection of atoms (see Refractive and Atomic Interaction, Phil. Mag., vol. 33 (1917), p. 521, especially general formulæ (2), (3) on p. 522) to refractive properties of diamond considered as assemblage of fixed "atomic centers," each containing a single dispersive electron and becoming a doublet in presence of an external electric field.

Electrical Action, Laws of

On the Fundamental Law of Electrical Action, Megh Nad Saha. Lond., Edinburgh, and Dublin Phil. Mag., vol. 37, no. 220, Apr. 1919, pp. 347-371, 1 fig. Theoretical study based on electro-dynamic principles as modified by Lorents, Einstein and Minkowski according to the principle of relativity. Method followed is that of four-dimensional analysis as initiated by Minkowski in Mathematische Annalen, vol. 68, p. 472, et seq.

Electrons

Movements of Small Particles With and Against Light Rays. Engineering, vol. 107, no. 2771, Feb. 7, 1919, pp. 180-181, 5 figs. Ehrenhaft's investigations with particles of solids and liquids are said to demonstrate that the electronic charge is not the ultimate unit of electricity. From Annalen der Physik, July 12, 1918, pp. 81-132.

Flame Propagation

The Propagation of Flame Through Tubes of Small Diameter—II, William Payman and Richard Vernon Wheeler. Jl. Chem. Soc., no. 675, Jan. 1919, pp. 36-45, 2 figs. Experiments to determine the safety practice in testing miners' lamps.

Gravitation

Experimental Researches on Gravitation (Recherches expérimentales sur la gravitation), V. Crémieu. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 4, Jan. 27, 1919, pp. 227-230, 1 fig. Investigation of electromagnetic field, Hertzian field, and plane of polarization of light, in vicinity of 50-kg. led cylinder rotating 1200 r.p.m., undertaken to examine relation between gravitation and electromagnetism, which theories hold are both properties of ether.

Gyroscopic Force of Fluids

Gyroscopic Force of Fluids (Sur la force gyroscopique des fluides), E. Faure. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 8, Feb. 24, 1919, pp. 395-398. Forces in system of pipes containing a fluid when subjected to gyroscopic motion.

Ionic Movement in Electrolysis

Movement of Ions in Electrolysis (Sul Movimento degli joni nell'elettrolisi), Carlo Del Lungo. Il nuovo Cimento, Series 6, vol. 16, nos. 3-4, Sept.-Oct. 1918, pp. 173-181. Formula for velocity.

Luminosity, Electrolytically Produced

An Application of Electrolytically Produced Luminosity, Forming a Step Towards Telectroscopy, L. H. Walter. English Mechanic, vol. 109, no. 2822, Apr. 25, 1919, pp. 160-161, 1 fig. Attempting to reproduce Johnstone's experiments, writer claims to have succeeded in constructing various luminous devices out of aluminum alloys. Paper read before Roy. Soc.

Mathematical Physics

Examples of Operational Methods in Mathematical Physics, T. J. I'a. Bromwich. Lond., Edinburgh, and Dublin Phil. Mag., vol. 37, no. 220, Apr. 1919, pp. 407-419, 1 fig. Heaviside's methods (Proc. Lond. Math. Soc. vol. 15, 1916, p. 401, particularly paragraph 3 and 4) to examine whether assumption of uniform rate of descent and uniform temperature-gradient are sufficient to explain various observations recorded on thermometers carried in aeroplanes.

Matter and Light

Matter and Light (Matière et lumière), Jean Perrin. Annales de Physique, vol. 11, Jan.-Feb. 1919, pp. 5-108. Dissociations and combinations, phosphorescence, radioactivity and changes of physical state explained by theory which represents light as immediate cause of chemical reactions and establishes fundamental law governing many physical and chemical phenomena.

Pendulum, Foucault

On the Irregularities of Motion of the Foucault Pendulum, A. C. Longden. Physical Rev., vol. 13, no. 4, Apr. 1919, pp. 241-258, 20 figs. In brief historical statement emphasis is put on current opinion that Foucault pendulum must be very long and very heavy in order to be successful. It is shown then that the elliptical motion so common in Foucault pendulum experiments is not due to insufficient length or weight, or atmospheric disturbances, but to unequal freedom of motion in different directions.

Piezo-Electricity

Piezo-Electricity and its Applications. Engineering, vol. 107, no. 2782, Apr. 25, 1919 pp. 543-544, 6 figs. Experiments exhibiting formation of electricity by pressure acting on tourmaline crystals and similar substances Paper read before Roy. Instn.

Radioactive Lead

The Problem of Radioactive Lead—I Nature, vol. 103, no. 2579, Apr. 30, 1919, pp. 93-96. Comparison of two kinds of lead—the ordinary metal, in non-uraniferous ores, and that apparently produced by decomposition of uranium, radium being one of the intermedia products.

Vapor Tensions of Metals

The Vapor Tensions of the Metals, J. W. Richards. Jl. Franklin Inst., vol. 187, no. May 1919, pp. 581-598, 4 figs. Vapor-tensi curves, straight-line equation, Trouton's ru and Richards' rule discussed in their appli tion to physical phenomena taking place sherardizing and calorizing.

X-Ray Spectra

Researches on the X-Ray Spectra (Recherches sur les spectres des Rayons X), A Muller. Archives des Sciences physiques naturelles, vol. 1, 5th period, Mar.-Apr. 1919, pp. 127-132, 2 figs. Experimental verificati of law of Einstein.

Pulverized Coal as a Fuel

This Paper Together With the One Which Follows, on Pulverized Coal for Stationary Boilers, and the Discussion Thereon, Represent the Predominating Thought of the Fuel Session Held During the Spring Meeting

By N. C. HARRISON,[1] ATLANTA, GA.

This paper first reviews some of the uses of pulverized coal in the industries—such as the cement, steel and copper industries, and then gives a technical definition of pulverized coal, describes the process by which it is prepared for use and furnishes a table of cost of preparation. The pulverized-coal-burning open-hearth steel plant of the American Iron & Steel Manufacturing Co., Lebanon, Pa., is described and the advantages of pulverized coal, compared with producer gas as a fuel for open-hearth furnaces, are listed.

The use of pulverized coal in stationary boiler plants is discussed, five determining factors in the successful operation of such a plant being taken up in detail. As compared with mechanical-stoker plants the advantages of the pulverized-coal plant are enumerated and certain precautions to be observed with the latter type of plant are brought out.

A report of a test of a 468-hp. Edge Moor boiler with pulverized-coal equipment is included in the paper and the efficiency obtained is compared with the efficiency of a stoker-fed boiler in the same plant, a greater net efficiency being found in the pulverized-coal plant. The paper concludes with a statement of some advantages obtained in the pulverized-coal plant.

THE gradual disappearance of fuels, like natural gas, and the shortage in the supply of crude oils, have compelled in recent years a consideration of pulverized coal as a fuel. Pulverized coal was first used in the United States about twenty-six years ago for the economical burning of cement rock in the rotary kilns of the portland-cement industry and the growth of the industry has had a great bearing on the development and use of pulverized coal. Because of this growth pulverizing machines were also brought to their present high state of development, for in the manufacturing of cement not only is the coal pulverized but for every barrel of cement manufactured (weighing 380 lb.) there are required about 600 lb. of raw material such as limestone shale or cement rock and 380 lb. of clinker produced by the kilns, all of which must be pulverized in order to make the finished product. As there are a hundred million barrels of portland cement made in this country annually, these figures will give one a reason why pulverizing machines have been so highly developed. Fine grinding of the raw material means reduction in the quantity of fuel required and also makes possible the highest quality of the finished product, so far as the chemical analysis or combination is concerned. Fine grinding of the clinker means increased strength for the reason that the hydraulically active units in cement are in direct proportion to the percentage of fine or impalpable powder in the finished product.

The application of this form of fuel has been gradually taken up by engineers connected with other industries, and its recognized value is such that the steel industry today is using in the neighborhood of two million tons of pulverized coal annually in various types of furnaces such as open-hearth, heating, puddling, soaking pits, continuous-heating, reheating, annealing, and forging furnaces.

The copper industry is also using between one and two million tons per year in ore-roasting furnaces, reverberatory and copper-melting furnaces of all types. Large amounts of pulverized coal are used in rotary kilns (other than the cement industry) for the desulphurizing and roasting of various grades of ores; for nodulizing blast-furnace flue dust so as to make available products heretofore very expensive to recover; for burning lime to oxide of lime for use in open-hearth furnaces; for burning dolomite for open-hearth furnaces; and for the calcining of various minerals, from which are obtainable such commodities as plaster of paris, stucco, potash, etc. A total of approximately 10 million tons of pulverized coal are burned annually in the United States in the above industries.

A still further and very important development is now going on, which will, when it attains its growth, require more pulverized coal than probably all of the other industries combined, and that is in its application to locomotives, particularly in the West. There is still another field in which enormous quantities of this fuel will be used and a field in which we are all concerned, and that is in the generation of power in stationary power houses.

Practically any coal can be burned in pulverized form with a proper furnace and burning equipment. Each application however must necessarily be governed by the quality of the fuel available in the district in which it is made. Generally speaking, the coals which give the most satisfactory results are those in which the ash content is less than 10 per cent, the volatile averaging between 30 and 40 per cent and the fixed carbon between 40 and 50 per cent. The sulphur content should be low although coal with a sulphur content running as high as $4\frac{1}{2}$ to 5 per cent is being burned in pulverized form under boilers and without any detrimental results. The ash should have a high melting point. These statements, however, are tentative, as most excellent results have been obtained from all sorts of coals, differing widely from the ideal analysis stated.

What is Pulverized Coal?

From a technical standpoint pulverized coal is that coal which is properly dried, crushed and pulverized so that the product contains the highest percentage of impalpable powder. Merely powdering coal does not fulfill the requirements. Coal must be pulverized so that at least 95 per cent will pass through a 100-mesh sieve having 10,000 openings to the square inch, or in terms of dimension 95 per cent must be less than one two-hundredth of an inch cube.

The average person does not fully realize to what a high degree of fineness it is possible to reduce the coal today by pulverization. The finer the coal is pulverized the more efficiently it can be burned and the more readily it will be diffused when mixed with the air for combustion and fed into the furnaces.

Pulverizing certainly does not change the nature of the coal, but it does change its form to a certain extent in that the coal is changed from a solid into a fuel having liquid properties. As the coal is pulverized it is mixed with air, and when handled in the conveyor it flows like water; when fed to the furnaces it is more or less like a gas, and the furnaces must be designed to burn a gaseous mixture.

Description of a Coal-Pulverizing Plant

A pulverizing plant consists of three main units: a crusher, a crushed-coal drier and a pulverizer, the number of each depending on the size of the plant. The coal is dumped in a track hopper and conveyed by either a belt or apron conveyor into a hopper feeding a single-roll coal crusher, or where slack coal is at hand, direct to an elevator pit. After being crushed to about one inch in diameter, it passes by gravity to an elevator pit, where it is taken by bucket elevators to the drier storage bin. Automatic weighing scales may be installed if desired before the drier storage bin. Magnetic-separator pulleys are also installed (where a belt

A Report prepared for the Atlantic Steel Company, Atlanta, Ga., and later presented at a meeting of the Local Section, Atlanta, and at the Spring Meeting, Detroit, Mich., June 16 to 19, 1919, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. The paper is here printed in abstract form, and is subject to revision. Copies of the complete paper may be obtained at a nominal cost.

[1] General Supt., Atlantic Steel Company, Atlanta, Ga. Mem. Am. Soc. M. E.

conveyor is used from the track hopper) to remove iron or steel scrap in the shape of nuts, bolts, pick-points, wedges and such foreign matter, which would interfere with the pulverization.

From the drier storage bin the coal passes to a coal drier. This drier must be of a size to deliver the required quantity continuously and thoroughly dried. The drier is heated either by hand firing on grates or by pulverized coal, so arranged in either case to avoid igniting the drying coal. The cylinder of the drier is rotated by power, either a small motor or line shaft being used. The dried coal falls from the drier through a chute into the pit of an elevator. In this chute the coal passes over another magnetic separator to remove any pieces of metal which might be left in the coal and which were not removed by the magnetic separator previously mentioned.

This elevator carries it to a storage bin set aloft for supplying the pulverizer. By spouts and gates the coal is permitted to enter the pulverizer as desired. This pulverizer grinds the coal to the fineness required. From the pulverizer the coal is conveyed in various ways to the pulverized-coal bins. With the type of mill used at the plant of the Atlantic Steel Company, Atlanta, Ga., the pulverized coal is carried by spouts from the mill to the pit of an elevator, which carries it aloft to the screw conveyor, and the latter feeds the pulverized-coal bins. In another type of mill the finely pulverized coal is conveyed by suction fan from the mill to a cyclone separator, properly located over the pulverized-coal storage bin. This separator will allow the coarser particles to fall back to the mill to be reground, while the fine dust passes to the storage bin. No fine-dust elevator is necessary with this mill.

These pulverized-coal storage bins are of a capacity proportional to the service and hold a supply in excess of the amount required in the intervals when the grinding is not going on. Thus the mills may supply in eight to ten hours all that the furnaces may use in 24 hours.

If the pulverizing plant is located within 200 ft. of the furnaces and the furnaces are of large capacity, these storage bins are located directly at the furnaces, but if there are numerous small furnaces located at a considerable distance from the pulverizing plant, then the storage bins are located at some central point and the pulverized coal conveyed from these points to the various furnaces by means of one of three methods: first, screw conveyor; second, in a mass by means of compressed air; third, in suspension in a current of air.

Costs of Pulverizing Coal

The cost of pulverizing coal depends upon four items: first, the amount of moisture that must be expelled from the coal before pulverizing; second, the cost of labor; third, the cost of coal delivered at the pulverizing plant; fourth, the cost of electricity. Table 1, issued by a pulverized-coal engineering company, gives the cost of pulverizing plants, including buildings, and costs of pulverizing coal in plants of capacity from 10 to 250 tons per day. These figures include all costs, except interest and depreciation, in the pulverizing plant proper, and deliver the dust from the top of the last elevator to the screw conveyor, which feeds the pulverized-coal storage bins.

TABLE 1 COSTS OF COAL-PULVERIZING PLANTS AND COSTS OF PULVERIZING COAL PER TON NET

Tons daily	Total cost pulverizing per ton, dollars	Cost of plant including building, dollars
10	0.56	31,000
20	0.51	31,000
30–40	0.49	31,000
50–90	0.39	37,000
100–130	0.34–0.33	45,000
140–180	0.32	50,000
190–250	0.30	62,000

Pulverized Coal in Metallurgical Furnaces

The development and use of pulverized coal in this country has primarily been due to its application in the cement industry and its gradual application to other types of metallurgical furnaces. Marked economies, and in some cases increased production, have been obtained from this fuel and within the last few years it has been applied very successfully to various kinds of heating furnaces, including forging, continuous-heating, busheling, puddling and open-hearth furnaces. Pulverized coal is also being used on continuous-heating furnaces with very gratifying results, and as a fuel for soaking pits its promises to be used more extensively in the future.

One of the first applications of pulverized coal to the various types of metallurgical furnaces was made by the American Iron & Steel Manufacturing Co., now the Bethlehem Steel Co., Lebanon, Pa., at whose plant this form of fuel was successfully applied to heating, busheling and puddling furnaces, this being practically the first attempt to apply it to the iron and steel industry. Taking into consideration the knowledge obtained from the experience at the above-mentioned plant, and also that obtained from other installations, it has been found that furnaces can be successfully operated by various methods of applying this fuel. Each type of metallurgical furnace presents different requirements as to the kind of burners to be used. Probably the greatest recent development in its use has been as a fuel for open-hearth furnaces and boilers.

All open-hearth furnaces using pulverized coal as a fuel are of the reversing type. There has been only one exception in this country to this, as far as the writer knows, and that exception was at the plant of the American Iron & Steel Manufacturing Co., Lebanon, Pa., where they fired their open-hearth furnaces from one end only. On the other end they installed waste-heat boilers and economizers. As an open-hearth proposition this turned out to be a failure, but as a waste-heat boiler proposition it was a wonderful success. During 1918 they remodeled these furnaces and fired them from both ends.

In the open-hearth furnaces the pulverized coal is delivered into storage bins located at each end of the furnace. On the bottom of these bins are screw feeders, driven by variable-speed motors for supplying the amount of coal desired. This carries the coal by gravity into the burner pipe. These burners are usually a combination of compressed air at from 60 to 80 lb. pressure and fan air at about 8 oz. pressure. In some cases compressed air alone is used as the medium for conveying this coal into the furnaces. The hearth of a pulverized-coal open-hearth furnace is practically the same as the hearth of any other open-hearth furnace but the uptakes, slag pockets and checker chambers are entirely different. The uptakes are made as small as possible so as to hold the gases in the furnace as long as possible without blowing, and the slag pockets are made large so that the gases will have a slow velocity going through them, thereby depositing a large percentage of the heavy particles that are in the outgoing gases. On account of this heavy deposit, removable slag pockets, or very deep stationary pockets, should be used, so as to collect this accumulation over the run of the furnace. Where removable slag pockets are used, they are taken out and cleaned and replaced about every two weeks.

Only one checker chamber is needed on each end of the furnace. If the checker chamber is large enough, these chambers should be built up with large tiles and laid in such a manner as to form vertical flues, having openings of at least 6 by 9 in., or better, 9 by 11 in. In some cases, no checkers at all are used but the chambers are filled with baffle walls with openings from the outside, so that the accumulation between these baffle walls can be raked out. All passages from slag pockets to stack must be as straight as possible and wherever any bends must be made, some agitating device should be installed at these points. The reversing valves are usually of the mushroom and damper-slide type.

The best coal for use in pulverized form in open-hearth practice is a bituminous coal as high in volatile matter as possible, and preferably low in ash. It should never contain below 32

per cent of volatile, nor more than 8 per cent of ash. For open-hearth furnace use it is necessary that the coal be as finely ground as possible and it should be so fine that about 97 per cent will pass through the 100-mesh sieve, preferably 90 to 93 per cent and not less than 85 per cent through the 200-mesh sieve, and from 70 to 75 per cent through the 300-mesh sieve.

This very fine pulverization is necessary for quick combustion and for the removal of sulphur in the coal; and in order to obtain this complete combustion before the flame strikes the bath, some 6 or 8 ft. are necessary from the end of the burners to the bath.

Pulverized Coal vs. Producer Gas

The advantages and disadvantages from the use of pulverized coal, as compared to gas producers, as a fuel for open-hearth furnaces, from observation of its use up to date are as follows:

a Since the coal is of a more even chemical composition all the heat units are consumed in the furnace, while in the case of the gas producer from 18 to 25 per cent of the heat units are lost in the producer itself when converting the coal into gas. This will result in a greater number of heats per week.

b Open-hearth furnaces using powdered fuel operate on a very low fuel consumption equal to the best producer-gas practice, and much better than the average of the older plants in this country; at the writer's plant (The Atlantic Steel Company, Atlanta, Ga.) about 50 per cent less.

c Coal can be pulverized in plants of about 100 tons daily capacity and delivered to the furnace for approximately 50 cents per ton, which is about the same as the costs for gasifying coal in gas producers.

d Although the use of this fuel in metallurgical furnaces has been developed only about 75 per cent, it is believed that this development is steadily increasing. In the writer's plant the pulverized-coal open-hearth furnace has been shut down more often than the producer-gas furnace of the same size. This has been due to checkers and slag pockets filling up with cinders and slag after about 80 heats; these troubles, however, are being gradually overcome by decreasing the size of the uptakes and enlarging the slag pockets, thereby holding the gases in the furnace longer and passing them slowly through the large slag pockets, so that the heavy particles can settle, and now only the fine particles are going to the checkers, which particles are being blown off daily by compressed air. By these means it is expected to get a much longer life out of the checkers, and consequently longer runs out of the furnace, since the filling up of the checkers has always been the deciding factor in the length of run of the furnace.

e Sulphur does not give any trouble as long as there is a good draft and the furnace is working hot, as this plant is now using over 1 per cent sulphur in its coal and getting good results, although when checkers get clogged up and the furnace begins to blow, due to lack of draft, there is trouble with the bath taking up sulphur. This takes place during the last week's run of the furnace, just before it goes down for repairs.

f The pulverized-coal open-hearth furnace is under complete control of the first helper as to the amount of coal being used at all times, air blast and temperature.

g The flame, using the same coal as on gas producers, is hotter, which allows the use of a greater percentage of scrap per ton of steel, thus reducing the consumption of high-priced pig iron.

h The finished steel is quieter in the molds, due to not being overly oxidized, as the coal coming directly in contact with the bath has a greater reducing action. All gas-house troubles are eliminated (cleaning fires, burning out flues, etc.) although the pulverizing plant must be given attention as to dryness and fineness of coal.

i Up to date, the refractory costs have been very much greater on the furnace using pulverized coal than on the gas-producer furnaces and was almost twice as great a year or so ago, although the writer believes that on account of the steadily increasing development of the use of this fuel, these refractory costs will be steadily decreased.

Table 2 shows a comparison of fuel costs for all fuels now used on open-hearth furnaces and it will be seen that natural gas is not only the ideal fuel but is the cheapest.

Pulverized Coal in Stationary Plants

Many engineers who attempted to burn coal in pulverized form obtained unsatisfactory results, and concluded it was "impossible." In many of the earlier trials to burn pulverized coal under boilers the usual method was to install coal-feeding devices of some kind in the furnace as it stood, with the result that the fire bricks melted down and the tubes were plastered with unconsumed carbon, ashes and soot. So destructive were the results

TABLE 2 FUEL COSTS FOR OPEN-HEARTH FURNACES

Kind of fuel	Remarks	Amount per ton steel	Rate cost fuel, dollars	Cost of fuel and labor, dollars	Cost per ton steel, dollars
Natural gas..	....	6000 cu. ft.	0 04 per M	....	0.24
Natural gas...	....	6000 cu. ft.	0.12 per M	....	0.72
Producer gas..	Hot metal	510 lb. coal	3 40	3.93	1.00
Producer gas [1]	Cold metal	739 lb. coal	3.40	3.93	1.46
Fuel oil......	....	40 gal.	0 02	....	0.80
Tar[2]!........	....	40 gal	0 025	....	1.00
Pulverized coal.......	....	500 lb. coal	3.40	3 90	0 975
Electric power		500 kw-hr.	0 0075	...	3 75

Above includes handling cost.

[1]Atlantic Steel Company, Atlanta, Ga.

[2] Tar is a waste product at some plants and has to be burned.

that those making the tests can hardly be blamed for arriving at the conclusion they did. How close some were to success was not fully realized. Conditions were not ripe. Today results are being obtained that are of sufficient importance to warrant careful investigation and consideration.

For the proper combustion of coal under boilers, there are five main points which must be given serious consideration, otherwise the burning of this fuel will not be a success. These five points are coal fineness, size of combustion chamber, necessary air opening, proper damper regulation, and clean tubes.

Coal Fineness. The pulverized coal should run about 96 per cent through the 100-mesh screen and about 85 per cent through the 200-mesh screen. If it runs below 80 per cent through the 200-mesh screen, particles of carbon will fly through the air inside of the combustion chamber, and as these particles are not completely burned when the gases reach the tubes, they will deposit themselves on the tubes. These heavy particles in the pulverized-coal mixture will sometimes settle on the bottom of the combustion chamber and will soon build up in the shape of stalactites. This accumulation will continue to build until the bottom of the combustion chamber continues to be raised, until it comes in contact with the flame. These built-up particles will then fuse into a solid mass, which, in a very short time, will cause a shut down of the boiler to dig this fused mass out. It is, therefore, necessary, for the successful burning of this pulverized fuel under boilers, to have this coal as finely pulverized as possible.

Size of Combustion Chamber. Before installing, or considering the use of pulverized coal under boilers, a study of the boiler-house installation should first be made, the rating at which the boilers will be operated decided upon, considering any peak load which may develop. The combustion chamber should be designed large enough to take care of the maximum loads which will be developed from the boilers at any time. After this maximum rating has been determined, the combustion chamber is designed, using a cubical capacity equivalent to approximately 50 cu. ft. per lb. of coal burned per min., or approximately $2\frac{1}{2}$ cu. ft. per hp. developed by the boiler. If it is decided to run this boiler at 150 per cent of this rating and the combustion chamber is designed accordingly, the efficiency will not be decreased perceptibly if the boiler is run under this 150 per cent rating, but if over a 150 per cent of the rating is developed serious difficulties will result. More coal and air must be admitted to the boiler to develop the greater rating, and consequently more combustion space is needed; and finally if this combustion space is not available the flames impinge on the brickwork and cut it away very rapidly. Also, combustion is not complete at the time the gases strike the bottom row of tubes and consequently the gases will pass up the stack unburned. Efficiency is then decreased. The size of the combustion chamber should also be so designed that the velocity of the gases should not pass through this combustion chamber at a speed of more than 6 ft. per sec. The mixture of air and coal entering the combustion chamber, as stated above, should be at as low a pressure as is possible to

bring this mixture in in suspension; or, in other words, breathe it in.

Proper Air Openings. The pressure at which the pulverized coal is admitted to the furnace is as low a pressure as can be used to carry this fine coal in suspension, and is about half an ounce pressure at the nozzle. In some installations the coal falls by gravity from the variable-speed screw conveyor, located on the bottom of the pulverized coal bin, into a fan air line which carries it into the furnace and also supplies the necessary air for combustion. Some few openings are placed in the front wall of the boiler to give any additional air which may be needed, and a few may also be placed on the side walls of the boiler to protect the brickwork at times.

In other installations the amount of air necessary to convey the coal into the furnace varies, according to the rate at which the boiler is being operated. The balance of the air to burn the coal properly is admitted through adjustable air openings in the front, sides and bottom of the combustion chamber. These openings are made adjustable and are placed on all sides of the combustion chamber to take care of the various grades of coal which may be used in the boiler plant. By properly observing the combustion in this chamber, by a little experience the fireman knows at exactly what points to give more, or less air needed for combustion.

Damper Regulation. In order to give the proper velocities of gases passing through the combustion chamber, it is necessary to have very accurate damper regulation to take care of the various load conditions which the boiler is to supply. The damper should be so regulated that it will maintain practically a balanced draft inside of the combustion chamber and only a slight vacuum in the first pass, while at the damper itself not more than 0.10 to 0.15 in. is required. If there is more vacuum than this, it pulls the gases through the combustion chamber too fast, causing them to be unburned before reaching the first row of tubes and will then build up very fast on the outside of these tubes. This very small draft needed at the base of the stack will allow us to operate boilers using pulverized coal with stacks of about 30 to 35 ft. in height.

Clean Tubes. In order to get the maximum evaporation from any boiler it is necessary that the tubes be kept clean. They should therefore be blown at least every 6 hours. Once every 24 hours the bottom of the first row of tubes should also be blown as these are the tubes in which the gases come into contact first after leaving the combustion chamber. This material can be blown off easily if the combustion chamber has been properly constructed and if the tubes are blown regularly as needed. If they are not blown regularly this material accumulates very fast and in time will become fused and cannot be blown off.

Another item, which might have been called the sixth point, is the removal of ash which deposits at the bottom of the combustion chamber. This ash should be removed at regular intervals, which intervals will be determined by the amount of ash in the original coal. If the ash is not removed regularly, it will build up until it comes in contact with the flame, when it becomes fused and has to be dug out. But if removed at regular intervals, it can be easily raked out with the ordinary boiler-room ash rake and will not consume more than half an hour per 24 hours, and will not interfere with the operation of the boiler while this is being done.

Pulverized Coal vs. Stokers

The following are some advantages of pulverized coal as a fuel for boilers over stokers:

a Much wider variation in the quality of the coal usable is obtained when burning coal in pulverized form. Practically any and all grades of coal can be burned in this form with economy.

b The ability to take care of peak loads almost instantaneously. In other words, a pulverized-coal burning system is much more flexible than a stoker installation. Its flexibility approaches that of oil or natural gas.

c The amount of coal that can be burned per square foot of grate surface on stokers is limited so that for increased capacity the boiler setting must be spread out to cover more area. When using pulverized coal, this condition does not exist, for proper furnace conditions can be obtained by increasing the height of the boiler setting or the depth of the combustion chamber.

d By throwing a switch the entire firing operation ceases; an advantage in case of accident or emergency.

e Ash is in much better condition to handle. The ash is in the form of a dust or slag depending upon its melting point. This helps to maintain constant furnace temperature as there are no interruptions to firing conditions on account of cleaning fires.

f Pulverized coal is fired dry, containing less than 1 per cent of free moisture, whereas coal burned on stokers may vary anywhere from 1 to 10 per cent, of free moisture as fired.

g Considerably less excess air is necessary for complete combustion. This item is of the utmost importance when making comparisons. Less excess air means less power for furnishing air supply, particularly where forced draft is used. With less excess air the stack losses are less. Lower grades of coal fired on stokers require more excess air as it is quite difficult for the oxygen to get in close contact with the combustible. An air supply sufficient to furnish all the air for combustion should be available, although at times only 50 per cent of the air is necessary to be injected into the furnace with the coal, the balance being supplied by the induction action of the burner or drawn in by the stack draft through the various adjustable openings in front and sides of combustion chamber. The air going into the furnace should be under control to permit close regulation under all conditions of firing.

h With furnace properly proportioned and with properly designed burning equipment smokeless operation may be maintained indefinitely. This is due to complete combustion of all the particles of coal before coming in contact with the cold surface of the tubes of the boiler.

The following few points must be kept in mind for the successful burning of pulverized coal under boilers:

a A boiler furnace using pulverized coal should have as few burners as is possible consistent with good regulation. The burners must be proportioned for the maximum rating of the boilers, and they must be adjustable. Simplicity of design is desirable. It has been found much more desirable to introduce coal into the furnace as far away from the side walls as possible so that the rapid continuous expansion of the gases will not develop high velocities in close contact with the furnace refractories. Furnaces under boilers should be proportioned so that the velocity of the gases should not be excessive, particularly at the smallest cross-sectional area of the furnace. Vertical baffles should replace all horizontal baffles.

b A boiler of any size can be fired successfully with pulverized coal. Various designs and makes of boilers can be readily arranged for pulverized-coal firing, but those containing the smaller percentage of space for the lodgment of ash are preferable.

c Feeders for regulating the flow of pulverized coal to the furnace must be designed so that at all times the variation in quantity will be directly proportional to the speed of the screw and no flooding allowed. The speed of the feeder should be so regulated that operating at its maximum r.p.m. the supply of pulverized coal to the furnace will not exceed the capacity of the furnace. Soot blowers should be installed in settings where pulverized coal is used.

d The equipment for using pulverized coal is standard for any grade of coal so far as handling, preparing and delivering to the furnace is concerned. Only a slight change is necessary in the furnace to take care of coals of very low volatile content, such as anthracite, culm and coke breeze, and increased drying capacity is desirable when lignite coal is used. With stokers this is not the case as the varying quality of coals require different type stokers to obtain highest efficiency.

Test of a Boiler Using Pulverized Coal

The following is a report of a test made on a 468-hp. boiler using pulverized coal as fuel. This installation is noteworthy not only by reason of the high efficiency obtained, but also because of the fact that it has made clear some of the conditions necessary for the successful operation of boilers utilizing powdered fuel.

When the boiler was first put into operation, a number of undesirable conditions resulted. An insufficient air supply caused high furnace temperature resulting in fusion of the ash particles and a consequent accumulation of slag between the tubes, on the furnace walls and in the ashpit. The removal of the molten slag presented considerable difficulty. It was also found that the combustion chamber was of insufficient size. High gas velocities resulting from insufficient air in the chamber tended toward destruction of the refractory surfaces of the furnace.

A new furnace was therefore designed. The combustion chamber was enlarged and a regulated air supply was provided for by means of a number of auxiliary air openings equipped with dampers. The accumulation of slag in the pit was prevented by raising the point of admission of the fuel into the

furnace. As a result the flame path has been raised above the base of the pit, hence particles of ash dropping from the flame are not fused. The ash, therefore, can be drawn from the pit in the form of a powder and small slugs of slag. Analysis has shown that the ash contains practically no carbon.

Having established satisfactory furnace-operating conditions, a series of efficiency and capacity tests were conducted preliminary to proving the contract guarantees. The brickwork was then given a thorough trial by carrying the boiler at a continuous rating of 180 per cent over a period of several days. On August 12 and 13 a final efficiency test was made. The results are given in Table 3. The boiler is a three-pass water-tube boiler, equipped with a superheater.

At this same plant are other boilers fired by one of the most efficient types of underfeed stokers. A comparison is made between results of above test and tests made on the stoker-fired boilers.

Pulverized Coal vs. Mechanical Stokers

Under this heading fuel-preparation costs will first be considered. In the case of powdered coal this can be classed under three general divisions:

a The cost of crushing the coal. This expense is the same for pulverized-coal equipment as for stokers.

b The cost of drying and pulverizing the coal. Although no cost records are available at present, it is estimated that 32 cents per ton will cover this preparation cost on a 200-ton-per-24-hr. plant using bituminous coal containing about 12 per cent moisture.

c The maintenance costs of the drying and pulverizing plant. This unit has not been determined from actual experience; however, it is estimated that 3 cents per ton will cover the maintenance. In stoker practice the maintenance cost per ton of fuel fired is close to 5 cents per ton.

TABLE 3 LOG OF TEST OF A PULVERIZED-FUEL-BURNING STATIONARY BOILER. DATE AUGUST 12–13, 1918

Make of boiler				Edge Moor
Rated hp				468
Heating surface, sq. ft				4685
Time fired or test started				11 15 a.m. 8/12/18
Time fire out or test finished				11 15 a.m. 8/13/18
Duration of test hr				24
		Maximum	Minimum	Average
Temperature of boiler room, deg. fahr		99	85	93.3
Temperature of feedwater		168	135	157.2
Temperature of steam, deg. fahr		477	427	448.7
Barometer, in. of mercury		29.35	29.20	29.25
Temperature of flue gases, deg. fahr		515	455	495.3
Average boiler pressure, lb				167
Atmospheric pressure, lb				14.4
Temperature of steam, deg. fahr				373.8
Superheat, deg. fahr				74.99
Safety valve set for, lb				175
Fuel fired per hr., lb				1,990.6
Total fuel, lb				47,775
Total water, lb				393,168
Water apparently evaporated per hr., lb				16,393
Water apparently evaporated per lb. of coal, lb				8.23
Factor of evaporation				1.1502
Water evaporated from and at 212 deg. fahr. per lb. of coal, lb				9.47
		Maximum	Minimum	Average
Carbon dioxide (CO_2) per cent		15.4	12.2	13.85
Oxygen (O) per cent		5.6	3.2	4.38
Carbon monoxide (CO)				None
Fuel used				Bituminous screenings
Fuel analysis	No. 1	No. 2	No. 3	Average
Amount of coal represented by each sample, lb	19,775	20,000	80,000	..
Per cent of total	41.3	41.1	16.9	..
Moisture, per cent	10.3	11.0	9.7	10.49
Volatile, per cent	33.81	36.96	38.77	35.96
Fixed carbon, per cent	50.43	49.13	48.29	49.53
Ash, per cent	14.36	13.91	12.94	13.93
Sulphur, per cent	1.90	2.06	2.12	2.04
B.t.u. as received	10,600	10,763	11,263	10,779
B.t.u. dry	11,817	12,093	12,473	12,045
Vacuum in burner, in				0.000
Vacuum under primary arch, in				0.000
Vacuum in combustion chamber, in				0.000
Vacuum in first pass, in				0.000
Vacuum in second pass, in				0.0057
Vacuum in breeching, in				0.09
Feeder speed, r.p.m				(No. 1), 53.6; (No. 2), 50.7
Coal per revolution of screw, lb				0.318
Accumulation of slag on tubes				None
Flues blown during test				5 times
Operation of furnace				Very satisfactory
Pulsation				None
Condition of smoke				Light
Heat effect on brick				None
Backlash of flame in burner				None
Pounds of steam per hr. from and at 212 deg. fahr.				18,842.6
Horsepower				546.2
Per cent of rating				116.7
Boiler efficiency, per cent				85.22
Memoranda—Fuel-preparation deduction:[1]				
Coal used in drier, lb.				1,140
Motor operation, kw-hr				449.3
Coal equivalent at 3 lb. per kw-hr., lb				1,348
Total deduction, lb.				2,488
Resulting net efficiency, per cent				81.1

[1] No deduction made for stand-by losses in drier.

Summarizing the above facts it is evident that, with fuel at $5 per ton, the gross efficiency shown by the pulverized-fuel boilers will have to exceed that shown by the mechanical-stoker-fired boilers by 6 per cent in order to offset coal-preparation costs. A 6 per cent deduction from a gross efficiency of 85.22 per cent results in a net efficiency of 79.22 per cent for the powdered-coal burner. In stoker practice the maximum attainable gross efficiency at any of our plants has been 80.54 per cent. Deducting the 2.5 per cent for auxiliary uses, the resulting net efficiency is 78.04 per cent, which is lower by 1.18 per cent than the figure obtained in pulverized-fuel practice.

Other advantages resulting from the use of pulverized fuel are summarized herewith:

a Continuous boiler operation at a uniform rating as well as a constant efficiency is made possible. At no time is there a loss in capacity due to the clinkering of coal on the grates or the cleaning of fires, as is the case in stoker practice.

b Heavy overloads can be taken on or dropped off in a very brief time through adjustment of the coal feeders and the furnace drafts.

c From 97 to 98 per cent of the combustible in the coal is utilized, regardless of the quality of the fuel.

d The ash-handling costs are reduced to a minimum due to the reduced volume.

e The banking conditions when operating with pulverized coal are somewhat different from those obtained in stoker practice. By stopping the fuel supply and closing up all dampers and auxiliary air inlets a boiler can be held up to pressure for about 10 hr. The furnace brickwork having been heated to incandescence during operation gives off a radiant heat which is absorbed by the boiler rather than being sent out through the stack. The ease of controlling the fuel, feed and drafts, the ability to take on heavy overloads in a brief time, the thorough combustion of the coal and the uniform high efficiency obtainable under normal operating make pulverized coal a most satisfactory form of fuel for central station uses.

The full story of maintenance expense is only partly known, however, but all indications are that no unusual difficulties will be met. The cost of fuel preparation and labor for operating a boiler room fully equipped with pulverized-coal-burning boilers will be a question for the engineer to decide for himself according to his particular conditions. If properly installed with respect to capacity of storage, size of drier and pulverizers, and on a sufficient number of boilers to properly and fully employ the minimum number of men, the pulverized-fuel installation will undoubtedly be more advantageous. The main item that must be borne in mind by engineers is that the ease with which a high efficiency is obtained and the constant nature of that efficiency, as compared to the lack of constancy of efficiency in a stoker-fired boiler, unless very closely supervised, is the one factor which justifies the burning of pulverized fuel. There is no doubt that with a well-equipped plant burning pulverized fuel, having all the necessary recording and indicating instruments to guide the operators in maintaining the proper conditions, a lower cost of generating steam will be possible than has heretofore been the case in any type of equipment.

Pulverized Coal for Stationary Boilers

By FRED'K A. SCHEFFLER,[1] NEW YORK, N. Y., and H. G. BARNHURST,[2] ALLENTOWN, PA.

It is the purpose of this paper to present those facts which the authors believe indicate the coming general adoption of pulverized coal as a fuel for boilers. Since stoker firing is the most efficient method when solid fuels are used, a comparison of stoker and pulverized-fuel plants is given, with particular reference to reliability, cost, adaptability and efficiency. The cost of pulverizing coal and the cost of stoker operation are discussed in detail and tables given showing results of tests on pulverized-fuel plants and data regarding boiler installations using pulverized coal as a fuel.

Although a very great interest has been aroused throughout this country and abroad in the adaptation of pulverized coal to boiler furnaces, it is remarkable how little is known, in a practical way, of what is actually being done, how it is accomplished, and what results have been obtained. The purpose of this paper is therefore to set forth the facts which indicate the coming general adoption of pulverized coal as a fuel for boilers, the discussion being presented in the form of a comparison with stoker firing—the most efficient method in general use for burning solid fuel under boilers. It is hoped that the data and illustrations presented will prove of interest and will call forth discussion which will serve to develop further this study of the best method of reducing power-operating costs.

The ultimate adoption of a new method depends entirely on its overall commercial efficiency. In the generation of power, overall efficiency may be considered as composed of the following factors: reliability, cost and adaptability. A method may acquire a wide field if it shows improvement in any one or two of these points. Improvement in all three points leads to the general superseding of other methods.

Reliability. This factor depends on two items: apparatus for preparing and presenting the fuel for combustion, and continuity of operation of the furnace itself. In a stoker installation the first of these includes the stoker itself. Neglecting the inherent defects of any system that presents a metal mechanism to the action of high temperatures, it may be admitted that the stoker system is satisfactorily reliable, with respect to its apparatus, for preparing and presenting the coal for combustion.

The corresponding mechanisms for pulverized fuel are equally reliable. This fact is proved by their widespread use for years in the cement industry and more recently in an ever-increasing variety of industries. It should be recognized that these mechanisms are not innovations, but are the result of years of development under operating conditions. Proper design of equipment by engineers of standing who are specialists in this line has made negligible the danger of dust explosions, the occasional occurrences of which in years past have furnished ammunition to the opponents of pulverized fuel.

The second condition for reliability is the continuity of operation of the furnace. Here again there will be found an apparent balance between stoker and pulverized-fuel installations. The advantage, however, lies with pulverized fuel, and for several reasons. The mechanism is altogether outside the furnace, hence cleaning and adjustment and the making of the few repairs required need not interrupt the operation of the boiler. In case of sudden necessity the fire may be ignited and quickly brought to full intensity, or it may be extinguished almost instantly. The greater uniformity of flame and temperature is also conducive to longer life of the furnace lining in a properly designed furnace, and to a minimum variation in furnace efficiency. Finally, the pulverized-fuel installation relieves the power plant from dependence upon the availability of a certain grade of coal. Stokers will not handle all grades of coal.

Cost. This second factor refers to the cost per B.t.u. delivered to the boiler. The various items entering into this cost by the stoker system comprise power, repairs and maintenance, labor, interest on investment, depreciation, insurance and taxes.

With pulverized-coal equipment the cost of fuel for the drier should be added to the preceding items, as it is clearly cheaper to remove the excess moisture content from the coal in a drier, from which the gases leave at very low temperature, than in the furnace itself, where the evaporation of the moisture damps the fire, increases the content of inert gases and carries off a very perceptible amount of heat.

Returning to the balanced cost items, it appears that these show a saving in favor of pulverized fuel in a large power plant and for the stoker in a small power plant. The figures in question are discussed further on in detail. It should be noted that when central pulverizing plants are built they will relieve small power plants of the necessity for maintaining pulverizing equipment and will make pulverized fuel considerably cheaper than stoker-fed fuel, regardless of the size of installation. This feature is already being carried out successfully.

The final item of the cost, namely, furnace efficiency, which governs all the others, results in all respects to the advantage of pulverized fuel for the following reasons:

First: The fuel enters the combustion chamber in a finely divided state, being introduced with air at low pressure, and is approximately perfectly mixed with the air for theoretically perfect combustion. Therefore no excess air is required for complete combustion. Should it be desired for other reasons to introduce excess air with pulverized fuel, it can be done in exact amounts, evenly distributed, without affecting the uniform nature of the flame and flue gases. This uniformity, which cannot be obtained in either grate or stoker installations, means maximum efficiency in all parts of the furnace and a maximum rate of heat transference to the boiler throughout its exposed area. It also means that flue-gas analysis gives an accurate determination of conditions in the furnace, and that control of coal delivered and air supply can be adjusted with great accuracy.

Second: In pulverized form all of the combustible is burned, a consummation certainly impossible in lump-coal firing by either hand or stoker. It is not unusual to find 20 to 30 per cent of carbon in ash refuse from grate- or stoker-fired boilers.

Third: With pulverized fuel there are no stand-by losses, either with change of load or when shutting down, such as banked fires, etc.

Fourth: With properly designed pulverized-fuel apparatus nothing of a mechanical nature takes place in the furnace. In stoker and grate firing not only is the mixing with the air done in the furnace, but the presentation of fresh surfaces of combustible to the air supply must take place by the removal of the ash and its discharge through the grate bars, or the pressure must be great enough to force the air supply through the ash bed.

Adaptability. The third factor of overall efficiency is adaptability. Pulverized fuel is here preëminent. The primary feature is the possibility of burning all grades of fuel without affecting the efficiency of the furnace. To burn anthracite and very low grades of fuel requires a furnace allowing a return flow of the flame past the incoming flame, to heat up the incoming fuel, and in a furnace of this type fuel containing over 50 per cent ash has been burned with high efficiency.

The flexibility in the use of pulverized fuel is perfect, and the fire may be instantly adjusted to suit any condition of overload or lower load, including the cutting in and out of the boilers. The paramount importance of this feature and the utter impossibility of approaching it with stoker or grate firing is readily evident. Furthermore, the operation and the determination of conditions for complete combustion may be made automatic, the result being a smokeless and sootless boiler plant, which is essential in modern cities.

Presented at the Spring Meeting, Detroit, Mich., June 16 to 19, 1919, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and is subject to revision. Copies of the complete paper may be obtained at a nominal cost.

[1] Manager Pulverized Fuel Dept., Fuller Engineering Co.

[2] Chief Engineer, Fuller Engineering Co.

Furnace Design. The primary requisite for good results is to maintain low velocities in the furnace in order to avoid damage to the linings and their erosion. A furnace cubical in shape usually gives the most satisfactory results. The burners should inject the coal under low pressure and should permit of varying the density of the mixture in the burner itself. Their location and number will depend upon the size of the boiler and rating required, and also may be varied to suit the grade of fuel. High boiler ratings such as are used in modern boiler practice can be obtained when desired, and such overratings should be predetermined and the furnace volume designed accordingly.

In Table 1 will be found an itemized statement of the costs of pulverizing coal, and in later paragraphs some statements as to the cost of stoker operation for purposes of comparison. Table 2 gives reports of preliminary tests made on some of the pulverized-fuel installations now in operation. A third table in the complete paper gives particulars regarding 19 installations since August 1916, comprising 96 boilers of various types and sizes ranging from 100 to 600 hp. and aggregating 25,000 hp. in capacity. While these do not show the maximum efficiency to be expected with the further development of the art, they nevertheless indicate that the inherent difficulties have been solved and that at the present moment pulverized fuel is in a position to compete advantageously with any other method of burning solid fuel under boilers.

TABLE 1 COST OF DELIVERING PULVERIZED FUEL TO BOILERS

	100-ton plant, dollars per net ton	1000-ton plant, dollars per net ton
Power at ¾ cent per kw-hr. and 17 kw-hr. per net ton	$0.1275	$0.1275
Labor at 40 cents per hr	0.14	0.04
Drier coal at $5 per net ton delivered	0.06	0.06
Repairs	0.07	0.07
Total actual cost of pulverizing per net ton	$0.3975	$0.2975
Interest at 6 per cent	0.105	0.039
Depreciation	0.12	0.04
Taxes and insurance	0.035	0.013
Total cost per net ton	$0.6575	$0.3895

Comparison on an Efficiency Basis

One of the most prominent engineers in this country, a member of the Society, has stated that the combined boiler and furnace efficiency by the month, day in and day out, of a modern stoker-fired power plant with the best average plant operation is not better than from 63 to 65 per cent, although a carefully conducted test on one boiler and furnace might show during several hours' run 75 per cent efficiency. This statement has been confirmed by other engineers. The results with pulverized fuel, however, would be totally different. There is no apparent reason why a combined furnace and boiler efficiency of 75 per cent, and even higher, could not be maintained throughout the year, as the operation of the plant would be practically equivalent to that of a fuel-oil installation, in which stand-by losses, banked fires, etc., are almost entirely eliminated. Unquestionably there should be a saving, under these circumstances, of 12 to 15 per cent of the total coal consumption in favor of pulverized coal, and this reduction, on a basis of even a 2000-boiler-hp. plant, will show a very fair return on the investment, neglecting the fact that a lower-grade and cheaper coal could be used.

Cost of Pulverizing Coal

The cost of pulverizing the coal is of prime importance, as low costs are essential for success and are achieved when the quantity used per day of 24 hr. exceeds 100 tons. The cost of pulverizing is made up of a number of items, namely, power, repairs, coal for drying, labor, interest, depreciation, taxes and insurance.

Power. The power required in an up-to-date pulverized coal plant is from 12 to 13 kw-hr. per net ton of coal crushed, dried and pulverized. The additional power required for transferring the coal to the point of use and feeding it to the boilers will vary considerably, depending upon the distance transported, the size and number of the boilers, and the conditions under which they operate. The power required for this latter purpose varies between 4 and 6 kw-hr. per net ton, so that the total power for the entire process from the track and storage delivered to the boilers is 17 or 18 kw-hr. per net ton. In the following paragraphs the cost of power has been assumed at ¾ cent per kw-hr.

Repairs. The item of repairs, including material, labor and general upkeep of the plant or maintenance, for the entire pulverizing plant and burning equipment will vary from 7 to 10 cents per net ton of coal handled. The figures depend upon local conditions and the size and general arrangement of the entire installation.

Coal for Drying. This item depends directly upon the percentage of moisture and upon the price of coal. Ordinarily only from 1 to 1¼ per cent of the total amount of coal used is required for drying. Assuming coal to have an average of 7 per cent moisture as received and the cost to be $2.50 per net ton, the cost per net ton of drying the coal will be 3 cents. At $5 per net ton the cost of the drier coal will be 6 cents.

Labor. This item is the greatest variable in connection with the pulverizing of coal, due to the increased output that can be obtained in larger plants per man employed. It is also subject to local rates of wages. For example, assuming labor at 40 cents per hour, a plant of 100 tons daily capacity, properly designed

TABLE 2 REPORT OF PRELIMINARY TESTS MADE ON PULVERIZED-FUEL PLANTS

Date of test	Location of plant	Duration, hr.	Coal used	Efficiency maintained, per cent	B.t.u. per lb. of coal as fired	Ash, per cent	Rating per cent
April 16, 1917	Seattle, Wash.	14.5	Renton buckwheat	77	10,000	11.60	122
Dec. 4, 1917	Chanute, Kan.	5	Kansas bituminous	72	11,996	17.7	125
Dec. 12, 1917	Chanute, Kan.	5	Kansas bituminous	83.94	12,500	18.25	125
Jan. 28, 1918	Chanute, Kan.	(25 days)	Kansas bituminous	78.1	11,435	....	100
April 26, 1918	Parsons, Kan.	6	Kansas bituminous	80.3	12,900	17.49	...
April 28, 1918	Parsons, Kan.	6	Kansas bituminous	80.9	12,289	17.49	130.8
June 14, 1918	Milwaukee, Wis.	12	Illinois and Indiana screenings	83.3	10,897	15.89	117.7
Nov. 5, 1918	Lykens, Pa.	10	Lykens No. 3 buckwheat anthracite	84.2	12,530	16.92	135
Nov. 15, 1918	Lykens, Pa.	5	Lykens slush buckwheat anthracite	81.2	13,653	11.09	142
Nov. 22, 1918	Lykens, Pa.	5	Lykens slush buckwheat anthracite	85	12,753	18.04	146
Nov. 23, 1918	Lykens, Pa.	5	No. 3 buckwheat anthracite	72.7	12,530	16.91	115
Dec. 2, 1918	Lykens, Pa.	5	Lytle slush anthracite	75.3	15,420	23.92	188
Feb. 1, 1919	Seattle, Wash.	24	Issaquah screenings	78.95	11,660	14.31	126
Feb. 2, 1919	Lykens, Pa.	4	No. 3 buckwheat anthracite	78.9	13,067	14.02	177
April 7, 1919	Vancouver, B. C.	4	Nanaimo slack	83.3	9,364	28.4	125
April 17, 1919	Vancouver, B. C.	5	Nanaimo slack	77.1	10,050	24.3	160
Feb. 3, 1919	Lykens, Pa.	5.5	No. 3 buckwheat anthracite	78.9	12,530	14.00	...
Sept. 24, 1918	Verde, Ariz.	(6 days)	Gallup, New Mexico	79.5	10,680	14.31	155

and equipped, will require approximately 34 labor hours to prepare the fuel and deliver it to the conveyors, whereas in a plant having a daily capacity of 1000 tons, approximately 115 labor hours are required. Therefore the labor cost would be 14 cents per net ton in a 100-ton plant, only 4 cents per net ton in a 1000-ton plant, and as low as $2\frac{1}{2}$ cents per net ton in a plant of 5000 tons daily capacity.

Interest. The interest item is based on 6 per cent of the entire investment, and the cost of the pulverized-coal plant and burning equipment will of course vary considerably with the conditions under which the plant is installed. Roughly speaking, however, the actual investment will vary from $12.80 per kw. output in a 5000-kw. plant down to $4.80 per kw. in a 50,000-kw. plant and $4.12 in a 100,000-kw. plant (assuming a turbo-generator water rate of 16 lb. and continuous boiler and furnace efficiency of 75 per cent).

All these figures in relation to cost are based on the present high prices. The investment required for a 5000-kw. plant using 100 tons of pulverized coal daily is approximately $64,000 and for a 50,000-kw. plant using 1000 tons of pulverized coal daily, approximately $240,000, so that, on a basis of 6 per cent and allowing for 365 days' continuous operation, the interest item will vary from $10\frac{1}{2}$ cents per net ton in a 100-ton plant down to 3.9 cents per ton in a 1000-ton plant.

Depreciation. Depreciation in a coal-pulverizing plant is usually calculated as follows: The life of the building is considered as 40 years, of the coal driers as 15 years and of the remainder of the equipment as 20 years. With a 100-ton pulverized-coal plant and burning equipment the depreciation item will be approximately 12 cents per net ton, and in a plant of 1000 tons daily capacity it will be approximately 4 cents per net ton.

Taxes and Insurance. Taxes and insurance are based on 2 per cent of the entire investment, and for a 100-ton plant this item is approximately $3\frac{1}{2}$ cents per ton and for a 1000-ton plant, 1.3 cents per ton. Summarizing, the foregoing results show that the total cost of pulverizing and delivering pulverized coal to boilers is approximately as given in Table 1. The cost of the pulverizing equipment complete compares favorably with the stoker equipment when everything, such as coal- and ash-conveying machinery, etc., is taken into consideration, and in large plants it is considerably less.

Cost of Stoker Operation

The equipment required for a first-class stoker installation must necessarily be taken into consideration when making a comparison of the costs of the different installations. The cost of pulverizing is an item of expense which must be included with the cost of the fuel, and since it includes the complete handling of the coal, the expense of crushing, handling, power, repairs, maintenance, interest, taxes and insurance covering the stoker equipment must also be considered when making comparisons.

Stoker installations and operation are expensive and the investment is as great, if not greater, than that required for a pulverizing equipment in plants of 10,000 kw. and upward. For example, in a plant using 1000 tons in 24 hours the cost of operation will be approximately as follows:

Power for stoker, 2 per cent of the total boiler hp. developed..	$180.00
Power for fans, 2 per cent of the boiler hp. developed.......	180.00
Coal handling, 100 kw. at $\frac{3}{4}$ cent per kw-hr...............	18.00
Labor for coal handling, 2 men per shift and 3 shifts at 40 cents per hour	19.20
Repairs for stokers at 30 cents per boiler hp. per annum....	17.50
Repairs for coal-handling equipment......................	10.00
	$424.70
Total cost per net ton.......................$0.425	

To this must also be added the cost of fuel used to heat the moisture in the coal, interest, depreciation, insurance and taxes, showing that even on a basis of equal efficiency the cost of operating a pulverized-coal equipment is considerably less than the cost of operating an equivalent stoker installation. It should be stated that the figures just given are based on present average results in both cases.

DISCUSSION AT FUEL SESSION OF SPRING MEETING

The Fuel Session of the Spring Meeting was held on the morning of Thursday, June 19, Vice-President John A. Stevens officiating as chairman. Three papers were presented at this session: namely, Pulverized Coal as a Fuel, by N. C. Harrison; Pulverized Coal for Stationary Boilers, by Fred'k A. Scheffler and H. G. Barnhurst; and Economy of Certain Arizona Steam-Electric Power Plants Using Oil Fuel, by C. R. Weymouth. The latter paper, which was presented by title only, was published in Mechanical Engineering for June, p. 523; the two papers on pulverized coal, which were jointly discussed, appear elsewhere in this issue. Extensive extracts from the discussions of these papers immediately follow.

Discussion of Papers on Pulverized Coal

Thomas A. Marsh[1] (written). The writer would preface his discussion by the statement that the general proposition of taking raw coal with all of its by-products and preparing it to the most expensive size (pulverized) and then burning still raw coal and losing the by-products, appears to be a move very much in the wrong direction. Pulverized coal has a field, no doubt; for instance, such fuels as lignites as cannot be burned on stokers. This field is limited, however, for chain grates are now developed to burn lignites containing 30 to 35 per cent moisture, which embraces practically all but those of the North Dakota field.

Pulverized fuel is adaptable to certain processes as the cement process and certain metallurgical processes. In substantiation of its adaptability for steam boilers, however, the paper by Messrs. Scheffler and Barnhurst represents pulverized fuel at its best, hints at not a drawback or trouble, submits tests of four or five hours' duration and evidently not made under the A. S. M. E. code, and contrasts stokers of the most expensive type to operate as to power to drive and as to power for fans. If it is necessary to resort to such extremities to make a comparable showing for pulverized fuel, it cannot be said that it is on a competitive basis with modern automatic stokers and furnaces.

The following discussion and questions are submitted in the hope that the full answers thereto will provide facts on which to base conclusions in accordance with the Society's past standards.

Reliability. Under the item of "Reliability" in the above-mentioned paper it is stated unqualifiedly that the mechanisms for pulverizing fuel are equally reliable with those for crushing coal for stokers. The extra equipment necessary for this exceedingly elaborate preparation of the fuel is another link to the mechanism (and a high-speed one at that), and I think no engineer will agree that the combination of a crusher system and a pulverizing system is as reliable as a stone crusher alone. Even if this complex system were equally reliable as a crusher, which it is not, the station dependent on pulverized fuel would suffer shutdowns unless the crusher and pulverizer equipment were duplicated. The writer understands that cement plants are usually equipped with duplicate pulverizing systems. This will all have a bearing on investment charges.

Further, it is stated in the paper that all grades of coal can be used. There are stokers which have limitations only on anthracite or coke breeze and in this connection the question arises as to whether a pulverized-coal furnace and burner designed for, say, bituminous 35 per cent volatile will burn anthracite or coke breeze. I ask this because in one of our other technical societies it is a matter of recent record that for burning low-grade

[1] Chief Engineer, Green Engineering Co., Chicago, Ill. Mem. Am.Soc.M.E.

anthracite or coke breeze in pulverized form, reversal of the flame is necessary, a firing method not suitable for the richer bituminous coals. It was also brought out that with coke breeze or anthracite culm the fire was unresponsive and the load had to be varied to suit the fire rather than the fire to suit the boiler load. What occurs when a rich high-grade fuel is used in a furnace and burner designed for low-grade fuels?

Adaptability. Under this heading the authors state that the primary feature is the possibility of burning all grades of fuel without affecting the efficiency of the furnace. In order for this to be true, it is necessary to burn the 50 per cent ash coal with no more excess air than the 3 per cent ash coal and suffer no more ashpit loss in the former case than in the latter. The writer therefore specifically asks if the 50 per cent ash coal requires in practice no more air than the 3 per cent ash coal. When 50 per cent ash coal is used the sensible heat of this amount of refuse leaving the furnace chamber is in itself an item which will affect the efficiency of the furnace. Can efficiencies be independent of these items? The tests show wide variation in efficiencies. What causes these wide variations?

Chain grates are burning coals containing 35 per cent ash and producing some excellent results, and have been for years. It would be desirable along with this statement by the authors regarding high-ash fuels for them to submit figures of tests with over 28.4 per cent ash, which is rather a low percentage as compared with chain-grate practice with western fuels.

As to flexibility with pulverized coal, the writer has seen cases where the furnace became unresponsive when forced. There is certainly no evidence in the paper to indicate that the pulverized-fuel burner is quickly responsive over a wide range of loads; in fact, the evidence is much to the contrary, for of all the tests referred to, the maximum overload indicated is 188 per cent, which is not considered a high overload in modern specifications and practice.

Furnace Design. Under this heading the tests of Table 2 are referred to. Tests of four or five hours' duration should not be included in an A. S. M. E. paper. Efficiencies of 70 to 80 per cent are shown here. Starting and stopping conditions, surging of water in the boiler and other items are so uncertain as to make these short tests absolutely unreliable. Under similar conditions, tests of 100 per cent efficiency and even higher are frequently made.

To be more specific, the writer would inquire if in the test of April 16, 1917, at Seattle, the heating value of the coal was determined by a calorimeter or was it assumed. The even figure of 10,000 simply suggests estimated figures.

What great difference brought about the marked increase in efficiency between the December 4 and December 12, 1917, tests at Chanute, Kan.? This wide difference is inconsistent with the statement of uniform efficiencies, regardless of operatives, coal or other items.

On the January 28, 1918, test at Chanute, Kan., of 25 days' duration, were the water and coal weighed? Did the boiler operate this long without the blow-off being opened, or if the boiler was blown down, how was the blow-off discharge measured?

Tests of April 26 and 28 at Parsons, Kan. Some tests were made at this plant simply by measuring the coal in a spiral conveyor. Was this done in this instance or were the coal and water properly weighed? The writer has a record of other tests made at this plant, as follows:

Horsepower Developed	Combined Boiler and Furnace Efficiency Per cent.
186	53.9
194	73.5
230	67.8
247	67.4
506	61
356	59.0
230.5	71.5

These results indicate the possibility of low efficiencies on tests with pulverized fuel. What, then, may we expect in daily operation? Why should we pick only favorable tests for comparative figures?

On the test of April 26, should not the percentage of rating be given?

The writer is surprised at the high calorific value of the slush anthracite in all tests reported, as it has the highest heat value of any coal in the tabulation. We should not confuse this with low-grade anthracite, which contains less than 9000 B.t.u. The fuel mentioned in the test of December 2, 1918, is evidently incorrect, as it is difficult to imagine a coal containing 23.92 per cent ash and 15,420 B.t.u. This discrepancy is concurrent with the highest-rating test recorded, casting more or less doubt on the entire test.

The complete data of temperatures, draft and CO_2, together with methods of measuring fuel and water, should be given for these tests.

Referring to the statement that a modern stoker-fired power plant with the best average plant operation obtains an efficiency of not better than 63 to 65 per cent, while carefully conducted tests show 75 per cent efficiency, the writer suggests that the authority for this statement be mentioned so that full credit can be given. This may be true with some types of stokers not completely automatic but dependent largely on the firemen's skill. With the chain-grate type, however, it is far from true, in fact the chain-grate plant operates within 2 or 3 per cent of the test figures, and test figures with modern chain-grate furnaces run frequently in excess of 75 per cent net efficiency. It has always been a feature of chain-grate performance that daily operating results approach very closely to maximum test efficiencies with no deductions to be made for fans or other auxiliaries. The fuel costs for modern chain-grate power stations may be adduced to confirm this fact.

The authors have selected for their comparison those types of stokers with which it is most difficult to get high operating efficiencies, whereas if the comparison were made with completely automatic stokers such as chain grates, the statement made of the operating advantage becomes void, as chain grates are evidently more capable of reproducing test results in daily operation than the pulverized fuel furnace.

Cost of Pulverizing Coal. Under the item of Drier Fuel the writer notes that all costs are based on only 7 per cent moisture and yet many of the fuels mentioned in the tests contain more than 7 per cent. Comparatively few fuels have as low as 7 per cent moisture, particularly west of Pittsburgh. The figures run from 10 to 40 per cent in the western section of the country, figures of 15 per cent predominating. The writer suggests therefore that the drying coal cost should be doubled.

Interest. As mentioned earlier, the pulverizing equipment should be duplicated to prevent shutdowns, which would, of course, raise the equipment's interest charge. There are some uncertainties regarding the cost of this equipment, as some of the plants mentioned are reported to have cost several times the figures quoted in the paper. The writer would therefore safeguard this figure by making it at least three times that used by the authors.

Depreciation. In figuring depreciation, everything should be limited to 10 years, inasmuch as we have all seen three or four complete changes in power-plant equipment in the last 30 years and are likely to see the same in the next 30 years. To figure that the fuel-pulverizing building has a useful life of 40 years is making a pretty strong effort to show up pulverized fuel in a favorable light.

The writer would therefore recalculate Table 1 as given on the following page.

Cost of Stoker Operation. In making this comparison, the authors have again selected those types of stokers which show highest operating costs and cause the pulverized-fuel installation to benefit by contrast.

The power to drive some types of stokers may be as high as 2 per cent. Chain grates require but 1/10 of 1 per cent. Power for fans with those types of stokers requiring fans may be 2 per cent of the power developed. Chain grates have no fans, so this item is eliminated. Coal handling would seem to be an item which would cancel out, as it should cost no more to deliver coal to the stoker hoppers than to the pulverizer. However, accepting these

TABLE 1 COST OF DELIVERING PULVERIZED FUEL TO BOILER

	100-ton plant, dollars per net ton	1,000-ton plant, dollars per net ton
Power at 3/4 cent per kw-hr. and 17 kw-hr. per ton..	0.1275	0.1275
Labor at 50 cents per hour (40 cents too low).....	0.175	0.05
Drier coal at $5 ton delivered (15% H_2O)	0.12	0.12
Repairs (no data—accept authors')..........	0.07	0.07
Total cost of pulverizing per net ton[1]	$0.4925	$0.3675
Interest at 6 per cent. (Triple the investment)....	0.315	0.117
Depreciation (10-yr. basis): Multiply authors' figures by 3....................	0.36	0.12
Taxes and insurance (no data—accept authors' figures)............................	0.035	0.013
	$1.2025	$0.6175

[1]In existing plants of 500 to 600 tons daily capacity this figure is reported to actually be $1 or more per ton, indicating that in actual practice and operation many incidental items of cost enter which are not shown in a theoretical estimate.

figures on the authors' basis, we have as follows per 1000 tons of coal:

Power for stokers, 1 hp. per 1000 developed; chain-grate practice, 20 cents per 1000 lb. of steam.......	$ 4.00
Power for fans, standard chain-grate practice........	0.0
Coal-handling power (accept authors' figures)......	18.00
Labor for coal handling (accept authors' figures)....	19.20
Repairs for stokers (accept authors' figures)........	17.50
Repairs for coal-handling equipment (accept authors' figures)	10.00
	$68.70
Total cost per net ton..........$0.0687	

We have, therefore, an additional cost of from 55 cents to $1.13 per ton against the pulverized-fuel plant, a figure that cannot be made up by increased efficiency, for it must be realized that many stoker installations have given performances within 5 per cent of the highest theoretically possible.

Now as to some of the items not mentioned by Messrs, Scheffler and Barnhurst in their paper.

Fine Ash. The writer understands that from 60 to 80 per cent of the ash carries over to lodge in tubes and combustion chambers, but mostly goes out of the chimney to scatter over the surrounding country. This may by comparison not be objectionable in a cement mill or in some of the localities mentioned in the list of installations, but it is evident that if the Commonwealth Edison Company of Chicago were to scatter fine ash from the 5000 or more tons of coal they burn daily, say 600 to 800 tons of ash, it would create a condition compared to which the worst smoke fog would seem like a paradise.

Slag. Some installations have encountered trouble due to the fine ash slagging in the tubes. The writer would inquire how prevalent this is, how it is overcome or prevented and what influence high boiler ratings seem to exert on it.

The refuse from pulverized-fuel firing contains some combustible. It has been reported that the slag containing this combustible causes damage to ashpits. Is this a serious item of maintenance?

It is reported that pulverized fuel if stored will pack and become difficult to handle. Where the container is jarred or vibrated this action is reported to increase. How serious is this action? Does it interfere with the use of stored powdered coal? Does it preclude its use on shipboard?

Turning now to Mr. Harrison's paper, the coals he states as most suitable seem to have (*a*) less than 10 per cent ash, (*b*) volatile 30 to 40 per cent, (*c*) low sulphur, and (*d*) high melting point of ash. This, of course, means a very choice bituminous coal. Such fuel commands a high price in any market, much higher per 1000 B.t.u. than the high-sulphur, high-ash fuels frequently competing. For instance, there are in Illinois and Indiana coals containing 18 to 20 per cent ash, 3 per cent volatile, 6 to 8 per cent sulphur, with the fusion point of ash at 1900 deg. The writer would inquire as to whether in the present state of the art this fuel could be commercially used to develop, say, 150 per cent rating from a boiler by means of pulverization.

It seems to be a prevalent opinion that lignites cannot be burned on stokers. The writer would rectify this at once. Lignites and sub-bituminous coals are being burned and producing high efficiencies and capacities. The following results of a few tests will substantiate this statement:

Fuel..........................	Colo. Lig.	Tex. Lig.	Mont. Sub-Bit.	Mont. Sub-Bit.	Mont. Sub-Bit.	Mont. Sub-Bit.
Moisture, per cent........	23.73	29.93	20.73	15.28	15.27	20.52
Volatile, per cent	35.25	30.96	33.44	37.56	41.24	31.23
Fixed carbon, per cent..........	33.23	25.45	32.50	38.07	30.91	39.00
Ash, per cent..................	7.79	11.66	13.28	15.09	12.58	9.25
B. t. u. (comm.).............	8511	7124	8772	9118	9553	9096
B. t. u. (dry)................	11116	10314	11073	10763	11275	11444
Type of stoker................	Green	Green	Green	Green	Green	Green
Type of boiler................	B & W	B & W	B & W	B & W	B & W	B & W
Coal per sq. ft. per hr., lb.......	28	32	28.91	38.06	30.46	35.31
Furnace draft, in..........	0.232	0.32	0.167	0.221	0.17	0.196
CO_2 at damper, per cent	12	11.81	10.36	12.97	11.77	12.62
Per cent. rating developed.....	128	....	145.8	209.1	181.5	195.09
Combined efficiency, per cent	69.7	69	72	75.6	77.3	78.04

The ability to burn these coals is a development of the last few years, and has opened up a wonderful fuel field to chain grates. Some of these fuels contain as high as 30 per cent moisture, in which case the drying cost when pulverized fuel is used would be 4 2/7 times those given in Table 1 and would make it necessary for the pulverized-fuel installation to obtain somewhere in the neighborhood of 100 per cent efficiency to be on a competitive basis.

Moreover, these fuels do not at this time command a price anywhere near $5 per ton, so that the cost of drying and pulverizing represents probably about 25 per cent of the fuel cost, a figure not to be regained by increased efficiency.

Reference is made to the use of low-grade refuse around the mines, as at Lykens, Pa. Mr. Sheffler and Mr. Barnhurst also refer to this same fact in their paper. The coals they mention, however, have calorific values not only far beyond the average idea of culm piles (12,500 to 15,400 B.t.u.), but are good enough to be used to advertise the coal. Certainly no western fuels and few mid-western fuels will equal these supposedly refuse coals.

It should be understood that when a chain-grate engineer refers to low-grade coal, he certainly has in mind fuel containing less than 9000 B.t.u., dry basis. No such fuels seem to be discussed even as refuse fuels in pulverized-fuel practice.

Mr. Harrison bases his costs of pulverizing on pre-war labor prices (30 cents per hour for millers, 20 cents for firemen and common labor), war coal prices (which is not consistent with 20-cent labor), and 7 per cent moisture in the fuel. His figures for labor should be doubled. For average fuels the moisture percentage should be doubled, and for the real field as mentioned by the author at least quadrupled for coal with 30 to 35 per cent moisture.

Referring now to (*a*) under Pulverized Coal vs. Stokers, the writer would inquire if a furnace suitable for lignite will handle anthracite. High overloads are spoken of freely and he would also inquire just what ratings have been sustained or even reached to confirm this.

Stokers are criticised in (*c*) as requiring more area for high overloads than pulverized-fuel burners. Has this been proved to be commercially true? With chain grates and coals such as mentioned in the average pulverized-fuel test, ratings of over 250 per cent are sustained for long periods, and peaks swung for short periods beyond this rating. Have any pulverized-fuel installations so far equaled this?

Referring to (*e*), the writer would state that not only is ash more easy to handle, but there is only about one-fourth of the usual amount, the remainder going out the chimney. This is one item of decreased cost that pulverized-fuel exponents seem loath to claim. We certainly must overcome this difficulty if we are to make pulverized-coal plants commercially successful, as our city and health ordinances will soon put the ban on this wide distribution of fine ash.

The writer would correct item (*f*) to say that coal burned on stokers may contain from 1 to 35 per cent of free moisture as fired. As a point of interest, he would inquire as to how readily pulverized coal picks up moisture when stored.

Under (*d*) in the following paragraph certain changes in the furnace are mentioned to suit various coals, also rather extensive changes in drying equipment. This is contrasted with stoker practice. The author presents as a favorable argument for pulverized-fuel burners that, with only a slight change in the furnace and some increased drying capacity, the equipment may be changed from one suitable for anthracite to one suitable for lignite. The writer would inquire in what commercial fuel market or location is this a valid benefit. What market receives both anthracite and lignite as steam coals?

Referring to the comparison of costs given under the heading Pulverized Fuel vs. Mechanical Stokers, the writer would question the estimated figure of 32 cents and would state that since the installation had its acceptance test ten months ago, the costs should not be concealed, but should be made part of the paper.

Reference to Table 1 in the complete paper would indicate that pulverizing cost would be

(*a*) For pulverizing and drying 12 per cent moisture coal	\$0.516
(*b*) Labor (use 2 times tabulated cost)	0.08
	\$0.596
Maintenance (use author's estimate)	0.03
	\$0.626

As a matter of fact, in existing installations of from 500 to 600 tons daily capacity, the cost of drying and pulverizing fuel is over \$1 per ton. This makes pulverized fuel prohibitive for steam-making purposes.

From all the figures presented, some good efficiencies are indicated when high-grade coals are burned (no tests are presented on low-grade coals). The advantage in efficiency, however, is insufficient to offset the increased cost of preparing the fuel, even on a basis of \$5 fuel. This causes the pulverized-fuel burner to operate at a loss, regardless of the efficiency obtained. Fuel costs will have to be from 50 to 100 per cent higher before the increased cost of pulverizing will be justified, unless pulverizing and drying costs decrease materially.

Further, no modern ratings are recorded in the paper; furnace and slag troubles are minimized; quick pickups of boiler load over a wide range of rating are not proved and seem very problematic; ash from chimneys is at present a prohibitive feature in cities.

FRED'K A. SCHEFFLER (written). I cannot agree with Mr. Harrison in his statement that when a boiler is being run with pulverized coal it is not necessary to have more than 0.10 to 0.15 in. draft at the damper of the boiler, and consequently the boiler could be operated with stacks about 30 to 35 ft. in height. It is a well-known fact that it is necessary to have at least 0.10 in. in the furnace, and that the average water-tube boilers have a frictional or draft loss through the boiler of about 0.30 in. when run at rating, and when run at 200 per cent of rating this draft loss is almost double, or 0.60 in. Consequently, the stack would have to be at least 125 ft. in height in order to be sure that there is sufficient draft to overcome the frictional resistance through the boiler and allow a suction of at least 0.10 in. in the furnace.

W. N. BEST[1] (written). I should like to inquire how many open-hearth furnaces there are in the U. S. that are successfully burning pulverized coal, and for how long a period they have been operated.

The Boiler Test Code Committee of the A.S.M.E. would like to know of large power plants that are and have been successfully burning pulverized coal for a period of, say, 4 years. We have endeavored to locate such plants for some time in order to examine same and secure some data for the Society. I am aware that many plants have experimented with pulverized coal in the generating of steam, but results were very disappointing.

[1] Pres., W. N. Best, Inc., New York City.

At the beginning of Mr. Harrison's paper, he states: " . . . and the shortage in the supply of crude oils which have become of too great value for ordinary fuel purposes." This, I think, is misleading, for statistics prove that the production of oil has never before been so great, and the demands for it never so great, as today. In Mexico alone there are many reservoirs as large as lakes filled with crude oil awaiting transportation, and hundreds of wells are capped awaiting to be turned on to meet the demand.

The increased price of coal and the liability of further increases in its price have compelled many boiler plants along the Eastern Coast to change to oil as fuel, and many more contemplate changing soon. The cost of oil is now very attractive in boiler plants owing to the fact that it only requires 147 gal. of oil to represent a long ton (2240 lb.) of bituminous coal, the coal having a calorific value of 14,000 B.t.u. per lb. One man can fire and water-tend twelve 300-hp. boilers. Oil is so attractive at the present time as a fuel along the Atlantic Coast that I believe it will only be a matter of a year or a year and a half until all the larger power plants will use Mexican oil as a fuel in their boilers.

It is my opinion from close observation and study that the two distinct fields for pulverized coal are the furnaces of rotary kilns and copper matting furnaces. Both of these are constructed so that the building is quite open, and there is practically no liability of explosions being caused by spontaneous combustion. I believe the large quantities of poor coal and lignite that we have in our country can be successfully burned in combination with oil, the coal and lignite referred to being, of course, in the pulverized state. By this combination practically perfect combustion can be attained and maintained at all times, and this combination could be of value owing to the low calorific value of the coal and lignite, and the high calorific value of the oil. The process of burning this combination of fuels would not be by mixing them together, but each fuel should be delivered separately to the furnace.

W. G. DIMAN[1] (written). So far as the better grades of bituminous coals are concerned, I think that the cost of drying, pulverizing, conveying, feeding and the first cost of the apparatus, together with the fact that all grades of fuel can be burned with a tolerable degree of smokelessness and efficiency in the regular stoker apparatus, will restrict the use of pulverized coal for boiler purposes to special cases. If low-grade waste coal can be utilized for pulverized fuel there is a great field for its use. There must be some limit, however, in the use of low-grade fuel, for the cost of grinding would eat up any advantage in the economy. Where low-grade fuels are high in ash and slate there should be a limit to the proportion that one can afford to grind. The use of high-ash coal will be bad, as it will accumulate rapidly and be difficult to remove, especially if it slags to any extent. This would occur more where the ash deposits are within the limit of the flame. With anthracite, especially culm and of that nature, it might be difficult to pulverize and must be finely pulverized; it needs a higher temperature for combustion, burns more slowly, and in certain boilers like a H. R. T. it would require plenty of brickwork and a large combustion chamber to avoid the chilling effect and to maintain combustion. The best coal to use is one high in volatile and low in ash. Such a coal would not be a very satisfactory one for outside storage in large quantities due to the likelihood of spontaneous combustion. In order to successfully use the pulverized fuel, I am of the opinion that the best results can be obtained by designing the furnace and equipment to meet a specific grade of fuel. I do not think that the average cost per ton for getting the coal from the car into the boiler is as low as stated, and if the overhead is also taken into consideration it will run still higher.

E. H. PEABODY[2] (written). In Mr. Harrison's paper I note that among other important matters he mentions three points which occur to me as particularly significant in the use of pulverized coal for boiler purposes:

[1] Supt. of Power, Amoskeag Mfg. Co., Manchester, N. H. Mem.Am.Soc.M.E.
[2] Marine Dept., The Babcock & Wilson Co., New York City.

1 Very large furnace volume required, or, in other words, the fuel must be burned under conditions which imply a very low rate of combustion per cubic foot of furnace volume;
2 The continual effort necessary to keep the boiler tubes, and, to a less degree, the furnace itself, free from slag and clinker caused by the refuse in the coal; and
3 The very high, and apparently inaccurate, boiler efficiency reported in the tests of August 12-13, 1918, which appears to be due to crediting the boiler with work done by the coal driers.

If, as seems to me proper, the boiler efficiency is figured on the basis of the heat value of the dry fuel, the result should be 76.3 instead of 85.2. The degree of efficiency obtained in the drier itself would in no way affect the results obtained in the boiler in actually transferring the heat in the fuel to the steam.

Oil fuel is undoubtedly superior to all others for boiler purposes. The furnace volume required for this fuel to give satisfactory results is about one-quarter the furnace volume specified in the paper for pulverized coal.

The similarity of action in many features between oil fuel and pulverized coal appears to me to constitute one of the principal attractions of the latter. It would seem, however, that the large furnace, with its extra first cost and extra radiation loss, together with the difficulties due to slag and their effect on operation, would offset the desirability of pulverized coal to a very large extent.

Albert A. Cary[1] (written). To many who have not had occasion to keep informed concerning the previous use and past applications of powdered coal as a fuel, the idea seems to be prevalent that such fuel is a recent development, holding almost unlimited possibilities for all kinds of furnace applications and capable of easily and cheaply accomplishing phenomenal results.

As a matter of fact, inventors have been struggling for almost a century to make powdered coal a practical and successful fuel.

In 1831 an English patent was issued to J. S. Daws for a process for burning powdered coal, and this was rapidly followed by a large number of patents relating to this subject in England, the United States, Germany and elsewhere.

In 1881 a United States patent was issued to C. H. Palmer describing the means for feeding fine coal to a locomotive boiler with an air blast, while in 1870 Whelpley & Storer began to take out a series of patents for using pulverized coal in reverberatory metallurgical furnaces. In 1876 an elaborate series of tests was conducted by the Bureau of Steam Engineering of the Navy Department under the direction of B. W. Isherwood—using the Whelpley & Storer pulverized-coal system applied to a steam boiler.

Thus we are able to understand that the preparation and use of pulverized coal fuel is by no means a recent development, and notwithstanding the considerable expenditure of money, effort and ingenuity by many inventors, including men whose past experiences qualified them to carry on such work; most of these older productions have been scrapped so that today we have left merely the benefit of their varied experiences, which has, nevertheless, proved a valuable source of information for the more recent developments in the preparation and use of pulverized coal.

Turning now from this record to the more recent developments, it will require but little investigation to find that during the last decade (or even for a much shorter period) there have been many powdered-coal installations which have either been rejected or found to give poor satisfaction.

After the presentation of such facts, I may be accused of condemning the use of pulverized fuel as a practical and efficient fuel.

On the contrary, in the light of my experience and with the evidence presented by many satisfactory equipments now in operation, I am an unqualified advocate of the use of such fuel, but I must limit my endorsement to applications where a desirable grade of fuel is available—where proper preparation of the fuel and proper furnace conditions can be obtained and where other methods for burning the available fuel are inferior—to accomplish the desired heating.

About 24 years ago I was called upon to assist in the development of a pulverized coal equipment for a cement plant, and since that time I have been called upon to test, investigate and design a number of pulverized coal equipments for cement kilns, boilers, metallurgical and other industrial furnaces and thus have had an opportunity to follow the development of this art since the early days of its practical commercial adoption in this country.

[1] Consulting M. E., New York City.

Pulverized Coal in Cement Plants

Mr. Harrison has very properly given first place in his paper to the use of pulverized-coal fuel in the rotary kilns of our cement plants, as not only do we owe the present development of our pulverized-coal equipments to the pioneer work done in their development at such plants, but the very form of these long, cylindrical, refractory-lined furnaces furnishes us with the ideal construction for the use of this form and kind of fuel.

They permit the use of the long, air-projected current of finely powdered fuel, giving it ample time to complete its combustion while being held in suspension and without direct flame and ash impingement upon any impeding furnace wall.

The simplest form of burner and fuel-feeding device can be used with such furnaces, and the ash resulting from the combustion of this finely ground coal causes little or no trouble, providing the ash content and its quality remains nearly constant, as this ash drops down and mingles with the burned clinker without materially affecting the quality of the final product.

Pulverized Coal in Metallurgical Furnaces

Next in order of desirability in the way of furnace design for the use of pulverized coal, we have our reverberatory metallurgical furnaces of great length (100 to 150 ft.), such as are used for copper smelting, where the flame is projected from the front toward the rear of these furnaces over the charge of ore on the hearth.

Without the exceptional facilities for taking care of the ash resulting from the combustion of the pulverized coal as found in the rotary cement kilns, ash troubles proved to be a pretty serious matter with the early pulverized-coal installations applied to these furnaces about a dozen years ago.

The ash fused and formed a slag blanket over the top of the ore charge and stuck to the interior of the flue outlets in a way to block these passages; but these and other associated troubles were finally overcome by stopping the infiltration of large amounts of cold air, by stopping the practice of charging large quantities of cold ore into the furnace, by using a better design of burner and coal-feeding device, and by a more careful preparation of the pulverized coal.

By these means a much higher temperature was maintained in the furnace, a very much higher ratio of charge to fuel used was obtained, and a better and more constant regulation was secured at the burner. Then pulverized coal began to be recognized as a most excellent reverberatory fuel.

When pulverized coal was used as a fuel for shorter and smaller reverberatory furnaces and directly fired into their interiors, the above-named troubles were accentuated and due to the imperfect absorption of the heat in these furnaces, the use of waste-heat boilers generally became a necessity in order to obtain efficient results. Accumulations of more or less fused ash piled up rapidly on the heating surface of these boilers necessitating frequent cleanings. Experience has shown that the reversing type of furnace for the production of open-hearth steel, such as described in Mr. Harrison's paper, is the best design of pulverized-coal furnace for that purpose. Checkerwork and baffle walls must be specially designed for use of this fuel.

A modification of the above-described reverberatory furnace, consisting of an extension furnace in front of the main furnace chamber, so proportioned as to retain a large percentage of the ash within this chamber, makes a highly efficient equipment. It requires a burner equipment permitting a close regulation of its

coal and air supply, and one which will produce a short, brush-like flame close up to the burner, which means a very rapid combustion and a high temperature in the combustion chamber.

In some recently-built extension furnaces a large percentage of the ash is separated from the body of the flame and drops into a comparatively cool part of the chamber as a fine, dry ash mingled with but a small percentage of fused ash nodules, which do not interfere with the easy removal of the refuse from the furnace bottom.

With other recent designs of extension furnaces, where very high temperatures are maintained at the burner outlet, the rapid fusing of the ash is expedited, which refuse drops to the slag pit below in a molten mass and under proper conditions may be drawn off through tap holes from the bottom of the extension furnace.

Such a design of extension furnace has been installed by the Lopulco Company in a steel plant near Pittsburgh, in connection with their heating furnaces, where it has given excellent satisfaction.

Application to Stationary Boiler Plants

The application of pulverized-coal fuel to steam boiler furnaces meets with many challenging difficulties, which, however, recent developments have done much to overcome. A number of such installations are in use, some of which are showing very desirable economy and producing a material increase in the steaming capacity of the boilers.

Great care must be taken to prevent any of the unconsumed coal from coming in contact with the chilling water-containing surfaces of the boiler, which, therefore, demands the use of an extension furnace in which the complete combustion of the coal is accomplished, and in which the proper handling of the fine ash (and its resulting slag) is provided for.

All that has previously been said concerning the requirements needed for extension furnaces applied to short reverberatory furnaces apply with equal force here.

With the intense heat generated in burning pulverized coal, much trouble has been experienced in improperly designed boiler furnaces due to the rapid melting down of the refractory linings, which may also be subjected to the scouring or cutting action of impinging ash, thus requiring frequent and expensive relining.

Process of Combustion of Pulverized Coal

Pulverized coal *must* be burned while suspended in the current of air which accompanies it into the furnace.

As the finely divided coal enters the highly-heated furnace, any moisture contained by each minute particle is first driven out, and if this is excessive, it will form a steam cloud around the particle and suppress its further rapid combustion, thus defeating to a greater or less extent the purpose for which the coal was prepared.

One of the necessities for supplying the furnace with very dry pulverized coal is thus appreciated.

With little or no moisture present, the next effect of the very high surrounding temperature in the furnace is to almost instantly distill off the volatile matter occluded in the coal as this gas is liberated at a comparatively low temperature and thus, with properly designed furnace and burner, the dust cloud entering the combustion chamber suddenly becomes thoroughly saturated with a highly inflammable gas, mixed with an ample supply of air.

Under these conditions the gas is raised to its ignition temperature with great rapidity, and the flame produced is propagated with intense speed throughout the atmosphere of fuel and air entering the furnace; all of which is simultaneously subjected to the same action.

With the intense degree of heat thus generated, not only is the temperature of the furnace maintained to stimulate further combustion, but the particles of fixed carbon (or flecks of coke) left behind, after the volatile gases have been driven out of the coal, have their temperature raised with great rapidity to their temperature of ignition and so are most speedily burned leaving behind the non-combustible matter (which we have called ash) to be more or less effectively taken care of in a properly designed furnace, or to give great trouble in furnaces where its importance has been ignored.

Mr. Harrison very tritely states that "The *finer* the coal is pulverized, the more efficiently it can be burned."

With the above analysis of the process of combustion before us, we can more readily understand the reason for this statement. Not only does the greatly increased fuel surface (presented to the highly heated interior of the furnace) facilitate the more rapid distilling off of the volatile gases, but with the volume of the particle itself greatly reduced, the penetration of the heat to its interior takes place in a very much shorter period of time. Aside from these advantages the important fact stands out that the Law of Mass Action applies to such combustion (which is akin to the action of explosives) by which we find that the amount of the reaction in a unit of time is proportional to the active mass, or, in other words, the smaller the particle of coal, the smaller the number of gram molecules of combustible matter found in the unit mass.

Under these most favorable conditions, the velocity of combustion is greatly accelerated, which is the principal object striven for when pulverized coal is chosen for a fuel.

A moment's thought will recall the fact that the volume of a mass varies as the cube of its diameter and thus a particle of coal 1/100 in. in diameter has eight times the volume that is found in another particle that is 1/200 in. in diameter.

The effect of the decreased surface in proportion to the mass results in a very great retardation of the combustion of the larger particles as is very plainly shown in the photographic study of the combustion of coal dust in Bulletin No. 102 of the Bureau of Mines, entitled The Inflammability of Illinois Coal Dusts on Plate IV. B and Plate V. B.

Uniformity in the size of pulverized particles is also very desirable, as we can readily understand that if we have mixed a considerable percentage of each of the above named sizes of coal fed to our furnace, the combustion of the larger size will proceed much slower than the burning of the smaller size, which condition not only reduces the velocity of combustion of the total mass, but it prevents the production of that "gas-like flame," which Mr. Harrison refers to.

When such grades of coal, averaging from 30 to 40 per cent of volatile matter, as described above, are pulverized so that over 90 per cent will pass through a 200 mesh screen, the finer coal accompanying it does not seem to materially affect its even rapid burning effect in general furnace practice; and further, as Mr. Harrison has stated, with this very fine pulverization, which insures rapid and high temperature combustion, the sulphur in the coal burns rapidly to SO_2 gas, which passes to the stack without affecting the product of the reverberatory furnace.

When a coal, running high in fixed carbon, is used as pulverized fuel, we have a different and less desirable set of furnace conditions.

Lacking the production of an ample supply of volatile combustible gases given off by the coal at a comparatively low temperature, and also lacking the heating effect which the burning of these gases produces, to hasten the combustion of the associated fixed carbon, we must necessarily maintain a higher furnace temperature to ignite this fuel, and to obtain the best possible results, the coal should be ground finer, as it will be found that this fuel is slower to ignite. Much of such coal carries a higher ash content, which still further complicates matters and lowers the heat value of the coal.

Mr. Harrison gives a table purporting to give the cost of coal pulverized-coal system upon which these figures are based nor question the reliability of these figures. Nothing is said of the pulverized-coal system upon which these figures are based nor the class of machinery or equipment included.

There is a considerable range in cost of equipments as furnished by different concerns and the figures presented in this table appear low for the better class of equipment.

Much depends upon the class of equipment one is willing to in-

stall, which has much to do with results obtained including cost of future upkeep.

There are many elements entering into the cost of such equipments. For example: should one be obliged to handle very wet coal in the coal dryers, the normal capacity of the drier would be reduced and either larger driers or more driers would be required to obtain a fixed amount of dried coal, which would also require a greater building space.

Again, should one decide to grind the coal very fine to obtain maximum furnace results, the output capacity of the pulverizer would be materially reduced below that needed for coarser pulverization and more or larger mills would be needed, and thus I might continue this list.

Whereas, Mr. Harrison's total cost for pulverizing 80 and 90 tons of coal per day agrees pretty well with the cost estimate given in this table, his cost for producing 100 tons per day runs 21 per cent higher than the figure shown in the table.

In looking over the log of the boiler test quoted by Mr. Harrison I note what appear to be a few discrepancies, but lacking full and complete data, I have been unable to check them up as carefully as I would otherwise do.

Taking his analysis of furnace gases, he gives the maximum result obtained as 15.4 per cent of CO_2 and 5.6 per cent of C with no CO.

This is consistent and possible.

He then gives his minimum result obtained as 12.2 per cent of CO_2 and 3.2 per cent of O with no CO; the sum of these gases giving 15.4 per cent with 84.6 per cent of N by difference.

There is evidently some discrepancy here, as I do not see how it is possible to burn such a coal as he indicates so as to obtain such an analysis.

The percentage of boiler efficiency given in this table as 85.22 per cent seems entirely inconsistent and I cannot find sufficient indication contained in the other data submitted to assure me that the total losses in the performance of this test amounted to only 14.78 per cent.

One very interesting question in connection with this test is, What means were used for accurately weighing the pulverized coal used? As a matter of secondary importance I might also ask, What means were used for ascertaining the weight of water fed to the boiler?

J. E. Muhlfeld[1] (written). Mr. Harrison's excellent paper reviews data that conform in general to my experience during the past few years in the development of systems for the more effective and economical utilization of coals and lignites in pulverized form, for stationary, locomotive and marine boilers, and for metallurgical and chemical heating furnaces, and the information that he has given will be of great assistance to existing and prospective users of this method of firing and burning solid fuels.

Until recently power-plant capacity and efficiency have been dependent upon combustion possibilities. Fortunately, this has now changed and the problem is in boiler design and construction.

In the log of test on a pulverized-fuel-burning stationary boiler given by Mr. Harrison, the operating capacity deductions on account of the power and other items necessary for the preparation of the coal in pulverized form should be 3.17 per cent, in place of 4.22 per cent, as used in arriving at the net efficiency. This figure of 3.17 per cent compares with the power necessary to operate mechanical stokers, and which, in an installation of this kind, would amount to from 2½ to 5 per cent, varying with the boiler load carried.

In connection with this log of test data it may be of interest to give the heat balance for the same 24-hour run, which is as given in Table 2.

Furthermore, to show the definite control over stand-by losses by the use of the same pulverized-fuel system, at the same plant, the data in Table 3 are of interest.

To further show the positive control over the combustion, the performance of one of these boilers in Table 4 is of interest. During the 14-hour run, from 6 p. m., February 1, to 10 a. m., February 2, for which period the boiler was sealed and operated at about 150 per cent rating, it will be noted that there was a change of only 0.2 per cent in CO_2 and 0.4 per cent in O_2, and no slag was produced.

Observations made of the stack from the outside of the power-plant building, when operating the pulverized-fuel and the stoker-equipped boilers in combination and independently have also demonstrated that no smoke was produced from the pulverized-fuel-fired boilers.

The four pulverized-fuel-equipped boilers at this plant were cut in on the main line over 90 per cent of the time during the months of February and March, 1919, and when line banked no fuel was required.

Referring to various information as set forth in Mr. Harrison's paper, I would like to point out the following:

I can hardly agree with Mr. Harrison that the equipment for

[1] V. P., Ry. and Industrial Engrs., Inc., New York; Mem. Am. Soc. M. E.

TABLE 2 HEAT BALANCE FOR BOILER TEST IN TABLE 3 OF MR. HARRISON'S PAPER

Ultimate analysis of pulverized Indiana and Illinois screenings as fired, given in percentages;

1	Moisture	3.20
2	Carbon	55.66
3	Hydrogen	4.47
4	Oxygen	19.77
5	Sulphur	1.97
6	Nitrogen	1.45
7	Ash	13.48
		100.00

The distribution of the calorific value of one pound of coal as fired among the several items of heat utilized and lost is as follows;

	B.t.u.	Per cent.
Heat absorbed by boiler	9,934	85.22
Loss due to evaporation by moisture in coal	41	0.35
Loss due to heat carried away by steam formed by burning of hydrogen	493	4.22
Loss due to heat carried away in dry flue gases	975	8.37
Loss due to carbon monoxide	0	0.00
Loss due to combustible in ash and refuse	51	0.44
Losses due to heating moisture, in consumed hydrogen, hydrocarbon, radiation and unaccounted for	163	1.40
Calorific value of fuel as fired	11,657	100.00

TABLE 3 SHOWING CONTROL OVER STAND-BY LOSS

Date	August 18-19, 1918
Boiler No. 5	Edge Moor, Rated 468 nominal hp.
Fuel feed shut off, uptake damper closed and auxiliary air inlets closed	9.00 p.m.
Boiler steam outlet to header closed and 175 lb. steam on boiler	9.20 p.m.
Safety valves released about one minute at the following times (p.m.). 9.40, 9.55, 10.08, 10.15, 10.25, 10.38, 10.43, 10.52, 11.02, 11.09, 11.18, 11.28, 11.38, 11.48, 11.52.	
Steam on boiler 155 lb. when fuel feed started and boiler steam outlet to header opened	7.00 a.m.
Drop of steam pressure in boiler, from 9 p.m. until 7 a.m., or during 10 hours while fuel feed was off and during which time safety valves popped 15 times, for one minute each, or a total of about 15 minutes	20 lb.
Time required to bring boiler from 155 to 175 lb.	4 minutes

TABLE 4 SHOWING POSITIVE CONTROL OVER COMBUSTION

Date	Time	CO_2	O_2	CO
February 1, 1919	5.00 p.m.	13.00	6.00	0
	....	13.6	4.2	0
	.....	13.2	5.2	0
	6.30 p.m.	13.0	6.0	....
	.	13.8	....	....
	..	14.2	3.2	0.2
	......	14.4	....	0
	......	14.6	3.4	1
	8.00 p.m.	14.8	4.6	0
February 2, 1919	10.00 a.m.	13.0	5.0	0

preparing pulverized coal has been developed past the experimental stage. There is still considerable to be done in this direction, particularly with respect to the elimination of the reabsorption of moisture and of entrained moisture, which results in condensation in the dry- or pulverized-fuel bins and the consequential trouble that it causes. The type and operation of drier and pulverizer has a great deal to do with these factors, and experience has demonstrated that certain fuels require special treatment in that regard or trouble is bound to occur.

From my experience, when pulverized fuel is used for steam generation the detrimental effect from the ash and sulphur content is nil, regardless as to the melting point of the former.

The economic use of coke breeze is at this time problematical, as the expense of preparing the fuel will, in a large number of cases, offset the fuel value of this by-product. A study should be made of each specific application before the use of coke breeze is gone into.

The utilization of the full thermal value of anthracite silt has been developed to a point where there are no commercial obstacles in its way, and this in itself will release an equivalent amount of commercial size of coal. The shipment of silt to a considerable distance from the mines, however, may not be economical, but the power consumption by the mining and nearby industries is sufficient for the full utilization of this by-product, which should make it unnecessary to ship the silt to other points.

The author's specific statement as to how the coal should be pulverized is not in conformity with my experience on this subject, as the degree of fineness should vary with the character of the fuel. The results of careful analyses and tests have demonstrated that this degree of fineness for effective and economical use cannot be arbitrarily set down, as it varies with the volatile content and the combustion characteristics of the fuel handled.

Commercially the expense of pulverizing increases with the degree of fineness, and consequently the coarser the particles of the fuel the less the cost chargeable against the pulverizing process, for which reason it is advantageous to use coarse pulverization whenever the character of the fuel is such that this is feasible.

From my experience the author's tabulated costs for pulverizing are somewhat misleading, as the cost for preparation will vary over wide ranges. While the information as set forth is valuable from a general standpoint, it must be used with care for the reason that it is not susceptible to specific adaptations.

In the case of open-hearth practice the system to be used for burning the pulverized fuel determines the degree of fineness. The high-velocity method of burning, such as described, will, of course, require much finer grinding than a low-velocity method such as obtains with other systems in which the time limit is increased, thereby permitting combustion to take place more slowly with the same thermal results.

By using a low-velocity flame the length of from 6 to 8 ft. mentioned by the author can be decreased.

Some of the steel companies have reduced their pulverized-coal consumption per ton of output to a little less than 450 lb. instead of 500 lb. as given in the paper.

It has been found in operating practice that pulverized-fuel-burning furnaces, under the best system of combustion, can be reduced to a little less than 1 cu. ft. of volume per b.hp. developed, and that the rating can be increased up to the capacity of the furnace to keep the lower tubes of the boiler free from honeycomb and still maintain effective combustion below the boiler-tube line.

The best system of combustion necessitates—

1 Proper preparation of the fuel
2 Effective means for feeding
3 Furnace properly designed and equipped with auxiliary air supply to insure a distinct hot zone and a distinct cold zone, and gas areas and baffles and draft coördinating with the foregoing.

The pressure at which pulverized fuel can be admitted to the furnace has been found, in service practice, to be not more than plus 0.05 in. of water at the burner nozzle.

In my opinion a boiler cannot be successfully operated at any capacity with the natural draft obtained with a 30- to 35-ft. stack, the reason being that the friction losses of the gases passing through the boiler tubes, and the gas areas produced by the baffles, will reduce the draft, due to this low height. When operating at full capacity about 0.10 in. of water draft in the furnace, plus the friction losses through the boiler setting, is the minimum under which any pulverized-fuel boiler installation should be operated. Anything less than this will limit the factor of regulation and will tend to cause constriction of heat to the furnace chamber and result in slag, which latter, in all cases, is to be avoided. Any pulverized-fuel-burning installation, in combination with a steam generator, in which the formation of slag is of any considerable consequence, can be taken as a failure from the standpoint of effective and economical results.

Under proper combustion conditions the use of a hand-lance steam jet to clean the bottom tubes as recommended by the author is unnecessary. The top of the tubes should, of course, be kept free from the accumulation of ash, which acts as an insulator and which tends to carry the heat in the ash and gases through the boiler to the stack.

While any ash accumulation in the bottom of the furnace should be periodically removed, at the same time with a proper design of hot-zone and cold-zone furnace any ordinary accumulation should not convert into slag.

In comparing pulverized equipment with stoker equipment, the author states that considerably less excess air is required with the former. The amount of air injected with the fuel into the furnace, however, should be a negligible percentage of that required for combustion, the only function of that air being a conveying and commingling medium. In the Edge Moor installation to which the author refers, the percentage of air entering with the fuel is about $1\frac{1}{2}$ per cent of that necessary for combustion, the remaining $98\frac{1}{2}$ per cent being induced by the stack.

[Mr. Muhlfeld supplemented the foregoing discussion and comment upon Mr. Harrison's paper with data upon performance of pulverized-fuel equipment in locomotive and marine practice, which constitute a most acceptable addition to his paper on Pulverized Fuel for Locomotives, given at the annual meeting, December 1916, and published in Vol. 38 of Transactions. Space does not permit the publication of these in this issue, but it is hoped to present them later.—Editor.]

Edwin Lundgren,[1] who opened the oral discussion, called attention to the large combustion space specified in Mr. Harrison's paper for a boiler burning pulverized fuel as compared to a stoker-fired boiler, especially when the boiler was to be operated at, say, 300 per cent of rating. In the matter of draft, he thought Mr. Harrison had not taken the resistance of the boiler into consideration in specifying but 0.10 to 0.15 in. For the ordinary type of boiler a draft of about 0.15 in. was required at 100 per cent rating, which increased to about 0.7 in. for 300 per cent. rating. A stack 100 ft. high would give about 0.6 in. draft, so that a height of 35 ft. was out of the question.

As to the low efficiency (63 to 65 per cent) of stoker-fired plants mentioned in the paper by Messrs. Scheffler and Barnhurst, he would cite the Detroit Edison plant where an average efficiency of 76 per cent was maintained throughout the year, and where Dr. Jacobus' series of 24-hour tests showed efficiencies of 80 per cent or better. Also, the Cincinnati Gas & Electric Co. maintained a combined boiler and furnace efficiency of about 80 per cent in their plant constructed to maintain 365 per cent maximum capacity and 300 per cent continuous capacity.

There was no question but what pulverized-fuel equipment would be useful in burning some of the cheaper grades of fuel, like some of the western fuels, for which it seemed no real type of stoker had been designed. He did not believe, however, that it would be generally applied to modern central stations, for one reason because the pulverized-fuel-equipment buildings, to judge from the slides shown, appeared to be about as large as power stations.

[1] Chief Engineer, Stoker Dept., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

C. F. Hirshfeld[1] said that in modern boiler plants the chief losses were due to carbon in the ash and to heat escaping up the stack. The Detroit Edison Co. operated under good conditions with 10 per cent of carbon in the ash, or a very small per cent of the fuel originally fired, and with but 10 to 12 per cent of excess air. If use of powdered fuel would make it possible to burn all the carbon in the coal—which was contrary to his experience—and with no greater amount of excess air, the saving effected would still be of little consequence. He believed in using powdered coal where conditions were such that it was distinctly economical to do so, but these did not obtain at the Detroit plant. In his opinion there was a greater chance for improvement in the turbine end of the plant than in the boiler room.

As to greater uniformity of flame and temperature, which conduced to larger life of the furnace lining, he believed that the advantage was with the stoker with its smooth bed of incandescent fuel. While powdered fuel might be more adaptable when a wider range of fuels was available, the stoker was just as adaptable so far as the art had developed.

In the paper by Messrs. Scheffler and Barnhurst, the power for operating a stoker was stated to be 2 per cent of the total boiler hp. In the Detroit Edison Co.'s plant, however, it was much less than 1 per cent with the boilers operated at 200 per cent of rating.

H. Wade Hibbard[2] said that in a larger plant he had in mind an increased efficiency resulted from adding moisture to coal that had dried out too much before it reached the stokers. He therefore asked whether drying was necessary in order that the coal might be thoroughly pulverized, and also whether there had been any experiments performed in introducing steam along with the powdered coal. Affirmative replies were respectively made to these queries by Messrs. Scheffler and Barnhurst, the latter adding that he did not know whether the introduction of moisture had increased the efficiency.

P. A. Poppenhausen,[3] referring to a statement made by Mr. Lundgren, said that his company had successfully adapted the chain-grate stoker to the burning of lignites of all grades and containing as high as 30 per cent of moisture, and that 24-hour tests had shown efficiencies of from 76 to 78 per cent. The power to operate a stoker was insignificant—less than 0.5 hp. per unit, whether a 200-hp. or a 600-hp. unit. He thought Mr. Scheffler's figure of $64,000 low for the cost of a pulverizing plant of 100 tons daily capacity, and asked how large a plant should be in order that this cost would not be prohibitive.

John Van Brunt,[4] calling attention to Mr. Harrison's reference to coke breeze, said he could state that over 75,000 hp. of boilers equipped with traveling-grate stokers were now satisfactorily operating on this waste fuel in the large steel plants and gas works of the country.

Gilbert A. Young[5] spoke of successful experimental work carried on for the past two years at Purdue University on a furnace for burning crushed, undried coal containing as high as 20 per cent moisture. The particles after crushing ranged from the size of a match head down to powder passing a 200-mesh screen. He hoped to submit a paper later giving comparative tests of the crushed-coal furnace and several types of stokers, all operating under the same conditions.

W. P. Frey[6] said that his company burned 1,000,000 tons of coal a year for steam and electric power, and that he was interested in pulverized fuel as a possible means of utilizing the twenty-odd million tons of small coal lying on the ground in the anthracite regions. But as it was said to take twice as much power to pulverize anthracite as bituminous coal, and as the minimum wage for the anthracite union laborer was 43 cents per hour, this would make the cost of pulverizing the $1 coal in question about 75 cents, and he did not see how pulverizing would make up for this enormous difference. Firing a boiler at a high rating with anthracite required far more draft at the damper than the 0.10 to 0.15 in. mentioned in Mr. Harrison's paper, and in consequence stacks much higher than 40 ft. The fire-brick problem was a very important one, and he would be obliged if Mr. Scheffler or Mr. Barnhurst would give specifications for bricks that in the long run would stand the steady temperature of over 3000 deg. that they would have with their low supply of air, unless they reduced the temperature in the combustion chamber.

[1] Chief, Research Dept., The Detroit Edison Co., Detroit, Mich. Jun. Am.Soc.M.E.

[2] District Engineer, U. S. Fuel Administration, Columbia, Mo. Mem. Am.Soc.M.E.

[3] Pres., Green Engineering Co., Chicago, Ill. Mem. Am.Soc.M.E.

[4] Chief Engineer, Combustion Engineering Corpn., New York. Mem. Am.Soc.M.E.

[5] Head of Department of Mechanical Engineering, Purdue Univ., Lafayette, Ind.

[6] Fuel Engineer, Lehigh Coal & Navigation Co., Lansford, Pa.

C. W. Lotz,[1] in reply to Mr. Frey, said that in his experimental plant the cost of pulverizing anthracite was but 33 instead of 70 cents a ton. They were also burning coke breeze efficiently. As to stack heights, it was to be remembered that the furnace itself acts as a big stack and drives the gases up through the first pass of the boiler.

W. L. Wotherspoon[2] told of tests he had made some ten years ago in South Africa on a Bettington boiler fired with pulverized fuel and a B. & W. boiler with a chain-grate stoker. Both boilers were 1000-hp. units and the efficiencies obtained were practically equal. There were low-grade fuels (9500 B.t.u. and less) available in the Transvaal, and the results obtained with pulverized fuel were such that the plant was still in operation.

Lately he had been paying attention to the use of powdered coal where the combustion took place under pressure—for the generation of heat in a blast furnace smelting nickel ores. On a continuous 18-day run it had been found possible to replace 50 per cent of the coke used, which cost twice as much as bituminous coal. At the Tennessee Copper Co.'s smelter he had not only been able to replace all the coke with powdered coal, but to actually do the smelting with 25 per cent less fuel. Even better results were shortly to be expected. Their pre-war cost for drying and pulverizing was 40 cents per ton. Now it was practically double that figure.

The impression prevailed in the United States that the screw feed was necessary, but in Canada he had experimented and found that by using compressed air at 70 lb. pressure, 2½ tons could be transmitted in 5 min. through a 3-in. pipe over a horizontal distance of 1200 ft. and then elevated 60 ft. This method might prove available for the use of a central pulverizing plant supplying small, isolated power plants through an underground pipe line.

W. E. Snyder[3] felt that while pulverized coal was an ideal fuel in the cement plant, there were, nevertheless, many problems to be solved in regard to its use in steel furnaces and under boilers. The best modern stoker-fired plants showed very high efficiencies, and with the same expenditure of intelligence the pulverized-coal plant might be brought to equal them.

He had experienced difficulty in obtaining definite facts regarding performances of pulverized-fuel installations, and was skeptical as to the accuracy obtained in measuring the coal by observing the revolutions of the feed screw, for it did not always give the same quantity per revolution. Apropos of accurate measurements, Mr. Snyder caused considerable amusement by telling of the man in charge of a small power plant who had succeeded in overcoming troubles he had experienced with a venturi meter by merely boring out the narrow part!

Narrowing down the comparison of the two methods of getting coal into the boiler furnace, he said, it resolved itself into a very simple matter of reducing waste in the ashpit and up the stack,

[1] Pottsville, Pa.

[2] Consulting Metallurgist, International Nickel Co., New York.

[3] Mechanical Engineer, American Steel & Wire Co., Pittsburgh, Pa. Mem. Am.Soc.M.E.

and a possible saving in repairs and maintenance of the means employed to handle the fuel.

W. F. Verner[1] gave estimates that had been prepared covering the comparative costs of operating six 2400-hp. boilers at the Ford Motor Company's blast-furnace plant with pulverized fuel and with stoker fuel. The estimated cost for the pulverizer equipment and buildings was $691,000 and for a corresponding stoker plant $475,000. The cost of pulverizing per ton, including fixed charges, power, maintenance, lubricants, etc., and labor (at $8 per day), was $0.76; for transmission from pulverizing building to boiler room, $0.25; and for boiler room, $1.13; or a total of $2.14. For a corresponding stoker plant the figures were: for transmission from breaker building, $0.24; boiler room, $1.66; total, $1.90. For a plant with twelve 2400-hp. boilers the total for the pulverized-coal installation was $1.63, and for the stoker equipment, $1.49. These figures, in connection with the higher estimated efficiency of the pulverized-fuel plant, indicated for it a saving of 4 per cent over the stoker plant.

One important point in favor of pulverized-fuel plants was that the stand-by losses were reduced to a minimum as compared with stoker installations, where the fires had to be banked over the shutdown periods. An additional reason for installing the former was that blast-furnace gas would be available for use under the boilers and in quantity sufficient to carry the light loads.

John A. Stevens thought that the matter of stand-by losses brought out by Mr. Verner a very important one. In New England factories running on one shift of 9 hours a day, the stand-by coal required in the best hand-fired plants ranged from 20 to 25 per cent of the daily consumption. This, of course, decreased with more shifts, or with continuous runs of, say, 72 hours, as in paper mills. With stoker-fired boilers there was a loss in running full load right up to washing-up time—usually 10 minutes before the quitting hour, and also when burning a bank of coal on the grates and then rejecting it. The elimination of non-productive fuel in shop power plants was also claimed as an advantage by the advocates of oil fuel or the purchase of power from central stations. A prominent engineer had told him that 2¼ per cent of unconsumed carbon passes out of the stacks of these large stations, and to obviate this he trusted that an effective silt separator would shortly be developed.

R. Sanford Riley[2] said that the papers and discussion were valuable in directing attention to the problem involved in all combustion—the carburization of air. The final question regarding the two systems of burning fuel under consideration was which was the better carburizer, and he felt that in the long run the simpler apparatus would win out.

Edward N. Trump[3] spoke of experiments he had made about 25 years ago in burning powdered fuel under a 300-hp. B. & W. boiler. The furnace used had too small a combustion chamber, and the ash accumulated and blocked the passages between the tubes in less than a week. This ash had taken up tar from the combustion products and clung to the tubes, and it proved very difficult to scrape off. It was important, therefore, to see that the combustion chamber was large enough, and, as noted in Mr. Harrison's paper, that the boiler tubes and surfaces were carefully and frequently blown.

H. G. Barnhurst, in closing the oral discussion, said that there were certain arguments in favor of pulverized coal for certain localities and for certain grades of fuel which could hardly be overcome by any other method of burning. One point which had not been brought out was the fact that by pulverizing coal and burning it in a furnace the boiler installation was made entirely independent of any particular quality of fuel. In the course of experimenting his company had burned coal with as low as 2 per cent of volatile matter and up to 40 per cent with an ash content running as high as 51 per cent, just to show that the percentage of ash did not affect or interfere with the combustion conditions. Mr. Trump's main troubles, he thought, were due not only to the small combustion chamber used, but also to the fact that his coal was not finely pulverized. He wished again to emphasize the fact that the coal must be pulverized to a very high degree of fineness in order to get good results—two or three hundred million particles to the cubic inch. This increased the surface exposed to the air about 700 times over that which it was in the form of lumps, and made it very much easier to effect combustion. Moreover, various grades of coal could be burned which could not be handled on stokers.

As to the volume of a furnace per pound of coal burned per minute, he would not care to assign any particular value, because all combustion chambers had different shapes. The essential feature was low velocity of the gases, for the brick became plastic at high temperatures, and if subjected to the action of gases at a high velocity, the under rows of lining would be destroyed.

The question of furnace firebrick was, of course, very important, and the higher the grade used the better would be the results. The ash accumulation in the bottom of the furnace by further refinements might be cared for by movable hearths so that it would not build up in the furnace and interfere with the operation. The ash going out of the stack, in some cases, was now being recovered to a certain extent, and there was certainly a field for recovering ash not only from pulverized-coal-fired furnaces, but also from stoker-fired furnaces, because the percentage of ash from many stoker installations, under forced-draft conditions, rose very high.

[1] Mechanical Engineer, Ford Motor Co., Detroit, Mich., Mem.Am.Soc.M.E.
[2] President, Sanford Riley Stoker Co., Worcester, Mass. Mem. Am. Soc.M.E.
[3] Vice-President, Solvay Process Co., Syracuse, N. Y.

Discussion of Mr. Weymouth's Paper on Arizona Power Plants Using Oil Fuel

Mr. Weymouth's paper treated of the performances of three steam-electric power plants situated in Arizona where load factor and high fuel cost demand economical operation. These plants are those of the Inspiration Consolidated Copper Company; the New Cornelia Copper Company; and the Arizona Power Company. Tables and curves of operating characteristics were given in Mr. Weymouth's paper and some of the difficulties encountered in practice were also enumerated.

C. H. Delany[1] (written). The Pacific Gas and Electric Company is operating at Sacramento, Cal., an oil-burning plant which is similar in some respects to the three plants discussed in Mr. Weymouth's paper. This plant was built in 1911 and is equipped with one 5000-kw. Curtiss turbine, Stirling boilers, Peabody-Hammel oil furnaces, and a surface condenser taking water from the Sacramento River. This plant was designed for 175 lb. pressure and 100 deg. superheat at the turbine throttle, and is therefore similar in this respect to the Inspiration Copper Co.'s plant. The plant, however, being essentially a standby plant, is not equipped with economizers, steel casings for the boilers, or automatic fuel-oil regulators.

In comparing the operation of different steam plants operating at variable loads, it is convenient to plot on a diagram the kilowatt-hours generated against the total oil burned, each point plotted representing the average results of a month or a day as the case may be. If a sufficient number of points at different loads is obtained, it is possible to draw a line through them representing their average, and this line in most cases is found to be practically a straight line. Such a diagram for the Sacramento station for the year 1918 is given in Fig. 1, and to it have been added points taken from Mr. Weymouth's paper for the three Arizona plants. The points for the Inspiration Copper Co.'s plant are sufficiently numerous to enable the line AC to be drawn through them, corresponding to the line AB for the Sacramento plant. It will be noted that these two lines intersect the ordinate of zero load at almost the same point, A, indicating about the same quantity of oil (that is, in the neighborhood of

[1] Pacific Gas & Electric Co., San Francisco, Cal. Mem. Am.Soc.M.E.

25 or 30 bbl. per day) required to operate either plant at no load.

There are not sufficient points to enable a similar line to be drawn for either the New Cornelia Copper Co. or the Arizona Power Co. plants. However, assuming the point A for zero load to be the same as for the Inspiration Copper Co., the line AD has been drawn as an approximate average for these two plants.

This diagram brings out more clearly than a mere statement of the kilowatt-hours per barrel of oil, though perhaps somewhat crudely, the essential differences between the various plants.

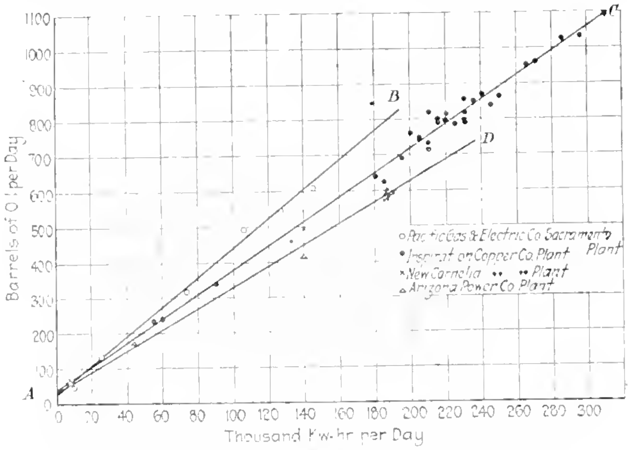


Fig. 1 Diagram Showing Relation Between Barrels of Oil Burned per day and Kilowatt-Hours Generated

Thus a comparison of the lines AD and AC shows at a glance the effect of the higher steam pressure, higher superheat and better vacuum carried at the New Cornelia Copper and Arizona Power Companies' plants. The line AC compared with the line AB shows the economy resulting from the use of economizers, steel casings, fuel-oil regulators, and other minor differences such as the greater age and smaller size of the turbine in the Sacramento plant.

W. W. Jourdin[1] (written). Referring to the fourth paragraph of the paper, the Inspiration power plant is equipped with engine-driven circulating units and barometric hotwell, with sealed sump and lift pumps located on a hillside at a sufficient distance below the condensers to secure positive drainage of the condensate therefrom.

The high-pressure cylinders of the blowing engines are being replaced with poppet-valved cylinders good for 250 lb. pressure, and all new equipment, including boilers recently installed, is designed for the higher pressure. However, until such time as the original boilers may be disposed of, a maximum of only 200 lb. pressure will be available at the throttles.

The cooling tower was not put into service until November 1918, therefore the plant operated under the handicap of poor vacuum, due to insufficient cooling capacity, throughout the period covered by the curves given by the author in his Fig. 3.

Figs. 1 and 2 do not represent present practice—in fact, there has been a very considerable departure in numerous operating features from the original instructions, although these in principle were good. Owing to labor troubles, the plant was shut down from July 2 to September 20, 1917, inclusive, and in the absence of detailed explanation concerning conditions, the curves would better be broken between June and October 1917.

The heat recovery is low in the economizers not so much on account of inadequate heating surface as because the recovery by the boilers is so high, compared with coal-burning practice, that little heat available for warming feedwater is contained in the gases to the economizers.

The Inspiration plant is jointly owned by two companies, and the money involved is so large, due to high fuel costs, that it is essential that the measurement of all quantities shall be so made as to secure the highest possible accuracy. The metering equipment is quite elaborate, and the accounting is on the basis of continuous overall plant test; consequently the operators are enabled to check economic performance more closely than is usually possible even in the most highly developed plants.

The economy reported is based on net electrical production, and no deduction is made for fuel consumed in warming up and stand-by due to changes in electrical load.

[1] Chief Engineer, Power Plant, Inspiration Consolidated Copper Co., Miami, Ariz. Mem. Am.Soc.M.E.

W. D. Ennis[1] (written). The maintenance of high overall efficiency in regular operation is a feature to be expected with well-designed plants using oil fuel. In discussing the reasons for the superiority of the New Cornelia plant over the Inspiration the author omits mention of the higher superheat used. Allowing for differences in pressure and superheat, the steam temperatures in the two cases are 471 deg. and 551 deg. The load factor may have been of weight also, but there seems to be nothing in the table dealing with this plant to show whether or not both turbines were running. If they were, the New Cornelia load factor was around 0.50 as compared with a value of about 0.70 for the Inspiration plant.

A most interesting feature of this paper is the indication of maximum boiler efficiency at about 0.60 rating (Fig. 2). The author attributes this to the tightness and insulating efficiency of the sheet-metal casing. It is regrettable that the boiler proportions are not given in some detail. The curve of boiler efficiency against rating cannot be considered a normal curve. The (actual) rate of evaporation at normal rating works out 3.26 lb., or at 60 per cent rating, less than 2 lb.

W. H. Best[2] (written). There is one particular point to be emphasized in the use of oil fuel in power plants, and that is the importance, wherever possible and wherever plants are of sufficient size, of the company's employing an engineer whose duties will be to see that the oil is properly burned in order that the strictest economy and highest efficiency may be attained and maintained at all times. I have always recommended this in power plants and in forge shops, and I am glad to learn that there is one plant in the United States that really has placed a man in charge, whose duty it is to see that the oil is properly burned. He can save his wages many times by the economy effected in fuel by his attention to his specific duties.

Why Does the Water in a Boiler Lift When the Safety Valve Blows? An editorial written in connection with a recent action of the Boiler Code Committee of The American Society of Mechanical Engineers in regard to the question of safety valves. An attempt is made to answer the question, "What lifts the water from the level of the water line and throws it out of the safety valve?"

When the valve opens the steam rushes out at a rate proportionate to its absolute pressure, resulting in a diminution of pressure in the area immediately below the valve.

When the boiler is steaming, there is, the editor states, no definite water level. The surface is tossing and heaving with the disengagement of steam bubbles. This disengagement will be very active for the first instant that the pressure upon the surface of boiling water is reduced and may be so active right under the valve as to throw up a column of water which, aided by the sweeping action of the steam rushing to the opening with the velocity of a cyclone, is carried out of the boiler.

It is claimed that this lifting action can be avoided by a gradual opening of the valve, the term "gradual" being used in a comparative sense. From this point of view and as far as the relations between the movement of the valve to the lifting of the water are concerned, it appears to be a question more of time operation than of valve lift, and a smaller valve with large lift does not necessarily give a more sudden release. (*Power*, vol. 49, no. 25, June 24, 1919, p. 983, *gt*)

[1] Acting Professor of Mechanical Engineering, Columbia University, New York City. Mem. Am.Soc.M.E.

[2] Pres., W. N. Best, Inc., New York City. Mem. Am.Soc.M.E.

The Organization of an Industrial Laboratory

Following This Paper is One on Industrial Research Laboratory Organization, and the Two, with the Discussion at the Research Session of the Spring Meeting, form a Valuable Digest of the Methods and Importance of Industrial Research

By A. D. LITTLE,[1] CAMBRIDGE, MASS., and H. E. HOWE,[2] CAMBRIDGE, MASS.

During the war industrial research in the United States was naturally stimulated, and as a result there now exists a deeper interest than heretofore in the applications of science to manufacturing processes. New laboratories will undoubtedly be built and many old ones reorganized in order to render more efficient service. It is the purpose of this paper to point out the organization and conduct of such a research laboratory.

The authors first outline the aims of a research organization, following which the divisions of the laboratory are enumerated and discussed, the laboratories of Arthur D. Little, Inc., being taken as a type. The methods of management, writing of reports and the commercial organization of the laboratory are also discussed at some length, and the paper concludes with a description of the building and equipment best suited to carry on this type of work.

PREVIOUS to the war there were about 375 industrial research laboratories in the United States, including those maintained by manufacturers for their own benefit, and commercial laboratories prepared to render similar service. At the present time there are no figures available regarding the number of new laboratories established as a result of the war, but there is no doubt but that the war created a deeper interest in industrial research, and the application of science to manufacturing processes. It is also evident that those laboratories which existed before the war are displaying a greater interest in fundamental research, and in rehabilitating their organizations are paying far more attention to the research phases of their problems than they have been willing to do heretofore.

In discussing the industrial laboratory we may choose between the one organized for the purpose of exploring some small corner of the broad field symbolic of our ignorance and an establishment concerned with the greatest variety of problems. A laboratory of the latter type should consist of a collection of special laboratories carefully articulated to produce results most efficiently, and the work common to all of them should be organized separately in a large general laboratory. Fortunately for our country there are several such laboratories doing splendid work, and notwithstanding the care exercised to avoid undue specialization, nearly all of them contain departments which dominate, due either to stronger men or the greater appeal which these departments make to the company; or perhaps to a seemingly greater importance of their class of problems at the moment. The great majority of these laboratories are maintained in the plants of industry at an annual expense running up to two millions in at least one case, and with many spending hundreds of thousands each year.

Another plan which should be mentioned involves the training of men as a primary consideration, and the Mellon Institute, at Pittsburgh, affords a conspicuously successful example of what may be done in educational institutions in solving the problems of industry, while at the same time men are trained in research.

The Aims of a Research Organization

Broadly stated, the aims of a research organization should be:

a To find, develop and train men

b To create such a background in the public mind as shall insure support for research and the industrial utilization of research results

c To secure coöperation between different branches of science, as, for example, between chemists and mathematicians

d To avoid repetition and duplication of effort, first by rendering present knowledge readily available to research workers, second by applying clearing-house methods to research projects

e To stimulate research by emphasizing the importance of specific problems, making special grants, rendering material and facilities as generally available as possible.

f To furnish a general staff for research which shall work out the plan of attack for major problems, assign the several lines to competent workers and coördinate and focus the whole

g To bring home to manufacturers the advantages of research with the view of promoting the establishment of private, corporation, and group laboratories

h To make and publish a census of available research facilities in men and equipment

i To survey the natural resources of the nation and direct research toward their development

j To appraise our great industrial wastes and develop plans and methods for turning them to profitable use.

As regards any research laboratory, it goes without saying that it is the personal factor which determines performance and this is preëminently true of the laboratory director. Sir Humphrey Davy truly said that his greatest discovery was Michael Faraday, and no greater problem is likely to confront a research laboratory than that involved in the discovery of a director. Successful laboratory directors may be of several types, but a militant optimism, contagious enthusiasm, controlled imagination and quick human sympathy are common to them all. Such a man will naturally in selecting his subordinates look for these personal qualities almost as carefully as he will weigh specialized scientific training, and having been thus guided in his selections will find it relatively easy to inspire throughout his organization those relations of good fellowship and that *esprit de corps* which multiply enormously the effectiveness of any working force.

The so-called commercial laboratory devoting its efforts to industrial research and operated on a strictly business basis will best serve our present purpose, and that of Arthur D. Little, Inc., in Cambridge, Mass., will be taken as a type in the belief that much of interest will be found in this establishment, which is "dedicated to industrial progress." During the past thirty-three years this laboratory has grown from a partnership of two chemists to an organization of sixty people, and scheme after scheme has been devised for the management of the enterprise, only to find new conditions and rapid growth calling for constant revision. Being a corporation, it is managed by the usual officers with a board of directors, all of whom do not devote their entire time to the business.

The Divisions of the Laboratory

Within such a laboratory there are two distinct sets of duties which may be designated as scientific or technical, and commercial or financial. These two divisions have at least two points in contact, one being through a service manager, and the other the department charged with obtaining new business for the organization.

Presented at the Spring Meeting, Detroit, Mich., June, 1919, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and is subject to revision. Copies of the complete paper may be obtained at a nominal cost.

[1] President, Arthur D. Little, Inc., Mem. Am. Soc. M.E.
[2] With Arthur D. Little, Inc.

The fundamental duty of the scientific division is to interpret the results of pure science in the terms of industry. While the work of the commercial laboratory is of the same order as that done in any laboratory even where the dollar is never discussed, it must be conducted with full recognition of the fact that many industrial problems are as intimately concerned with economic questions as with scientific. In other words, while for instance a laboratory process in glass may be intensely interesting and of fundamental importance, the client can hardly be expected to be satisfied with a report unless a commercial method for operating it can be devised. The technical work should be in charge of the president, under whom various departments should be organized, so that each phase of a given problem may have the attention of a specialist, provided with adequate equipment to facilitate the work.

In this connection it may be emphasized that it pays to provide congenial, inspiring surroundings for the laboratory worker. The laboratory can be made attractive without being ornate, or involving unreasonable expense, and every effort should be made to have the workers reasonably happy. Under no other condition can the best work be expected, and it must be remembered that the heaviest investment is in the time of these workers, the salary cost being much greater than that for equipment or material maintenance. Rewards other than monetary for faithful service also play an important part.

The departments into which the technical division are divided will naturally differ in each laboratory, but a fairly definite line can be drawn between research, engineering and standardized or routine work. It is advantageous to have all of the standardized work, including that incident to research and engineering, carried on under one department head, for in this way it can be done to better advantage both as regards efficiency and economy.

The research department should be organized for both laboratory and small-factory-scale work. There will be a multiplicity of subjects, and since special facilities cannot be provided in advance of close acquaintance with the problem, the organization of departments for research along special lines will concern personnel more than a division of floor space or equipment.

Engineering will embody plant inspection, design, construction and operation, and although much of its work will be in the field, many phases of its problems will be worked upon concurrently in the laboratory.

The analytical department will be subdivided under such headings as textiles, fuels, food, metallurgy and metallography, chemical microscopy, water, lubricants, construction materials, pulp and paper, fermentology, etc. Some of these subjects will require special accommodations, while others can share a large laboratory which provides space for certain apparatus kept in place for a large number of similar determinations.

Nothing is more expensive or demoralizing than experimentation in the plant. An industrial research laboratory should therefore be adequately provided with equipment of semi-commercial size. Infant mortality among processes is high in any case and the most critical period in their young lives is that covering the transition from the laboratory to the plant. They require and the research laboratory should provide a nursery to protect and foster them during this period of their development. Some large manufacturers have even found it desirable to operate in connection with and under the sole direction of their research laboratory a small plant in which actual commercial manufacture is regularly conducted. Such extension of the laboratory's function permits the complete reduction to practice of new methods and the commercial demonstration of the sufficiency of the product before the innovations are introduced into the main plant.

Even when no such provision appears feasible, it is, nevertheless, highly desirable to have the industrial research laboratory actually engaged in some small scale, highly specialized, commercial manufacture, preferably of some product which it has itself originated. The least advantage of this procedure is that such manufacture of a properly selected product may frequently defray a substantial proportion of the expenses of the laboratory. The major benefits are the acquirement of a certain commercial sense by the laboratory staff, an appreciation of the conditions and difficulties of actual production, and finally the strengthening of the position of the laboratory through the increase in its turnover and equipment.

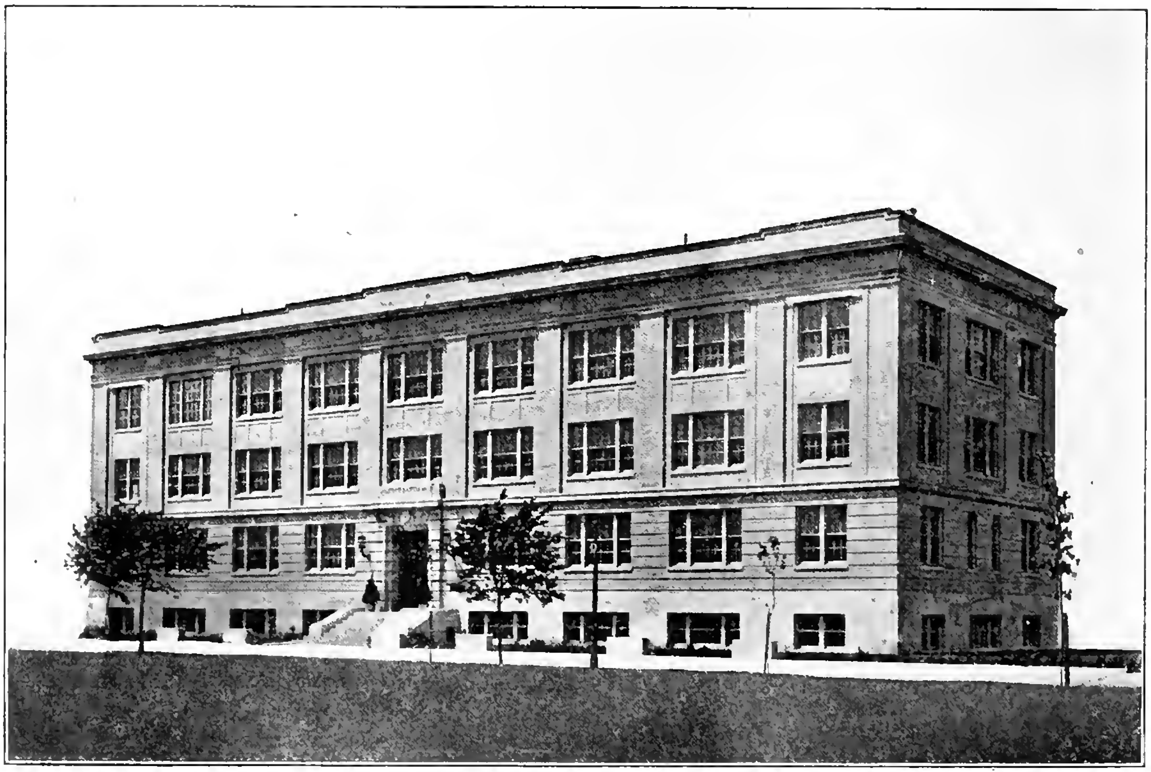


Fig. 1 The Laboratory of Arthur D. Little, Inc.

The Method of Management

It is easy to visualize the organization chart for such a laboratory, and a brief description of how a new piece of work will be handled may therefore convey a better idea of the method of management. The authorization for the work will go to the service manager, who sees all incoming mail, and to the authorization will be attached any correspondence or data bearing on the case, all of which will be given a case number for identification, and this number will be entered in a case register, which will indicate the name of the client, the subject of the problem, the date the authorization is received and the date when the work shall have been completed. The service manager, who must be familiar with the ability of each member of the staff, as well as with the work in hand, will assign the case to the division which can render the best service. Conferences will then be called, into which any member of the organization who can contribute anything to the solution of the problem in hand will be drawn, and outside associates or independent consultants may be included. The problem will then go into work by means of instruction sheets, setting forth what is to be accomplished, suggesting methods of attack, relating any special circumstances, references to literature, and standard methods which may be applicable, and as much light as possible given to the individual who is to do the work. Accompanying the case there will be a tag bearing the case number and upon it a date at which it is expected the work can be completed, or a progress report made, must be indicated. The tag is then returned to the service manager. Through the means of data sheets, time slips and verbal reports the progress of the problem will be readily followed. This procedure will be followed in all the divisions, the individual reporting to his superior, and the service manager will be alert to insure prompt and efficient service to all clients.

At the completion of the work the report, varying in extent from a single printed form to a bound volume of several hundred pages, will pass through the hands of all concerned, and will thus be distinctly the report of the organization and not of an individual in the organization.

Reports

Writing a report requires skill, for it must be comprehensive. It should begin with a clear statement of the problem, followed by the conclusion reached as a result of the work, which may then be described in detail. Patents, cost data, tables, graphs, photographs and samples should be dealt with in an appendix, and in some instances descriptions of apparatus should be included. The whole must be carefully indexed, and a copy sent to the library to be bound and kept as confidential information in locked cases, but as part of the library it should be carded for the library card index. Obviously no fast rule can be laid down for writing reports, but it should be borne in mind that many of those who read technical reports are not interested in minute details, and that the subject-matter must be presented in a form that will be interesting and understood by the layman. It must also have its important points so emphasized that they can be readily picked out by those not caring to read the entire report, but at the same time it should include sufficient data to serve the purpose of a fully qualified technical man to whom the report may be referred at some later time.

This brings up the question of the library, which may easily be considered the backbone of the industrial laboratory. Its extent will depend upon other library material available in the community but there are few things which obstruct research more seriously than the absence of easily accessible proper library facilities. A few dollars spent in books and literature frequently saves as many hundreds otherwise spent in work of duplication. The useful periodicals must be provided, elaborate indexes will be found a good investment, also abstracts and patents; in short, every means for quickly locating literature references should be at hand. The current literature, with articles of interest indicated on an attached slip, should be circulated among the members of the staff whose names are checked on this slip, and some one, preferably a chemist, should have assigned to him the task of constantly reading the literature in order that no scrap of information shall escape. Such a chemist-librarian will conduct searches in other libraries, prepare abstracts, and in fact direct

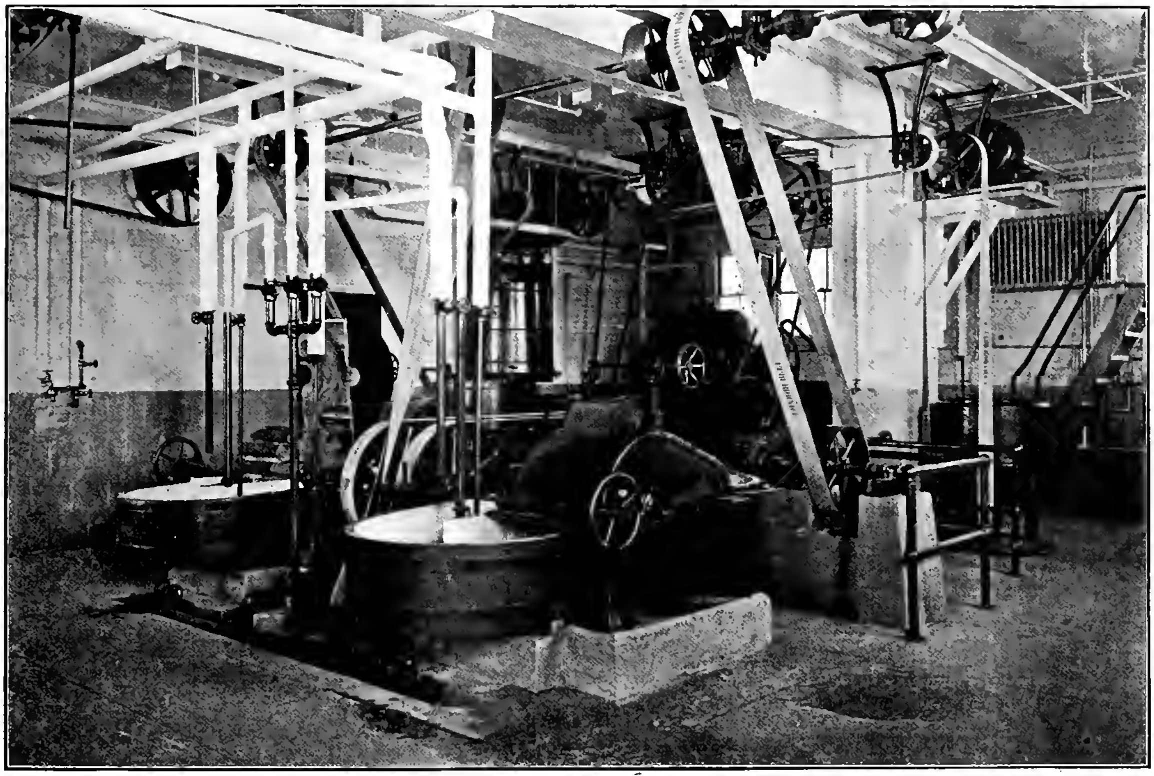


Fig. 2 Experimental Paper Mill, Laboratory of Arthur D. Little, Inc.

the information service for the laboratory, and through the laboratory to its clients.

BUILDINGS AND EQUIPMENT.

With this general plan of management before us, we may now consider the equipment and space required for effective work.

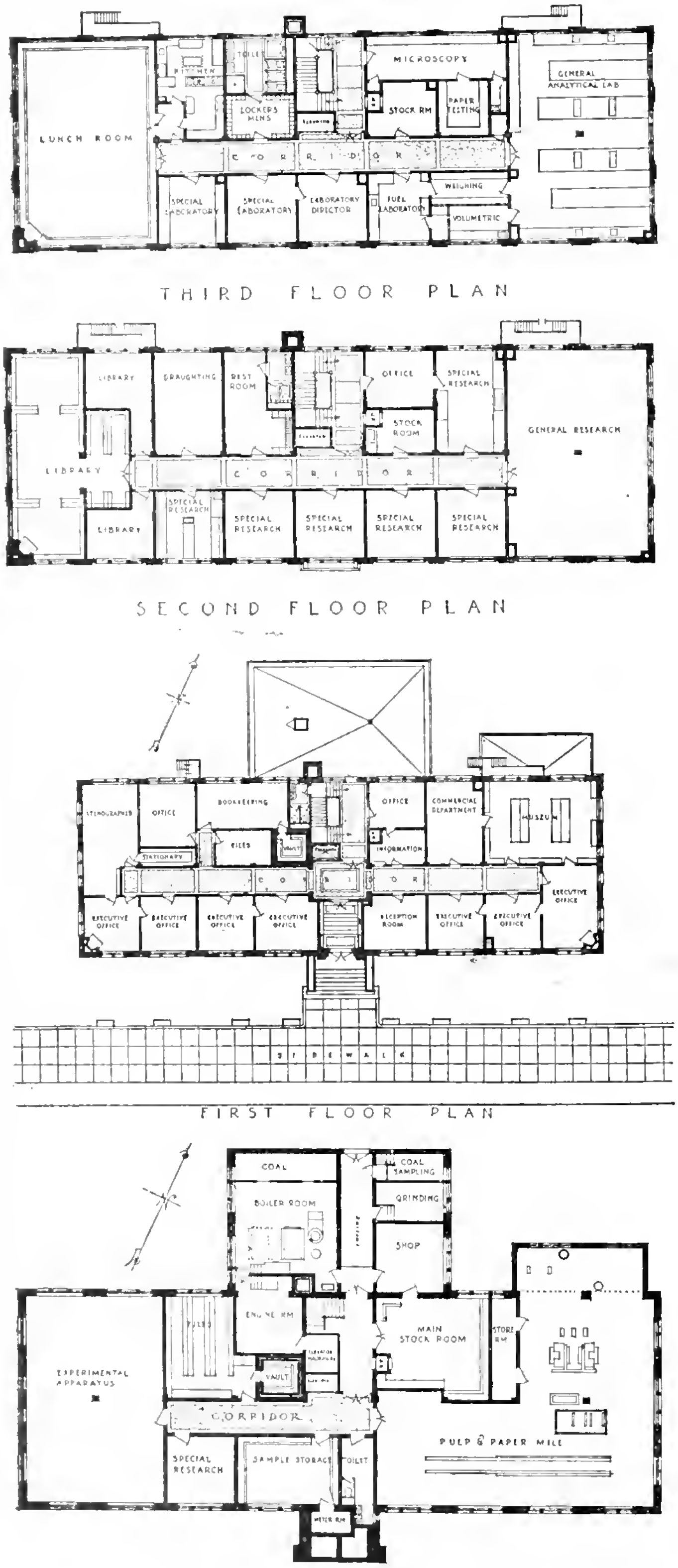


FIG. 3 PLANS OF THE LABORATORY OF ARTHUR D. LITTLE, INC.

Experience has shown that a satisfactory building is one approximately 50 ft. by 150 ft. (planned so that another building may be easily connected in H-formation) and consisting of a basement, with three floors, the basement itself being so designed that it is as light and airy as the upper floors. Such a building with a wing housing the power plant and small grinding rooms (this being the connected wing of the H) has a total floor space of approximately 30,000 sq. ft. The building occupied by Arthur D. Little, Inc., is of this type and the various departments are allotted the following space: Analytical division, 5328 sq. ft.; research division, 3458 sq. ft.; engineering, 1155 sq. ft.; commercial department, 768 sq. ft.; management (meaning the management of outside enterprises), 538 sq. ft.; special department devoted to pulp and paper, 4118 sq. ft. The portions of the building which are non-producing, such as miscellaneous offices, which includes stairs, corridors, halls, lavatories, etc., comprise 8000 sq. ft., and the space unassigned amounts to 3815 sq. ft. This includes laboratory space provided for emergencies and expansion but not in constant use.

These area measurements form the basis of apportioning overhead due to interest on investment, depreciation, repairs, insurance, upkeep, etc., and among the departments is distributed the charge for carrying 768 sq. ft. devoted to an industrial museum and 1536 sq. ft. devoted to the library.

The basement will provide room for the power plant, the current sample room, the general stock room, two very large rooms for small-factory-scale equipment, two small rooms for coal and other crushing and grinding operations, and a machine shop in which the physical testing machinery can be installed. A laboratory for testing construction materials, such as cement, may also be placed in the basement to advantage, and here, too, a room and vault can be set aside for inactive letter files and records.

The first floor will provide a series of offices each of about 250 sq. ft. area, two larger ones which may be used by officers of the company, consulting engineers and others, a reception room, and an information booth with switchboard. The museum can also be on the first floor, together with the rooms devoted to the commercial department's work. Quarters for the financial division, with ample vault space, and room for current correspondence and the general stenographers' office complete the floor. The engineering division might also occupy rooms on the first floor.

The second floor may be properly devoted to research and the library. It is frequently advantageous to be able to segregate research problems, and it will be well to provide a series of small rooms, say of approximately 250 sq. ft. in area, which can be fitted up in accordance with the requirements of the problem, and easily dismantled at the conclusion of the work, to be refitted according to the next undertaking. A branch stock room should be located on the second as well as the third floor, and these should be served by elevator from the general storeroom in the basement. There are always a number of scattering problems in research that can be handled in one laboratory, and so a special-problems laboratory should also be provided on the second floor with an office for consultation purposes. Finally a large room, say of 1500 sq. ft., should also be available for large undertakings, and as a space for emergency overflow.

The third floor may comprise the general analytical laboratory, a room of about 1500 sq. ft., adjacent to which should be a room for titration and the balance room (each of approximately 125 sq. ft.), a fuel-testing room and a special room for extraction. A branch stockroom and the offices of the head chemist and assistants should also be on this floor. The optical room should be placed where north light can be obtained, and a small dark room must be provided, as well as a specially equipped room for the physical testing of paper and textiles. The kitchen can adjoin the assembly room. A locker room for the men and a rest room for the women must also be provided. Space under the roof can be used for fans and a ventilating appliance, water tanks, etc.

Such a building as has been thus briefly described will cost about $200,000 and $50,000 will provide general equipment. There is always something new to buy for a laboratory. Such an establishment will provide working space for approximately 150 people, and more could be accommodated if necessary, depending largely on the type of work being conducted. The cost of operation and maintenance, based on a staff of sixty, will be about $20,000 per month.

Industrial Research Laboratory Organization

By K. C. Mees,[1] Rochester, N. Y.

The great value of scientific research, both to the industries and the nation at large, is now generally recognized. The industrial research laboratory is an important factor in maintaining the supremacy of an industry, and its success depends to a considerable degree upon its relation to the other departments of the company with which it is associated. In this paper these statements are discussed, and the author presents his views regarding the establishment and function of industrial laboratories, giving in connection with the latter three annular diagrams. The form and operating costs of industrial laboratories are also discussed.

THE triumphs which have already been won by research laboratories are common knowledge. The incandescent-lamp industry, for instance, originated in the United States with the carbon-filament lamp, but was nearly lost to this country when the tungsten-filament was developed, only to be rescued from that danger by the research laboratory of the General Electric Company, who fought for the prize in sight and developed first the drawn-wire filament and then the nitrogen lamp; and we may be sure that if the theoretical and practical work of the research laboratory of the General Electric Company were not kept up, the American manufacturers could by no means rest secure in their industry, as, undoubtedly, later developments in electric lighting will come and the industry might be transferred, in part if not completely, to the originators of any improvement. Manufacturing concerns and especially the powerful, well-organized companies who are the leaders of industry can, of course, retain their leadership for a number of years against smaller and less completely organized competitors, but eventually they can insure their position only by having in their employ men who are competent to keep in touch with and to advance the subject, and the maintenance of a laboratory staffed by such men is a final insurance against eventual loss of the control of its industry by any concern.

The success of an industrial research laboratory depends to a considerable extent upon its position in the organization and upon its relation to the other departments of the company with which it is associated.

If industrial enterprises had been organized afresh with the research laboratory as a definite part of the organization, it is probable that by this time some general opinion would have been formed as to the position which the laboratory should occupy, but in fact nearly all industrial research laboratories have been added to organizations already formed, and their relations to the other departments of the organization are usually closely associated with their origin.

Laboratories are established in many different ways. If there is a technical scientific expert in the executive of the manufacturing company he may feel the need of a laboratory and become its director, and in this case the laboratory will necessarily be very closely associated with the work of the executive who initiated it.

A laboratory may also be established under a separate director, not himself associated with the executive officers of the company, but as a reference department for the executives, and in this case also it will be very closely associated with the officers of the company and will tend to be concerned more with questions of policy and the introduction of new products than with any other of the problems of the company.

In a large company a research laboratory may be established as a separate department, having its own organization and being available as a reference department for all sections of the company, in which case its activities will cover a very wide field, but at the same time it will not have as direct an influence upon the policy of the company as will happen if it is closely associated with one or more of the executive officers.

The earliest research laboratories grew out of the works testing and control laboratories and were therefore responsible directly to the works manager. More recently, laboratories have generally been established as independent departments of the company and responsible only to the general manager.

The executive official to whom the laboratory should report will depend upon the nature of the work to be done. There may be industries in which research work is required for only a single department, and in this case the research workers should be responsible to the head of that department; there are others in which the interest in the research is confined to the works, and in such cases the laboratory should be responsible to the works manager; but in most technical industries research work will have a great bearing not only on the methods of production but even on the general policy of the industry, and in such cases it is necessary that those who direct research should be in touch with, and responsible to, the executives who control policy.

The position of the research laboratory in an industrial organization is perhaps best determined by the criterion that the research department should be responsible to the officer of the company who is in charge of the development of new products. If the introduction of new products is in the hands of the works organization, then the research department should be responsible to the works manager; if there is a definite development department, or, if new products are introduced through the agency of some definite executive, then it is to that executive that the research department should be responsible. The research laboratory, in fact, should primarily be associated with development.

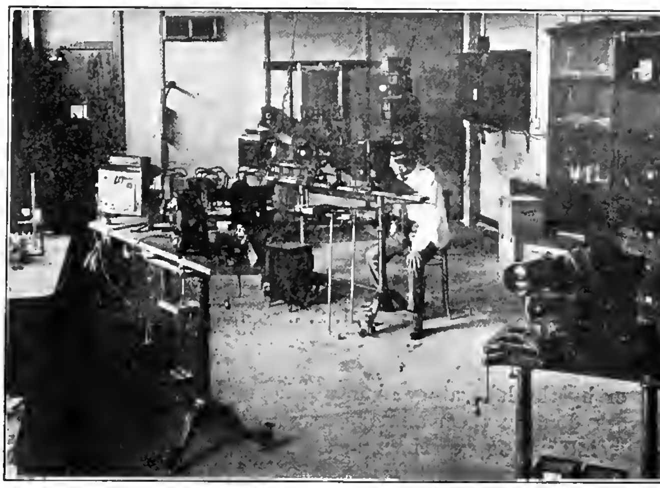


Fig. 1 A Laboratory of the Eastman-Kodak Company

The chief functions of the laboratory are as follows:

1 The provision of information regarding the technical and scientific matter in which the industry is interested, and the supply of this information in a form suitable for the education of the employees, of the customers, and of the general public.

2 Service in the form of the provision of specifications and standards for materials, the making of analyses and tests, assistance to the works in regard to difficulties and to customers in the relation of problems arising from the use of the product.

3 The development of new processes or products, utilization of by-products, the development of new departments of the industry.

These functions may be expressed by means of annular diagrams such as those shown in Figs. 1, 2 and 3. Fig. 1 shows

Presented at the Spring Meeting, Detroit, Mich., June, 1919, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and is subject to revision. Copies of the complete paper may be obtained at a nominal cost.

[1] Director of the Research Laboratory of Eastman-Kodak Company, Rochester, N. Y.

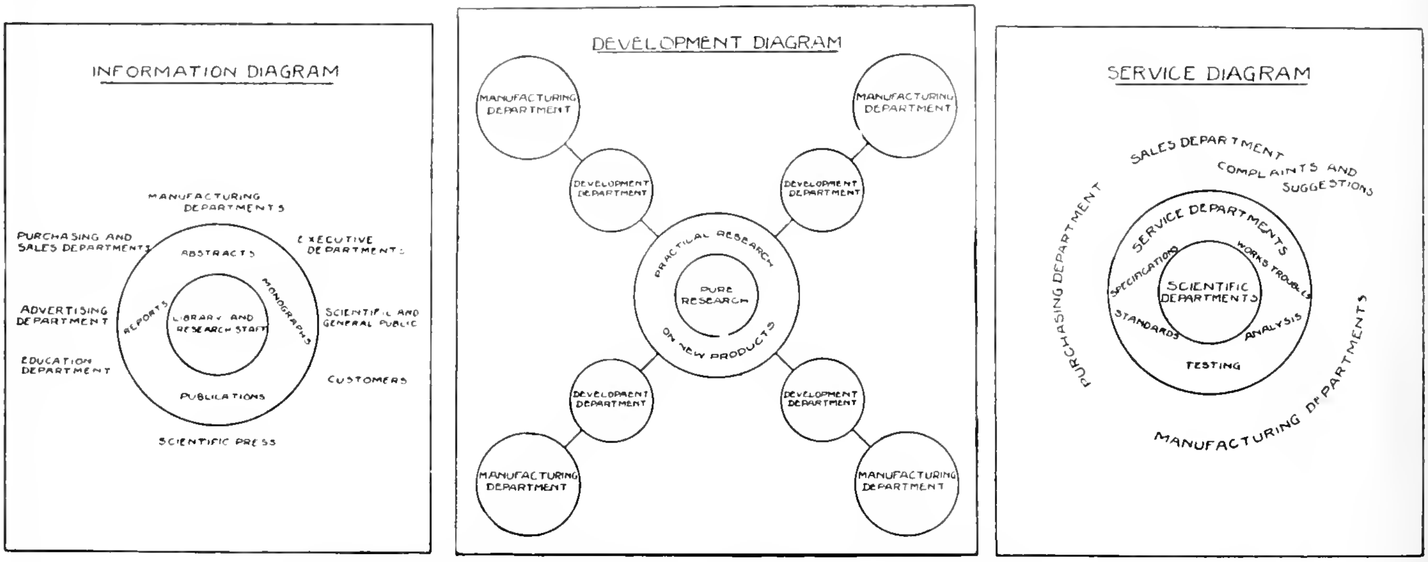
the information diagram. The information originating from the library and from the research staff is issued in the form of abstracts, reports, scientific publications and monographs, and first goes to the executive, manufacturing, purchasing and sales departments for their information; then to the advertising and educational departments to be placed in the form required for publication in the scientific and general press.

The organization of the development work is shown in Fig. 2, where the work is shown to be founded upon pure research done in the scientific department, which undertakes the necessary practical research on new products or processes as long as they are on the laboratory scale, and then transfers the work to special development departments to form an intermediate stage between the laboratory and the manufacturing departments. These development departments are really small scale manufacturing departments which may be operated either by the works department or by the laboratory; but which are controlled, as regards the work done in them and the method used, by the laboratory itself, being run as experimental departments in order to develop a new process or product to the stage where it is ready for large scale manufacture.

Under the alternative or cell system the laboratory consists of a number of investigators of approximately equal standing in the laboratory, each of them responsible only to the director, and each of them engaged upon some specific research. Each such investigator, of course, may be provided with assistants as may be necessary.

In practice, some system between these two systems of organization is essential and will develop in any laboratory. It is not possible to work a rigid divisional system, and on the other hand no cell system in its most definite form could be effective.

The scientific work of the research laboratory is best directed by means of a conference or series of conferences of all the men having knowledge of the subject, and this will have the further advantage that, while it will relieve the director of the details of the direction of the scientific work, it will keep him constantly informed as to all the work going on in the laboratory.



FIGS. 1, 2, 3 DIAGRAMS ILLUSTRATING THE FUNCTIONS OF AN INDUSTRIAL RESEARCH LABORATORY

In Fig. 3 the service diagram shows the scientific divisions as the operating center, each of which supports and controls the necessary service departments which prepare specifications and standards, undertake testing and analysis, the investigation of works troubles, complaints of customers, and suggestions from the sales department, the results of which are communicated to the departments interested.

The laboratory organization will therefore consist of a section of administration, which will be responsible for the direction of the work, the control of accounts and the issuing of reports; a section of information, which will operate the library, prepare abstracts of the literature, keep in relation with the patent department and constitute its technical wing, and prepare reports and publications of all kinds; and the scientific section, which will carry on the operation of the laboratory work.

There are two forms of organization possible for the scientific work of the laboratory. For brevity these may be spoken of as the "divisional" system and the "cell" system. In the divisional system the organization is that familiar to most businesses. The work of the laboratory is classified into several divisions; physics, chemistry, engineering, and so on, according to the number necessary to cover the field, and each of these divisions has a man of suitable scientific attainments in charge of it. In a large division each of these men will in turn have assistants responsible for sections of the department, all the heads of divisions finally being responsible to the director of the laboratory.

From various sources, but chiefly from the convenient list of American laboratories given by Fleming there can be found the cost of a research laboratory per scientific worker employed. It might seem that there would be very great variations in this, but, provided that the laboratories are all of the physical and chemical type, there is a surprising agreement between the figures, which show that the cost of building and equipment for a laboratory will be between \$3000 and \$4000 per man. From the same sources the annual cost of maintenance of such a research laboratory appears to be slightly lower than the first cost. Probably \$3500 per man will be a fair estimate of the cost of maintenance, and of this we may take 60 per cent as representing salaries and wages and the remainder all other expenses.

As laboratories are organized and experience gained in the types of laboratory suitable for different industries it will doubtless be possible to lay out definite schemes of organization for a laboratory suitable for the requirements of any industrial undertaking. At the present time, however, it is possible to do this only in the most general way, and it is necessary to consider each case independently, taking into consideration the requirements of the particular industry involved.

Fortunately data on this subject are being accumulated at the present time and the whole question of laboratory organization is being studied carefully both here and abroad. In this country the National Research Council has appointed a special committee to promote industrial scientific research and this body is now engaged in drawing up a scheme for the establishment of an alloys research laboratory and is considering other lines of industrial research all of which I am sure will meet with the approval and support of The American Society of Mechanical Engineers.

DISCUSSION AT RESEARCH SESSION OF SPRING MEETING

THE Spring Meeting of the A. S. M. E., held at Detroit, June 16 to 19, devoted its second session to a consideration of the status of research in this country. Four papers and an address were delivered. Those by Arthur M. Greene, Jr., on The Present Condition of Research in the United States, by Enrique Touceda, on Research Work on Malleable Iron, and by G. H. Clevenger, on The Division of Engineering of the National Research Council, appeared in abstract form in MECHANICAL ENGINEERING for July and in this issue the remaining two are presented. One of these, by Arthur D. Little and H. E. Howe, is on The Organization of an Industrial Laboratory, and the other, by Dr. C. K. Mees, deals with The Organization of a Research Laboratory. Abstracts of the discussion of these various papers follow and it is not surprising to find that opinions regarding the value of research vary but little, for it is unquestionably true that research is rapidly coming into its own and bids fair to occupy to a considerable extent the attention of the industrial world.

P. F. WALKER[1] (written). The author has truly said that in most of our educational institutions the members of the faculty are so burdened with routine teaching that large amounts of research work cannot be expected. There is good reason, however, why the schools need to give active attention to scientific investigation. It is the schools that must produce the men to go into active professional work, including research. In the schools these men have implanted in them certain ideals which will remain, perhaps unconsciously, as determining factors in their lives. To promote research is therefore of vital importance in order that the students should be brought face to face with research problems, and thus imbibe something of the spirit of the investigator.

A matter in which the writer is at present personally interested and to which he is giving a great deal of attention is the state industrial problem. It is a research side of that new branch of the profession sometimes designated as industrial or commercial engineering. Every state and every community has problems peculiar to itself and it is a function of state educational institutions as well as of the engineering profession to interest themselves in such problems with the aim of rendering service. A combined survey and study of industrial possibilities is being made. This is mentioned here because it is a kind of research not always thought of as coming within the scope of the engineer. To the writer, however, it seems that it is an activity which comes distinctly within the terms of that definition which states that engineering is the application of all of the sources of power to the use and convenience of man. In any community, and particularly in one where the natural resources are not yet developed by industries to the full extent that economic conditions will warrant, it is the business of the engineer to encourage and pave the way for new industrial development as truly as it is to develop the natural agencies for its successful prosecution.

F. J. SCHLINK[2] (written). The importance of real research work and its possibilities in returning a quite extraordinary profit for a very moderate expenditure, cannot be overemphasized. If this end is to be attained, however, the venture must be undertaken with a broad vision and the investigator must be permitted within reasonable limits to carry on studies which may not promise immediate pecuniary benefits.

It is nothing less than astonishing to find, as we occasionally do, that a long-established product, supposedly fully standardized, is being manufactured without even a superficial knowledge of the simple engineering and scientific facts that underlie its performance. Some of the portable or hand-operated fire extinguishers are splendid examples of this class, and in these simple devices, which are not nearly so complex, from the designing and manufacturing standpoint, as an alarm clock or a lawn mower, the varied and manifest types of mechanical and operating failures presented are well-nigh unbelievable. One can say with a high degree of certainty that the expenditure of \$500 in a real engineering study of the problems of materials and function in any one of several such extinguishers would have made unnecessary the waste of many thousands of dollars in ineffective designs, some of which are absolutely a menace in that they give the user a false and unfounded sense of security against fire hazards.

The condition of American business in which large profits could be made without the necessity of careful and rigorous attention to engineering research and standardization, is rapidly passing away in the face of the present perplexing industrial situation. The advancing costs of labor and material with the concurrent unwillingness of the public to pay increased prices for the manufactured product it consumes, are bringing to every manufacturer a problem of almost crucial character, of holding down or reducing his manufacturing costs without depreciating his product. This difficulty must be met on the one front by research and standardization, and on the other by the efficient management of labor; and the former, though not so well advertised or perhaps even so highly regarded, is likely to prove at least as powerful an ally as the latter.

ARTHUR J. WOOD[1] (written). In his paper, the author states that one of the great needs of the present time is for research men and then follows this with a statement which in itself explains why there are not more men available. He says, "The love of the work will prove to be the incentive as in many cases the monetary returns are small." I believe that the author is conservative in saying "many cases,"—it should read "most cases."

Monetary returns will never make a research engineer out of one whom nature never fashioned for such work, but it will produce results of unmeasured value from the one who has the love of and ability for research work if it frees him from financial cares which he otherwise must carry.

Surely the need is for more research men and the industrial laboratories look primarily to the colleges for their material, but what are the colleges, as a whole, doing to develop men along these lines?

In the period of awakening to the value of research there will be plunges into subjects without proper preparation or preliminary study and analysis and some half-baked results of tests will doubtless be put forth as research, partly because the colleges cannot or do not pay salaries to teachers and investigators which would train the right men in the proper lines. The making of a research worker is a long-time process, and it calls for a normal, straight-thinking mind, well informed and evenly balanced, which must be left free to get results. One of the apparent needs for men in collegiate research is for more leisure in which to think out methods, to plan work in fields not already well occupied and to keep the mind thoroughly saturated with the subject at hand. How much leisure should be granted? The man himself should be the one best qualified to answer this.

Regarding industrial vs. pure research, there should be no conflict; no line of demarcation can be drawn between the two although they are essentially different. One is helpless without the other. No research is so "pure" but that it may some day lead to results of commercial value. It is unfortunate that many engineers do not have a true conception or an adequate appreciation of the value of scientific research.

The Society through its Committee on Research and the various sub-committees, may also be an important factor in guiding the pioneer work. It may help to raise the standards of pure research so that industrial and educational institutions alike will accept the definition of research as given by the late Dr. R. H. Thurston as "the art of revelation and prophecy." The Society must be a leader in the great work and place research in its accepted and well-deserved place among engineering enterprises.

[1] Dean, Schol of Engineering, Lawrence, Kan. Mem. Am.Soc.M.E.
[2] Associate Physicist, Bureau of Standards, Washington, D. C. Jun. Am.Soc.M.E.

[1] Professor of Mechanical Engineering, Pennsylvania State College. Mem. Am.Soc.M.E.

H. S. Coleman.[1] The system of research at the Mellon Institute was formulated by the late Robert Kennedy Duncan and placed in experimental operation at the University of Kansas in 1906. In 1911 the system was inaugurated at the University of Pittsburgh, and in 1913 established on a permanent basis there through a gift, by Messrs. Andrew William and Richard Beatty Mellon, bankers of Pittsburgh, of a modern research building and an endowment to cover the general overhead expenses and salaries of the administrative staff.

Any company or association of manufacturers having a problem or group of problems requiring investigation may become the donor of an industrial fellowship by contributing to the Mellon Institute a definite amount of money, for a period of not less than one year. This foundation sum must be adequate for the purchase of all necessary special apparatus or other equipment as well as to furnish the annual stipend of the research man or men selected to work on the particular problem. The Institute houses the investigatory work, furnishes it with the use of its permanent equipment, affords library and consultative facilities, gives careful direction to the progress of the research, and provides an atmosphere which is conducive to productive inquiry. All results obtained during the course of the industrial fellowship belong exclusively to the donor.

The institute is not, in any sense of the word, a commercial institution, being entirely independent and deriving no financial profit from any investigation conducted under its auspices. In fact, during the last fiscal year, it was necessary to draw upon the endowment fund for almost $70,000.

Up to the present time the engineering research carried on at the Mellon Institute has been rather limited in scope as the present building and equipment were designed mainly for chemical research. There are, however, three fellowships at present in operation involving engineering research, and plans are now under way for the construction of an engineering research building which will provide adequate facilities for extensive engineering investigation.

Investigations are usually worked out in three stages. First, there is the laboratory stage; then comes the unit plant or semi-commercial stage and finally the process is placed on a commercial basis in the plant of the donor. The fellow who has developed the process through the laboratory and unit-plant stages is usually at this time taken over by the company and placed in direct charge of the new process.

As a result of the investigations involving the development of new processes, a large and valuable collection of special equipment has been acquired. This equipment, in most cases, becomes the property of the Institute at the expiration of the fellowship for which it was purchased, and is available for further use in connection with new problems.

John R. Allen.[2] About a year ago, the American Society of Heating and Ventilating Engineers decided to establish a research laboratory, and the committee in charge of the work decided to associate themselves with the Bureau of Mines, as the Bureau agreed to provide the necessary laboratory space.

The funds that have been provided for the laboratory have come largely from manufacturers and others interested in the work; although the work in general will not be of a commercial nature but rather of a fundamental character. With that consideration in view the committee has laid down three principal activities for the institution: first, the obtaining of data covering the subject of heating and ventilating; second, the establishment of standards for the use of heating and ventilating engineers; and third, the work of research.

The work of research has been divided into two departments, one to be conducted at Pittsburgh and the other at the mines. Many of the laboratories in this country that are doing research work along the lines of heating and ventilating can materially assist our laboratory and thus the work of acquiring information on the subject of heating and ventilating can be accelerated. In the Bureau of Mines itself the principal work to be done is in connection with the subject of ventilation as this is one of the most difficult questions to be considered.

[1] Asst. Director, Mellon Institute of Industrial Research, Pittsburgh, Pa. Mem. Am.Soc.M.E.

[2] Dean, College of Engineering and Architecture, University of Minnesota, Minneapolis. Mem. Am.Soc.M.E.

Zay Jeffries.[1] The Aluminum Castings Co. is engaged in a line of endeavor which for a long time has been determined by research that has been largely limited to the more refined methods of production. As a parallel to our line of work, the American Smelting Refining Company's method of research is something, which while it might not be termed research in an ordinary concern, is nevertheless very highly specialized. They examine a great many prospects and I believe in a certain three-year period, ending about 1916, they had examined about 900. At that time they had selected three for purchase and further development. That is a type of research work that one does not ordinarily come upon, but it nevertheless is considered essential for their business.

The Aluminum Casting Company's laboratory employs between 80 and 90 individuals. It is a two-story building 50 x 230 ft.; and its equipment is valued at approximately $150,000. The annual expenditure for this work alone, is about $300,000. We are finding out a great many things in connection with the non-ferrous alloys, but we have only advanced far enough to begin to apply these fundamentals to our industry. Our work is new, and yet its application is even now finding itself here, and no doubt will find its way further in the future.

Charles Russ Richards.[2] Some 25 odd years ago the first effort was made to provide for congressional action in engineering experiment stations, but for one reason or another the efforts to secure action of Congress were futile. A few years later the officers of the College of Engineering, University of Illinois, succeeding in interesting their board of trustees in engineering research, and in December 1903, the Engineering Experiment Station was organized and it has since undertaken, in a rather systematic fashion, the conduct of research in a great variety of lines. This is an organization within the college of engineering. Each member of the faculty is encouraged to devote any time he may have at his disposal to conduct research work. If he has a good problem which he wishes to undertake, we undertake to relieve him of exacting teaching or administrative duties, to permit him to give time to the work. The principal portion of our work, however, is carried on by the research corps, which is composed of various full-time and a number of part-time students.

In addition to the work which we are doing in research, there have been from time to time coöperative investigations of problems undertaken at the direct request of an industry or group of industries. At the present time there are at least four or five such investigations in progress.

As a state institution it becomes essential for us to safeguard the work which we do and in all of our coöperative investigations we reserve absolute proprietorship in the results obtained and the rights to publish them.

The Engineering Experiment Station now expends approximately $50,000, but as this must be divided among nine or ten different departments, it thus gives only a small sum to each. It is my hope that each one of our men who is a specialist in his particular line may have the opportunity to direct a special corps of investigators, thus developing scientific knowledge to a point where it would be helpful to industries, and through the accumulation of large sums of money, enabling us to do work on a scale which is not possible for any college, no matter how magnificent that may be. If I can secure the coöperation of the industries of Illinois, I have little doubt but that it will be accomplished.

Charles H. Benjamin.[3] The Engineering experiment station at Purdue is an infant but two years old, but it is a very lusty infant, alive and kicking. We now have a paid staff of workers, and a very good field in which to work, and our future is still before us. Our object in establishing the station was primarily to

[1] Director of Research Laboratory, Aluminum Castings Co., Cleveland Ohio.

[2] Dean College of Engineering, University of Illinois, Urbana, Ill., Mem. Am.Soc.M.E.

[3] Dean, Purdue University, Lafayette, Ind., Mem. Am.Soc.M.E.

coördinate the research work which has been carried on at Purdue for so many years, and to enable us to do it more satisfactorily, and to publish the results more widely. Another purpose in forming this organization in coöperation with the industries of the State is that primarily we are interested in Indiana, its products, its manufacturers, and its future, and it is going to be our first aim to collaborate with the men of Indiana to increase this productiveness. There is a certain advantage in a university laboratory. A university laboratory or engineering experiment station has no particular axe to grind, and this removes it from any suspicion of commercial interest. Sometimes we are required to investigate problems that perhaps could be better investigated by the private concerns but that establishment feels that its own efforts would be misinterpreted, and that the results from the engineering experiment station will receive more universal credence and support. The organization, and our methods of work, are very similar to those which Dean Richards has so well outlined. The time is too short to tell of the things that we are doing and expect to do. I will only mention one or two. One is the testing of road materials and the coöperation with the highway commissioners in the building of good roads. Another is the efficiency of the carburator. One of the most important however, of our investigations, is that of the farm tractor, in which we are coöperating with the agricultural school of the university. We expect to see a testing plant at the university which will bear somewhat the same relation to the farm-tractor proposition as the locomotive laboratory does to the problems of the railroad, and our only difficulty is to take care of the amount of work which it brings, and which comes to us without solicitation.

In conclusion, I wish to express my appreciation of the work of the research committee. I do, however, want to urge caution, not on the part of this committee, but on the part of perhaps some governing agencies in trying to shape research work. The research man is a genius. He is born, not made. He is peculiar and he must work in his own way and on his own initiative. He must not be interfered with, and he must be allowed to follow a thing in his own way.

J. R. Bibbins,[1] as chairman of the Chicago Section of the Research Committee, offered the following resolution:

Whereas, it is a matter of generally accepted concern that any advanced policy of the American Society of Mechanical Engineers, in common with other complementary learned societies and associations, should incorporate prompt and extended recognition of scientific and industrial research as a specific means of advancing technology and proper industrial development of the nation; and,

Whereas, the Great War has fully demonstrated the principle of research, applied broadly as well as in detail, to be of inestimable benefit in advancing national welfare; and,

Whereas, the Committee on Aims and Organizations has specifically recommended that the American Society of Mechanical Engineers take a more active interest in this field; therefore, be it

Resolved, That it be declared the sense of this research session of the A. S. M. E., that Engineering Council shall be encouraged to undertake active support of a plan and organization of scientific and industrial research to the end that the following objects may be accomplished with all reasonable dispatch:

1 To secure the passage in the present Congress of a special act furthering nation wide research in State units through congressional appropriations for this purpose under the general coördination of Engineering Council, or other national agency thoroughly representative of the engineering profession.

2 To encourage trade, industrial, and utility associations to interest themselves in the advance of the Arts and the constructive benefits to be derived from research work in their respective fields and to coöperate with them in their efforts in these directions.

3 To encourage the various research institutions or instrumentalities now or to be established by the Federal and State governments in their close coöperation in this general research policy.

4 To encourage and assist in the establishment of organized departments of engineering research at the various universities, adequately equipped with material and personnel and to bring such department as closely as possible in touch with the vital problems of industrial development confronting the Nation.

5 To institute organized publicity with the industries of the country and ascertain broadly by a thorough canvass their vital needs, with a view to directing the research work of the country and the coöperative development of the industries through the agency of the technical laboratories both public and private.

6 To organize and support a separate department of the societies activities, in close coöperation with similar departments of other technical societies, to act, through Engineering Council, or other representative national agency, as a permanent clearing house for all research work.

On presenting this resolution Mr. Bibbins stated that while there has been a considerable amount of discussion as to the propriety of state institutions undertaking work of this character he firmly believed in the necessity of each state developing itself as a unit. "They cannot do too much," he declared. "We should encourage by all possible means, every form of intelligent and efficient research. We do not disparage in the slightest degree purely scientific research and we recognize the absolute necessity of it. At the same time we also recognize the equal necessity of research in the more practical phases of the research work.

"The industries want men. They already have the money in abundance. Their executives are keen in search of improved materials, methods, and processes. If successful, the product instantly becomes better and cheaper. Many of the larger industries are alone spending millions for research of such a character as adapted to their essentially commercial undertakings. But what of the lesser industries? They have not the means to maintain expensive research laboratories, nor perhaps the vision to see the need of them, although it is these very industries that are most in need of encouragement. Where, then, may we find a solution of this modern pressing need?

"The answer seems to be in that agency that will produce men of vision, ability and perspective. These men are produced at the seats of learning, whose academic influence is admittedly nation-wide. They are usually supported by the State and indirectly through taxation by the industries. Yet for some reason, the impression of academic limitations still prevails in industry, although this is being gradually broken down by the splendid work of unselfish pioneers in technical learning who have given of themselves to obliterate the unfortunate impression.

"What can the A. S. M. E. do to secure recognition, establishment and support of a broad, nation-wide foundation for industrial research? The answer of the Chicago Research Committee, as far as present formulated, is found in the foregoing resolution, which is purposely suggestive and submitted to the Detroit Convention in the hope that concrete action will result."

Following Mr. Bibbins' presentation of the resolution offered by the Chicago Committee, there was a general discussion which centered around the question of governmental supervision of reasearch. The resolution was first discussed by Dean A. A. Potter, who stated that while he believed The American Society of Mechanical Engineers should encourage reasearch, and while it is unquestionably the purpose of the Society to urge governmental recognition, it would nevertheless be a mistake to approve a resolution asking Congress to appropriate a certain amount of money to support research in certain types of institutions. He believed that The American Society of Mechanical Engineers should express its approval of all kinds of scientific and industrial research, but should not approve any specific bill.

Doctor Mees, Director of the Eastman Kodak Research Laboratory, then took the floor and stated that he was in accord with Dean Potter's remarks and did not believe in urging Federal research. It was a question whether Federal research was desirable. The leaders of industry were against it, and the advice that he would give to the Society—he was not a member of it—was to pay for its own research.

Several members of the Society who favored financial assistance on the part of the Government next presented their views and urged that the Society endorse any measure which would obtain an appropriation from the National Government for the benefit of such institutions as might be selected.

C. H. Bierbaum also discussed the resolution. A bill of the kind proposed was proper enough from a theoretical point of view, but from a practical point of view he did not believe anything worse could be done than to have Congress pass a bill for Federal research, for there would then be a most inefficient distribution of

(*Continued on page 718*)

[1] Engineer with Bion J. Arnold, Chicago, Ill., Mem.Am.Soc.M.E.

Suggested Formula for Rating Kerosene Engines

This and the Following Paper on Standards of Carburetor Performance, Together With the Discussion at the Gas Power Session of the Spring Meeting, Form a Timely Presentation of Subjects Dealing With Standardization of Internal-Combustion Engines

By D. L. Arnold,[1] Chicago, Ill.

At the present time there is no standard method of rating kerosene oil engines, and consequently engines of the same displacement are given different ratings by each manufacturer. A standard formula might therefore be of value and in this paper the writer discusses the various formulæ now in use and suggests that a piston displacement of 13,000 cu. in. per minute be taken as one brake horsepower. The subject of a standard nameplate is also discussed and a suggested form is given.

Among the various companies manufacturing kerosene engines there seems to be no uniform standard of rating in use, and as a result engines of the same bore, stroke and speed—or in other words, of the same piston displacement per minute—are given different ratings by almost as many manufacturers. In the past little attention has been paid to this minor detail, as it seems to have been considered, but the purchaser of engines and tractors has had much experience with this inconsistency. For instance, one buys an engine of 4 hp. that will actually develop 6.5 hp.; another buys one also rated 4 hp. but it will only develop 5 hp., and it will in all probability have a different piston displacement per minute. Apparently this means nothing as far as the customer is concerned, for in each case he receives more horsepower than he believed he was purchasing. A very great difficulty does arise, however, when these engines are judged by the amount of maximum work which they will perform in a given length of time, not on brake tests but on users' equipment, and the result is that the purchaser of the smaller engine is greatly dissatisfied, despite the fact that his engine will develop a 25 per cent overload.

TABLE 1 FORMULÆ NOW IN USE FOR FOUR-STROKE-CYCLE ENGINES

D = diameter of piston, in. L = length of stroke, in.
n = number of cylinders N = number of revolutions per minute

No.	Authority	Formula
1	N.A.C.C.[1] or A.L.A.M.	$\frac{D^2n}{2.5}$ (at 1000 ft. per min.)
2	E. P. Roberts	$\frac{D^2LNn}{18,000}$
3	French Automobile Club	$0.45\ D^2n$ (at 985 ft. per min.)
4	Royal Automobile Club, British	$0.405\ D^2n$
5	Royal Automobile Club, Swedish	$\frac{D^2LNn}{15,240}$
6	Prof. H. L. Collanders	$0.565\ D(D-1)n$
7	T. Thornycrofts	$\frac{D^2L^{0.75}n}{2700}$
8	M. Faroux	$0.121\ D^{2.4}L^{0.6}$
9	M. Arnon	$0.1\ D^2n$
10	E. W. Roberts[2]	$\frac{D^2LNn}{X}$

[1] Vol. 1, p. 30, S.A.E. Standards Data Sheets.

[2] Gas Engine Handbook, p. 131. X is a factor varying with the fuel and cycle. For 4-cycle engines X equals 16,000 for natural gas and 14,000 for gasoline.

The foregoing is only a sample case of the inconsistency which has resulted in many bills now being introduced, or about to be introduced, in state legislatures, specifying how an engine shall be rated. If these bills should all pass it might be that each state would reqnire a different rating, and thus the manufacturers would be obliged to furnish a different nameplate in each state. It would therefore seem advisable for the manufacturers to get together and adopt a standard rating for kerosene engines. If standard rating is to be of service, it must give equal protection to the manufacturer and the customer, and any formula which is obtained must therefore be based upon practice covering a sufficient period of time. Before taking up the proposed formula, however, the writer wishes to review some of the formulæ that are in use today and which are listed on Table 1.

Formulæ Now Used for Four-Stroke-Cycle Engines

The A.L.A.M. formula[1] is based on the assumption that there is developed within the cylinder a mean effective pressure of 90 lb. per sq. in., that the engine operates with 75 per cent mechanical efficiency, and that the piston speed is 1000 ft. per min. With ungoverned engines this formula is perhaps as good as any, but for engines operating with governors it is obvious that if a piston speed of other than 1000 ft. per min. is maintained, it will be necessary to make a correction to cover this point, in which event the formula is unwieldy and inconvenient.

An empirical formula[2] which is considered as very conservative practice when compared with the various ratings now used by engine manufacturers is as follows: B.hp. $= 0.00006042\ D^2LNn = V/13,000$. Before deriving this formula the writer compared the

Presented at the Spring Meeting, Detroit, Mich., June 1919, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and is subject to revision. Copies of the complete paper may be obtained at a nominal cost.

[1] Chief Engineer, Gas Power Engineering Dept., International Harvester Co., Chicago, Ill.

[1] Derivation of A.L.A.M. Formula:

Let HP_b = brake horsepower
HP_i = indicated horsepower
HP_r = rated horsepower
A = area of piston, sq. in.
D = diameter of piston, in.
E = mechanical efficiency (assumed at 0.75)
L = length of stroke, in.
n = number of cylinders
P = mean effective pressure, lb. per sq. in. (assumed at 90 lb.)
V = piston displacement per minute, cu. in.
N = revolutions per minute
s = piston speed, ft. per min. (assumed at 1000)

$$HP_b = HP_i \times E = \frac{1}{4}\ \frac{PAsNn}{33,000}\ E = \frac{90 \times 0.7854\ D^2 \times 1000 \times n \times 0.75}{4 \times 33,000 \times 12}$$

$$= \frac{D^2n}{2.489}, \text{ or for practical purposes, } \frac{D^2n}{2.5}$$

Also, since $s = \frac{2LN}{12}$

$$HP_b = \frac{90 \times 0.7854\ D^2 \times 2LN \times n \times 0.75}{4 \times 33,000 \times 12} = \frac{D^2LNn}{14,939} = 0.00006693\ D^2LNn$$

and substituting V for $0.7854\ D^2LNn$

$$HP_b = \frac{90 \times V \times 2 \times 0.75}{12 \times 33,000 \times 4} = \frac{V}{11,733}$$

[2] Derivation of Empirical Formula:

$$HP_r \text{ (recommended)} = \frac{0.7854\ D^2LNn}{13,000} = \frac{V}{13,000}$$

$$HP_r \text{ (transformed)} = \frac{D^2LNn}{16,550} = 0.00006042\ D^2LNn$$

ratings of 115 engines manufactured by 61 companies and found them to vary from 8,256 to 19,985 cu. in. per b.hp. Forty-six engines were rated using 11,000 cu. in. or less as 1 b.hp.; 29 used 11,000 to 12,000 cu. in.; 12 used 12,000 to 13,000 cu. in.; 10 used 13,000 to 14,000 cu. in. and 18 used above 14,000 cu. in.

It will thus be seen that 87 engines or approximately 75 per cent were rated as using less than 13,000 cu. in. per b.hp. and while this value may be more conservative than some manufacturers might wish to use, it gives a standard basis of comparison and allows the engine to develop a fair percentage of overload above its rating, since any engine should be able to develop as a maximum 1 b.hp. per 11,000 cu. in piston displacement per min. when the engine is in good condition.

At this time it seems desirable to compare this new formula with those already in use, and for that reason Table 2 has been compiled. It should be noted, however, that the table does not show the maximum horsepower that can be expected from an engine but has reference only to the rated brake horsepower which should be reasonably expected. If one engine can develop a higher maximum than another, or, in other words, can make good on a lower piston displacement per minute than its competitor, the credit is certainly due to the manufacturer who can consistently produce these conditions. However, practically all engines of correct design will develop a maximum horsepower according to the formula heretofore given, namely 1 b.hp. per 11,000 cu. in. piston displacement per minute.

TABLE 2 COMPARISON OF ENGINE-RATING FORMULAE

Formula No.	Authority		Expressed in piston displacement per minute	Expressed in terms of Roberts formula
1	N.C.C.C. or A.L.A.M.		$\frac{V}{11,733}$	$\frac{D^2LNn}{14,939}$
2	E. P. Roberts		$\frac{V}{14,137}$	$\frac{D^2LNn}{18,000}$
3	French Automobile		$\frac{V}{13,180}$	$\frac{D^2LNn}{16,781}$
5	Royal Automobile Club, Swedish		$\frac{V}{11,969}$	$\frac{D^2LNn}{15,240}$
10	E. W. Roberts	16000	$\frac{V}{12,566}$	$\frac{D^2LNn}{15,999}$
		14000	$\frac{V}{10,995}$	$\frac{D^2LNn}{13,998}$
		11500	$\frac{V}{9,032}$	$\frac{D^2LNn}{11,499}$
11	Rated Horsepower Recommendation		$\frac{V}{13,000}$	$\frac{D^2LNn}{16,550}$

With reference to the rating of four-stroke-cycle engines, it would seem best for all concerned that this rating should be made the nearest whole horsepower to that determined by the standard formula, it being a very easy matter to change the rated speed of the engine in order to accomplish the exact rating. In any event, however, the rated horsepower would not, if the foregoing condition is adhered to, vary more than plus or minus 0.5 hp.

Tractor-Engine Nameplates

Having established a standard rating for this class of engine, there should also be a standardized nameplate; to state the horsepower alone with no reference to speed is insufficient and misleading. This nameplate should be clear and concise, leaving no cause for doubt as to what is meant.

In considering the internal-combustion-engine rating we must also consider the tractor rating as the internal-combustion engine forms its power unit and the tractor rating is therefore dependent upon the engine rating. The owner of a tractor is not only interested in the amount of power that can be delivered by the engine but also in the amount that can be delivered to the drawbar at the different speeds. Here again, however, manufacturers have been inconsistent in the ratings which they have made. The majority of manufacturers have followed the rule that drawbar horsepower should be considered as 50 per cent of the rating of the power unit and in actual practice covering many years of experience this seems to be a very conservative figure to use. It is true that the tractor will often develop greater drawbar horsepower, but when taking into consideration the wide range of conditions through which the tractor must work, such as changes of soil and class of work, a 50 per cent rating for the drawbar pull seems on the whole to be the best value to use; therefore, on the tractor engines it would seem that the best nameplate would be one like that given above.

> 16 Brake HP at 500 RPM
> 8 Drawbar HP at 500 RPM of the engine
> Drawbar pull:
> —— lb., reverse speed at —— miles per hour
> —— lb., first speed at —— miles per hour
> —— lb., second speed at —— miles per hour
> —— lb., third speed at —— miles per hour
> Drawbar pull and HP are on the average good footing.

Formulæ Best Adapted to Rating Engines and Tractors

The following formulæ are those which it would seem are best adapted to the rating of internal-combustion engines and tractors:

$$\text{Rated engine horsepower} = \frac{0.7854\, D^2LNn}{13,000} \quad \ldots\ldots [1]$$

$$\text{Drawbar horsepower} = \frac{HP_r}{2} \quad \ldots\ldots [2]$$

$$\text{Drawbar pull,}^1 \text{ lb.} = \frac{375 \times HP_d}{S} \quad \ldots\ldots [3]$$

$$\text{Motor torque,}^2 \text{ in-lb.} = \frac{63,025.21 \times HP_b}{N} \quad \ldots\ldots [4]$$

Practical work in experimental testing laboratories and on regular test floors has proved that four-stroke-cycle engines operating on kerosene will develop for periods of two hours or more 1 b.hp. per 11,000 cu. in. piston displacement per min. and a few engines have for short periods of time developed 1 b.hp. for every 9800 cu. in. piston displacement per min. Therefore, making allowances for general wear, mishandling and improper adjustment, the four formulæ given in the preceding paragraph will be seen to be conservative and well adapted for the rating of this type of engine.

---

[1] Derivation of Drawbar Pull Formula:

Let F_d = drawbar pull, lb.
HP_d = drawbar horsepower
S = speed in miles per hour

$$\text{Then } F_d = \frac{HP_d \times 33,000 \times 60}{5280 \times S} = \frac{375\, HP_d}{S}$$

[2] Derivation of Motor Torque Formula

Let HP_b = brake horsepower
l = length of brake arm, in.
W = lb. pull at end of arm
N = revolutions per minute
T = motor torque, in-lb.

$$\text{Then } HP_b = \frac{2\pi\, lNW}{33,000}$$

$$T = \frac{HP_b \times 33,000 \times 12}{2\pi N}$$

$$= \frac{63,025.21 \times HP_b}{N}$$

Standards of Carburetor Performance

By O. C. Berry,[1] Lafayette, Ind.

The type of test which a carburetor is most frequently given to establish its merit or lack of merit is carried out in the following manner: An engine in good mechanical condition is tested, using a carburetor which bears a high reputation. These tests are then repeated, using the new carburetor, and its merits are thus reported in terms of the comparative performances of the engine. The results of these tests are valuable and convincing, and while they will always be the final criterion of carburetor performance, they fall a little short of the ideal in that they fail to show the reasons for the differences. Several writers have recently pointed this out and suggested that the performance of a carburetor should also be expressed in terms of its ability to perform those functions which are essential to proper carburation. In order to do this it will be necessary to determine these essentials. This is a difficult task, but its accomplishment should prove of great benefit. In this paper a list of the essential factors, as now understood, has accordingly been made and some experimental data are also presented which it is hoped will help to establish certain of the standards of performance.

Satisfactory carburation of a liquid fuel depends jointly upon the carburetor, the intake manifold, and the temperature of the combustion-chamber walls. These parts may therefore be considered the carburating apparatus and the headings under which are grouped the tests to determine the degree of excellence with which each of these parts performs its respective functions may all be listed together. These headings, expressed in the general order of their importance, are as follows:

a The range of flow-rate capacities, or, in other words, the maximum and minimum number of cubic feet of air per minute that can be handled

b The richness of the mixture as affected by: the rate of flow of the air through the carburetor; sudden changes in the rate of flow; the amount the throttle is open

c The pressure drop through the carburetor at different rates of flow

d The thoroughness and uniformity with which the fuel and air are mixed

e The uniformity of the richness of the mixture furnished to the different cylinders

f The temperature and dryness of the mixture entering the cylinders

g The temperature of the combustion-chamber walls, particularly the piston head.

The relative importance of these items is largely a matter of opinion and will be different under different conditions. For example, the capacity for handling large amounts of air is much more important in passenger cars than in trucks and tractors, while in tractors using kerosene the temperature of the mixture and combustion-chamber walls becomes comparatively much more important than it is in passenger cars burning gasoline.

Items To Be Investigated

Range of Flow-Rate Capacities. In passenger-car engines great importance is attached to flexibility, and the buying public would not consider a car that was notably defective in this respect. The power developed by an engine varies almost directly with the weight of air used per minute, and the carburetor must therefore be able to supply this air, properly mixed with fuel, through a wide range of flow rates.

The passenger car is expected to idle down to one or two miles per hour on high gear and at the same time have a maximum speed capacity well above 50 miles per hour. Few carburetors are capable of furnishing a proper mixture over so wide a range, although most carburetors are sold under claims of wonderful flexibility.

A carburetor is truly suited to an engine only when its flow-rate capacities correspond to the requirements of the engine, and this condition will be attained with the greatest certainty when the requirements of the engine and the capacities of the carburetor are both given in cubic feet of air per minute. It is therefore suggested that the flow-rate capacities of all carburetors should be stated definitely in cubic feet per minute, and that this information should always accompany the statement of the size of the carburetor flange.

With the carburetor adjusted so that the engine carries its full torque with open throttle, the air required per brake horsepower per minute will remain nearly constant irrespective of the amount of gasoline used or the speed of the engine. For the usual passenger-car type of engine with compression ratio of about 4 to 1 this constant is about 2.1 cu. ft. per min. at full power, and seldom exceeds 2.3 cu. ft. per min. The air used when idling at any speed is almost exactly one-quarter of that used under full load at the same speed. With these data, which are based upon the performance of the engines tested at Purdue, it is easy to compute the air requirements for any engine of the same type, for any torque and any speed.

Richness of the Mixture. The thermal efficiency of an engine at any speed and load is affected more by the richness of the explosive mixture than by any other factor. It is therefore highly important that the carburetor deliver the mixture to the engine in the proper proportions, at all speeds and loads. The richness of mixture giving the best power and the one giving the best efficiency must each be experimentally determined for various speeds and loads, so as to learn what effect a change in either will have on the mixture requirements of the engine. The temperature and the dryness of the mixture must also be varied to determine whether or not they affect the power or efficiency of the engine.

In the Purdue tests the richness of the mixture is expressed in pounds of gasoline per pound of dry air. With a dry mixture at half load and 1000 r.p.m., regular firing may be obtained with mixtures between 0.0575 and 0.12. The best efficiency under the same conditions accompanies a mixture of about 0.067, and the best power, 0.08. The method used in obtaining these results and a few of the characteristic curves will be presented at the end of this paper.

Pressure Drop Through the Carburetor. It is always necessary to have the gasoline in the float chamber of the carburetor at a lower level than the delivery orifice in order to prevent overflowing when the engine is not running, and the suction in the carburetor must be great enough to overcome this safety head before any gasoline will be delivered. The best attainable condition, therefore, will be to have just enough vacuum in the carburetor to cause a satisfactory flow of fuel and air, and no more. Because of the influence of volumetric efficiency on engine capacity the importance of a small carburetor vacuum is very great.

Thoroughness of the Mixing. The thoroughness and uniformity with which the fuel is mixed with the air is important. One of the greatest helps in reducing the fuel to a gas is to atomize it thoroughly and mix it with the air. This gives the fuel a large amount of exposed surface and helps to bring all parts of the mixture up to the same degree of saturation.

The mixture in all parts of each individual cylinder must be uniform and the fuel reduced to a gas at the end of the compression stroke or else the combustion will not be complete, thus lowering the power and efficiency of the engine and causing uneven running. Therefore, if the engine runs with a regular and even exhaust, the thoroughness of the mixing is probably good

[1] Professor of Mechanical Engineering, Purdue University.

Presented at the Spring Meeting, Detroit, Mich., June 1919, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and is subject to revision. Copies of the complete paper may be obtained at a nominal cost.

along with all of the other factors influencing engine performance. The best direct test of the quality of the mixing is to have the carburetor discharge into a section containing glass placed between the carburetor and manifold. The best dry mixtures appear as colorless and dry as pure air, while wet mixtures resemble a fog, and in most cases streams of liquid fuel are seen following a spiral path along the walls of the manifold.

Uniformity of Mixture to All Cylinders. The richness of the mixture entering the various cylinders often differs widely, especially when very wet mixtures are used. Some manifold designs also aggravate this condition. The results attained by any given manifold may be tested by removing the exhaust manifold and observing in comparative darkness the flames from the exhaust openings. By adjusting the carburetor for continuously leaner mixtures the impoverished cylinders will be caused to miss, and then by gradually enriching the mixture the yellowish flame will indicate the cylinder with the rich mixture.

Temperature and Dryness of the Mixture. With the rapidly increasing difficulty in vaporizing the commercial liquid fuels, the temperature of the mixture becomes a more and more important consideration. Before the fuel can be burned it must be vaporized, and this requires both heat and time. The mixture should be dry and thoroughly mixed at the end of the compression stroke in order to get good combustion, and the gas temperature should be as low as possible at the end of the suction stroke, in order to keep up the volumetric efficiency. It is therefore desirable to make the fullest possible use of the heat in the combustion-chamber walls, piston head and compression, and to introduce the mixture into the cylinder as wet as possible and still be sure of having it dry before it is burned.

It is possible to compute approximately the change in power that will accompany a definite change in the temperature of the mixture furnished to the engine. The computation is based upon the fact that the density of a gas varies inversely as its absolute

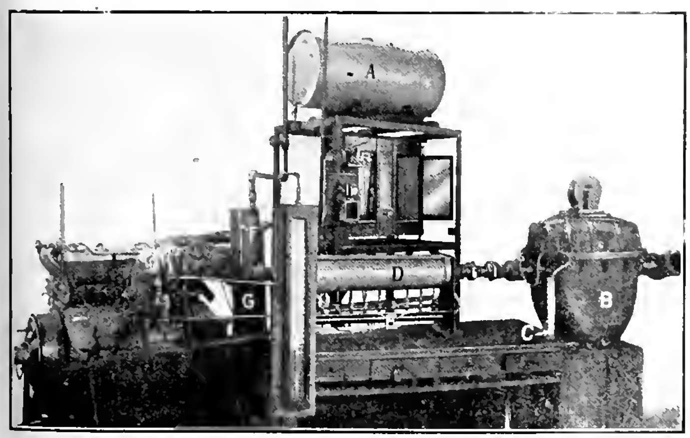


Fig. 1 Willys-Knight Engine and Equipment for Testing Its Carburetor

A, gasoline tank; *B*, air meter; *C*, manometer; *D*, heater; *E*, gas jets; *F*, thermometer; *G*, water tank

temperature. Since the power generated in the cylinder varies almost in direct proportion to the weight per minute of the mixture used, it will vary almost in the inverse ratio of the absolute temperatures of the mixtures. As an illustration, suppose the engine will develop 12.5 hp. when the mixture has a temperature of 250 deg. fahr. What will it develop when the temperature is 60 deg. fahr.? The power times the inverse ratio of the mixture temperatures is as follows:

$$12.5 \times \frac{460 + 250}{460 + 60} = 17.06$$

This indicates that 17.06 hp. is to be expected with the 60 deg. fahr. mixture. As a matter of fact, the temperature in the cylinders at the end of the suction stroke rather than the intake manifold temperature determines the density of the charge, but this temperature cannot be measured. Again, the indicated rather than the brake horsepower is the one that varies with the density of the charge, while the brake horsepower is the one that is usually measured. These are the main reasons why the results obtained are only approximately correct. The figures given are from two Purdue tests run at the same speed with the same throttle orifice, and the power was increased from 12.5 to 16.0 instead of 17.06 b.hp.

The task of determining the best method of introducing into the mixture the heat for vaporizing the fuel is both important and difficult and will require considerable careful experimentation. The Purdue tests with the "hot spot" warrant the conclusion that it is superior to any method of preheating the air, in that it dries the mixture sufficiently at lower temperatures and, therefore, does not decrease the power of the engine so much. These tests also indicate that the design of the hot spot is still in need of experimental development.

Temperature of the Combustion Chamber. When the mixture is dry as it enters the cylinders, or the fuel so well atomized that it remains suspended in the air and is entirely vaporized during the compression stroke, the heat absorbed from the combustion-chamber walls does not improve the carburation, but decreases

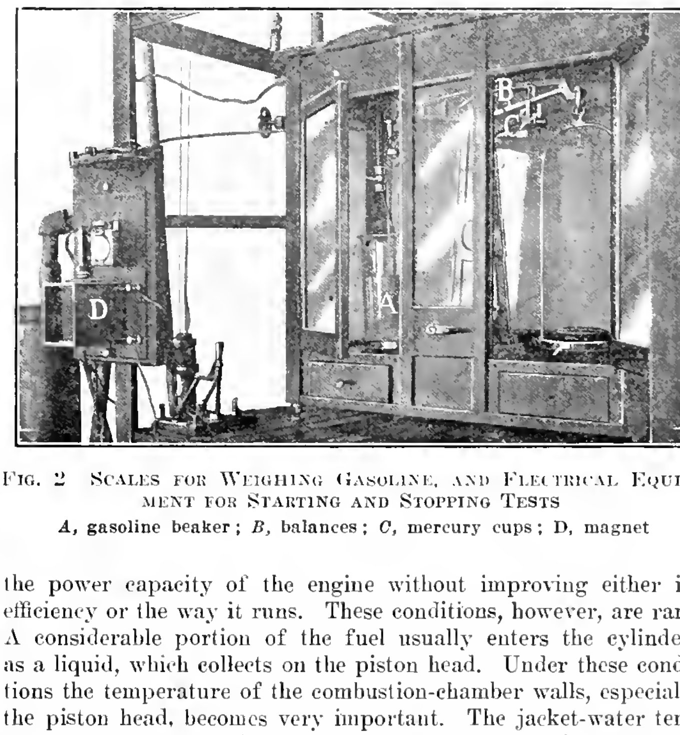


Fig. 2 Scales for Weighing Gasoline, and Electrical Equipment for Starting and Stopping Tests

A, gasoline beaker; *B*, balances; *C*, mercury cups; D, magnet

the power capacity of the engine without improving either its efficiency or the way it runs. These conditions, however, are rare. A considerable portion of the fuel usually enters the cylinders as a liquid, which collects on the piston head. Under these conditions the temperature of the combustion-chamber walls, especially the piston head, becomes very important. The jacket-water temperature should therefore be kept high when the piston head is depended upon to flash any considerable amount of liquid fuel into a gas. This conclusion is borne out by the engine tests. With the air entering the carburetor at 70 deg. fahr. and the jacket water maintained at 110 deg., the engine would not fire regularly with any richness of mixture. When the jacket-water temperature was raised to 200 deg. fahr. the engine would fire some of the richer mixtures regularly, and by raising the air temperature to 80 deg. fahr. the engine developed full power and efficiency and would fire a wide range of mixtures.

The Purdue Tests

The tests at Purdue University were carried out on a Haynes Light Six and a Willys-Knight four-cylinder engine, mounted on a Diehl electric dynamometer. Fig. 1 shows the Knight engine mounted ready for a test. Fig. 2 gives a more detailed view of the scales and the electrical apparatus for starting and stopping the tests. The supply of gasoline is piped from tank *A*, Fig. 1, into a 2-qt. glass vessel placed in one of the scale pans. This is shown at *A*, Fig. 2. In order to give the balances freedom of motion, the gasoline was siphoned from this vessel to the carburetor. The balances *B*, Fig. 2, were capable of weighing the

gasoline to the one-hundredth part of an ounce, and were equipped with wires dipping into mercury cups C, Fig. 2, which completed an electric circuit just when a balance was reached. The hand on the dial of the air meter was equipped with an electrically operated clutch and brake, the stop watch was operated by a strong magnet D, Fig. 2, and the revolution counter on the end of the dynamometer shaft was electrically operated. By these means, when the scales came to a balance they would start the stop watch, the revolution counter and the recording hand on the air meter and ring a gong. Weights corresponding to the gasoline to be used were then removed from the scale pan, and when the scales again came to a balance the recording apparatus was electrically stopped, making it possible to time all of the readings together and make the record at leisure from instruments that were standing still.

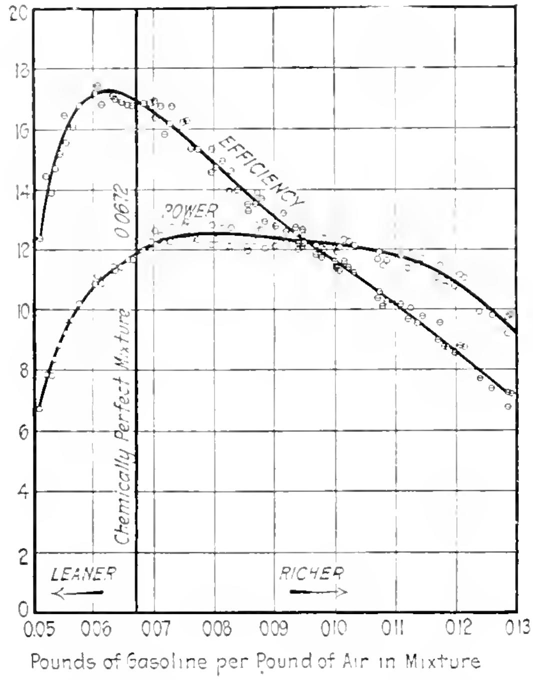


Fig. 3 Power and Efficiency Curves of Willys-Knight Engine

Throttle set for half-load. Speed, 1000 r.p.m. Cooling-water temperature, 200 deg. fahr.

The air was metered through an Emco No. 4 gas meter B, Fig. 1, reading to cubic feet, so that tenths of a cubic foot could be estimated. The drop in pressure through the meter was indicated by the water manometer C, Fig. 1. The barometer and the wet and dry-bulb readings on a hygrometer were taken periodically, so as to be able to determine the pounds of dry air used in each instance.

The meter was connected by rubber tubing to a heater D, Fig. 1, made up of 4 ft. of 3-in. wrought-iron pipe surrounded by an asbestos cylinder with a space between large enough to allow the pipe to be heated by the flames from the gas burners E. The exit air temperature was indicated by the thermometer F whose bulb was exposed directly to the air inside of the pipe. The temperature of the air could be regulated within close limits by careful adjustment of the gas flames. In some instances a section containing glass was inserted between the carburetor and engine, which offered ample opportunity to observe the character and behavior of the mixture inside.

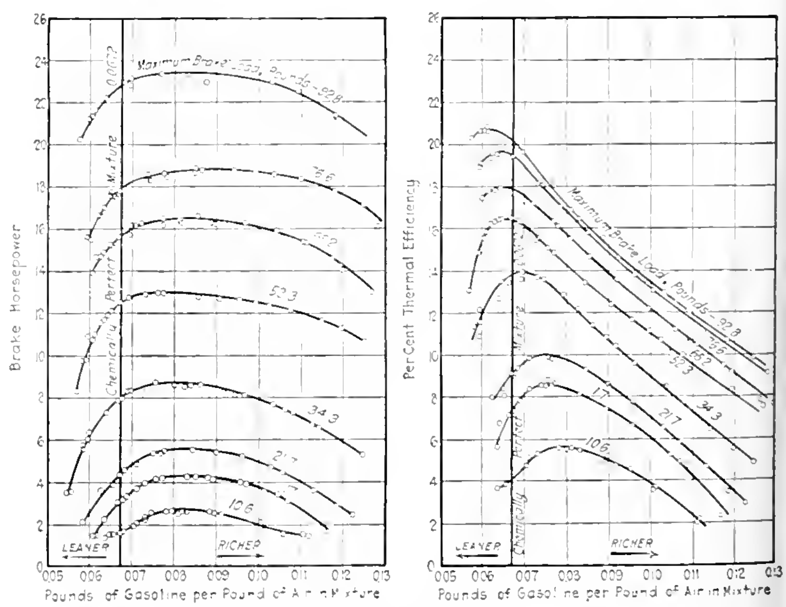
The speed of the engines was read on a tachometer as well as being computed from the stop-watch and revolution-counter readings. The torque developed by the dynamometer was weighed by means of a sensitive set of Fairbanks scales. This is the same as the brake load on the engine, thus making it possible to compute the power developed by the engine to a satisfactory degree of accuracy.

The object of the first series of tests was to determine the effect of changing the richness of the mixture on the performance of an engine. It was planned to determine the mixture that would give the best power, the one for the best efficiency and the range of mixtures that could be fired regularly.

Accuracy of Results

The vertical line in Fig. 3 (at 0.0672) represents the chemically perfect mixture, or the one in which there is just enough oxygen in the air to burn the fuel and no excess of either fuel or air exists. The curves show that the engine will run with a mixture as lean as 0.05 lb. of gasoline per lb. of air, but will not pull well with so lean a mixture. The test log shows that it misses frequently at this power, but that the performance becomes better as the mixture is made richer, until at 0.055 it fires every cylinder regularly. The best efficiency is obtained at 0.063, when the engine is developing 91 per cent of its maximum power capacity with this orifice at 1000 r.p.m. The best power accompanies a mixture of about 0.08, at which point the thermal efficiency has dropped from 17.25 to 14.8 per cent. The richest mixture that can be fired regularly is about 0.1275, but the engine will run with mixtures as rich as 0.135. Nearly full load can be carried with a mixture as lean as 0.065, or as rich as 0.115. In other words, a carburetor can be adjusted with as lean a mixture as can be used to carry full load and the amount of gasoline can be nearly doubled without greatly affecting the power developed or the smoothness of running of the engine.

In applying the information obtained from these tests to other conditions it must be remembered that these results are for half-load at 1000 r.p.m. when a warm mixture was used that was dry as it left the intake manifold. Before applying the conclusions to other conditions, one must learn the effect of the load carried, the speed and the temperature and dryness of the mixture upon the mixture requirements, power and efficiency of an engine.



Figs. 4 and 5 Power and Efficiency Curves of Willys-Knight Engine

Throttle set for various loads. Speed, 1000 r.p.m. Temperature, air to carburetor, 150 deg. fahr. Cooling water temperature, 120 deg. fahr.

Effect of Load Upon Mixture Requirements

Figs. 4 and 5 show the power and efficiency curves taken from the Willys-Knight engine running at 1000 r.p.m., but with different throttle orifices. During these tests the temperature of the air entering the carburetor was kept at about 150 deg. fahr., and the cooling water at about 120 deg. fahr. This was true of all of the curves excepting the one for 92.8 lb., in which case the mixture was heated up to 125 deg. fahr. in a "hot spot" and the

cooling-water temperature was 160 deg. fahr. Fig. 4 shows that the mixture giving the best power at a fixed throttle setting does not vary with the brake load carried, but remains constant at about 0.08. At light loads the engine will not operate well with as wide a range of mixtures as it can use when carrying more nearly its full capacity. Fig. 5 shows that with light-load throttle settings the mixtures for best power and best efficiency tend to coincide, but as the brake load is increased the mixture for best efficiency becomes continuously leaner, until at full load it is 0.062. In the case of the higher brake loads the engine will hit regularly and run smoothly with the lean mixtures which give the high efficiencies, but the power developed is reduced considerably below the highest attainable at that throttle setting. The most satisfactory mixture for general use at or near full load will therefore be approximately 0.067, giving almost full power and nearly the best efficiency. For higher pulling conditions the mixture had better be caused to approach 0.08, the one for best pulling.

Effect of Speed Upon Mixture Requirements

In Fig. 6 is shown a set of curves taken from tests on the Haynes Light Six engine. The curves show that the mixture giving the best power is not noticeably affected by changes in speed, but that at high speeds the engine cannot hold up its power with quite as much excess fuel as at lower speeds. The data sheets show that the mixture for the highest efficiency also remains unchanged.

Effects of Changing Air Temperatures

Figs. 7 and 8 show a series of curves taken from the Willys-Knight engine with air furnished to the carburetor at temperatures varying from 80 to 275 deg. fahr. They show that 80 deg.

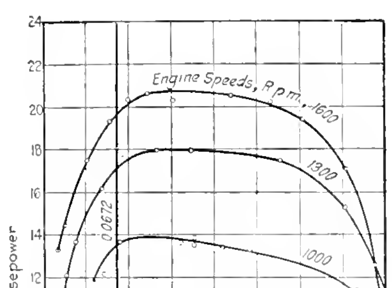
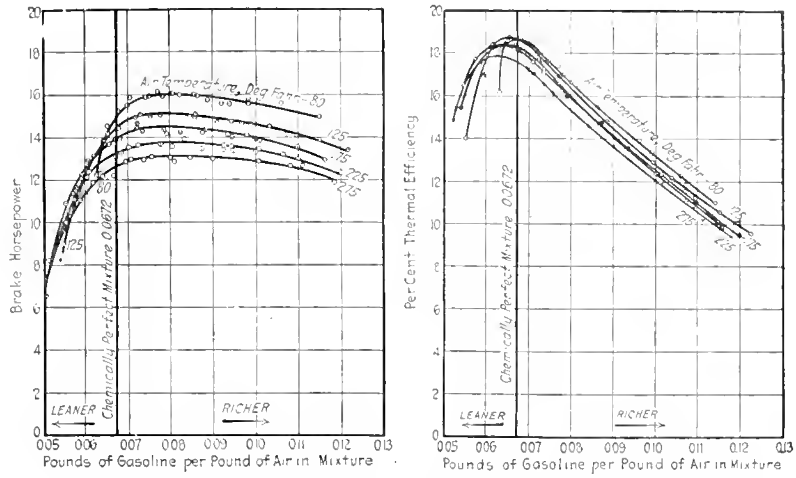


FIG. 6 SPEED CURVES OF HAYNES LIGHT SIX ENGINE
Throttle set for half load. Temperature, air to carburetor, 100 deg. fahr. Cooling-water temperature, 130 deg. fahr.

fahr. air gives the most power and the best efficiency, but that at so low a temperature the engine is unable to use the lean mixtures. Each increase in the air temperature decreases the power of the engine. Up to 150 deg. fahr. the ability of the engine to use the lean mixtures also increases. From 150 to 300 deg. fahr. air temperatures the engine develops its best ability to hit regularly and run smoothly with the lean mixtures, firing every cylinder with a mixture as lean as 0.055. Fig. 8 gives the efficiency curves. The best efficiencies at 80 and 125 deg. fahr. are nearly exactly the same, 18.75 per cent, but at 80 deg. fahr. it accompanies a mixture slightly richer than for 125 deg. fahr. Each increase in temperature between 125 and 275 deg. fahr. decreases the efficiency slightly. At 150 deg. fahr. the mixture for the highest efficiency reaches its leanest point, 0.063, and remains the



FIGS. 7 AND 8 HEATED-AIR TEST CURVES, WILLYS-KNIGHT ENGINE
Throttle set for half load. Speed, 1000 r.p.m. Cooling-water temperature, 200 deg. fahr.

same up to 275 deg. fahr. The effects of increasing the temperature of the air entering the carburetor above 80 deg. fahr. are therefore to decrease the power capacity of the engine considerably and its efficiency slightly, but to make it fire regularly when using leaner mixtures.

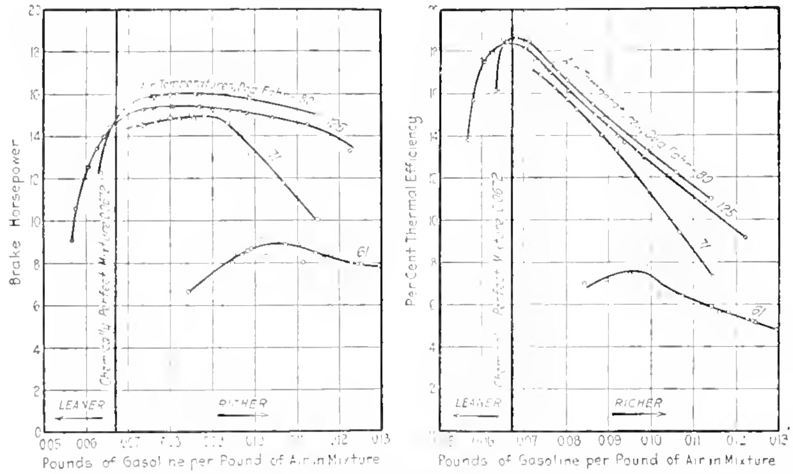
Figs. 9 and 10 show the curves for the same series of tests, but with colder air temperatures. Fig. 9 shows that with an air temperature of 61 deg. fahr. the engine could use only the comparatively rich mixtures and its power capacity was greatly reduced. When the air temperature was increased to 71 deg. fahr. the power was brought nearly up to maximum, but still the engine could not fire the leaner mixtures with regularity. Fig. 10 shows that the efficiency for the 61 deg. fahr. air is very poor, while the 71 deg. fahr. air was much better but the engine stopped before it reached a lean enough mixture to give the best results. It may therefore be seen that 80 deg. fahr. is about the lowest temperature at which the air may be drawn into a carburetor when using Red Crown power gasoline, to get good carburation in an engine having a 200 deg. fahr. cooling-water temperature. If the cooling-water temperature is lowered the temperature of the air will have to be raised correspondingly, while raising the quality of the gasoline will improve the performance with cold air, cool water or both.

The Hot-Spot Tests

Figs. 11 and 12 show curves taken from the Willys-Knight engine using a "hot spot" between the carburetor and the intake manifold. This hot spot was designed to flash the liquid fuel into a gas while heating the air as little as possible. The curves show that by using the hot spot the engine is able to fire the lean mixtures without in turn lowering either its power or its efficiency. The explanation is that the factor controlling the power of the engine is the weight of air that can pass through the throttle orifice in a given time. The air always being cold when it passes this point, the power is not affected by the heat. This is always true for a throttled condition, but as the throttle is opened and the manifold or valves become the limiting factors in the production of power, the advantage of the hot spot decreases, but it does not disappear. It is therefore clear that the method of introducing heat into the mixture by means of a hot-spot is superior in every way to the hot-air method, and particularly so when the engine is throttled down.

Conclusions

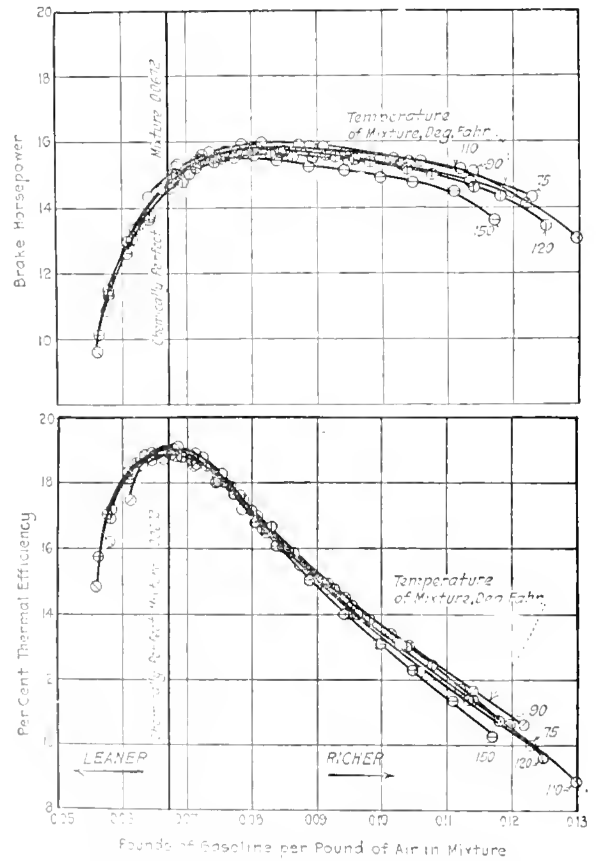
It may be well to again point out the importance of judging the merit of a carburating system in terms of the degree of thoroughness with which the system performs those functions which



Figs. 9 and 10 Cold-Air Test Curves, Willys-Knight Engine

Throttle set for half load. Speed, 1000 r.p.m. Cooling-water temperature, 200 deg. fahr.

are necessary to proper carburation. It is hoped that a discussion of the topic will result in establishing specifications for these tests, and that many may join in the task of carrying out the experi-



Figs. 11 and 12 "Hot Spot" Test Curves, Willys-Knight Engine

Throttle set for half load. Speed, 1000 r.p.m. Cooling water temperature, 200 deg. fahr.

ments that will determine the standards of performance in each case. Tests are needed showing the richness of mixture that will give the best power and the one for best efficiency when using liquid fuels other than gasoline. It would also be interesting to extend the gasoline tests to include wider ranges of speed and higher compression.

The problem of determining the best method of introducing into the mixture the heat necessary to vaporize the fuel is one of great importance, especially in connection with the heavier fuels. As a part of this problem it will be interesting to determine the actual temperatures found in the metal of the piston head and cylinder walls of automobile, truck and tractor engines, and how these temperatures affect the carburation.

The fullest discussion of these problems and the methods employed at Purdue in attacking them is earnestly solicited, and any suggestions in connection with carrying out this line of investigations will be received most gratefully by those in charge of the Purdue Engineering Experimental Station.

Acknowledgments

The experimental work presented in the foregoing paragraphs was carried out in the laboratories of Purdue University under the direction of the Purdue Engineering Experiment Station, and has received throughout the personal attention and encouragement of Prof. G. A. Young, Head of the School of Mechanical Engineering. Most of the tests were carried out and the computations made by Mr. C. S. Kegerreis, Research Assistant. It is hoped that the Experiment Station will have a bulletin on carburation ready for distribution by early winter, and it is planned to present in this bulletin a detailed report of the work which has been summarized in this paper, and also to include such other data as are then available for publication. When available, copies of this bulletin may be obtained by addressing C. H. Benjamin, Director of the Engineering Experiment Station, Purdue University, Lafayette, Indiana.

Although there is scant information on the service and cost of treated roof timbers in cotton mills, paper mills, and other buildings where high humidity causes rapid decay, a number of preservative treatments which it will undoubtedly pay to use may be suggested.

The steeping process consists merely in soaking the timber in a water solution of a preservative such as zinc chloride, sodium fluoride, or mercuric chloride. The wood must be thoroughly seasoned. It is left in the solution 1 day for each inch in thickness and 1 additional day. After treatment, the timber should be air dried before using. Specific directions for the use of this process (and they are especially necessary for handling mercuric chloride) may be secured from the Forest Products Laboratory, Madison, Wis. Zinc chloride attacks lead paints, but is very desirable otherwise. Mercuric chloride is very effective, but is poisonous and has a decided corrosive action on steel, so that steel tanks cannot be used with it. Sodium fluoride does not attack paint, is not corrosive, and in most other respects is very desirable.

Timbers may be coated with coal-tar creosote by a brush treatment, by dipping in hot oil for 5 to 15 minutes, or the hot- and cold-bath method. This last method consists in submerging the lumber in hot oil for several hours and then either allowing the oil to cool down slowly with the wood in it or plunging the wood into cool oil and leaving it for several hours.

Although pressure treatments are the most expensive, they are the most effective because they result in the greatest absorption and penetration of preservative. Roof planking should receive 8 to 12 lb. of creosote per cubic foot, or 0.5 lb. of the salt if zinc chloride is used. Such treatment should add at least 20 years to the life of roof plank.

Whenever it becomes necessary to cut into treated timber, the untreated wood exposed by cutting should be given two brush coats of creosote or some other preservative.—Technical Notes No. A-3, Forest Products Laboratory, U. S. Forest Service, Madison, Wis.

DISCUSSION AT GAS POWER SESSION OF SPRING MEETING

THREE papers were read and discussed at the Gas Power session of the Spring Meeting, held on the morning of Wednesday, June 18, under the auspices of the Sub-Committee on Gas Power, Prof. W. T. Magruder presiding. The titles of the papers were: Crude Oil Motors versus Steam Engines in Marine Practice, by J. W. Morton; A Suggested Formula for Rating Kerosene Engines, by D. L. Arnold; and Standards of Carburetor Performance, by O. C. Berry. Mr. Morton's paper appeared in the July issue of MECHANICAL ENGINEERING (p. 609) and consisted of a discussion of the various factors to be considered in choosing the form of motive power for war vessels and cargo ships, together with a presentation of the advantages as compared to steam engines of high- and low-powered oil motors of both the constant-pressure and constant-volume type. The relative values of four-stroke cycle, two-stroke cycle, double-acting, and horizontal oil motors were also compared and some details of their construction such as lubrication systems, piston cooling and scavenging pumps were analyzed. The papers by Messrs. Arnold and Berry will be found elsewhere in this issue.

DISCUSSION OF MR. MORTON'S PAPER ON CRUDE-OIL MOTORS VS. STEAM ENGINES IN MARINE PRACTICE

LOUIS ILLMER[1] (written). In the paper under discussion, Mr. Morton apparently favors the four-stroke oil engine and appears to give insufficient credit to the recent advances made in heavy-duty two-stroke engine design as applied to the merchant-marine service.

Undue complication of mechanism is probably chiefly responsible for the slowness on part of the American shipbuilder in adopting the oil engine for the propulsion of large cargo ships, since each additional vital moving part adds to the first cost, the liability to accident and the overhauling required for maintenance of operating efficiency.

Other things being equal, the oil engine with the least number of vital working parts will most adequately meet the demand for reliable low-cost power, particularly so under American conditions of high labor and relatively low fuel costs.

It is conceded that a perfected oil engine of the two-stroke type admits of the simplest possible construction for marine propulsion. The four-stroke marine engine suffers from inherent difficulty in reversing the mechanically operated inlet and exhaust valves as driven from the half-speed cam-shaft drive. Furthermore, the long-stroke slow-speed engine of the four-stroke type does not compare favorably in weight, floor space or in first cost with the cargo-ship type of two-stroke engine.

With but a single power impulse per cylinder for every two revolutions, the heavy power parts of a four-stroke engine do not work to advantage during the idle inlet- and exhaust-stroke periods. Hence the two-stroke engine is enabled to show a decided weight reduction and consequent lowering in first cost. For example, a six-cylinder slow-speed two-stroke engine suitable for cargo-ship propulsion can readily be made to deliver approximately 1¾ times as much shaft power for the same weight and floor space as will a four-stroke oil engine of the same speed and bore. This advantage is of decided importance when large merchant ships are to be engined, since the usefulness of such a prime mover is determined in a large measure by the ultimate power capacity to which a compact six- or eight-cylinder unit can be built.

Another advantage of the two-stroke engine is that it requires no mechanically operated inlet and exhaust valves. The cylinders of such oil engines are best charged from the under side of the power piston, through inlet poorts overrun by the piston. If desired, the scavenging air supply may be supplemented by additional low-pressure pumps but this is not essential when liberally proportioned injection-air compressors are provided.

With this mode of charging a two-stroke cylinder, the timing events of the inlet and exhaust ports must be correctly proportioned and the shape of the piston deflector lug must be properly designed to produce effective scavenging of the power cylinder, otherwise the incoming fresh-air charge will blow out of the exhaust ports without displacing the burnt products of combustion. Deficiency in oxygen for combustion of the fuel oil has been responsible for the failure of a number of two-stroke engine designs.

The described mode of charging two-stroke power cylinders reduces the valve gear parts to a minimum and requires only one air starting valve and one fuel valve opening into each cylinder head. Since these valves run in unison with the piston movements, they may be eccentric-driven and reversed by a Stephenson link in the manner of a steam-engine gear. The elimination of the half-speed cam-shaft drive is a feature of the two-stroke engine that makes for a simple and compact reversing valve gear.

While the thermal efficiency of a well-designed two-stroke engine is not quite as high as that of a four-stroke engine, the difference is not large. Most of the loss of economy is chargeable to the increased pump work required to charge the power cylinder, but the relatively small gain of about 10 per cent in brake efficiency in favor of the four-stroke engine is not in itself sufficient to offset the other advantages which a perfected two-stroke engine affords.

A good two-stroke engine is somewhat more difficult to design than a four-stroke engine, partly because of the greater heat flow through the cylinder walls. For equal bore dimensions, the rate of heat flow in a two-stroke engine is approximately 1.6 times that in a four-stroke engine running at the same speed.

The limiting rotative speed at which an oil or gas engine may be safely run is largely determined by the temperature assumed by the cylinder-bore wall, and if this is not kept within prescribed limits, troubles from piston lubrication and cracking of cylinder parts will result.

The temperature head required to drive heat at a given rate of flow through the cylinder wall increases with the wall thickness. For equal shaft power the bore dimensions of a four-stroke oil engine are about 4/3 those required for a two-stroke engine. Allowing for the thicker four-stroke cylinder wall and assuming equal rotative speeds, the rate of heat flow in the case of the two-stroke engine should not exceed 5/4 that obtained in a four-stroke cylinder of equal power capacity.

In high-speed marine oil engines, which are usually worked up to their limiting rate of heat flow, the four-stroke cycle offers some advantage. On the other hand, the relatively slow speed demanded for cargo-ship engines is exceptionally favorable to the two-stroke type, since these engines operate under heat-flow conditions so moderate as to allow ample cooling of all vital parts even in the largest-sized cylinders. It is therefore readily possible to keep the bore-wall temperatures of such two-stroke engines well below the critical limits required for safe and reliable running. To further safeguard against fatigue and breakdown, it is advisable to provide for liner cylinders and such other constructive features common in high-powered oil-engine practice, so as to give the cylinder parts the requisite long life and complete immunity against cracking.

The greater frequency of impulse and the consequent more even turning effort of the two-stroke engine largely improve the speed control and reduce to a minimum the flywheel effect needed for a smooth-running marine engine.

Still another feature of the two-stroke cycle that gives promise for rapid future development, is its special adaptability to the hot-bulb type of engine.

Judging from the recent trend of marine oil-engine developments, it now appears that a combination of the constant-pressure Diesel cycle with the hot-bulb constant-volume cycle is likely to overcome the defects of both parent types. The resulting cycle is especially suited to meet American oil-engine requirements, since the lowering of the maximum Diesel working pressure to approximately that used in the automobile engine will increase the reliability of operation.

The constant-volume or explosive engine, when working with

[1] Gas Engine Expert, American-Whaley Engine Co., Boston, Mass., Mem. Am.Soc.M.E.

a compression pressure of about 250 lb. per sq. in., shows a thermal shaft efficiency but little inferior to that of the Diesel engine. By further reducing the compression to about 150 or 175 lb. per sq. in. the fuel economy of the explosive engine is but slightly sacrificed, while for a given size of crankshaft the weight and cost relations as taken upon the power-output basis show a considerable improvement as compared with the high-compression engine.

An engine operating with the combined type of cycle should be provided with an efficient timed spray valve for the fuel-oil injection, and in large engines this should preferably be of the air-injection type used for Diesel engines.

When working with such limited compression, self-ignition may best be obtained by holding a portion of the products of combustion from stroke to stroke within a water-jacketed vaporizer chamber, without, however, requiring the use of a hot plate. The trapped hot burnt gases may then be used to preheat the air that is pressed into the bulb chamber to a point where it is capable of promoting self-ignition of the injected fuel oil. This sets up a light explosion at constant volume, after which the remaining oil may be gradually fed into the power cylinder in the manner of a Diesel engine.

While the water-cooled bulb will not of itself start the engine from the cold, it does not require an external flame; instead it is only necessary to preheat the small amount of air enclosed within the vaporizer chamber, which may readily be done by means of an electric coil heater or spark plug. After the first few explosive charges are thus ignited, the required heat transfer takes place from stroke to stroke to make the engine self-igniting.

The jacketed vaporizer is especially applicable to oil engines of the single-acting type, the bulb chamber being preferably formed centrally in the cylinder head about the cylinder axis. The timed fuel valve can then be made to inject straight through the bulb chamber and directly against the hot piston head. This arrangement gives the nozzle considerable distance for proper spray formation before striking the piston top, after which the oil charge spreads out over the piston-head surface and intimately mixes with all the air throughout the combustion chamber.

Finally it is pointed out that this late development in true semi-Diesel engines is especially suited to the two-stroke-cycle engine. In the four-stroke engine considerable constructive difficulties are involved in placing the mechanically operated inlet and exhaust valves about the water-cooled vaporizer chamber. Furthermore, in a two-stroke engine the vaporizer chamber may be kept at a smaller size with respect to the piston displacement, due to the fact that the confined hot gases have less chance to cool off between power impulses.

These and other advantages previously cited would indicate that a two-stroke semi-Diesel engine along the lines discussed should in the near future find favor for the propulsion of merchant ships and be capable of fully establishing the inherent possibilities of a slow-speed oil engine for marine service.

W. D. Ennis[1] (written). The value of this paper would be increased if the author would add particulars regarding the motors used. The mean effective pressures range from 87 to 91 lb. per sq. in., values often surpassed by stationary Diesel engines. Apparently the cylinders are the ordinary 4-cycle single-acting form, but there seems to be no statement of the fact.

A chief argument in favor of the crude-oil motor appears from Table 2, where "repeat orders" in 1916 are quoted for lines which began with this construction in 1912. What has happened since 1916?

It is to be assumed that the eight factors listed in the second paragraph are not presented as a complete list. In fact, the author refers to others, admitting a shorter life for the crude-oil motor and referring to the absence of sufficient data on maintenance costs. He also discusses what is almost an overwhelming disadvantage for any but slow-speed cargo ships, the multiplicity of cylinders. The largest cylinder in Table 2 is below 30 in. bore and develops only 333 hp. The largest plant listed is 4000 hp.

[1] Acting Professor of Mechanical Engineering, Columbia University, New York. Mem. Am.Soc.M.E.

It is doubtful whether steam can ever be eliminated in naval practice. Requirements for heating, humidifying and evaporators do not tend to decrease. It is even proposed now to use steam heat for submarines. It is difficult for internal-combustion engines to displace steam where they cannot displace it completely.

Table 1 is obviously based on coal fuel for steam. If oil fuel is used, the ratio R directly following the table becomes about 2.0 instead of 7.4.

Forrest E. Cardullo[1] characterized the adoption of the Diesel and analogous cycles as a standard as an advance too far in the direction of theory. He said he knew of no reason why a satisfactory producer for gasifying oil could not be designed which would operate continuously at 90 per cent efficiency or even higher. He referred to the number of times a plant operating Diesel or semi-Diesel engines must be laid up in order to clean out the engines. The practical weight of experience, and of actual reliability and cheapness, he believed, was in favor of the oil-type gas-producer fuel. Lewis H. Nash concurred in the idea of adopting the principle of gasifying oil in some type of gas producer.

Henry B. Oatley,[2] referring to Table 1 in which Mr. Morton presented the comparative weights of power plants in steamships and motorships, said that in the comparative installations aboard the U. S. S. *Maumee* and *Tioga*, steam and motor-driven ships, respectively, the Diesel-engine plant weighed decidedly more than the steam plant. The difficulties of getting high pressure and the limitations of superheaters of which the author spoke while discussing the heat elements of temperature range for the various types of engines existed, according to Mr. Oatley, only in the present motor designs, but he saw no difficulty in the further development of the types which have been successfully operated at pressures as high as 500 or 700 lb. per sq. in. Thus, with higher pressures and with higher degrees of steam temperature the boiler plant, in point of weight and size, would become markedly smaller, and the contrast in point of space occupied aboard the ship for the steam plant as compared to the motor plant would decrease, possibly to the point of being on a par. Mr. Oatley further criticized the argument advanced for preferring the motorship over the steam-driven ship by reason of the depreciation of the hull because of the sulphur content of coal and the amount of coal space required in the steam-driven ship, on the ground that rapid progress had been made in the utilization of oil as fuel for steam-driven ships, and that this practice would in all likelihood continue to increase.

O. C. Berry,[3] commenting on Mr. Cardullo's suggestion of gasifying oil in some type of gas producer, mentioned that in experiments conducted at Purdue University for the purpose of finding the best means of introducing into the mixture the heat required to vaporize the liquid fuel, it had been concluded that two elements are required to get the mixture in a burnable condition. In the first place, the temperature of the mixture must be hot enough to maintain in the liquid fuel sufficient vaporizing pressure so that the fuel, once reduced to a vapor, will stay in a vaporized state and get into the cylinder as a vapor and not a liquid. The other was the time element. Because of the smallness of this time element, though the temperatures are hot enough to maintain the required temperatures, still the mixtures retain their wet condition when they arrive in the cylinder. For this reason, observed Professor Berry, the hot spot had come into automobile practice as one of the solutions for the vaporization of kerosene, and he expressed his belief that it could be applied to good advantage to the use of fuels heavier than kerosene. A properly designed hot spot, he said, would eliminate the difficulty found in gas producers, where the temperature is often so ho

[1] Engineer of Tests, Curtiss Aeroplane & Motor Corp'n., Buffalo, N. Y. Mem. Am.Soc.M.E.

[2] Chemical Engineer, Locomotive Superheater Co., New York, N. Y. Mem. Am.Soc.M.E.

[3] Professor of Mechanical Engineering, Purdue University, Lafayette, Ind.

that it is not possible to keep a high enough compression without getting preignition.

Mr. Cardullo said in reply that in mentioning the gas producer he had intended to convey the idea of the actual combustion of oil in a producer so as to form a clean, burnable mixture in the engine.

L. H. Johnson[1] spoke of his experience with the two-cycle semi-Deisel hot-balb, hot-surface engine and stated that after investigating the various theories advanced to explain this type of engine he had finally formulated the following conclusion as to its operation: That the oil must be injected into the engine in the form of a spray or a mist, and if low compression is to be used, it must be sprayed against a hot surface and vaporized; then this oil gas mixes with the air compressed in the chamber and explodes by the heat of compression or the heat stored in the combustion chamber. Tests, he said, had convinced him that it is necessary for successful operation of the engine to remove the deposit of carbon or residue of material that is left in the cylinder. In the experiments to which he referred no trouble had been found in maintaining the right temperature necessary for successful operation and the main problem had been the elimination of the deposits.

Discussions of Mr. Arnold's Paper on a Suggested Formula for Rating Kerosene Engines

Harry F. Smith[2] thought that it would be altogether out of place to attempt to create any arbitrary standard of cubic-inch displacement for the determination of the horsepower of the kerososene-oil engine. He said he knew of tests recently made on substantially identical kerosene-oil engines in which the b.hp. developed differed by 100 per cent, due to change in cylinder design. That meant that the thermal efficiency of one engine was 100 per cent better than the other. It seemed to him, therefore, that the manufacturer who was in a position to double the thermal efficiency of the kerosene oil engine ought to be entitled to whatever benefits might accrue thereby, and not be handicapped by the action of the Society or of state legislatures in rating his engine at a certain horsepower according to its size or the number of pounds of cast iron put into it.

Stafford Montgomery[3] inquired whether the rating of kerosene engine builders from 8000 to 20,000 cu. in. per b.hp. was limited to kerosene engines or whether it applied also to gasoline engines. This question was referred to the meeting by the chairman.

Fredrik Ottesen[4] protested against manufacturers of large gas engines having to adopt the formula set forth in Mr. Arnold's paper.

William T. Magruder remarked that in the Ohio State University School of Aeronautics they had formulated a statement which was fairly accurate, that instead of using 13,000 or 14,000, 10,000 cu. in. represented quite closely the horsepower of a Curtiss aeroplane engine up to 100 per cent capacity, and increased speed after that did not give correspondingly increased horsepower. He said that the horsepower of a steam tractor is unknown until tested for the reason that its overload capacity is not like that of a boiler, one or two or three hundred per cent, but from four to five hundred per cent; and that in tests perfomed at the laboratories of the university tractors nominally rated at 20 hp. gave over 100 hp. and kept it up; on the other hand, in actual tests of kerosene and gasoline tractors on blocks, either in field work or in comparative b.hp. tests, many of the tractors fail to operate at their rated horsepower and not even their own experts could always get from them what the nameplates indicated they should deliver. Such being the conditions in practice, it appeared to him that by the standardization of horsepower, misunderstandings arising from the erroneous interpretation of the discrepancy between rated and actual horsepower could be avoided. He further observed that the question was bound to be soon taken up by the various legislatures and, as Mr. Arnold said in his paper, the conditions at present existing in the gas tractor and the kerosene tractor would be duplicated in the automobile if the Society did not take prompt and effective steps to translate the idea of a horsepower so as to make it intelligible to the average man who knows nothing about machinery or about mechanics.

John Chucan[1] assented to the remarks made by Professor Magruder and asserted that he had actually used for several years the formula proposed by Mr. Arnold and had found it to be very conservative. The formula, he said, was intended only for tractors and not for stationary engines or any other engines.

[1] Gen. Mgr., Anderson Foundry and Machine Works, Anderson, Ind. Mem. Am.Soc.M.E.

[2] Secretary, General Manager, Smith Gas Engineering Co., Dayton, Ohio. Mem. Am.Soc.M.E.

[3] Consulting Industrial and Production Engineer, Chicago, Ill. Jun. Am.Soc.M.E.

[4] Chemical Engineer, Gas Engine Department, Mesta Machine Co., Pittsburgh, Pa. Mem. Am.Soc.M.E.

Discussion of Professor Berry's Paper on Standards of Carburetor Performance

Forrest E. Cardullo remarked that the carburetor design was intimately connected with the structural details of the engine, with the form of the admission parts, and especially with the form of the manifold. The real problem of carburetor design, as he saw it, was to get the combination of a carburetor and inlet port in an engine which would give a uniformly suspended mixture of minute droplets in air at the instant the spark fires the charge. In order to get at this, Professor Berry recommended the application of certain standards to the testing of the carburetor in order to determine the uniformity of the mixture under operating conditions of the engine. But this would not lead, say, to the knowledge of the best kind of a combination carburetor, manifold and engine which would enable an automobile to climb a good stiff hill at ten or fifteen miles per hour, and at the same time give a speed of three miles per hour in a crowded traffic street and a speed of fifty miles per hour on a smooth, clear road.

Mr. Cardullo further observed that a rich mixture could be secured at the instant of acceleration more by properly designing the form of the manifold than by providing methods for increasing the mixture. Also that by reason of the separator action of the manifold it would be impossible to get a representative sample of the mixture entering the cylinder, and he believed the proper thing to do would be to analyze the exhaust of each cylinder for the proportion of carbon dioxide in order to determine whether each cylinder was getting its due proportion of gasoline in the mixture provided.

Thomas J. Litle, Jr.,[2] observed that in automobile practice many difficulties are encountered which do not occur in stationary engine work. With reference to the statement in the paper that the best performance is obtained with a temperature of 80 deg., he preferred to take the temperature of the mixture entering the block, after it passes through the carburetor intake manifold. He claimed that the temperature of the charge as it entered the block, after it passed through the carburetor and intake manifold, was the controlling factor in motor performance. He suggested as a future line of research work tapping into the intake passage just at the end of the supply pipe and analyzing a sample of the mixture taken at that point. To a question of Chairman Magruder inquiring how that sample of air and gasoline vapor was going to be obtained, Mr. Litle explained that he had succeeded in drawing it off by lifting the valve of a tall gasometer with a long water still.

In closing the discussion Professor Berry called attention to the fact that a temperature of 300 deg. on the air in the carburetor had been used in all of the tests reported in the paper. He had

(Continued on page 718)

[1] Goodwin Car and Manufacturing Co., Inc., Chicago, Ill. Assoc. Mem. Am.Soc.M.E.

[2] Research Engineer, Lincoln Motor Company, Detroit, Mich.

WORK OF THE BOILER CODE COMMITTEE

FOR over two years, a sub-committee of the Boiler Code Committee, known as the Sub-Committee on Railway Locomotive Boilers, has been engaged in formulating a set of rules for the construction of railway locomotive boilers, to be known as Part I, Section III, of the A. S. M. E. Boiler Code. The necessity for such an addition to the Boiler Code arose from the fact that, while the boilers of locomotives operated on railways engaged in interstate service are covered by the construction and inspection rules of the Interstate Commerce Commission, there was found to be a vast mileage of industrial and short-line railroads in operation in the various states, which by virtue of their location, are not subject to the Interstate requirements.

As a result of calls for a Code to cover the construction of boilers of this class, the Sub-committee on Railway Locomotive Boilers was appointed in 1916, and great care was taken to select for the membership of this Sub-committee men particularly qualified for the work. The Sub-committee of the Boiler Code Committee on Railway Locomotive Boilers consists of the following members:

F. H. CLARK, *Chairman*
F. J. COLE
ALEX. C. HUMPHREYS
S. F. JETER
WM. F. KIESEL, JR.
H. H. VAUGHAN.

While the work of this Sub-Committee was interrupted somewhat during the period of the war, its investigations were completed in the earlier part of the year and a preliminary report was submitted to the Boiler Code Committee in April. The preliminary report was next printed and distributed at the Spring Meeting at Detroit in June where it was discussed and upon motion, the preliminary report of the Committee was accepted by the meeting. The report is here published for the information of the membership. Any one desiring to discuss the preliminary report is requested to address the Secretary of the Boiler Code Committee, 29 West Thirty-Ninth Street, New York, N. Y.

A. S. M. E. BOILER CODE

PART I—SECTION III

PRELIMINARY REPORT ON RULES FOR THE CONSTRUCTION OF BOILERS OF LOCOMOTIVES WHICH ARE NOT SUBJECT TO FEDERAL INSPECTION AND CONTROL[1]

NOTE—When this Section is incorporated in the Boiler Code, it will be desirable to change the word "STATIONARY," to "STEAM," at the top of front cover and of the title page and on page 3 of the Code. Also the sentence in italics on page 3 will be changed to read, as follows:

"*These rules do not apply to boilers which are subject to Federal inspection and control.*"

Also to insert, after bracket in line beginning Part I, the following:

"SECTION III—LOCOMOTIVE BOILERS"

SELECTION OF MATERIALS

L—1 (X—1) Specifications are given in the Rules for Power Boilers, Pars. 23 to 178, for the important materials used in the construction of boilers, and where so given, the materials herein mentioned shall conform thereto, except as noted in Par. L—18.

L—2 (X—2) Steel plates for any part of a boiler when exposed to the fire or products of combustion, and under pressure, *excepting front tube sheets*, shall be of firebox quality as designated in the Specifications for Boiler Plate Steel.

L—3 (3) Steel plates for any part of a boiler, where firebox quality is not specified, when under pressure, shall be of firebox or flange quality, as designated in the Specifications for Boiler Plate Steel.

L—4 (4) Braces, when welded, shall be of wrought iron of the quality designated in the Specifications for Refined Wrought Iron Bars.

L—5 (5) Manhole and handhole covers and other parts subjected to pressure, and braces and lugs when made of steel plate, shall be of firebox or flange quality, as designated in the Specifications for Boiler Plate Steel.

L—6 (6) Steel bars for braces and for other boiler parts, except as otherwise specified herein, shall be of the quality designated in the Specifications for Steel Bars.

L—7 (X—7) Staybolts shall be of iron of the quality designated in the Specifications for Staybolt Iron.

L—8 (8) Rivets shall be of steel or iron of the quality designated in the Specifications for Boiler Rivet Steel, or in the Specifications for Boiler Rivet Iron.

L—9 (X—12) Throttle and throttle pipe, dry pipe or dry pipe ring, tee head, superheater header and steam pipes to cylinders, may be of cast iron.

L—10 (13) Water-leg and door-frame rings shall be of wrought iron or steel, or cast steel of Class A or Class B grade, as designated in the Specifications for Steel Castings. The OG or other flanged construction may be used as a substitute in any case.

ULTIMATE STRENGTH OF MATERIAL USED IN COMPUTING JOINTS

L—11 (14) In determining the maximum allowable working pressure, the tensile strength used in the computations for steel plates shall be that stamped on the plates as herein provided, which is the minimum of the stipulated range, or 55,000 lb. per sq. in. for all steel plates, except for special grades having a lower tensile strength.

TABLE 1 MINIMUM THICKNESS OF BUTT STRAPS

Thickness of Shell Plates, Inches	Minimum Thickness of Butt Straps, Inches	Thickness of Shell Plates, Inches	Minimum Thickness of Butt Straps, Inches
1/4	1/4	17/32	7/16
9/32	1/4	9/16	7/16
5/16	1/4	5/8	1/2
11/32	1/4	3/4	1/2
3/8	5/16	7/8	5/8
13/32	5/16	1	11/16
7/16	3/8	1 1/8	3/4
15/32	3/8	1 1/4	7/8
1/2	7/16		

L—12 (15) The resistance to crushing of steel plate shall be taken at 95,000 lb. per sq. in. of cross-sectional area.

L—13 (16) In computing the ultimate strength of rivets in shear, the following values in pounds per square inch of the cross-sectional area of the rivet shank shall be used:

Iron rivets in single shear	38,00
Iron rivets in double shear	76,00
Steel rivets in single shear	44,00
Steel rivets in double shear	88,00

The cross-sectional area used in the computations shall be tha of the rivet shank after driving.

[1] Numbers in parentheses at the beginning of paragraphs indicate paragraphs in A.S.M.E. Boiler Code (Edition of 1918) to which these paragraphs correspond.
The letters X, Y and Z indicate as follows: X—Rules of present Boiler Code modified; Y—New rules; Z—Interstate Commerce Commission rules.
Presented at the Spring Meeting, Detroit, Mich., June 1919, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Minimum Thickness of Plates and Tubes

L—14 (17) The minimum thickness of any boiler plate under pressure shall be $\frac{1}{4}$ in.

L—15 (18) The minimum thickness of shell plates, and dome plates after flanging, shall be as follows:

When the Inside Diameter of Shell is

36 in. or Under	Over 36 in. to 54 in.	Over 54 in. to 72 in.	Over 72 in.
$\frac{1}{4}$ in.	$\frac{5}{16}$ in.	$\frac{3}{8}$ in.	$\frac{1}{2}$ in

L—16 (19) The minimum thickness of butt straps for double strap joints shall be as given in Table 1. Intermediate values shall be determined by interpolation. For plate thicknesses exceeding $1\frac{1}{4}$ in., the thickness of the butt straps shall not be less than two-thirds of the thickness of the plate.

L—17 (X—20) The minimum thickness of tube sheets for locomotive boilers, shall be as follows:

When Diameter of Tube Sheet is

42 in. or Under	Over 42 in. to 54 in.	Over 54 in.
$\frac{3}{8}$ in.	$\frac{7}{16}$ in.	$\frac{1}{2}$ in.

L—18 (X—22) The minimum gage thickness of tubes or flues exposed to the products of combustion on the inside shall be as specified in Table 2 for the various pressures and outside diameters given.

The gage thickness in Table 2 is that measured by the B. W. gage with a permitted variation in thickness at any section not varying more than 10 per cent from that specified, except at the weld of lap-welded tubes where an additional thickness of 0.015 in. shall be allowed. In the case of superheater tubes which are expanded, the gage of the expanded end may be $1\frac{1}{2}$ gages lighter and the swaged end two gages heavier than the gage thickness.

TABLE 2 MINIMUM THICKNESS OF WALLS OF FIRE TUBES

Outside Diameter, In.	Maximum Allowable Working Pressure, Lb. per Sq. In.				
	160	180	200	225	250
$1\frac{1}{2}$	13	13	12	..	..
$1\frac{3}{4}$	13	12	12	.	..
2	12	12	12	11	11
$2\frac{1}{4}$	12	12	12	11	11
$2\frac{1}{2}$	12	12	11	11	11
3	12	11	11	11	10
$3\frac{1}{2}$	11	11	11	10	10
4	11	10	10	10	9
$4\frac{1}{2}$	10	10	10	9	9
5	10	9	9	9	8
$5\frac{1}{2}$	9	9	9	8	8
6	9	9	8	8	7

L—19 (Y) The minimum thickness of walls of brick arch tubes shall be determined by the following formula:

$$t = \frac{PD}{16{,}000} + \frac{1}{8} \text{ in.}$$

where P = allowable boiler pressure, lb. per sq. in.
t = thickness of walls, in.
D = outside diameter, in.

Construction and Maximum Allowable Working Pressure for Boilers of Locomotives

L—20 (179) The maximum allowable working pressure is that at which a boiler may be operated as determined by employing the factors of safety, stresses and dimensions designated in these rules.

No boiler shall be operated at a higher pressure than the maximum allowable working pressure, except when the safety valve or valves are blowing, at which time the maximum allowable working pressure shall not be exceeded by more than six per cent.

Wherever the term "Maximum Allowable Working Pressure" is used herein, it refers to gage pressure, or the pressure above the atmosphere, in pounds per square inch.

L—21 (X—180) The maximum allowable working pressure on the shell of a boiler shall be determined by the strength of the weakest course, computed from the thickness of the plate, the tensile strength stamped thereon, as provided for in Specifications for Boiler Plate Steel, the efficiency of the longitudinal joint, the inside diameter of the course, and the factor of safety.

$$\frac{TS \times t \times E}{R \times FS} = \text{maximum allowable working presure, lb. per sq. in.}$$

where

TS = ultimate tensile strength stamped on shell plates, as provided for in Specifications for Boiler Plate Steel, lb. per sq. in.
t = minimum thickness of shell plates in weakest course, in.
E = efficiency of longitudinal joint.
R = inside radius of the weakest course of the shell, in.
FS = factor of safety, or the ratio of the ultimate strength of the material to the allowable stress. For new constructions covered in Part III, FS in the above formula = 4.

Boiler Joints

L—22 (181) The efficiency of a joint is the ratio which the strength of the joint bears to the strength of the solid plate. In the case of a riveted joint this is determined by calculating the breaking strength of a unit section of the joint, considering each possible mode of failure separately, and dividing the lowest result by the breaking strength of the solid plate of a length equal to that of the section considered. (See Appendix, Pars. 410 to 416, Power Boilers, for detailed methods and examples.)

L—23 (X—182) The distance between the center lines of any two adjacent rows of rivets, or the "back pitch" measured at right angles to the direction of the joint, shall have the following minimum values:

a If $\frac{P}{D}$ is 4 or less, the minimum value shall be $1.75D$;

b If $\frac{P}{D}$ is over 4, the minimum value shall be:

$$1.75\,D + 0.1\ (P - 4\,D)$$

where

P = pitch of rivets in outer row where a rivet in the inner row comes midway between two rivets in the outer row, in.
P = pitch of rivets in the outer row less pitch of rivets in the inner row where two rivets in the inner row come between two rivets in the outer row, in. (It is here assumed that the joints are of the usual construction where the rivets are symmetrically spaced.)
D = diameter of the rivet holes, in.

L—24 (X—183) On longitudinal joints the distance from the centers of rivet holes to the edges of the plates, except rivet holes in the ends of butt straps, shall be not less than one and one-third times the diameter of the rivet holes.

L—25 (X—184) The strength of circumferential joints of boilers shall be at least 50 per cent of that required for the longitudinal joints of the same structure.

L—26 (187) The longitudinal joints of a shell which exceeds 36 in. in diameter, shall be of butt and double-strap construction.

This rule does not apply to the portion of a boiler shell which is stayed to the firebox or combustion chamber.

L—27 (188) The longitudinal joints of a shell which does not exceed 36 in. in diameter, may be of lap-riveted construction; but the maximum allowable working pressure shall not exceed 100 lb. per sq. in.

L—28 (X—190) With butt and double-strap construction longi-

tudinal joints of any length may be used, provided the tension test specimens are so cut from shell plates and butt-strap plates that their lengthwise direction is parallel with the circumferential seams of the boiler, and the tests meet the standards prescribed in the Specifications for Boiler Plate Steel.

L—29 (191) Butt straps and the ends of shell plates, forming the longitudinal joints shall be rolled or formed by pressure, not blows, to the proper curvature.

L—30 (X—194) The longitudinal joint of a dome shall be of butt and double-strap construction or made without a seam of one piece of steel pressed into shape, and its flange shall be double-riveted to the boiler shell, unless the dome be less than 24 in. in diameter, in which case the longitudinal joint may be of the lap type, and its flange may be single-riveted to the boiler shell provided the maximum allowable working pressure on such a dome does not exceed 160 lb. per sq. in., and is computed with a factor of safety not less than 8.

(Y) When boiler shells are cut to apply steam domes or manholes, the amount of metal in flange and liner, if used, must provide strength equivalent to that of the metal removed multiplied by the efficiency factor of the longitudinal seams. A height of vertical flange equal to three times the thickness of flange shall constitute flange reinforcement, using net area after rivet holes are deducted.

Braced and Stayed Surfaces

L—31 (X-199) The maximum allowable working pressure for various thicknesses of braced and stayed flat plates and those which by these Rules require staying as flat surfaces with braces or stays of uniform diameter symmetrically spaced, shall be calculated by the formula:

$$P = C \times \frac{T^2}{p}$$

where

P = maximum allowable working pressure, lb. per sq. in.

T = thickness of plate in sixteenths of an inch

p = maximum pitch measured between straight lines passing through the centers of the staybolts in the different rows, which lines may be horizontal, vertical or inclined, in.

C = 112 for stays screwed through plates not over $\frac{7}{16}$ in. thick with ends riveted over

C = 120 for stays screwed through plates over $\frac{7}{16}$ in. thick with ends riveted over

C = 135 for stays screwed through plates and fitted with single nuts outside of plate

C = 150 for stays with heads not less than 1.3 times the diameter of the stays, screwed through plates or made a taper fit and having the heads formed on the stays before installing them and not riveted over, said heads being made to have a true bearing on the plate.

If flat boiler plates not less than $^3/_8$ in. thick are strengthened with doubling plates securely riveted thereto and having a thickness of not less than $^2/_3$ T, then the value of T in the formula shall be three-quarters of the combined thickness of the boiler plate, and doubling plates, but not more than one and one-half times the thickness of the boiler plate, and the values of C given above may also be increased 15 per cent.

When two sheets are connected by stays and but one of these sheets requires staying, the value of C is governed by the thickness of the sheet requiring staying.

In curved sheets of a combustion chamber, half of which is a semicircle (radius R, in.) an increased pitch (p_i, in.) based on the following formula, may be used:

$$p_i = p\sqrt{\frac{PR}{PR - 250T}}$$

L—32 (X-200) The ends of screwed staybolts shall be riveted over or upset by equivalent process. The outside ends of solid staybolts 8 in. and less in length shall be drilled with a hole at least $\frac{3}{16}$ in. diameter to a depth extending at least $^1/_2$ in. beyond the inside of the plates, or hollow staybolts may be used. Solid staybolts over 8 in. long and flexible staybolts of either the jointed or ball and socket type need not be drilled.

Staybolts behind brickwork, frame braces, or grate bearers shall have holes at least $\frac{3}{16}$ in. diameter for entire length, which must be kept open at all times.

L—33 (201) When channel irons or other members are securely riveted to the boiler heads, the stress on such members shall not exceed 12,500 lb. per sq. in. In computing the stress the section modulus of the member shall be used without addition for the strength of the plate. This spacing of the rivets over the supported surface shall be in conformity with that specified for staybolts.

If the outstanding legs of the two members are fastened together so that they act as one member in resisting the bending action produced by the load on the rivets attaching the members to the head of the boiler, and provided that the spacing of those rivets attaching the members to the head is approximately uniform, the members may be computed as a single beam uniformly loaded and supported at the points where the through braces are attached.

L—34 (202) The ends of stays fitted with nuts shall not be exposed to the direct radiant heat of the fire.

L—35 (X-203) *a* The maximum spacing between centers of rivets or between the edges of tube holes and the centers of rivets attaching the crowfeet of braces to the braced surface, shall be determined by the formula in Par. L—31, using 135 for the value of C.

b The maximum distance between the edges of tube holes and the centers of other types of stays shall be determined by the formula in Par. L—31, using the value of C given for the thickness of plate and type of stay used.

c The maximum spacing between the inner surface of the shell and lines parallel to the surface of the shell passing through the centers of the rivets attaching the crowfeet of braces to the head shall be determined by the formula in Par. L—31, using 175 for the value of C.

d The maximum distance between the inner surface of the shell and the centers of braces of other types shall be determined by the formula in Par. L—31, using a value of C equal to 1.3 times that value of C, which applies to the thickness of plate and type of stay as therein specified.

e In applying these Rules and those in Par. L—31 to a head or plate having a manhole or reinforced opening, the spacing applies only to the plate around the opening and not across the opening.

L—36 (Y) *a* When the edge of a stayed plate is flat and is fastened by riveting, the distance from the center line of the rivets to a line through the centers of the nearest row of stays may be made to equal the pitch of the stays as given in Table 3 plus twice the thickness of the plate.

b When the edge of a flat stayed plate is flanged and riveted, the distance from the center of the outermost stays to the inside of the supporting flange should not exceed the pitch of the stays from the table plus the inside radius of the flange.

L—37 (X-204) Where values for screwed stays with ends riveted are required for conditions not given in Table 3, they may be computed from the formula in Par. L—31 and used, provided the pitch does not exceed $8^1/_2$ in.

L—38 (206) The distance between the edges of the staybolt holes may be substituted for p for staybolts adjacent to a furnace door or other boiler fitting, tube hole, handhole or other opening.

L—39 (X-208) The diameter of a screw stay shall be taken at the bottom of the thread, or at the body of the bolt between the threads—whichever is the lesser.

L—40 (X-209) The least cross-sectional area of a stay shall be taken in calculating the allowable stress, except when the stays are welded and have a larger cross-sectional area at the weld than at some other point, in which case the strength at the weld shall be computed as well as in the solid part and the lower value used.

L—41 (210) Holes for screw stays shall be drilled full size or punched not to exceed $\frac{1}{4}$ in. less than full diameter of the hole for plates over $\frac{5}{16}$ in. in thickness, and $\frac{1}{8}$ in. less than the full diameter of the hole for plates not exceeding $\frac{5}{16}$ in. in thickness,

TABLE 3 MAXIMUM ALLOWABLE PITCH, IN INCHES, OF SCREWED STAYS, ENDS RIVETED OVER

Pressure Lb. per Sq. In.	Thickness of Plate, In. — Maximum Pitch of Staybolts, In.						
	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$
100	$5\frac{1}{4}$	$6\frac{3}{8}$	$7\frac{3}{8}$	...	...		
110	5	6	7	$8\frac{3}{8}$	...		
120	$4\frac{3}{4}$	$5\frac{3}{4}$	$6\frac{3}{4}$	8			
125	$4\frac{3}{4}$	$5\frac{5}{8}$	$6\frac{5}{8}$	$7\frac{3}{4}$			
130	$4\frac{5}{8}$	$5\frac{1}{2}$	$6\frac{1}{2}$	$7\frac{5}{8}$			
140	$4\frac{1}{2}$	$5\frac{3}{8}$	$6\frac{1}{4}$	$7\frac{3}{8}$	$8\frac{3}{8}$		
150	$4\frac{1}{4}$	$5\frac{1}{8}$	6	$7\frac{1}{8}$	8		
160	$4\frac{1}{8}$	5	$5\frac{7}{8}$	$6\frac{7}{8}$	$7\frac{3}{4}$		
170	$4\frac{1}{16}$	$4\frac{7}{8}$	$5\frac{5}{8}$	$6\frac{3}{4}$	$7\frac{1}{2}$	$8\frac{3}{8}$	
180	$3\frac{15}{16}$	$4\frac{3}{4}$	$5\frac{1}{2}$	$6\frac{1}{2}$	$7\frac{3}{8}$	$8\frac{1}{8}$	
190	$3\frac{13}{16}$	$4\frac{5}{8}$	$5\frac{3}{8}$	$6\frac{3}{8}$	$7\frac{1}{8}$	$7\frac{7}{8}$	
200	$3\frac{11}{16}$	$4\frac{1}{2}$	$5\frac{1}{4}$	$6\frac{1}{8}$	7	$7\frac{3}{4}$	$8\frac{1}{2}$
225	$3\frac{1}{2}$	$4\frac{1}{4}$	$4\frac{7}{8}$	$5\frac{7}{8}$	$6\frac{1}{2}$	$7\frac{1}{4}$	8
250	...	4	$4\frac{5}{8}$	$5\frac{1}{2}$	$6\frac{1}{4}$	$6\frac{7}{8}$	$7\frac{5}{8}$
300	...	...	$4\frac{1}{4}$	5	$5\frac{5}{8}$	$6\frac{1}{4}$	7

and then drilled or reamed to the full diameter. The holes shall be tapped fair and true, with a full thread.

L—42 (211) The ends of steel stays upset for threading shall be thoroughly annealed.

L—43 (X—212) *a* The maximum allowable working pressure for any curved stayed surface subject to internal pressure shall be obtained by the two following methods, and the minimum value obtained shall be used:

First, the maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays. To this pressure there shall be added the pressure secured by the formula for braced and stayed surfaces given in Par. L—31, using 70 for the value of C.

Second, the maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays. To this pressure there shall be added the pressure corresponding to the strength of the stays for the stresses given in Table 4, each stay being assumed to resist the steam pressure acting on the full area of the external surface supported by the stay.

TABLE 4 MAXIMUM ALLOWABLE STRESSES FOR STAYS AND STAYBOLTS

Description of Stays	Stresses, Lb. Per Sq. In. — For lengths between supports not exceeding 120 diameters	For lengths between supports exceeding 120 diameters
a Unwelded or flexible stays less than twenty diameters long, screwed through plates with ends riveted over................	7500	....
b Hollow steel stays less than 20 diameters long, screwed through plates with ends riveted over..	8000	....
c Unwelded stays and unwelded portions of welded stays, except as specified in line *a* and line *b*...	9500	8500
d Welded portions of stays..........	6000	6000

b The maximum allowable working pressure for a stayed wrapper sheet of a locomotive-type boiler shall be determined by the two methods given above and by the method which follows, and the minimum value obtained shall be used:

$$P = \frac{13{,}500t \times E}{R - s\Sigma \sin \alpha}$$

in which

α = angle any crown stay makes with vertical axis of boiler

$\Sigma \sin \alpha$ = summated value of $\sin \alpha$ for all crown stays considered in one transverse plane and on one side of vertical axis of boiler

s = transverse spacing of crown stays in crown sheet, in.

E = minimum efficiency of wrapper sheet through joints or stay holes

t = thickness of wrapper sheet, in.

R = radius of wrapper sheet, in.

P = working pressure of boiler, lb. per sq. in.

13,500 = allowable stress, lb. per sq. in.

L—44 (X—213) A segment of a head shall be stayed by through, diagonal, crowfoot or gusset stays.

L—45 (X—214) The area of a segment of a head to be stayed shall be the area enclosed by lines drawn 2 in. from the tubes and at a distance d from the shell as shown in Figs. 15 and 16, Part I, Section I. The value of d used may be the larger of the following values:

(1) d = the outer radius of the flange, not exceeding 8 times the thickness of the head

(2) $$d = \frac{5 \times T}{\sqrt{P}}$$

where

d = unstayed distance from shell in inches

T = thickness of head in sixteenths of an inch

P = maximum allowable working pressure in lb. per sq. in.

(Y) The feet for braces to back head and front tube sheet should be distributed so as not to concentrate the stress on any one section; preferably a proportion of the braces should be attached to the second course from the back head or front tube sheet.

(Y) No supporting value shall be assigned to the stiffness of inside liner plates on flat surfaces, except as provided in L—31.

L—46 (X—221) In calculating stresses for diagonal stays in Pars. L—47-48 the angularity of the stays must be taken into account.

L—47 (X—223) All rivet and pin holes shall conform to the requirements in Par. L—54 and the pins shall be made a neat fit. To determine the sizes that shall be used, proceed as follows:

1 Determine the "required cross-sectional area of the brace" by first computing the total load to be carried by the brace, and dividing the total load by the values of stresses given in Table 4.

2 Design the body of the brace so that the cross-sectional area shall be at least equal to the "required cross-sectional area of the brace."

3 Make the area of pins to resist double shear at least three-quarters of the "required cross-sectional area of the brace."

4 Make the combined cross-section of the eye at the side of the pin (in crowfoot braces) at least 25 per cent greater than the "required cross-sectional area of the brace."

5 Make the cross-sectional areas through the blades of diagonal braces where attached to the shell of the boiler at least equal to the required rivet section; that is, at least equal to one and one-quarter times the "required cross-sectional area of the brace."

6 Design each branch of a crowfoot to carry two-thirds the total load on the brace.

7 Make the net sectional areas through the sides of the crowfoot, tee irons, or similar fastenings at the rivet holes at least equal to the required rivet section; that is, at least equal to one and one-quarter times the "required cross-sectional area of the brace."

8 Make the combined cross-sectional area of the rivets at each end of the brace at least one and one-quarter times the "required cross-sectional area of the brace."

L—48 (X—224) Gusset stays when constructed of triangular

web plates secured to single or double angle bars along the two sides at right angles shall have a cross-sectional area (in a plane at right angles to the longest side and passing through the intersection of the two shortest sides) not less than 10 per cent greater than would be required for a diagonal stay to support the same surface, assuming the diagonal stay is at the same angle as the longest side of the gusset plate.

L—49 (X—230) Crown bars and girder stays for tops of combustion chambers and back connections, or wherever used, shall be proportioned to conform to the following formula:

$$\text{Maximum allowable working pressure} = \frac{C \times d^2 \times t}{(W - P) \times D \times W}$$

where

W = extreme distance between supports, in.
P = pitch of supporting bolts, in.
D = distance between girders from center to center, in.
d = depth of girder, in.
t = thickness of girder, in.
C = 7000 when the girder is fitted with one supporting bolt
C = 10,000 when the girder is fitted with two or three supporting bolts
C = 11,000 when the girder is fitted with four or five supporting bolts
C = 11,500 when the girder is fitted with six or seven supporting bolts
C = 12,000 when the girder is fitted with eight or more supporting bolts

Example: Given W = 34 in., P = 7.5 in., D = 7.75 in., d = 7.5 in., t = 2 in.; three stays per girder, C = 10,000; then substituting in formula:

Maximum allowable working pressure =

$$\frac{10{,}000 \times 7.5 \times 7.5 \times 2}{(34 - 7.5) \times 7.75 \times 34} = 161.1 \text{ lb. per sq. in.}$$

(Y) In boilers with crown bars supported on firebox side sheets, and sling stays, the sling stays shall be considered as carrying the entire load.

L—50 (248) *Tubes.* Tube holes shall be drilled full size from the solid plate, or they may be punched at least $\frac{1}{2}$ in. smaller in diameter than full size, and then drilled, reamed or finished full size with a rotating cutter.

L—51 (249) The sharp edges of tube holes shall be taken off on both sides of the plate with a file or other tool.

L—52 (X—250) The ends of the tubes shall be substantially rolled and beaded, or rolled and welded, at the firebox or combustion-chamber end, and rolled at the smokebox end; 10 per cent of the flues at the smokebox shall be beaded.

Riveting

L—53 (253) All rivet holes and staybolt holes and holes in braces and lugs shall be drilled full size or they may be punched not to exceed $\frac{1}{4}$ in. less than full diameter for material over $\frac{5}{16}$ in. in thickness, and $\frac{1}{8}$ in. less than full diameter for material not exceeding $\frac{5}{16}$ in. in thickness, and then drilled or reamed to full diameter. Plates, butt straps, braces, heads and lugs shall be firmly bolted in position by tack bolts for drilling or reaming all rivet holes in boiler plates, except those used for the tack bolts.

L—54 (254) After drilling or reaming rivet holes the plates and butt straps shall be separated, the burrs and chips removed, the plates and butt straps reassembled metal to metal with barrel pins fitting the holes, and with tack bolts.

L—55 (X—255) Rivets shall be of sufficient length to completely fill the rivet holes and form heads at least equal to those shown in Fig. 20, Part I, Section 1.

L—56 (256) Rivets shall be machine-driven wherever possible, with sufficient pressure to fill the rivet holes, and shall be allowed to cool and shrink under pressure. Barrel pins fitting the holes and tack bolts to hold the plates firmly together shall be used. A rivet shall be driven each side of each tack bolt before removing the tack bolt.

L—57 (257) The calking edges of plates, butt straps and heads shall be beveled to an angle not less than 70 deg. to the plane of the plate, and as near thereto as practicable. Every portion of the sheared surfaces of the calking edges of plates, butt straps and heads shall be planed, milled or chipped to a depth of not less than $\frac{1}{8}$ in. Calking shall be done with a round-nosed tool.

L—58 (X—265) A locomotive boiler shall have washout handholes or screw plugs, as follows: One at each corner of firebox just above mud ring; one in back head over fire door; one or more on each side of roof sheet above the level of crown sheet, which shall be staggered on opposite sides; one or more in barrel of boiler; and one or more in back head above crown sheet.

(Y) Screw plugs must have at least four full threads in the sheet, including reinforcement, if such is used.

L—59 (Y—268) All holes for injector checks, whistle, and safety valves when screwed into boiler, and all holes in boiler barrel, firebox, roof sheet, and all unstayed surfaces when diameter of the hole is over $3\frac{1}{4}$ in. and exceeds $4\frac{1}{2}$ times the thickness of the plate, must be reinforced with a liner or flange riveted to the boiler.

The thickness of the liner or flange must be at least 75 per cent of the thickness of the plate. The rivets must have a shearing strength of at least 52 per cent of the tensile strength of the metal removed.

Safety Valves

L—60 (Z—269) Every locomotive boiler shall be equipped with at least two safety valves, the capacity of which shall be sufficient to prevent, under any conditions of service, an accumulation of pressure more than 6 per cent above the specified boiler pressure.

L—61 (Z—271) Safety valves shall be set to pop at pressures not exceeding 6 b. above the working steam pressure. When setting safety valves, two steam gages shall be used, one of which must be so located that it will be in full view of the person engaged in setting such valves; and if the pressure indicated by the gages varies more than 3 lb., they shall be removed from the boiler, tested and corrected before the safety valves are set. Gages shall in all cases be tested immediately before the safety valves are set or any change made in the setting. When setting safety valves, the water level in the boiler shall not be above the highest gage cock.

L—62 (X—272) Safety valves may have the seat and bearing surface of the disk inclined at any angle between 45 deg. and 90 deg. to the center line of the spindle. The valves shall be rated at a pressure 3 per cent in excess of that at which the valve is set to blow.

All safety valves shall be so constructed that no detrimental shocks are produced through the operation of the valve.

L—63 (273) Each safety valve shall be plainly marked by the manufacturer. The markings may be stamped on the body, cast on the body, or stamped or cast on a plate or plates permanently secured to the body, and shall contain the following:

a The name or identifying trademark of the manufacturer
b The nominal diameter
c The steam pressure at which it is set to blow
d Blow down, or difference between the opening and closing pressures
e The weight of steam discharged in pounds per hour at a pressure 3 per cent higher than that for which the valve is set to blow
f A.S.M.E. Std.

L—64 (X—275) Safety-valve capacity may be checked in the following manner; and, if found sufficient, additional capacity need not be provided:

> By making an accumulation test with fire in good bright condition, and all steam exits closed, and fire forced under these conditions, the safety valves should relieve boiler and not allow an excess pressure of more than 6 per cent above the working pressure.

L—65 (X—278) Each safety valve shall have full-sized direct connection to the boiler.

L—66 (X-279) If a muffler is used on a safety valve it shall have sufficient outlet area to prevent back pressure from interfering with the proper operation and discharge capacity of the valve. The muffler plates or other devices shall be so constructed as to avoid any possibility of restriction of the steam passages due to deposit.

L—67 (280) When a boiler is fitted with two or more safety valves on one connection, this connection to the boiler shall have a cross-sectional area not less than the combined area of all of the safety valves with which it connects.

L—68 (X-283) The seats and disks of safety valves shall be of non-ferrous material.

L—69 (284) Springs used in safety valves shall not show a permanent set exceeding $\frac{1}{16}$ in. ten minutes after being released from a cold compression test closing the spring solid. The spring shall be so constructed that the valve can lift from its seat at least one-tenth the diameter of the seat before the coils are closed or before there is other interference.

L—70 (285) The spring in a safety valve shall not be used for any pressure more than 10 per cent above or below that for which it was designed.

L—71 (287) When the valve body is marked with the letters A.S.M.E. Std. as required by Par. L—64, this shall be a guarantee by the manufacturer that the valve conforms to the details of construction herein specified.

L—72 (X-290) Every boiler shall have proper outlet connections for the required safety valve or valves, independent of any other steam outlet connection or of any internal pipe in the steam space of the boiler, the area of opening to be at least equal to the aggregate nominal area of all of the safety valves to be attached thereto.

L—73 (X-291) Each boiler should have at least one water glass and lamp and two gage cocks for boilers 36 in. in diameter and under, and three gage cocks for boilers over 36 in. in diameter.

(Y) The lowest gage cock and the lowest reading of water glass shall not be less than 2 in. above the highest point of crown sheet on boilers 36 in. in diameter and under, and 3 in. for boilers over 36 in. in diameter. These are minimum dimensions, and on large locomotives, and those operating on steep grades, the height should be increased if necessary to compensate for change of water level on descending grades.

L—74 (X-292) No water-glass connection shall be fitted with an automatic shut-off valve.

L—75 (Z-296) Every boiler shall have at least one steam gage which will correctly indicate the working pressure. Care must be taken to locate the gage so that it will be kept reasonably cool, and can be conveniently read by the engineman.

Every gage shall have a siphon of ample capacity to prevent steam entering the gage. The pipe connection shall enter the boiler direct, and shall be maintained steam-tight between boiler and gage. The siphon shall be of brass, copper or bronze composition.

L—76 (297) The dial of the steam gage shall be graduated to not less than $1\frac{1}{2}$ times the maximum allowable working pressure on the boiler.

L—77 (298) Each boiler shall be provided with a valved connection not less than $\frac{1}{4}$-in. pipe size for attaching a test gage when the boiler is in service, so that the accuracy of the boiler steam gage can be ascertained.

Fittings and Appliances

L—78 (X-311) Locomotive boilers are to be equipped with at least one blow-off cock located at the lowest water space practicable, directly connected to the boiler, either with screw connections or flanged.

L—79 (X-315) Each boiler shall be equipped with two injectors, or two pumps, or one injector and one pump, with separate delivery pipes connected to the injector checks. The water shall be delivered to the boiler at a point nearer the front than the back flue sheet.

Hydrostatic Tests

L—80 (X-329) After a boiler has been completed, it shall be subjected to a hydrostatic test of 25 per cent above the maximum allowable working pressure. The pressure shall be under proper control so that in no case shall the required test pressure be exceeded by more than 6 per cent.

L—81 (330) During a hydrostatic test, the safety valve or valves shall be removed, or each valve disk shall be held to its seat by means of a testing clamp, and not by screwing down the compression screw upon the spring.

L—82 (X-331) In laying out shell plates, furnace sheets and heads in the boiler shop, care shall be taken to leave at least one of the stamps, specified in Par. 36 of Part I, Section I, so located as to be plainly visible when the boiler is completed. Butt straps shall have at least a portion of such stamps visible, sufficient for identification when the boiler is completed.

L—83 (X-332) Each boiler shall conform in every detail to these Rules, and shall be distinctly stamped with the symbol as shown in Fig. 23, Part I, Section I, denoting that the boiler was constructed in accordance therewith.

After obtaining the stamp to be used when boilers are to be constructed to conform with the A.S.M.E. Boiler Code, a state inspector, municipal inspector, or an inspector employed regularly by an insurance company which is authorized to do a boiler insurance business in the state in which the boiler is built and in the state in which it is to be used, if known, is to be notified that an inspection is to be made and he shall inspect such boilers during construction and after completion. At least two inspections shall be made, one before reaming rivet holes and one at the hydrostatic test. In stamping the boiler after completion, if built in compliance with the Code, the builder shall stamp the boiler in the presence of the inspector, after the hydrostatic test, with the A.S.M.E. Code stamp, the builder's name and the serial number of the manufacturer. A data sheet shall be filled out and signed by the manufacturer and the inspector. This data sheet, together

Official Symbol for Stamp to Denote The American Society of Mechanical Engineers Uniform Standard

with the stamp on the boiler, shall denote that it was constructed in accordance with the A.S.M.E. Boiler Code.

Each boiler shall be stamped adjacent to the symbol as shown in Fig. 24, Part I, Section I, with the following items, with intervals of about one-half inch between the lines:

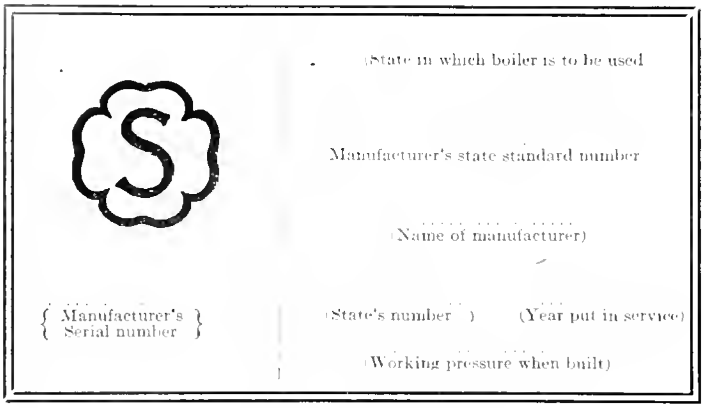
1. Manufacturer's serial number
2. State in which boiler is to be used
3. Manufacturer's State standard number
4. Name of manufacturer
5. State's number
6. Year put in service
7. Working pressure when built.

Items 1, 2, 3, 4 and 7 are to be stamped at the shop where built.

Items 5 and 6 are to be stamped by the proper authority at point of installation.

L-84 (X-333) The stamps shall be located on the boiler head in the cab and should not be covered by lagging and jacketing if the boiler head is lagged.

L-85 (X-334) Each boiler shall be equipped with a metal badge plate, showing the maximum allowable working pressure, which shall be attached to boiler head in the cab. If the boiler head is lagged, the lagging and jacketing shall be cut away a sufficient amount to leave the plate visible.



Form of Stamping

Use of the Boiler Code in Universities

Recognition of the value of the A. S. M. E. Boiler Code as an agency for standardization in this important branch of the industrial field is indicated by its growing use in technical schools and universities as a reference work or textbook. There has been found to be a growing number of engineering departments in the universities of this country which are either utilizing the Code as a reference work, a textbook or as a manual upon which to base their instruction in boiler design.

A. M. Greene, Jr., professor of mechanical engineering, Rensselaer Polytechnic Institute, Troy, N. Y., and member of the Boiler Code Committee, recently canvassed the engineering departments of the various universities and technical schools in order to learn the present status of the Code as an instruction work and the result is of more than usual interest. For the convenience of those having occasion to investigate this matter, the following summary of reports from engineering departments is given.

The following universities use the Boiler Code as a textbook: Massachusetts Institute of Technology, Sheffield Scientific School, Yale University, Armour Institute of Technology (Chicago), Case School of Applied Science (Cleveland), University of Vermont, University of Cincinnati, Johns Hopkins University (Baltimore), University of Michigan, University of Minnesota, and Rensselaer Polytechnic Institute. Rutgers College and University of Texas start with the coming year to make use of the Code as a textbook. The Boiler Code is used as a reference book at the following universities: Vanderbilt University (Tennessee), New Mexico College of Agriculture and Mechanic Arts, Tulane University of Louisiana, University of Colorado, University of Washington, University of Maine, University of Wyoming, Virginia Polytechnic Institute, and Washington University (St. Louis).

CORRESPONDENCE

Contributions to the Correspondence Departments of Mechanical Engineering by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in this journal, or brief articles of current interest to mechanical engineers.

Contributions on Society Policy

Mr. Calvin W. Rice, *Secretary:*

In our efforts to place the organization of The American Society of Mechanical Engineers well abreast of the agencies making for an ever-greater America, we should be unmindful of the lessons of the past if we fail to give special attention to the development of the mechanisms making for free discussion and free speech. Hence it is that the policy which is to control the conduct of the Correspondence Department in Mechanical Engineering is by no means without its importance in the whole scheme of A. S. M. E. activities. Should it not be so conducted as to afford one of the principal outlets for comment on, and constructive criticism of, the Society's management and affairs? This is not now its function. In the six issues, January to June of this year, there have been published twelve (12) communications occupying about as many pages and every one of these letters is devoted exclusively to some technical phase of engineering. During the past six months there has not been published a line of "suggestions on Society affairs," which is the kind of contributions which are "particularly welcomed" according to the announcement which stands at the head of the section. This fact is especially significant because during this six months the affairs of the Society have been under special investigation at the hands of the Committee on Aims and Organization.

The late Dr. S. Weir Mitchell, shortly after I was put in charge of Philadelphia's public works, made the suggestion that we should adopt the policy of not only welcoming complaints and constructive criticism but of actively organizing to secure them. He rightly considered such an attitude as fundamental to the building up of our work. Following his advice in the next few months we handled over 100,000 complaints. But with all outlets for criticism thrown wide open and every effort being made by our organization to remedy the causes of criticism, it was not long before the volume of complaints began to recede. The character of the criticisms also became more constructive and we began to receive letters of commendation in increasing number. I am confident that no really great program making for progress can be executed in any field without constantly affording every one at interest a broad opportunity for comment and criticism.

"Formulated rules for the acceptance or rejection" of communications of this character should be very simple. Especially in the beginning I would publish everything offered unless there is an overpowering reason against doing so. At the present time the feeling is quite prevalent that the doors to criticism are not wide open. Until confidence in this matter is fully established the editor is not likely to be overwhelmed with suggestions. As our membership constitutes a carefully selected group the expectation is decidedly against the necessity for the rejection of contributions for cause. In order to fully establish confidence an appeal should be provided where a communication is rejected for cause.

The democratization of the A. S. M. E. will be impossible except as this and other channels for critical comment are thrown wide open. We need to remind ourselves constantly that the cure for democracy is more of it.

Morris Llewellyn Cooke.

Philadelphia, Pa.

To Mr. Cooke's letter the Secretary has replied as follows:

It is recognized that Mechanical Engineering can be improved and developed in various ways and the problem of how best to do that is now being given careful consideration by men with publishing experience and having a thorough acquaintance with the Society's organization and activities.

On account of lack of space and for other reasons which it is not necessary or desirable to specify for the moment, it has been impossible to do immediately all the things that were perceived to be desirable, and a number of them have had to be deferred.

One of these is the further development of the correspondence department in Mechanical Engineering which you now advocate. No communications of the character you so wisely sug-

gest have been received, except possibly Mr. Crawford's—with which I assume you are familiar, and my reply to that was in effect that we were already doing what he proposed, but nevertheless, if he would condense his letter we would be glad to publish it. He never came back.

It is hoped that the crowded condition of MECHANICAL ENGINEERING will soon be remedied, as it is generally agreed that it would be very desirable to afford, by means of our journal, a channel of communication between members of the Society; not only upon technical matters, but upon Society affairs as well.

CALVIN W. RICE, *Secretary.*

Fire Engines and the Essentials of Fire Fighting

To the Editor:

Mr. Fox's paper on Fire Engines and the Essentials of Fire Fighting, presented at the Spring Meeting, covers the general subject in a most complete manner and no particular phase of the many items involved has been given undue prominence to the exclusion of others. However, in order to refresh the minds of those who have dealt with some of the problems in times past and to put on guard those who may be called upon to apply some of the principles without having time to give them proper consideration, it may be desirable to treat certain parts of the subject more in detail.

Although the principles of design of the centrifugal pump and of the gasoline engine are well known by the designers of each class of equipment, yet the observations of the writer during the past ten years show that much trouble is encountered when the centrifugal-pump manufacturer purchases a gasoline engine and attempts to drive his pump with it, or when the manufacturer of a gasoline engine attempts to drive a centrifugal pump with his engine.

The pump manufacturer has tested his pump and determined its most economic speed, capacity and pressure, while the gasoline-engine manufacturer has determined the horsepower delivered at different speeds. In many cases sufficient study is not given to the performance curves of the two pieces of equipment before the capacity and size of each which are to be selected to form the combined motor-driven pump are determined.

In order to have the equipment successful it is fundamentally necessary that the power developed by the gasoline engine at any speed shall exceed that required to operate the centrifugal pump at the same speed. To the casual reader this statement may appear entirely superfluous, yet the failure to meet this axiomatic requirement has cost many manufacturers much time, money and trouble.

The writer is in absolute accord with the statement that the efficacy of fire streams up to $2\frac{1}{4}$ in. in diameter cannot be materially improved by increasing the nozzle pressure beyond 100 lb. per sq. in. Observations made on a $1\frac{1}{2}$-in. stream by experienced observers showed that the increase in the effective vertical reach when the nozzle pressure was increased beyond 100 lb., was not over 15 ft. up to 150 lb. pressure and that when the nozzle pressure was increased beyond 150 lb. the effective vertical reach decreased. This decrease was evidently due to the increased resistance which the air offered to the surface of the water jet. It is thus evident that a pressure of from 80 to 100 lb. at the nozzle is required to develop efficient streams from deluge sets, turret nozzles, deck guns, ladder pipes and water towers; for hand lines, even when operated by trained men, 60 to 80 lb. is sufficient. There are a few cases, however, when pressures in excess of 100 lb. may be of some advantage on 2-in. and $2\frac{1}{4}$-in. tips. For instance, in overhauling lumber when stacked, overturning walls or breaking through obstructions when the nozzle can be brought up close, and horizontal or vertical reach are not desired, pressures as high as 200 lb. at the nozzle enable the operator to take advantage of the added momentum of the stream and accomplish more efficient work.

In passing, it may not be out of place to remark that one of the best methods of placing a fire stream in favorable position for observations is to carry them out at night with the stream directed between a bank of electric lights and the observer.

The capacity of a pumper or steamer should always be stated in gallons per minute against the observed net pressure, the latter to be the actual difference in the pressures observed on the suction and discharge sides of the pump. As an example two cases will be cited: (1) An engine is taking suction from a reservoir 5 ft. below the suction inlet and the friction loss through the suction hose when delivering 750 gal. per min. is $6\frac{1}{2}$ ft., making the total lift 11.5 ft. or 5 lb.; the observed discharge pressure is 115 lb., therefore the net head pumped against by the engine is 120 lb. (2) An engine is taking suction from a hydrant fed by a street main carrying a pressure of 55 lb. when the engine is delivering 750 gal.; the friction loss through the hydrant and branch is 3 lb. and through the suction hose 2 lb., making the total friction loss 5 lb., thus delivering a pressure of 50 lb. on the suction side of the pump; the observed discharge pressure is 170 lb., therefore the net pressure pumped against by the engine is 120 lb.

Many engineers of steamers have maintained that their engines worked better at draft than when suction was furnished under pressure from a hydrant. It is the opinion of the writer that this is an erroneous notion and he has never seen it substantiated in practice. At any rate it is an established fact that the pressure furnished on the suction side of the pump increases the capacity of a pumper when delivering at pressures above that pressure at which it is rated.

If a pumper is rated at 750 gal. at 120 lb. net pressure and water is delivered to the suction side of the pump at 0 lb. pressure, then it will discharge somewhat more than one-half this quantity at 200 lb. pressure and a little more than one-third the quantity at 250 lb. pressure. Now if water is delivered to the suction side of the pump under 80 lb. pressure the discharge pressure will be 200 lb. and the capacity will remain at 750 gal., and if the water is delivered to the suction under 130 lb. pressure the pump will continue to discharge 750 gal. per min. with a discharge pressure of 250 lb.

It is thus evident that the pressure in the water mains should be taken advantage of in all cases. This is particularly important in large fires where high pressures are required to develop the more powerful streams and to overcome the friction losses in long lines of fire hose which must be laid from the engines located farthest from the fire. Where good hydrant pressures are available, say from 40 to 60 lb., the more nearly can the rated capacities of the engines be maintained when required to work against discharge pressures greater than 120 lb.

The one and main object of the pumper or steamer is to deliver water at the nozzle at a pressure suitable to develop an efficient fire stream. Now it has been shown that any increase in discharge pressure reduced the delivery of the apparatus, therefore every means should be adopted which will relieve the necessity of raising the discharge pressure. Increasing the carrying capacity of the hose lines from the engine to the nozzle will cut down the friction loss which in turn will cut down the pressure at the engine which is required to deliver the water at the nozzle under suitable pressure.

The use of 3-in. hose will accomplish this result in the most economical manner and practically the same results can be accomplished by siamesing $2\frac{1}{2}$-in. hose lines. For a given quantity of water flowing the friction loss through a 3-in. hose line is about one-third that through a $2\frac{1}{2}$-in. line of equal length. Two $2\frac{1}{2}$-in. lines siamesed offer about one-fourth the frictional resistance of a single $2\frac{1}{2}$-in. line. It therefore is advisable to lay 3-in. hose lines from pumpers to the entrance of buildings and to ladder pipes, turret nozzles, deluge sets and water towers in order to enable the pumper to deliver larger quantities of water.

The successful fighting of a fire depends much upon the development of powerful hose streams and these in turn depend upon the efficient operation of the pumpers or steamers. An untrained and unexperienced engineer may so operate an engine that is in first-class condition that it will not give as good service as a much poorer engine is well-trained hands. So much depends upon the operation of pumpers and steamers that it is of prime

importance that the crews be trained in the operation of their machines at capacity at frequent intervals, say, once a month.

Clarence Goldsmith.

New York, N. Y.

Comment on the Still Engine

To the Editor:

Roughly, an internal-combustion engine converts a third of its heat supply into power and throws away another third in the jacket discharge and a final third in the exhaust. The Still engine represents an attempt to reclaim the wasted two-thirds by means of a steam plant. The steam-plant efficiency can scarcely exceed 20 per cent. Hence the maximum potential efficiency from the apparatus proposed is $^1/_3 + (0.2 \times ^2/_3) = 46.7$ per cent.

The exhaust-gas heat has the desirably high temperature. Transmission from dry gas is slow and transmitting apparatus may be (as with hot-air engines) hard to maintain, but experience with economizers has shown these objections not to be fatal. A transmitting surface of 3 sq. ft. per hp. of the internal-combustion cylinder should be sufficient.

The jacket heat exists at low temperature and hence at low availability. The proposed engine increases the temperature and further increases availability by using the exhaust gas. The jacket heat (except for radiation) is all reclaimed. The exhaust heat is reclaimed to the extent represented by a temperature drop from 900 deg. to 150 deg. Unfortunately, 80 per cent of these reclaimed amounts must immediately be thrown away to the steam-plant circulating water.

A steam generation of 7 lb. per b.hp-hr. can scarcely be expected. Under the illustrated conditions, this implies a jacket loss of about 6300 B.t.u. per hr., or $2^1/_2$ times the normal.

The general idea is sound, but it makes the further extended development of the gas engine contingent on some radical improvement in the economy of the steam engine.

W. D. Ennis.

New York, N. Y.

The First Steamship to Cross the Atlantic

To the Editor:

In the June number of Mechanical Engineering, on page 554, there is an article entitled The Crossing, which states than "On May 26, 1819, an American ship, the *Savannah*, was the first steam-driven vessel to cross the ocean, etc."

As a matter of history the *Savannah* did not make the entire voyage under steam. As stated in the Encyclopedia Britannica, "She was fitted with sails, and used them in rough weather, unshipping her paddle boxes."

I give below extracts from the Toronto *Daily Star* treating on this very matter which I think should be put before the Society.

A letter recently appeared in the London *Times* from Prof. W. H. Vander Smissen, of the University of Toronto, now resident in England, in which he pointed out that it was neither the American-owned *Savannah* nor the British steamship *Sirius* or *Great Western*, but the Canadian-owned and built *Royal William* which was the first vessel propelled by steam to cross the Atlantic.

From time to time disputes have arisen on this question, and Professor Vander Smissen recalls that in 1894 the Earl of Aberdeen, as Governor-General at the time the Intercolonial Conference was in Ottawa, unveiled a tablet placed on the wall of one of the corridors of the Parliament Buildings inscribed with the details of the *Royal William's* performance. The burning of the buildings early in the war destroyed this tablet, which it is hoped will be replaced. Professor Vander Smissen says that the *Royal William* was designed by Mr. James Goudie, a native of Quebec. Her builders were Messrs. Campbell and Black, of that city; she was engined in Montreal, and before making her memorable trip from Quebec via Picton, N. S., to London, in August, 1838, had traded between Quebec, Halifax, and Boston. She was bought by the Portuguese Government and renamed, and later served as a Spanish warship under the name *Isabel Segunda*. She had a length of 176 ft., a width between the paddle boxes of 28 ft., and a gross tonnage of 1,370.—*Toronto Daily Star*, May 7, 1919.

It was in 1833 (not 1838, as previously stated) that the *Royal William* made her famous voyage, and she was not only the first ship to cross the Atlantic under steam, but the first to be built with a system of water-tight compartments and the first war steamer that ever fired a shot. This was in 1836, after she had been sold to the Spanish Government and was being used (under the name *Isabel Segunda*) in operations against Don Carlos

The origin of the Canadian steamer which thus has a triple distinction in marine history is rather interesting. Influential men who in 1821-24 wished to bring about a union of the North-American Provinces were met with the objection that there was really no inter-Provincial trade. As a result of the discussion subsidies were offered by the Legislatures of Lower Canada and Nova Scotia for steamship communication between Quebec and Halifax. Citizens of the two cities formed a joint stock company, and the *Royal William* was built in 1830-31 at Quebec at a cost of about $80,000. She was fitted with 200 hp. engines at Montreal, and in August of 1831 steamed from Quebec to Halifax with 90 passengers, 120 tons of coal, and some other freight. In 1833, after being sold to satisfy a mortgage, she left Quebec for London, Eng., via Picton. The voyage from the latter port to Gravesend lasted from August 18 to September 11, and steam was utilized the entire distance.—*Toronto Daily Star*, June 14, 1919.

To this it may now be added that two Britishers on June 15, 1919, made the first trip from Newfoundland to Ireland successfully by aeroplane.

James Milne.

Toronto, Ont.

James Watt Centenary

On August 25 one hundred years will have elapsed since the close of James Watt's life.

In honor of this centenary the engineers of Birmingham, England, the city of Watt's adoption, where his most important work was accomplished, are to provide permanent memorials. These are to consist of (1), the endowment of a professorship of engineering to be known as the James Watt Chair at the University of Birmingham, for the promotion of research in the fundamental principles underlying the production of power and the study of the conservation of the natural sources of energy; (2) the erection of a James Watt memorial building which shall serve both as a museum for examples of the work of Watt and his contemporaries, and as a meeting place and library for scientific and technical societies; and (3) the publication of a memorial volume.

Inasmuch as the benefits which the genius of James Watt bestowed on mankind are too widespread for any purely local celebration, the exercises in connection with the establishment of the memorials will be of an international character, with representatives from various organizations in different countries.

The representative of The American Society of Mechanical Engineers will be Mr. W. E. Symons, Chairman of the Finance Committee of the Society, who is now on his way abroad. A further announcement will probably be made in a later issue.

In his work throughout the country in behalf of discharged service men Colonel Arthur Woods, Assistant to the Secretary of War in charge of finding employment for demobilized soldiers, sailors and marines, has learned that in many sections people generally do not know just what the Government is doing to enable men disabled in the line of duty to reëstablish themselves in civil life. The authorized agency of the Government for carrying on this work is the Federal Board for Vocational Education, which is charged by Congress with the "vocational training of disabled soldiers and the placement of rehabilitated persons in suitable and gainful occupations," after their discharge from the Army.

Disabled men should accordingly get in touch with this Board which will place them in educational institutions, where suitable trades or occupations will be taught them according to their individual experience, capacities and preferences. A disabled man so incapacitated that he cannot take up his old occupation will be allowed to choose any occupation or trade which he thinks he would like to follow, subject, of course, to approval by the Board, which is interested only to be assured that the man is fitted to pursue the occupation or trade elected.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A. S. M. E.

Coöperation in Research by Government of Great Britain

THE following letter indicates action of the British Government in aiding research and is given for the information of the membership of the Society:

EDITOR MECHANICAL ENGINEERING,
29 West 39th Street, New York.

Dear Sir:

The action of the British Government, which has placed a fund of £1,000,000 at the disposal of the Research Department to enable it to subsidize industrial research, should be of interest to mechanical engineers and manufacturers.

The opinion is held in some quarters that we have been ahead of Great Britain in the matter of research work. The work of our Agricultural Department, Bureau of Mines and Bureau of Standards are held up as models of Government Research, and the work of the Altoona Locomotive Testing Plant of the Pennsylvania R.R., the Nela Park Laboratories of the General Electric Company and the laboratories of the Eastern Kodak Company, to select a few examples which occur to me, are held up as models of research work by private industrial companies.

The British system looks to the coöperation of Government and private effort. Thus, to select an example, instead of our Bureau of Mines making a more or less independent study of the combustion of coal in various types of furnaces and on various types of grates or stokers, the British idea is that such work should be done by an association composed of grate and stoker manufacturers aided financially by the Government. Each firm contributes a certain amount of money to its association and naturally has a voice in determining the problems to be studied. The Government supplies a certain aid or subsidy to the association, also exemption from taxation on funds contributed by individual companies.

At first it may seem that such an arrangement would be superior to our own because the work undertaken would conform more nearly to the immediate and pressing needs of the manufacturers. But, viewing the problem in its broad aspect and from the standpoint of future wealth and prosperity of the nation, it does not necessarily follow that all research work should be intensely commercial, that is, directly trained upon a pressing commercial problem. Many of the most valuable scientific discoveries have been made by men who were working purely in the search for truth and without any definite commercial object.

Our great national research organizations might therefore confine their efforts to work which has a less definite commercial value, while the more pressing problems could be handled by research associations after the British pattern and also, of course, by individual research work in each plant. This would make three links in the chain of research work. The work of the various research bodies could be coördinated or harmonized by suitable councils. Such bodies would recognize problems of a more purely scientific nature to be undertaken by the national bodies which have grown out of and are suggested by the more pressing commercial problems being studied by the research associations, or, on the other hand, recommend problems for study by the associations which have grown out of more general investigations made by the national organizations. To return to the example of the combustion of coal: elaborate studies of how coal is burned on grates and stokers are bound to suggest ideas for the design of a better stoker. Such a problem cannot be investigated further, however, by a purely government body, because it involves invention and patent rights. The British idea is to have such work done by a coöperative association of manufacturers and any patent rights become the property of the association, subject only to a few limitations, such as approval of foreign license. If the Government controlled inventions an undesirable, not to say dangerous, clash between industry and Government might eventually arise.

I am attaching the draft letter concerning the conditions as to the payment to research associations by the British Government.

Very truly yours,
(*Signed*) PAUL BANCEL.

New York, May 12, 1919.

Labor and Scientific Research

The American Federation of Labor at its Atlantic City meeting adopted a series of resolutions advocating scientific research as the basis for increased productivity in the industries and the promotion of the health and well being of employees. These resolutions, the most important of which were printed on page 625 of MECHANICAL ENGINEERING for July, call attention to the numerous pressing problems whose wise solution depends upon scientific and technical research, and to the overwhelming importance of science and technology to the national welfare whether in war or peace.

A—RESEARCH RESULTS

Cement and Other Building Materials A3-19 Roofing Materials, Specifications for plastic cements having troweling and brushing consistency for coal tar, pitch and asphalt from experiments. Address Director, Bureau of Standards, Washington, D. C.

Cement and Other Building Materials A4-19 Effects of Fine Grinding of Portland Cement. Cement ground 99 per cent fine when used in concrete mixtures of varying proportion at age of 7 days gave increase of strength ranging from 15 to 61 per cent of concrete of normal fineness. Tests of 28 days 3 months, 6 months and one year are in progress. Address Director, Bureau of Standards, Washington, D. C.

Cement and Other Building Materials A5-19 Reinforced-Concrete Beams. Recent tests of beams failing by compression on upper side indicate that ultimate compressive strength of concrete is considerably greater when tested in form of beam than when tested in the form of prism under uniformly distributed load. This fact gives promise of forming a reliable basis for increase in safe working stress in compression. Work is now being carried on regarding shearing stresses in beams. The work was conducted in connection with the design of reinforced-concrete ships. Results indicate that much larger web reinforcement may be more advantageously used than that hitherto deemed permissible. Address Director, Bureau of Standards, Washington, D. C.

Heat A1-19 Heat-Transfer Rate in Boiler Tests. Experiments on the rate of heat transfer from a hot gas through a cooler metallic substance. Babcock & Wilcox Company, 1916. The results of these experiments are given in a book of 84 pages published by the Babcock & Wilcox Company, New York. The heat-transfer rate in B. t. u. per hour per deg. fahr. temperature difference per sq. ft. is given by the formula

$$R = a + b\ (W/A)$$

where W = weight of gas passing through absorbing surface per hour, in lb.

A = area of cross-section through which gas passes, sq. ft.

The value of a is 2.0; b is 0.0014 in general, although it changes with temperature as shown by Figs. 1 and 2.

The temperature difference to be used is given by

$$\text{Temp. Diff.} = \frac{\Delta T_1 - \Delta T_2}{\log_e (\Delta T_1 / \Delta T_2)}$$

where ΔT_1 and ΔT_2 are temperature differences between gas and steam at entrance and exit. Figs. 1 and 2 show the plotted results for values of R with ordinary tubes and for annular channels.

Electric Power A2-19 The Present Development of Transmission Lines in Kansas, by F. Ellis Johnson, University Experiment Station, University of Kansas, Lawrence, Kan. Address Director A. A. Potter. This Bulletin describes the growth of transmission lines, their origin, agreements, service to farmers, popular feeling, industrial power lines, agricultural lines, construction features and economy.

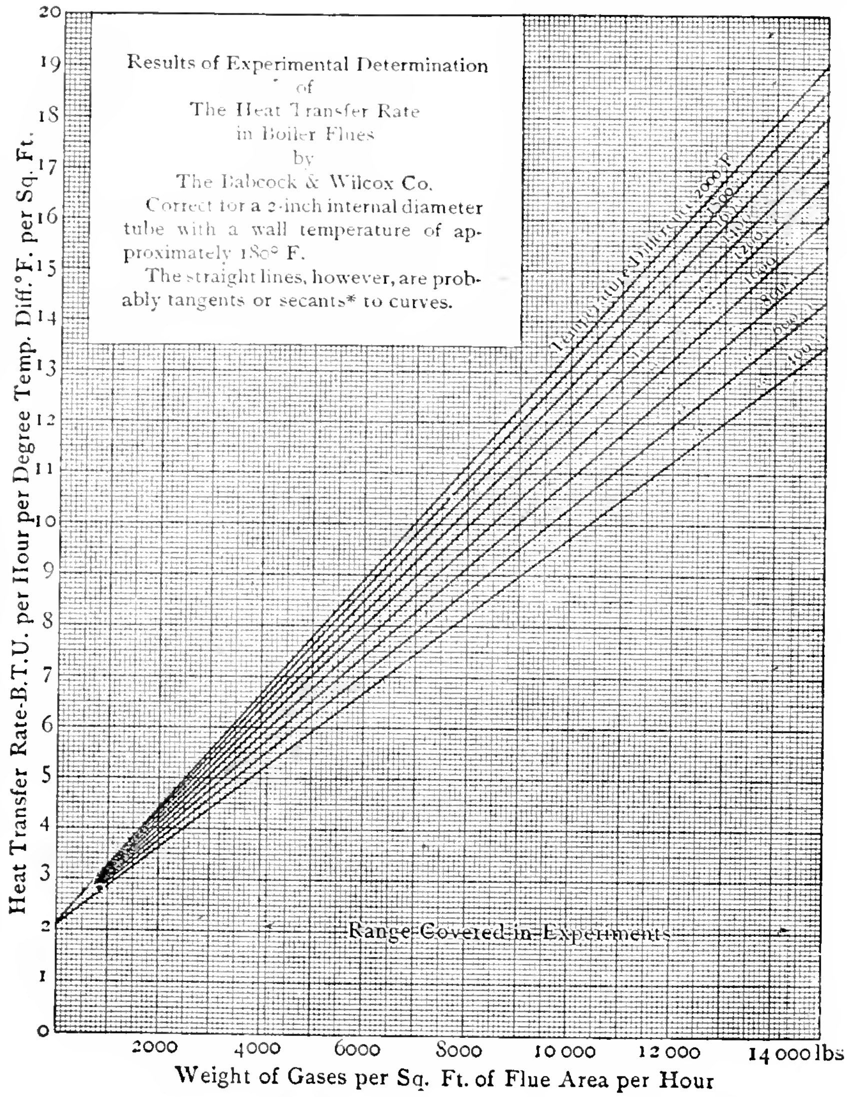


Fig. 1 Heat-Transfer Rates for 2-in. Boiler Tube

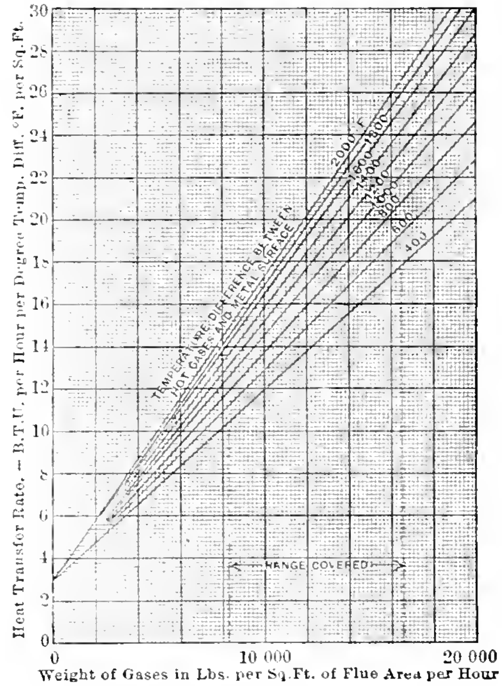


Fig. 2 Heat-Transfer Rates for Tube 2 in. in Internal Diameter Fitted with a Core 1 in. in External Diameter

Leather and Glue A1-19 Linoleum Cements. Investigation on linoleum cement showing that shellac cements with alcohol as thinner with and without finely powdered mineral filler were more waterproof and held linoleum more tenaciously to concrete or steel than those cements made from dextrin or other water-soluble gums or some other resins cut in alcohol. Shellac cement with mineral filler adhered more tenaciously and did not become brittle or dry as that without filler. When water-soluble pastes are used a strip 1 ft. on either side of seam should be cemented with waterproof cement. Address Director, Bureau of Standards, Washington, D. C.

Metallurgy and Metallography A4-19 The Relation of the Phase Changes to Microstructure in the Heat Treatment of Aluminum Bronze, by L. R. Seidell and G. T. Horvitz. See *Chemical and Metallurgical Engineering*, or address New York Testing Laboratory, 51 E. 42nd St., New York.

Metallurgy and Metallography A5-19 The Relation of Quenching Temperature to the Microstructure in High-Speed Steel with Effect on Physical Properties. Paper to be read before American Steel Treaters' Society. Address New York Testing Laboratory, 51 E. 42nd St., New York.

B—Research in Progress

Apparatus and Instruments B7-19 Diaphragm Indicator for Internal-Combustion Engines. Development work is being carried on by the Bureau of Standards on an indicator for gas engines at high rotational speed with a diaphragm indicator with beam of light. Address Director, Bureau of Standards, Washington, D. C.

Apparatus and Instruments B8-19 Bourdon Gages for 30,000 lb. per sq. in. A study of the performance of two Bourdon pressure gages for 30,000 lb. per sq. in. with reference to drift of indication.

Apparatus and Instruments B9-19 Abrasion Machines. Investigation to determine relationship, if any, which exists between abrasion test on Deval machine when using shot and when no shot are used. By R. A. Seaton, Engineering Experiment Station, Kansas State Agricultural College, Manhattan, Kan.

Cement and Other Building Materials B4-19 Reinforced-Concrete Beams. Recent tests of beams failing by compression on upper side indicate that ultimate compressive strength of concrete is considerably greater when tested in form of beam than when tested in the form of prism under uniformly distributed load. This fact gives promise of forming a reliable basis for increase in safe working stress in compression. Work is now being carried on regarding shearing stresses in beams. The work was conducted in connection with the design of reinforced-concrete ships. Results indicate that much larger web reinforcement may be advantageously used than that hitherto deemed permissible. Address Director, Bureau of Standards, Washington, D. C.

Cement and Other Building Materials B5-19 Reinforced-Gypsum Beams. Standards of design for beams and floors with gypsum in connection with Committee C 11 of the American Society for Testing Materials. Bureau of Standards. Address Director, Bureau of Standards, Washington, D. C.

Cement and Other Building Materials B6-19 Run-of-Pit Gravel for Concrete Without Use of Other Aggregate in Kansas. Engineering Experiment Station, Kansas State Agricultural College. Address Dean A. A. Potter, Manhattan, Kan.

Cement and Other Building Materials B7-19 Sand-Cement Concrete Without Coarse Aggregate. A research to determine at what price crushed stone can be used. A study for localities where little coarse aggregate is available. Engineering Experiment Station, Kansas State Agricultural College. Address Dean A. A. Potter, Manhattan, Kan.

Cement and Other Building Materials BS-19 Use of Joplin Chats as Concrete Aggregate in Coarse or Fine Condition. Engineering Experiment Station, Kansas State Agricultural College. Address Dean A. A. Potter, Manhattan, Kan.

C—Research Problems

Glass and Ceramics C1-19 Enameling by the Use of Colloids instead of Petroleum Solvents. General Efficiency Department, Chevrolet Motor Company, Tarrytown, N. Y.

D—Research Equipment

Aircraft D2-19 Propeller Dynamometer. Designed for 14 lb-ft. torque, 60 lb. thrust and 5600 r.p.m. to test model air propellers in large wind tunnel through variable-speed motor of 15 hp. capacity. Address Commander McEntee, Navy Yard, Washington, D. C.

Aircraft D3-19 Research Facilities at the Curtiss Engineering Corporation. The Curtiss Engineering Corporation is situated conveniently near New York City, the aviation fields and the bays of Long Island, at Garden City, L. I. The plant is primarily an experimental plant and is devoted to aeronautical research in all forms. Address Research Laboratory, Curtiss Engineering Corporation, Garden City, L. I. (See Research Personal Notes. *Aircraft E1-19*, for private use of this laboratory.)

Equipment. The plant with all manufacturing facilities.

Research Department. This department has three wind tunnels in operation:

One large Eiffel-type wind tunnel recently completed, run by a 400-hp. gasoline motor, electrically controlled. The experimental chamber is an improvement on all existing types. The experimental chamber is 15 ft. long, 13 ft. wide, and about 20 ft. high, and the cross-section of the air stream at the balance is 7 ft. Speeds up to 100 m.p.h. are now obtainable and shortly will exceed this value. The balance is a specially designed one of the unipivot type sensitive to less than 0.0001 lb. of wind force.

One 4-ft. wind tunnel of the enclosed type improved, actuated by a Curtiss OX motor and an especially designed air-turbine propeller; a special Curtiss-type wind-tunnel balance is used. Air speeds up to about 80 m.p.h. are available in this tunnel.

One 2-ft. wind tunnel for qualitative work, run by an electric motor giving wind speeds around 30 m.p.h.

A completely equipped model-making and instrument-making shop. This shop is equipped with three lathes (one of great precision and all electrically driven), one jointer, one hand saw and a wood-turning lathe, and a number of special apparatuses to facilitate the work of model making.

Research Work. The Research Department undertakes any special investigation of a theoretical nature required. Wind-tunnel tests of all kinds are carried out in these tunnels by a competent staff. Tests on new wing sections at various speeds, tests on new models giving stability and performance before the full-size machine is built or flown make for the utmost safety in the work. Tests on stream-line forms such as fuselages, dirigible shapes, flags, propellers, gasoline pumps, generator turbines, etc., are being made continually.

The Curtiss Aeronautical Library is a very complete collection of aeronautic literature in all languages. It subscribes to all aeronautic periodicals of any importance.

Chemical and Materials and Heat-Treatment Laboratories. These laboratories are equipped to test all materials entering into airplane construction.

Staff of Research Department. J. P. Tarbox, Director, Dr. J. G. Coffin, Assistant Director and Physicist, and three to five technical research engineers and a librarian. The model shop employs a corps of expert model makers.

Staff of Chemical and Material Laboratories. Mr. Frisbie, Mr. Crossley, Chemist.

Research Time. All of the work in general is of a research nature. About one-half is devoted to pure research.

Automotive Vehicles and Equipment D1-19 Equipment, Personnel and Problems of the Packard Engineering Laboratory. Address Packard Motor Car Co., Engineering Executive, Detroit, Mich.

Equipment. The equipment is divided into two classes, motor-testing equipment and bench-testing equipment. The motor-testing equipment consists of three electric cradle-type dynamometers, one for high-speed passenger-car work up to about 100 hp. and 3500 r.p.m., an airplane-engine dynamometer capable of carrying 400 hp. continuously and over 500 hp. for a brief period for speeds up to 2000 and 2200 r.p.m. maximum, and a truck-engine dynamometer to take care of heavy torques at low speed and capable of carrying about 60 hp. at 1000 r.p.m. The accessories of these three dynamometers are practically identical. The grids of the absorption resistance are located in a separate room and the heat is carried away by forced draft.

In laying out the dynamometer room proper the chief point was to eliminate all possible obstructions above ground in the way of piping and wiring in order to preserve a clean room free from excessively high temperatures or noxious gases so that the operators would have the best of surroundings and be able to concentrate on the problems at hand. This layout permitted of a maximum amount of daylight, which is very desirable for accurate work. The exhaust system is taken care of by underground tunnels connected to a 10-hp. electric fan located outside of the room and communicating with a stack extending above the roof. Communication between the engine exhaust pipe and the exhaust tunnel is afforded by a standard manhole cover into which suitable lengths of flexible steel tubing are screwed for connection to the exhaust pipe of the engine. For airplane-engine work exhaust stacks are used which discharge into suitable sheet-iron exhaust boxes which take the place of the manhole cover so as to present a minimum obstruction to the free exit of the exhaust gases.

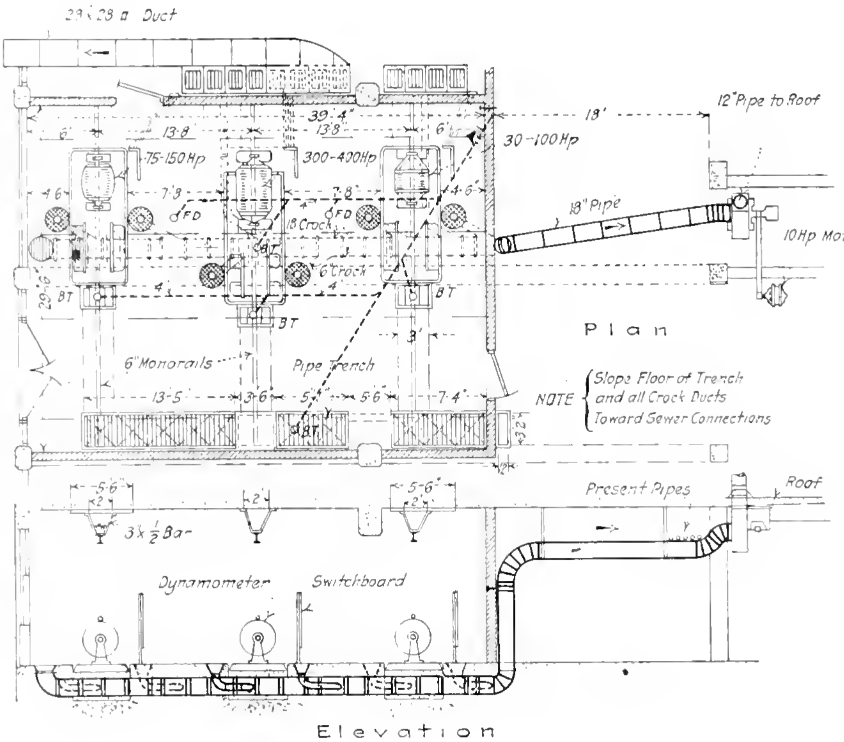


Fig. 3 Plan and Elevation of Packard Laboratories for Heavy Motors

Gasoline is delivered to the dynamometer room by the remote-control Bowser system with a meter located in the dynamometer room. Two gasoline tanks are provided at an elevation of about 8 ft. from the floor, one of which is mounted stationary and the other is fixed on the platform of a sensitive balance. Gasoline feed pipes to the three dynamometers are run in roomy tunnels under the floor, and by a system of six valves it is possible to feed any one of the three dynamometers from either the fixed tank for ordinary runs or from the tank mounted on the scales for economy tests.

Water piping and the water system are underground as far as possible, a 25-gal. tank being located in each of the three tunnels leading to the respective dynamometers. Suitable hot- and cold-water connections are made to this tank and controlled by valves the handles of which project above the floor. Access to these tunnels is provided by hatchways which are readily removable. The entire piping and tunnel layout is clearly shown in Fig. 3.

Ample bench room is provided to do the minor fitting work required in work of this character. Dynamometer readings consist of speed

and torque readings. Speed readings are taken by carefully calibrated tachometers and checked by positive counters. Torque readings are taken by means of springless scales and checked by tare beam. Specially designed dynamometer couplings are used to take care of slight misalignments. A uniform system of engine controls is mounted on each dynamometer so as to be readily adaptable to any kind of engine. A trolley runs over each dynamometer and a chain hoist is used for mounting and dismounting the engines. The airplane dynamometer has in addition to its gasoline and water feeds an oil-circulating feed, the oil being returned to a tank mounted on a sensitive scale adjacent to the gasoline scale. Oil consumption of truck and car motors is arrived at by separate portable apparatus which involves the use of a small oil pump driven by an electric motor and an oil reservoir mounted on a sensitive scale. The engine being tested with latter apparatus is run with a dry sump. See Fig. 4.

Compressed air, suitable sockets for electric drills, hot and cold water, 6-volt battery current, etc., are all piped to the front of each dynamometer for purposes required in various tests.

The bench-dynamometer room (Fig. 5) is intended for all tests other than motor-power tests and its equipment is of growing and varied nature. It is not necessary to describe in detail each piece of apparatus but the diversity of tests can be judged by the following list:

1 Endurance tests on plain and ball bearings.

2 Endurance tests of magnetos, generators, starting motors, fans, oil pumps, air pumps, tire pumps, camshaft drives, universal joints, and many other accessories which are submitted from time to time. In this connection the object is to provide in each case a more or less permanent set-up so as to be available for a repetition of the test at any time in the future.

3 Calibration of radiators to determine their efficiency alone and in conjunction with various water pumps and fans.

4 Storage-battery characteristics.

It can be readily realized that the above list does not by any means comprise all the various experiments which come under the general heading of bench tests. It is also impossible to start out with a laboratory for this work fully equipped since the very nature of the work demands the designing of new equipment from time to time. A comprehensive switchboard for electric-motor speed control has been worked out for all the motors used in this room and some such system is essential to do accurate work of this nature. In general each piece of apparatus is directly connected to an electric motor and in no case is a belt or any other form of a friction drive used. Direct current (220 volts) is used and the field and armature connections from each motor are brought to a common switchboard. A bank of cast iron grids is connected across the line and 220 equally spaced taps off of these grids are connected to a special dial switch. By means of suitable plugs similar to a telephone switchboard any motor in the room can be connected to this dial switch and in this manner its speed variation can be controlled very closely since the increments of voltage supplied to the armature or field differ by only one volt. When the proper speed has been reached for any particular run the proper plug connection is made and the dial switch is again free to use with any other motor.

Another room is provided into which cars and trucks can be run for such special work or inspection as may be desired.

Personnel. The dynamometer-room personnel consists of a foreman with about twelve men with particular experience for this class of work. This demands a thorough understanding of all engines and a fair amount of mechanical skill of a wide nature. The office force consists of four engineers and a man to take care of the clerical and stenographic work. The work is generally divided among the engineers in a manner to develop specialists. One man, for example, will concentrate on the getting out of reports, another man will supervise bench tests, another man will do the necessary designing of all the apparatus required and concentrate on calculations, etc. A cast-iron rule is that a record be kept of every experiment whether successful or not.

Problems. The problems presented generally can be classed as follows:

1 Routine Work. This is generally a matter of proving out certain elements in a new design and for the most part present no difficulties since it is generally a comparison between an old design and a new one. These tests, of course, cover a very wide range, some might take but a few minutes and others might stand over a period of several months.

2 Factory Troubles. All tests pertaining to factory troubles are given precedence over all other work and these generally consist of troubles which do not manifest themselves until wholesale production of a certain design is gone into. Work of this character demands the utmost concentration and all possible speed.

3 Research Work. This work generally contemplates improvements in the product which are not essential for immediate production and which are of such a character as not to permit of their solution on the drawing board. This work is used as a filler-in proposition and generally jobs coming under the previous headings have precedence over this work. A certain amount of design work is necessary to carry on these researches and this necessitates the co-operation of the other Engineering Department.

No work is undertaken by this Department unless the Engineering Executive gives his authority and reports are given him from time to time showing the progress made on various tests. In case of a conflict as to the precedence of various tests, appeal is made to the Engineering Executive. This department also controls all road testing and aims to have on the road a car or truck for day and night running at all times. These cars operate over carefully-laid-out routes with competent crews for operation. Careful reports are kept of all incidents affecting the tests.

In general it is the aim of this department to insure that all defects in apparatus undergoing tests should be brought to light and viewed from this light its responsibilities are great. The vast amount of money spent by all automobile concerns in service and free replacements can be greatly diminished by the use of suitable testing equipment and it is felt that this aspect is being realized more all the time. The fact that so many points in design can be definitely proven to be good or bad by accelerated test is of the utmost importance in proving out a design. An engine for instance can be run for 24 hours a day at a speed of 60 miles per hour on the dynamometer and in this manner an astonishingly high mileage can be secured in a very short time. Of course, good judgment must be exercised in making these tests since under certain conditions they can be very much more severe than will ever be encountered in service, but in general the only disadvantage from going by an accelerated test is that the factor of safety may be too high and the particular part may be too heavy or too expensive.

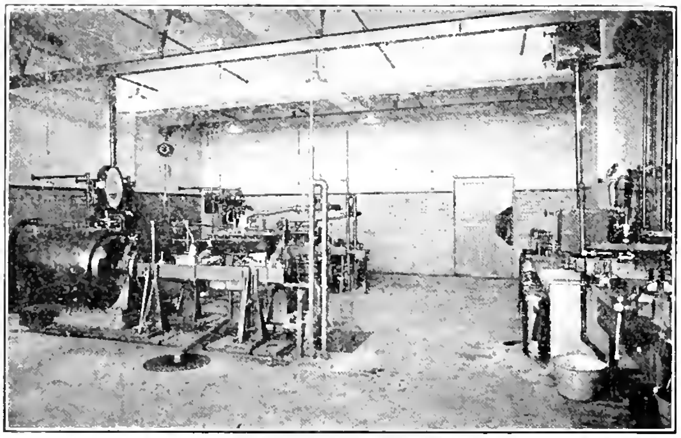


FIG. 4 PACKARD LABORATORY FOR HEAVY MOTORS

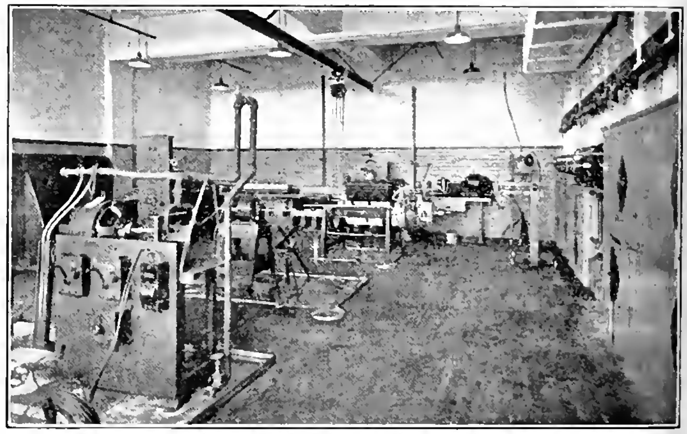


FIG. 5 PACKARD LABORATORY FOR SMALL DYNAMOMETERS

Curtiss Engineering Corporation D1-19 Description of equipment and personnel under *Aircraft D3-19*.

Detroit Testing Laboratory D1-19 Chemical and physical apparatus, testing machines for strength, hardness, impact, metallographic equipment. High-temperature furnaces and pyrometers for heat treatment of metals, chemical processes and oil production from shale.

The James H. Herron Co. D1-19 Laboratories equipped for chemical analysis, physical tests, metallurgical and metallographic work, 500,000-lb. universal machine, 200,000 lb. compression machine, Brinell hardness tester, Shore hardness tester, metallographic equipment for ferrous and non-ferrous metals, crucible, open-hearth and electric furnaces

heat-treatment apparatus. The laboratory works in iron, steel, bronzes, brass, bearing metals, clays, refractories, enamels, fuels, oils and lubricants. The work of research for development is one feature of the laboratory. Address James H. Herron Co., Cleveland, Ohio.

Robert W. Hunt Company D1-19 Laboratory for commercial testing for clients. Address Robert W. Hunt Co., Chicago, Ill. The general equipment of the physical testing laboratory is as follows:

- Riehlé horizontal testing machine fitted with 200-lb. and 1000-lb. spring balances
- Riehlé vertical-screw machine, 50,000 lb. capacity. Maximum sizes taken: 6 ft. on tension tests, 20 in. on compression tests, and 16 in. on transverse tests
- Riehlé vertical-screw machine, 30,000 lb. capacity. Maximum sizes taken: 5 ft. on tension or compression tests, 8 ft. on transverse
- Riehlé vibratory machine for staybolt iron
- Standard brick rattler
- Standard Deval abrasion machine
- Bausch & Lomb microphotographic outfit
- Gas furnace and LeChatelier pyrometer
- Shore scleroscope
- Standard Tyler sand sieves
- Stone sieves, size 2 in. — ¼ in.
- Completely equipped chemical laboratory. Rotary cement kiln, ceramic furnace for shales and clays, and apparatus for melting points to 3000 deg. fahr.

Kansas State Agricultural College, D1-19 Equipment for Research.

Material-Testing Machines

- 50,000-lb. Riehlé universal testing machine
- 100,000-lb. Riehlé universal testing machine
- 200,000-lb. Olsen universal testing machine adapted to beams to 20 ft. span and columns of 15 ft. high
- 250,000-lb. torsion testing machine
- Upton-Lewis toughness-testing machine for reversal of stress
- Shore scleroscope for hardness
- Brinell hardness machine
- Bausch & Lomb metallurgical microscope

Laboratories

- Cement laboratory
- Concrete and aggregate laboratory
- Road-materials laboratories for non-bituminous and bituminous materials
- Hydraulic laboratory with weirs, orifices, tanks, pumps, rams, turbines, meters, pipes and fittings.

Lincoln, Hanson & Abbott D1-19 Laboratories of Lincoln, Hanson & Abbott, Portland, Me., equipped for standardizing instruments, testing transmission systems and central stations, investigations of high voltage, and with apparatus for making tests of materials for underwriter's requirements. Laboratories also equipped for photometric measurements. The equipment is complete for all kinds of electrical investigations.

Marine Engineering D1-19 Ship Model Basin. Experimental model basin, Navy Yard, Washington, D. C., 380 ft. long, 40 ft. wide and 14 ft. deep with tow carriage carrying resistance dynamometer and other measuring apparatus. Capacity of dynamometer, 450 lb. maximum. Speed of carriage, 18 knots (or 30 ft. per sec.). Basin is equipped for measuring rolling and pitching. For shallow-water experiments false floor can be installed. Apparatus for producing waves in basin is installed. Propellers of 16 in. in diameter or 6 in. in diameter may be tested at this plant. Address Commanding Officer, Department of Construction and Repair, Navy Yard, Washington, D. C. See Research Personnel Notes, *Marine Engineering, E1-19*, p. 537 of June issue, for use of above in interest of private parties.

Metallurgy and Metallography D3-19 Electric Furnaces. Northrup Ajax furnace operated with alternating current of from 10,000 cycles per second, giving temperature within an inductor coil of 2500 to 2800 deg. cent. Furnace of special value in obtaining carbon-free melts. Address Pyrolectric Instrument Co., Trenton, N. J.

Packard Motor Car Company D1-19 Research Laboratory. See *Automotive Vehicles and Equipment D1-19*.

New York Testing Laboratory D1-19 Organization composed of graduate chemists and metallurgists with wide experience in the manufacture of iron and steel, furnaces, foundry practices for ferrous and non-ferrous metals, forging practices, heat treatment, physical tests, impact, metallographs, analyses. Address New York Testing Laboratory, 51 E. 42nd St., New York.

Henry S. Spackman D1-19 Private Laboratories of Henry S. Spackman Engineering Company, 2024 Arch St., Philadelphia, Pa. Specially equipped for chemical and physical tests of cement, concrete, steel, iron and alloys.

Enrique Touceda D1-19 Laboratory of Enrique Touceda, Albany, N. Y. Laboratory well equipped for physical and chemical properties of ferrous and non-ferrous metals and alloys. Structural composition and heat treatment. Laboratory well equipped for special research. Analytical investigations of a routine nature are made. Address Enrique Touceda, Albany, N. Y.

E—Research Personal Notes

Aircraft E1-19 Use of Research Laboratory of Curtiss Engineering Corporation.

The equipment of this laboratory may be used for solutions and investigations of problems in aerodynamics at reasonable rates. Address Curtiss Engineering Corporation, Garden City, N. Y.

F—Bibliographies

Air F2-19 Utilization of Wind Power. A bibliography of 9 pages. Search 2430. Address A. S. M. E., 29 West 39th St., New York.

Apparatus and Instruments F1-19 Wet Gas Meters. A bibliography of 1½ pages. Search 2478. Address A. S. M. E., 29 West 39th St., New York.

Boilers F1-19 Use of Boiler Compounds or Kerosene Oil for Boiler Cleaning. Search 2482. Address A. S. M. E., 29 West 39th St., New York.

Economics F1-19 Labor Hiring and Discharging. A bibliography of 4 pages. Search 2510. Address A. S. M. E., 29 West 39th St., New York.

Economics F2-19 Depreciation and Amortization of Machinery and Machine Tools. A bibliography of 4 pages. Search 2545. Address A. S. M. E., 29 West 39th St., New York.

Foundry Equipment, Materials and Methods F1-19 Aluminum Castings: Remelting. A bibliography of 4¼ pages. Search 2581. Address A. S. M. E., 29 West 39th St., New York.

Fuels, Gas, Tar and Coke F1-19 Pulverized Coal. Search 2301. Address A. S. M. E., 29 West 39th St., New York.

Fuels, Gas, Tar and Coke F2-19 Burning Tan Bark Under Steam Boilers. A bibliography of 1 page. Search 2567. Address A. S. M. E., 29 West 39th St., New York.

Fuels, Gas, Tar and Coke F3-19 Calorific Value of Fuel Oils. A bibliography of 1 page. Search 2496. Address A. S. M. E., 29 West 39th St., New York.

Fuel Utilization F1-19 Furnaces for Green Bagasse. A bibliography of 1½ pages. Search 2578. Address A. S. M. E., 29 West 39th St., New York.

Heat F1-19 Utilization of Solar Energy. Search 2431. Address A. S. M. E., 29 West 39th St., New York.

Heat F2-19 Transmission of Heat Through Glass. A bibliography of 4 pages. Search 2461. Address A. S. M. E., 29 West 39th St., New York.

Heat F3-19 Heat Radiation and Convection. A bibliography of 3 pages. Search 2495. Address A. S. M. E., 29 West 39th St., New York.

Hydraulics F3-19 Flow of Oil Through Orifices. A bibliography of 1 page. Search 2563. Address A. S. M. E., 29 West 39th St., New York.

Hydraulics F4-19 "United States Water Power Resources." A bibliography of 6 pages. Search 2508. Address A. S. M. E., 29 West 39th St., New York.

Internal-Combustion Engines F1-19 Gas Turbines. A bibliography of 2 pages. Search 2547. Address A. S. M. E., 29 West 39th St., New York.

(*Continued on page 718*)

ENGINEERING SURVEY

A Review of Progress and Attainment in Mechanical Engineering and Related Fields, as Gathered from Current Technical Periodicals and Other Sources

SUBJECTS OF THIS MONTH'S ABSTRACTS

FACTORY MANAGEMENT

The Silent Watchman Over Industry. The necessity of plant protection against human destructive agencies has been forcibly emphasized by various occurrences during the period of the war, but even in times of peace there is an essential need of adequate protection for plants.

The article briefly discusses the problem of fire protection and then goes into considerable detail as to protection by fencing in the premises. Such fencing-in protects the plant against trespassers, with all the danger that they involve in the way of theft and increased possibility of fire.

Many types of fences designed to give plant protection are on the market. During the war the amount of such fencing sold to industrial plants was very large. In some instances the Government itself paid for the fencing, while in other cases it refused to award contracts until the fencing was installed by the company itself. The cost of fencing may be as high as $2 a lineal foot.

In addition to fencing, flood light was extensively used during the war. It has been estimated that during 1917 and 1918 some 100,000 flood lights were sold to American plants for protection purposes, but the sales fell off tremendously after the signing of the armistice. (*The Iron Trade Review*, vol. 64, no. 25, June 19, 1919, pp. 1609 to 1612, 6 figs., *g*)

FOUNDRY

A Permanent Mold or a New Method of Molding, F. B. Gordon. The author begins by justly pointing out that our modern methods of molding are to all practical purposes the same as those which were practiced by the Egyptians 4000 to 5000 years ago. From this he proceeds to a brief description of a discovery by William M. Hoffman, of Buffalo, N. Y., who claims that he has found a new molding material.

While exploring corundum veins in the Blue Ridge Mountains of North Carolina, he came upon a surface of combination amphibole and actinolite.' These minerals belong to the same class as asbestos, with the addition of magnesia and other minerals of a refractory nature. It is claimed that with a proper binder, which is said to have been perfected, it is possible to use these materials for permanent molds. No data as to the method of using such molds, their life and way of restoring the mold face are given in the original article. (*Canadian Foundryman*, vol. 10, no. 6, June 1919, p. 147, *d*)

FUELS AND FIRING

The Alcohol Fuel Committee's Report. Abstract of the report of the Alcohol Fuel Committee appointed in October 1918 by the British Government.

The Committee consisted mainly of the nominees of Government Departments, not necessarily fuel experts, but appointed to survey the situation, to estimate the importance of the problem and to report as to the best steps to be taken.

The report indicates that the climate in Great Britain is not well suited to the growth of most alcohol crops, but that synthetic production of alcohol is a commercial possibility. A spirit can be obtained from ethylene extracted from coal and coke-oven gases and it is estimated that the production of 100,000,000 gal. a year might be reasonably expected in Great Britain if the necessary facilities were given for the development of the method.

The statement is made, however, that the main sources of power alcohol must be found in the vegetable world in tropical and subtropical countries.

The main conclusions of the report are that in order that the fuel may be available in quantities and at the right price, a material change must be made in many government regulations. The use of cheaper denaturants must be permitted, continuous distillation must be allowed and also simultaneous fermentation and distillation in the same building. These changes would occasion the abandonment of the present regulations for ascertaining specific gravity before fermentation.

The report also recommends the establishment by the government of a permanent organization to initiate and supervise experimental and practical development work on production and utilization of power alcohol. (*Motor Traction*, vol. 29, no. 748, July 2, 1919, pp. 5-6, *g*).

German Experience with Coke Firing of Boilers During the War

Coke Firing, Reichelt. Data on the present state of knowledge of coke firing in Germany, embodying apparently experience gained during war.

It is pointed out that a clear distinction should be made between gas coke and metallurgical coke. Gas coke is easier to ignite because its structure is less compact, while coke from coke ovens, especially that made from fat coals, has a compact structure and is less easy to ignite.

When burned, coke keeps the shape of the lump longer than coal. Coke is more difficult to bring to the state of incandescence, but it burns slower. It does not give off its heat with the same speed as coal and because of this, in order to burn the same weight of fuel one has to employ a larger grate and use a deeper fuel bed; its lower specific weight as compared with coal also makes a larger grate necessary.

The size of the lumps is essential. If the lumps are too large, the surface subject to the action of the air is too small to maintain the combustion process, at least if the draft remains within

the same limits. Metallurgical coke as it comes is usually in too large lumps. It is pointed out that the users of coke cannot be expected to crush it, as under present conditions it is impossible to secure crushing equipment, so that the coke should be crushed at the plants. The limits of size are indicated by the author as 10 mm. (0.4 in.) on the one hand to 40 mm. (1.6 in.) on the other.

The finer sizes, and in particular coke breeze, make too dense a layer and with ordinary draft do not provide for a sufficient contact with the air. Their combustion on a plain grate is possible only when special appliances are used.

As a rule, coke requires a stronger draft, which is due to the greater depth of the fuel bed and the resulting increased resistance to the flow of air.

The portable boilers easiest to equip for coke combustion are of the locomotive type, because of the powerful draft available. As a rule, in locomotive operation coke is mixed with coal in the ratio of 1 to 2.

Otherwise coke is but little adapted for portable boilers because of the lack of suitable draft.

For use on shipboard coke is likewise not well suited because the ship bunkers cannot take up as much coke as they would coal. Furthermore, coke is not as convenient as coal where operation of the boilers is of an intermittent character, as it is in river- and canal-boat transportation.

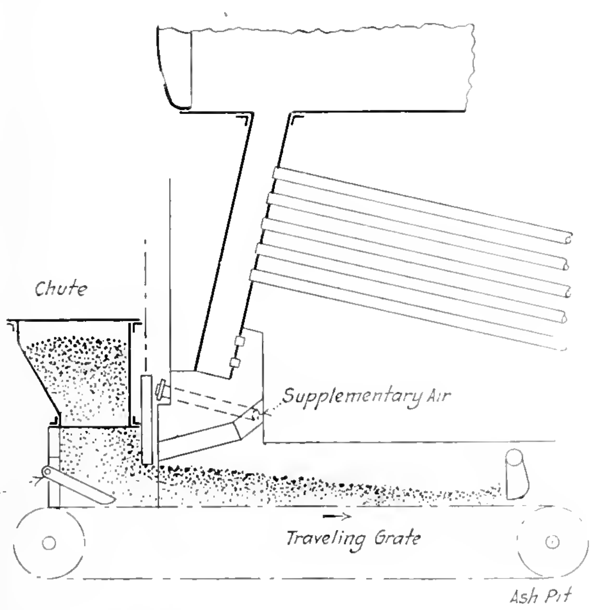


Fig. 1 Traveling Grate with Producer Hopper

It would appear, therefore, that stationary boilers are the main prospective consumers of coke.

It has been stated on many occasions, however, that with coke the boiler cannot deliver as much steam as with coal, especially when working at overload. This is due to the unsatisfactory flame formation resulting from the lack of volatile compounds (1 to 2 per cent in coke as compared with 20 to 30 per cent in coal) and also to the slower combustion of coke equivalent to a lower grate output. Hence, when it is impossible to increase the grate area, the output of steam is apt to fall off.

Likewise lower superheater temperatures have to be taken into consideration, as the exhaust gases enter the superheater at a lower temperature than when coal is used, due partly to the shorter flame and partly to greater excess air.

Coke firing makes greater demands on the fireman. It is recommended that in large plants those boilers that carry normal load be fired with coke, while the peaks of the load curve should be taken care of by boilers equipped for mixed or straight coal firing.

As regards the grate construction it was obvious that the traveling grates designed for coal would not do for coke. This problem was solved by subjecting the coke to a generator action. This means that the coke was brought to a bright glow in a separate hopper and from there delivered on to the traveling grate in a layer from 0.4 m. to 0.5 m. (1.31 to 1.64 ft.) deep, depending on the size of the coke. On the grate the coke was burned in a gradually decreasing depth, as shown in Fig. 1. At the end of the grate slag pockets were provided to prevent too much air from entering.

In order that the combustion should go on properly, it is important to maintain a powerful fire in the lower part of the auxiliary hopper, the purpose of which is to ignite the mass of coke lying above it. A sort of hearth is employed, so arranged that it has nothing to do with the advance of the fuel toward the

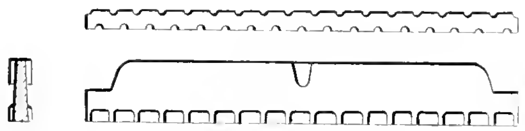


Fig. 2 Nozzle Grate Bar

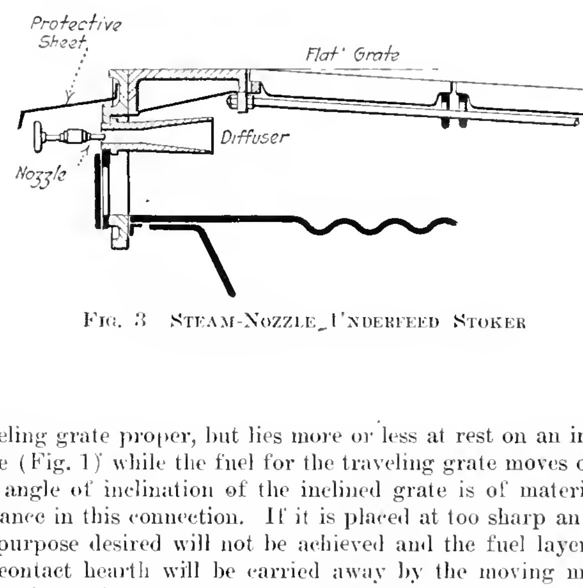


Fig. 3 Steam-Nozzle Underfeed Stoker

traveling grate proper, but lies more or less at rest on an inclined grate (Fig. 1) while the fuel for the traveling grate moves over it. The angle of inclination of the inclined grate is of material importance in this connection. If it is placed at too sharp an angle, the purpose desired will not be achieved and the fuel layer from the contact hearth will be carried away by the moving mass of coke, which will result in stopping the ignition of the coal in the hopper and "freezing" the latter.

The producer action of the auxiliary hopper, together with the deep layer of fuel, favor the production of carbon monoxide and hence flame formation, which is highly desirable. In order, however, to bring about a complete combustion of the gases, it is necessary to admit fresh air directly into the combustion space, which can be done most simply by means of tubes passing through the fire arch.

Several German concerns have devoted a considerable amount of effort to the study of coke combustion. Some of the results of this investigation were published in 1916 in a German publication; from that publication are taken the data of an evaporative test given in Table 1.

The following should be noticed in this connection: The heat balance is very good at the efficiency of 73 per cent, and with the factor of evaporation of 6.7 as compared to the efficiency of 71.5 per cent and the factor of evaporation of 7.5 of the same boiler with coal firing. Should the prices of fuel be proportional to the factors of evaporation and no other considerations enter into the question, the test would indicate that coke is just as good a fuel as coal.

The CO_2 content of 12.5 per cent is quite good and tends to

indicate that there was no particular excess of air. At the same time it should be borne in mind that this test was carried out under very favorable conditions. In particular the coke was quite carefully sorted so that the lumps were between 70 and 90 mm. (2.7 in. to 3.5 in.) in size and approximately uniform.

TABLE 1 EVAPORATIVE TEST OF A COKE-FIRED BOILER

Heating area of boiler, sq. m.	245.0
Grate area, sq. m.	5.3
Fuel, metallurgical coke	
Lump size, mm.	70 to 90
Duration of test, hr	6
Feedwater, by volume, liters	23,900
Feedwater, by weight, kg	23,309
Feedwater temperature at boiler inlet, deg. cent.	80.3
Steam pressure, gage, atmospheres	10.8
Steam temperature, deg. cent.	367.7
Heat content of steam (according to Mollier tables), kg-cal. per kg	765.1
Heat content of feedwater, kg-cal. per kg	80.3
Heat of evaporation, kg-cal. per kg	684.8
Total weight of fuel, kg.	3475
Residues of combustion, kg.	435
Residues of combustion in relation to total fuel, per cent	12.5
Exhaust-gas temperature at damper, deg. cent.	305
Boiler-room temperature, deg. cent.	25
CO_2 content of exhaust gases, per cent	12.5
Draft at the damper, mm. of water	16
Steam generated per kg. of coke, kg	6.7
Steam generated per sq. m. of heating area per hour, kg.	15.9
Fuel consumption per sq. m. of grate area per hour, kg	109
Heat value of fuel kg.-cal.	6280
Combustible in the ashes, per cent	7.7
Heat Balance	
Efficiency of boiler and superheater, per cent	73.0
Smoke-stack losses (according to Siegert tables), per cent	14.5
Heat losses through unconsumed combustible in the ashes, per cent	0.8
Losses through radiation, etc., per cent	11.7
	100.0

An entirely different picture is obtained when the tests are made with unsorted coke, varying in size from breeze up to 90 mm., with the breeze and dust content at about 50 per cent. In these tests the CO_2 content fell from more than 12 per cent in the previous test to as low as 3.5 per cent, a clear indication of the fact that the irregular size of the material caused an excess admission of air.

The other data of the test are essentially of the same character, which led the Rhine Association for the Inspection of Steam Boilers to the conclusion that in the present state of combustion engineering the use of unsorted coke on traveling grates is uneconomical, and further, that the irregularity of the combustion process leads to a considerably diminished output of the boilers.

It appears also that overloading the boiler leads to an excessive wear of the grates and cannot be maintained for any length of time. On the other hand, it appears that coal-firing installations can be converted to coke firing with comparative ease by the employment of steam jets as auxiliaries in the production of draft.

This arrangement can be used particularly well with fine coke, when either a grate with small interspaces may be used, or, still better, a so-called nozzle grate bar designed substantially as shown in Fig. 2.

In order to raise the air pressure under the grate the steam nozzle is led into the smaller end of a conical tube (diffuser) whereby the air compression is raised from 15 to 20 mm. of water. As shown in Fig. 3, the air suction occurs through the ring-shaped space between the nozzle and the tube. In accordance with the size of the furnace one or more nozzles may be used side by side.

The use of the Wilton grate and the evaporator grate in connection with water-tube boilers are also referred to. (*Zeitschrift fur Dampfkessel und Maschinenbetrieb*, vol. 42, no. 9, Feb. 28, 1919, pp. 57-61, 4 figs. d.)

HYDRAULIC ENGINEERING

Bucket and Waste-Water Turbines

Investigations on Bucket Turbines, E. Reichel and W. Wagenbach. (*Zeits. Vereines Deutsch. Ing.*, 62, pp. 822-829, Nov. 23, and pp. 870-876, Dec. 7, 1918). In an earlier series of investigations (ibid., pp. 441 et seq., 1913) the behavior of various types of buckets *A* to *J* was examined under the same load and stress and the results were compared. With the exception of the *G*-bucket, all were obtained for a jet diameter of 30 mm.; jet distance (from center of wheel) of 275 mm.; and head of 100 m. The *G*-bucket was developed for a jet diameter of 40 mm. and for high speeds, other conditions being as before. Four different sizes of *G*-buckets were tested, all with nozzle and needle No. 6. The bucket notch was of the same width (40 mm.) in each case, thus permitting the same diameter of jet to be used throughout. Various numbers of buckets were mounted on the two sizes of disk, and so arranged that for each disk diameter the jet distance was the same for all sizes of bucket. From the results given in this paper it is possible to determine the most favorable construction for any new turbine using *G*-buckets in conjunction with No. 6 nozzle and needle, and working within the conditions and limits for specific speed determined by these investigations. Incidentally the investigations bring out a number of points concerning constructional details as well as considerable information relating to operating phenomena.

The linear dimensions of the four bucket sizes used are in the ratio 0.8: 1.0: 1.2: 1.35. At least four different numbers of buckets were tested for each size of disk and bucket. A complete statement is given of all the essential data, and two- and three-dimension curves are plotted showing the efficiency and other operating characteristics under various conditions. Owing to the number of variables concerned, reference must be made to the original for details. (*Science Abstracts*, Section B—Electrical Engineering, vol. 22, pt. 4, no. 256, April 30, 1919, Item 246, p. 120.)

Waste-Water Turbines. H. Baudisch. (*Zeits. ges. Turbinenwesen*, Nos. 16, 17, 18, 1918. *Elektrot. u. Maschinenbau*, 36, pp. 547-548, Dec. 22, 1918. Abstract.) The energy in the effluent water of turbines can be utilized in waste-water turbines. If H = fall in meters, and c_s = velocity of outflow from suction pipe in meters per second, the effluent energy, hitherto wasted, is $k = c_s^2/2g$. According to the construction and speed of the turbine, h may be from 5 to 15 per cent of H. The waste-water turbine being connected behind the main turbine, the constructional problem is to build a compound turbine dividing the fall very unequally. Axial, radial, or axial-radial turbines may be used, and there is no restriction on the construction of the turbine, the shaft length or the method of building in. The only stipulation is that both turbines be full-stream machines. However, although there is no difficulty in building turbines for the same flow under different heads, it is very difficult to obtain the same speed in both cases. The problem is simplified if the turbine speeds be different and, say, a belt transmission be used to allow for this. If u be the ratio of the belt transmission, and n'_1, n'_2, the turbine shaft speeds, then $n'_1/n'_2 = u\sqrt{(H_2/H_1)}$. If $H_1 = 4H_2$, $Q'_1 = Q'_2/2$, and $n'_1 = un'_2/2$; and $u/2$ may be so chosen that the two turbines work at maximum efficiency. An arrangement offering many advantages is to use the waste-water turbine to drive a d.c. generator which acts as exciter to a three-phase alternator driven by the main machine and also serves station lighting and other d.c. circuits. If the two turbines are coupled (this being the cheapest arrangement), the governing gears must be suitably connected to maintain the distribution of head under all conditions. Such interconnection is effected easily where the electrical equipment is employed. The auxiliary turbine will always run faster than the main turbine: usually $n_{s_1}/n_{s_2} = 0.4$ to 0.8. A gain in power of from 5 to 10 per cent is obtainable by the use of waste-water turbines, the only additional investment being the cost of the latter. (*Science Abstracts*, Section B—Electrical Engineering, vol. 22, pt. 4, no. 256, April 30, 1919, Item 245, pp. 119-120.)

INTERNAL-COMBUSTION ENGINEERING

What the Germans Found from Tests of a Captured Liberty Motor

Liberty Motor, Otto Schwager. Account of a Liberty motor captured by the Germans with the English bomber Hyderabad No. 3, built at the Westland Aircraft Works.

The account is both descriptive and critical. Several interesting features are pointed out. Thus, in connection with the water circulation system, it is stated that on the basis of 80 liters (21 gal.) per hp.-hr. and a maximum engine output of 400 hp.

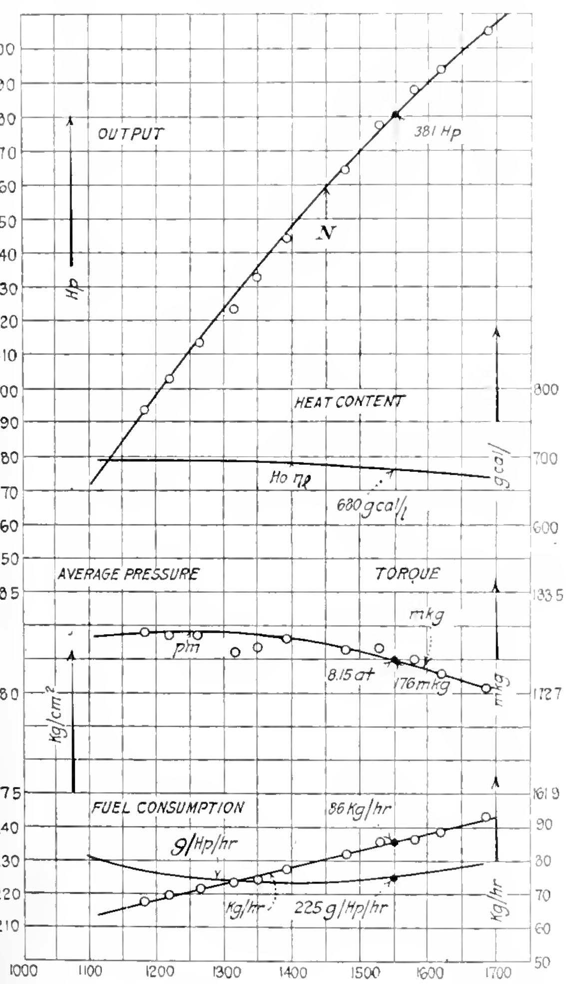


Fig. 4 Data of German Tests on the Liberty Motor

ı circulation of 8.9 liters of water per second would be required. ın the article a curve is given showing the output of the water-irculating pump. This curve indicates that not more than half ıf that amount is actually obtained with a pressure of between ive and six meters (19.6 ft.) of water. Therefore, as compared vith the usual German practice, a radiator of about twice the sual dimensions is necessary with the Liberty engine, and a ange of cooling in the radiator amounting to 10 deg. cent., in rder that the necessary amount of heat should be carried off by ıe air.

An interesting series of curves is presented in Fig. 4, which ives the test data of the captured motor with the standard Zenith ırburetor.

The following comment is given: The curve of output, as funcon of the number of revolutions, is unusually good, which is cribed mainly to well-selected valve-opening cross-sections to-ther with moderate velocity of the flow of gases through the ılves. The fuel consumption of 226 grams (0.49 lb.) per hp.-hr. called very good for "foreign" (which means non-German) gines. The output at 1550 r.p.m. was 381 hp., which is somewhat less than the nominal rating of 400 hp., but it is stated that it is likely that an output of 400 hp. could be secured at that speed with a different setting of the carburetor.

The weight of approximately one kilogram per horsepower is said to be very good.

The general opinion of the motor is that its construction and weight are very good and that the ignition system is novel. The only objection made as regards the ignition system is in respect to the starting of the engine.

The direct drive of the air propeller is considered to be a basic defect of construction, in that with a motor of such a high output it is possible to secure an efficient propeller operation only by reducing the speed in revolutions. It is considered desirable that the motor should be equipped with a reducing gear.

In order to increase the output it would be further necessary to raise the speed of revolution of the motor as high as possible, say about 1800 r.p.m., which would, however, necessitate a redesign of the pistons and connecting rods. In this way, it might be possible to raise the motor output to about 500 hp., maintaining the propeller speed at its most efficient level and reducing the unit weight, including water and oil, to 0.9 kg. (1.9 lb.) per hp. (Der Liberty-Flugmotor, Otto Schwager, *Der Motorwagen*, vol. 22, No. 5, February 20, 1919, pp. 75-80, 20 figs., *e*)

Italian Diesel Engine for Submarine Use Developed During the War

Tosi Diesel Engines for Submarines. The Tosi Company has built a considerable number of Diesel engines for submarines both on the 2-cycle and on the 4-cycle principle. Table 2 for the first time gives in detail test results of these engines.

TABLE 2 COMPARATIVE DATA OF TESTS OF TOSI DIESEL ENGINES FOR SUBMARINES

	Full Load	Full Load	Three-quarter Load	Half Load	Overload
Type of engine.....	Two-cycle	Four-cycle	Four-cycle	Four-cycle	Four-cycle
Number of cylinders	6	8	8	8	8
Duration of trial, hr.	...	36	96	12	1
Power, hp.........	1300	1300	950	650	1485
Revs. per min......	300	300	260	240	...
Fuel-oil consumption, lb. per b.hp-hr....	0.540	0.390	0.410	0.438	...
Lubrication-oil consumption, lb. per b.hp-hr.........	0 0334	0.0180	...	...	...

The conclusions arrived at as a result of these trials were in favor of the 4-cycle type on account of lower fuel- and lubricating-oil consumption and greater flexibility. At the same time it should be borne in mind that they have built a considerable number of very large 2-cycle engines which are running quite satisfactorily and it is possible that for very large powers the 2-cycle engine may be at least as good as the 4-cycle.

The article for the first time gives drawings for certain interesting details of construction.

Thus, Fig. 5 shows the gudgeon-pin construction with the sleeve keyed on to the pin proper and forming the bearing surface. This sleeve permits of a reduction of pressure in the gudgeon-pin bearing from about 2000 lb. per sq. in. to 1400 lb. The bearing is force-lubricated by a supply of oil under pressure through the hollow connecting rod.

The piston crown is made concave to increase the efficiency of oil cooling (its outward shape being somewhat like that in the Willys-Knight engines built in this country).

Two exhaust valves per cylinder are provided but they are placed in separate cages and do not sit in the cylinder head as in the slow-speed engine. Although the diameter of each valve

is relatively small (there being two per cylinder), the valves are internally water-cooled, the water supply being by means of a spiral pipe attached to a spiral nut on the top of the exhaust valve spindle. The construction of the valve and its cage is shown in Fig. 6. The inlet valves sit in the lower face of the cylinder head. The main water-cooled exhaust connecting pipe is fitted internally with a light spiral baffle to prevent interference

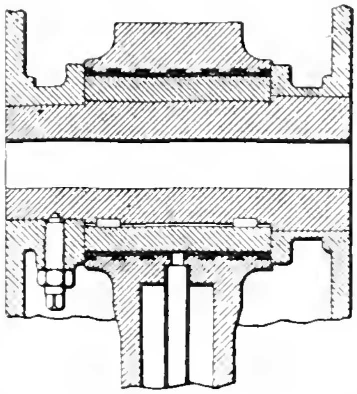


Fig. 5 Gudgeon-Pin Construction for Tosi Submarine Diesel Engine

of the exhaust of one cylinder with that from another, which is necessary since with an 8-cylinder 4-stroke-cycle engine two cylinders will exhaust at the same time at certain points in the revolution, as indicated by one of the diagrams in the original article.

The 4-cycle engine is not fitted with any starting device and is started electrically by the main propelling motors or by a separate starting engine. There are, however, certain objectionable

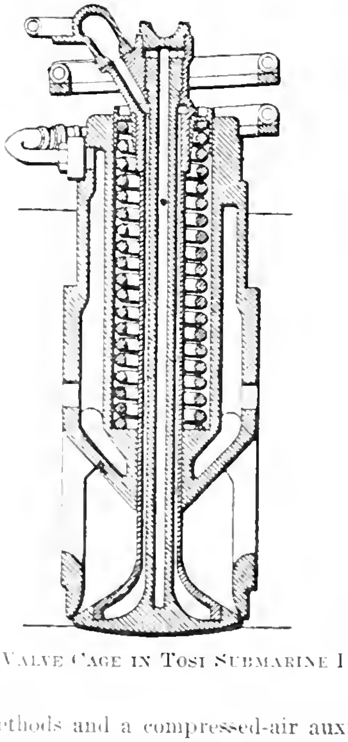


Fig. 6 Valve and Valve Cage in Tosi Submarine Diesel Engine

features to such methods and a compressed-air auxiliary starting engine has been designed for starting by compressed air. This engine has three radial cylinders and drives a pinion with teeth engaging with the periphery of the flywheel. These teeth are slightly spiraled in order to keep in engagement as long as the starting motor is driving, but when the main engine picks up and becomes the driver the thrust of the spiral teeth pushes this pinion forward sufficient to throw it out of engagement with the flywheel. (*Engineering*, vol. 107, no. 2788, June 6, 1919, pp. 732-734, 8 figs., *de*)

LUBRICATION

Economical Lubrication of Steam Engines, K. Schmid. (*Würtemberg Revisions-Verein, Geschaeftsbericht*, 1915. *Elektrot. u. Maschinenbau*, 35, pp. 194-195, April 22, 1917. Abstract.) The data presented are derived from material collected by inspecting a great number of working installations. Only in five engines among those investigated was there a really low consumption of lubricating oil; the minimum was 0.178 gram of cylinder oil and 0.23 gram of bearing oil. In order to obtain results applicable to any engine, the oil consumption must be referred to the actual engine dimensions rather than to the horsepower developed. The temperature of the cylinder walls and their area are of primary importance in determining the oil consumption. The piston speed is also an important factor; and so is the diameter of the low-pressure cylinder in multi-cylinder engines. If D_n = diameter of cylinder (low-pressure cylinder in multi-cylinder engine); s = stroke, both in meters; n = r.p.m.; and K = constant; then the consumption of cylinder oil in grams per hour is given by: $O_s = KD_n \times \pi \times sn/30$. Denoting by μ the term $K\pi/30$, we have $\mu = O_s/D_n sn$. In the five most economically lubricated engines, O_s = 99.1, 100.6, 164.5, 148, 180 grams per hour and corresponding values of μ = 1.275, 1.633, 1.48, 1.6, 1.6 respectively. The author concludes that μ may be as low as 0.8 or 1.0 before wear occurs. With $\mu = 1.6$ there is about 50 per cent saving in oil compared with present consumption, and this saving may be increased to 75 per cent if special efforts be made.

It is recommended that oil separators be installed in the exhaust, and that the separated oil be cleansed and used again for lubrication; also, that the exhaust pipes be drained and the superheat reduced. An allowance of oil on the basis of $O_s = 1.6\ D_n sn$ should suffice, and a premium may be offered to encourage economy. When using drip-feed lubricators with thick oil, the lubricator should be heated by locating it on a hot part of the cylinder, or by other means. Springs and valves are to be avoided in lubricators. Improved bearings and lubricators save oil. Graphite often makes possible important economy in oil. Suitable greases may replace considerable quantities of oil, especially in bearings. "Tar fat" oils are a useful substitute for petroleum oils in bearings but not in cylinders. The author considers that 90 per cent saving in cylinder oil is possible. A saving of 87 per cent in bearing oil has already been effected. (*Science Abstracts*, Section B—Electrical Engineering, vol. 22, pt. 4, no. 256; April 30, 1919, Item 230, pp. 114-115.)

MOTOR-CAR ENGINEERING

Motor-Car-Engine Governors of German Design

Governing of Motor-Car Engines, Pretorius. Description of some of the governor devices developed in Germany.

The devices shown do not represent anything radically different from those used in this country. Of interest is the governor for aircraft motors diagrammatically shown in Fig. 7, the purpose of which is to cut out ignition in case the motor exceeds the desired speed of revolution. The underlying idea in this governor is that in the case of the rupture of the transmission system, the engine may run away to a dangerous extent. It should be borne in mind, however, that the cutting out of the ignition when the engine has reached a very high speed of revolution may produce dangerous stresses in the engine parts.

The device shown in Fig. 7 is so designed as to obviate this to a certain extent. At the normal speed of rotation the governor *a*, and the spindle *b* controlled by it, take the position indicated in the figure. As this speed is exceeded the governor takes gradually the position indicated in the figure in broken lines, and thereby the ignition apparatus is short-circuited by passing the current through the engine frame mass *f*, and the ignition system is put out of action. In order to restart the engine the spring *g* has to be brought by hand into its original position where it engages with the catch *c*.

Fig. 8 shows an interesting device, the purpose of which is to keep several engines running at the same speed. The speed indicators of various engines are provided with sliding contacts so

arranged that the ignition of the engine running beyond the desired speed is cut out until the engine reaches a certain lower speed.

It is not quite clear how the engine of which the ignition has

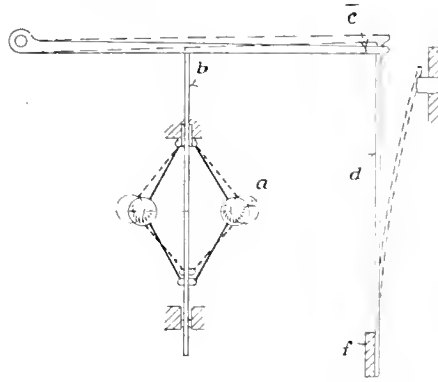


FIG. 7 AIRCRAFT-ENGINE GOVERNOR

been cut out is restarted, unless this is done by the driven element utilizing the power of the engines still running. (Die Regelung der Kraftwagenmotoren, *Der Motorwagen*, vol. 22, no. 8, March 20, 1919, pp. 138-142, 5 figs.)

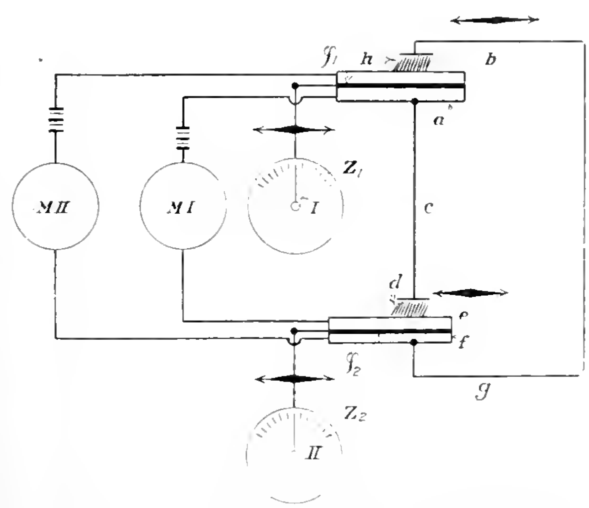


FIG. 8 GOVERNOR FOR A MULTIPLE ENGINE INSTALLATION

PRIME MOVERS

Recent Developments in Design of Small and Medium-Sized Turbines for Mechanical Drives

TURBINES FOR MECHANICAL DRIVES, R. R. Lewis. A comparatively recent development in the construction of small and medium-sized turbines are the units intended for the direct drive of pumps, fans, and other moderate-speed apparatus.

Turbines of this type are often located in basements and similar more or less inaccessible places where they are likely to receive very little care and attention, and must be therefore of a rugged and simple construction.

This can be secured by the utmost care in design and manufacture and by the use of the best material throughout, conditions which are very difficult to meet because it is necessary that the units should be of moderate cost and at the same time suitable for a wide range of operating conditions. For instance, in driving centrifugal pumps, the speed depends largely on the head under which a pump is to operate; and turbines for this service must run at speeds from 800 to 3600 r.p.m. Again, the steam pressure may be anywhere from 75 to 200 lb. or over, and the back pressure may be from atmospheric pressure to 20 or 30 lb., or the turbine may be required to operate with a vacuum.

To build a special turbine for each combination of conditions, of course, would be impossible; but practically the same result is secured by designing certain standard elements, a number of which can be combined to form a complete turbine that will exactly fit any particular case.

In the design of the type L turbine of the General Electric Company, the plan of construction involves the use of one, two, or three bucket wheels, and a variation in the length of the buckets and the arc of steam admission through the first stage nozzles, in addition to which the size of the steam and exhaust connections is varied and also the governor parts for regulation at different speeds.

The turbine (Fig. 9) is of the Curtis impulse type, in which the steam is given relatively high velocity by passing through a divergent nozzle. In entering the turbine the steam passes first through an emergency valve chest, if one is used; then through a steam strainer, and next through the governor valve. From this it enters the turbine proper through the first-stage nozzles, and after passing through the buckets of a single-stage turbine goes out of the exhaust opening.

The governor is of the centrifugal type and is mounted on the

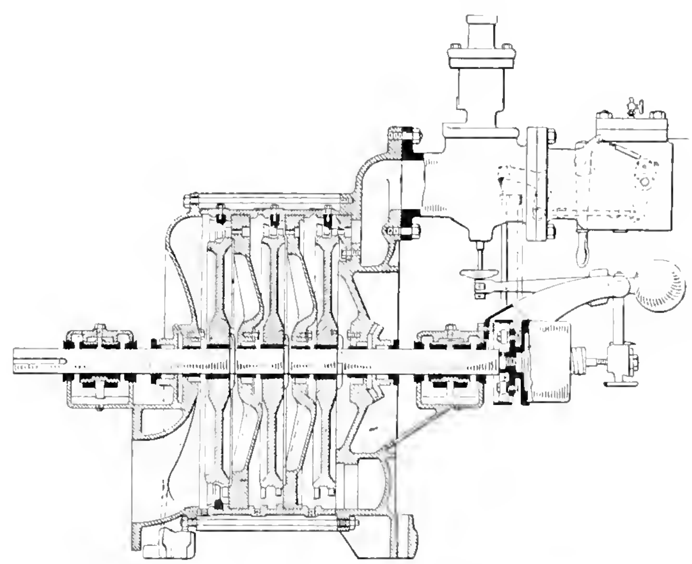


FIG. 9 CURTIS IMPULSE TURBINE FOR MECHANICAL DRIVE

end of the shaft. It operates, through a bellcrank, the governor valve of which is of the double balanced poppet type.

By means of a simple device the speed may be altered while the turbine is running, the governor continuing to exert full control at the altered speed. An emergency governor may be fitted to the machine to shut off the steam supply in emergency, and prevent excessive speed. Hand valves may be used for operation at two different steam pressures. These valves modify the effective capacity of the nozzles. (*General Electric Review*; vol. 22, no. 6; June, 1919; pp. 438-442; 12 figs. *d*)

RAILROAD ENGINEERING

Startling Savings in Power Achieved by Applying Aeronautical Experience to High-Speed Locomotives

THE WIND RESISTANCE ON A TRAIN, C. F. Dendy Marshall. This article is abstracted partly for the information which it contains and partly because it presents a good example of the benefits of what is known as the cross-fertilization of sciences, that is, the application in one branch of science of theory in another and apparently unrelated branch.

It has been known for a number of years that wind resistance affects the power consumed in propelling fast trains, but little or nothing has been done actually to take care of this condition. The author mentions only the fact that about 25 years ago on the South-Western Railway, Mr. Drummond made some of his

smokebox doors conical in shape, a plan followed on some continental railways. With the same end in view a wedge formation has been adopted on the Paris, Lyons and Mediterranean Railway.

It might be added here that the question of wind resistance attracted considerable attention in connection with the high-speed electric railway tests on the experimental line at Zossen, Germany, but the matter had not been placed on a scientific basis until quite recently—thanks to the work which has been done in connection with aeronautics.

The horsepower needed to overcome front wind pressure increases with the cube, not merely of the speed of the train, but also with that of what is called the "created wind," which in the case of express trains may easily exceed 80 m.p.h.

The resistance of the air to a surface moving normally to itself at high speed may be represented by the expression KAV^2, where A is the area exposed, V the speed, and K a constant. If A is measured in square feet and V in miles per hour, $K=0.0033$. At 60 m.p.h. the value of this expression per square foot of transverse surface is approximately $1\frac{1}{4}$ hp., and at 80 m.p.h., 3 hp. If we know the "all out" speed in a calm, say, 70 m.p.h., numerical limits can be assigned between which the speeds will lie for any ratio of train to wind speed, such as are shown in Fig. 10. Here $V \cos \alpha$ represents the resolved part in the direction of travel over wind blowing with velocity V at an angle α to the rails.

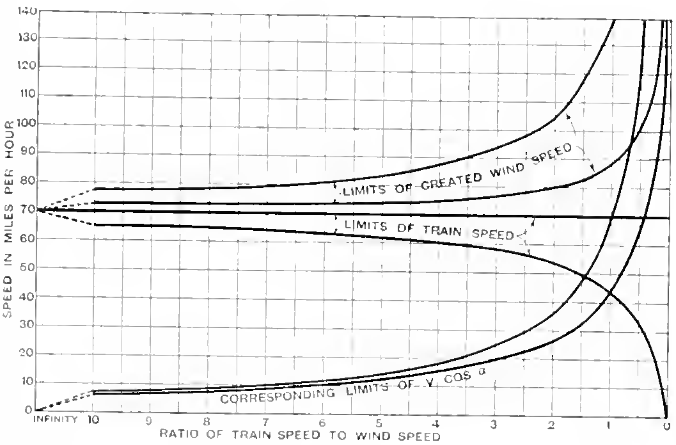


FIG 10 TRAIN-SPEED AND WIND-SPEED CURVES FOR FAST-MOVING TRAINS

The speed of the "created wind" increased with the strength of the natural wind and 80 m.p.h. is quite a moderate figure to take for it.

Aeronautical practice has shown what is the best shape for a body which is to be driven through the air at speeds of the order under consideration. The front should be quite "bluff," a sharply conical or wedge-shaped form not being at all the ideal to be aimed at. What is required is to reduce the transverse flat surface as much as possible, smooth off projections and use gentle curves parallel to the natural flow of the air.

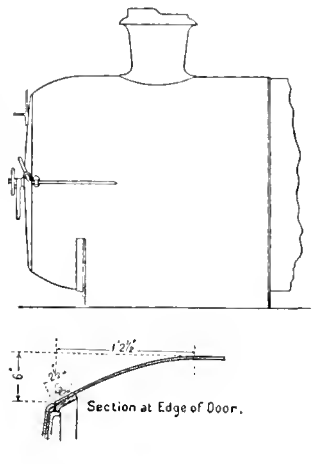
The modern "extension" type of smokebox lends itself very well to modifications in this direction.

Take, for example, a large smokebox 5 ft. 8 in. in diameter. With the very slight bulge usually adopted for the door, the front may be taken as equivalent, as far as the pressure is concerned, to a flat surface—in this case an area a little over 25 sq. ft. The horsepower abstracted for $V=60$ is 32, and for $V=80$, is 75.

It is a simple matter to reduce these figures to a great extent. If the ring at the front end ot the box is made only just large enough to carry the door, as shown in Fig. 11, or, say, 4 ft. 8 in. diameter instead of 5 ft. 8 in., the front surface is reduced by 8.12 sq. ft. The result is a clear saving of 10.5 hp. for $V=60$, and as much as 24 hp. when $V=80$.

But we can go further than this. By forming the door with a radius of something under 3 ft., instead of the usual one, which is frequently as much as 18 ft., we can produce a front door much superior from an aeronautical point of view, such, for example, as is shown in Fig. 12. It is reasonable to expect this smokebox to effect a saving of the order of 25 hp. when the "created wind" speed is 60 m.p.h. and 60 hp. when it is 80 m.p.h.

The author claims that the shape of the locomotive is deserving of careful study and that some modifications of such value as not only to be worth making in the case of new engines, but possibly even worth while to be introduced in the existing ones as they come into the shops for heavy repairs.



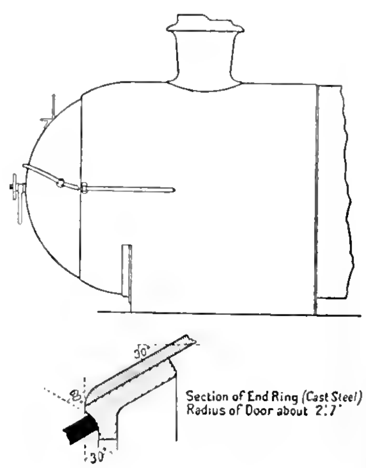


FIG. 11 (LEFT) LOCOMOTIVE DESIGN WITH REDUCED RING AT THE FRONT END OF THE BOX

FIG. 12 (RIGHT) IMPROVED SMOKEBOX DESIGN EFFECTING A GREAT SAVING IN AIR RESISTANCE

Credit is given to the Report of the Electric Railway Test Commission, New York, 1906. (*The Engineer,* vol. 127, no. 3207, May 16, 1919, pp. 473-474, *p.d.*)

LIMIT OF WEAR OF STEEL WHEELS. A test was recently conducted by the testing department of one of the large railroads to determine whether or not steel wheels of $\frac{1}{4}$ in. below the present scrap wearing limit can be used with safety.

For this purpose four rolled-steel wheels which had been in service under locomotive tenders were selected from a lot of scrap wheels. They had treads worn from $2\frac{3}{8}$ to $2\frac{1}{2}$ in. below the new diameter or about $\frac{1}{4}$ in. above the limit mark.

The treads of two of the wheels, Nos. 1 and 4, were turned to a thickness of 1 in. or to the present scrap wearing limit. All flanges were turned to the minimum allowable thickness of 15/16 in. and with vertical surfaces and sharp fillets, similar to the worn conditions developed in service.

The M.C.B. drop-test machine was used for this test, the wheels being supported in a way that caused the entire thrust to be taken by the flange.

For static tests sections 1 in. thick were cut from each steel wheel and tested in a Riehlé testing machine in a manner shown in an illustration in the original article. The arrangement was such as to provide a loading which produced a thrust in a direction parallel to the axis of the wheel and similar to that which occurs in service.

In addition to this three cast-iron wheels were selected from among the scrapped wheels at a large wheel foundry and tested in a manner similar to the steel wheels.

The results showed a decided superiority of steel over cast-iron wheels under the drop test and indicated that a reduction of the thickness of the tread does not affect the strength of the flange in rolled-steel wheels.

The failures of the 1-in. test sections were similar in that all broke in the same way at about the same place. In no case did the break occur at the throat of the flange or at the thinnest section of the tread, but always to one side of the thinnest section toward the center of the tread.

The results of the drop test indicate that the rolled-steel wheels whose treads were turned 1/4 in. below the present scrap wearing limit, with flanges of the minimum allowable thickness, have decidedly stronger flanges than cast-iron wheels, the flanges of which are worn to the minimum allowable thickness.

The nature and similarity of the failures of the 1-in. sections indicate that there is no weakening effect on the flange proper caused by reducing the tread thickness. There is, however, a weakening of the tread due to its own reduced section. (*Railway Mechanical Engineer,* vol. 93, no. 7, July 1919, pp. 437, 438, 6 figs. *ep*)

Pulverized Fuel for the Railways. Abstract of a report presented by a special committee at the 11th Annual Convention of the International Railway Fuel Association, held in Chicago the week of May 19, 1919. This report is based on tests made under regular service conditions just before the war.

A carefully conducted test between two engines of the same class, one burning pulverized coal and the other hand-fired, showed a saving of 23 per cent in fuel burned in favor of pulverized coal.

The main difficulties encountered were the slagging over of the fuel sheet and burning out of the brick arch, and the first was largely overcome by an air jet to blow off the slag accumulations.

The cost of replacing the arch brick largely overcame the saving in fuel, in addition to which there was a delay to the locomotive. In the end a comparison of total costs of hand firing vs. pulverized-coal firing on the locomotives tested, which include cost of pulverizing, cost of handling, cost of arch maintenance, interest and depreciation, showed the hand firing to be most economical. It was, however, thought possible to design a firebox that would avoid burning out the brick arch.

On the other hand, pulverized fuel had been burned satisfactorily, generating all the needed steam and with good control.

The report recommends that experiments should be made to determine if thoroughly air-dried coal ground to the fineness of, say, coarse granulated sugar, and burned in suspension, in specially designed furnaces, will not produce greater overall economy.

It is further suggested that it might be possible to arrange a pulverizing or stoking device that would prepare any grade of coal on the tender and deliver it to the firebox in the pulverized form. (*Power,* vol. 49, no. 25, June 24, 1919, p. 997, *g*)

SAFETY ENGINEERING

Safety in Power-Press Work Without Reduction in Output

Safety Practice in Power-Press Work. Accident records show that more injuries occur on power presses than on any other machine except, perhaps, the circular saw. In practically all press accidents the operator's fingers are caught under the ram at the point of operation. This may be due to the press repeating, or the operator leaving his hand between the dies as the ram descends, or an unexpected stroke caused by accidental tripping.

Analysis of the accidents tends to prove that to prevent them a study of the operation of each press must be made to eliminate if possible the need of the operator placing his hands between the dies, or if this is not practicable, to install a guard which will prevent the operator's hands being caught between the dies when the ram descends.

The most effective way to remove the operating-point hazard is by using the automatic feed, but for some operations it is difficult to develop such a feed.

The same guarding of presses should begin with the design of the dies and it is essential to design them so that the operator need not put his hands between them. The use of sliding, revolving or dial dies as compared with the old types where each separate piece had to be put under the die by hand has already been a great step forward in the direction of insuring greater safety. But even in hand-fed dies increased safety may be secured by cutting away superfluous metal from the die block, thus allowing more space for the fingers. Wherever possible the die should be designed so as to permit the operator to grasp the material by the sides instead of at the top and bottom. Whenever possible guards should be attached to the dies.

The original paper, which is extensively illustrated, discusses in some detail the operations on power presses and cites interesting instances of devices used to increase the safety of operation.

The writer comes to the general conclusion that properly designed safeguards actually increase production. It is true that in some instances the only safeguards available are such as decrease production to a certain extent in units per hour, but even in such cases it must be remembered that without the guard production may be entirely stopped by an accident to the operator. Furthermore, if a "green" operator is put on the machine, it will require considerable time to attain the rate of output, so that in the end any decrease in production due to the use of safeguards will be quite small in itself and amply compensated in other ways. (*American Machinist,* vol. 50, no. 25, June 19, 1919, pp. 1177-1184, 29 figs., *gp*)

Spontaneous Combustion, What It Is and in What Materials It Occurs

Spontaneous Combustion, Watson Smith. Discussion of the nature of spontaneous combustion and factors contributing to its occurrence.

The following definition is given: Spontaneous combustion is caused by the physical and chemical capacities of certain carbonaceous and organic matters to condense on their surfaces gases and moisture. The amount of gas thus condensed varies with the chemical nature of the gas and is also dependent on the degree or subdivision of the absorbent substances. If the atmospheric oxygen is the gas thus condensed, evolution of heat accompanies the condensation, and if this occurs within a bad conductor of heat, the heat accumulates and eventually gives rise to combustion.

As a result of this, it is pointed out that coal containing pyrites is particularly inclined to ignite when in a damp state. It is also pointed out that air shafts through the masses of coal on board ship actually favor the tendency of the coal to spontaneous combustion. On the other hand, explosions of coal gas, which may accumulate in ship bunkers, are best eliminated by passing currents of air directly over the coal and then into the open. The extinction of bunkers on fire by means of carbon dioxide was held by the British Commission of Inquiry (about 1890) to be impracticable, as this gas has no cooling effect, and the Commission was inclined to give preference to the employment of steam and water.

There are a number of contributing causes which may lead to spontaneous combustion. Thus, it is stated that fires may arise through accidental contact of water with stocks of quicklime. It has also been found that finely ground charcoal placed in a barrel attained a temperature of 75 deg. cent. after 15 hours, and after 20 hours ignition took place. Having once had the management of a wood distillery, the writer testifies to the need of great precautions to avoid the danger of outbreaks of fire in the charcoal sheds.

The statement that wet cotton is liable to break out in combustion is improbable, but a spark getting into a bale will smolder for a long time and may cause a fire eventually, which may then be improperly ascribed to spontaneous combustion.

Greasy cotton is particularly dangerous as most fatty oils absorb oxygen rapidly with generation of much heat. Heavily weighted silk is dangerously liable to heat up and burn, two cases of such occurrences being definitely known.

The firing of haystacks is also an undoubted fact. Among other things, it has been shown that fermentation caused by bacteria in hay is responsible for such occurences, and in Holland a preventative is found in common salt which is scattered between the layers of hay during the erection of the stacks. Tschirch, who gives a theory to account for the spontaneous ignition of hay, recommends thorough drying of the hay before stacking,—a process designed

to minimize enzymic action, and also thorough aeration of the stacks.

From other data collected in the paper it appears that quite a large number of substances have the ability to take fire spontaneously under certain conditions. Among such materials are mentioned tobacco, lupulin (an extract of hops), aniline dyestuffs, dried fish, bone dust, wool, and various chemicals. The paper is of particular interest in connection with the question of storing and transportation of the materials above enumerated, particularly on shipboard. (*Journal of the Royal Society of Arts*, vol. 67, no. 3474, June, 1919, pp. 500-507, *g*)

STEAM ENGINEERING

How a Difficult Problem in Measuring Air Volume Has Been Solved

Determination of the Efficiency of the Turbo-Alternator, S. F. Barclay and S. P. Smith. The efficiency of the turbo-alternator is usually expressed in terms of the rate of steam consumption in relation to the output of electrical energy. Because of this the purchaser has little direct economic interest in the accurate determination of the efficiency of the alternator, which is, nevertheless, a matter of considerable interest, as it indicates the quality of the active materials employed and the degree of excellence of the design.

The authors point out that in determining the efficiency of alternators stray losses are either deduced in some conventional way or ignored altogether, but as the size of the alternators becomes larger the stray losses become of greater importance and furthermore cannot be conveniently determined on account of the difficulty of making tests.

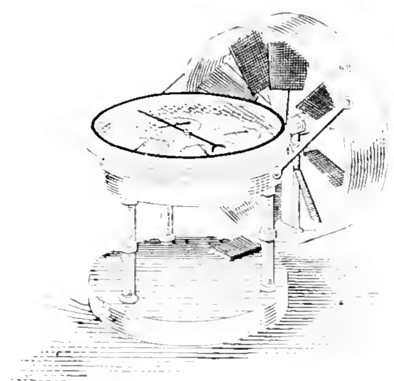


Fig. 13 Negretti & Zambra Anemometer

The present paper shows how stray losses can be deduced from measurements of the cooling air flowing through the alternator and also what precautions should be taken in order to avoid securing misleading results.

The electrical part of the paper, while of considerable interest in itself, lies beyond the strict scope of Mechanical Engineering, but the part referring to measurements of air volume and temperature is of general interest.

For measurement of air velocity the writers consider four methods—the pitot tube, venturi tube, electrical methods, and the use of an anemometer. For purposes of the tests carried out by the writers the anemometer shown in Fig. 13 was used. Because it was found that a well-made instrument when properly handled gave sufficiently accurate results and further on account of the air flow being variable in direction, the anemometer is probably better adapted to read the absolute value of the average velocity at a given point than are more exact instruments.

The two inherent defects of the anemometer are due to the effects of friction and the inertia of the moving parts. The effect of friction on the reading is, however, slight when the velocity of the air is considerable and the velocity of the air discharge from a turbo-alternator is of the order of 2000 ft. per min. With an instrument of the kind used by the authors measuring about 2.6 in. over the tips of the vanes, the frictional effect is not more than 3 per cent of the vane-wheel speed, so that even an appreciable error in the correction for friction has only a negligible effect on the result. The effect of inertia is of appreciable importance only when the air flow is variable.

The authors have checked the accuracy and consistency of the anemometer in several ways. When a fan delivers air to a given system of ducts, the volume of air discharged is a linear

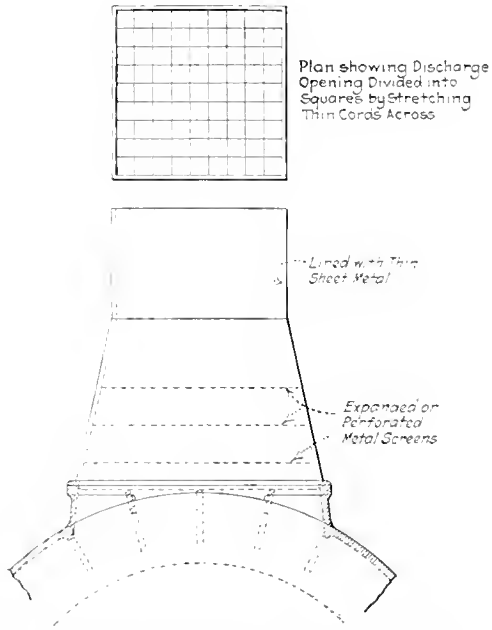


Fig. 14 Temporary Discharge Trunk Used to Facilitate Measurements of Air Volume and Temperature

function of the speed of the fan—that is, if V is the volume of air delivered in unit time, and n is the speed of revolution of the fan, then $V = Kn$, where K is a constant. Therefore, by running an alternator at various speeds and measuring the air volume in each case, the accuracy of the anemometer readings is established if they bear a constant ratio to the speed of rotation. The authors have found that the results obtained in this way are very satisfactory, as is shown in the typical case given in Table 3.

TABLE 3 TYPICAL TEST RESULTS SHOWING CONSTANT RATIO BETWEEN VOLUME OF AIR DELIVERED BY FAN AND SPEED OF ROTATION (MACHINE NO. 7634)

V	4,550	7,200	8,950	10,900
n	1,500	2,400	3,000	3,600
K	3.033	3.000	2.983	3.028
Variation from mean value of K, per cent	+0.73	−0.37	−0.93	+0.56

The accuracy of the anemometer was further checked by comparing the known loss in the alternator with the heat energy being carried away by the air; and still further, two new instruments calibrated at the National Physical Laboratory and an instrument that had been in use for two years were mounted in succession in a given position at the discharge outlet of an alternator and were run for varying periods, during which the speed of the alternator and the load were maintained as constant as possible. All these tests simply indicate quite a satisfactory performance on the part of the anemometers.

The measurement of the volume and temperature of the air discharged from the alternator proved to be no easy matter. The first difficulty encountered was a consequence of the great varia-

tion in the velocity of the air at the discharge opening of the alternator due to the peculiar shape and disposition of the openings in the stator core and frame and also of the rotation of the rotor tending to cause the air to discharge obliquely instead of vertically.

In order to equalize the air flow a temporary discharge trunk

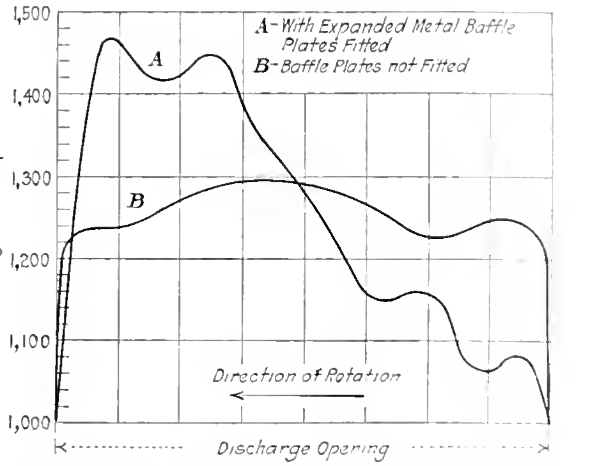


Fig. 15 Curves Plotted from Pitot-Tube Readings Taken at Opening of Temporary Discharge Trunk

such as shown in Fig. 14 was fitted and the air velocity measured by traversing the pitot tube across the discharge opening. The results obtained are shown by curve *B* in Fig. 15. To equalize the air velocity still further, close-mesh expanded-metal baffle plates were fitted in the trunk. Curve *A* in Fig. 15 shows the improvement obtained. There is still some variation, yet if the anemometer readings are taken at fairly frequent intervals, the average velocity can be found with a sufficient degree of accuracy. The resistance of the expanded-metal baffles to the flow of air was found to have no appreciable effect on the temperature of the alternator.

For the accurate measurement of the air volume it was found desirable that the discharge opening should be divided into squares not much larger than the overall diameter of the anemometer. This can be done by stretching thin guards across the trunk as shown in Fig. 14 and taking the anemometer reading over each square. For small and medium-sized machines the squares could conveniently be made with the length of side of 4 in., but for very large machines the size might be increased somewhat to avoid taking an unnecessarily large number of readings. A certain error is introduced into the readings by the delay in starting and stopping the anemometer, and also as a consequence of the manipulation of the catch that throws the recording dials in and out of gear interfering locally with the air flow. These difficulties can readily be overcome by moving the instrument rapidly from square to square without stopping it, and the average value of the air velocity is found by dividing the total reading by the number of squares. The authors have found a slight but appreciable effect in adopting this safeguard. It is desirable to run the anemometer for an appreciable period over each square, 15 sec. being the minimum desirable time, and a longer period up to one minute being preferable when circumstances permit.

The paper discusses various corrections to be made, such as effect of temperature on air density, effect of atmospheric pressure on air density, effect of humidity on air density and specific heat, and effect of temperature on specific heat.

The discussion, which was quite extensive, dealt mainly with the electrical part of the paper. (*Journal of the Institution of Electrical Engineers*, vol. 57, no. 281, April 1919, pp. 239-314, 11 figs. in the paper and 3 in the discussion, *eA*)

The Large Turbine Has Come to Stay

Status of Large Turbines. Report of Prime Movers' Committee of the National Electric Light Association.

A consideration of the practical limit in size of single-shaft machines, so far as the questions of design enter into the problem, indicates that, in general, higher efficiencies at equal or less cost per kilowatt output can be obtained as the size of the unit is increased, particularly in capacities up to 30,000 kw., but although one single unit of 45,000 kw. capacity is now in service it cannot be assumed that the size of single-shaft units can be increased indefinitely.

It would appear in the opinion of the committee that with the present prevailing frequencies and speeds and the recognized factors of safety, efficiency and cost, the size of systems today will hardly warrant units larger than 30,000 kw. capacity. The increase of percentage which the individual turbo-generator bears to the total generating capacity of a system make the reliability of this type of machine a matter of much more importance from the operating standpoint than it was previously considered, and it is becoming increasingly onerous on account of overhead charges to safeguard this capacity.

In this connection it is stated that certain of these large machines have records of continuous performances and output which surpass anything previously considered possible. For example, one of the 25,000-kw. units has completed two 77-day runs at 67 per cent load factor in the first instance and 70 per cent in the second, without shutdown.

As regards causes of troubles in units of 20,000 kw. and over, certain features of design appear to be the most frequent source of trouble. Labyrinth packings and thrust bearings belong to this class, also excessive vibration of parts, breaking of buckets and dangerous rubbing of stationary and moving elements, which, in extreme cases have resulted in permanent deflection of shafts. The most serious situation, however, has been the number of recent turbine-wheel failures.

In general, records of operating performances of these larger units tend to indicate that as high a standard of performance may be expected from them as had been obtained earlier from machines of smaller capacity. The following statement is reproduced verbatim: "The situation is now a critical one, and while any definite statement at this time would be premature, the committee wishes to indicate the necessity for early action both in safeguarding against further possible failures of machines now in operation and in definitely reaching solutions of those problems which involve important features of design and construction."

In the discussion which followed, W. L. Abbott, Mem. Am. Soc. M. E., chief engineer of the Commonwealth Edison Co., Chicago, stated that although a number of failures had occurred in large machines, nothing in the situation warranted distrust of the large units, and the trouble was due to what may be considered as incidental faults.

W. S. Finlay, Jr., Mem. Am. Soc. M. E., of the Interborough Rapid Transit Co., New York City, pointed out that his company had in operation three 30,000-kw. and one 60,000-kw. reaction turbines, but as the stations were respectively of 205,000-kw. and 195,000-kw. capacity, the huge machines were really comparatively small units considering the total station capacity. (Report of Prime Movers Committee of the National Electric Light Association, abstracted through *Power*, vol. 49, no. 21, May 27, 1919, pp. 832-834, *gA*.)

Flow of Steam Through Pipes, A. Stodola. (*Zeits. Vereines Deutsch. Ing.* 63, pp. 31-36, Jan. 11, and pp. 96-100, Feb. 1, 1919.) Describes experiments on the forms of the stream lines of high-pressure steam flowing in pipes of various shapes. The experiments are based on observations with pitot tubes at various distances from the axes of the pipes and at different positions along their lengths. (*Science Abstracts*, Section B—Electrical Engineering, vol. 22, pt. 4, No. 256, April 30, 1919, Item 233, p. 116.)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

MECHANICAL ENGINEERING
THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Published Monthly by the Society at
29 West Thirty-ninth Street, New York

M. E. Cooley, *President*
William H. Wiley, *Treasurer* Calvin W. Rice, *Secretary*

PUBLICATION COMMITTEE:
George A. Orrok, *Chairman* J. W. Roe
H. H. Esselstyn George J. Foran
Ralph E. Flanders

PUBLICATION STAFF:
Lester G. French, *Editor and Manager*
Leon Cammen, C. M. Sames, *Associate Editors*
W. E. Bullock, *Assistant Secretary Editor Society Affairs*
Frederick Lask, *Advertising Manager*
Walter B. Snow, *Circulation Manager*
136 Federal St., Boston

Yearly subscription \$3.00, single copies 35 cents. Postage to Canada, 50 cents additional; to foreign countries \$1.00 additional.
Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

A Tribute to Mr. Wellman

It was my happy privilege to be a close friend of Mr. Samuel Thomas Wellman; to be associated with him in many organizations, and often to be his companion in traveling through Europe and the Orient. Throughout this period, covering more than a third of a century, my affection and admiration for him constantly deepened.

As one of the constructive men in this, the steel age, Mr. Wellman was known, not only in this country and in Europe, but throughout the world. I remember an incident when visiting the great steel works at Hankow, China, a few years ago. The Chinese works manager was conducting me through the plant, and when we came to one of the charging machines recently installed in connection with the heating furnaces, and stood watching the powerful arm reach into the oven as though it were human and handle the white-hot ingots, the manager remarked, "This machine is from America, and the invention of Mr. Wellman." It was indeed a pleasure to say to him that the inventor was one of my best friends.

Mr. Wellman was intensely devoted to the work of his profession; yet because of his exalted principles and his broad view of life, he was interested in all that pertained to the uplift of his fellow men.

Holley, Fritz, Wellman—a trio of contemporary engineers and pioneers in the steel industry! They have passed from among us, but because of their notable achievements and their splendid characters they will continue to live in the hearts of all those who knew them, and to be an inspiration for good as long as industry exists.

Ambrose Swasey.

What Are Your Ideas?

Is the membership of The American Society of Mechanical Engineers making the best use of its opportunity to have its views on the affairs of the Society and the conduct of those affairs considered and incorporated in the report of the Committee on Aims and Organization?

The tentative report of this Committee was presented at the Spring Meeting in Detroit and was discussed at three sessions: at the first session the attendance was reasonably large; at the second session there were only 37 present; and at the third session not half that number.

Does this mean that the Society is satisfied with its present aims and organization and not interested in its future development?

That cannot be, for they are of course interested.

Then why not give some evidence of it and take part in discussing the report and offer suggestions?

The report was published in full in the July number of Mechanical Engineering, (page 601), together with changes suggested at the Spring Meeting and a summary of the discussion. It is the duty of every member of the Society to read the report and the discussion carefully and to give the Committee on Aims and Organization the benefit of his views. This should be done at once, for between now and the Annual Meeting, early in December, the committee must prepare its final report, after which necessary changes will be made in the Constitution and By-Laws.

The Society will have had a full year to make up its mind what it wants to do in the future. If it has not made up its mind it will be the fault of the members of the Society.

These are days of great changes in almost every walk of life. The Society desires to keep abreast of these changes in order that it can render the service desired of it. It is then the duty, the immediate duty, of the members to send on their ideas, and their suggestions of the things they would like to see the Society do,—or forever after to hold their peace!

M. E. Cooley,
President.

International Standardization

Prof. Comfort A. Adams, Chairman of the American Engineering Standards Committee, has recently returned from France and England, where, in company with H. M. Hobart, also a member of the Committee, he investigated the work of standardization societies and the possibilities of establishing coöperative relations with them.

In this country, according to Professor Adams, the work of engineering standardization has up to the present time been conducted largely by independent organizations, and, although in some instances there has been fairly effective coöperation between organizations with overlapping of interests, this has been entirely voluntary and without any well-established coördinating central body. The result has been not only much confusion resulting from conflicting standards, but also in many cases the task of standardization has been undertaken with more energy than knowledge of the requirements of the work.

Standardization is a task which should either be thoroughly done or not at all. In fact, many of the efforts in this field have been largely wasted. It is impossible, for example, for any organization to enforce standards, and the only way to bring them into universal use is by enlisting the interests and services of all of the organizations involved in their application.

The need of coördination in this field has been increasingly felt for some years past, and about two and a half years ago the four national engineering societies and the American Society for Testing Materials laid plans for establishing the American Engineering Standards Committee, whose formal organization took place in October 1918. The Committee is now undergoing reorganization to the end that other societies interested in the work may be admitted, and the proposed reorganization has been fully reported in Mechanical Engineering for July (p. 638).

Standardization abroad is also receiving considerable thought. In France the organization is called a Permanent Commission on Standardization, and is appointed by the Minister of Commerce. In Holland the organization is known as the Normalization Bureau. In England it is the Engineering Standards Association. In Switzerland a similar organization is contemplated, but it has not as yet been perfected.

The organizations of Holland and France are of comparatively recent origin, but the British association has been in operation about eighteen years and is doing an enormous amount of very important work, having secured the confidence of the government and many large organizations.

Professor Adams points out that the final outcome of this movement of world-wide organization in the field of engineering standardization is likely to be accomplished in somewhat the following manner: First, the organization in each country of a national coördinating body covering the entire field of standardization; and second, the organization in each section of that field of an international body coördinating the national sections.

At the present time such an organization exists in the electrical field. It is the International Electrotechnical Commission, and an attempt is now being made to bring about a similar organization in the aircraft field, and also in the field of testing materials.

A development of such a scheme of organization will mean much to the world's industry, to the increase in the productivity of labor, to international commerce, and to the establishment of commercial ties and better international feeling.

Screw Thread Commission Sails for Europe

The work of the Screw Thread Commission in connection with the standardization of screw-thread terminology, shape of threads, systems of threads and couplings, and methods of thread measurements and tests has been referred to in several of the recent issues of Mechanical Engineering. In the April number it was stated that the Commission believed that an international conference would be necessary in order to provide a basis for arbitrary recommendations. Such an international conference will soon be held, for a delegation representing the Screw Thread Commission recently sailed on the U. S. S. *Leviathan*, which was bound for Brest, France. Upon their arrival the party will proceed first to Paris and then to London, where arrangements have been made for a conference with the British Engineering Standards Association. The delegation was to have been headed by Dr. S. W. Stratton, Director of the Bureau of Standards and Chairman of the Commission, but at the last moment he found it impossible to sail. The remaining members of the delegation are: Lt.-Col. E. C. Peck, Vice-Chairman, representative of the U. S. Army; Capt. John O. Johnson, representative of the U. S. Army; Commander L. B. McBride, representative of the U. S. Navy, and at present attached to the American Embassy, London; F. O. Wells, representative of the A. S. M. E.; Luther D. Burlingame, representative of the A. S. M. E., alternate for James Hartness; H. L. Horning, representative of the S. A. E., alternate for E. H. Ehrman; Earle Buckingham, representative of the S. A. E., alternate for H. T. Herr; and H. W. Bearce and Lieut. Robert Lacy, Technical Secretaries.

A New Attitude Toward Increased Production

In the last number of Mechanical Engineering reference was made to the resolutions adopted by the American Federation of Labor at its Atlantic City meeting (page 629) recognizing the importance of research work as the basis for industrial development. The significant passages in these resolutions were those acknowledging the necessity for increased productivity as "a most potent factor in the ever-increasing struggle of the workers to raise their standards of living." In other words, to state it conversely, that the welfare and success of workers cannot result from restriction of output so long advocated by many labor organizations.

Coincident with this action by the American Federation of Labor was an incident of similar import, even if of smaller moment, which occurred at the Industrial Relations Session of The American Society of Mechanical Engineers at Detroit. This was a statement during the discussion by Mr. Boyd Fisher, Consulting Engineer in Management, that the officers of three labor unions had agreed to employ a firm of consulting engineers jointly with their employers, to install systems of scientific management.

While this may be an isolated case—merely a straw, perhaps—this attitude has undoubtedly been helped by and is complemental to the recent movement toward shop committees, whereby workmen may share in the management of a business to a greater or less extent as it affects their own interests. It indicates a willingness on the part of labor to accept methods for promoting increased production, *provided* it may have a share in the determination of these methods and in the allotment of gains.

Many features of this matter were ably brought out by the papers and discussion at the Detroit meeting, including the fact that the first shop committee was probably organized by Mr. H. F. J. Porter, Mem.Am.Soc.M.E., in 1903-4, at the plant of the Nernst Lamp Company, Pittsburgh, although such organizations have not been generally accepted as a foundation for harmonious relations in industry until very recently.

Enemy Opinion of the Liberty Motor

Toward the end of the period of hostilities the British bomber Hyderabad No. 3, built by the Westland Aircraft Works, fell into German hands. The engine, which was a Packard-built Liberty 12 of the standard army type, was apparently uninjured and gave the German engineers full opportunity to investigate its construction and performance ability. In this issue of Mechanical Engineering are reproduced some of the results secured by them and published in a German technical periodical, *Der Motorwagen*.

It is hardly possible to suspect the Germans of partiality to the production of our War Department, which makes their opinion particularly interesting.

There is no doubt but that the German engineers were most favorably impressed with the design and performance of the engine. Their tests have confirmed practically along the whole line the results of similar tests made for example at McCook Field by the Aircraft Engineering Department of the War Department and published by special courtesy of the War Department in the March issue of this journal.

In fact, the only serious criticism made by the German engineers is that with a motor of such tremendous power, direct propeller drive was used. This criticism, however, has nothing to do with the design of the motor itself, and, as a matter of fact, is by no means new to our own engineers, as a vast amount of work was done by the Aircraft Engineering Department in the United States along lines of developing a reduction transmission for aircraft propellers to be used with the Liberty motor. Not only that, but at the time when the armistice was signed, a most interesting design was actually developed and extensively tested out and would have been probably used had not the armistice brought about a slowing down of the work of production and development.

Particular attention is called to the German data on the fuel consumption of the Liberty motor, which, if anything, are even more favorable to the motor than similar data officially published in this country.

Another First Flight

Particulars regarding the British giant dirigible R-34, which completed its round trip across the Atlantic on July 13, have been given by the column and page in the daily press, but should be recorded nevertheless as another of the remarkable demonstrations in aviation which have occurred this season in such rapid succession.

From an engineering standpoint this was a vivid and spectacular demonstration of the great value of the research activity of the Allies during the war. By united effort of the French, British and American engineers and chemists, the unwieldy and unreliable gas bags of pre-war times have been transformed into mighty dirigibles, larger than anything that the world believed to be possible only four or five years ago. A great contribution of American engineering toward the development of lighter-than-air machines lies, of course, in the perfection of a method for

producing on a commercial scale helium gas, the use of which in dirigibles is expected to revolutionize ultimately the whole art by making balloon fires and explosions practically impossible, the need for which was so shockingly demonstrated by the recent explosion of the dirigible at Chicago. (See Mechanical Engineering for February, 1919, p. 155). Helium, however, was not used in the recent trip of the R-34 from East Fortune in Scotland to Roosevelt Field, Long Island.

This performance would have been impossible in the present year of grace without the feverish work done in the research laboratories of the allied countries under the stress of the past struggle, and in that way represents the fruition of that work. It also opens up great vistas of new possibilities for the utilization of lighter-than-air machines and for the application of the great inventions in that field of engineering made in this country as well as abroad.

Important Federal Commission

It having been made clear to President Wilson that the electric railways of this country are in a very bad way with respect to their finances, he appointed a commission called the Federal Electric Railway Commission, to investigate and report. This commission consists of

Charles E. Elmquist, President and General Solicitor of the National Association of Railway and Utilities Commissioners; formerly chairman of the Minnesota Railroad and Warehouse Commission.

Edwin F. Sweet, Assistant Secretary, U. S. Department of Commerce, formerly Mayor of Grand Rapids, Michigan.

Eugene Meyer, Jr., Managing Director of the War Finance Corporation, by profession a banker. During his absence in Europe Lewis B. Wehle, counsel of the War Finance Corporation, will serve in his stead.

Royal Meeker, Statistician, U. S. Department of Labor.

George L. Baker, Mayor of Portland, Oregon, and chairman of the Organization Committee of the American Cities League of Mayors.

Charles W. Beall, Nominated by the Investment Bankers' Association, member of the firm of Harris, Forbes & Company, investment bankers of New York City.

W. D. Mahon, President of the Amalgamated Association of Street and Electric Railway Employees.

P. H. Gadsden, Chairman of the American Electric Railway Association's Committee on Readjustment and of its Committee on National Affairs, formerly chairman of the Association's War Board; Vice-President of the United Gas Improvement Company and president of the Charleston Consolidated Railway & Lighting Co.

The American Electric Railway Association has appointed a committee of 100 prominent business men engaged in a great variety of businesses. The chairman of this committee is Mr. Guy E. Tripp, of the Westinghouse Electric & Mfg. Co., New York City. Experienced men from all over the country are being called before the commission to testify. There is now the opportunity for doing great good in the country by putting forth unbiased information which will enable the utilities and the people to come to common grounds of understanding.

Considering the fact that a large number of electric railways have either gone out of business or into receivers' hands, and that vast amounts of capital are jeopardized, and that the great public dependent upon street railways for their daily journeys to and from their business are thereby seriously inconvenienced, it is truly an *important* federal commission. If its work be done well, as it is sure to be, and the public profits thereby, much will have been accomplished toward dispelling the prevailing ignorance concerning this important utility and public utilities generally.

This Commission has no power except to report and recommend —that is, it cannot enforce its decisions. It is appointed as a war time measure and its members serve without compensation. Thus it may go out of existence at the time when expenditures for war cease.

The urgency of the situation is such that the Commission feels it cannot take time to investigate the different methods of valuing properties; that its main function will have been performed when it suggests remedies which will meet the immediate needs of the electric railways in order that they can continue to exist and give service to the public.—M. E. C.

Coöperative Course in Electrical Engineering

The coöperative course in electrical engineering which was established previous to the war under the joint supervision of the Massachusetts Institute of Technology and the General Electric Company, but was discontinued because of the S. A. T. C. courses, is now to be resumed.

The course covers a period of five years, of which the first two are identical with the old and well-established course in electrical engineering at the Institute, and the last three are divided between instruction at the Institute in Cambridge and experience associated with instruction at the West Lynn and other works of the General Electric Company. The work of the final year of the course is of advanced nature, with emphasis laid on the problems of administration, the design and development of engineering projects, etc.

While students are at work at the General Electric Company they receive regular compensation but are under supervision of teachers and their work in the shops is supplemented by conferences with works department heads in which technical and administrative problems arising at the works are discussed.

Distinguished Service Cross Awarded

It is with pleasure that we give below an announcement regarding one of our junior members which has been received from France:

Capt. Horace L. Smith, Jr., First Engineers, distinguished himself by extraordinary heroism in connection with military operations against an armed enemy of the United States at Charpentry, France, on October 4, 1918, and in recognition of his gallant conduct I have awarded him in the name of the President the distinguished service cross.

Awarded on December 17, 1918.

John J. Pershing,
Commander-in-Chief.

No. 2660.

This distinguished service cross citation is the culmination of many citations received by Captain Smith for valorous deeds rendered in the line of duty. Captain Smith is at present stationed near Coblenz, Germany.

Professor Lucke Honored

Prof. Charles E. Lucke, Mem.Am.Soc.M.E., and Head of the Department of Mechanical Engineering at Columbia University, has recently been honored by promotion to the rank of Commander in the United States Naval Reserve Forces. During the war Professor Lucke had the rank of lieutenant-commander and as head of the Gas Engine School at Columbia University directed the training of large numbers of men as engineering officers for submarine chasers and coast-patrol vessels. Professor Lucke's promotion was recommended by the Official Selection Board of the Navy and he is the first reserve officer to be honored with the rank. In announcing the promotion Franklin D. Roosevelt, Assistant Secretary of the Navy, also made it known that a special citation calls attention to Professor Lucke's "valuable assistance in training personnel to meet the great demands of the war."

Notes

President Cooley appeared before the Federal Electrical Railway Commission at Washington on Thursday, July 17, to give the results of his experience of 20 years in the valuation of public-utility properties, to the number of several hundred and aggregating in value well over one and one-quarter billions. Comment on the important bearing of the Commission's work will be found in another column.

On the afternoon of June 20 a sudden storm in the vicinity of New York so completely obliterated the sun's rays that there was an unprecedented condition of darkness, equal to that of the blackest night. According to the *Electrical World*, the demand upon the New York Edison Company was the greatest in its history, increasing in a very short space of time from 250,000 hp. to 425,000 hp. In spite of the suddenness and magnitude of this change, every part of the system met the exigency without failure.

ENGINEERING COUNCIL

Engineering Council[1] is an Organization of National Technical Societies of America, Created to Consider Matters of Common Concern to Engineers, as Well as Those of Public Welfare in Which the Profession is Interested

NATIONAL SERVICE COMMITTEE

Contributed by the Washington Office[2]

Department of Public Works

As a result of a conference held at Chicago, April 23 to 25, and attended by the representatives of over seventy engineering organizations (see MECHANICAL ENGINEERING for June, p. 557, and July, p. 633), there has been introduced in each House of Congress a bill which proposes far-reaching changes in the executive machinery of the Federal Government. The new bill creates a Department of Public Works which will replace the Department of the Interior and will assemble under one head all engineering activities of the Government.

Such bureaus of the Interior Department as are non-engineering in character are to be placed under the jurisdiction of existing appropriate departments. The bill proposes that the Patent Office be removed from the Interior Department and placed under the Department of Commerce. The Bureau of Pensions is assigned to the Department of the Treasury. The Bureau of Education goes to the Labor Department. The Bureau of Indian Affairs is also transferred to the Department of Labor, but with the proviso that the engineering and construction work of the land and mineral surveys now performed under the direction of the Bureau of Indian Affairs are to be prosecuted under the Department of Public Works.

The new Department will also absorb the Supervising Architect's Office of the Treasury Department; the Construction Division, River and Harbor Improvements, Mississippi River Commission, and California Débris Commission of the War Department; the Bureau of Standards and the Coast and Geodetic Survey of the Department of Commerce; and the Bureau of Public Roads and the Forest Service of the Department of Agriculture.

The bill further provides that the Secretary of Public Works "shall by training and experience be qualified to administer the affairs of the Department and to evaluate the technical principles of operations involved in the work thereof." The measure, however, excepts from the foregoing provision the Cabinet officer who is at the head of the Department at the time of the passage of the bill.

Four assistant secretaries, each to be paid $7500 per annum, are provided and their duties outlined. One is to have administrative jurisdiction over all matters of engineering design and construction; another is to have charge of architectural design and construction; the third is to have jurisdiction over all scientific work and surveys, while the fourth is to be in immediate charge of all land and legal matters. The assistant secretaries are charged with the duty of coördinating and bringing into efficient relationship all the activities of the department so that it may be harmoniously and efficiently administered.

An important feature of the bill is the proviso that engineer officers of the U. S. Army detailed on non-military work are to be assigned by the Secretary of War to like duties under the new department, but for not over two years. This enables the Secretary of Public Works to make a gradual transfer of improvements and instrumentalities to civil administration without detriment to the public interest. Members of the Corps of Engineers may therefore, under the direction of the Secretary of Public Works, be detailed by the Secretary of War to temporary duty in the new department for such instruction, training and experience as is desired.

[1] Officers of Engineering Council; J. Parke Channing, *Chairman;* Alfred D. Flinn, *Secretary,* Engineering Societies Building, 29 West 39th Street, New York.

[2] Washington Office in charge of M. O. Leighton, *Chairman,* National Service Committee, McLachlen Building, 10th and G Streets.

Water-Power Legislation

A bill to create a Federal Power Commission composed of the Secretary of War, the Secretary of the Interior, and the Secretary of Agriculture, has been passed by the House and is now awaiting action by the Senate. Since the water-power question was the subject of exhaustive hearings at the last session of Congress, the committee which reported the bill decided that no further hearings would be held. The bill is accordingly substantially the same as those previously introduced and provides for the improvement of navigation, the development of water power and the use of land. The necessity for the legislation embodied in this bill is felt in all parts of the country and especially by those engineers who are intimately connected with the projects which it will affect. The bill should therefore have the close attention and active support of every engineer. Copies of the bill will be mailed upon request made to the Washington office of the National Service Committee.

Patents Legislation

Important hearings started before the House Patent Committee on July 9, preliminary to reporting bills which propose to remove the Patent Office from the jurisdiction of the Department of the Interior and to establish a United States Court of Patent Appeals. Another bill being considered proposes increased compensation and a larger force of employees for the Patent Office.

The former bills were drafted by and have the backing of the National Research Society which has been making extensive surveys of several Government Departments during the past year. It is the purpose of the National Research Society to provide for carrying out many proposed plans to encourage inventors by making the Patent Office an independent organization.

The Patent Office is one of the few Governmental agencies which is self-sustaining. Last year saw the first deficit since this office was established in 1837. The office carries a surplus of $8,150,464.

Other minor changes are proposed by the bills, such as decrease in patent fees and the manner in which they are paid, as well as restrictions upon patent attoneys. Testimony already taken before the committee indicates that the employees of the Patent Office are greatly underpaid and that comparative inefficiency has resulted because of loss of personnel.

Appropriation for Topographic Mapping

Although Engineering Council urged the importance of increasing the Government appropriation for topographic mapping from $300,000 to $500,000, this important item was reduced to $289,000 by the House, increased to $425,000 in the Senate, and finally approved for $325,000 by the House conferees. It is understood, however, that an additional $100,000 may be obtained from the Army's topographic appropriation.

Engineering Council interested itself in having this appropriation increased because of the value of complete topographic maps to the engineering profession. It was estimated that $500,000 would enable the Geological Survey to complete the topographic-map program in twelve and a half years. It is now hoped to get the remaining appropriation necessary through as an urgent deficiency appropriation.

Army Equipment for Highway Work

In addition to the 20,000 motor trucks which were recently turned over to the Bureau of Public Roads by the War Department, arrangements are now being made to distribute among the

states a large quantity of additional engineering equipment. This equipment will be distributed without charge and in accordance with recent legislation, empowering the Secretary of War to provide the States with military equipment not needed for military purposes but valuable in highway construction work.

The additional equipment will be returned from France as soon as possible. It includes about 1500 caterpillar tractors; about 400 road rollers, steam and gas-driven; and a large number of concrete mixers, road graders, elevating graders, rock crushers, industrial locomotives, industrial-railway track, dump cars, steam shovels, hoisting engines, electric motors, and quantities of smaller equipment. In urging the immediate return of this equipment, the Secretary of Agriculture called attention to the fact that the road program was the largest scheme now being developed for the improvement of the country, for the use of materials that will help stabilize business along a number of lines, and for the employment of labor.

Air-Service Development Problems

Despite the fact that Congress failed to appropriate what many considered a sufficient amount for the development of the U. S. Air Service, the Equipment Section of the Engineering Division is nevertheless anxious for inventors and designers to lend their assistance in the development of various airplane improvements and devices. The following equipment is suggested as being of particular value and accordingly well worth development:

Gasoline Tanks. A tank is desired which will withstand a salvo of 30-caliber ammunition, equally mixed, service, tracer, incendiary and armor-piercing bullets, fired at a range of 30 yd. and at the most vulnerable angle. There are to be 10 consecutive tests on as many tanks without fire occurring. The weight should be kept as low as possible, the maximum limit being 75 per cent more than for standard tank weights.

Air-Bag Floats, Landing Skids, Etc. The object of these devices is to prevent the machine from capsizing when landing in water and to keep the machine afloat after landing. Such devices should present as small an amount of wind-resistance surface as possible, should be light and readily detachable.

Mobile Independent Cranking Device. This should be mounted on a small auto truck. The cranking device should be electrically driven and arranged so that it can be backed up to the front end of any aeroplane and attached to the propeller with a flexible arm. The electric motor is then used to crank the engine, causing it to begin firing. When the engine picks up, the device should be automatically thrown out of connection with the propeller.

Gasoline Supply Gage. This gage should be responsive, serviceable, and accurate to the last half-gallon. It may be mounted on the tank, although it preferably should be mounted on the dashboard. This gage of course must register under conditions existing in aeroplane service when the center line of the tank changes rapidly to practically every possible plane, and is often 180 deg. out of its normal position for short intervals.

Portable Hangars for Field Service. At present canvas hangars do not weather winds or rainstorms well enough to be practical and they are generally too small. The improved hangar should be capable of housing four De Haviland planes with working space. They should provide for the necessary electric lighting and small machine work.

Campaign for Uniform Traffic Regulations

The Council of National Defense, through its Highways Transport Committee, is inaugurating a nation-wide campaign for the purpose of bringing about the adoption so far as possible of suggested uniform traffic regulations and directions. An alarming number of accidents occur daily on the highways and it is the belief of the Committee that through this movement life and limb may be conserved and results of an impressive character attained.

These suggested regulations and directions represent, the Council of National Defense believe, the best and most disinterested thought on the subject of highway accidents, and their cause and remedies, possible to be had. Prepared originally by Mr. William P. Eno, an authority on traffic, these regulations and directions have since been submitted for constructive criticisms to secretaries of state, state highway commissioners, the American Automobile Association, the National Automobile Chamber of Commerce, the Highway Industries Association, the National Highway Traffic Association and to scores of individuals competent to pass upon this question.

The Council of National Defense will be glad to give the public the benefit of lessons learned in this campaign, which affects every city and village throughout the country, and inquiries as to the progress of the campaign should be addressed to the Highways Transport Committee.

Coal for Foreign Shipment

An interesting condition has arisen in the position of the American coal producers in what may be called a world trade. On the one hand, the coal producers, through their various organizations, have expressed considerable dissatisfaction in the progress made in getting export coal trade under way. They regard the methods thus far devised as not promising. There is dissatisfaction arising from the rates which the Shipping Board will charge, and fear is expressed that American exporters will be unable to compete with English rates which are so much lower.

On the other hand, the Navy has found it necessary to take special steps to provide for an adequate supply of satisfactory coal for its use on vessels engaged in the return of troops and to carry out Navy orders. Under a recent issue of proposals soliciting bids for the furnishing of steaming coal after July 1, definite offers were received for only about one-half the quantity requested, some of the operators offering only a meager supply and some failing to submit bids. This is only partly due to the stringent Navy specifications.

It is therefore clear that this country cannot successfully compete in foreign markets if it cannot supply its own Navy. Apparently there is no question but that considerable business can be done under existing conditions in Europe with Northern Europe and the Mediterranean ports. Many, however, express the idea that there is little hope of establishing permanent markets there, but there is obviously a good opportunity to take advantage of the present situation by rushing quantities of coal to those markets at very respectable profits. Besides, our coal producers would benefit from the experience. Permanent and fertile fields for this product probably can best be found in Latin America and Canada.

It is now apparent that it is an economic necessity for the country to do an export coal business, but the restrictions of the Shipping Board's high rates, a decided timidity on the part of the Government to assist, together with the fact that on the face of things our coal men are not caring for the home market, the way that such export trade is to be accomplished is not clear. Nevertheless there is concentrated effort being put forth in Washington to reduce the formidableness of the obstacles which confront coal exportation and it now seems probable that a working plan will be hit upon.

National Conference on Commercial Engineering

There was recently held at Washington, D. C., a very important conference composed of administrative professors in engineering and commerce and representatives of several national engineering and educational societies. The purpose of the conference was primarily to direct public attention to the positive need in our country for an increasing supply of well-trained young engineers to enter upon business careers in the direction of industrial and commercial management.

Dr. Glen L. Swiggett, of the Bureau of Education, Department of the Interior, was chairman of the conference, and the A. S. M. E. was officially represented by Dean R. L. Sackett, of the School of Engineering, Pennsylvania State College. The conference served largely as a clearing house for the exchange of ideas leading to common thinking and action in respect to the program of the conference, and to the end that these might be placed on record the following resolutions were passed as representing the sense of the conference:

1 Industrial and commercial development has created a demand for men with technical engineering training and business ability. Manufacturing industries are seeking engineers qualified to serve in capacities requiring sound business training. Banks and brokers also need men with business training and the engineering point of view.

This need is rapidly increasing and bids fair to demand a large number of technically trained men for both domestic and foreign commerce.

2 In order to meet this demand the economic phases of engineering subjects should be emphasized wherever possible in engineering instruction. This may be done by emphasizing the problems of values and costs in the regular technical work and by introducing or extending courses in general economics, cost accounting, business organization and business law into the engineering curricula. These courses should be designed particularly to meet the needs of the engineering student.

3 The engineering phases of economic subjects should be emphasized wherever possible in commercial instruction. Students in commercial courses should also be given opportunity to take special courses in the basic principles and practices of engineering so that they may understand in general terms the operation of power plants and transportation systems from the engineering point of view.

4 It is also urged upon all institutions with departments in engineering and economics or commerce that they consider some plan of coördination to develop a course in preparation for those careers wherein practical training in modern languages, in the essentials of engineering and business theory and practice have been found to be both helpful and necessary.

Government Activities in Engineering

The National Service Committee through its Washington office is in immediate touch with governmental affairs affecting the engineering profession in general. These are naturally of a numerous and varied nature, and it is therefore impossible to cover them all in detail, but Mechanical Engineering strives to give information regarding those which it deems of special interest and value. There may be, however, certain affairs of interest to some which we have failed to present, and on these the Washington office of the National Service Committee will gladly supply information. At the present time full and up-to-date particulars may be obtained on the following subjects:

Shipping Board's Reports and Addresses. Summer positions for college men; specifications for new ships; proportion of world's shipping; proposed plans for next fiscal year.

Road Construction Work. Latest state status; national appropriation bills; war material available; comparative U. S. and foreign program; committee arrangements for coöperation.

War Department. Contract-settlement regulations and operations; statistics series; equipment and realty advertised for sale.

Mining. Plans for completing and executing findings of War Minerals Relief Commission; Safety Engineer and Accident Statistics, by A. H. Fay, of Bureau of Mines; proposed plans to protect war minerals, potash, etc., by license and duty; detailed report of Geological Survey on shipments of coal and coke.

Railroad Administration. Latest operating and financial statements; movement of traffic in various regions.

New Sundry Civil Appropriation. Government departments and bureaus; reports for current year, etc.

Purchase of Airplanes or Motors. The Salvage and Sales Branch of the Air Service, 6th and B Streets, N. W. Washington, D. C., announce that those persons who contemplate purchasing a Government airplane or motor, should list their names in the above office, so that they may be advised when the opportunity arrives for them to make a purchase. Detailed information of equipment proposed for sale and method of sale can be obtained from the Salvage and Sales Branch.

Oil Lands in Utah. Reports from the Geological Survey, Department of the Interior, indicate that although considerable drilling has been done in the state of Utah, no oil has been produced in commercial quantities. Sandstone saturated with asphalt and other hydrocarbon compounds and small showings of oil in wells at several places suggest that oil may be found in commercial quantities where the rocks are favorable for oil accumulation.

Mineral Deposits in the United States. The United States Geological Survey recently published Bulletin 690, which contains those papers dealing with zinc and copper ores at Ophir, Utah; gravel deposits in Arkansas, with special reference to their possible utilization as a source of hard pebbles for grinding mills; phosphate deposits in the Uinta Mountains, Utah; quicksilver deposits in the Phoenix Mountains, Ariz.; and manganese deposits near Butte and in Madison County, Mont. This bulletin is completely descriptive and contains important illustrations and maps.

Outline Map of the United States. The Coast and Geodetic Survey, Department of Commerce, recently completed a new outline map of the United States on the Lambert Conformal Conic Projection, scale 1-5,000,000, dimensions, 25 in. by 39 in. This map is intended merely as a base to which may be added any kind of special information desired. The shoreline is compiled from the most recent Coast and Geodetic Survey charts. State names and boundaries, principal rivers, capitals and largest cities in the different states, are the only information otherwise embodied. This map is based on the same system of projection as that of the armies of the allied forces in the military operations in France. It is being used extensively by the Army and will probably be of interest and value to engineers.

NATIONAL RESEARCH COUNCIL

DIVISION OF ENGINEERING [1]

Dr. Henry M. Howe, Chairman of the Division of Engineering of the National Research Council, who has been serving for the past three months as Scientific Attaché to the American Embassy at Paris recently returned to New York. Time has not as yet permitted Dr. Howe to prepare a report of his work during his stay in Paris and at present details are accordingly lacking. Research abroad, however, is receiving considerable attention and plans are now being made whereby the United States may be properly acquainted with and assist in the extension of international research.

The work of the Division of Engineering in this country is progressing along many lines and recent tentative reports are now available in connection with the work of three important committees. These are briefly presented herewith.

Committee on Improvement of Metals at Blue Heat. A meeting of this committee was recently held at the new offices of the Division of Engineering at 29 West Thirty-Ninth Street, New York City. The committee has been engaged for some time past in a study of the behavior of high-speed steel when at temperatures below the critical point, and since it proposes to confine itself in the future to problems associated almost entirely with steel, the committee requested that it hereafter be known as the Committee on Physical Changes in Iron and Steel. The personnel of this committee is as follows: Zay Jeffries, Chairman, R. R. Abbott, G. H. Clevenger, J. V. Emmons, F. B. Foley, H. J. French, A. H. Miller and Albert Sauveur.

Committee on Fatigue Phenomena of Metals. This committee was created in August, 1918, for the purpose of investigating problems arising in connection with the electric welding of ships and the failures of aircraft. Prof. H. F. Moore, of the University of Illinois, is chairman of the committee and at a meeting held at Atlantic City on June 27, plans were made for an elaborate and intensive study of the problems lying within the committee's field.

Committee on Neumann Bands. This committee was formed as a result of testimony given in connection with the investigation of the molasses tank disaster at Boston. An expert stated that it was his opinion, based upon the number and formation of the Neumann bands, that the speed of impact which caused the breakage was not over 15 ft. per sec., and if the primary break was located as was claimed then the results disprove the theory of an explosion, for in such case the speed of impact would have reached well into the hundreds of feet per second and the formation of the Neumann bands would have been entirely different. This implied relationship between speeds of impact and Neumann bands was hitherto unknown to exist but upon having its attention called to the fact the Division of Engineering immediately appointed a committee to investigate the entire field. The chairman of the committee is Prof. Charles E. Munroe and although some work has been done the relationship as expressed above has not as yet been determined.

[1] Dr. H. M. Howe, *Chairman*; G. H. Clevenger, *Vice-Chairman*, Engineering Societies Building, 29 West 39th Street, New York.

NEWS OF THE ENGINEERING SOCIETIES

Reports of Annual Conventions of American Railroad Association, American Water Works Association, American Society of Civil Engineers, American Institute of Electrical Engineers, etc.

American Railroad Association

That fifty out of the three hundred exhibits shown on Young's Million Dollar Pier, Atlantic City, at the convention of the American Railroad Association held on June 18 to 25, were of machine tools, indicates how close is the relation between the machine-tool industry and the builders of railway equipment. Many of the machine tools on exhibition were new models and a casual study of their design indicates a tendency toward greater weight, making for rigidity and greater production. In the course of the numerous official sessions considerable time was given to the discussion of reports on many subjects pertaining to car and locomotive design and maintenance. Among these were such subjects as car wheels, couplers, draft gears, car trucks, tank cars, mechanical stokers, locomotive headlights, superheater locomotives, and design, maintenance and operation of electric rolling stock.

American Water Works Association

A notable feature of the thirty-ninth annual convention of the American Water Works Association, held in Buffalo on June 9 to 13, was a paper describing a new and unique reciprocating pumping engine which incorporates the uniflow principle in the operation of the pump. The engine is of the horizontal extended type having one steam cylinder and one double-acting plunger pump. Its normal working water pressure is 100 lb. per sq. in.; the suction lift is approximately 15 lb. plus the friction in about 60 ft. of suction pipe. This engine will operate in the Porter Ave. water-works pumping station of the City of Buffalo. It is anticipated that the tests will show a duty of 180,000,000 ft-lb. per 1000 lb. of steam.

The report of the Committee on Private Fire Protection Service reviewed the various physical and financial questions involved and made specific recommendations as to each. Much hearty commendation of the report followed its reading. It was voted to continue the committee instead of adopting the report and discharging the committee as it recommended.

A progress report of the American Committee on Electrolysis stated that a technical sub-committee had been created and a plan had been formulated under which experts would be engaged to study electrolysis.

National Gas Engine Association

Plans for increasing the activities of the National Gas Engine Association were laid at the twelfth annual meeting of the Association held on June 2 and 3 in Chicago. The reason for reorganizing the Association, as expressed by President O. H. Fischer, was the necessity for developing a greater coöperation between the manufacturers of internal-combustion engines in order to cope with the present situation, particularly in regard to labor conditions. Various aspects of the labor question were treated by Chris Heer in a paper entitled The Industrial Committee, Its Work and Future. Complete organization of the employer and employees of each industry affiliating with national organizations, coöperating and working in conjunction for the best interests of all, he believed, would come nearer solving and taking care of the labor question than any other method.

I. R. Todd, in a paper on Reconstruction Problems, took a most hopeful and optimistic view of the future awaiting American industry. With the balance of trade in our favor, with our growing merchant marine and our recent legislation permitting American bankers to establish foreign branches, American business men to coöperate for foreign trade, and authorizing the War Finance Corporation to extend credit to the extent of one billion dollars to promote this trade, he said, one cannot contemplate present conditions without anticipating a great future for American business.

Another paper of interest was an account of early pioneering days in the gas-engine field, by George Cormack.

American Concrete Institute

Many of the papers presented at the annual meeting of the American Concrete Institute, which was held on June 27 and 28 in Atlantic City, N. J., were devoted to the work of the Emergency Fleet Corporation. During the war the Concrete Ship Section, Emergency Fleet Corporation, developed a special light-weight aggregate for concrete, thereby obtaining a concrete of considerable strength weighing only 99 lb. per cu. ft. The possibilities of using such light concrete in building construction were discussed by A. W. Stephens in a paper entitled Economic Possibilities of Light-Weight Aggregate in Building Construction. The data and allowable costs per cubic yard in this paper would permit the higher-priced but lighter aggregate to compete with trap rock and gravel.

The report of the Committee on Standard Building Regulations for the Use of Reinforced Concrete contained the following clause:

> Cinders shall not be used as coarse aggregate in concrete for reinforced-concrete structures without tests acceptable to the Building Department showing the strength of such concrete. Cinder concrete may be used for fireproofing, for floor and roof slabs, not exceeding 8-ft. span, and for partitions. Where cinders are used as the coarse aggregate they shall be composed of hard, clean, vitreous clinker, free from sulphides, unburned coal or ashes.

This regulation brought out considerable comment. Ira H. Woolson, who has had much experience with cinder concrete, went on record to the effect that, in his opinion, 15 per cent of unburned coal was not detrimental and might be permitted in anthracite cinders, and that a small percentage of ashes could also be allowed without bad effects in the resultant concrete. The matter will be considered further by the committee in the light of the discussion.

American Society of Civil Engineers

The annual convention of the American Society of Civil Engineers was held in Minneapolis on June 17. The main topic of the business session was the report of the Development Committee, which included recommendations in regard to internal relations and local associations, technical activities and public service, and relations with other societies. It was the opinion of the committee that the identity of the four national societies known as the Founder Societies should be preserved, but they added that the time had now come when the society should adopt the principle of becoming an active national force in economic, industrial and civic affairs. To do this effectively they recommend that jointly with other engineering organizations a comprehensive organization should be formed embracing (1) the local affiliation of the branches of the national technical societies and the local technical societies, (2) a state council composed of representatives from the local affiliations, and (3) a national council consisting of representatives of the national technical societies and from the state council or state group organizations. With respect to the internal relation of the society, the committee suggested the establishment of regulations intended to develop greater activities

among the local associations. The creation of committees of the parent society and local associations charged with the responsibility for promoting greater technical activity was advised by the committee. Recommendations were also made to prepare, in coöperation with other founder societies, a standard form of bill for the licensing or registration of engineers, to be used in the framing of legislation, and to maintain an agency in Washington, D. C., or elsewhere, for the purpose of keeping advised of all proposed Federal legislation and departmental rulings and regulations involving directly or indirectly questions of engineering.

Engineering Educators Meet in Baltimore

The lessons of the Great War in matters of education were discussed at the 27th annual meeting of the Society of the Promotion of Engineering Education, held at the Johns Hopkins University, Baltimore, Md., during the last week of June.

At the opening session, following an address of welcome by President Frank J. Goodnow, of Johns Hopkins University, and the response by Professor John F. Hayford, president of the society, the Special Committee on the Report of the Joint Committee on Engineering Education presented its preliminary report in the form of six specific resolutions based on Dr. Charles R. Mann's paper on The Study of Engineering Education, which was presented to the society at its last annual meeting. These resolutions prompted considerable discussion and comment. Two of the resolutions of general interest are quoted below:

Resolved. (1) That this Society, through its Committee on Admission, or otherwise, recommend that as a matter of experiment and research psychological "objective," "trade" or other similar tests be given to all students after admission to engineering courses of study and that the ratings thus obtained be compared with their subsequent scholastic progress.

(2) That the Society should coöperate with the national and other engineering societies, with a view to establishing a classification of the work, or positions, including specifications as to necessary preparation and qualifications, into which our engineering graduates enter, so that undergraduate students would thus have a clearer understanding of the work for which they are preparing themselves and instructors have before them a constant reminder of the main purpose of their teaching work.

The subject of psychological tests was further discussed in two papers. One, entitled Mental Tests for Engineering Students, was presented by Prof. C. L. Thurston, Division of Personnel and Psychology, Carnegie Institute of Technology, Pittsburgh, Pa., and the other, entitled Vocational Intelligence Examination to Fourth-Year M. E. Students, was read by Prof. William T. Magruder, of Ohio State University. Both of these papers were enthusiastically received.

The second session of the convention was devoted to a general discussion of the Effect of the War on Engineering Education. The discussion was opened by Dean Anson Marston of Iowa State College, and was participated in by many, including the following A. S. M. E. members: Profs. Carl C. Thomas and Alexander G. Christie, of the Johns Hopkins University; Prof. William T. Magruder, Dean A. A. Potter, Kansas State Agricultural College, and Prof. Dugald C. Jackson of the Massachusetts Institute of Technology. This theme was carried into a later session when Col. F. J. Morrow, Chairman of the War Department Committee on Education and Special Training, described the Government's plan for the continuation of the Reserve Officers' Training Corps. As part of the discussion of the topic set for this session, viz., Military Training in Engineering Schools, Major Harrison Tilghman from Fort Monroe told how the Coast Artillery was already putting its plans for the R. O. T. C. into operation.

During the convention a number of the standing committees of the society made their annual reports. Of special interest to the mechanical engineering profession are those of Committee No. 16, Mechanical Engineering Courses, Prof. Oscar A. Leutwiler (Mem. Am. Soc. M. E.), Chairman, and of Committee No. 20, Standardization of Technical Nomenclature, Prof. John R. Faig (Mem. Am. Soc. M. E.), Chairman.

At the final session held on Saturday morning, Arthur M. Greene, Jr., Mem. Am. Soc. M. E., Professor of Mechanical Engineering, Rensselaer Polytechnic Institute, and Chairman of the A. S. M. E. Committee on Research, was elected president for the ensuing year, and Dean A. A. Potter, vice-president. Following the election Dr. Ira N. Hollis, Past-Pres. Am. Soc. M. E., President of Worcester Polytechnic Institute, read a paper on Engineering Colleges and Their Administration.

The social features of the convention included an annual-mixer meeting and the annual dinner, both held at the Baltimore Country Club, an informal smoker and round table discussion, and a half-day excursion to the United States Naval Academy and the Engineering Experiment Station.

C. B. Le P.

American Institute of Electrical Engineers

The program of the annual convention of the American Institute of Electrical Engineers, held at Lake Placid Club, N. Y., June 24 to 27, provided an even balancing of the business and entertainment features, and this innovation met with general approval. Of special interest were the three sessions held under the auspices of the Institute's Development Committee. The report presented by this committee, which was based on suggestions forwarded to its members by the local sections and by individual members, outlined a plan for the improvement and development of the Institute's activities. Among the recommendations proposed were the following:

1 Development of the scope of the monthly Proceedings in order to include, in addition to the high-grade electrical engineering papers which have formed the principal part of the publication up to the present time, other material of more general interest, without in any way lowering the Institute's standards.

2 Inclusion in the monthly publication of a set of abstracts of practically all papers presented at section meetings throughout the country.

3 Consideration of whether or not a satisfactory plan can be developed which will eliminate the present wasteful practice of printing practically all papers twice, once in the monthly Proceedings and again in the annual Transactions, by possibly printing the monthly in two sections, bound together in one publication when issued and so arranged that they may be separated later by the recipient, who may wish to dispense with the transient matter and retain the part containing technical matters and discussions of permanent value.

4 As a result of the improvement of the monthly publication, it will become a better advertising medium; and it is suggested that advantage be taken of this fact to develop the advertising section and thereby meet the additional cost of enlarging the editorial staff and printing more material.

5 Create a New York Section, organized and conducted along the same lines as existing sections elsewhere.

6 Extend the present practice of holding some of the Institute and Directors' meetings in different parts of the country where local sections are established, instead of holding nearly all of these meetings in New York as at present.

7 Divide the country into geographical divisions corresponding in number with the number of Institute vice-presidents; and select one vice-president from each of these districts.

8 Make it a part of the duty of each vice-president to visit the sections in his own division at least once a year.

9 Pay the traveling and living expenses of the officers and board members attending Institute meetings.

10 Increase the vice-presidents' term of office from one year to two years. Provide that no member of the Board of Directors may continuously hold office for more than six years.

11 Decentralize committee work as far as may be found feasible and desirable, by substituting section committees for some of the Institute committees. Appoint a general committee to study this question and to make recommendations.

12 Present more high-grade papers of general engineering interest.

13 Create a committee in each section charged with the duty of assigning to the younger members specific participation in designated meetings by the preparation of papers and discussions, or otherwise. By this and other methods, including appointment of a reasonable number of the younger men to membership on committees, it is hoped to stimulate the interest of the younger members and thereby increase their loyalty to the organization and their opportunity for self development.

All of these recommendations were approved in principle, with the understanding that details would be worked out by appropriate committees.

In his presidential address, Comfort A. Adams emphasized the

great need of closer cooperation in commercial, industrial and scientific transactions. After delivering his address President Adams introduced President-Elect Calvert Townley, who in a brief address called attention to the tremendous work the engineer had done during the war, and added that the possibilities for the engineer making a prosperous period of peace were many times greater.

The Power Station Committee announced that it would shortly present to the Institute the results of its labors for the last two years on Limits of Speed and Power of Single-Shaft Steam Turbo Generator Units.

In the report of the Instruments and Measurements Committee reference was made to the effect of the war on the development of the manufacture of thermoelectric couples in this country. Thermoelectric couples of American manufacture, the report indicated, "are superior in every way [to those of German manufacture] and are now available for the accurate measurement of alternating current of any frequency. Their sensibility is such that a current of one milliampere will produce a deflection of three millivolts in a direct-current voltmeter."

"The increase in the use of electrical energy in the iron and steel industry in the last few years," according to the report of the Iron and Steel Industry Committee, "has been remarkable and partly responsible for the prominent position the United States has taken in furnishing steel products to the entire world. Over 500 motor equipments are in use in this country, driving main rolls with a maximum horsepower of over 850,000, while the total horsepower of auxiliary motors exceeds 1,350,000, making a total of 2,200,000 hp. which requires about 650,000 kw. in generator capacity. In addition, electric furnaces require approximately 250,000 kw. in generator capacity, or a grand total of 900,000 kw. generator capacity in the iron and steel industry. This is by far the largest amount of electric energy required in any one industry, and from all indications will continue to increase considerably in the future."

American Society for Testing Materials

Of special interest is the action on phosphorus and sulphur limits in various specifications covering steel products taken by the American Society for Testing Materials at their 1919 meeting held in Atlantic City, N. J., June 24-27. Last year, by suggestion of the Committee on War-Emergency, the society introduced in the specifications for finished steels what is known as the phosphorus and sulphur note. This note read as follows:

> In view of the abnormal difficulty in obtaining materials in time of war, the rejection limits for sulphur in all steels and for phosphorus in acid steels shall be raised 0.01 per cent above the values given in these specifications. This shall be effective during the period of the war and until otherwise ordered by the society.

It has now been decided to restore the normal figures at once for those steels in which quality is most essentially affected by the change, and to retain the war clause in the other specifications until next year. This action may be summarized as follows:

War Clause Removed 1919:	War Clause Retained for Present:
Bridge steel	Building steel
Structural nickel steel	Ship steel
Plates for stationary boilers	Carbon-steel rails
Forgings and steel for forgings	Tie plates
Splice bars, except low-carbon	Splice bars, low-carbon
Track bolts, except low carbon	Track bolts, low-carbon
Wheels and tires (railway), all	Plates for locomotives and cars
Spring steels, all	Tubes for locomotive and stationary boilers
Tool steel	Chain
Automobile steels	Bars for concrete reinforcement
Girder and high tee rails	Castings.
Screw stock.	

A new tentative specification for plates for forge welding, which was adopted upon recommendation of Committee A-1 on steel, limits carbon to a maximum of 0.18 per cent, phosphorus to 0.04 per cent, and sulphur to 0.05 per cent. The manganese range is 0.30 to 0.60 per cent. The minimum tensile strength for plates $^3/_4$ in. or under is 48,000 lb. per sq. in., and for plates over $^3/_4$ in., 45,000 lb. per sq. in. The yield point is put at one-half the tensile strength. Modifications in elongation are made in proportion to thickness.

The results obtained from an experimental study of the effect of heat treatment on fatigue-resisting strength of nickel steel and chrome-nickel steel were presented by H. F. Moore and Arthur G. Gehrig. The nickel steel was of about 3.3 per cent nickel content and the chrome-nickel steel contained about 0.8 per cent chromium and 1.3 per cent nickel. The conclusion was reached from the performance of both static tension tests and tests under reversed bending stresses made with annealed, heat-treated, and polished specimens, that the results of a static tension test are not a reliable index of fatigue strength of a material under oft-repeated low stresses, and that high-stress, short-time fatigue tests do not give a reliable index of fatigue strength under oft-repeated low stresses. It was also established that a heat treatment may raise the elastic strength of a steel without increasing its fatigue resistance under low stresses, and that perfection of surface finish is an important factor in determining fatigue resistance under oft-repeated low stresses.

Five papers were presented in which magnetic analysis as a method of testing ferrous material for quality was discussed. The first, by C. W. Burrows and F. P. Fahy, described the methods used and the results of some measurements, emphasizing the very close relationship between the magnetic and the mechanical characteristics of steel. Various practical applications of magnetic methods were dealt with in three papers as follows: To the discovery of defects in steel rails, by P. H. Dudley; to the testing of ball-bearing races, by R. L. Sanford and M. F. Fischer; and to the location of flaws in rifle-barrel steel, by R. L. Sanford and W. B. Kouwenhoven. Finally, magnetic properties as affording a basis for determining microstructure were considered by C. Nussbaum.

Five new instruments and machines for testing were also described. T. D. Lynch and P. H. Brace, in a paper entitled Wire Testing Extensometer, explained the operation of this instrument. It grips the wire by a spring clamp at one end of a pair of distance bars, and at the other end of the bars by two small rollers which carry mirrors on their ends. These mirrors reflect a beam of light from a small collimation tube at one side of the instrument to a curved scale attached on the opposite side. Reading to 0.00002 in. is possible. A miniature Brinell machine for use in inspection of cartridge cases was described by S. L. Goodale and R. M. Banks in a paper entitled Development of Brinell Hardness Tests on Thin Brass Sheet. The impression is made by a 1/16-in. ball under a 15-kg. load. The design of a very compact repeated-stress machine for testing electrically welded ship plates was reported by F. M. Farmer in his paper on A Fatigue Testing Machine. The test piece is a rotating simple beam, loaded at the third-points, and the whole machine is only 5 in. by 19¼ in., though the specimen is 0.4 in. in diameter and 13 in. long. A new viscosimeter for gasoline, designed by W. H. Herschel, as described in his paper, A Viscosimeter for Gasoline, has an outflow tube 24 diameters in length instead of 7 as in the Engler and Saybolt instruments. An apparatus in which a slab of pitch is bent on a hinged plate while immersed in water, the temperature of which can be varied, was described by H. E. Lloyd and P. P. Sharples, in a paper on Apparatus for Determination of Breaking Point of Pitches.

There are now 620 known trade associations in the eastern half of the United States, of which 323, or over half, are located in New York City, 75 in Chicago, and the remaining 222 in smaller cities. The increase in the number of these associations has been rapid and their utility has been emphasized by the conditions of business and trade resulting from the war. A building is now being erected in New York, known as the National Association Building, on Forty-third Street, which it is expected will eventually become the headquarters of a large number of trade associations, thus bringing together many of the important business activities of the industries in the direction of interchange of data, unification of methods in specifications and accounting, direction of educational campaigns, etc.

REPORT OF THE COMMITTEE ON INDUSTRIAL RELATIONS

Appointed to Report Upon the Advisability of Establishing a Permanent Committee on the Relations Between Employer and Employee

THE following report of the Committee on Industrial Relations was presented at a meeting of the Council on February 22, 1919:

To THE PRESIDENT AND COUNCIL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS,

29 West 39th Street, New York City.

Gentlemen:

In compliance with your request, the special Committee appointed by the Council of the A. S. M. E. on December 6, 1918, to report upon:

a "The advisability of establishing a permanent committee on the relations between employer and employee; and

b The best method of encouraging our membership to fulfill their high duty in that field for which their training and activities should fit them,"

held a protracted session on Friday, January 17, 1919, in New York City. Aside from the undersigned Chairman, there were in attendance: John W. Lieb, Vice-President, New York Edison Co., New York City; W. H. Manss, Director War Service Executive Committee, Chamber of Commerce, U. S. A., Washington, D. C.; Henry D. Sharpe, Treasurer Brown & Sharpe Mfg. Co., Providence, R. I., and Magnus W. Alexander, Managing Director, National Industrial Conference Board, Boston, Mass.

At the outset the Committee discussed and agreed on the importance of a desirable coöperative relation between employer and employee as a fundamental and potent factor in the efficient conduct of industry and the proper discharge of social obligations resting upon both parties. The Committee, moreover, was unanimous in the opinion that a clear understanding of the employment relation and of correlated phases of industrial activity by all classes of the population is necessary for the development of sound and sane public opinion regarding these vital issues; and that the engineers of the country, both as primary factors in the country's industrial development and as intelligent citizens, must be enlisted on the task of correctly informing the public and properly shaping its opinion in respect to industrial questions.

The Committee, therefore, urges most strongly that adequate space be provided on programs of meetings of the Society and its branches in order that qualified speakers may keep the members of the Society in close touch with the latest developments in the human relationship in industry. Speakers should be chosen, however, who do not merely propagate a personal opinion but who can speak with the authority of deep knowledge of and long experience with the subject under discussion. They should, in engineering fashion, analyze the elements of a proposition, show its feasibility and, where possible, its practical application and resultant benefits so that justified deductions may be drawn from accumulated data and experience.

The Committee will be very glad to assist the Council and the Committee on Meetings of the Society in suggesting topics and speakers on the employment relation and allied subjects.

The Committee fully discussed the advisability of establishing in the Society a standing committee on relations between employer and employee, and unanimously agreed that it does not seem advisable at this time to recommend to the Council the appointment of such a committee. In this decision is involved a consideration of the Society's purposes and the character of its membership. We submit, therefore, the following observations:

In the language of the Society's Constitution, "The object of the Society is to promote the Arts and Sciences connected with Engineering and Mechanical Construction."

We believe that The American Society of Mechanical Engineers was created for the purpose of bringing together knowledge and experience in the scientific mechanical engineering field in order to help in the promotion of the Arts and Sciences of Engineering and Mechanical Construction and in the advancement of the status and prestige of mechanical engineers. In this scientific field, The American Society of Mechanical Engineers occupies a commanding and influential position and its achievements are a credit alike to the Society as a whole and to individual members who have been active in promoting the Society's legitimate ends.

Unlike the mechanical engineer, who deals with the ascertainment of scientific facts and with their application to the mechanical arts, the sociologist in industry, if we may use this term in contradistinction, endeavors equally to ascertain facts, but, supplementary to this, he also collects opinions and finally compromises between abstract judgment founded on facts and justified consideration of prevailing public opinion and social and political conditions. We believe that as an organization The American Society of Mechanical Engineers should steer a scientific rather than a sociological course and deal more largely with facts and experience rather than with opinions and expediency compromises.

In so far as the membership of the Society is concerned, it may be conveniently divided into those who are in active administrative charge of industrial enterprises, those who are devoting their energies to scientific engineering in private or public capacity, and those who constitute the group of teachers of engineering and general science. Only the men comprising the first group, aside from some individuals in the other two groups, would have practical knowledge of and intimate experience with the many complex and often perplexing questions involved in the employment relation. But these men are usually also members of national and local trade and civic organizations and of specially organized bodies, whose chief endeavor is devoted to the considerations of the employment relation and kindred subjects. As far as these latter activities are concerned, the men of the first-named group of the A. S. M. E. function, therefore, principally through such organizations.

Merely to establish in the Society a standing committee on relations between employer and employee without giving the committee the necessary authority and large financial resources to prosecute its investigations and formulate reports with the thoroughness and accuracy which they demand, would neither contribute materially to the solution of the many vexing problems involved in the situation nor hold the Society true to its established course. It would, moreover, project the Society into a field in which there are now effectively operating several organizations especially devoted to the study of economic and sociological problems in industry.

These organizations are constantly tapping the knowledge and experience of those members of The American Society of Mechanical Engineers who are engaged in executive and administrative functions in industry. A close connection between the Society and these organizations, therefore, already exists and can be made more effective by placing before the membership of the A. S. M. E., through papers and discussions as suggested, the progress made in the study and development of the so-called Labor Problem by those who are qualified for this task.

For these reasons the committee deems it inadvisable for the Society at present to enter the controversial field of industrial economics as involved in the relationship between employer and employee. Individual members of the Society should, however, be encouraged to join organizations especially studying the human relationship in industry, and the Society as a whole may properly seek, where it is practicable, to be represented on committees of such organizations, especially the National Industrial Conference Board and the War Service Committee organizations of the Chamber of Commerce of the United States.

Respectfully submitted,

(Signed) ANSON W. BURCHARD, *Chairman,*
JOHN W. LIEB,
W. H. MANSS,
HENRY D. SHARPE,
MAGNUS W. ALEXANDER.

American Machinery in Indo-China

The following has been received by the Secretary from W. H. Rastall, Trade Commissioner, Buitenzorg, Java:

Manufacturers interested in exporting machinery will find the present situation in Indo-China very interesting. Formerly practically all equipment was imported from France and the French policy was to retain this business where practicable. War conditions have made it difficult for France to supply this colony with the necessary equipment and as American ships are now running direct to Saigon, the buyers in Indo-China are beginning to send their inquiries to America. This is prompted by a spirit of friendliness as well as business convenience.

A certain amount of American equipment is being used with very satisfactory results. Also the performance of the United States in the war has advertised to the buyers of Indo-China American manufacturing ability and the general excellence of American machinery.

A further inducement operating in favor of American goods at this time is the rate of exchange as American dollars are very much cheaper in Saigon than they were formerly.

The market in Indo-China is not large but there is a certain demand for rice mills, mining machinery, road- and railroad-building equipment, automobiles and the miscellaneous equipment needed in all countries.

NECROLOGY

SAMUEL T. WELLMAN

Samuel T. Wellman, a past-president of the Society, and a pioneer in the world's steel industry, whom Charles Schwab once characterized as "the man who did more than any other living person in the development of steel", died suddenly from heart trouble on July 11, 1919, in Stratton, Me., while on his way to camp. His death came as a shock to his very large circle of friends, many of whom had only recently met him at the Spring Meeting of the A. S. M. E., at Detroit.

Mr. Wellman was born on February 5, 1847, in Wareham, Mass. At that time his father was superintendent of the Nashua Iron Co. of Nashua, N. H. He was educated in the schools of Nashua and in Norwich University, Norwich, Vt., where he spent

SAMUEL T. WELLMAN

one year in the engineering course. During the Civil War he served as a corporal in the First New Hampshire Heavy Artillery.

Perhaps the most interesting account of Mr. Wellman's entrance into and activities connected with the steel business is that given in a letter which he wrote to the Cleveland Engineering Society at the time of his election to honorary membership in that body. Mr. Wellman wrote:

Perhaps the story of my leaving home at that time might be interesting. My father was superintendent of a small iron works among the hills of New Hampshire, which among other business included the rolling of steel locomotive tires which they made from hammered steel blooms imported from England. To properly heat these blooms, they had arranged with C. W. Siemens to build a regenerative gas furnace. The drawings were sent over and turned over to me, who had never seen a drawing of that kind before. My father asked me if I thought I could build the furnace and have it exactly like the drawings. After studying them over a little while, I told him that I thought I was equal to the task. He told me to get the furnace built at the earliest possible moment. I had just finished the furnace and had a drying-out fire in it when a big black-whiskered Englishman walked into the office and announced that he was the Siemens engineer who had been sent from England to build this particular furnace. My father turned him over to me to go out into the works and show him where the furnace was to be located, which I did, and my English friend was very much amazed to find the furnace all finished. He was pleased as well, and said, "Why, we have only to start the furnace now; you have made a proper job of building it." So everything else being ready, we started up the gas producers and the furnace and everything worked to perfection. The engineer was so pleased with what I had done that when he left he asked me to go with him to Pittsburgh as his assistant in the starting of a crucible-steel furnace which was finished and waiting for him to start. It is needless to say that I did not have to have a second invitation, but went to Pittsburgh with him. This was in 1867, and I spent over a year there. The first few months of that time were spent starting up and operating the first crucible-steel furnace built in America, at the works of Anderson, Cook & Co. To show what a tremendous saving this furnace was over the old coke-fired furnaces, I will only say that it melted a ton of steel with an average of 1000 lb. of nut coal which cost less than $1, while to melt a ton of steel in crucibles in the old-fashioned coke furnaces took three tons of the very best coke, costing anywhere from $2 to $10 per ton. This style of furnace was a great success and in a very few years had driven the coke furnace out of use.

From Anderson, Cook & Co. I went to Singer, Nimick & Co's. works, where I built two crucible-steel melting furnaces of the same type as the one which I went to Pittsburgh to start. After that I spent some time in the office of the Siemens agents in Boston, and also at steel works in different parts of the country starting crucible steel furnaces of the same type. I then built a crucible-steel melting furnace at the Chrome Steel Works in Brooklyn, N. Y., which was a success. From there I went to the Bay State Iron Works, in South Boston, Mass. (I having separated myself from the agents of the Siemens furnace some time before this), where I built the first open-hearth furnace that was a commercial success in the United States. This was a pronounced success in a great many ways, making a quality of steel which up to that time had not been reached in this country. The principal use to which it was put at that time was in the manufacture of locomotive fireboxes. From there I went back to the old works in New Hampshire where my father was still superintendent, and built for them an open-hearth furnace, a plate-rolling and bar-rolling mill.

I then came to Cleveland in 1873 to design and build the Otis Steel Works, with which I was connected as engineer and superintendent for 16 years. It is useless for me to say very much about the history of the Otis Steel Co., as it is too well known here. But there are two inventions which I worked out during the time I was connected with the Otis company that are today absolutely indespensable to the economic operation of any open-hearth steel works. I refer to the open hearth charging machine and the use of the electromagnet for handling pig iron and scrap steel. Just a few figures will give you a little idea of their importance to the trade and what they are saving every day.

There were made in this country in 1916 approximately 39,000,000 tons of pig iron and about the same quantity of steel ingots of all kinds. Very conservative figures show that at least half of this, or say 20,000,000 tons, was pig iron and scrap handled and used in open-hearth furnaces. This was all handled by the open-hearth charging machine and electromagnet at least once, the bulk of it twice, and a great deal of it three times. By the use of the electric open-hearth charging machine, the direct saving in labor is estimated by one of the large users at 25 cents per ton. This was about 10 years ago, and of course labor is much higher today. At the same time he estimated the indirect saving in handling of the material charged into the open-hearth furnace (calling it only 20,000,000 tons) of $10,000,000. If we go back 17 years, this saving amounts to not less than $85,000,000. This is a big sum of money, but the estimate is far below the maximum amount which has been actually saved. The saving in labor by the use of the electromagnet in the United States per year at the rate pig iron and scrap are being handled today is not less than $1,500,000. We can very safely say that in the last ten years at least five times that amount, or the sum of $7,500,000, has been saved; or a total for both of these inventions of nearly $100,000,000,—a saving of which any inventor might well be proud. Every open-hearth plant of any size in the world today is equipped with these inventions, and they are considered as much a necessary part of the equipment as the furnace itself.

Mr. Wellman's machine for charging open-hearth furnaces with white-hot steel was his greatest contribution to steel making and has been adopted by the steel concerns of the world, earning the inventor international fame. Machinery built under his patents is being used in Great Britain, France, India, Japan, Russia, Spain, Egypt and Germany.

Mr. Wellman was a member of the American Society of Civil

Engineers, the American Institute of Mining Engineers, the British Iron and Steel Institute, the British Institution of Mechanical Engineers and the Cleveland Engineering Society, in which latter he had held the offices of vice-president and president. He was a life member of our Society, joining in 1881, and served it respectively as manager from 1885 to 1888, vice-president from 1896 to 1898, and president in 1901.

At the age of twenty-one Mr. Wellman married Julia A. Ballard at Stoneham, Mass., who died in Cleveland, July 3, 1914. He is survived by two daughters, Mrs. A. D. Hatfield, Mrs. C. W. Comstock, and three sons, W. S. Wellman, president of the Wellman Products Co., and M. C. and F. S. Wellman, of the Wellman Bronze Co.

The funeral service was held Monday afternoon, July 14, at the Euclid Avenue Congregational Church, Cleveland, and was attended by many prominent engineers, manufacturers, and business men. Robert W. Hunt and Ambrose Swasey represented the Society. Members of the Cleveland Engineering Society and delegations from the Wellman-Seaver-Morgan Co., and Wellman Bronze Co. were present.

WILLIAM P. DONOVAN

William P. Donovan, general superintendent of the gasoline department of the Gypsy Oil Co., Tulsa, Okla., died in Philadelphia on May 30, 1919. Mr. Donovan was born on January 7, 1875, in Eagle Rock, Pa., and received his early education in the home schools. His father instructed him in telegraphy and later he attended a business school at Oil City, Pa. While studying there he found time to work as telegraph operator at Smoky Station of the National Transit Co.

William P Donovan

In 1892 he entered the employ of the Crescent Pipe Line Co., where he assisted in the construction of an oil-pipe line from Oakdale to Marcus Hook, Pa. He was later promoted to the position of stationary engineer in charge of trunk-line stations on the same pipe line. When the Gulf Refining Co. was organized in 1903, Mr. Donovan became superintendent of distribution at Bayonne, N. J., having also supervision of all additions to the plant. In 1913 he was transferred to the gasoline department of the Gypsy Oil Co., an affiliated concern. Here he designed and constructed plants in Oklahoma, Texas, Louisiana and Mexico for the production of gasoline from casinghead gas. Mr. Donovan was actively interested in the Mid-Continent Section organization. He became a member of the Society in 1916.

HENRY WILLIAM HENES

Harry W. Henes, of the Acme Steel Goods Co., Chicago, died on January 19, 1919. Mr. Henes was born in January, 1887, in New York City, and was educated in the city schools. Later he entered Columbia University from which he was graduated in 1909 with the degree of M. E.

His first position was as structural-steel estimator and inspector with A. Bolter's Sons, Chicago, where he remained for about three years, when he became associated with the Dueth-Henes Corporation, manufacturing agents in the same city, as secretary and treasurer. His next connection was with the Stromberg Motor Devices Co., also in Chicago, first as assistant purchasing agent and later as sales engineer. In July 1918 he became associated with the Acme Steel Goods Co. in charge of the manufacture of nailless box-strapping tools. Mr. Henes was a member of several social clubs in Chicago He became a junior member of the Society in 1909.

GEORGE ROBERT SHEPHEARD

George R. Shepheard, chief engineer of the Viscose Co., Marcus Hook, Pa., died on May 1, 1919. Mr. Shepheard was born on October 24, 1889, in Wilmington, Del., and received his early education in the Wilmington schools, while his later training was obtained through home study and courses in the International Correspondence Schools. He was connected at various periods in his career with the following concerns: the Taylor Iron & Steel Co., High Bridge, N. J., the Edgar Allen American Manganese Steel Co., New Castle, Del., the J. Morton Poole Co., Wilmington, Del., and with the E. I. Du Pont Co., also in Wilmington. In 1913 he became associated with the Viscose Co. and in 1916 was advanced to the position of chief engineer. Mr. Shepheard became an associate-member of the Society in 1918.

JULIAN G. GUITERAS

Julian G. Guiteras, Captain, Engineers' Corps, A. E. F., France, died of pneumonia on October 12, 1918, in Base Hospital, No. 15, Chaumont, France. Captain Guiteras was born on November 14, 1889, in New York City. He was graduated from Columbia University in 1913 with the degree of M. E. For several years he was connected with the Cadillac Motor Car Co., Detroit, Mich., as draftsman. Later he was with the Hall-Scott Motor Car Co., West Berkeley, Cal. In January 1917 Captain Guiteras passed successfully his examination for a second lieutenancy in the Regular Army and upon receiving his commission was ordered to Fort Leavenworth for training. Upon the completion of his course there he was promoted to the rank of first lieutenant and assigned to Vancouver Barracks, Washington. Before sailing for France in December 1917 he received his captain's commission. In France he was an instructor in the Pioneer School of Chatillon-sur-Seine and was later ordered to bridge reconnaissance work. It was while on this work that he contracted influenza which developed into pneumonia. Captain Guiteras became a junior member of the Society in 1916.

Julian G. Guiteras

PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by August 15 in order to appear in the September issue.

CHANGES OF POSITION

Major Hugo Diemer, Ordnance Department, U. S. A., has resigned as professor of industrial engineering at Pennsylvania State College to accept the position of superintendent of personnel with the Winchester Arms and Manufacturing Company, New Haven, Conn.

R. L. Rowley, former advisory engineer to the district plant engineer, United States Shipping Board, S. P. District, San Francisco, Cal., resigned on April 15 and is now associated with the survey and engineering department of Johnson and Higgins, San Francisco, Cal.

C. Bateman Swasey is no longer connected with the Gorham Manufacturing Company of Providence, R. I., where he was engaged as superintendent of the Allen's Avenue plant, but is now associated with the Belcher Malleable Iron Company, of Easton, Mass., in the capacity of treasurer.

R. Renton Hind has resigned as consulting engineer for the America Factors, Ltd., Honolulu, and has assumed the duties of manager of the Pampanga Sugar Mills, Del Carmen, Pampanga, P. I.

ANNOUNCEMENTS

Morris Knowles has concluded his engagement as chief engineer of the Housing Department of the Emergency Fleet Corporation, United States Shipping Board, and has returned to Pittsburgh, Pa.

J. E. Muhlfeld and V. Z. Caracristi announce the formation of Railway and Industrial Engineers, Inc., with offices in New York, with a competent staff of experts thoroughly familiar with domestic and foreign methods and practices.

Lieut.-Colonel Henry M. Byllesby, Signal Corps, U. S. A., president of H. M. Byllesby and Company, has had the English Distinguished Service Order conferred upon him.

E. L. Maher announces the formation of the Maher Engineering Company with offices in Chicago, to handle the sales and installation of Erie Engine Works high-speed engines, the Sims Company feed-water heaters, Dayton-Dowd Company centrifugal pumps, Wagener Steam Pump Company pumps and Pratt Engineering and Machine Company fertilizer and sulphuric acid machinery.

Peter M. Smith, until recently in France as a lieutenant in the Signal Corps, is again associated with the Standard Engineering Company, Ellwood City, Pa., in the capacity of chief draftsman.

H. B. Prindle has opened an office in New York, as engineer, appraiser and adjuster of railroad loss and damage claims.

George S. Barker, formerly First Lieutenant, Aircraft Armament Division, Air Service, A. E. F., has received his discharge and is now connected with the Farnsworth Company, Conshohocken, Pa., in the capacity of mechanical engineer.

Lieut Colonel Elmer K. Hiles, Engineers, A. E. F., who went over as Captain in the 15th Engineers, has just returned after nearly two years' service in France, and has joined the Pittsburgh Testing Laboratory as manager of laboratories, with headquarters in Pittsburgh.

Christian Girl, president of the Standard Parts Company, Cleveland, has been awarded the Distinguished Service Cross by the War Department in appreciation of the aid he rendered in developing the Standard Government motor truck.

H. H. Esselstyn, commissioner of public works of Detroit, Mich., has resigned, to return to the firm of Esselstyn, Murphy and Hanford, engineers and architects, Detroit. His resignation was made necessary by the increased scope of the work of the company.

Milton F. Flewelling, Jr., has been released from the U. S. Navy on inactive duty as engineering ensign, and has been detached from the U. S. S. *Chinampa*. He has accepted the position of chief draftsman for the Ashton Valve Company, Boston, Mass.

Robert W. Hunt has been made an Honorary Member of the American Society for Testing Materials.

Major Thomas H. Allen has returned from France after two years' service with the American Expeditionary Forces and will assume his practice as consulting engineer, Memphis, Tenn.

F. E. Matthews, specializing in mechanical refrigeration, engaged for the past nine months as an expert on refrigeration by the U. S. Bureau of Markets, Washington, D. C., having to do with problems dealing with food storage and distribution under war conditions, has returned to his home at Leonia, N. J., preparatory to resuming civilian engineering work in New York.

Charles L. Allen has been made president and general manager of the Norton Company, Worcester, Mass., when the company recently took over its subsidiary the Norton Grinding Company. Mr. Allen was treasurer and general manager of the company for some time. William LaCosta Neilson, Leicester, England, foreign manager, and Carl F. Dietz, general sales manager, have been made vice-presidents, newly-created offices of the new Norton organization. Charles H. Norton, for many years chief engineer of the Norton Grinding Company, has been chosen chief engineer of the grinding machine department of the Norton Company under the reorganization plan.

C. B. Lord has resigned as general superintendent of the Wagner Electric Manufacturing Company, St. Louis, Mo., and, after a period of rest, will assume the position of consulting mechanical engineer to the company.

Jos. J. Nelis, for the past year with the Engineering Section, Emergency Fleet Corporation, Philadelphia, Pa., has accepted a position with the Power Specialty Company, New York, as marine representative for Foster boilers, superheaters and air heaters.

Myer M. Shuster who has been discharged from the Naval Air Service has associated himself as production engineer with the Clip-Bar Manufacturing Co., of Philadelphia, manufacturers of the Shuster Speed Wrench.

APPOINTMENTS

Herbert S. Eades, formerly assistant mechanical engineer, American Bridge Company, Ambridge, Pa., has been appointed assistant mechanical engineer of the Pencoyd, Pa., plant of the company.

L. C. Sprague formerly district manager of sales at New York, Chicago Pneumatic Tool Company, has been appointed manager of western railroad sales, with headquarters at Chicago, Ill.

DISCUSSION AT RESEARCH SESSION

(Continued from page 671)

funds. The securing of funds, however, for doing this work was, he believed, the smallest problem and the securing of men to do the work, the greatest. He was decidedly in favor of private or semi-private research work, but not for Federal control.

Albert Kingsbury urged a careful consideration of the resolution. There were many members of the Society, he said, who were not present at the meeting, and it seemed to him rather inadvisable to take action which would construe the whole Society as against any particular policy. He therefore suggested that the report of the Chicago Committee be brought to the attention of all members of the Society through suitable means of publication. Certainly a large number of the members were interested in the matter and they ought to receive consideration. Those present constituted but a small part of the Society and they ought not therefore to commit the entire membership to any action the meeting might take. His suggestion, therefore, was that the very interesting and valuable report of the Chicago Committee be published in Mechanical Engineering and that no definite action be taken by the meeting.

Replying to Mr. Kingsbury's objections, Doctor Mees called attention to the fact that the resolution as offered spoke only of "the sense of the meeting" and the Society could do as it chose in the matter, and the action of the meeting would not be binding upon any one. The resolution was then put to final vote and passed.

DISCUSSION AT GAS POWER SESSION

(Continued from page 681)

given up the problem of getting a good sample of a wet mixture, he said, and devoted his attention to using a dry mixture instead. The statement he had made that the best performance was secured with an air temperature of 80 deg. was to be understood to have been so when the temperature of the water in the cylinders was about 200 deg., that is, under definite running conditions.

Some one had asked whether in his experiments with the hot spot any deposit of carbon had been noticed at the higher temperature and regarding this he would say that he had not run tests under those conditions for longer than thirty or forty hours without changing the hot spot in some way or other, and that therefore he had not observed any appreciable deposit at any time. He felt, however, that with the heavier oils a deposit was likely to collect after a certain time.

ENGINEERING RESEARCH

(Continued from page 695)

Machine Tools F1-19 Metal-Cutting Tools. Bibliography from 1903 to 1918. Search 2546. A bibliography of 21 pages. Address A. S. M. E., 29 West 39th St., New York.

Manufactures F1-19 Recovery of Oil from Cotton Seed Cake. A bibliography of 2 pages. Search 2565. Address A. S. M. E., 29 West 39th St., New York.

Manufactures F2-19 Making Up Paper Boxes and Containers. A bibliography of 2 pages. Search 2582. Address A. S. M. E., 29 West 39th St., New York.

Marine Engineering F1-19 Steel or Wood Paddle Steamers or Barges for River Use. A bibligraphy of 5 pages. Search 2489. Address A. S. M. E., 29 West 39th St., New York.

Metal Manufactures F1-19 Taper Holes in Draw Plates. A bibliography of $1\frac{1}{2}$ pages. Search 2550. Address A. S. M. E., 29 West 39th St., New York.

Petroleum, Asphalt and Wood Products F2-19 Dehydration of Oils by Electric Means. A bibliography of 3 pages. Search 2467. Address A. S. M. E., 29 West 39th St., New York.

Pumps F1-19 Rubber Lining for Centrifugal Pumps. A bibliography of 2 pages. Search 2551. Address A. S. M. E., 29 West 39th St., New York.

LIBRARY NOTES AND BOOK REVIEWS

THE BLIND. Their Condition and the Work Being Done for Them in the United States. By Harry Best. The Macmillan Co., New York, 1919. Cloth, 6 x 8 in., 780 pp., illus., tables, $4.

The particular sections of this comprehensive survey likely to interest engineers are those treating of the industrial employment of the blind and of indemnities for the loss of sight. Both topics are given full consideration. Attention is given to the theoretical aspects of industrial establishments for the blind, the organization and results of present establishments, and the possible and present employment of the blind in general occupations. The payment of indemnities through suits at law, insurance policies and workingmen's compensation acts is also described very fully.

BOILER CHEMISTRY AND FEED-WATER SUPPLIES. By J. H. Paul. Longmans, Green and Co., New York, 1919. Cloth, 6 x 9 in., 242 pp., 1 pl., tables, diag., $4.50.

The lack of any adequate discussion of the chemical reactions which occur in high-pressure boilers fed with natural waters, and of the effects of these reactions upon the steaming capacity of the boiler and upon the metal of which it is made, have led the author to prepare this volume, in which he gives the knowledge gained by long practical experience with boilers under varied circumstances and conditions. As far as possible, he has stated the facts and his conclusions in the language of everyday life.

THE CANADIAN MINING MANUAL, 1918. A Handbook of Information Concerning the Minerals and Mines of Canada. Edited by Reginald E. Hore. Mines Publishing Co., Toronto (copyright 1919). Cloth, 9 x 11 in., 352 pp., illus., pl., por., maps, tables, diag., $5.

This is the fourth edition of this handbook of Canadian minerals, metals, mining and metallurgical companies, in which the chief objects are to present concisely matters of interest to persons connected with the mining industry, and to attract attention to the possibilities of Canadian mineral resources. A preliminary survey of progress in 1918 and a summary of the official reports for 1917 are given for each province and product. There are also a number of special articles on topics of interest, a directory of mining companies and a list of the producers of various mine products.

THE ELEMENTS OF ASTRONOMY FOR SURVEYORS. By R. W. Chapman. J. B. Lippincott Co., Philadelphia, 1919. Cloth, 6 x 8 in., 247 pp., tables, 56 diag., $1.75.

The author of this small volume has attempted to provide students of surveying with an elementary exposition not only of the practical methods of observation and computation, but also of the main principles by which the formulæ are derived. The methods of observation are illustrated by fully worked out actual observations and prominent attention is given to the effects of observational and instrumental errors.

ENGINEERING DESCRIPTIVE GEOMETRY AND DRAWING. A Treatise on Line Drawing, Descriptive Geometry, and Engineering or Mechanical Drawing, for the Use of Midshipmen at the United States Naval Academy. By Frank W. Bartlett and Theodore W. Johnson. John Wiley & Sons, Inc., New York, 1919. Cloth, 6 x 9 in., 617 pp., illus., pl., tables, $5.50.

This volume consists of three independent treatises on Line Drawing, Engineering Descriptive Geometry, and Engineering Drawing. Collectively they represent the course in drawing at the United States Naval Academy and are intended to provide a complete course for students with no previous knowledge of mechanical drawing.

Part One has been written to replace Bartlett's Mechanical Drawing. Part Two which treats of the science of orthographic projection, was issued as a separate work in 1910 and has been revised to date. Part Three, the work of Professor Johnson, deals with the application of Parts One and Two to the needs of engineers, draftsmen and mechanics, for practical construction of machines of every kind. Part Three is also issued separately for those who wish a general course in mechanical drawing.

EXCAVATION. Machinery Methods and Costs, Including a Revision of "Excavating Machinery." By Allen Boyer McDaniel. First edition. McGraw-Hill Book Co., Inc., New York, 1919. Cloth, 6 x 9 in., 560 pp., 209 illus., $5.

Frequent requests for information on recent types of excavators and the newer uses of older types, have led the author of this work to prepare it to replace his "Excavating Machinery," published in 1913. The present work is divided into two sections; the first describes the construction, method and typical cost of operation of each type of excavator, the second is a comparative study of the efficient and economic use of the different types of machines in the various fields of construction work. Highway and railroad construction, reclamation, river, harbor, canal and municipal work, quarrying, tunneling and mining are considered. References to the literature are included.

IRRIGATION ENGINEERING. By Arthur Powell Davis and Herbert M. Wilson. Seventh edition, revised and enlarged. John Wiley and Sons, Inc., 1919. Cloth, 6 x 9 in., 640 pp., 249 illus., 59 tables, $4.50.

The early editions of Wilson's Manual of Irrigation Engineering were especially valuable because of the author's familiarity with large irrigation works in India and Egypt. Subsequent activity in irrigation, particularly in the United States, and developments in related lines of municipal water supply and hydroelectric construction, have presented new problems and evolved new solutions of old ones. Social and economic differences between America and Asia have also caused distinctive changes in practice. In preparing this revised edition Mr. Davis has taken the changed situation into consideration, with the result that the book is in the main rewritten and rearranged, and contains much new material.

LIQUID FUELS FOR INTERNAL-COMBUSTION ENGINES. A Practical Treatise for Engineers and Chemists. By Harold Moore. D. Van Nostrand Co., New York, 1918. Cloth, 6 x 9 in., 215 pp., 49 illus., tables, $5.

The author describes in part one of this volume the chemical differences between the various fuels: petroleum, shale oil, coal and lignite tars, wood and peat distillation products, oils and alcohols, which are used for internal-combustion engines. In part two of the book these fuels are classified according to their suitability for use in engines fitted with carburetors, vaporizers or atomizers. Part three presents methods for the examination and valuation of liquid fuels with a view to their use in these engines, the procedure in such cases being different from that used in determining their value for external combustion.

MAGNETISM AND APPLICATIONS OF MAGNETS. By John D. Ball. (School of Practical Electricity, Book 4). Electroforce Publishing Co., Milwaukee (copyright, 1919). Cloth, 7 x 10 in., 113 pp., 95 illus., tables. $1.50.

This volume which is one of a series of textbooks for technical high schools, trade schools, etc., combines a brief description of the laws and principles of magnetism and the commercial uses of magnets with a selection of laboratory experiments to illustrate the theories of magnetism and electromagnetism. Only elementary mathematics is used.

MOTOR VEHICLE ENGINEERING. Engines (for Automobiles, Trucks, and Tractors). By Ethelbert Favary. First edition. McGraw-Hill Book Co., Inc., New York, 1919. Cloth, 6 x 9 in., 345 pp., 133 illus., 39 tables, $3.

The present volume, the first of a contemplated series intended to give designers, engineers and students a concise summary of modern practice in automobile design and construction; deals with engines. Only simple mathematics is used.

ACCESSIONS TO THE LIBRARY

The following accessions to the Library of the United Engineering Society are a selection from the large number of books which have been added during the last month. In particular the Library was the recipient of a gift from Mr. Kirby Thomas of some seventy-odd books, catalogs, and pamphlets dealing in great part with mining and mining concerns.

ROTHROCK, J. T., M. D. Areas of Desolation in Pennsylvania. Gift of Pennsylvania Forestry Association.

CAST IRON IN THE LIGHT OF RECENT RESEARCH. By W. H. Hatfield. 1918. Second edition. Purchase.

CENSUS OF MANUFACTURERS. 1914. vol. 1. Gift of Bureau of the Census.

CENTRIFUGAL PUMPS AND SUCTION DREDGERS. By E. W. Sargent. Second edition 1918. Purchase.

COLLOIDAL FUELS. By Lindon W. Bates. 1919. Properties, Tests & Costs.

COLLOIDAL FUEL. Composites of Oil and Carbon. By Lindon W. Bates. 1918. Gift of Submarine Defense Association.

THE CO-OPERATIVES IN RUSSIA. A Power for the Reconstruction of Russia's Economic Life. Gift of Alexander Zelenko.

ECONOMIC PRODUCTION PLUS INDUSTRIAL DEMOCRACY. By C. E. Knoeppel. (Reprint.) Gift of author. Two copies.

ETHICS OF DEMOCRACY. By Louis F. Post. Third edition.

THE FLYING BOOK. The Aviation World Who's Who and Industrial Directory. Edited by W. L. Wade. 1918 edition. Purchase.

GLOSSARY OF ATMOSPHERIC ELECTRICITY TERMS. By W. W. Strong. Gift of author.

HEAT TRANSMISSION TABLES. By W. R. Jones. (Reprint) Gift of The Heating and Ventilating Magazine.

HISTORY OF THE METALLURGY OF IRON AND STEEL. By Sir Robt. A. Hadfield. Gift of author.

THE IMPORTANCE OF ADEQUATE DRAINAGE AND FOUNDATIONS FOR ROAD AND STREET SURFACES. By Clifford Richardson. (Reprint.) Gift of author.

AN IMPORTANT DEVELOPMENT IN THE RAILWAYS OF SPAIN. By F. Lavis. (Reprint) Gift of author.

INDUSTRIAL ELECTROMETALLURGY, including Electrolytic and Electrothermal Processes. By Eric K. Rideal. Purchase.

INDUSTRIAL RESEARCH IN AMERICA. By Raymond F. Bacon. 1916. (Reprint.) Gift of author.

INTERNAL GEAR, THE. The Fellows Gear Shaper Co. *Springfield, Vt., 1919.* Gift of the Company.

AN INTRODUCTORY TREATISE ON DYNAMICAL ASTRONOMY. By H. C. Plummer. *1918.* Purchase.

INVENTIONS AND RECONSTRUCTION. By Lawrence Langner. Reprint from *Printer's Ink.* Gift from author, March 20, 1919.

THE ISTHMIAN CANAL. By H. H. Rousseau. 1909.

JANE'S ALL THE WORLD'S AIRCRAFT. 1918. Founded by Fred T. Jane. *London.* Purchase.

LEGAL AID SOCIETY, THE. 43rd Annual Report for the year 1918. *New York, 1918.* Gift of the Society.

LOS PETROLEOS DEL PERU Y DE PENNSYLVANIA. By Ricardo A. Deustua. *Lima, 1919.* Gift of the author.

MANCHESTER STEAM USERS' ASSOCIATION, THE. Memorandum by Chief Engineer for the year 1917-18. Gift.

THE MANUFACTURE OF INTERMEDIATE PRODUCTS FOR DYES. By John Cannell Cain. *London, 1918.* Purchase.

MAPS. Purchase.
- Croquis de los rios Napo y Putumayo por el Coronel D. Pedro Portillo.
- Planta Geral da Cidade de Sao Paulo.
- Planto del rio Tambopata.
- Geologia de las inmediaciones de Morococha, por A. Raimondi. 1861.
- Plano del rio P. staza.
- Mapa de la Navegacion del alto Maranon. 1913.
- Plano del Cuzco. 1900.
- Plano del rio Amazonas Peruano. 1908.
- Region Oriental del Perú. 1906.
- Plano del rio Huallaga. 1908.
- Mapa Histórico Geográfico de los valles de Paucartambo. 1901.
- Corte Geologico por E. I. Duenas. Siguiendo el Itinerario de Casma á Chacas.
- Carta Geral do Estado de S. Paulo. 1912.
- Plano del rio Manú. 1902.
- Croquis de los Rios Alto Ucayali y Bajo Urubamba. 1904.
- Plano del rio Morona. 1908.
- Plano del rio "Ucayali". 1904.

THE MARINE STEAM TURBINE. By J. W. M. Sothern. Fifth edition, rewritten. *Glasgow, 1918.* Purchase.

MECHANICAL HANDLING OF MATERIAL AND ITS NATIONAL IMPORTANCE DURING AND AFTER THE WAR. By George F. Zimmer. *London, 1917.* Gift of the author.

THE MENACE OF PATERNALISM. By Otto H Kahn. *1918.* Gift of author.

LES MÉTAUX ET LEURS CONDITIONS D'EMPLOI DANS L'INDUSTRIE MODERNE. 1918. J. Oertlé. Purchase.

MINERAL ENTERPRISE IN CHINA. By W. F. Collins. Purchase.

MODERN BUS AND SWITCH STRUCTURES. By C. D. Gray & M. M. Samuels. (Reprint from *Electrical World.*) Gift of J. G. White, Engineering Corp.

NATURAL GAS RATE SITUATION OF THE UNITED FUEL GAS CO. IN WEST VIRGINIA, KENTUCKY AND OHIO. By Samuel S. Wyer. Gift of author.

NATIONAL RAILROAD QUESTION OF TO-DAY, THE. By Francis Lee Stuart. An address before the American Society of Civil Engineers, Feb. 5, 1919. Gift.

THE NEW SCIENCE—THE FUNDAMENTAL PHYSICS. By W. W. Strong. Gift of author.

NEW YORK IMPROVEMENT AND TUNNEL EXTENSION OF THE PENNSYLVANIA RAILROAD, THE. *Philadelphia, Pa., 1919.* Gift of Geo. F. Fowler.

PAPER FOR THE AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS. On agronomy and fertilizers. By Woolsey McA. Johnson. Gift of author.

PAPERS BY CLIFFORD RICHARDSON. (Subject of Asphalt) 1897-1913. Gift of author.

PHOENIX FOUNDRY (later Delameter Iron Works) COPY OF DEED OF SALE, 1842. Foundry stood on Vestry and High Sts., from about 1838-50. John Ericsson was consulting Engineer. *New York.* Gift of H. J. Porter in March, 1919.

A PLAN FOR RAILROAD REORGANIZATION. By Wm. G. Raymond. *1919.* Gift of author.

POWDERED COAL AS A FUEL. By C. F. Herington. *New York, 1918.* Purchase.

POWER PLANT Installation, Upkeep and Economical Operation. By T. Roland Wollaston. *Manchester, 1918.* Purchase.

PRACTICAL SHELL FORGING. By C. O. Bower. Gift of Longmans, Green & Co.

PRINCETON ENGINEERING ASSOCIATION. Year Book, 1918-1919. Gift of the Association.

PRINCIPLES OF PHARMACY. By Henry V. Arny. 2nd edit. *Philadelphia, Pa., 1918.* Gift of the author.

PROCEEDINGS OF THE PUBLIC SERVICE COMMISSION FOR THE FIRST DISTRICT, STATE OF NEW YORK. vol. XV. From July 1 to Dec. 31, 1917. Gift of the Commission.

PRODUCTION OF QUICKSILVER IN EUROPE. By Dr. Roland Sterner-Rainer. Repriut from Chem. & Metal. Engng., vol 19, nos. 10 and 11; vol. 20, nos. 1 and 2. Gift of Chem. & Metal Engng.

PUBLIC OPINION ON THE TRACTION PROBLEM. Interborough Rapid Transit Co. *1919.* Gift.

PUBLIC UTILITIES REPORTS. Annotated, 1918, E. & F. Containing Decisions of the Public Service Commissions and of State and Federal Courts. Gift of The Lawyers Coöperative Publishing Co. 2 vols.

WAARSCHIJNLIJKHEIDSREKENING BIJ AUTOMATISCHE TELEPHONIE. 1918. Den Haag. By Urssul Philip Lely. Gift of the author.

WHAT THE NATIONAL FORESTS MEAN TO THE WATER USER. By Sam'l T. Dana. U. S. Dept. of Agriculture, Forest Service. *1919.* Gift of U. S. Dept. of Agriculture.

WHEN COAL OIL JOHNNY GOES TO SEA. By E. N. Hurley. Gift of U. S. Shipping Board.

WORKMEN'S COMPENSATION LAW OF PENNSYLVANIA. Court Decisions. Edit. by H. A. Mackey. 1916-1918. *Harrisburg, Pa.* Purchase.

YOUR STREET CAR SERVICE. New York Railways Company. 1919. Gift.

TRADE CATALOGS

ANACONDA COPPER MINING CO., Anaconda, Mont. The Anaconda Reduction Works, January 1919.

ATLANTIC LOADING CO., New York City. Shell Loading at Amatol, N. J.

BAILEY METER CO., Boston, Mass. How to Save Coal. Bulletin No. 41.

BLAIR ENGINEERING CO., Chicago, Ill. Blair, Ports, Valves and Slag Pockets.

CARNEGIE STEEL CO., Pittsburgh, Pa. Ship Building Channels and Bulb Sections. Fifth edition.

COEN CO., San Francisco, Cal. The Coen System of Mechanical Oil Burning, 1919. Catalog 3.

CONNEAUT METAL WORKS CO., Conneaut, Ohio. Automatic Valve-closed Watertight Electrical Plug Receptacles and Attaching Plugs. Bulletin B. April 10, 1919.

DECARIE INCINERATOR CO., Minneapolis, Minn. Incineration for Municipalities. The Disposal of City Refuse.

THE DEFENDER AUTOMATIC REGULATOR CO., St. Louis, Mo. Catalog no. 11.

DE LAVAL STEAM TURBINE CO., Trenton, N. J. Geared Marine Steam Turbines.

DOEHLER DIE CASTING CO., Brooklyn, N. Y. Finished Brass Castings.

THE ELECTRICAL POWER CLUB.
Bulletin No. 6300—Polyphase a. c. motors
" " 6500—d. c. motors
" " 6400—Large single-phase motors

EMERSON-BRANTINGHAM IMPLEMENT CO., Rockford, Ill. The E-B Line General Catalog no. 67.

THE M. GARLAND COMPANY, Bay City, Mich. Catalog No. 40. Special Saw-Mill and Wood-Working Machinery.

GENERAL ELECTRIC COMPANY, Schenectady, N. Y. Bulletin 47163. Alternating Current Standard Unit Panels with Oil Circuit Breakers ou Panel. Oct. 15, 1918.
CR 7006 Form A1 Enclosed Magnetic Switches..

THE ENGINEERING INDEX

Published Monthly by The American Society of Mechanical Engineers

The Engineering Index was Founded in 1884 by the Association of Engineering Societies; Published from 1895 to 1919 by The Engineering Magazine Company; and Acquired January 1919 by The American Society of Mechanical Engineers

THE following pages form a descriptive Index to articles on engineering and related subjects in current periodicals. In its preparation the Society's engineering staff regularly examines all of the technical journals and society publications received by the Engineering Societies Library, which form one of the greatest and most complete collections of scientific periodicals in the world, comprising upward of 1100 distinct publications in some ten languages. Cross-references are freely introduced in the Index, and in all cases where the titles of articles are not sufficiently descriptive, explanatory sentences are appended. The main abbreviations used in the items are given at the bottom of this page.

PHOTOSTATIC COPIES OF ARTICLES LISTED

THE Society is prepared to supply photostatic copies (white printing on black background) of any of the articles listed. Copies of the periodicals themselves, or clippings of articles, cannot be supplied.

Price of each print (up to 11 x 14 in. in size), 25 cents plus postage. A separate print is required for each page of the larger-size periodicals, but where possible two pages will be photographed together on the same print. Bill will be mailed with the prints.

Those holding coupon books for clippings formerly issued by The Engineering Magazine Company may use the coupons in payment for photostatic prints. In ordering, state plainly

(1) Page number of Index on which item appears
(2) Title of article
(3) Name of periodical.

Orders should be sent to

Harrison W. Craver, *Director,*
Engineering Societies Library,
29 West 39th Street, New York City.

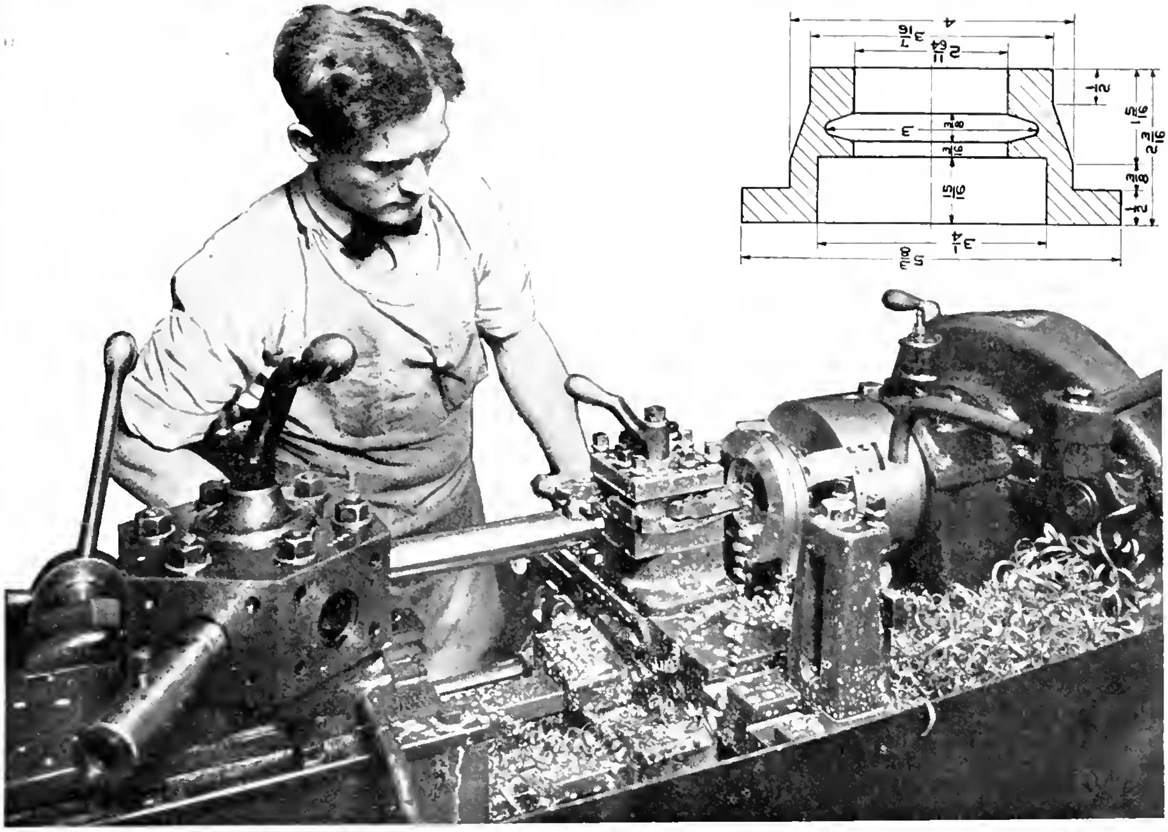
DIVISIONS OF THE ENGINEERING INDEX

Note.—The abbreviations used in indexing are as follows:

Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
New York (N. Y.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
Ventilating (Vent.)
Western (West.)

LIST OF TOPICS IN THE ENGINEERING INDEX

AUGUST, 1919



Mechanical Engineering

AIR MACHINERY

Air Conditioning

Refrigeration in Relation to Air Conditioning in War Industries, J. I. Lyle. Am. Soc. Refrig. Engrs., vol. 5, no. 5, March 1919, pp. 376-382, 4 figs. Illustrating uses of dehumidifier.

Air Valves, Compressor

Magnetic Air Valve. Iron & Coal Trades Rev., vol. 98, no. 2673, May 23, 1919, p. 702, 2 figs. For unloading automatically a motor-driven air compressor before starting and stopping driving motor. Valve is a combination of electromagnet of contactor type, a two-way valve and a small switch controlled by a dashpot.

Automatic Valves for Motor Driven Air Compressors. Elecn., vol. 82, no. 24, June 13, 1919, pp. 676-677, 2 figs. Valve patented by British Thomson-Houston Co. is said to insure that air compressor is unloaded before current is switched on to motor as well as throughout starting period.

Air Washers

Air Washer Experiences, Samuel R. Lewis and E. V. Hill. Heating & Ventilating Mag., vol. 16 no. 6, June 1919, pp. 25-31, 4 figs. Suggests scheme with two sets of sprays arranged so that they wet thoroughly entire surface of front baffles.

Air Weight and Volume Measurements

Air Weight and Volume Measurement—II, Don T. Hastings. Automotive Industries, vol. 40, no. 25, June 19, 1919, pp. 1399-1402, 1 fig. Theory of venturi meter as applied to liquids and also to gases.

Compressors

Some Recent Improvements in Air Compressor Design. Engineer, vol. 127, no. 3309, May 30, 1919, pp. 538-540, 7 figs. Rotary compressor of crescent type in which blades instead of being forced against bore of stationary casing press against interior of liner which revolves on ball bearings concentric with casing.

Flow in Pipes, Compressed Air

Flow of Compressed Air in Pipes, Johan Sarvaas. Proc. Australasian Inst. Min. Engrs., no. 31, Sept. 30, 1918, pp. 121-130, 1 fig. Tables and equation offered as serviceable in simplifying computations involved in application of Rankine's and D'Arcy's formulæ.

Pump, Marine

The Marine Air Pump as a Power Factor, Harold C. Walker. Mar. Engr. & Naval Architect, vol. 4, no. 505, June 1919, pp. 270-276, 11 figs. Also Mar. Eng., vol. 9, no. 6, June 1919, pp. 205-208, 12 figs. Discusses wet, Edwards and rotary types and their comparative efficiency. Paper read before Inst. of Marine Engrs.

Receivers

The Air Receiver, Frank Richards. Power Plant Eng., vol. 23, no. 12, June 15, 1919, pp. 554-558, 2 figs. Suggestions in regard to determining capacity and avoiding explosions.

Uses

Air Uses at Newburgh Shipyards Plant, Francis Judson Tietsort. Compressed Air Mag., vol. 24, no. 6, June 1919, pp. 9155-9160, 10 figs. Plant builds 9000-ton ships.

CORROSION

Copper and Corrosion of Steel

The Influence of Very Low Percentages of Copper in Retarding the Corrosion of Steel, D. M. Buck. Am. Soc. Testing Materials University of Penna., 22nd annual meeting, June 24, 1919 advance copy, 14 pp., 10 figs. Concluded from tests that very low amounts of copper in steel materially lower corrosion rate.

Iron Alloys

The Relative Corrosion of Cast Iron, Wrought Iron and Steel Pipe in House Drainage Systems, F. N. Speller. Plumbers' Trade Jl., vol. 66, no. 12, June 15, 1919, pp. 752 and 754-755, 2 figs. Discussion of paper by Wm. Paul Gerhard presented at Am. Soc. Mech. Engrs. meeting, Dec. 1918.

Rustproofing

Rustproofing Cast-iron Parts. Machy. (N. Y.), vol. 25, no. 10, June 1919, pp. 919-921, 5 figs. Process is based on fact that film of magnetic iron oxide is formed on surface of iron castings when heated to temperature of 700 deg. cent. or over in oxidizing atmosphere.

Metallic Coatings for Rust-Proofing Iron and Steel—III. Bibliography. Henry S. Rawdon, M. A. Grossman and A. N. Finn. Chem. & Metallurgical Eng., vol. 20, no. 11, June 1, 1919, pp. 591-592. Divided into following sections: Nature of corrosion, microstructure, methods of coating, black finishes and similar coatings, "pickling" and its effects, and methods of testing coatings.

Calorizing Process for Protection of Metal from Oxidation at High Temperatures, W. E. Ruder. Jl. Am. Steel Treaters Soc., vol. 1, no. 5, Feb. 1919, pp. 160-170, 14 figs. Notes on various processes and account of tests on carbonizing and annealing boxes.

Tests

Corrosion Tests (Essai de corrosion), H. Le Chatelier and B. Bogitch. Revue de Métallurgie, vol. 16, no. 2, Mar-Apr. 1919, pp. 129-139, 16 figs. Chemical heterogeneity of reheated or slowly cooled steels is considered as being due entirely to oxygen.

FORGING

Marine Forgings

Keeps Pace With War Requirements. Iron Trade Rev., vol. 64, no. 25, June 19, 1919, pp. 1616-1617, 3 figs. Describes Camden Forge Co's. plant which formerly manufactured railroad forgings and is now turning out marine forgings.

Shells

Forgings and Inspecting Ordnance Shells, Stanley A. Richardson. Sibley Jl. Eng., vol. 33, no. 4, May 1919, pp. 40-43 & 45. Particular reference is made to successive steps in inspecting, gaging, checking and testing.

Stamps

Drop-Stamping, Drop-Forgings, Etc.—III, Joseph Horner. Mech. World, vol. 65, no. 1691, May 30, 1919, p. 259, 6 figs. Illustrating stamps where top tools or dies are not necessary. (Continuation of serial.)

FOUNDRIES

Aluminum Castings

Casting Aluminum (Das Giessen von Aluminium), H. Stoesser. Metall, no. 5, Mar. 10, 1919, pp. 61-62. Instructions as to kind of sand to be used, construction of molds, and type of crucible.

Brass Castings, Porosity of

Some Principles Involved in Melting Metals —VI, Charles Vickers. Brass World, vol. 15, no. 6, June 1919, pp. 175-176. Cases of porosity in brass castings due to shrinkage of individual crystals made possible by their having grown abnormally large. (To be continued.)

Brass Foundry

Modern Works of The Mueller Co., Sarnia, Ontario. Can. Foundryman, vol. 10, no. 6, June 1919, pp. 139-141, 6 figs. Production of brass castings.

Cupolas

A Cupola With Novel and Interesting Features, J. F. Mullan. Can. Foundryman, vol. 10, no. 6, June 1919, p. 152, 1 fig. Wind jacket is placed inside of shell instead of outside.

Electric Steel

Electric Steel Castings made in Chicago Shop. Foundry, vol 47, no. 324, June 1, 1919, pp. 352-355, 8 figs. Battery of three electric furnaces in use at foundry of Electric Steel Co. at Chicago. Two furnaces are of Schneider type and one of Pittsburgh type.

Engine Cylinders

Patterns and Moulds for Engine Cylinder Castings—II, Joseph Horner. Foundry Trade Jl., vol. 21, no. 208, Apr. 1919, pp. 215-223, 22 figs. Discusses various practices in process of molding. (Continued.)

England

Progress in Metal Casting in England, W. R. Barcay. Metal Indus., vol. 17, no. 6, June 1919, pp. 266-268, 6 figs. Comparison of technique of casting process as carried out by steel and metal casters.

Feeder-Head Method

A "Feeder-head" Method in Non-ferrous Ingot Casting, W. R. Barclay. Metal Industry, vol. 14, no. 18, May 2, 1919, pp. 361-364, 6 figs. Draws comparison between general methods adopted in crucible-steel ingot casting and those followed in crucible non-ferrous ingot casting.

Jarring Machine

The Manufacture of Semi-steel Shells, E. A. Suverkrop. Am. Mach., vol. 50, no. 22, May 29, 1919, pp. 1041-1043, 9 figs. Shockless jarring machine adapted for molding shells.

Molding

Steel Castings for Our First Line of Defense, Walter S. Doxsey. Foundry, vol. 47, no. 9, June 15, 1919, pp. 367-372, 14 figs. Additions to foundry of naval gun factory with reference to molding methods and layout of shop.

Sand

Production of Albany Molding Sand. Iron Age, vol. 103, no. 23, June 5, 1919, pp. 1499-1501, 4 figs. Analysis of origin and composition. States that standard specifications based on grain size are difficult to draw up.

Ship Parts

Making Castings Used in Ship Construction —III, IV, Ben Shaw and James Edgar. Foundry, vol. 47, no. 8 & 9, June 1 & 15, 1919, pp. 336-339 & 388-392, 27 figs. Building rudder yoke pattern. Suggestions in regard to exercising care to obviate subsequent foundry difficulties. Methods of molding and casting rudder yokes as pursued in English steel foundries.

Waste

Modern Methods Applied to the Foundry—II, W. R. Dean. Metal Industry, vol. 14, no. 17, Apr. 25, 1919, pp. 349-350, 5 figs. Recommends classification of wastes and their causes and suggests methods for establishing a system of classification.

FUELS AND FIRING

Ash, Fusibility of

Fusibility of Ash from Pennsylvania Coals, W. A. Selvig and A. C. Fieldner. Coal Age, vol. 15, no. 24, June 12, 1919, pp. 1086-1089. Table giving results obtained. Samples tested are said to have been gathered in accordance with method adopted by Bureau of Mines.

Coal

Utilization of Fuel (Zur Frage der zukünftigen Brennstoff-Ausnutzung), De Grahl. Annalen für Gewerbe und Bauwesen, vol. 84, no. 1, Jan. 1, 1919, pp. 1-8, 7 figs. Characteristics of gasification of bituminous coal at high and low temperatures.

The Gasification of Coal and the Rational Utilization of Fuels (Kohlenvergasung und rationelle Ausnutzung der Brennstoffe), M. Dolch. Montanistische Rundschau, vol. 11, nos. 3, 4, 5 & 6, Feb. 1 & 16, Mar. 1 & 16, 1919, pp. 61-64, 93-97, 125-129, and 162-166. From the economic point of view. Importance and future of by-products. (To be continued.)

Coal, Pulverized

Use of Pulverized California Coal, Chas. H. Delaney, Nat. Engr., vol. 23, no. 6, June 1919, pp. 278-279. Discussion of its economical employment as substitute for fuel oil from standpoint of initial cost and comparative operating expense. Paper read before Nat. Elec. Light Assn.

Pulverized Coal Systems in America, Leonard C. Harvey. Elecn., vol. 82, no. 22, May 30, 1919, pp. 616-619, 3 figs. Also in Iron & Coal Trades Rev., vol. 98, no. 2673, May 23, 1919, pp. 704-705. Analysis of costs and efficiency secured leads writer to conclude that advantages of burning coal in pulverized form have been definitely proved and that heat values of coal can be utilized to a far higher degree by this means than by any other process.

The Use of Pulverized Coal, L. C. Harvey. Eng. & Indus. Management, vol. 1, no. 14, May 15, 1919, pp. 423-426, 3 figs. Quigley semi-automatic bin-filling system. It is claimed that by this system coal dust can be readily conveyed to ships in harbor or at sea.

Coal Selection

The Economical Use of Coal, T. J. Nelson. Domestic Eng. & Estate Engr., vol. 39, no. 5, May 1919, pp. 62-65. Price delivered at works, suitability to furnaces installed, calorific value and amount of ash suggested as factors governing choice of coal to be used when it has to be brought some distance by rail to works.

Coal Waste

Utilization of Coal Waste (L'Utilization des déchets de Houille), L'Echo des Mines et de la Métallurgie, vol. 47, no. 2626, May 18, 1919, pp. 298-300. A committee of the Société de l'Industrie minérale report that their experiments have demonstrated that coal having 40 per cent ash and 23 per cent volatile matter yields tar in greater quantity and of better quality than the kind generally obtained in gas works.

SERVICE

Riley Stoker Service *is more* than a cost transaction which places a given amount of equipment in your plant leaving it at your mercy ever after.

Riley Stoker Service *begins at the source;* takes your needs into consideration and *stays with you* as long as your equipment is in operation.

Before installation our engineers carefully investigate the conditions for each installation and design the equipment exactly suited to those needs. Should special developments be desired then our designing department is at your disposal.

After installation our field engineers periodically follow up each plant whether it needs it or not. They are always ready to advise, direct and remedy.

Unusual as it may seem, our sales engineers are not so much interested in volume of sales—as satisfactory operation.

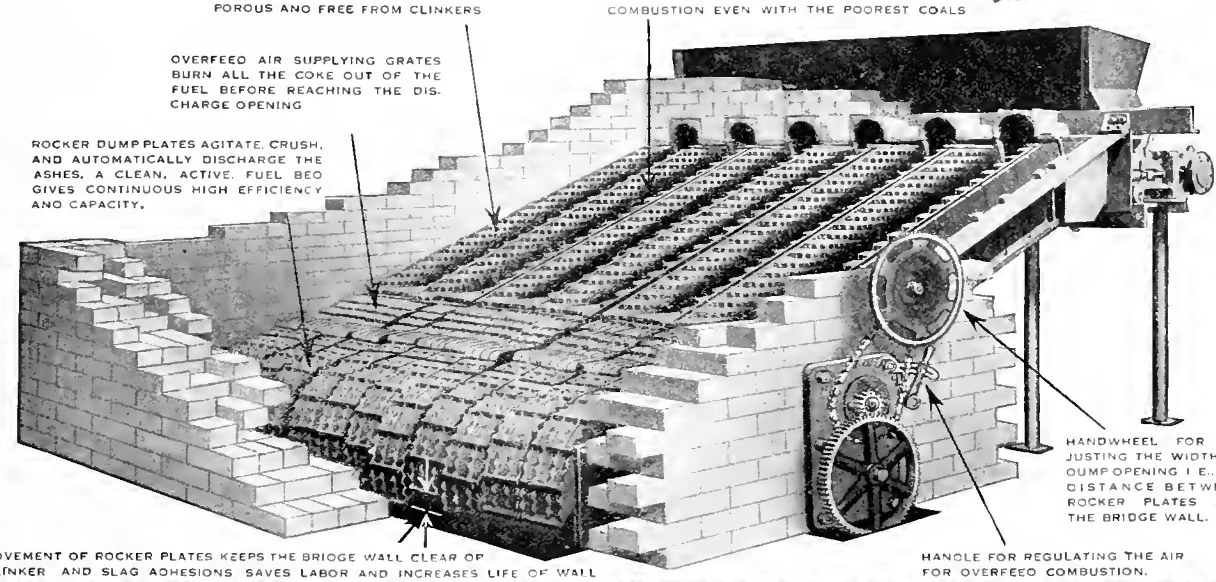
This policy protects present, as well as future customers. It is the customers' assurance that if they need advice on the operation of present equipment, or on the selection of new equipment, they can count on our being ready to serve them.

Bear in mind that the spirit of the service rendered by Riley Stoker engineers is constructive, not arbitrary nor forced, but designed as a co-operative influence to achieve the best possible results not only before but after purchase.

Catalog A-8 sent on request.

SANFORD RILEY STOKER COMPANY, WORCESTER, MASS.

British Licensees: Erith's Engineering Co., Ltd., London - French Licensees: Erith Leroy & Cie., Paris



TRADE MARK Rx REGISTERED

RILEY UNDERFEED STOKERS

TRADE MARK Rx REGISTERED

Waste Due to Excessive Ash or Non-Combustible in Coal, W. A. Shoudy. Stevens Indicator, vol. 36, no. 1, Jan. 1919, pp. 11-17, 4 figs. Reduction in heating value due to presence of ash schematically illustrated. Report prepared for Eng. Committee of National Research Council.

Utilizing Mine Waste and Inferior Fuels, F. Blache. Colliery Guardian, vol. 117, no. 3047, May 23, 1919, pp. 1225-1226, 2 figs. Plant of Société de Montcambert comprises set of two gas producers of cylindrical section and about 10 ft. in diameter, with automatic charging and distributing mechanism to spread fuel evenly over entire surface.

Colloidal Fuel

Possibilities of Colloidal Fuel. Power Plant Eng., vol. 23, no. 13, July 1, 1919, pp. 583-585, 2 figs. Methods of preparation and results of boiler tests.

Colloidal Fuel—A Chemist's Dream Come True, Robert G. Skerrett. Rudder, vol. 35, no. 6, June 1919, pp. 271-275, 12 figs. Examples of application of mixtures composed of powdered coal, liquid fuel and "fixateur," and account of instances of uses of this fuel for naval operations.

Fuel Conservation

Electricity vs. Gas in Regard to Coal Conservation, Hugh M. Goody. Elecn., vol. 82, no. 21, May 23, 1919, pp. 595-596. Examines figures on which Sir Dugald Clerk based his conclusion that "There is no case for electricity for the production and distribution of heat energy; there is a case in strong competition with gas for illumination; and as against the average reciprocating steam engine of the country, the advent of the steam turbine of high efficiency shows a distinct advantage."

Gasoline

Motor Gasoline Properties, Laboratory Methods of Testing, and Practical Specifications, E. W. Dean. Dept. Interior, Bur. Mines, Technical paper 214, Petroleum Technology 52, Feb. 1919, 33 pp., 2 figs. Based on properties which are considered desirable by Bureau. These are absence of too large a percentage of highly volatile products or of heavy or nonvolatile constituents, freedom from substances that attack metal either before or after combustion or which leave residue that collects in motor.

Hand Firing

Standard Practice of Hand Firing, Robert June. Elec. Rev., vol. 74, no. 23, June 7, 1919, pp. 937-939, 3 figs. Of the two methods of hand firing—spreading method and coking method—writer believes that modern practice leans more and more to spreading method, because, he says, of its higher efficiency, higher CO_2, lower flue gas and more uniform steam generation.

Oil

Oil Gains Importance as Ship Fuel, V. G. Iden. Mar. Rev., vol. 49, no. 7, July 1919, pp. 321-324, 5 figs. What the Government did to standardize oil burning on merchant ships.

Peat

Peat, Oil and Gas Fuel, B. J. Forrest. Jl. Eng. Inst. Can., vol. 2, no. 6, June 1919, pp. 439-445, 5 figs. Writer's opinion is that industrialization of peat could be most efficiently brought about by gasifying in gas producers, because, he says, this procedure would render feasible the recovery of several valuable by-products.

The Production of Peat Fuel, Ernest V. Moore. Jl. Eng. Inst. Can., vol. 2, no. 6, June 1919, pp. 435-438. General properties, mode of occurrence and present utilization of peat found in vicinity of Montreal.

The Future of Peat as a Fuel—II, J. B. C. Kershaw. Coal Age, vol. 15, no. 21, May 22, 1919, pp. 946-950, 7 figs. Gasification and powdering are believed to be routes of improvement along which future progress in peat utilization may be expected.

Stokers

Fuel-Burning Equipment of Modern Power Stations, Joseph G. Worker. Power House, vol. 12, no. 7, May 20, 1919, pp. 187-191, 15 figs. Data relative to installations where inclined multiple retort has been completed. With performance curves of a six-retort stoker and a 558-hp. boiler.

Economical Fuel Burning Equipment, J. G. Worker. Blast Furnace & Steel Plant, vol. 7, no. 6, June 1919, pp. 227-280, 8 figs. Steam-cylinder mechanism for operation of forward and rear dumping grates of multiple-retort inclined underfeed stokers.

Surface Combustion

Surface Combustion (La Combustion de surface), M. Desmarets. Revue Générale des Sciences, vol 30, no. 9, May 13, 1919, pp. 274-278, 5 figs. Historical account of researches and industrial applications. Geological characteristics of deposits and notes on manner of instituting their research.

Tar Oil

Tar Oil as Fuel (Teeröl als Brennstoff). Zeitschrift des Bayerischen Revisions-Vereins, vol. 23, nos. 1 & 3, Jan. 15 and Feb. 15, 1919, pp. 1-2 and 17-19. Evaporation tests.

FURNACES

Grates

Minimum Distance between Grates and Lower Part of Arch Tubes, L. M. Stewart. Ry. Jl., vol. 25, no. 6, June 1919, pp. 19-22. As depending upon grade of coal being used and whether or not firemen have been taught to shake grates and keep fire worked down. Paper before Master Boiler Makers' Assn.

Heat Treating

Heating Furnaces and Annealing Furnaces—VI, W. Trinks. Blast Furnace & Steel Plant, vol. 7, no. 6, June 1919, pp. 294-297, 7 figs. Discusses means by which fuel consumption per unit weight of steel (heated or annealed) can be reduced.

GAGES

Gage Making

Examples of Gauge Making, A. G. Robson. Engineer, vol. 127, no. 3308, May 23, 1919, pp. 499-501, 33 figs. Examples chosen are of straightforward kind. Modus operandi of gage-maker, rather than extent of calculations required, is indicated.

Hoke Gages

Government Steel Plant, S. W. Stratton. Blast Furnace & Steel Plant, vol. 7, no. 6, June 1919, pp. 268-270, 4 figs. Research work done by Bur. of Standards in connection with manufacture of Hoke precision gages.

Plate Gages

Master and Working Plate Gauges, R. Worthy. Machy. (Lond.), vol. 14, no. 346, May 15, 1919, pp. 185-193, 40 figs. Laying out, testing, hardening and lapping.

GAS ENGINEERING

Distribution Pressures

Distribution Pressures, S. C. Singer. Gas Rec., vol. 15, no. 10, May 28, 1919, pp. 343-344, 1 fig. Experience of rapid growing city. Schematic diagram or distribution system is presented.

Joints, Pipe

Wherein a Joint in the Outlet Pipe from a 2,000,000 Cu. Ft. Holder 18 Ft. from Tank Bottom and a Diver Cleans Out Bottom with Holder Full of Gas, A. H. Harris. Am. Gas Eng. Jl., vol. 110, no. 25, June 21, 1919, pp. 525-536, 7 figs. Leaky joint let in enough ground water to interfere with working of seal and cleaning was necessitated by naphthalene accumulation that tilted lifts to the extent of distorting side-guide rubber shafts.

Natural Gas

Displacing Natural Gas with Manufactured Gas, Kay C. Krick. Gas Age, vol. 43, no. 11, June 2, 1919, pp. 583-585. Anticipates failure of natural gas supply. Paper read before Natural Gas Assn.

Manufactured Gas to Supplement Natural Gas, Kay C. Krick. Gas Age, vol. 43, no. 11, June 2, 1919, pp. 567-568. Advises greater conservation through increased price. Address delivered before Natural Gas Assn.

Retorts

Steaming Retorts, H. J. Toogood. Gas Rec., vol. 15, no. 11, June 11, 1919, pp. 377-378, 2 figs. Proposes connecting retorts in different stages of carbonization to work in series.

Results from Vertical Retorts at Meriden. Gas Age, vol. 43, no. 12, June 16, 1919, pp. 633-634, 4 figs. In regard to labor required.

Standards

Gas Standards. Gas Jl., vol. 146, no. 2920, Apr. 29, 1919, pp. 238-240. Also Gas Age, vol. 43, no. 11, June 2, 1919, pp. 569-572, and Gas World, vol. 70, no. 1814, Apr. 26, 1919, pp. 312-314. Recommendations of Fuel Research Board as to "most suitable composition and quality of gas and the minimum pressure at which it should be generally supplied, having regard to the desirability of economy in the use of coal, the adequate recovery of by-products, and the purposes for which gas is now used."

Water Gas

Water-Gas Plant at Colchester, W. W. Townsend. Gas Jl., vol. 146, no. 2921, May 6, 1919, pp. 296-299 and (discussion) pp. 299-300, 4 figs. Reconstruction of plant effected by converting two sets, each of capacity of 300,000 cu. ft. per day, to capacity of 500,000 cu. ft. each. Paper read before Eastern Counties Gas Managers' Assn.

HANDLING OF MATERIALS

Ash

See Coal and Ash.

Coal and Ash

New Coal Handling Plants for Philadelphia Water Works, Harrison R. Cady. Eng. News-Rec., vol. 82, no. 23, June 5, 1919, pp. 1095-1097, 3 figs. General and detailed design for three systems supplying total of 16 boilers with total boiler capacity of 7400 hp.

Handling Coal and Ashes at the Pusey & Jones Power Plant, Henry J. Edsall. Power Plant Eng., vol. 23, no. 11, June 1, 1919, pp. 483-487, 5 figs. Details of system employing bucket conveyor.

Coal and Ore

The Coal Shortage and Handling by Gravity, George Fred. Zimmer. Eng. & Indus. Management, vol. 1, no. 13, May 8, 1919, pp. 413-416, 3 figs. Gravity-driven band conveyor for loading ore erected by Fraser & Chalmers, Ltd., of Erith and London, and similar installations for handling of concrete, etc.

Handling Plant of the Galveston (Tex.) Coal Co., Chas. Fowler, Jr. Coal Trade Jl., vol. 50, no. 25, June 18, 1919, pp. 737-739, 4 figs. Equipped with Lidgerwood installation, coal being handled by one Hayward 3-cu. yd. clamshell bucket on one transfer and a 2-cu. yd. bucket on the other.

Electricity as Applied to Loading and Unloading Coal and Ore Boats, R. H. McLain. Gen. Elec. Rev., vol. 22, no. 5, May 1919, pp. 352-365, 26 figs. Notably at coal-loading pier of Baltimore & Ohio R. R. Co. at Curtis Bay and at ore docks of Duluth and Iron Range R. R., Two Harbors, Minn. Paper read before Soc. Terminal Engrs.

Conveyors

Economical Handling of Materials. Can. Manufacturer, vol. 39, no. 6, June 1919, pp. 27-28, 6 figs. Uses of portable scoop conveyor.

Belt Conveyors for Ore Handling. Chem. Eng. & Min. Rev., vol. 11, no. 124, January 5, 1919, pp. 95-98, 4 figs. Plan showing general layout of bins and conveyors in connection with handling of charge for blast furnace.

Grain

Mechanical Grain-Loading Devices on the Roumanian Danube, George Frederick Zimmer. Eng. & Indus. Management, vol. 1, no. 15, May 22, 1919, pp. 477-480, 5 figs. Include means for unloading of railway trucks by mechanical shovels. (To be continued.)

Live Stock

Proper Loading and Handling of Live Stock, W. J. Embree. Off. Proc. St. Louis Ry. Club, vol. 23, no. 12, Apr. 11, 1919, pp. 289-296. Disease and injury received by smaller cattle from larger cattle in same car are considered as chief losses from shipment of cattle.

Ore

See Coal and Ore.

Truck Loading

Truck Loading Devices Reduce Lost Time, J. Edward Schipper. Automotive Industries, vol. 40, no. 24, June 12, 1919, pp. 1346-1350, 12 figs. Examples of installation of apparatus for handling loose or bulky material.

HEAT-TREATING

Duralumin

Heat Treatment of Duralumin, P. D. Merica, R. G. Waltenberg, and H. Scott. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 150, June 1919, pp. 913-949, 26 figs. Experiments carried out in laboratory of Bureau of Standards and partly in cooperation with Aluminum Co. of America. Temperature of quenching, it is concluded, should not be above that of the aluminum eutectic which is usually about 520 deg. cent., but should be as near to this as possible without danger of eutectic melting.

Forging, Large

Temperature Observations on Heating, Quenching and Drawing of a Large Steel Forging, O. A. Knight and F. F. Hansen. Chem. & Metallurgical Eng., vol. 20, no. 11, June 1, 1919, pp. 590-591, 3 figs. Experiments conducted at heat-treating plant of Watertown Arsenal.

Furnace

New Features in Heat Treating Plant. Iron Age, vol. 103, no. 23, June 5, 1919, pp. 1493-1495, 4 figs. Car type furnace with chamber 30 ft. by 6 ft. for annealing large parts of automobile frames in plant of Parish & Bingham Co., Cleveland.

See also Furnaces, Heat-Treating.

Quenching

Influence of Quenching Temperature on Structural and Mechanical Characteristics of Steel (Influenza della temperatura di ricottura sulle caratteristiche strutturale e meccaniche degli acciai), Pietro Forcella. Rivista Tecnica della Ferrovie Italiane, vol. 15, no. 4, Apr. 15, 1919, pp. 144-150, 23 figs. on three supplement plates. Researches undertaken under auspices of Instituto Sperimentalo della Ferrovie.

Quenching Cracks in Carbon Steels, Kôtarô Honda and Tozajirô Matsusata. Science Reports of the Tôhoku Imperial University, vol. 8, no. 1, Apr. 1919, pp. 31-42, 8 figs. Experimental. It is concluded that cause of retarded cracks in quenched carbon steel is neither thermal stress caused by unequal cooling of specimens nor impulsive stress due to differential expansion of adjacent parts caused by rapid cooling through a range of the A_1 point, but it is the persistent stress due to differential expansion of adjacent parts caused by different degree of martensitization.

Steel

Heat Treatment of Steel, C. O. Bannister. Jl. & Trans. Soc. of Engrs., vol. 10, no. 4, 1919, pp. 163-179, and (discussion) pp. 179-184, 9 figs. Suggestions in regard to various accepted practices based on examination of specimens and results obtained in tests.

Heat Treatment of Alloy Steel, K. A. Juthe. Am. Mach., vol. 50, no. 233, June 5, 1919, pp. 1077-1079. Suggestions based on writer's experimental research.

Theory

Some Notes on Heat Treatment Theory, W. F. Edwards. Jl. Am. Steel Treaters Soc., vol. 1, no. 5, Feb. 1919, pp. 141-159, 12 figs. Considerations intended to show that phase law is of little value in explaining phenomena of heat treatment of steel. It is believed that rates of heating, cooling or changes of pressure, etc., are of much more significance than usual interpretations of equation diagram.

HEATING AND VENTILATION

Engine Houses

The Heating and Ventilation of Engine Houses, T. W. Reynolds. Ry. Age, vol. 66, no. 21, May 23, 1919, pp. 1245-1248, 3 figs. Discusses use of underground concrete air ducts as applied to a 30-stall engine house, having concrete floors, brick walls and timber frame and roof.

Mechanics' Liens

Heating and Ventilating Plants and Mechanics' Liens, Arthur L. H. Street. Heat. & Vent. Mag., vol. 16, no. 5, May 1919, pp. 19-23. Review of Appellate Court decision defining circumstances under which security is available. (To be continued.)

Radiation, Computation

Standard Rules for Computing Required Radiation. Metal Worker, vol. 91, no. 25, June 20, 1919, pp. 790-792. Also Heat. & Vent. Mag., vol. 16, nos. 5 & 6, May & June 1919, pp. 23-26 & 36-39. Proposed regulations for figuring steam and hot-water radiation in heating systems. Reprint from Bul. Nat. District Heating Assn.

Radiators, Flow of Water to

Care of Heating and Ventilating Equipment, Harold L. Alt. Power, vol. 49, no. 24, June 17, 1919, pp. 932-933. Discusses various methods of controlling flow of water to radiators.

Steam Heat

Preventable Economies in the Use of Steam Heat, Lloyd Howell. Heating & Ventilating Mag., vol. 16, no. 6, June 1919, pp. 22-24. Damages caused by incorrect installation are pointed out.

Workshops

The Heating and Ventilation of Workshops. Engineer, vol. 127, no. 3308, May 23, 1919, pp. 504-506, 8 figs. System in plant having reinforced-concrete roof.

HOISTING AND CONVEYING

Cranes

Heavy Shop Framing for 250-ton Traveling Crane. Eng. News-Rec., vol. 82, no. 24, June 12, 1919, pp. 1172-1173, 3 figs. Columns carry double-deck runways with T-section girders for overhead crane handling locomotives.

Electrically Operated Travelling Cranes. Elec. Rev., vol. 25, no. 5, May 1919, pp. 316-321, 17 figs. The different types of modern traveling cranes are defined with idea of bringing out inherent features of each. Included also is a short history of evolution of electric traveling cranes from hand-operated jib cranes.

Freight Elevators

Freight Elevators, Charles H. Weeks. Safety Eng., vol. 37, no. 6, June 1919, pp. 307-313, 4 figs. Statistics of accidents and their causes as collected by Dept. of Labor of New Jersey; also instructions for elevator operators.

Hoists

Progress in the Electrification of Mine Hoists, R. S. Sage. Gen. Elec. Rev., vol. 22, no. 5, May 1919, pp. 332-341, 17 figs. Brief historical survey and description of modern hoist equipments used at various mines.

Electrically Operated Hoists. Elec. Rec., vol. 25, no. 6, June 1919, pp. 386-394, 21 figs. Constructional and operating features of hoists as used in different industries.

A New Electrically-Driven Winding Equipment. Elecn., vol. 82, no. 20, May 16, 1919, pp. 570-571, 2 figs. Designed for 720-ft. shaft. It has cylindro-conical drum 11 ft. to 15 ft. in diameter. (To be concluded.)

Steam and Electric Mine Hoists, Frank C. Perkins. Nat. Engr., vol. 23, no. 6, June 1919, pp. 264-266, 2 figs. Types used at various plants, especially direct-acting steam type used at Michigan Copper Co. and electric hoist of 1,850 hp. employed by North Butte Mining Co.

Overspeed Prevention

A New Electrically-Driven Winding Equipment. Elecn., vol. 82, no. 21, May 23, 1919, pp. 593-594, 3 figs. Description of overspeed preventer device. (Concluded.)

Overwinding

Safety in Winding Operations, J. A. Vaughan. South African Jl. Sci., vol. 15, no. 4, Nov.-Dec., 1918, pp. 207-216. Remarks are confined to question of safe handling of winding engine and particularly statistical records of accidents due to overwinding.

Winches

Applications of the Williams-Janney Variable Speed Gear. Engineering, vol. 107, no. 2787, May 30, 1919, pp. 693-695, 10 figs. Advantages claimed for application of this gear to winches. (Continuation of serial.)

HYDRAULIC MACHINERY

Pipe Lines

The 25-Mile Gravity Pipe Line of Everett, Washington, W. A. Scott. Eng. World, vol. 14, no. 12, June 15, 1919, pp. 41-46, 14 figs. Pipe line has length of 133,000 ft., and between intake and reservoir there is net head of 252 ft.

Economical Size of Pipe for Given Loss of Head, E. W. Rettger. Cornell Civil Engr., vol. 27, no. 4, Apr. 1919, pp. 83-92, 2 figs. Formula derived on Adams principle which writer states as follows: That type is most economically designed for which interest and depreciation on first cost of pipe, plus annual value of power loss due to friction in pipe, is a minimum.

Sluices

Automatic Sluices (Les barrages automatiques), E. Freté. Génie Civil, vol. 74, no. 22, May 31, 1919, pp. 429-433, 21 figs. Diagramatic representation of various types.

Surges

Graphical Records of Surge Pressures in Pipe Lines, Ralph Bennett. Eng. News-Rec., vol. 82, no. 22, May 29, 1919, pp. 1048-1050, 9 figs. Tests made for determining effect of varying air-chamber conditions and changing choke-gate area.

The Surge-Chamber Problem, E. Parry. New Zealand Jl. of Sci. & Technology, vol. 2, no. 2, Mar. 1919, pp. 78-86, 2 figs. Derivation of formula when limited in its application to chamber with parallel sides.

Williams-Janney Speed Gear

The Williams-Janney Variable Speed Gear. Engineering, vol. 107, no. 2786, May 23, 1919, pp. 662-666, 14 figs. Device consists of two similar hydraulic units each of which comprises a group of cylinders, mounted upon a shaft revolving in a fixed casing, one unit fulfilling function of pump and supplying fluid to other which acts as motor. (To be continued.)

INTERNAL-COMBUSTION ENGINES

Carburation

The Carburation of Low-Grade Distillates, H. O. Eneign. Pac. Mar. Rev., vol. 16, no. 6, June 1919, pp. 121-124, 7 figs. Carburetor development in California and having as distinguishing factors, according to writer, that maximum air velocity equals in all cases that of engine manifold, and that fuel is delivered to center of metering chamber at point where velocity is practically zero.

Diesel Engines

Internal Combustion Engines for Submarines. Constructed by Messrs. Franco Togi, Engineers, Legnano, Milan. Engineering, vol. 107, no. 2788, June 6, 1919, pp. 732-734, 8 figs. Results of tests with two types: Two-cycle engine with six working cylinders and a four-cycle type with eight working cylinders.

An All-American Diesel. Pac. Mar. Rev., vol. 16, no. 6, June 1919, pp. 111-114, 7 figs. Winton 8-cylinder engine.

The Diesel Engine, Charles Day. Automobile Engr., vol. 9, no. 127, June 1919, pp. 169-171, 6 figs. Features and limitations. Paper presented to Instn. Automobile Engrs.

Vickers High-Powered Submarine "Diesel" Engines. Motorship, vol. 4, no. 6, June 1919, pp. 35-36, 3 figs. Eight- and twelve-cylinder, 1,800 b.hp. motors of "solid injection" type. Cast-steel cylinder heads said to be used successfully.

Slow-Combustion Engines and Their Uses, J. Drosne. Motorship, vol. 4, no. 6, June 1919, pp. 43-45, 1 fig. Together with details of Schneider crosshead type merchant-marine and naval Diesel engines.

An American Diesel Engine. Motorship, vol. 4, no. 6, June 1919, pp. 30-32, 7 figs. Six-cylinder Winton marine engine. Outstanding features are enclosed crankcase, trunk-pistons, and crankshaft bolted up to its bearings.

Dorman Engines

The Dorman Engines. Automobile Engr., vol. 9, no. 127, June 1919, pp. 191-193, 9 figs. Post-war program includes six engines, ranging in power from 10 hp. to 40 hp. Power curves for these types are given.

Flame Propagation

A New Method of Determining Rate of Flame Propagation, P. M. Heldt. Automotive Industries, vol. 40, no. 24, June 12, 1919, pp. 1256-1258, 3 figs. Based on principle that when flame surrounds pair of spark terminals electrical pressure required to break down resistance of gap is reduced.

Fuels and Performance

Engine Performance, H. L. Horning. Jl. Soc. Automotive Engrs., vol. 4, no. 5, May 1919, pp. 344-345 and (discussion) pp. 345-348, 1 fig. Diagram of power available in a 60-hp. engine with different fuels.

The Future of Internal-Combustion Engines (De toekomst der verbrandingsmotoren), P. Meyer. De Ingenieur, vol. 34, no. 17, Apr. 26, 1919, pp. 313-318. Discusses future from technical as well as from economic point of view. Special attention given to the fuel question.

The Fuel Question of Internal-Combustion Engines (Zur Betriebsstoffrage der Verbrennungsmotoren), Hugo Brach. Oelmotor, vol. 8, no. 3, Mar. 1919, pp. 65-69. Special consideration is given to the automobile motor. Tables.

Gas Engines

Installation and Working of Large Horizontal Gas-Engines, H. Pilling. Gas Jl., vol. 146, no. 2919, Apr. 22, 1919, pp. 191-193. Possibility of utilizing 20,700 cu. ft. gas per min. for blowing and power purposes in a supposed blast-furnace installation producing 2,000 tons of iron per week. Paper read before Cleveland Instn. Engrs.

Gile Engine

A New Combustion Engine. Mar. Eng. & Can. Merchant Service Guild Rev., vol. 9, no. 5, May 1919, pp. 177-178, 4 figs. Gile engine. Fuel is mixed in cylinder by forcing charge of compression around subpiston head through series of small restricted passages to combustion chamber against cylinder head.

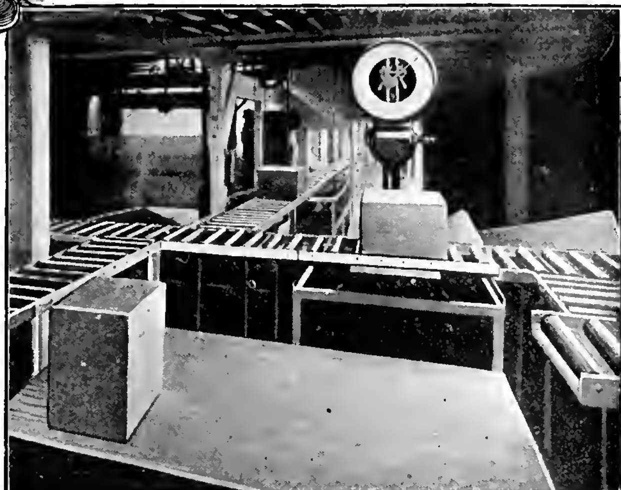
High-Speed Engines

High-Speed High-Efficiency Engines, D. McCall White. Jl. Soc. Automotive Engrs., vol. 4, no. 5, May 1919, pp. 327-334, 18 figs. Fundamentals of high-speed engines, survey of various types manufactured in United States, and uses which have been given to these engines, particularly during the war.

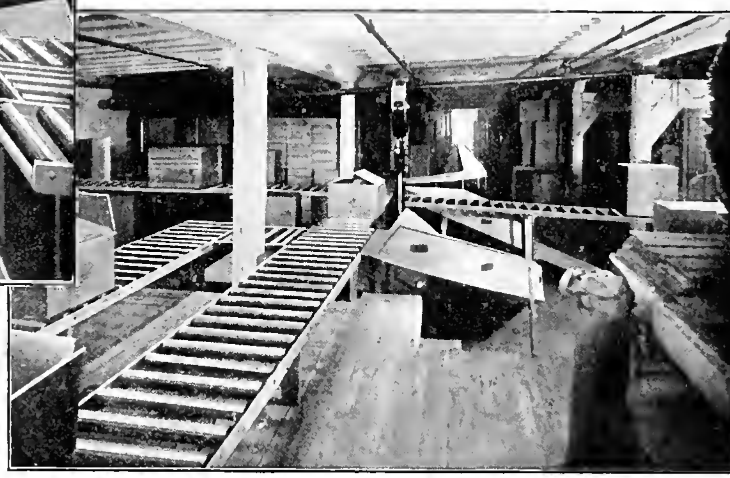
Hot-Surface Oil Engines

Hot Surface Oil Engines for Industrial Purposes, A. H. Goldingham. Jl. Soc. Automotive Engrs., vol. 4, no. 6, June 1919, pp. 482-485, 1 fig. Engines of horizontal or vertical design arranged for direct connection or by belting to electrical or pumping and other machinery are discussed from viewpoints of reliability, first cost, and economy.

Lamson Conveyors



The picture below shows the general arrangement of top floor. The "booster" from first floor delivers cases to the two roller conveyors in the foreground. Notice that the boxes pass to scales and to chutes and distributing conveyors in the background, without lifting by human hands.



The picture above shows a "close-up" of the conveying section at the weighing scales. Cases are weighed automatically without leaving conveyor. Notice the chute at the right. This is one of the two that lead to storage and to shipping-platforms below, where cars are loaded in one-sixth the time it took before the Lamson System was installed.

Right Packing and Shipping Methods Quicken Production

IN the plant of the John Hoberg Company, Green Bay, Wis., rolls of tissue paper are cut, wrapped and packed on the first floor. Originally, the cartons and cases were sealed or nailed on this same floor.

But the volume of work outgrew the space available. There was a jam of carrying, trucking and toting, which slowed up the packers, and delayed the cutting, wrapping, storing and shipping departments in their work.

Lamson Conveyors cleared up the packing floor by removing the pasting and nailing to the top floor. Now, cartons and cases, the moment they are packed, are automatically conveyed to the top floor where all pasting and nailing is quickly done while moving along the conveyor. The cartons and cases then gravitate to storage and shipping—from the time they are packed they are not lifted by human hands.

Lamson Conveyors are increasing production and lowering the unit cost of production in hundreds of factories through similar rearrangements of work and departments, and more efficient operation.

Is part of your plant delayed by the congestion of materials or products, while another part, easily reached by conveyors, is comparatively free? Are the employees in your plant wasting valuable time because of confusion, congestion and delay in transit of materials? Are your raw materials, parts in process, finished goods and packing cases being conveyed from machine to machine, department to department, and out to storage and shipping at that steady, even flow that insures the highest efficiency in production and contentment of workmen?

Think these things over, then ask our engineering department to report just how Lamson Conveyors can become automatic organizers of your production. There is no obligation.

Write for book on Conveying, illustrating the versatility of the Lamson System for carrying all kinds of things.

THE LAMSON COMPANY
100 BOYLSTON ST., BOSTON, MASS.

Boston,	100 Boylston St.	Cincinnati,	119 East 5th St.	Seattle,	215 Stewart St.
New York,	15 West 44th St.	Indianapolis,	Illinois and Washington Sts.	San Francisco,	617 Mission St.
Philadelphia	1200 Walnut St.	Chicago,	6 N. Michigan Ave.	Los Angeles,	627 So. Broadway
Pittsburg,	319 Third Ave.	Minneapolis,	221 Tribune Annex	Dallas,	905½ Elm St.
Rochester,	194 Main St. East	Omaha,	Brandeis Bldg., Room 675	Baltimore,	Equitable Building
Detroit,	97 Woodward Ave.	Denver,	1622 Arapahoe St.	New Orleans,	124 St. Charles St.
Cleveland,	2063 East 4th St.	St. Louis,	709 Pine St.	Atlanta,	30 Moore Bldg.

Toronto, Jones & Glassco, Reg'd., 136 Simcoe St.
Vancouver, B. C., 603 Hastings St.
Montreal, Jones & Glassco, Reg'd., St. Nicholas Bldg.

LAMSON SERVICE

Kessler Super-Charge Engine

The Kessler Super-Charge Engine Developed for Automobile Purposes. Automotive Industries, vol. 40, no. 24, June 12, 1919, pp. 1289-1293 and 1308, 9 figs. Uses four-stroke cycle with ramming charge of excess air; time compression crankcase employed.

Marine Engines

Automotive Applications of Marine Engines in the War, George F. Crouch. Jl. Soc. Automotive Engrs., vol. 4, no. 5, May 1919, pp. 349-357, 20 figs. partly on supp. plate. Particularly of 220-hp. Internal-combustion engine used on United States 110-ft. submarine chaser. Reference is made to British M L submarine chasers.

Motorcycle Engines

Two-Stroke Engines for Motorcycles, E. Tilston. Automotive Industries, vol. 40, no. 24, June 12, 1919, pp. 1304-1305, 2 figs., also Automobile Engr., vol. 9, no. 127, June 1919, pp. 185-187, 4 figs. Model with distinct type exhaust valve designed by writer. Paper presented to Instn. Automobile Engrs.

Still Engine

A New Prime Mover of High Efficiency and British Origin, Frank E. D. Acland. Jl. Roy. Soc. Arts, vol. 67, no 3472, June 6, 1919, pp. 463-475 and (discussion) pp. 475-482, 6 figs.; also Engineer, vol. 127, no. 3309, May 30, 1919, pp. 540-541, 2 figs.; Automotive Industries, vol. 40, no. 25, June 19, 1919, pp. 1404-1405, 1 fig.; Elec. Rev., vol. 84, no. 2165, May 23, 1919, pp. 643-646, 4 figs.; Shipbuilding & Shipping Rec., vol. 13, no. 22, May 29, 1919, pp. 697-698, 2 figs., and Eng. & Indus. Management, vol. 1, no. 18, June 12, 1919, pp. 567-573, 6 figs. Engine is said to be capable of using any form of liquid or gaseous fuel and to make use of recoverable heat which passes through surfaces of combustion cylinder as well as of exhaust gases. Combines features of steam and gas engine.

Thermal Efficiencies

Recent Developments in the Internal Combustion Field, A. L. Taylor. Utah Soc. Engrs., vol. 5, no. 3, Mar. 1919, pp. 54-61. Thermal efficiency of various types.

Valves

New Valve Operating System. Autocar, vol. 42, no. 1231, May 24, 1919, pp. 814-815, 4 figs. Rotary reciprocating valve engine with single-sleeve valve in each cylinder which both rotates and reciprocates, dual motion being obtained through action of gears and cams respectively.

Valves, Air-Flow Through

Study of Air Resistance and Air Flow. H. Levy. Automotive Industries, vol. 40, no. 24, June 12, 1919, pp. 1260-1264, 10 figs. Laws of air resistance determined for various air speeds; applications to aircraft and automobile problems.

LUBRICATION

Bureau of Standards

Lubricating Oil Program of the Bureau of Standards. Automotive Industries, vol. 40, no. 23, June 5, 1919, pp. 1230-1232. Outline of problems which bureau proposes to solve by experimental research work.

Experiments

Notes on Lubrication. S. Skinner. Proc. Phys. Soc., Lond., vol. 31, part III, Apr. 15, 1919, pp. 94-100, 2 figs. Experiments on pressure of air in neighborhood of a flywheel running in contact with a flat, long board are presented as exhibiting properties of a compressible lubricant.

MACHINE ELEMENTS AND DESIGN

Ball Bearings

Ball Bearings, H. D. McGuire. U. S Naval Inst., Proc., vol. 45, no. 196, June 1919, pp. 973-986, 16 figs. Advantages claimed for them.

Ball Bearings' Application in Industry. Raw Material, vol. 1, no. 4, June 1919, pp. 222-226, 14 figs. Application to two machine shop tools. (Continued.)

Cams

Cam Design and Construction—V, Franklin de R. Furman. Am. Mach., vol. 50, no. 24, June 12, 1919, pp. 1123-1126, 5 figs. Deals with swinging follower arms, with both roller and sliding contact and method of finding length of shoe of sliding arm.

Cam Profiles, A. Johnson. Automobile Engr., vol. 9, no. 127, June 1919, pp. 166-169, 12 figs. Technical. Types used to operate valves of internal-combustion engines.

Gears

Horse-Power Chart for Spur and Bevel Gears. Machy. (Lond.) vol. 14, no. 347, May 22, 1919, p. 232, 1 fig. Plotted from Lewis and Barth formulæ.

Angles for Spiral Bevels. Machy. (Lond.), vol. 14, no. 349, June 5, 1919, pp. 282-283. Tables giving increment angles for spiral bevel pinions.

Radio-Thrust Bearings

Load Characteristics of Radio-Thrust Bearing, F. W. Gurney. Am. Mach., vol. 50, no. 26, June 26, 1919, pp. 1233-1236, 4 figs. Description of chart for finding capacity of ball bearings of radio-thrust type.

Springs

Tables for Calculating Helical Springs, J. H. Sullivan. Machy. (N. Y.), vol. 25, no. 10, June 1919, pp. 961-964. Showing maximum loads in pounds and corresponding compressions in inches in helical round bar springs.

MACHINE SHOP

Chucks

Collet Chucks—IV, Fred Horner. Mech. World, vol. 65, no. 1690, May 23, 1919, p. 243, 3 figs. Advantages of hinged collet construction. (To be continued.)

College Machine Shop

Machine Work at the Ohio State University, W. A. Knight. Eng. Education, vol. 9, no. 10, June 1919, pp. 446-460, 9 figs. Electrical and mechanical engineering students required to take 6 hr. per week in a school year. Of this time 5 hr. per week are spent in shop and 1 hr. in classroom for lectures and recitations. Aim is to bring student in contact with such features in shop production as organization, interchangeable parts, work limits, inspection, standard time and progress reports.

Finishing Operations

Finishing Operations on Liberty Motor Cylinders, H. A. Carhart. Am. Mach., vol. 50, no. 25, June 19, 1919, pp. 1197-1201, 11 figs. Various operations involved are taken separately and reference is made to special fixtures used.

Jigs and Tools

Jigs, Tools and Special Machines, with their Relation to the Production of Standardized Parts, Herbert C. Armitage. Jl. Instn. Mech. Engrs., no. 4, May 1919, pp. 213-253 and (discussion) pp. 253-320, 18 figs., also Can. Machy., vol. 21, nos. 22 and 23, May 29 and June 5, 1919, pp. 542-544, and 576-580, 17 figs., and Model Engr. & Elecn., vol. 40, no. 943, May 22, 1919, pp. 393-399, 11 figs. Advantages and disadvantages of use of jigs and special tools in repetition work are discussed from viewpoint of relationship between output and cost of components and study of possible scheme for securing maximum efficiency from standardization of machines and methods.

Templets, Jigs and Fixtures—XXIV, Joseph Horner. Engineering, vol. 107, no. 2785, May 16, 1919, pp. 622-624. Limitations imposed on jig and fixture work by dimensions, shapes or numbers required. (Concluded.)

Metal Finishing

Progress in Metal Finishing, P. S. Brown. Metal Indus., vol. 17, no. 6, June 1919, pp. 274-276, 3 figs. Operations as practiced at Corona Typewriter Co., Groton, N. Y.

Milling

Planer Milling Practice in Automobile Plants, Edward K. Hammond. Machy. (N. Y.), vol. 25, no. 10, June 1919, pp. 965-971, 7 figs. Milling operations on crankcases. (First of two articles.)

Methods of Milling and Boring Yoke and Cap, F. Scriber. Can. Machy., vol. 21, no. 25, June 19, 1919, pp. 630-632, 9 figs. Illustrating jigs employed in various operations.

Shafting

Shaft Alignment and Its Importance, J. Y. Dahlstrand. Power, vol. 49, no. 23, June 10, 1919, pp. 882-886, 6 figs. Reasons are presented as to why two or more members of a unit mounted on the same bedplate lose their alignment. Uneven strain on the anchor bolts, incorrect foundation, improper and insecure doweling and wearing are causes for misalignment.

Tinsmithing

What a Tinsmith Can Do in a Machine Shop, Peter F. O'Shea. Am. Mach., vol. 50, no. 23, June 5, 1919, pp. 1067-1076, 21 figs. Example of homemade time and labor savers at tinsmith shop of New England plant.

MACHINERY, METAL-WORKING

Chucks

The Design of Concentric Chucks, A. Clegg. Machy. (Lond.), vol. 14, no. 349, June 5, 1919, pp. 277-281, 11 figs. Concerned with power, truth and durability and strength.

Some Interesting Features of the Massey-Harris Brantford Plant, J. H. Moore. Can. Machy., vol. 21, no. 21, May 22, 1919, pp. 509-511, 8 figs. Among jigs and fixtures described, a quick-action chuck and automatic milling machine are considered as distinctive features of shops.

Counterboring and Reaming

Automatic Machines, H. E. Thomas. Page's Eng. Weekly, vol. 34, no. 769, June 7, 1919, pp. 309-310, 3 figs. Tools recommended for counterboring and reaming. (Concluded.) Paper read before Manchester Assn. Engrs.

Milling Machines

The No. 4 Cincinnati Vertical High-Power Milling Machine. Am. Mach., vol. 50, no. 26, June 26, 1919, pp. 1229-1232, 7 figs. Intended for extremely heavy work and patterned after No. 5.

Designs Novel Continuous Miller. Iron Trade Rev., vol. 64, no. 21, May 22, 1919, pp. 1559-1560, 3 figs. Work is carried on a rotary platen which is set at 15-deg. angle to facilitate loading and unloading.

"Ohio" Tilted Rotary Milling Machine. Machy. (N. Y.), vol. 25, no. 10, June 1919, pp. 979-982, 5 figs. Provision is made for employing either continuous rotary method of milling or for applying an indexing principle of operation by which successive pieces of work are brought opposite cutter.

A New System of Thread Milling. Machy. (Lond.), vol. 14, no. 348, May 29, 1919, pp. 271-272, 4 figs. Headstock carries chuck in which work is held and has hollow spindle for accommodating rods that require their ends screwed.

Continuous Rotary Milling. Machy. (Lond.), vol. 14, no. 348, May 29, 1919, pp. 245-252, 14 figs. Davis & Thompson, Kearney & Trecker, and Becker Milling Machine Co. milling machines. Article deals chiefly with design of fixtures, methods of operation and statement of rates of production which are obtained in handling various classes of work.

MACHINERY, SPECIAL

Balancing Machines

Balancing Machines, F. G. Hechler. Jl. Am. Soc. Naval Engrs., vol. 31, no. 2, May 1919, pp. 405-419, 6 figs., partly on supp. plates. Carwen dynamic balancing machine, made by Carlson Wenstrom Co., and combined static and dynamic balancing machine, built by Vibration Specialty Co. examined in reference to requirements writer believes should be fulfilled by ideal balancing machine.

Capstan Lathe Tools

Capstan Lathe Tools—III, E. W. Field and A. E. Simpson. Machy. (Lond.), vol. 14, no. 347, May 22, 1919, pp. 227-231, 11 figs. Recessing tool-holders, centering and facing tools; floating reamers.

Cooling Towers

Natural Draught Cooling Towers, Harold Nielsen, Engineer, vol. 127, no. 3309, May 30, 1919, pp. 526-527, 1 fig. Making transverse free section as large as possible in order, writer contends, to give air proper time to get saturated with vapor. He offers modifications in Rankine's formula to make it apply in determining force of draft for natural-draft water-cooling towers.

Crushers and Pulverizers

Power Requirements of Rock-Crushing Plants, Mark H. Reasoner. Min. & Sci. Press, vol. 118, no. 24, June 14, 1919, pp. 819-820. Table showing approximate power requirements of various types of crushers and pulverizers.

Evaporators

Modern Commercial Evaporators, W. L. Badger, Mich. Technic, vol. 32, no. 2, May 1919, pp. 77-88, 14 figs. Comparison between horizontal and vertical types. (To be continued.)

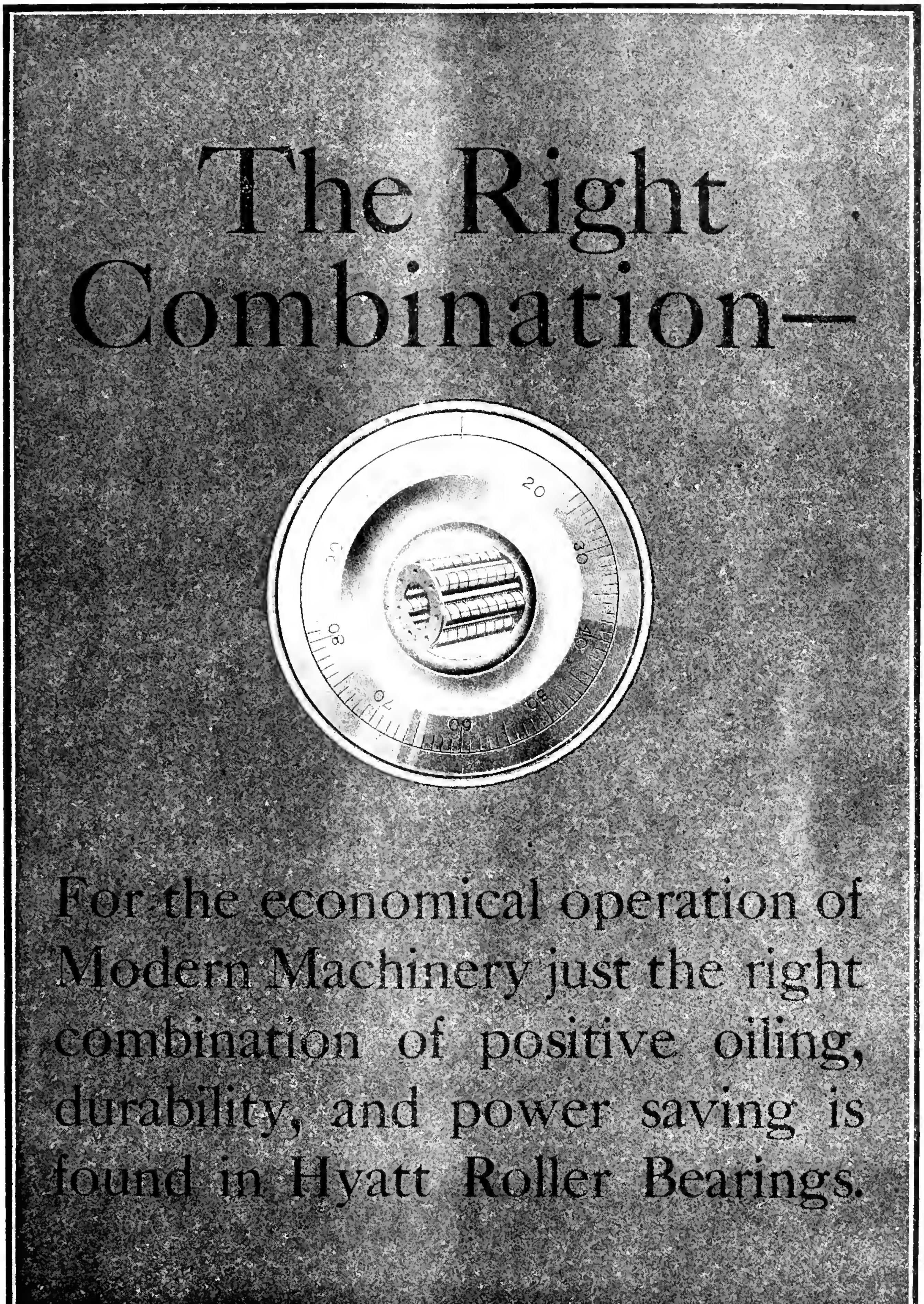
Industrial Vacuum Evaporators—VIII, Frank Coxon. Mech. World, vol. 65, no. 1693, June 13, 1919, p. 282, 5 figs. Test figures on use of evaporators.

Piercing and Shearing Tool

An Automatically Indexed Piercing and Shearing Tool, L. L. Dodds. Am. Mach., vol. 50, no. 24, June 12, 1919, pp. 1133-1135, 4 figs. Laminated copper contact brush made up of twelve strips of leaves, all of which are of equal length, but riveted together so as to give each end of brush a beveled appearance.

Pile Drivers

"Daza" Electric Pile-Driver (Machina eléctrica, sistema Daza, para hinca de pilotes), J. Eugenio Ribera Revista de Obras Públicas, vol. 67, no. 2271, Apr. 3, 1919, pp. 157-160, 5 figs. Comparison with "Lacour" machine. Writer


The Right Combination—
20
30
40
50
60
70
80
For the economical operation of Modern Machinery just the right combination of positive oiling, durability, and power saving is found in Hyatt Roller Bearings.

prefers "Taza," which he says is designed specially for driving reinforced-concrete piles, but can be also used for driving piles of other materials.

Typewriters

The Principles of Typewriter Mechanism, Nathan Sharpe. Model Engr. & Elecn., vol. 40, nos. 940 and 941, May 1 and 8, 1919, pp. 327, 330-332 and 354-360, 16 figs. Diagram showing various actions and details of mechanism. Several American types are considered.

MATERIALS OF CONSTRUCTION AND TESTING OF MATERIALS

Binders

Viscosity and Sticking Strength of Binders, Allen Abrams. Textile World Jl., vol. 55, no. 26, June 28, 1919, pp. 41-45, 6 figs. Stated on basis of experiments that usually full sticking strength of textile binders is obtained only by heating to at least 90 deg. cent.

Brass

Notes on the Influence of Certain Variables Associated with the Anneal of Cold-Worked Alpha Brass, Arthur Phillips and George C. Gerner. Chem. & Metallurgical Eng., vol. 20, no. 12, June 15, 1919, pp. 622-628, 16 figs. Engine tests on annealed samples. Concluded that while grain size before final reduction has some influence on mechanical properties to anneal brass, magnitude of effect is small, especially in metal annealed at high temperatures.

Structural Characteristics of Rolled Sheet Brass, H. A. Eatick, Metal Industry, vol. 14, no. 19-20, May 9-16, 1919, pp. 381-383 and 402-404, 8 figs. Study of cumulative hardening effect of cold work by examination of characteristic curves of various alloys. Study of equilibrium diagrams. (Concluded.)

Bronze

Use of Bronze for Valve Snap Rings and Piston Surfaces, and Bull Rings in Large Cylinders, C. E. Fuller. Ry. Age, Daily Edition, June 26, 1919, pp. 1791-1793, 2 figs. Experiments performed and results obtained by Union Pacific.

See also Copper and Bronze, Copper Aluminum Alloys.

Copper-Aluminum Alloys

Physical Properties of Copper Aluminum Alloys, A. H. Robinson and S. C. Zylstra. Mich. Technic, vol. 32, no. 2, May 1919, pp. 134-140, 9 figs. Tests performed on copper-aluminum-iron and copper-aluminum alloys established, it is reported, that the former is the stronger of the two at ordinary temperatures but has only a slight advantage at higher temperatures; also that the iron alloy is more free from blow-holes and slag-inclusions than the straight alloy.

Copper and Bronze

Copper and Bronze—a Technological Study Regarding the Effects of Heat Treatment with Special Reference to the Duration of the Tensile Test (Kupfer und Bronze—eine technologische Studie über die Wirkung des Reckens und Glühens unter besonderer Berücksichtigung der Zerreissversuchsdauer), Willy Müller. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no. 211, 1918, pp. 3-47, 16 figs. General remarks regarding the behaviour of metals when breaking. Metals tested were copper, manganese bronze and tin bronze.

Elasticity

Note on the Elasticity of Metals as Affected by Temperature, A. Mallock. Proc. Roy. Soc. Series A, vol. 95, no. A671, Apr. 1, 1919, pp. 429-437, 6 figs. It is reported that the ratio of Young's modulus were measured for 15 methods between temperatures of liquid air and 100 deg. cent.

Hemp

Sisal and the Plaint for Extracting the Fiber, South African Eng., vol. 30, no. 1, Jan 31, 1919, pp. 3-4 and p. 8, 4 figs. Size of hemp obtained from leaves of agava as cordage fiber.

Machine Construction, Materials for

Materials of Machine Construction, G. H. Kendall. Machy., (N. Y.), vol. 25, no. 10, June 1919, pp. 944-947. Properties and uses of principal materials.

Steel

Influence of Rolling and of Initial Thickness of Ingot on Quality of Steel (Influence du corroyage et de la grosseur du lingot initial sur la qualité d'une pièce en acier), André Pouilloux. Bulletin et comptes rendus de la Société de l'Industrie Minérale, vol. 15, no. 5, 1919, pp. 311-337, 9 figs. Based on experiments conducted at Firminy Steel Works. Forming an article from the smallest possible ingot is advocated principally because larger ingots are said to be necessarily of inferior quality.

Gear Steels, J. Heber Parker. Automotive Industries, vol. 40, no. 23, June 5, 1919, pp. 1220-1221. Classifications of gears according to application, materials and treatment. Methods employed in carbonizing and heat treatment. Paper read before Am. Gear Mfrs. Assn.

The Mechanical Properties of Steel, W. H. Hatfield. Engineering, vol. 107, no. 2785, May 16, 1919, pp. 634-636 & 638, 14 figs. Evidence substantiating occurrence of steels possessing true brittleness. (Continuation of serial.) Paper read before Instn. Mech. Engrs.

Steel, High Speed

The Properties of High Speed Steel, G. J. Horvitz. Iron Age, vol. 103, No. 26, June 26, 1919, pp. 1711-1714. 13 figs. Its metallography and heat-treatment; crucible and electric process in its production; effect of uranium; theory of hardening. Paper presented at New York chapter of Am. Steel Treaters' Soc.

Toughness

Static, Dynamic, and Notch Toughness, Samuel L. Hoyt. Iron & Steel of Can., vol. 2, no. 5, June 1919, pp. 126-131, 10 figs. A high degree of notch toughness to insure against failure is recommended because, it is said, that even a hasty examination of such machines as locomotives, automobiles, stationary gas engines, steam engines, etc., reveals an amazingly large number of notches.

MEASUREMENTS AND MEASURING APPARATUS

Abrasion Meters

The Abrasion Meter, Raymond Francis Yates. Sci. Am. Supp., vol. 87, no. 2267, June 14, 1919, pp. 372-373, 7 figs. Device for determining cutting efficiency of abrasive wheels.

Air Flow

The Determination of the Efficiency of the Turbo-Alternator, S. F. Barcay. Jl. Instn. Elec. Engrs., vol. 57, no. 281, Apr. 1919, pp. 293-304 and (discussion) pp. 305-314, 14 figs. Shows that actual losses on load can be deduced conveniently and accurately from measurements of cooling air flowing through alternator. It is further shown, however, that although such methods are sound in principle, misleading results may be obtained unless certain precautions are taken in applying them.

See also Air Machinery.

Flatness

Flatness Tests at Bureau of Standards, R. L. Rankin. Am. Mach., vol. 50, no. 26, June 26, 1919, pp. 1218-1220, 3 figs. Optical method based on principle of light interference.

Hardness

Methods of Testing for Hardness, Dean Harvey. Elec. Jl., vol. 16, no. 6, June 1919, pp. 264-266, 2 figs. Advantages and limitations of various test methods presented with suggestions for selecting test for given application.

Heat Penetration

Studies on Canning. An Apparatus for Measuring the Rate of Heat Penetration. W. T. Bovie and J. Bronfenbrenner. Jl. of Indus. & Eng. Chemistry, vol. 11, no. 6, June 1919, pp. 568-570, 5 figs. Apparatus consists of constant thermo-junction which is maintained at temperature of 0 deg. cent. and is located just outside of can.

Manometer

An Optical Lever Manometer, J. E. Shrader and H. M. Ryder. Physical Rev., vol. 13, no. 5, May 1919, pp. 321-327, 6 figs. Type devised for measuring vapor pressures in range between that which can be measured by Knudsen gage (0.001 mm) and ordinary mercury manometer.

Notched-Bar Impact Test

The Single Blow Notched Bar Impact Test as Used in the American Industry, E. H. Dix, Jr. Am. Soc. for Testing Materials, Univ. of Pa., annual meeting, June 24-27, 1919, 36 pp., 12 figs. Research conducted in effort to standardize tests. It was concluded that striking distance for Olsen and Izod machines should be made 0.866 in., and span of Charpy machine, 40 mm. (1.575 in.); no broad method of converting results of one machine from terms of another was found possible.

Pendulum Meters

Theory of the Aron Meter; A Note on the Effect of Impulsive Forces on Pendulums, H. G. Rowledge. Elecn., vol. 82, no. 22, May 30, 1919, pp. 622-624. Concludes that such errors as may arise by using a pendulum to measure an irregular attraction are compensatory, and that in a large number of periods the compensation, by the law of averages, tends to become exact, so that the time integral of the attraction is correctly registered by the oscillations of the pendulum.

Pitch, Apparatus to Determine Breaking Point of

Apparatus for Determination of Breaking Point of Pitches, H. E. Lloyd and P. P. Sharples. Am. Soc. for Testing Materials, Univ. of Pa, annual meeting, June 24-27, 1919, 8 pp., 3 figs. Metal hinge on which pitch cast in mold is placed, is bent while submerged in cold water at constant rate until pitch is fractured. Temperature of water is then raised and process repeated until no fracture occurs.

Prony Brakes

Construction and Dimensions of Prony Brakes (Ueber die Abmessungen und die Bauart von Bremszäumen), W. Wilke. Oelmotor, vol. 8, no. 3, Mar. 1919, pp. 57-65, 9 figs. Calculation of dimensions. Equations and curves. (To be continued.)

Pyrometer

Practical Fundamentals of a Pyrometer, W. A. Gatward. Jl. Am. Steel Treaters Soc., vol. 1, no. 5, Feb 1919, pp. 172-178, 3 figs. Suggests protecting couple from contamination from furnace gases or fumes and advises that most satisfactory leads are those made from same alloys as couple.

Refractometer

Refractometers. Nature, vol. 103, no. 2582, Apr. 24, 1919, pp. 145-147, 4 figs. Instrument as construed by firm of Zeiss and other types, such as the Pulfrich and the Bellingham & Stanley refractometers.

Spectrophotometer

A New Sector Spectrophotometer, Samuel Judd Lewis. Jl. Chem. Soc., vols. 115 & 116, no. 678, Apr. 1919, pp. 312-319, 2 figs. Apparatus designed with object of combining accuracy and refinement in resulting spectra and also to be able to use instrument alternately with photometer and for other purposes.

Steam Meters

Reduced Model of Steam Meter (Présentation d'un modèle réduit du compteur de vapeur), H. Parenty. Comptes rendus des Séances de l'Académie des Sciences, vol. 168, no. 17, Apr. 28, 1919, pp. 835-837, 2 figs. Further observations on the apparatus described in Comptes Rendus, vol. 168, 1919, p. 492.

Tile, Drain

An Investigation of Tests of Iowa Shale Drain Tile, W. J. Schlick. Off. Pub. Iowa State College of Agriculture, vol. 16, no. 43, Mar. 27, 1919, bul 49, 71 pp. 18 figs. Object was to determine best method for making actual accelerated freezing, thawing and absorption tests upon drain tile.

MECHANICS

Beams, Theory of Bending

The Stresses in Braced Structures with Rigid Joints, John Case. Flight, vol. 11, no. 22, May 29, 1919, pp. 704-706, 7 figs. Extends theory of bending of beam under combined action of lateral distributed load and longitudinal thrust to treatment, as complete unit, of braced structures with stiff joints.

New Method of Calculating Stresses in Continuous Beams (Nouvelle méthode de calcul et propriétés diverses des poutres à travées solidaires), P. Sonier. Génie Civil, vol. 74, no. 16, Apr. 19, 1919, pp. 312-315, 8 figs. Suggested modifications in graphical method.

Lines of Influence of a Continuous Girder on Three Supports (Die Einflusslinien des kontinuierlichen Tragers auf drei Stutzen), Ernst Laube. Schweizerische Bauzeitung, vol. 73, no. 20, May 17, 1919, pp. 225-227, 10 figs. Simple method for determining the lines of influence of continuous girders on three supports at different spans.

Joints, Pinned

An Investigation Into the Strength of Pinned Joints, V. C. Davies. Machy. (Lond.), vol. 14, no. 346, May 15, 1919, pp. 194-195, 4 figs. Results of tests on plain shafts.

Shafts, Whirling

The Whirling of an Eccentrically Loaded Overhung Shaft, S. Lees. Lond., Edinburgh, and Dublin Phil. Mag., vol. 37, no. 221, May 1919, pp. 515-523, 3 figs. Derivation of expression of kinetic energy and potential energy of system and subsequent application of Lagrange's equations.

The Whirling of an Airscrew Shaft, J. Morris. Flight, vol. 11, no. 21, May 22, 1919, p.

679, 1 fig. Technical determination of whirling speed in cases of uniform shaft and conically tapered shaft.

MECHANICAL PROCESSES

Adding Machine

A Mechanical Mathematician. Ellsworth Sheldon. Am. Mach., vol. 50, no. 25, June 19, 1919, pp. 1185-1188, 13 figs. Construction and assembling of Monroe machine. Second article.

Bearings, Roller

Making the Timken Roller Bearing, Edward K. Hammond. Machy. (N. Y.), vol. 25, no. 10, June 1919, pp. 953-956, 20 figs. Methods of heat-treating, machining and inspecting. Second article.

Clocks

Clock Escapements. Nature, vol. 103, no. 2582, Apr. 24, 1919, pp. 155-168, 3 figs. Description of various types and manner of overcoming sources of error.

Drill Chucks

Manufacturing a Drill Chuck, Fred R. Daniels. Machy. (N. Y.), vol. 25, no. 10, June 1919, pp. 948-952, 11 figs. "Etco" drill chuck manufactured by Eastern Tube & Tool Co. Main features are said to be that it may be operated without use of wrench and that it is self-tightening.

Engine Cylinders

Modern Methods of Making Motor Cylinders, Fred H. Colvin. Am. Mach., vol. 50, no. 23, June 5, 1919, pp. 1099-1103, 15 figs. Cylinder department of Locomobile Co where, it is said, handling has been reduced to a minimum.

Engine, Hispano-Suiza

The Hispano-Suiza Airplane Engine—I, H. O. C. Isenberg. Am. Mach., vol. 50, no. 26, June 26, 1919, pp 1213-1217, 16 figs. Process in manufacture followed at New Brunswick plant, Wright-Martin Aircraft Corp., especially in regard to securing accuracy.

Engines, Marine

Efficiency in Marine Engine Production, G. N. Somerville. Pac. Mar. Rev., vol. 16, no. 6, June 1919, pp. 83-87, 6 figs. Illustrating practice of various Pacific Coast shops.

Building Marine Engines on a Quantity Basis, F. B. Jacobs. Mar. Rev., vol. 49, no. 7, July 1919, pp. 338-343, 7 figs. Manufacturing operations on lighter units such as valve gear, bearings, air pump, crosshead, etc. (Continuation of serial.)

Files

Some Points in the Manufacture of Files—II, Geo. Taylor. Machy, (Lond.), vol. 14, no. 348, May 29, 1919, pp. 273-276, 14 figs., also Iron Age, vol. 103, no. 25, June 19, 1919, pp. 1631-1636, 9 figs. How to deal with four defects in grinding which are said to exercise a deletrious influence in cutting process. These are: (1) Surface of blank ground slightly concave, (2) slightly convex, (3) wavy appearance giving series of depressions, (4) surface covered with scratches due to course gritstone.

Gold Leaf

The Manufacture of Gold Leaf and Metal Foil, W. Theobald. Metal Industry, vol. 14, nos. 16 & 17, Apr. 18 & 25, 1919, pp. 321-324 and 341-346, 15 figs. Historical account of beating industry, based on series of articles appearing in Annalen für Gewerbe and Bauwesen.

Rolling-Mill Practice

Alloy Steels for Helmets and Armor, John A. Coyle. Chem. & Metallurgical Eng., vol. 20, no. 12, June 15, 1919, pp. 618-620, 1 fig. Details of electric furnace and rolling-mill practice.

Rolling of Beams Having Profiles Made Up of Three Elements Converging in a Point (Sur le calibrage des profils à trois branches convergent en un même point). Norbert Metz. Revue de Métallurgie, vol. 16, no. 2, Mar.-Apr. 1919, pp. 89-127, 38 figs. Analysis of methods given by various writers in France and Germany and exposition of method devolved by writer, in which he endeavors to simplify the determination of elongation coefficients.

Roofing Products

Manufacturing Brantford Roofing Products, J. H. Moore. Can. Machy., vol. 21, no. 22, May 29, 1919, pp. 537-541, 6 figs Plant, buildings and yard cover area of seven acres. Concern conducts its own forge shop, toolroom and steam-fitting department.

Spheres

Automatic Machines, H. E. Thomas. Page's Eng. Weekly, vol. 34, no. 768, May 31, 1919, pp. 297-298, 6 figs. Method for producing a sphere. (Continuation of serial.)

Springs

Spring Making on a Quantity Basis, F. B. Jacobs. Iron Trade Rev., vol. 64, no. 21, May 22, 1919, pp. 1343-1348, 13 figs. Methods of Raymond Mfg. Co., Ltd., Corry, Pa., in manufacture of various classes of springs.

Westinghouse Marine System

Building the Westinghouse Marine System. Edward K. Hammond. Machy. (N. Y.), vol. 25, no. 10, June 1919, pp. 929-937, 28 figs. At Westinghouse plant in South Philadelphia, Pa. Second article.

Wrenches

Making an Automobile Wrench in Two Operations, Hugo F. Pusen. Am. Mach., vol. 50, no. 24, June 12, 1919, pp. 1147-1148, 3 figs. Valuable feature in follow dies of this nature is system of sliding stops for guidance of stock until regular latch stop comes into action

MOTOR-CAR ENGINEERING

Brakes

Building the Westinghouse Marine System, C. Baker. Jl. Soc. Automotive Engrs., vol. 4, no. 6, June 1919, pp. 508-511, 2 figs. By means of brake-rod gage which consists of several interchangeable rods of various lengths, graduated every inch and operating through a dial gage that indicates lengthening or shortening of rods when placed by attachments in position of brake rods themselves.

Carburetors

The Godward Carburetter. Autocar, vol. 42, no. 1231, May 24, 1919, p. 787, 3 figs. Designed, it is said, to provide easy starting, flexibility, and economical running.

Car Performance

Research of Car Performance, P. W. Steelsmith. Mich. Technic, vol. 32, no. 2, May 1919, pp. 125-133, 9 figs. Tests conducted in accordance with standard rules of Society of Automobile Engineers.

Car-Speed Chart

Engine and Car Speed Chart. Motor Age, vol. 35, no. 23, June 5, 1919, p. 45, 1 fig. Chart to determine car speed in miles per hour when engine speed in revolutions per minute, high-gear reduction ratio and wheel diameter are known.

Exhaust

Odorless Exhaust Gases (Verusche zur Erzielung geruchloser Abgase), Praetorius. Motorwagen, vol. 22, no. 2, Jan. 20, 1919, pp. 28-30, 6 figs. Suggests passing gases through colcium chloride and then through quicklime. Describes apparatus used for this purpose.

Fans

Radiator Cooling Fans, George W. Hoyt. Jl. Soc. Automotive Engrs., vol. 4, no. 5, May 1919, pp. 335-339, 8 figs. Writer observes that no one unit can do all the engine cooling and suggests that manufactnrers of motor vehicles cooperate with accessory manufacturers to such an extent that the latter can help to solve mechanical difficulties.

Gasoline-Electric Cars

The Stevens Petrol-Electric Vehicle. Electrical Review (Lond.), vol. 84, no. 2164, May 16, 1919, pp. 557-559, 4 figs. Electrical generator of four-pole interpolar type is direct coupled by means of flexible coupling to the gasoline engine, which is fitted with centrifugal governor, adjustable as to speed by handwheel on middle of dashboard.

Governors, Speed

Variable Speed Governors, W. W. Wells. Jl. Soc. Automotive Engrs., vol. 4, no 5, May 1919, pp. 375-379, 7 figs. Description of tests made by Clyde Cars Co.

Tractor Engine Governors, G. L. Moyers. Jl. Soc. Automotive Engrs, vol. 4, no. 5, May 1919, pp. 364-366, 1 fig. Centrifugal and vacuum types.

Kardell

Kardell Utility Tractor. Automotive Industries, vol. 40, no. 22, May 29, 1919, pp. 1162-1163, 3 figs. A two-plow tractor designed to be also suitable for cultivation aud other farm work.

Speedometers

Temperature Control of A-C Speedometer. Automotive Industries, vol. 40, no. 23, June 5, 1919, pp. 1228-1229, 2 figs. Magnetic instrument fitted with thermostatic compensator.

Tractive Resistance

Tractive Resistances to a Motor Delivery Wagon on Different Roads and at Different Speeds, A. E. Kennelly and O. R. Schurig. Mass. Inst. Technology, bul no. 10, June 1916, pp. 1011-1039, 19 figs. Also Am. Inst. Elec. Engrs., 33rd Annual Convention, June 30, 1916, bul. Investigation with wagon equipped with solid rubber tires: (1) overall efficiency of truck mechanism and (2) tractive resistance of a number of typical urban roads.

Tractors

Motor Plows, Tractors, etc., in Switzerland (Erprobung landwirtschaftlicher Maschinen in der Schweiz). Allgemeine Automobil-Zeltung, vol. 20, no. 1, Jan 5, 1919, pp. 6-12, 5 figs. Competitve tests of American and Swiss makes held at Orbe, Switzerland. Official figures of results.

Small Motors for Agricultural Purposes (Der Kleinmotor), Max Apel. Motorwagen, vol. 22, no. 4, Feb. 10, 1919, pp. 62-72, 16 figs. Points of design based on study of nature of work to be performed by machine as tractor, cultivation machine, or machine for driving others.

The Principles of the Wheeled Farm Tractor, Edward R. Hewitt. Gas Engine, vol. 21, no. 6, June 1919, pp. 182-185, 3 figs. Laboratory tests checked with work on machine in the open are said to have demonstrated that the maximum drawbar pull is a definite function of the weight per inch of width, amount available on sandy ground with a smooth metal wheel being about 30 per cent of weight on wheel when soil is dry and about 43 per cent when it is damp.

Farm Tractor Design—I & II, Joseph Jandasek. Automotive Industries, vol. 40, no. 24 & 25, June 12 & 19, 1919, pp. 1265-1273 & 1406-1407, 10 figs. Examples of calculations preceding design. Tabulated data on power requirements, soil packing and other items.

Agricultnral Motor Tractors, G. Hildick-Smith. Jl. of Chem., Metallurgical & Min. Soc. of South Africa, vol. 19, no. 10, Apr. 1919, pp. 195-200, 3 figs. Notes on work and organization of Technical Section of Food Prodnction Dept., England.

Tractor, Drawbar Location on

The Influence of Hitches and Drawbar Location on Tractor Design, A. W. Scarratt. Automotive Industries, vol. 40, no. 24, June 12, 1919, pp. 1334-1335 and 1359, 2 figs. Method of calculating weight required on front wheels to prevent rearing of tractor under full load on level or steep grades.

Trucks

Motor Lorry Design. Times Eng. Supp., vol. 15, no. 535, May 1919, p. 157. Lessons to be drawn from experience under war conditions as to construction of chassis of motor lorries; present article deals with engine and transmission gear.

Voisin

Voisin's Initial Chassis, W. F. Bradley. Automotive Industries, vol. 40, no. 22, May 29, 1919, pp. 1178-1179, 4 figs. Four-cylinder, 30-hp. Knight engine car, built in small volume with view to increasing quality.

War Vehicles

Utilization of War Vehicles for Industries and Agricultural Purposes (Was können die aus dem Kriege zurückkehrenden Feldkraftwagen für Industrie und Landwirtschaft leisten), P. Sauio. Motorwagen, vol. 22, no. 5, Feb. 20, 1919, pp. 84-85. Directs attention to the fact that rail and railless vehicles of all kinds will have received such rough usage at the front, improper treatment through overloading, and bad handling and use of unsuitable materials in their manufacture that many of them will be unsuitable for civil purposes.

The Employment of Motor Trucks After the War—I & II (Zur Frage der Verwendung von Motorlastwagen nach dem Kriege), Th. Wolff. Zeitschrift für Transportwesen & Strassenbau, vol. 35, nos. 35 & 36, Dec. 10 & 20, 1918, pp. 412-416 and 426-431. Discusses advantages of motor trucks for various industrial purposes.

POWER GENERATION

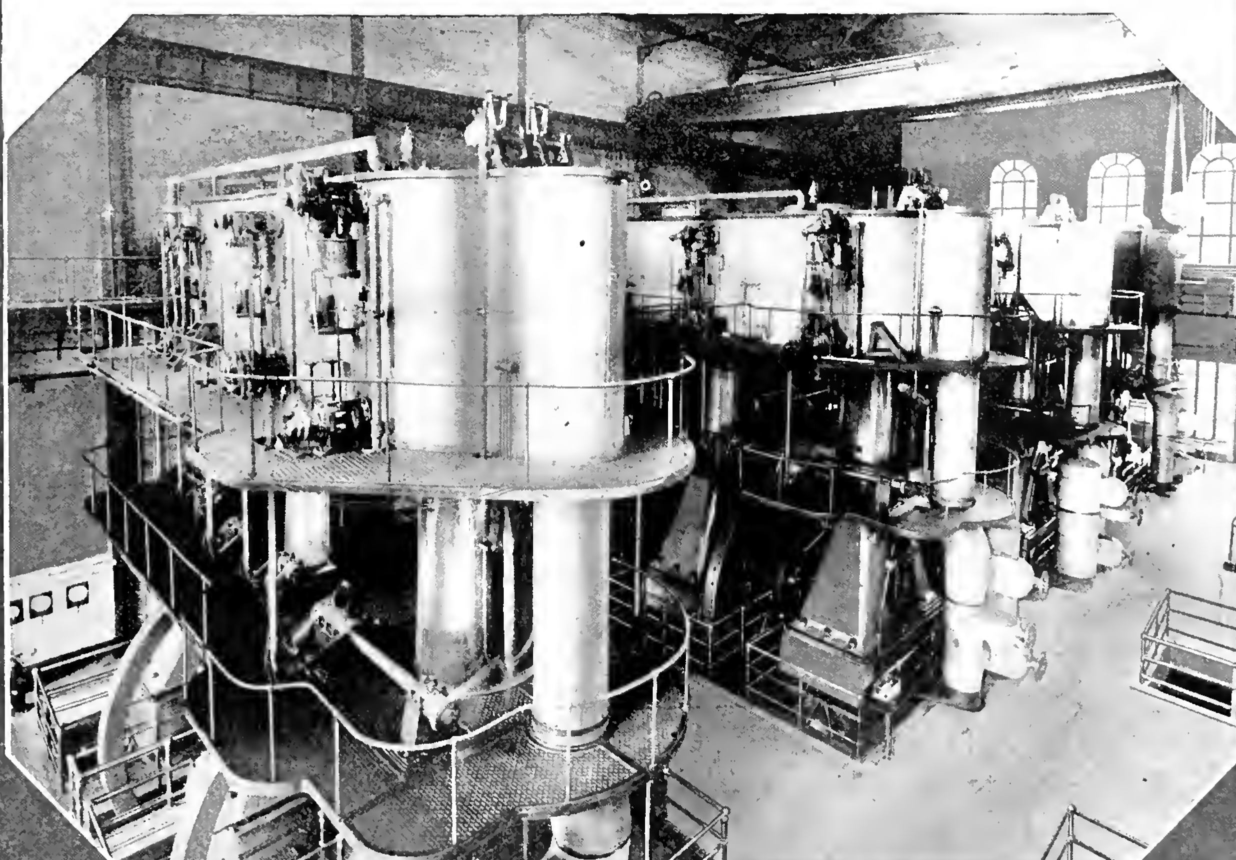
Canada

Hydro-Electric Development on Nipigon River. Can. Engr. vol 36, no. 24, June 12, 1919, pp. 529-531, 8 figs. Reported that Hydro-Electric Power Commission of Ontario will install five units, totaling 60,000 hp., at Cameron's Pool. A concrete dam 200 ft. long, 43 ft. high, is to be erected.

France

Intended Legislation on Water Power in France (Le nouveau pojet de loi sur les force hydrauliques). Houille Blanche, vol. 18, nos. 27-28, Mar.-Apr. 1919, pp. 41-46. Concerning state control of hydraulic energy developments.

Pumping Engine, Four Vertical Triple Expansion Units, for the Ridgewood Pumping Station, Brooklyn, New York



Great Britain

Electrical Energy from the River Dee. Engineer, vol. 127, no. 3309, May 30, 1919, pp. 524-526, 3 figs. Diagrams and plans of proposed utilisation of river between Llangollen and Chester.

The Supply of Electricity, John Somerville Highfield. Jl. Roy. Soc. Arts, vol. 67, no. 3469, May 16, 1919, pp. 408-420 and (discussion), pp. 420-424. Analysis of reports of Coal Conservation Sub-Committee, Elec. Trades Committee and Elec. Power Supply Committee, with tables showing amounts of capital expenditure and gross profits in various company- and municipally-owned electricity undertakings.

Isolated Plant

Effect of the War Upon Isolated Plant Costs. Elec. Rev., vol. 74, no. 25, June 21, 1919, pp. 1024-1027, 2 figs. Comparison of expenses of central station and isolated plant.

Niagara Falls

Structural Details of Plant Extension at Niagara Falls. Elec. Rev., vol. 74, no. 25, June 21, 1919, pp. 1028-1033, 9 figs. Addition of 40,000 hp. which involved construction of conduit 13.5 ft. in diameter.

Regional Planning of the Niagara District, Thomas Adams. Contract Rec., vol. 33, no. 25, June 18, 1919, pp. 563-566. Question examined from viewpoint of (1) industrial development, (2) economic use and regulation of sub-division of land and character and density of structures in rural and urban areas, (3) housing, sanitation, convenience and amenity (4) transportation—railways, highways and waterways, (5) sources and distribution of power, (6) water supplies and sewerage, (7) general amenities—including parks and boulevards and development of tourist facilities.

Norway

Hydroelectric Power Station near Hardanger, Norway (Storindustrien paa Vestlandet). Teknisk Ukeblad, vol. 66, no. 17, Apr. 25, 1919, pp. 211-212, 3 figs. Project for installing machinery to utilize 25,000 hp. out of 75,000 hp. available at Osa waterfalls.

Industrial Development in Norway (Den nye Tid i Norge. Nogen Track av det industrielle Gjennembrudds Historie). Teknisk Ukeblad, vol. 66, no. 18, May 2, 1919, 223-229, 14 figs. Figures showing effect of harnessing waterfalls.

Spain

Water Power Utilization in Spain (Salto de agua "Ribadelago" en el rio Tera), B. Oliver y Román. Revista de Obras Publicas, vol. 67, no. 2276, May 8, 1919, pp. 218-229, 3 figs. on supp. plate. Project to utilize 1880-ft. waterfall.

United States

The Energy Resources of the United States; A Field for Reconstruction, Chester G. Gilbert and Joseph E. Pogue. Smithsonian Instn., U. S. Nat. Museum, bul. 102, vol. 1, 1919, 165 pp., 23 figs. Extended discussion of coal and water as sources of power and their present utilization in the U. S. A. Claimed need of (1) provision of common-carrier system for transmission of electrical energy and (2) application of constructive economic policy to conditions surrounding petroleum.

Water-Power Legislation

Need for and Status of Water Power Legislation. Elec. Rev., vol. 74, no. 22, May 31, 1919, pp. 893-894. Summary of situation prepared by Nat. Service Committee of Eng. Council.

Wisconsin River

Hydroelectric Development on Wisconsin River at Stevens Point, William F. Snyder. Elec. Rev., vol. 74, no. 22, May 31, 1919, pp. 881-884, 7 figs. Flow of Wisconsin River is used as effective head of 14 ft. A total of 5700 hp. made up of six 950-hp. hydraulic turbines of the vertical type is comprised.

Zinc Industries

Conditions in Electrometallurgical and Electrochemical Zinc Industries (L'état actuel des industries électrométallurgique et électrochimique du zinc), M. Lemarchands. Houille Blanche, vol. 18, nos. 27-28, Mar.-Apr. 1919, pp. 46-53. In England, France and the U. S., both before the war and at present. Opinions of various writers in regard to advantages secured by utilizing hydraulic energy in zinc industries are presented.

PIPE

Concrete

Reinforced-Concrete Pressure Pipe for Hydroelectric Plants (In Japanese), A. Inokuty. Denki Gakkwai Zasshi, no. 370, May 10, 1919.

See also CIVIL ENGINEERING, Sanitary Engineering (Sewer Pipe.)

Sewer Pipe

See CIVIL ENGINEERING, Sanitary Engineering (Sewer Pipe.)

POWER PLANTS

Boiler Operation

The Practical Operation of Industrial Boilers, W. E. Snyder. Proc. Engrs. Soc. Western Pa., vol. 35, no. 2, March 1919, pp. 59-101 and (discussion) 101-116. With regard to safety and economy. A manual of instruction for boiler foremen is suggested.

Boiler Troubles; Their Origin and Remedy, T. H. Fenner. Power House, vol. 12, no. 7, May 20, 1919, pp. 183-186, 5 figs. Note on pitting, grooving and external corrosion.

Boiler Room

Improving Operation in Typical Industrial Plant Boiler Room, J. T. Beard, Jr. Power, vol. 49, no. 25, June 24, 1919, pp. 967-969, 6 figs. Replacing the pinhole grate with grate of proper design for coal to be burned; installing uptake dampers and operating them by hand independent of other regulators, and other similar changes.

Boiler Furnaces and Boiler Furnace Design, D. S. Jacobus. Stevens Indicator, vol. 36, no. 1, Jan. 1919, pp. 1-10. Recommend avoiding construction in which brickwork is heated on both sides when under too great stress; also torch-like action of flames on walls. Paper presented at Phila. Conv. of Am. Boiler Mfrs. Assn.

Boiler Room of the Sheet Metal Products Co, Ltd., W. F. Sutherland. Power House, vol. 12, no. 9, June 20, 1919, pp. 245-247, 5 figs. With reference to efficiency of operation.

Combustion Control

Combustion Control in Mill Boiler Plant—I, Robert June. Blast Furnace & Steel Plant, vol. 7, no. 6, June 1919, pp. 274-276, 2 figs. Analysis of causes of losses.

Condensers

Parkersburg Station, Monongahela Valley Traction Co. Power Plant Eng., vol 23, no 13, July 1, 1919, pp. 575-578, 8 figs. Condenser pit provided in which circulating system operates as a syphon.

Dominion Power Co.

Steam Electric Plant of the Dominion Power and Transmission Company, Hamilton—II. Elec. News, vol. 28, no. 11, June 1, 1919, pp. 28-30, 3 figs. Description of turbines and auxiliary steam equipment.

Electrical Equipment

Electrical Equipment in a Model Y. M. C. A. Building. Elec. Rec., vol. 25, no 6, June 1919, pp. 365-367, 4 figs. Brooklyn, N. Y., central building. Generating equipment includes two 200-kw. and one 75-kw. d.c. machines driven by side-crank reciprocating steam engines. B. & W. water-tube boilers supply steam for operating engine.

Improvements in Industrial Plant Operation, E. F. George. Elec. World, vol. 73, no. 23, June 7, 1919, pp. 1207-1209, 2 figs. Methods of electrical construction and operation at plant of Lodge & Shipley Machine Tool Co., Cincinnati.

Exhaust Utilization

The Contrallo System of Utilizing Exhaust. Mar. Eng., vol. 9, no. 6, June 1919, pp. 209-211, 4 figs. Illustrating various arrangements of system.

Hydraulic Operating Board

Operation at Holtwood—Features of Station Operation and Maintenance, Charles H. Bromley. Power, vol. 49, no. 23, June 10, 1919, pp. 892-896, 9 figs. Hydraulic operating board which indicates operation of pumps, governor valves, etc., is located on turbine-room floor and is visible to switchboard operator.

Ice Difficulties

Operation at Holtwood, Charles H. Bromley. Power, vol. 49, no. 22, June 3, 1919, pp. 850-854, 4 figs. Handling ice difficulties at plant.

Instruments

Boiler and Turbine Room Instruments. Power Plant Eng., vol. 53, no. 13, July 1, 1919, pp. 786-588, 2 figs. Their value in maintaining high degree of operating efficiency. From report of Committee on Prime Movers, presented at convention of Nat. Elec. Lighting Assn.

Johns Hopkins University

Mechanical Equipment at Johns Hopkins University, Julian C. Smallwood. Power, vol. 49, no. 21, May 27, 1919, pp. 811-814, 7 figs. Power plant designed with view to providing economical and continued service, and also facility for undergraduate experimentation and means for research, usual and special.

Muscle Shoals Plant

United States Nitrates Plant No. 2, Muscle Shoals, Am.—Station Heat Balance, Edward R. Welles and H. C. Lockwood. Power, vol. 49, no. 21, May 27, 1919, pp. 802-805, 8 figs. Hotwell water, which varies between 80 and 100 deg. fahr. used for cooling lubricating oil for main turbine. This turbine is of 60,000 kw. continuous capacity and is electrically in parallel with two noncondensing house turbines, which furnish power for driving auxiliaries.

Starting and Stopping Large Units

Operation at Holtwood, Charles H. Bromley. Power, vol. 49, no. 25, June 24, 1919, pp. 973-976, 6 figs. Procedure and precautions used in starting and stopping large main units.

Steam Traps

Notes on Steam Traps, F. G. Hechler. Jl. Am. Soc. Naval Engrs., vol. 31, no. 2, May 1919, pp. 430-437, 1 fig. Insisting upon regular inspection of all traps is advised.

Universal Portland Cement Co.'s Plant

Universal Portland Cement Co.'s Largest Plant, William B. Eastwood. Cement, Mill & Quarry, vol. 14, no. 11, June 5, 1919, pp. 17-19, 2 figs. Waste-heat power plant consists of 12 Babcock & Wilcox boilers, each individually fed with waste gases from rotary kilns.

POWER TRANSMISSION

Belting

Proper Use and Care of Leather Belting, Guy B. Smith, Cement, Mill & Quarry (Belting Section), vol. 14, no. 11, June 5, 1919, pp. 13-15, 1 fig. Contends that slippage is due chiefly to incorrect choice and an improper width of belt, undersized pulleys, poor alignment, insufficient precautions against oil from leaky bearings and use of poor belt dressings.

PRODUCER GAS

Gas Producers

Recent Development in Gas Producers (Ueber Gaserzeuger und ihre neuste Entwicklung), Dr Markgraf. Technische Blätter, vol. 9, nos. 13-13, Mar. 31, 1919, pp. 60-62, 4 figs. Historical review of use of gas for technical purposes. According to writer, so far the hope to use low-grade fuels has not been realized and the best fuel at present for revolving grates is washed nut coal. (To be continued.)

PUMPS

Bilge Pumps

Turbine-Driven Pipeless Salvage Bilge Pumps. Engineering, vol. 107, no. 2787, May 30, 1919, pp. 698-700, 8 figs. Vertical standard type with capacity of 1000 tons of water per hour.

Centrifugal Pumps

Steam Turbine-Driven Centrifugal Pumps. Fire & Water Eng., vol. 65, no. 23, June 4, 1919, pp. 1392-1393, 3 figs. Considered as advantageous for city water supply.

Design of Motor-Driven Centrifugal Pumps, A. T. Clark. Can. Engr., vol. 36, no. 25, June 19, 1919, pp. 548-549, 5 figs. Characteristic curves for different types under identical conditions.

Gear Reduction Drive

Helical Gears Solve Cornwall's Pumping Problem, R. N. Austin. Can. Engr., vol. 36, no. 23, June 5, 1919, pp. 507-509, 5 figs. High-speed single-stage centrifugal pumps are driven by low-speed hydraulic turbines, with pumping efficiency of 73 per cent including gear loss.

Louisville

Louisville's New Pumping Station. Mun. Jl. & Public Works, vol. 46, no. 23, June 7, 1919, pp. 398-402, 8 figs. Latest increase said to be 30,000,000 gal. vertical, triple flywheel pump.

Rotary Fire Pump

New Type Rotary Fire Pump. Fire & Water Eng., vol. 65, no. 25, June 18, 1919, pp. 1546-1547. With lateral intake and discharge and hardened steel pilot gears.

Salvage Pumps

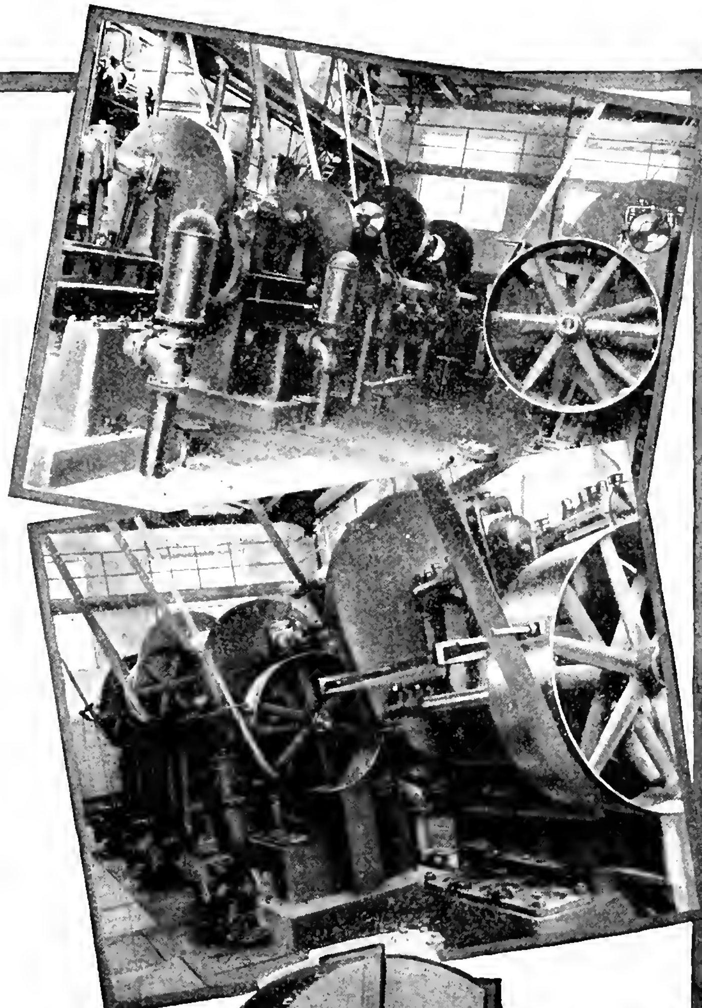
See Bilge Pumps.

San Francisco

San Francisco Pumping Stations, Charles W. Geiger. Power Plant Eng., vol. 23, no. 12, June 15, 1919, pp. 527-536, 7 figs. Details of two so-called earthquake-proof salt-water pumping stations.

16 GOULDS PUMPS

in the Minnequa Coke Plant of the Colorado Fuel & Iron Co.



A striking illustration of the great popularity of Goulds Pumps with large industrial organizations is the pumping equipment of the Minnequa Works of the Colorado Fuel & Iron Co. at Pueblo. Sixteen "Goulds" are operated for various purposes.

Three Fig. 1128, size 12 x 12, Triplex Pumps pump tar over ovens; a Fig. 1694, size 8 x 10 Triplex pumps tar to cars; three Fig. 1694, size 7 x 10, Triplex pump liquor to tanks and stills; two Fig. 3030, Centrifugals size 5 S, lift water to tank; three Fig. 3011, Centrifugals, size 2, pump lime water to tanks; and three Fig. 3030, size 6 S, and two Fig. 3030, size 5 S, recirculate water over cooler towers and gas coolers.

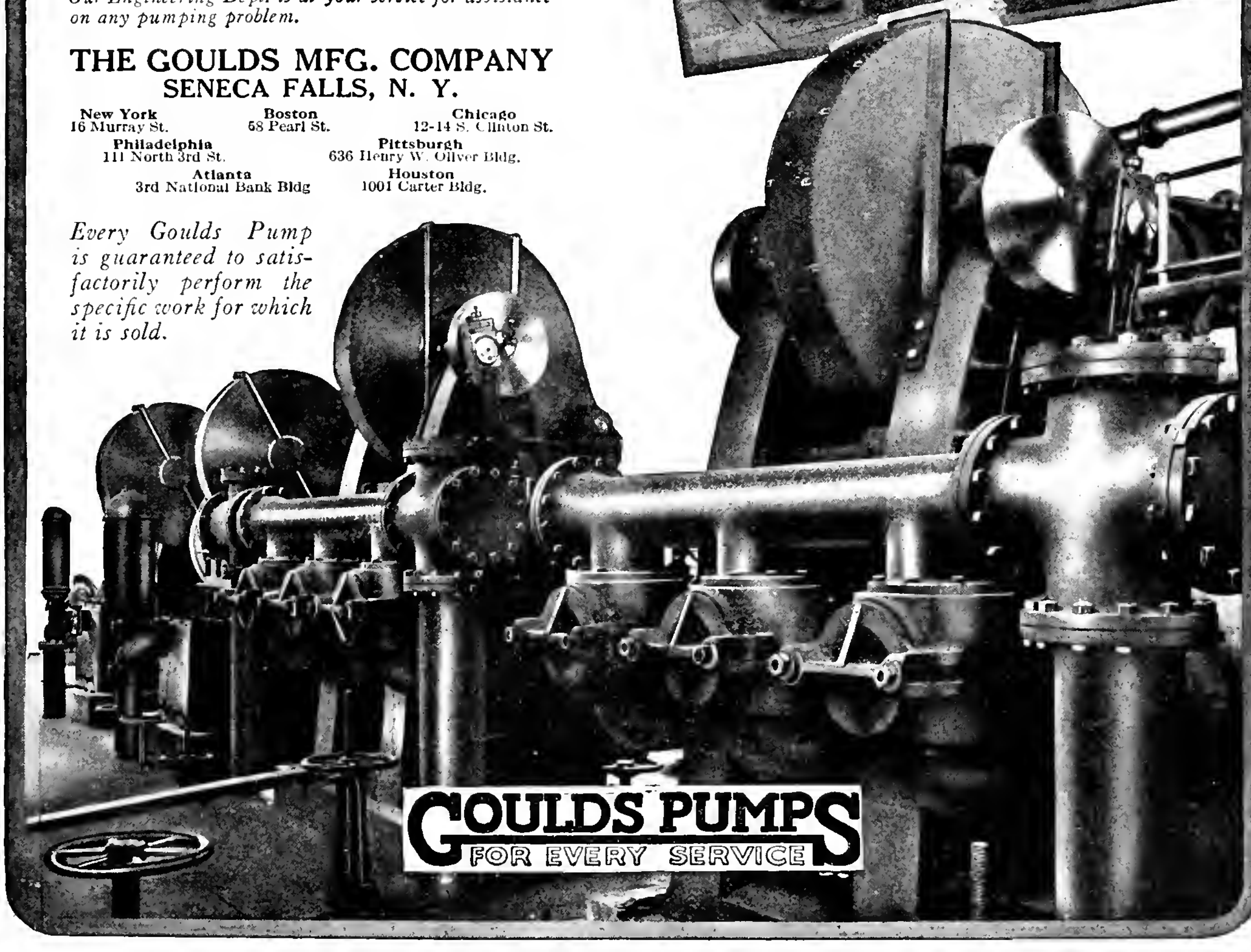
Goulds Pumps are built in many types and sizes—there is a Goulds Pump of remarkable efficiency for every pumping purpose.

Our Engineering Dept. is at your service for assistance on any pumping problem.

THE GOULDS MFG. COMPANY
SENECA FALLS, N. Y.

New York 16 Murray St. **Boston** 68 Pearl St. **Chicago** 12-14 S. Clinton St.
Philadelphia 111 North 3rd St. **Pittsburgh** 636 Henry W. Oliver Bldg.
Atlanta 3rd National Bank Bldg **Houston** 1001 Carter Bldg.

Every Goulds Pump is guaranteed to satisfactorily perform the specific work for which it is sold.



Toronto Waterworks

Main Pumping Station Toronto Waterworks, W. F. Sutherland. Power House, vol. 12, no. 7, May 20, 1919, pp. 177-182, 10 figs. Present capacity is 200,000,000 gal. per 24 hr.

REFRACTORIES

Dolomite

Experiments in Dead-Burning Dolomite, H. G. Schurecht. Jl. Am. Ceramic Soc., vol. 2, no. 4, Apr. 1919, pp. 291-305, 13 figs. Roll scale reported to have been found very effective in dead-burning dolomite without decreasing its refractoriness too much.

Firebrick

Firebrick-Manufacture and Use, W. H. Grant. Can. Manufacturer, vol. 39, no. 6, June 1919, 23-25. Particularly in steel and clay-products industries.

Porcelain

The Comparative Value of Kneading and Pugging in the Preparation of Porcelain Bodies, L. E. Barringer. Jl. Am. Ceramic Soc., vol. 2, no. 4, Apr. 1919, pp. 306-312, 2 figs. Results of tests are claimed to demonstrate that the center of pug-mill blank contains more air than the edge, this being due to greater pressure on blank where it comes in contact with die.

Some Physical Properties of American Commercial Porcelain Bodies, J. W. Wright and S. I. Sewell. Jl. Am. Ceramic Soc., vol. 2, no. 4, Apr. 1919, pp. 282-290, 3 figs. Numerical results obtained from determination made upon commercial bodies.

Zirconia

Fused Zirconia—The New Refractory, A. J. Franklin. Metal Industry, vol. 14, no. 20, May 16, 1919, pp. 401-402. Analysis of various varieties of Brazilian baddelyite and bibliography of zirconia including principally articles published in German magazines.

REFRIGERATION

A. E. F. Refrigerating Plant

Refrigerating Plant No. 1, American Expeditionary Forces, John V. Fisher. Power, vol. 49, no. 24, June 17, 1919, pp. 920-922, 7 figs. Capacity of 600-ton.

Refrigeration for the Army, L. R. Phillips. Ice & Refrigeration, vol. 56, no. 6, June 1919, pp. 369-375, 14 figs. Ice-making and cold-storage plants erected in France. Also plants erected at cantonments, notably one with large freezer capacity at Chicago.

Abattoir

The Municipal Abattoir of the City of Reichenberg (Der städtische Schlachthof in der Stadt Reichenberg). Zeitschrift für Eis-und Kälte-Industrie, vol. 11, no. 8, Feb. 1919, pp. 113-116, 3 figs. Total area occupied is 29,400 sq. m., of which 8,730 sq. m. is used for stock yards.

Code, Refrigerating

Tentative Refrigerating Code. Refrigerating World, vol. 54, no. 6, June 1919, pp. 11-14, 2 figs. For Municipal and State Regulations for refrigerating machines and refrigerants proposed by Refrigerating Regulations Committee and approved by Council of the A.S.R.E.

Marine Refrigeration

Notes on Marine Refrigeration, A. H. Baer. Am. Soc. Refrig. Engrs., vol 5, no. 5, March 1919, pp. 383-386. Results obtained by the Government.

Williams Refrigerating Machine

The Williams Refrigerating Machine, Wm. L. DeBaufre. Jl. Am. Soc. Naval Engrs., vol. 31, no. 2, May 1919, pp. 454-469, 10 figs. Test to determine capacity under various temperatures of refrigeration, also to note general operating characteristics and durability of parts.

RESEARCH

Industrial Laboratories

Lynite Laboratories of the Aluminum Castings Company Embody Most Progressive Ideas and Up-to-Date Equipment in the Field of Industrial Research. Aerial Age, vol. 9, no. 14, June 16, 1919, pp. 678-683, 11 figs. Organization and work undertaken by the three sections—research, development and technique—into which laboratory is divided.

Furnace Manufacturers' Research Plant. Metal Worker, Plumber & Steam Fitter, vol. 91, no. 23, June 6, 1919, pp. 727-729, 6 figs. Investigation at University of Illinois Engineering Experiment Station for which Nat. Warm Air Heating & Vantilating Assn. appropriated $8000 at its 1918 convention.

Works Laboratory Organization, J. E. Hurst. Foundry Trade Jl., vol. 21, no. 208, Apr. 1919, pp. 224-227, 1 fig. Chart of principal technical departments of a modern engineering works, showing relationship between scientific and production department. Paper read before Lond. Branch British Foundrymen's Assn.

Municipal Testing Laboratories

The Organization of a Standard Municipal Testing Laboratory, J. C. Preston. Can. Engr., vol. 36, no. 23, June 5, 1919, pp. 520-522, also Eng. & Contracting, vol. 51, no. 23, June 4, 1919, pp. 592-594, 1 fig. It is concluded that standard testing laboratory is an economical investment for any municipality, that its field or service is of almost unlimited expansion. Concluded in Can. Engr. from May 22 issue.

Naval Research

Naval Research, C. S. McDowell. U. S. Naval Inst. Proc., vol. 45, no 196, June 1919, pp. 895-908. List of problems in which it is considered desirable to undertake research work and enumeration of advantages

Norway

Christiania Experimental Testing Station (Kristiania Materialproveanstalt). Teknisk Ukeblad, vol. 66, no. 16, Apr. 18, 1919, pp. 204B-204D. Applications for tests on strength of metals, wood, rope and belts, and on building materials totalled 984 for 1917-1918. Instances are quoted indicating nature of tests required. (To be continued.)

Switzerland

Mechanical, Physical and Chemical Testing Laboratory of the Engineering School at Lausanne (Le laboratoire d'essais mécaniques, physiques et chimiques de l'École d'ingénieurs de l'Université, à Lausanne). Bul. Technique de la Suisse Romande, vol. 45, no. 9 & 10, May 3 & 17, 1919, pp. 79-81, 489-91, 47 figs. Compression press with capacity of 150 tons built similarly to tension machine described in preceding installment. Description of Amsler pendulum dynamometer. (Continuation of serial.)

STANDARDS AND STANDARDIZATION

German Motor Industry

Standardization and Specialzation in the German Motor Industry (Normalisierung-Spezialisirung), B. von Lengerke, Motorwagen, vol. 22, no. 3, Jan. 31, 1919, pp. 50-51. Although regarding outlook as rather dark for motor industry, writer thinks position could be improved by adopting American methods of quantity production.

Plate Industry, Steel

Features of the Steel Plate Industry. Raw Material, vol. 1, no. 4, June 1919, pp. 206-212, 7 figs. Guides to specification of various grades of plates and advice concerning specifications necessary to obtain solid homogeneous metal free from defects.

Quarry Products

Standardizatoin of Quarry Products (Die Normung der Steinbruchserzeugnisse), Freystedt. Zeitschrift für Tranportwesen & Strassenbau, vol. 36, no. 7, Mar. 1, 1919, pp. 75-84. From the viewpoint of the quarry operator. Tables of standard sizes.

Threads, Pipe and Screw

New Series of Pipe and Screw Threads. Jl. Soc. Automotive Engrs., vol. 4, no. 5, May 1919, pp. 358-360, 1 fig. Tables giving standards proposed by Nat. Screw Thread Commission.

STEAM ENGINEERING

Boiler Baffling

Suggestions for Correct Boiler Baffling, A. D. Williams. Blast Furnace & Steel Plant, vol. 7, no. 6, June 1919, pp. 283-286, 10 figs. Regulating gas velocity to permit maximum heat transfer.

Boiler Heads

Alignment Charts for Finding the Dimensions and Volumes of Bumped Heads, C. H. Berry. Power, vol. 49, no. 24, June 17, 1919, pp. 926-927, 5 figs. Deals in diameter, radius of spherical surface and height of bump.

Boiler Setting

Suspension and Concrete Setting of Boilers at the Robert Gair Plant, Brooklyn. Power, vol. 49, no. 24, June 17, 1919, pp. 934-935, 2 figs. Building columns, and boiler-support columns, will be exposed to furnace temperatures.

Compound Engines

The Design of Compound Engines, F. S. Bauer. University of Colorado, Jl. of Eng., vol. 15, no. 3, Apr. 1919, pp. 25-37, 2 figs. Curves showing relations between absolute boiler pressure and cylinder-volume ratio, total ratio of expansion and receiver pressure of various back-pressures.

Turbines

Westinghouse-Rateau Marine Geared Turbines. Engineering, vol. 107, no. 2786, May 23, 1919, pp. 666-668, 6 figs., partly on two separate plates. Turbine consists of independent high and low pressure cylinders, giving 2,500 shaft hp. Steam is supplied from three single-ended marine type boilers, 15 ft. in diameter, and 11 ft. 9 in. long.

Steam Turbine Reviewed Historically—II. Universal Engr., vol. 29, no. 3, Mar., 1919, pp. 29-45, 25 figs. Governor control employed by Westinghouse Co. Arrangement developed for automatic operation of bypass valves to enable turbine to carry heavy overloads.

Turbine Blade Fastenings—II. Mech. World, vol. 65, no. 1692, June 6, 1919, pp. 271-272, 7 figs. Blading reaction turbines in segments. (Continuation of serial.)

Uniflow Engines

Modern Advancement in Steam Prime Movers, E. H. Beckstrand. Utah Soc. Engrs., vol. 5, no. 3, Mar. 1919, pp. 45-54. Believes that prime mover best adapted to high pressure end of steam diagram would be Uniflow engine with poppet valves.

The "Uniflow" Pumping Engine, D. A. De Crow. Can. Engr., vol. 36, no. 25, June 19, 1919, pp. 557-558, 2 figs. Claims simplicity of construction, low cost of production as compared with compound and triple-expansion reciprocating pumping engines, and economy in use of steam. Paper read at convention of Am. Water Works Assn.

THERMODYNAMICS

Heats of Fusion, Latent

A Note on Latent Heats of Fusion and their Relation to Molecular Composition, Harbord George Wayling. Lond., Edinburgh, and Dublin Phil. Mag., vol. 37, no. 221, May, 1919, pp. 495-497. Expressing Trouton's rule as ratio of product of latent heat of fusion by molecular number, to melting point on absolute scale, writer finds that for several compounds this ratio is equal to number of atoms in molecule.

WELDING

Acetylene Generating Plant

Acetylene Generating Plant for Large Welding Shops. Acetylene & Welding Jl., vol. 16, no. 188, May, 1919, pp. 93-94, 1 fig. It consists of seven generators, gas collector, moisture separator, two condensers, gasometer capable of storing 350 cu. ft. of gas and four large purifiers with bypasses for working in pairs.

Acetylene Welding

Acetylene Welding. Ry. Jl., vol. 25, no. 6, June, 1919, pp. 18-19. Committee report before Master Boiler Makers' Assn.

Great Britain's Acetylene Welding Industry—its Birth, Growth and War Record, Norman MacLeod. Jl. Acetylene Welding, vol. 2, no. 12, June, 1919, pp. 601-606, 8 figs. Founding of Northern Polytechnic Inst., and featuring courses in autogenous welding. Among samples of welding applications, the reconstruction of a bomb dropped in London by a German zeppelin is described.

Shutdown of Great Steel Plant Avoided by Oxwelding, L. M. Malcher. Jl. Acetylene Welding, vol. 2, no. 12, June, 1919, pp. 611-614, 5 figs. Repairing wrecked low-pressure cylinder which was cracked at head end in seven different places.

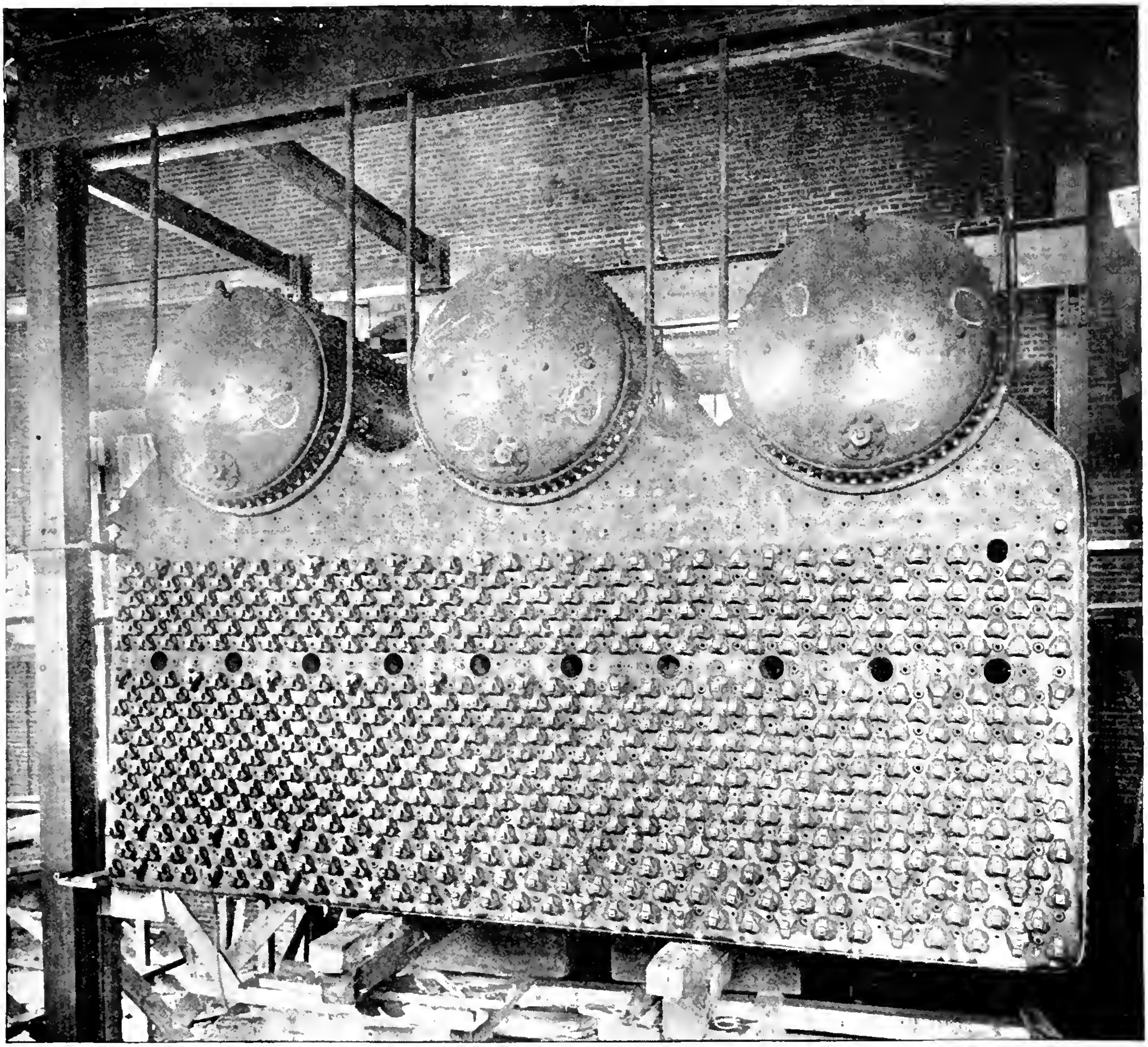
A Difficult Cylinder Bloc Job, David Baxter. Jl. Acetylene Welding, vol. 2, no. 12, June, 1919, pp. 607-610 & 622, 10 figs. Presented as case in which welding operator was handicapped by intense heat radiating against tip at close quarters from every direction and very limited space in which to manipulate.

Notable Repairs on Large Cylinder by Oxy-Acetylene Welding, L. M. Malcher. Pac. Mar. Rev., vol. 16, no. 6, June, 1919, pp. 104-105, 4 figs. Cylinder of Allis-Chalmers twin compound reversing engine, 70 in. diameter, badly fractured. Cost of repair estimated about one-third of that of a new cylinder.

Welding by the Oxy-Acetylene Method—III, J. F. Springer, Automobile Eng., vol. 4, no. 5, May, 1919, pp. 238-239, 2 figs. Examples of successful welds in cast-iron frames, with remarks on methods of making welding groove and filling it with new metal.

Aluminum Welding

The Vertical Welding of Aluminum. Acetylene & Welding Jl., vol. 16, no. 188, May, 1919, pp. 94 & 99, 2 figs. Tests made on sheet aluminum of 11 and 14 gage.



1000 H. P. HEINE BOILER

For Walter Reed Hospital, Washington, D. C.

During the war the entire force and plants of the Heine Safety Boiler Co. gave full service to Uncle Sam. We closely approached the half million h.p. production mark.

Today, we are far from idle. We are furnishing boilers for hospitals. We are doing everything in our power to care for our wounded boys. We are building boilers for ships to bring our boys home, and to assist Uncle Sam in the forthcoming commercial struggle.

The three-drum Heine boiler shown above and now being installed, contains 580 tubes, is 18 ft. long, and is built for a working pressure of 200 lb. per square inch. It is being set 10 feet high. The furnace, which is 17 ft. 10 in. wide, will be fed by a Westinghouse stoker. Both front and rear are supported from overhead. The method of supporting the front is clearly shown.

Note the one-piece header and the large throat connections made with the drums allowing abundant space for free and complete circulation. The Heine boiler does not contain small passages which restrict the flow of mixed water and steam to or from any tubes.

If in the market for a boiler you should study the merits of all constructions. Our treatise—"Boiler Logic" discusses these details. Write for a copy giving your position or responsibility.

Heine Safety Boiler Co.
5321 Marcus Avenue
St. Louis, Mo.

HELIOS

19

Boiler Repairs

Repairs to Boilers and Engines by Welding, E. G. Hiler. Can. Machy., vol. 21, no. 21, May 22, 1919, pp. 520-521, 2 figs. Examples such as repairing wrought steel, hot-water boiler which was fractured at fire hole and building up by electric welding flanged seams of flue tube for Lancashire boiler. Paper read before Instn. Mech. Engrs.

Concrete, Reinforced, Construction

Autogenous Welding in Reinforced-Concrete Construction (Die Flammenverschmelzung im Eisenbetonbau). Autogene Metallbearbeitung, vol. 12, no. 1, Jan. 1919, pp. 26, 12 figs. Description of method of construction said to be especially suited for concrete vessels and large tanks. (To be continued.)

Cylindrical Bodies

Welding Performed on Cylindrical Bodies, Ernest Schwartz. Can. Machy., vol. 21, no. 22, May 29, 1919, pp. 552-553, 4 figs. Concerning welding of seams and of head and bottom cylindrical bodies.

Dredges

Oxy-Acetylene and Electric Welding on Dredges, H. G. Blankman. Min. & Sci. Press, vol. 118, no. 21, May 24, 1919, p. 716. Also Metal Trades, vol. 10, no. 6, June, 1919, p. 257. Can. Klondyke Mining Co. operates three large dredges and has installed in its machine shop an oxy-acetylene weldink equipment. Article quotes results obtained.

Electric Welding

Electric Welding: Its Theory, Practice, Application and Economics, H. S. Marquand. Elecn., vol. 82, nos. 20, 21, 23 & 24, May 16 & 23, June 6 & 13, 1919, pp. 565-567, 591-593, 645-647, and 681-683, 19 figs. Best results with Bernardos system are said to be obtained with current supplied at about 75 to 80 volts; it is noted, however, that when this potential is obtained from a higher voltage circuit through resistance, there is great loss of energy and quality of work is likely to be impaired. (Continuation of serial.)

Electric Welding and Welding Appliances—XIII. Engineer, vol. 127, no. 3306, May 9, 1919, pp. 441-446, 5 figs. Machines manufactured by A1 Manufacturing Co., of Industry Works, Bradford. They produce machines and accessories for resistance welding only.

Electric Welding in Warships, W. H. Gard. Mar. Engr. & Naval Architect, vol. 41, no. 500, May, 1919, pp. 238-244, 7 figs. Among various examples of repair work, restoring of cast steel sternpost of battleship is quoted as significant development of process. Paper read before Inst. Naval Architects.

Electric Welding, Arc

Important Factors for Efficient Arc Welding, E. Wanamaker and H. R. Pennington. Ry. Elec. Engr., vol. 10, no. 6, June, 1919, pp. 179-185, 13 figs. Concerning flexibility of installations, location of accessories and eye and body protection.

Relation of Arc Phenomena to Electric Welding, C. D. Fawcett. University of Colorado, Jl. of Eng., vol. 15, no. 3, Apr. 1919, pp. 15-24, 2 figs. Suggestions in regard to welding practice with table giving approximate relation of electrode diameter, plate thickness, etc.

Electric Arc Welder for Portable and Stationary Use. Automotive Industries, vol. 40, no. 23, June 5, 1919, p. 1233, 2 figs. Outfit designed for operation on either direct current or alternating current lines.

Electric Welding, Plastic Arc

The Plastic-Arc System of Welding, J. O. Smith. Coal Age, vol. 15, no. 26, June 26, 1919, pp. 1162-1166, 7 figs. Also Ry. Rev., vol. 64, no. 24, June 14, 1919, pp. 898-900, 9 figs. Description of outfit and examples of repairs effected by this system. Paper presented before meeting of Coal Min. Elecns. and Mechanics Inst.

Engine Cylinders, Liberty

Welding Operations on Liberty Motor Cylinders, H. A. Carhart. Am. Mach., vol. 50, no. 22, May 29, 1919, pp. 1019-1025, 13 figs. Mixtures and apparatus used by Lincoln Motor Co.

Gas Cutting Torches

Modern Welding and Cutting. Am. Mach., vol. 50, no. 23, June 5, 1919, pp. 1084-1087, 15 figs. Difference between gas cutting torches and those used for welding; details of various makes of gas cutting torches. 13th article.

Modern Welding and Cutting—XIV, Ethan Viall. Am. Mach., vol. 50, no. 26, June 26, 1919, pp. 1237-1243, 15 figs. Gas-pressure regulators and working assemblies; directions for lighting of torch; charts showing various flame characteristics with different gas combinations.

Preheating Work

Pre-Heating Work for Oxy-Acetylene Welding, J. F. Springer. Ry. & Locomotive Eng., vol. 32, no. 6, June, 1919, pp. 184-185, 1 fig. On prevention of cracking.

Ship Construction

Welding as a Process in Ship Construction, S. V. Goodall. Gen. Elec. Rev., vol. 22, no. 3, Mar. 1919, pp 213-216. Observes that riveting being greatest single labor item, any improvement in method of binding together whole structure offers fruitful field for economy.

Strength of Welds

Electric Welding and Welding Appliances—XIV. Engineer, vol. 127, no. 3307, May 16, 1919, pp. 471-473, 1 fig. Acconnt of tests which have been devised for determining strength of electric welds. (Concluded.)

Stresses in Seams

Stresses in Seams in Autogenous (Wie wird beim Autogenschwissen die Schweissnaht beansprucht). Autogene Metallbearbeitung, vol. 12, no. 1, Jan. 1919, pp. 6-8. Phenomena observed in welding mild steel.

Thermit Welding

Thermit Process Used on Big Welding Job on Northern Pacific. Mar. News, vol. 6, no. 2, July 1919, pp. 96-97, 5 figs. Illustrating repair on cast-steel stern frame which was cracked through just above upper post gudgeon, the break forming roughly a triangle, each side of which was about 2 ft. long.

Restoring Steel Machinery to Service by the Thermit Process. Welding Engr., vol. 4, no. 6, June 1919, pp. 29 and 32-33, 14 figs. Examples of repairs of large pieces of work for Pittsburgh Steel Co.

Welding Jigs

Some Examples of Welding Jigs and Methods for Overcoming Distortion, C. S. Milne. Acetylene & Welding Jl., vol. 16, no. 187, Apr. 1919, pp. 66-73, 33 figs. Illustrates various kinds of defects that are usually remedied by welding and discusses practices in reducing cooling stresses. Paper read before British Ace'ylene & Welding Assn.

WOOD

Girders, Lattice

Wooden Lattice Girders (Boltede Gitterkonstruktioner af Trae med "Bufobrikker"). Ingeniøren, vol. 28, no. 30, Apr. 12, 1919, pp. 196-199, 8 figs. Corrugated steel "Bufo" washers are used between tie rod and beams.

Spruce, Seasoning

Emergency Seasoning of Sitka Spruce, L. A. Welo. Sci. Am., Supp. vol. 87, no. 2269, June 28, 1919, pp. 404-405, 2 figs. Strength of kiln-dried and air-dried spruce compared.

VARIA

Engineering Profession

The Engineer and the Community, E. H. Sniffin. Elec. Jl., vol. 16, no. 6, June, 1919, pp. 249-251. Writer asks why the engineer who has "made the world more habitable than was even dreamed of by the greatest imaginations of former ages" is not "a more conspicuous member of the community."

Proper Recognition of the Engineering Profession, W. W. K Sparrow. Ry. Rev., vol. 64, no. 18, May 3, 1919, pp. 668-670. Believes that prime requisites to obtaining greater recognition of engineering profession are organization, licensing and broader education.

Metric System

The Metric System in Engineering, Frederick A. Halsey. Eng. Education, vol. 9, no. 10, June 1919, pp. 491-499. Argues that value of introducing metric system should be measured by results to be expected from its introduction; as no special benefit is seen in changing already standardized mechanical constructions from their present values to metric units, acceptance of metric system in engineering is not considered practical.

National Dept. of Public Works

The Movement to Establish a National Department of Public Works, Frederic H. Fay. Jl. Boston Soc. Civ. Engrs., vol. 6, no. 6, June 1919, pp. 235-244 and (discussion) pp. 244-264. Prospect of establishing national budget system visualized as sound argument in favor of aiding Nat. Dept. of Public Works.

Stereoautograph

The Stereoautograph, Model 1914, Its Correction and Application (Der Stereoautograph Modell 1914, seine Berichtigung und Anwendung), H. Löscher. Zeitschrift für Instrumentenkunde, vol. 39, no. 1, Jan. 1919, pp. 2-19, 11 figs. Instrument for mechanical utilization of stereoautographic pictures. (To be continued.)

Tanks, Capacity

The Capacity of Cylindrical Tanks, Motor Age, vol. 35, no. 24, June 12, 1919, p. 51, 1 fig. Chart for computing contents of tanks of usual lengths and diameters or size required for desired capacity.

Organization and Management

ACCOUNTING

Cost Accounting

Cost Accounting to Aid Production—IX, G. Charter Harrison. Indus. Management, vol. 57, no. 6, June 1919, pp. 483-487, 1 fig. Predicts revolution in which retrospective systems will disappear because unfitted to meet demands of an industrial executive who must know before he can do.

Inventory

How We Keep Our Inventory Correct, H. F. Harris. Factory, vol. 22, no. 6, June 1919, pp. 1181-1185, 17 figs. Practice of Republic Motor Truck Co. Record forms illustrated.

EDUCATION

Cripples

Human Rehabilitation and Its Value, Douglas C. McMurtrie. Min. & Oil Bul., vol. 5, no. 6, May 1919, pp. 325-326 & 328, 4 figs. Method of dealing with men followed at Red Cross Inst. for crippled and disabled men at New York City.

Electrical Fittings

The Training of the Disabled Man from the Electrical Engineer's Point of View, F. H. Taylor. Electrictiy, vol. 31, no. 1491, June 6, 1919, pp. 349-352, 5 figs. Example illustrating training given in electrical fitting, installation, maintenance, repair work and similar occupation at various educational centers.

Executives

The New Science, James A Bowie. Eng. & Indus. Management, vol. 1, pp. 17, June 5, 1919, pp. 519-520. Discusses need of training for industrial administration and refers to work in this direction at College of Technology at Manchester.

Shipyard Labor

Intensive Training of Shipyard Labor, Harry H. Tukey. Indus. Management, vol. 57, no. 6, June 1919, pp. 452-456, 4 figs. Methods and results of Submarine Boat Corporation.

FACTORY MANAGEMENT

Committee System

Committee System in American Shops, William Leavitt Stoddard. Indus. Management, vol. 57, no. 6, June 1919, pp. 473-476. Review of acceptance of some form of representative shop committee, with reference to experience in Great Britain. Three types of such committees are differentiated, and the relations of trade unionism and shop committees are discussed.

Control Boards

How Control Boards Can Help Manage, B. L. Van Schack. Factory, vol. 22, no. 6, June 1919, pp. 1172-1176, 6 figs. Control boards, it is said, must back up facts with proof without too much detail or they will tend to confuse rather than explain.

Control of Production

Graphic Control on the Exception Principle, Frank B. Gilbreth. Eng. & Indus. Management, vol. 1, no. 14, May 15, 1919, pp. 433-434, 2 figs. No cost system or charge system should be considered as really satisfactory, in opinion of writer, unless it determines (1) what quantities of individual output should be, (2) prompt records of individual outputs, (3) what costs should be, (4) prompt records of costs, (5) causes of fluctuations and deviations of outputs aad costs from prophesied outputs and costs.

Dispatching Department

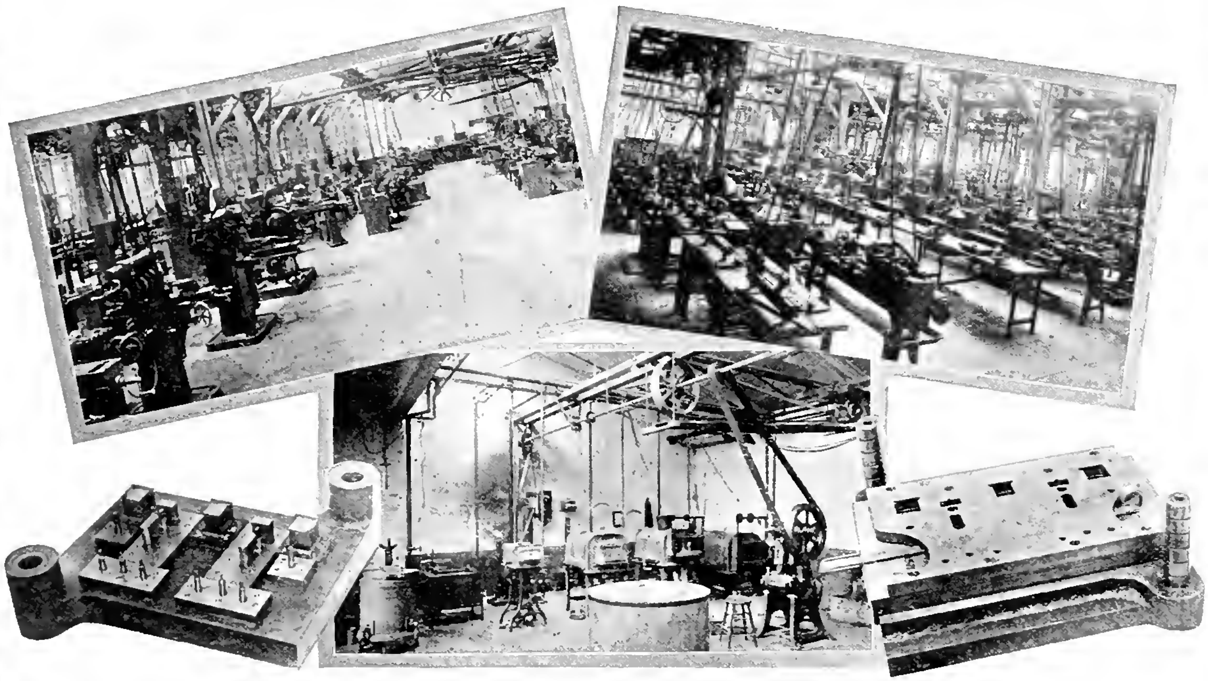
Organization of a Carburetor Plant, Fred H. Korff. Machy. (N. Y.), vol. 25, no. 10, June 1919, pp. 916-918. Work of mechanical and dispatching departments and practice in foundry. Second article.

Let us solve Your Problem

Our Tool Room—

where accurate, long-wearing tools are made—the kind that help you to improve and increase your production.

Designing and making special tools is one of the big features of our business. The illustrations below of our tool room, in which are provided every modern facility for producing accurate special tool work, gives a fair idea of our capacity for producing work of this character. Our many years of experience in solving mechanical and engineering problems covering almost every line of manufacturing insures a service that cannot be duplicated.



Tool Work for those who demand *the Best*

The fundamental principle of our business is to furnish the best tool work for those who want none but the best. Our staff of workers are experts and are careful in their methods. Every detail of the work is carried on with skill and precision. As the life of tools depends on proper heat treatment, this part of the work is given more than usual consideration. The result—perfect, accurate tools—dependable and long-wearing.

We are prepared to design and make special tools, dies, jigs, gages and fixtures, or to make such tools from your own designs.

Let the S A S Laboratories make your next tools.

This is the fifth of a series of advertisements showing our plant, our methods and the work we are doing—Production shops in the next issue.

SLOCUM, AVRAM & SLOCUM
LABORATORIES, Inc.

Production Plant: NEWARK, N.J. *New York Office*: Woolworth Bldg., N.Y.

Special Machinery QUANTITY PRODUCTION Jigs, Fixtures and Gages

SLOCUM-AVRAM-SLOCUM MANAGEMENT

Employee Cooperation

Co-operation Profitable to Employer and Worker, Harry Tipper. Automotive Industries, vol. 40, no. 23, June 5, 1919, pp. 1208-1209. Plan of "industrial democracy" as operated at tobacco-pipe manufacturing plant of Wm. Delmuth & Co. at Richmond Hill, Long Island, where 900 men and women are employed.

Employment Management

Employment-Management at the Eagle Mines, Robert Nye. Min. & Sci. Press, vol. 118, no. 24, June 14, 1919, pp. 821-822. Labor turnover said to have dropped from 32.9 per cent to 11.58 per cent after power of hiring and firing of all men was taken from superintendent and foremen and given to employment manager.

Factories

The Design and Construction of Factories—III, Arthur F. Wickenden. Eng. & Indus. Management, vol. 1, no. 16, May 29, 1919, pp. 498-499, 1 fig. Types of structure.

Fatigue

Devices to Prevent Unnecessary Fatigue, James F. Butterworth. Eng. & Indus. Management, vol. 1, no. 18, June 12, 1919, pp. 556-558, 9 figs. Studies in planning out work so as to shorten number of motions that arms and hands should make while under load, arranging materials to be dealt with in sequence of use and placing materials in such positions that they can be grasped, transported and released in shortest possible time and with least possible effort.

Industrial Efficiency from the Psychological Standpoint—III, Charles S. Myers. Eng. & Indus. Management, vol. 1, no. 13, May 8, 1919, pp. 395-397. Investigations of industrial fatigue, particularly Taylor's research of loads a man can carry; also security against danger as psychological factor tending to increase output. Lecture delivered at Imperial College of Sci. & Technology.

Foremen's Cooperation

C. P. R. Shop Production Methods, E. T. Spidy. Ry. Mech. Engr., vol. 93, no. 6, June 1919, pp. 320-326, 9 figs. Establishes that it is absolutely impracticable to get any results from any system unless coöperative effort from all foremen in all departments is secured. Canadian Pacific practice is quoted as instance of efficient coöperation, and how its productive department ties into the shop organization is shown by diagram.

French War Industries

Taylor Methods in French War Industries. Bul. Taylor Soc., vol. 4, no. 3, June 1919, pp. 8-15 and (discussion) pp. 29-35. Circular of the Ministry of War to the Under-Secretaries of State for Aeronautics, for Health and for Military Justice, the Military Governors General of Paris and Lyons, the Generals commanding districts and the General commanding the French troops of North Africa.

Garment Trades

Factory Management in Garment Trades, Mack Gordon. Indus. Management, vol. 57, no 6, June 1919, pp. 446-451, 10 figs. Purchasing and storekeeping methods.

Layout

The Design and Construction of Factories—II, Arthur F. Wickenden. Eng. & Indus. Management, vol. 1, no. 15, May 22, 1919, pp. 458-459, 1 fig. Arrangement of site and general layout.

Machine-Tool Plant

Organization and Management of a Machine Tool Plant. Machy (Lond.), vol. 14, no. 347, May 22, 1919, pp. 213-219, 11 figs. Principles of management discussed in case of medium-size machine-tool manufacturing plant making single line of machines. First article.

Machinery Selection

Continental Plant Layout Facilitates Production—II, J. Edward Schipper. Automotive Industries, vol. 40, no. 22, May 29, 1919, pp. 1168-1173, 11 figs. Exemplifying machines used to facilitate production. Deals with semi-automatic compound machine in piston department, said to be capable of turning and grooving 100 pistons per hour.

Office Management

Application of Scientific Principles to Office Management, Walter D. Fuller. Bul. Taylor Soc., vol. 4, no. 3, June 1919, pp. 8-15 and (discussion), pp. 15-28. Method of procedure adopted by Standardization Division of Curtis Publishing Co. It includes provision for paying employees extra for all production above a determined standard at a fixed rate.

Output Restriction

Industrial Efficiency from the Psychological Standpoint—IV, Charles S. Myers. Eng. & Indus. Management, vol. 1, no. 14, May 15, 1919, pp. 427-429. Factors which may bring about a restriction of output. Question is discussed with reference to causes arising both from side of employer and that of employee. (Concluded.) Lecture delivered at Imperial College of Science & Technology.

Planning

High Production Tooling Methods as Applied to the Machine-Gun Tripod, Model 1918, Albert A. Dowd and Donald A. Baker. Am. Mach., vol. 50, no. 22, May 29, 1919, pp. 1029-1036. Planning and organization. First article.

A Planning System for Non-Repetition Work. Machy. (Lond.), vol. 14, no. 347, May 22, 1919, pp. 223-225, 4 figs. Nucleus of system proposed for application to ship machinery assembly consists of card index of items and a series of specially prepared sheets made from arrangement drawings of the various systems of machinery and piping in vessel under construction.

Speeding-up Production, John A. Davenport. Eng. & Indus. Management, vol. 1, no. 13, May 8, 1919, pp. 391-394, 8 figs. Working out a time chart and rearranging it, in order to study possibilities for improvement.

Planning the Industrial Plant—I, Hugh M. Wharton. Indus. Management, vol. 57, no. 6, June 1919, pp. 433-437, 4 figs. Discussion of industrial plants as a whole, including general scheme, design, construction, layout and permanent equipment of buildings and yards. Three types of construction are shown and adaptability of each one pointed out. (To be continued.)

Planning a Machine Tool Shop for Systematized Manufacture, Erik Oberg. Machy. (N. Y.), vol. 25, no. 10, June 1919, pp. 905-913, 20 figs. Discussion based upon ideas embodied in plant of R. K. LeBlond Machine Tool Co., Cincinnati.

Production Department

Details of Production Department, M. H. Potter. Iron Trade Rev., vol. 64, no. 22, May 29, 1919, pp. 1410-1412, 7 figs. Method of classifying and checking work at every important stage, with suggested forms of transferring material in course of production.

Progress Department

Planning a Progress Department I & II, W. J. Hiscox, Eng. & Indus. Management, vol. 1, nos. 15 & 17, May 22 & June 5, 1919, pp. 472-474 & 526-528, 3 figs. Illustrating scope for activities of department afforded in manufacture of airplane engines. Forms of record cards.

Promotion

The Three Position Plan of Promotion, Frank B. Gilbreth and L. M. Gilbreth. Eng. & Indus. Management, vol. 1, no. 17, June 5, 1919, pp. 521-523. Emphasizes (1) necessity of attracting desirable applicants, (2) necessity of holding, fitting and promoting those already employed and (3) the interdependence of these two.

Transfer and Promotion of Employees. Iron Age, vol. 103, no. 23, June 5, 1919, pp. 1518-1519. Classifying capabilities and characteristics of workmen for the purpose of effecting transfers and promotions. Report prepared by Transfer and Promotion Committee of Chicago council, Nat. Employment Managers' Assn.

Routing

Where Power Transmission Machinery is made. Foundry, vol. 47, no. 324, June 1, 1919, pp. 325-328, 7 figs. Special attention is given to arrangement of plant for routing of material from pattern shop through foundry and cleaning room into machine shop.

Savings

Savings Facilities for Employees Make for Stability of Organization, Harry Tipper. Automotive Industries, vol. 40, no. 22, May 29, 1919, pp. 1180-1181. Suggests that plan be without taint of paternalism and that workers be allowed freedom of dealing at will with regularly recognized financial institutions.

Scientific Management

The Determination of Standards in Scientific Management, Henry W. Allingham. Eng. & Indus. Management, vol. 1, no. 17, June 5, 1919, pp. 536-540. Claims that much of opposition to scientific management is based upon misunderstanding, and, in a measure, to manner in which it has been advocated. Paper read before Indus. Reconstruction Council.

Scientific Management, with Especial Reference to Incentives and Motion Study, James F. Butterworth. Eng. & Indus. Management, vol. 1, nos. 16 & 17, May 29 and June 5, 1919, pp. 502-505 and 534-535, (6 figs.) 1. Emphasizes particularly adoption of standards throughout works, not only for machinery and tools, but also in method of performance, mnemonic symbols, phrasing on instruction cards, and even standard clothing to be provided by management. II. Henry R. Towne's system of gain sharing, H. L. Gantt's task with bonus system, Gilbreth three rate, with increased rate, F. A. Parkhurst's differential bonus system of compensation and Taylor's differential-rate piece system.

Productive Capacity and Industrial Property, H. L. Gantt. Eng. & Indus. Management, vol. 1, no. 16, May 29, 1919, pp. 487-489, 1 fig. "Idleness expense chart," indicating cost of inefficient management. Based on writer's paper, Efficiency and Democracy (Mech. Eng., Jan. 1919, p. 43), read before Am. Soc. Mech. Engrs.

Skill of Workers and Production

Modern Methods of Transferring Skill, Frank B. Gilbreth and L. M. Gilbreth. Eng. & Indus. Management, vol. 1, no. 18, June 12, 1919, pp. 559-560. After pointing out that increased productivity is usually attempted from angle of longer hours or more rapid rate of production, writers urge instead fundamental necessity of increasing skill of workers.

Telautograph

The Close Control of Steel Processes. Iron Age, vol. 103, no. 24, June 12, 1919, pp. 1569-1571, 3 figs. Uses of telautograph as substitute for telephone communication and transmitting figures and diagrams.

Tool Stores

The Modern Tool Stores, Herbert C. Armitage. Eng. & Indus. Management, vol 1, no. 18, June 12, 1919, pp. 551-553, 6 figs. Arrangement, organization, construction and equipment. (To be continued.)

INSPECTION

Chemicals and Explosives

Inspection of Explosives and Chemicals During the War Period, J. Richardson Donald, Can. Chemical Jl., vol. 3, no. 6, June 1919, pp. 187-191. As carried out for Imperial Ministry of Munitions, Can. Address delivered at Convention of Chemists, Montreal.

LABOR

Clubs

An Employees' Engineering Club, F. O. Wells. Indus. Management, vol. 57, no. 6, June 1919, pp. 443-445. Membership is paid for, dinners are given, speakers are invited in —all for purpose of developing and increasing spirit of organization to deal with technical problems. Plan devised on lines of organization of Am. Soc. Mech. Engrs.

Luxurious Factory Club and Roof Garden. Iron Age, vol. 103, no. 24, June 12, 1919, pp. 1575-1577, 9 figs. All employees are eligible to membership after 30 days in service. Officers and board of directors elected by individual vote of all employees.

Discontent

The Human Side of Engineering, F. Danvers Power. Proc. Australasian Inst. Min. Engrs., no 31, Sept. 30, 1918, pp. 131-144. Following causes of discontent are analyzed: Desire for better ratio between rate of pay and cost of living; bosses whose idea of efficiency is to speed up work and cut down wages; men put to class of work for which they are unsuited; monotony of work and uncongenial surroundings.

Industrial Relations

Relations between Employers and Labour, Evelyn Wallers. South African Jl. of Industries, vol. 2, no. 4, Apr. 1919, pp. 376-380. Question is dealt with more particularly with reference to mining industry. Address delivered before Transvaal Chamber of Mines.

League to Enforce Industrial Peace

A League to Enforce Industrial Peace, L. K. Comstock. Elec. World, vol. 73, no. 22, May 31, 1919, pp. 1164-1167. Tentative legislative program concerning private industry upon which it is proposed to build league.

Radicalism

Humanity and Tolerance will solve U. S. Labor Problems, Harry Tipper. Automotive Industries, vol. 40, no. 25, June 19, 1919, pp 1394-1398. Writer contends that radicals in labor circles have flourished through being opportunists and endeavors to ascertain causes which have produced recent strikes.

Announcement

We are prepared to demonstrate that the Fay Automatic Lathe offers the best known means for performing certain operations on the following automobile, truck, tractor and internal combustion engine parts:

Tractor belt pulleys
Cam shafts
Steering knuckles
Ring bevel gears
Pistons
Transmission Gears
Hubs
Stem pinions, both spur and bevel.

Our practice in machining these parts has been developed by specialized study, experiment and actual experience in the shops of our customers.

The advantages gained relate to labor cost, initial investment, ease of set up and cost of maintenance.

In each case the reasons for superiority are simple and definite, and will be immediately appreciated by the experienced mechanic.

If you are preparing to increase your output of any of the above parts you will find it to your advantage to consult with us.

JONES & LAMSON MACHINE COMPANY

SPRINGFIELD, VERMONT, U. S. A.

109 Queen Victoria Street, London, E. C.

France, Spain and Belgium: F. Auberty & Co., 91 Rue de Maubeuge, Paris
Holland: Spliethoff, Beeuwkes & Co., Rotterdam

SEE OUR DATA IN 1918 A.S.M.E. CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT

Restaurants

Feeding Factory Workers. Iron Age, vol. 103, no. 24, June 12, 1919, pp. 1579-1580, 2 figs. Plan said to be arranged for minimum route from storeroom to serving counters.

Technical Features of Disston Cafeteria, Arthur N. Blum. Safety Engineering, vol. 37, no. 5, May 1919, pp. 247-253, 1 fig. Direct benefits claimed to be derived from industrial restaurants in report drawn by committee appointed by Ministry of Munitions are: (1) marked improvement in health of worker; (2) less sickness; (3) less absence and broken time; (4) less tendency to alcoholism; (5) increased efficiency and output. Plant in Philadelphia is quoted as example of results.

Stock Ownership by Employees

Coming Status of the Employee in Industry, Charles F. Lang. Eng. News-Rec., vol. 82, no 22, May 29, 1919, pp. 1050-1051. Points out advantages of stock ownership by employees, and credits employee with ability to exercise salutary influence upon management of company. From address before Convention of Nat. Machine Tool Builders' Assn.

Temperament

Getting the Employee, Ralph Elsman. Am. Gas Eng. Jl., vol. 110, no. 21, May 24, 1919, pp. 437-438. Believes that temperament is important factor, but which nevertheless has not received sufficient attention from executives of Utility Companies.

Turnover

Principles of Employing Labor, E. H. Fish. Indus. Management, vol. 57, no. 6, June 1919, pp. 478-482. Devoted to non-financial conditions, influences and details of shop policy that causes men to leave and seek work elsewhere. (Concluded.)

Wages

Fundamentals of Wage Payment. Ry. Mech. Engr., vol. 93, no. 6, June 1919, pp. 297-299, 3 figs. Equations and graphs aiming to prove that all systems of labor compensation, including piece work and the various bonus systems, as well as the straight time basis, if properly administered, are nearly equally effective.

My Objections to the Piece Rate Method of Wage Payment—I, Harrington Emerson. Indus. Management, vol. 57, no. 6, June 1919, pp. 470-472. Author discusses practical or immediate objections, administrative or proximate objections, and psychological or ultimate objections.

Women

Attendance and Turnover Records of Women Workers. Automotive Industries, vol. 40, no. 23, June 5, 1919, pp. 1222-1224. Comparison of lost-time factors with male and female operators; effects of illness, hours of labor and idle shop time; value of rest rooms and rest periods. Statistical data are quoted from 115 establishments.

LEGAL

Compensation

Computation of Earnings, Chesla C. Sherlock. Am. Mach., vol. 50, no. 22, May 29, 1919, pp. 1037-1039. Determining for purpose of compensation to injured workman what should constitute annual earning for year preceding accident.

Dependency

The Riddle of Dependency—I & II, Chelsea C. Sherlock. Am. Mach., vol. 50, nos. 25 & 26, June 19 & 26, 1919, pp. 1174-1176 & 1226-1228. Distinguishing between persons whose dependency is conclusively presumed and who have only to establish their relationship to deceased workman to obtain compensation, and those others who must prove their dependency in order to recover.

France

Compilation of Laws, Decrees, Devisions and Other Acts Concerning Mines, Quarries, Sources of Mineral Waters, Steam Apparatus and Operation of Railroads, published under authority of Minister of Public Works (Recueil de lois, décrets, arrêtes et autres actes concernant les mines, les carrières, les sources d'eaux minérales, les appareiks à vapeur et l'exploitation des chemins de fer). Annales des Mines, 11th series, vol 7, Oct. 4 1918, pp. 337-478. Article deals with the last quarter of 1918.

Heating and Ventilation

Heating and Ventilating Plants and Mechanic's Liens, Arthur L. H. Street. Heating & Ventilating Mag., vol. 16, no. 6, June 1919, pp. 32-35. Review of Appellate Court decisions defining circumstances under which security is available. (Concluded.)

Mines and Mining

Abstracts of Current Decisions on Mines and Mining, J. W. Thompson. Dept. of Interior, Bur. Mines, bul. 179, law serial 18, 1919, 166 pp. Report extends over period from September to December 1918. It includes subjects of minerals and mineral lands, quarry operations, damages for injuries to miners, interstate commerce and explosives.

LIGHTING

Reconstruction Period

Illumination During the Reconstruction Period, S. E. Doane. Trans. Illuminating Eng. Soc., vol. 14, no. 4, June 10, 1919, pp. 209-214. Sees problems for near future as largely educational.

Shops

Shop Illumination (L'éclairage dans les usines), Jacques Deschamps. Technique Moderne, vol. 10, no. 9, Sept. 1918, pp. 413-417, 8 figs. Technical study with reference to selection of type of lamp and reflector and determination of total lighting power required in works.

RECONSTRUCTION

Machinery, American

Business Outlook for American Industry, Frederick H. Payne. Indus. Management, vol. 57, no. 6, June 1919, pp. 465-468. Particularly in machinery building and metal-working.

Municipal Engineering

Municipal Engineers and Problems of Reconstruction, E. J. Elford. Surveyor, vol. 55, no. 1427, May 23, 1919, pp. 379-380 and (discussion) pp. 380-381. Labor-saving appliances and cost reduction. Paper read before Instn. Mun. & County Engrs.

Social Reconstruction

Social Reconstruction. Survey, vol. 42, no. 10, June 7, 1919, pp. 402-409. Proposals for Federal Legislation affecting education, civil rights, probation, insurance and pensions, health, country life, conservation, labor, housing, public works, etc. Report of Committee on Nat. Program.

SAFETY ENGINEERING

Accidents, Industrial

The Prevention of Industrial Accidents, H. M. Vernon. Eng. & Indus. Management, vol. 1, no. 16, May 29, 1919, pp. 494-495, 1 fig. From records of four large industrial plants. Lecture delivered before Roy. Soc. of Medicine.

Chemical Compounds

The Chlorates, F. M. Griswold. Safety Eng., vol. 37, no. 6, June 1919, pp. 291-295, 2 figs. Dangers of fire and explosion from chemical compounds. Suggestions and references to accidents.

Dust

Health Risks from Dust caused by Buffing, Polishing and Grinding Metals, John Roach. Safety Eng., vol. 37, no. 5, May 1919, pp. 236-243, 3 figs. Relation between vitality and normal lung function illustrated by respiration during average workday in terms of expenditure of energy; thus it is said that respiration during average workday corresponds to lifting 7 tons 1 ft.

Grain Dust Explosions and Fires, David J. Price. Safety Eng., vol. 37, no. 6, June 1919, pp. 296-300, 1 fig. Direct appeal to workmen and the results.

Fencing

The Silent Watchman Over Industry. Iron Trade Rev., vol. 64, no. 25, June 19, 1919, pp. 1609-1612, 6 figs. Quotes from experience of protecting industries during war time and considers question of protecting them in peace times in light acquired by experience in war.

Fire Protection

San Francisco's High Pressure Fire Service. Mun. Jl. and Public Works, vol. 46, no. 25, June 21, 1919, pp. 454-455, 4 figs. Formerly maintained as reserve supply, now used as main fire-fighting system.

Private Fire Protection. Mun. Jl. and Public Works, vol. 46, no. 25, June 21, 1919, pp. 449-451. Report of Committee of Am. Waterworks Assn. giving recommendations for installation of private fire devices.

Fire Prevention in the Metal Trades—II, R. E. Sweeringen. Metal Trades, vol. 10, no. 6, June 1919, pp. 261-263. Principles to be observed when installing automatic sprinkler system.

The Fire at Millennium Mills, Victoria Docks Silvertown, London, on January 19th, 1917. A memorandum prepared by Ellis Marsland for "Red Books" of the British Fire Prevention Committee—no. 208, London, 1917, 46 pp., 38 figs. Points out that reinforced-concrete frame remained standing throughout fire said to have been of exceptional severity—without material portion collapsing, while all other materials were practically consumed or destroyed.

Gas Masks

Use of Army Gas-Masks in Atmospheres Containing Sulphur Dioxide, A. C. Fieldner and S. H. Katz. Min. & Sci. Press, vol. 118, no. 23, June 7, 1919, pp. 773-777, 5 figs. Results of tests. Warning is issued against indiscriminate use of gas masks for any and all purposes; poisonous gases used in warfare are chemically active and therefore combine readily with absorbents of mask, but they will easily penetrate mask when present in quantities of 1 or 2 per cent.

Health, Industrial

Industrial Health and Efficiency. U. S. Dept. Labor, Bur. Labor Statistics, bul. 249, Feb. 1919, 374 pp., 20 figs. Final report of the British Health of Munition Workers' Committee, published at request of Council of National Defense, in order to "investigate conditions affecting health and welfare of workers . . . so that the salient features thereof may be made applicable to conditions pertaining in the U. S. A. . . ."

Mine Accidents

Metal-Mine Accidents in the United States during the Calendar Year 1917, Albert F. Fay. Dept. of Interior, Bur. Mines, technical paper 224, 1919, 80 pp. Including supplemental labor and accident tables for the years 1911 to 1917, inclusive.

Power Presses

Safety Practice in Power-Press Work. Am. Mach., vol. 50, no. 25, June 19, 1919, pp. 1177-1184, 29 figs. Discussion and illustrations of various types of guards. From pamphlet published by Nat. Safety Council.

Safety Codes

National Industrial Safety Codes. Safety Eng., vol. 37, no. 5, May 1919, pp. 231-235. Proposal for an American Standards Association. Report of Committee of Three, appointed by conference on industrial safety codes at Bureau of Standards.

Transmission Machinery

Safety Precautions for Transmission Machinery. Eng. & Indus. Management, vol. 1, no. 13, May 8, 1919, pp. 398-402, 12 figs. Based upon reports by Home Office inspectors of dangerous trades.

TRANSPORTATION

Army Terminals

Army Supply Bases Useful Adjuncts to Railroads. Ry. Age, vol. 66, no. 26, June 27, 1919, pp. 1809-1812, 6 figs. Adapting port and terminal facilities made necessary by war to peace-time conditions.

Rural Motor Express

Development of Rural Motor Express, F. W. Fenn. Can. Engr., vol. 36, no. 24, June 12, 1919, pp. 539-541. Including statements in regard to motor-truck performances. Paper read at Can. Good Roads Congress.

Trucks, Electric

Electric Trucks and Transportation, E. E. Laschum. Elec. Rev., vol. 74, no. 23, June 7, 1919, pp. 931-933. Operating data of American Railway Express Co.

EXPORT

Brazil

Entering the Latin American Markets, Percy F. Martin. Eng. & Indus. Management, vol. 1, no. 15, May 22, 1919, pp. 474-476. Opportunities offered by Brazil.

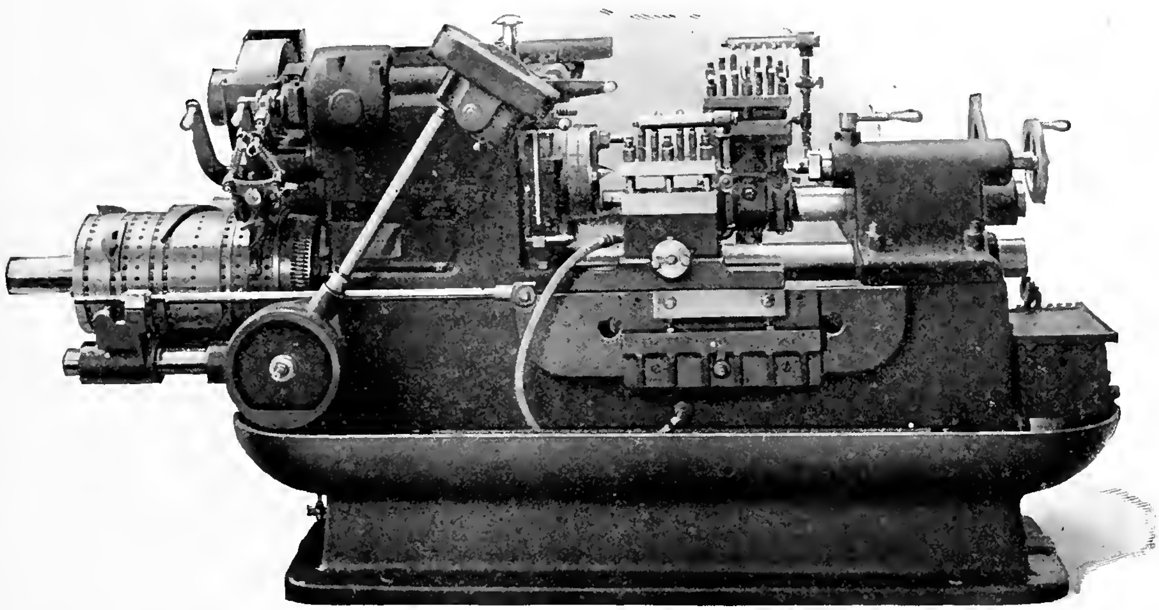
Europe

American Machine Tools in Many Markets, L. W. Alwyn-Schmidt. Am. Mach., vol. 50, no. 24, June 12, 1919, pp. 1135-1137. Survey of European field.

Payment for Exports

Export of Industrial Products, Edward Prizer. Am. Mach., vol. 50, no. 24, June 12, 1919, pp. 1130-1132. Establishes that U. S. A. must learn to take foreign stocks and bonds and share interest in local enterprises, in payment of her exports. Paper read before Sixth Nat. Foreign Trade Convention.

The Fay Automatic Lathe



An automatic machine for simultaneous turning, facing and shouldering cuts on bar stock and centered forgings, such as pinion shafts, steering knuckles, cam shafts, etc.

An automatic machine for second operations on work held on centered arbors, such as spur and bevel gear blanks, hubs, pulleys, etc.

Designed with strength and driving power to carry all the tools, speed, and feed the work will stand under balanced cuts.

Jones & Lamson Machine Company

SPRINGFIELD, VERMONT, U. S. A.

109 Queen Victoria Street, London, E. C.

France, Spain and Belgium: F. Auberty & Co., 91 Rue de Maubeuge, Paris
Holland: Spliethoff, Beeuwkes & Co., Rotterdam

SEE OUR DATA IN 1918 A.S.M.E. CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT

Electrical Engineering

ELECTROCHEMISTRY

Electrolytic Dissociation and Duplex Affinity

The Theory of Duplex Affinity, Samuel Henry Clifford Briggs. Jl. Chem. Soc., vols. 115 & 116, no. 678, Apr. 1919, pp. 278-291. Its application to electrolytic dissociation. It is said that the cause of electrolytic dissociation is combination of solute and solvent by means of unsaturated secondary affinity.

ELECTRODEPOSITION

Metal Plating

Metal Plating, W. G. Knox. Metal Indus., vol. 17, no. 6, June 1919, pp. 269-271. Tables indicating time required to deposit a given thickness of metal.

ELECTROPHYSICS

Electromagnetic Wave Absorption

The Absorption of Electromagnetic Waves on Two Parallel Wires (Über die Absorption elektromagnetischer Wellen an zwei parallelen Drähten), W. Arkadiew. Annalen der Physik, vol. 58, no. 2, 1919, pp. 105-138, 12 figs. On two parallel wires writer obtained pure, damped electric waves of 72.7 to 1.27 cm. in length. Energy of waves decreases on account of absorption according to exponential law. Method was worked out for measuring the absorption coefficient. Tables.

Electrostatic and Magnetic Fields

On a Reciprocal Relation Between the Electrostatic Fields of Certain Distributions of Electricity and the Magnetic Fields of Corresponding Uniform Currents, A. Gray. Lond., Edinburgh, and Dublin Phil. Mag., vol. 37, no. 221, May 1919, pp. 472-480, 4 figs. Establishes various reciprocal theorems of coaxial circles.

Oscillations, Electrical

Electrical Oscillations Under the Action of Any Given Forces (Oscillations Electriques sous l'action de forces données de forme quelconque), John R. Carson and J. B. Romey. Revue Générale de l'Electricité, vol. 5, no. 20, May 17, 1919, pp. 715-717. With reference to theory of propagation of current in telephone and telegraph lines, writers show that it is possible to take as fundamental solution either that relating to the case when acting forces are of exponential form or that in which a constant force is suddenly introduced in a circuit.

Overvoltage, Hydrogen

Hydrogen Overvoltage, Duncan A. MacInnes and Leon Adler. Proc. Nat. Acad. Sciences, vol. 5, no. 5, May 15, 1919, pp. 160-163, 2 figs. Concerning fluctuation observed by writer while determining overvoltage of small electrodes of "platinized" platinum.

Parallel Cylindrical Conductors

Electrical Theorems in Connection with Parallel Cylindrical Conductors, Alexander Russell. Proc. Phys. Soc. Lond., vol. 31, part III, Apr. 15, 1919, pp. 111-130, 5 figs. Relations connecting three capacity coefficients when cylinders are external to one another.

Vector Diagrams

Vector Diagrams of Some Oscillatory Circuits Used with Thermionic Tubes, W. H. Eccles. Proc. Phys. Soc. Lon., vol. 31, part III, Apr. 15, 1919, pp. 137-150, 8 figs. Vector diagrams used in study of a.c. circuit applied to assemblage made up of oscillator, the thermionic relay maintaining it in oscillation and the devices linking these two parts.

FURNACES

Booth-Hall Furnace

The Booth-Hall Electric Furnace, W. K. Booth. Can. Foundryman, vol. 10, no. 6, June 1919, pp. 142-145, 7 figs. Conducting-hearth electric furnace having auxiliary electrode for starting and automatic control.

California

Electric-Steel Furnaces in California. Metal Trades, vol. 10, no. 6, June 1919, pp. 245-247, 3 figs. Héroult furnace practice. First article.

Heat-Treating Furnaces

Electric Furnaces for Heat-Treating and Shrinkage, A. M. Clark. Metal Trades, vol. 10, no. 6, June 1919, pp. 259-260, 4 figs. Built in sections. Developed by General Electric Company.

Medium Temperature Furnace

How Electric Furnaces are Built. Iron Trade Rev., vol. 64, no. 24, June 12, 1919, pp. 1545-1548, 7 figs. Type developed by Electric Furnace Co., Alliance, Ohio, designed for melting non-ferrous metals and other work not requiring excessive temperature; claimed to be especially suitable for steel treating.

Sahlin Furnace

A New Type of Electric Furnace, Axel Sahlin. Elec. News, vol. 28, no. 11, June 1, 1919, pp. 32-34, 1 fig. Designed with view to embodying advantages of both arc and free-burning arc furnaces. Paper read before Instn. Elec. Engrs.

A New Type of Electric Furnace, Axel Sahlin. Electrical Review, vol. 84, no. 2165, May 23, 1919, pp. 591-593, 6 figs. General principle of furnace described is solid hearth which becomes conductive of electricity when hot. Furnace is built as circular ladle with contracted top and dished bottom. Abstract of paper read before Instn. Elec. Engrs.

GENERATING STATIONS

Ance, France

Ance Hydroelectric Station of the Compagnie Electrique de la Loire et du Centre (L'usine hydro-électrique de l'Ance de la Compagnie électrique de la Loire et du Centre), Jacques de Soucy. Revue Générale de l'Electricité, vol. 5, no. 19, May 10, 1919, pp. 689-700, 14 figs. Attention is directed to controlling devices which permit connecting 14,800 kw. to network of company, or else dividing it into various units which are separately connected to other steam or hydroelectric power houses. (Concluded.)

Brule River

Brule River Hydro-Electric Development, C. V. Seastone. Power, vol. 49, no. 22, June 3, 1919, pp. 842-845, 4 figs. Three-unit plant generating three-phase 60-cycle current at 6600 volts. Vertical shaft turbines operate under approximate head of 60 ft.

Buenos Aires

Generating and Distributing Stations of Buenos Aires (Les nouvelles installations de production et de distribution d'électricité de Buenos Aires.) Bulletin Technique de la Suisse Romande, vol. 45, no. 10, May 17, 1919, pp. 85-89, 4 figs. Three turbo-alternators of 5000 kv. each are used. (To be continued.)

Denver

New Electric Generating Station at Denver, T. O. Kennedy and H. H. Kerr. Elec. Eng., vol. 53, no. 6, June 1919, pp. 253-255, 3 figs. Enlarged by installing a 12,500-kw. 4000-volt General Electric turbo-generator.

Genoa

Electric Traction in Italy (La grande trazione elettrica in Italia). Industria, vol. 33, no. 8, Apr. 30, 199, pp. 232-236, 4 figs. Central thermo-electric station of the state railways at Genoa.

Individual Stations

Ontario Power Co.'s Plant Extension, H. A. Gardner. Eng. World, vol. 14, no. 11, June 1, 1919, pp. 27-31, 9 figs. Enlargement consisted of installation of third conduit, parallel to the two existing conduits and additional occupational space constructed in old power house.

G. E. C. Plant at the Winchester Corporation Power House. Electricity, vol. 31, no. 1492, June 13, 1919, pp. 367-368, 4 figs. Installation of 450-kw. geared d. c. turbine generator.

Dominion Power and Transmission Co.'s Plant. Contract Rec., vol. 33, no. 21, May 21, 1919, pp. 469-471, 6 figs. Also Elec. News, vol. 28, no. 12, June 15, 1919, pp. 25-27, 5 figs. Designed for ultimate capacity of 75,000 kva. and to deliver its output at 44,000 volts. Special attention is given to coal-handling and boiler-house equipment. Generators are of revolving field type, direct-connected to steam turbine and of 12,500 kva. each.

Power Factor

Increasing the Power Factor (Relevement du facteur de puissance), B. Guerschinovitch. L'Industrie Electrique, vol. 28, no. 646, May 25, 1919, pp. 184-187. Transformers. (Concluded.)

Turbo-Electric Stations

Economic Operation of Turbo-Electric Stations.—I. & I. C. T. Hirshfeld and C. L. Karr. Universal Engr., vol. 29, nos. 4 and 5, Apr. and May, 1919, pp. 33-37, and 27-33, 5 figs. Graph given shows water-rate curves for various relations of load and steam consumption and different station loads. Asserts that smallest thermal cost of auxiliary power is secured when generated by steam with complete absorption in feedwater.

AUXILIARY EQUIPMENT

Switches

New Features in Switch Construction (Neuerungen im Weichenbau), E. Borst. Annalen für Gewerbe & Bauwesen, vol. 84, no. 4, Feb. 15, 1919, pp. 38-40, 6 figs. Compares advantages and disadvantages of spring tongue and pivot switches.

GENERATORS AND MOTORS

Air Gap and Ball Bearings

The Use of Ball Bearings for Electrical Machinery, H. M. Trumbull. Power House, vol. 12, no. 8, June 5, 1919, pp. 222-224, 10 figs. Points out that ball bearings enable builder to use smaller air gap.

Boosters

On Harada's Booster (In Japanese), K. Harada. Denki Gakkwai Zasshi, no. 370, May 10, 1919.

Commutation

How Spacing and Thickness of Brushes Affect Commutation, Warren C. Kalb. Power, vol. no. 25, June 24, 1919, pp. 970-972, 9 figs. How spacing, alignment and thickness of brushes may cause circulating currents to flow in armature windings and thereby develop poor commutation.

Commutation Troubles—H. F. Ashton. Mech. World, vol. 65, no. 1690, May 23, 1919, p. 244. Using copper dampers in rotary converters.

Emcol Motor

The "Emcol" Motor. Elecn., vol. 82, no. 22, May 30, 1919, pp. 619-621, 7 figs. Said to provide a greatly increased cooling surface, amounting in some cases to ten times the effective area as compared with the ordinary totally enclosed motor.

Fan Motors

The Development of Fan Motor Windings, E. W. Denman. Elec. Jl., vol. 16, no. 6, June 1919, pp. 257-260, 10 figs. With reference to advantages of split-phase winding.

Fires in Generators

Generator Fires. Power Plant Eng., vol. 23, no. 12, June 15, 1919, pp. 547-550, 4 figs. Means of minimizing occurrence and limiting extent of damage. From report of Committee on Elec. Apparatus. read before Nat. Elec. Light Assn.

Generators, Large

Reinsulation of Large Generators. Elec. World, vol. 73, no. 25, June 21, 1919, pp. 1316-1318, 1 fig. To provide against interrupted service during period of heavy winter. Practice of Milwaukee Elec. Ry. & Light Co.

Features of Mammoth Waterwheel Generator. Elec. World, vol. 73, no. 22, May 31, 1919, pp. 1156-1158, 4 figs. Method of construction employed in one of the 32,500-kva. generators which are being built for Niagara Falls Power Co.

Induction-Motor Magnetizing Current

Calculating Induction-Motor Magnetizing Current, C. M. Laffoon. Elec. World, vol. 73, no. 24, June 14, 1919, pp. 1258-1262, 25 figs. Equation connecting magnetomotive force and effective magnetizing current, and magnetizing currents for polyphase induction motors are calculated from relation between counter electromotive force, flux and magnetomotive force.

The Design of Large Induction Motors for Steel Mill Work, H. L. Barnholdt, Elec. Jl., vol. 16, no. 6, June 1919, pp. 251-255, 9 figs. Success in this industry attributed to continuity of service which alone electricity is capable of giving over long periods of time.

Mill-Type Motors

Direct Current Mill-Type Motors for Steel Mill Auxiliary Drives, J. D. Wright. Gen. Elec. Rev., vol. 22, no. 5, May 1919, pp. 323-331, 19 figs. Compares details of construction of enclosed-frame and open-frame type motors, and furnishes information concerning ratings, brushes, bearings, and poles of various sizes of motors.

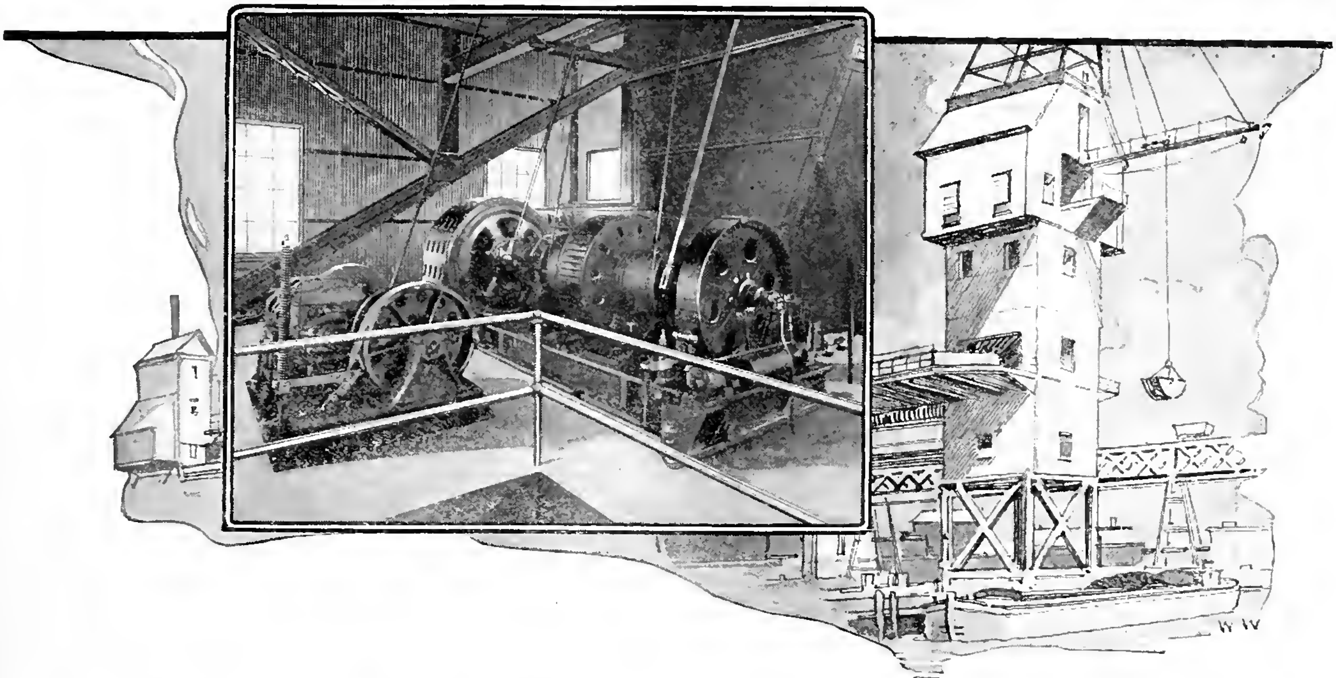
Mine-Type Motors

Mine-Type Motors, L. C. Mosley. Gen. Elec. Rev., vol. 22, no. 5, May 1919, pp. 348-351, 8 figs. Distinctive features claimed are: Heavy construction and mounting of back-gear bracket on stator frame.

Rating

The Continuous-Rated Motor and Its Application, L. F. Adams. Sci. Am. Supp., vol. 87, no. 2268, June 21, 1919, pp. 398-400. Interpretation of the A. I. E. E. standardization rules as applied to motors.

Electric power equipment is handling coal under the greatest natural handicaps, faster and at less cost than is possible with steam engines.



Over 100-foot lift of two-ton bucket for three round-trips per minute

AT the Baltimore Consolidated Gas, Electric Light and Power Company this hoist can handle a two-ton bucket with a vertical lift of 115 feet at the rate of three round-trips per minute. This is a capacity in excess of anything which has been claimed for similarly constructed steam-operated towers. It has been made possible by designing a motor with low fly-wheel effect, to permit rapid starting, stopping and reversing.

In applying electrical apparatus to coal and ore handling equipment, our engineers study the detailed requirements of each builder's machine, and co-operate to bring out its best individual features.

General Electric Company

General Office **Schenectady, N.Y.**

43-217

Regulation

Regulation Without Loss of Energy of Three-Phase Motors in Rolling Mills (Ueber den derzeitigen Stand der Frage der verlustlosen Regelung von Drehstrom-Walzenzugmotoren). H. Hermans. Elektrotechnische Rundschau, vol. 36, nos. 3-4, Jan. 22, 1919, pp. 9-10, 2 figs. Refers to various methods of regulation with special reference to the three-phase-commutator motor which can be regulated by changing the turning force of the rotating field, by displacing the brushes on the commutator, or by changing the rotor tension.

Ship-Propulsion Motors

The New Mexico's Motors, A. D. Badgley. Gen. Elec. Rev., vol. 22, no. 4, Apr. 1919, pp. 255-260, 8 figs. Single winding used to give variable poles with 2.3 speed ratio. Motors are cooled by forced draft. Ratio of rotor diameter to length, largely reduced from usual practice.

Synchronous Motors

The Synchronous Motor as a Means of Reducing Costs, Rob. Treat. Gen. Elec. Rev., vol. 22, no. 5, May 1919, pp. 407-412, 7 figs. It is claimed that under usual conditions where induction motors on a circuit have lowered its power factor, the addition of a properly selected synchronous motor will improve service and increase power capacity.

Thermionic Tubes in D. C. Motor

A Small Direct-Current Motor Using Thermionic Tubes Instead of Sliding Contacts, W. H. Eccles and F. W. Jordan. Proc. Phys. Soc., Lond., vol. 31, part III, Apr. 15, 1919, pp. 151-153, 1 fig. Rotating part is ebonite disk with iron teeth on its periphery and stationary part comprises two electromagnets with their poles close to two teeth.

IGNITION APPARATUS

Bureau of Standards

Ignition Work at the Bureau of Standards, Francis B. Silsbee. Automotive Industries, vol. 40, no. 24, June 12, 1919, pp. 1294-1299. Investigation has included brief study of effects of various types of spark discharge upon power developed by gasoline engine. Conclusions have been drawn in regard to condition of temperature and voltage at which a spark plug is required to operate.

Break

Notes on the "Break" of a Magneto or Induction-Coil, Norman Campbell. Lond. Edinburgh, and Dublin Phil. Mag., vol. 37, no. 221, May 1919, pp. 481-494, 2 figs. Experiments extending over various ranges of speed mentioned as demonstrating that greatest current which can be broken without sparking is independent of speed of separation of contacts.

LIGHTING AND LAMP MANUFACTURE

Argon Lamps

Argon Lamps (Du régime de fonctionnement électrique des lampes au tungstène en atmosphère d'argon), H. Pecheux. Revue Générale de l'Electricité, vol. 5, no. 19, May 10, 1919, pp. 683-686. Influence of voltage excess on luminous intensity, with study of variations of characteristic coefficient of filaments in terms of nature of filaments and, for a given material, in terms of time during which it is subjected to action of current.

Buildings

The Lighting of Buildings. Eng. & Contracting, vol 51, no. 22, May 28, 1919, pp. 568-573. From an architectural point of view.

Colored Lights in Fog

Transmission of Colored Light through Fog, C. L. Utterback. Trans. Illuminating Eng. Soc., vol. 14, no. 3, Apr. 30, 1919, pp. 133-140 and (discussion) pp. 140-145, 2 figs. Measurements made are interpreted as indicating that an automobile light, or any searchlight, will have maximum transmission through fogs if light is composed of wave lengths from 5,300 to 5,900 only.

Engine-Terminal Lighting

Illumination of Toledo & Ohio Central Engine Terminal at West Columbus, O., R. E. Rice. Ry. Rev., vol. 64, no. 23, June 7, 1919, pp. 815-816, 2 figs. Flood lighting system adopted for illumination of adjacent yards.

Industrial Lighting

Selecting Equipment for Industrial Lighting, J. Ward Harrison and H. H. Magdsick. Elec. World, vol. 73, no. 25, June 21, 1919, pp. 1319-1321, 5 figs. Problems of color and elimination of glare. Technical data concerning lamps.

Lamp Operation and Maintenance

Data on Lamp Operation and Maintenance, C. H. Shepherd. Elec. World, vol. 73, no. 23, June 7, 1919, pp. 1215-1216, 2 figs. Data secured of system at Lincoln Park, Chicago, indicate that life of lamps depends greatly on switching in circuit.

Lighting Codes

Present Status of Industrial Lighting Codes, G. H. Stickney. Trans. Illuminating Eng. Soc., vol. 14, no. 4, June 10, 1919, pp. 153-171 and (discussion), pp. 172-208, 5 figs. Also Am. Architect, vol. 115, no. 2268, June 11, 1919, pp. 835-836. Writer looks with apprehension on laws or regulations emanating from the professions whose business they affect most directly. He claims that investigation and experience indicate need of Government regulation for factory lighting. Codes adopted in various States and in Federal establishments are discussed. Location of controlling switches. Bibliography.

Mercury-Arc Tube

Mercury Arc Tube Operation, R. W. Kidd. Jl. Electricity, vol. 42, no. 11, June 1, 1919, pp. 527-528, 3 figs. Diagram of connections and remarks on care required by apparatus.

Street Lighting

A Modern Ornamental Street Lighting System, Wm. O. Kleine. Am. City, City Edition, vol. 20, no. 6, June 1919, pp. 535-537, 5 figs. Cast iron standards about 13 ft. 4 in. high carrying 600 c-p. Mazda C lamps used in Cincinnati.

MEASUREMENTS AND TESTS

Alternator Testing

Alternator Testing Under Reduced Power (Essai à puissance réduite des alternateurs), M. Togna. Revue Générale de l'Electricité, vol. 5, no. 22, May 31, 1919, pp. 779-787, 22 figs. Method for determining magnetization and short circuit diagram by generalization of diagrams of Potier and Blondel.

Axle Generators

How One Road Tests Its Axle Generators, J. Doornbein. Ry. Elec. Engr., vol. 10, no. 6, June 1919, pp. 169-171, 5 figs. Testing equipment of Grand Trunk Ry., which is said to have been designed to operate under all varying conditions of speed, stop and reversals, the same as in actual operation.

Meters

A Method of Calibrating Meters, H. Gewecke and W. von Krukowski. Elecn., vol. 82, no. 23, June 6, 1919, pp. 644-645, 1 fig. Method by which revolutions of disk are automatically recorded. From Elektrotechnische Zeitschrift, no. 36, 1918.

Installation and Testing of Primary Meters, Halbert R. Thomas. Elec. World, vol. 73, no. 23, June 7, 1919, pp. 1212-1214, 3 figs. More attention is believed to be demanded at present time than formerly because tendency is to supply large consumers with energy at 2,200 volts, metering on the primary side.

Phase Rotation

Power Factor and Phase Rotation, Leslie F. Curtis. Jl. Electricity, vol. 42, no. 11, June 1, 1919, pp. 530-533, 8 figs. Suggests laboratory methods for determining phase rotation of voltages, phase position of currents and effective power factor.

Radiometer

An Application of the Radiometer to the Measurement of Electric Current, Thomas D. Cope. Jl. Franklin Inst., vol. 187, no. 6, June 1919, pp 734-744, 3 figs. Experiments are said to have established usefulness of instrument in measuring currents.

Voltameters

The Richards Form Silver Voltameters, Jūichi Obata. Researches of Electrotechnical Laboratory, Tōkyō, Japan, no. 76, May 1919, 21 pp., 4 figs. Richards voltameters using least permeable porous-cup septum compared with Smith form; latter reported to have given heavier deposit (about 2 parts in 100,000) than Richards. Cause of difference attributed to effect of anode liquid and not to electrostenolysis.

MATERIALS OF CONSTRUCTION

Mica

Raw Materials Needed in Electrical Industries—Mica (De quelques matières premières nécessaires à l'industrie électrique: mica), Désiré Pector. Revue Générale de l'Electricité, vol. 5, nos. 19, 20 and 21, May 10, 17 and 24, 1919, pp. 701-706, 735-740 and 769-771. Deposits in Africa, America and Oceania. Notes compiled from various official publications. Dielectric properties; extraction and preparation. Combination with various substances for making insulator. Prices quoted at various markets of the world. (Concluded.)

Paper and Cloths

On Deterioration of Insulating Papers and Cloths (In Japanese), R. Mitsuda. Denki Gakkwai Zasshi, no. 370, May 10, 1919.

POWER APPLICATIONS

Agriculture

Electrical Plowing and Mechanical Agriculture in France. Elec. Rev., vol. 74, no. 24, June 14, 1919, pp. 985-987, 4 figs. Description of equipment and comparison of costs of plowing by gasoline engine and electric motor. From Revue Générale de L'Electricité.

Centrifugal-Machine Drive

Centrifugal Machines and their Adaptability to Electric Motor Drive, H. W. Rogers. Gen. Elec. Rev., vol. 22, no. 5, May 1919, pp. 413-420, 9 figs. Formulæ and curves offered as help in selecting proper motor for a given installation.

Heating

Experience with Electric Heating in the Northwest, J. D. Ross. Jl. Electricity, vol. 42, no. 12, June 15, 1919, pp. 566-568. Data presented as part of testimony before Idaho Public Utilities Commission in connection with study of economical generation of electric energy.

Heating of Buildings by Electricity, V. H. Greisser. Jl. Electricity, vol. 42, no. 12, June 15, 1919, pp. 564-566, 2 figs. Data of possibilities in electric heating for homes and office buildings; prepared by Washington Water Power Co.

Electricity in Household Service, H. C. Hoyt. Gen. Elec. Rev., vol. 22, no. 3, Mar. 1919, pp. 156-195, 55 figs. Illustrating various uses in lighting, supplying power for driving domestic utilities and heating and cooking.

Melting

Application of Electrical Energy to the Melting of Metals, W. A. Greaves. Eng. & Indus. Management, vol. 1, no. 15, May 22, 1919, pp. 462-464, 8 figs. Induction furnace is not considered as commercially satisfactory, owing to loss in efficiency caused by metal being in form of ring, which is said to bring about extremely high heat losses.

Oil Wells

The Operation of Oil Wells by Electric Power and the Resulting Gain to the Oil Producer, W. G. Taylor. Gen. Elec. Rev., vol. 22, no. 5, May 1919, pp. 384-394, 20 figs. Safety, reliability and convenience mentioned as advantages. Tables of comparative costs are presented.

Paper Mills

Electrification of Paper Mill Finishing-room Machinery, W. T. Edgell, Jr. Gen. Elec. Rev., vol. 22, no. 5, May 1919, pp. 399-406, 13 figs. Results obtained by Strathmore Paper Co., Woronoco, Mass.

Rod and Wire Mills

Electricity in the Making of Copper Wire. Jl. Electricity, vol. 42, no. 12, June 15, 1919, pp. 569-570, 3 figs. Rod and wire mill of Anaconda Copper Mining Co. with capacity of 100,000 lbs. of rods and 50,000 lbs. wire every 8-hour shift.

Soaking Pits

Electric Soaking Pits and Furnaces, T. F. Bailey. Blast Furnace & Steel Plant, vol. 7, no. 6, June 1919, pp. 264-267, 1 fig. Labor saving, precision of treatment produced and elimination of rejection of parts due to defective heat treatment. Paper read before Am. Iron and Steel Inst.

Steel Mills

Electric Drive for Steel Mill Main Rolls, K. A. Pauly. Gen. Elec. Rev., vol. 22, no. 5, May 1919, pp. 308-322, 23 figs. Examples of various installations with tables indicating characteristics of units employed.

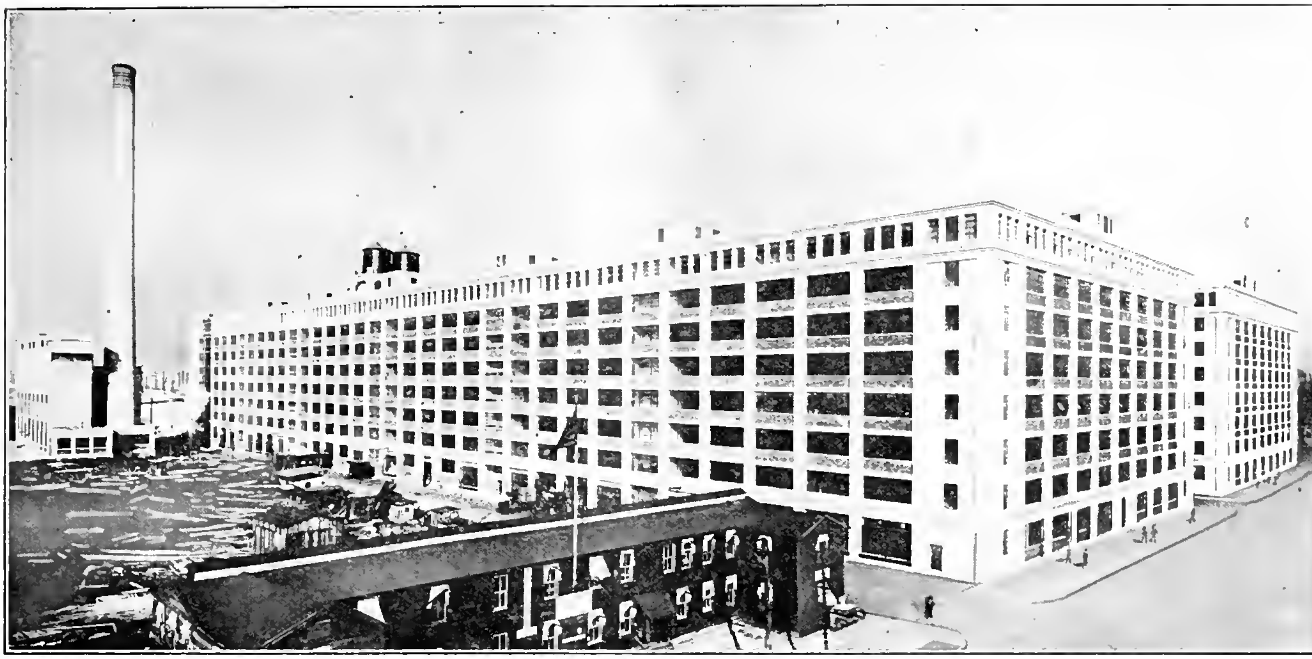
Transportation

Use of Electrical Equipment on San Francisco Water Front, Charles W. Geiger. Elec. Rev., vol. 74, no. 24, June 14, 1919, pp. 977-981, 4 figs. Methods of operating electric trucks, tractors, conveyors and piling machines to relieve traffic.

STORAGE BATTERIES

Lead Storage Batteries

On Lead Storage Batteries (In Japanese), J. Iwashiro. Denki Gakkwai Zasshi, no. 370, May 10, 1919.



U. S. Naval Supply Base, South Brooklyn, N. Y.

equipped with three Green's Fuel Economizers.
Turner Construction Co., Contractors.

U. S. Government Saving Money

BY USING

GREEN'S FUEL ECONOMIZERS

The economizers are grouped in three units, one being installed above each battery of two 440 H. P. boilers.

They raise the temperature of the incoming heating returns and make up water 100° F. under boiler pressure, insuring the highest practical feed temperature.

The fuel which would otherwise be used for heating this water in the boilers is saved and the ultimate steaming capacity is materially increased.

Power plant equipment that passes the rigid specification and tests by the U. S. Navy is safe for you to buy. Millions of boiler horse-power equipped with Green's Fuel Economizers are the best proofs of their reliability and high fuel economy established in public service, institutional and industrial plants.

Our engineers will be pleased to furnish full details regarding their application to your boiler plant. Write.

THE GREEN FUEL ECONOMIZER Co.
BEACON, N. Y.

TELEGRAPHY AND TELEPHONY

Radio

Antennæ

Radiation and Direction of Field of Certain Types of Unenclosed Antennæ (Die Strahlung und Richtwirkung einiger Luftdrahtformen im freien Raum), W. Burstyn. Jahrbuch der drahtlosen Telegraphie und Telephonie, vol. 13, no. 5, Jan. 1919, pp. 362-378. Radiation characteristics of various forms for different directions in space.

Quantitative Experiments with Coil Antennas in Radio-telegraphy, L. W. Austin. Jl. Wash. Acad. Sciences, vol. 9, no. 12, June 19, 1919, pp. 335-339. Equations show that, other things being equal, if an antenna be used, both for sending and receiving, the received current falls off as the wave length, while if one coil be used, it falls off as the square of the wave length and with two coils as the cube of the wave length.

Audions

See Vacuum Tubes.

Measurements

A New Method of Using Contact Detectors in Radio Measurements, Louis W. Austin. Proc. Inst. Radio Engrs., vol. 7, no. 3, June 1919, pp. 257-259, 1 fig. Based on use of low-resistance shunt across detector and galvanometer and calibration of arrangement using radio frequency currents which can be measured with hot-wire instruments.

Musical Sounds

Emission of Musical Sound in Radio Telegraphy (Note sur un problème d'émission musicale en radiotélégraphie), T. Minohara. Revue Générale de l'Electricité, vol. 5, no. 21, May 24, 1919, pp. 747-752, 4 figs. Technical determination of conditions for producing it.

Oscillations

Electrical Oscillations in Antennas and Inductance Coils, John M. Miller. Proc. Inst. Radio Engrs., vol. 7, no. 3, June 1919, pp. 299-326, 12 figs. After considering theory of circuits having uniformly distributed constants, writer shows graphically frequency-variation of reactance of such circuits and, after further analysis, those of inductance-loaded and capacity loaded antennas.

Poldhu Wireless Station

Great Wireless Stations, Poldhu. Wireless World, vol. 7, no. 73, Apr. 1919, pp. 1-5, 5 figs. Plant is rated at 75 kw.; normal transmitting wave length is 2,800 meters and the daylight range is given as 1,800 miles.

Poulsen

On the Poulsen Arc and Its Theory, P. O. Pedersen. Proc. Inst. Radio Engrs., vol. 7, no. 3, June 1919, pp. 293-297, 2 figs. Continuing discussion of sustained oscillation of the first or second type produced by Poulsen arcs (see roc. Inst. Radio Engrs., vol. 5, no. 4, p. 25) writer derives approximate value of peak voltage required for maintenance of such oscillations.

Receivers

Radiotelegraphic Receivers of the Italian Navy (Ricevitori radiotelegrafici della R. Marina), G. Vallauri and G. de Luigi. Elettrotecnica, vol. 6, no. 13, May 5, 1919, pp. 254-258, 5 figs. Description of three types used by Italian Navy.

The Possibilities of Concealed Receiving Systems, A. Hoyt Taylor. Proc. Inst. Radio Engrs., vol. 7, no. 3, June 1919, pp. 261-266, 2 figs. Closed 3-meter square loop of 16 turns of wire hung about 1.5 meters from ground, said to have given good service for reception from stations as distant as 3,000 miles.

Static

Reception through Static and Interference, Roy A. Weagant. Proc. Inst. Radio Engrs., vol. 7, no. 3, June 1919, pp. 207-244 and (discussion) pp. 245-256, 31 figs. Effect produced by static (stray) considered and Eccles classification of static as "grinders," "clicks" and "hissing" adopted.

Weagant's Anti-Static Invention—II, Elmer E. Bucher. Wireless Age, vol. 6, no. 10, July 1919, pp. 11-21, 25 figs. Experiments made with two loops, each consisting of a single turn of wire extending out from station and back again, as measure to overcome troubles incident to use of loops with long low leads; forms of Weagant's antennæ.

Telephone Transmitters

Wireless Telephone Transmitter for Seaplanes. Wireless Age, vol. 6, no. 9, June 1919, pp. 14-19, 7 figs. Flying Boat type S. E. 1,100, developed by American Marconi Co. for navy use during war.

Telephony

Recent Progress of Wireless Telephony (Sur les recents progès de la téléphonie sans fil), C. Gutton. Bulletin de la Société Française des électriciens, vol. 9, no. 80, May 1919, pp. 323-332, 6 figs. In Europe and in the U. S. A.

Trees

Tree Telephony and Telegraphy, George O. Squier. Jl. Franklin Inst., vol. 187, no. 6, June 1919, pp. 657-687, 13 figs. From experiments it is concluded that a growing tree is a highly organized piece of living earth which can be used in the same manner as the earth is used now as a universal conductor for telephone, telegraph and other electrical purposes.

Vacuum Tube

Cascade Amplification by a Single Vacuum Tube. Wireless Age, vol. 6, no. 10, July 1919, p. 23, 2 figs. Principle of operation is: Input e.m.f. is impressed between first section of cathode and its associated input element, and serves to vary discharge from cathode section to another electrode which is maintained positive with respect to cathode section.

The Three-Electrode Audion Lamp as Amplifier in Ordinary Telephony (La lampada a tre elettrodi (Audion) come ripetitore-amplificatore nella telefonia ordinaria), G. Marchesi. Elettricista, vol. 8, no. 10, May 15, 1919, pp. 73-77, 6 figs. Account of research undertaken by various experimenters.

External-Anode Vacuum Tube, H. P. Donle. Elec. World, vol. 73, no. 23, June 7, 1919, pp. 1204-1206, 9 figs. Filament, control electrode and anode are disposed as follows: Filament is surrounded by control electrode which consists of helical coil of drawn tungsten wire; these two elements are the only ones inside tube, anode being a silver coating applied directly to outside of vacuum tube on that portion surrounding filament and control electrode.

Wire

Cables

Accelerating Operation of Submarine Cables (Exploitation accélerée sur les longs câbles sous-marins). Revue Générale de l'Electricité, vol. 5, no. 22, May 31, 1919, pp. 802-804, 3 figs. Heurtley amplifier. German account of British apparatus. Translated from Archiv für Post und Telegraph.

Ocean Cable Receiving Instruments. Telegraph & Telephone Age, no. 11, June 1, 1919, pp. 255-258, 4 figs. Wiring diagrams of Gulsted relay, Brown "drum" relay and Heurtley magnifier.

Induction, Self-

Regarding the Propagation of High-Speed Telegraph Signals on Lines with Increased Self-Induction (Über die Fortplanzung schnelltelegraphischer Zeichen auf Leitungen mit vergrösserter Selbstinduktion), Ragnar Holm. Archiv für Elektrotechnik, vol. 7, nos. 9 and 10, Feb. 17, 1919, pp. 263-292, 6 figs. Discussion of formulæ on hand of curves. The law of reflection of a coil. Main equations for pupinized lines.

Measurements

On Measurement of Signal Strength, W. H. Eccles. Proc. Inst. Radio Engrs., vol. 7, no. 3, June 1919, pp. 257-280, 11 figs. "Shunted telephone" method for measuring audibility of received signals.

Relays

Relays Used in Taansoceanic Telegraphy (Relais employés en télégraphie sous-marine), J. B. Pomey. Revue Générale de l'Electricité, vol. 5, no. 22, May 31, 1919, pp. 797-801, 7 figs. With remarks on resonance relays.

Telephones, Service

The Telephone Service of Large Cities, with Special Reference to London, E. A. Laidlaw and W. H. Grinstead. Electrical Review, vol. 84, no. 2165, May 23, 1919, pp. 641-643. While holding as true that subscriber's estimate of telephone service is only criterion of satisfactory service, writer points out, however, certain factors inherent to human deficiencies of operators and concludes that there is a limit in exactness which can be expected from equipments of manual type.

TRANSFORMERS, CONVERTERS, FREQUENCY CHANGERS

Converter, Cabot

The Cabot Converter, Claude F. Cairns. Proc. Inst. Radio Engrs., vol. 7, no. 3, June 1919, pp. 281-291, 4 figs. Describes combination of a few-phase primary and many-phase secondary transformer and a secondary circuit commutator driven by a synchronous motor.

Transformer Connections

Parallel Running of Transformers Fed from the Same System or from Different systems (La pratique de la mise en parallele des transformateurs alimentes par le meme reseau ou par deux reseaux), B. Guerschinovitch. L'Industrie Electrique, vol. 28, no. 645, May 10, 1919, pp. 164-167, 4 figs. Tests required when connecting two systems in parallel. (Concluded.)

The Essentials of Transformer Practice—XXIII, E. G. Reed. Elec. Jl., vol. 16, no. 6, June 1919, pp. 267-268, 3 figs. Curve showing how vector sum of currents in two transformers connected in parallel compares to numerical sum with variable phase angle between currents.

Transformer Costs

Cost Comparison of Transformer Types, B. C. Dennison. Elec. World, vol. 73, no. 22, May 31, 1919, pp. 1152-1155, 5 figs. Comparison between five types of single-phase transformer designed from same specifications. It is concluded that for any type of transformer the design for dimensions that will reveal a given rating at minimum cost should be based upon (1) ratio of core section to coil section, (2) ratio of height of opening to width of opening, and (3) ratio of core depth to core width.

Transformer Dimensions

The Numerical Solution of the Equations of Transformer Dimensions, A. R. Low. Elecn., vol. 82, no. 24, June 13, 1919, pp. 671-673, 3 figs. Reduction of conditions for minimum loss with given output and cost found by application of Lagrange's method and outlined in Elecn., Nov. 15, 1918.

TRANSMISSION, DISTRIBUTION, CONTROL

Arresters, Electrolytic

Experiences with Electrolytic Arresters. Elec. World, vol. 73, no. 24, June 14, 1919, pp. 1269-1272, 5 figs. Tests at 110 stations of Southern California Edison Company are interpreted as indicating need of giving particular attention to condition of horn gaps, film and electrolyte, oil, and line and ground connections.

Cable Characteristics

High-Tension Single-Conductor Cable for Polyphase Systems, W. S. Clark and G. B. Shanklin. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 6, June 1919, pp. 663-715, 24 figs. Dielectric, inductive and general line characteristics of three-conductor and single-conductor cable are compared. It is asserted that line voltages of 44,000 and 55,000 are perfectly practical and mean a saving in copper over three-conductor cable of as much as 70 per cent.

Cables, Underground and Overhead

Underground and Overhead Alternating Current Maximum Power Cables (Unterirdische und oberirdische Wechselstrom-Hochstleistungskabel), W. Kummer. Schweizerische Bauzeitung, vol. 73, no. 19, May 10, 1919, pp. 213-216, 3 figs. Discusses advantages and disadvantages of overhead and underground cables, with special reference to advantages of underground cables as per technical data of Dr. Paul Humann.

Condensers, Synchronous

Notes on the Application of Synchronous Condensers to Large Power Systems, G. V. Adendorff. Trans. South African Inst. Elec. Engrs., vol. 10, part 3, Mar. 1919, pp. 33-43, and (discussion) pp. 43-48, 5 figs. and supp. plate. Rotary condenser treatment is held to be necessary only in such cases where original design of generating plant has not been specified to type of demand it has to meet.

Distribution, Factory

The Electrical Equipment of H. M. Factory, Gretna, A. S. Cross. Electrical Review, vol. 84, no. 2167, June 6, 1919, pp. 652-654, 6 figs. Lighting, performance and distribution. High-tension supply fed to eight substations extending about 4½ miles from power house over two overhead systems situated 150 ft. apart. (Concluded.)

Electrolysis

Electrolysis and Modern Cable Construction, W. W. Walsh. Assn. Iron & Steel Engrs., Apr. 1919, pp. 7-24 and (discussion) pp. 24-32, 1 fig. General conclusions drawn from study of case in which pipe is considered as running parallel to track, in which case potential between rails and pipe is considered as positive at end farthest from power house, polarity being reversed in region adjacent to power house.

Feeders

Losses in Feeders (Pertes dans les feeders), W. Vuillemier. Bul. Technique de la Suisse Romande, vol. 45, no. 9, May 3, 1919, pp. 7-8 and 80. Graphs for determining ohmic and induction losses. Percentage of losses is consid-

The Taylor Stoker

–more than a "Stoker"

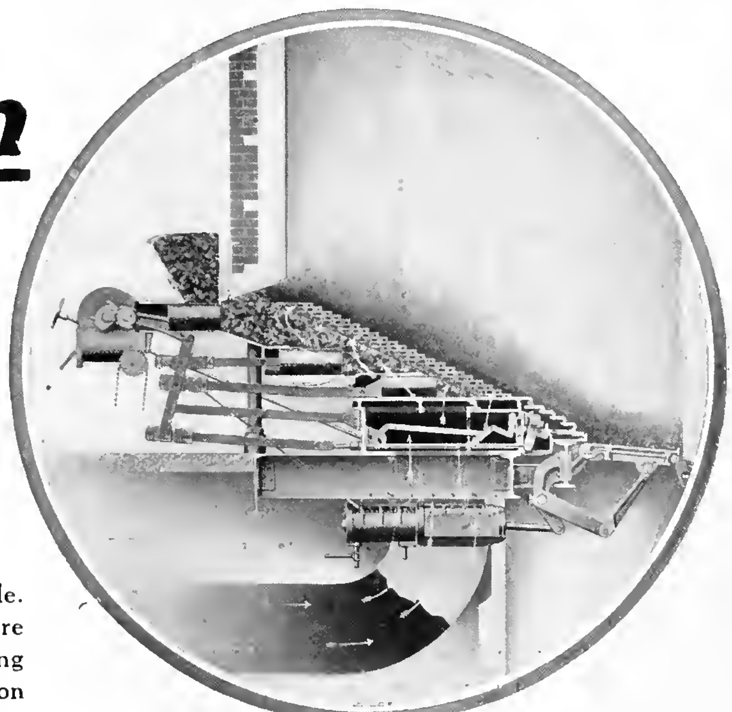
A Complete SYSTEM of Scientific Combustion

How the

Taylor System

meets the 6 basic demands of boiler plant efficiency:

3-Utmost Simplicity



The Taylor Stoker is remarkably rugged and simple. There are no moving parts in the fire. There are only 4 mechanical elements—(A) a series of sloping passages, called retorts. (B) a series of cast-iron tuyere boxes and tuyeres, (C) a series of low-moving rams for feeding and distributing the coal, (D) a dump plate, hand or power operated. To burn any given **grade** of coal, or meet any given **steam demand**, you simply regulate the rate of coal feeding and the forced draft, so that they are correctly proportioned. In this way, it is a simple matter to jump Taylor-Stokered boilers quickly from 50 to 300% of rating. And to clean the fire (while running) simply move the levers controlling the dump plates and get a CLEAN dump in 20 seconds. The Taylor Stoker is **simple.**

Send for the new Taylor Stoker Catalog, Engineers' Edition

THE 6 DEMANDS

When the American Smelting and Refining Co. of Omaha, Neb., installed Taylor Stokers, these were their six boiler plant requirements:

1. Continuous operation
2. Minimum Labor
3. Utmost simplicity
4. Ready Accessibility
5. Maximum capacity
6. Provision for future plant growth

How Taylor Stokers meet these demands is told in this series of advertisements.

ÆCO

American Engineering Company

Philadelphia

Foreign Licensee: Babcock & Wilcox, Ltd., Oriel House, Farringdon Street, London, England

The TAYLOR System of Scientific Combustion **The Taylor Stoker**

ered as varying inversely with square potential and directly with power.

Grounding

Grounding the Neutral of Generating and Transmission Systems, H. R. Woodrow. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 6, June 1919, pp. 745-749, 4 figs. Admitting his experience has shown that stresses on cables are relieved materially by grounding, writer, however, further believes that it is desirable to limit this grounding current as much as possible, thereby, he says, reducing stresses on system and particularly burning of lead sheath on grounding connections.

Interconnection

Interconnection of California Power Systems, P. M. Downing. Power Plant Eng., vol. 23, no. 13, July 1, 1919, pp. 580-582, 2 figs. Divided into a northern and a southern group of connected lines. Map indicating scheme of connections is presented.

Phase

Three-Phase Four-Wire Distribution, G. E. Wagner. Power Plant Eng., vol. 23, no. 11, June 1, 1919, pp. 507-510, 7 figs. Discussion of possible advantages and disadvantages and suggestions in regard to preventing troubles.

The Electrical Properties of Three-Phase Transmission lines, E. Parry. New Zealand Jl. of Sci. & Technology, vol. 2, no. 2, Mar. 1919, pp. 127-150, 3 figs. Tables applicable to sizes of conductors generally employed for transmission line work.

Power Transmission Practice

Power Transmission, H. B. Vincent. Jl. Engrs. Club of Philadelphia, vol. 36, no. 175, June 1919, pp. 220-227, 9 figs. General study of problems and obstacles confronting operating man whose function is to provide continuity of service on high-tension power transmission lines. Paper read before Assn. Iron & Steel Elec. Engrs.

Relay Protection

Transmission Line Relay Protection, H. R. Woodrow, D. W. Roper, O. C. Traver and P. MacGahan. Proc. Am. Inst. Elec. Engrs. vol. 38, no. 6, June 1919, pp. 631-662, 19 figs. Summary of replies received from 32 operating companies by Protective Devices Committee of Am. Inst. Elec. Engrs., in answer to questionnaire asking for their experience and present practice in regard to relay protection.

Substations

900 Kw. Substation, installed in 3-phase, 5,250 Volt, 50 Cycle Network of the Compagnie d'Electricité de Marseille (Poste de 900 kw. installé sur les canalisations triphasées, 5,250 v. 50 p:sec. de la Compagnie d'Electricité de Marseille), A. Racapé. Revue Générale de l'Electricité, vol. 5, no. 21, May 24, 1919, pp. 757-768, 7 figs. General plan and details of installation.

A Novel City Substation, Roy R. Kime. Elec. Eng., vol. 53, no. 6, June 1919, pp. 260-263, 4 figs. By reason of station being located in thickly populated New York district, dimensions of floor plan are only 24 ft. x 100 ft., although building is to contain 12,500 kva. of electrical apparatus.

Switchgear

European High-Voltage Switchgear, W. A. Coates. Elec. Jl., vol. 16, no. 6, June 1919, pp. 243-248, 13 figs. Pointing out particularly difference between British designs and those of Continental Europe. While in Great Britain transmission voltages over 15,000 to 20,000 are rarely needed, on the Continent there are in operation systems working at pressures up to 110,000 volts.

Transient Phenomena

The Effect of Transient Voltages on Dielectrics II. The Effect of Lightning Voltages on Arrester Gaps, Insulators and Bushings on Transmission Lines, F. W Peek, Jr. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 6, June 1919, pp. 717-744, 17 figs. It is concluded that there is a great difference in the relative lightning spark-over voltages of different gaps as well as in the settings imposed by operating conditions, and it is advised that both of these factors be considered in comparing relative protective values.

Transmission-Line Surveys

The Location of Long-Distance Electric Transmission Lines, G. F. Anderson. New Zealand Jl. of Sci. & Technology, vol. 2, no. 2, Mar. 1919, pp. 95-108, 7 figs. Methods which are said to have been found necessary in field and in office in order to expedite work of surveying and of plotting results.

WIRING

Hotel

Electric Service in World's Largest Hotel — II. Elec. World, vol. 73, no. 22, May 31, 1919, pp. 1159-1163, 7 figs. Electric laundry installation; details of wiring on portion of a guest-room floor.

Mines

Wiring at Mines, Jack L. Ball. Coal Age, vol. 15, no. 23, June 5, 1919, pp. 1040-1041, 1 fig. It is suggested that wiring of mine be installed with as much care as in a residence, factory or similar building. This, it is said, will contribute to securing better results and large measure of safety.

Pulling Conductors Into Conduits

Pulling Conductors into Conduits, Terrell Croft. Power, vol. 49, no. 22, June 3, 1919, pp. 846-848, 10 figs. Discusses various matters and offers suggestions in regard to precautions to observe during work.

Standardization

Industrial Maintenance and Rehabilitation Methods, E. E. George. Elec. World, vol. 73, no. 22, May 31, 1919, pp. 1167-1170, 2 figs. Arguments for use of 115 volts direct-current supply instead of 230 volts; savings affected by standardization of methods and materials.

Wire, Insulated

Insulated Conductors in Relation to Cheap Wiring, C. Beaver. Elecn, vol. 82, no. 24, June 13, 1919, pp. 679-680, 2 figs. Describes method of manufacturing twin wire for circular section in which a central strip of vulcanized rubber insulates wires.

VARIA

Electromagnets and Solenoids

The Construction of 120- and 240-Volt Electromagnets and Solenoids, Henry W. Townsend. Power, vol. 49, no. 23, June 10, 1919, pp. 888-890, 6 figs. Data are given of construction of a number of 120- and 240-volt electromagnets and solenoids.

Lightning Protection

Protecting Oil Storage Tanks from Lightning Oliver Lodge. Petroleum World, vol. 16, no. 224, May 1919, pp. 198-199; also in Petroleum Times, vol. 1, no. 19, May 17, 1919, pp. 409-410. Attachment of lightning conductors to tanks not considered advisable. It is held that metal tanks, not over-elevated and not specially earthed, with good joints and free from leaks, are safe from lightning. Report of chief of petroeum executive containing views of various owners of petroleum tank installations.

Civil Engineering

BRIDGES

Barriers

Yielding Barriers Close Roads at Drawbridges. Eng. News-Rec., vol. 82, no. 24, June 12, 1919, pp. 1168-1170, 2 figs. Impact of vehicles absorbed by traveling gate to stop motor trucks, and by cables to stop automobiles.

Bascule Bridges

New Bascule Bridge at La Seyne. Engineer, vol. 127, no. 3308, May 23, 1919, p. 502, 10 figs. partly on supplement plates. Lifting truss about 138 ft. long is movable around horizontally placed pin, housed in forward feet of trestle-like structure which is so situated than when truss is in vertical position entrance to harbor is entirely unobstructed.

Caissons

Pneumatic Caissons with Wooden Cylinders for Sinking Bridge Piers. Eng. & Contracting, vol. 51, no. 22, May 28, 1919, pp. 562-564, 3 figs. Pneumatic caisson of pivot pier was octagon 30 ft. on side, and walls consisted of one width of 10 x 10-in. timbers planked outside and inside.

Concrete Bridges

Reinforced Concrete Bridges and Their Architectural Treatment, F. G. Engholm. Cement & Eng. News vol. 31, no. 6, June 1919, pp. 21-23, 2 figs. Writer emphasizes what he terms "error of trying to produce a living structure by using forms associated with other materials."

Safe Stress in Reinforced-Concrete Bridge Arches (Zur Frage der zulässigen Spannungen in Beton-Brückengewölben), A. O. Lasser. Schweizerische Bauzeitung, vol. 73, no. 18, May 3, 1919, pp. 201-205, 4 figs. Compares safe stresses in plain and reinforced concrete. Reference is made to experiments by Bach and Graf. Curves showing breaking load of plain concrete columns and that of columns with 0.5 per cent iron reinforcement.

Delaware River Bridge

The Placement of the Delaware River Bridge, Warren P. Laird. Jl. Engrs. Club of Philadelphia, vol. 36, no. 175, June 1919, pp. 209-219, 9 figs. Based upon investigation conducted by writer as consulting architect to Delaware River Bridge and Tunnel Commission of Pennsylvania and Interstate Bridge and Tunnel Commission of New Jersey.

Electrical Equipment

Electrical Equipments for Movable Highway and Railway Bridges, H. H. Vernon. Gen. Elec. Rev., vol. 22, no. 5, May 1919, pp. 373-383, 31 figs. Equipments applicable to various types of movable span bridges are illustrated.

Genesee River Bridge

Rebuilding the Genesee River Bridge, Lehigh Valley R.R., at Wadsworth, N. Y. Ry. Rev., vol. 64, no. 25, June 21, 1919, pp. 947-950, 5 figs. Total length of structure, about 1311 ft. Reconstruction work is said to have involved purchase of new steel to the total weight of 3,308,000 lb.

Inspection

Points Requiring Special Observation and Investigation in Bridge Inspection, Herbert C. Keith. Eng. & Contracting, vol. 51, no. 26, June 25, 1919, pp. 681-683. Secondary stresses due to large gusset plates, investigation of compression members, decay of timber stringers, corrosion of beams and similar points. Paper presented before Brooklyn Engrs. Club.

Pontoon Bridges

Improved Form of Pontoon Bridge for Public Use. Eng. & Contracting, vol. 51, no. 26, June 25, 1919, pp. 689-691, 5 figs. Bridge over Rhine river composed of 14 sections—two draw sections equipped with steam winches, eight regular fixed sections, and at ends two short ramp sections.

Swing Bridges

Graphic Study of Stresses in Swing Bridges (Swing Bridges. Análisis racional y gráfico de sus resistencias), Rafael Agudelo C. Boletin de la Sociedad Antioquena de Ingenieros, vol. 4, nos. 4-5, pp. 52-63, 13 figs. Illustrates method of Professor F. la Rue by applying it to bridge of 12 spans, each 20 ft. long.

BUILDING AND CONSTRUCTION

Beams

How to Find the Proper Size Steel Beams for various Spans, George E. Thackary, and W. A. Giesen. Building Age, vol. 41, no. 6, June 1919, pp. 183-184. Table showing steel beams required for given span.

Churches

A Reinforced Concrete War Memorial Church. Building News, vol. 116, no. 3360, May 28, 1919, pp. 327 and 334-337, 6 figs. Semi-elliptical vaults of uniform thickness and springing directly from floor level take place of walls and roofs. Method is patented.

Concrete Structures

The Fitting of Machinery, etc. to Ferro-Concrete Structures—III. Mech. World, vol. 65, no. 1690, May 23, 1919, p. 246, 8 figs. Type used in case where it is desired to give light from a floor to a room or compartment below, as in the fore or after peak of vessels. (Concluded.)

Cost

Overhead and Time Cost to Erect Elevated Railway, A. P. Roscoe. Eng. News-Rec., vol. 82, no. 24, June 12, 1919, pp. 1164-1166. Nine hours per ton said to have been required to haul, erect, rivet and paint 13,500-ton structure.

Factories

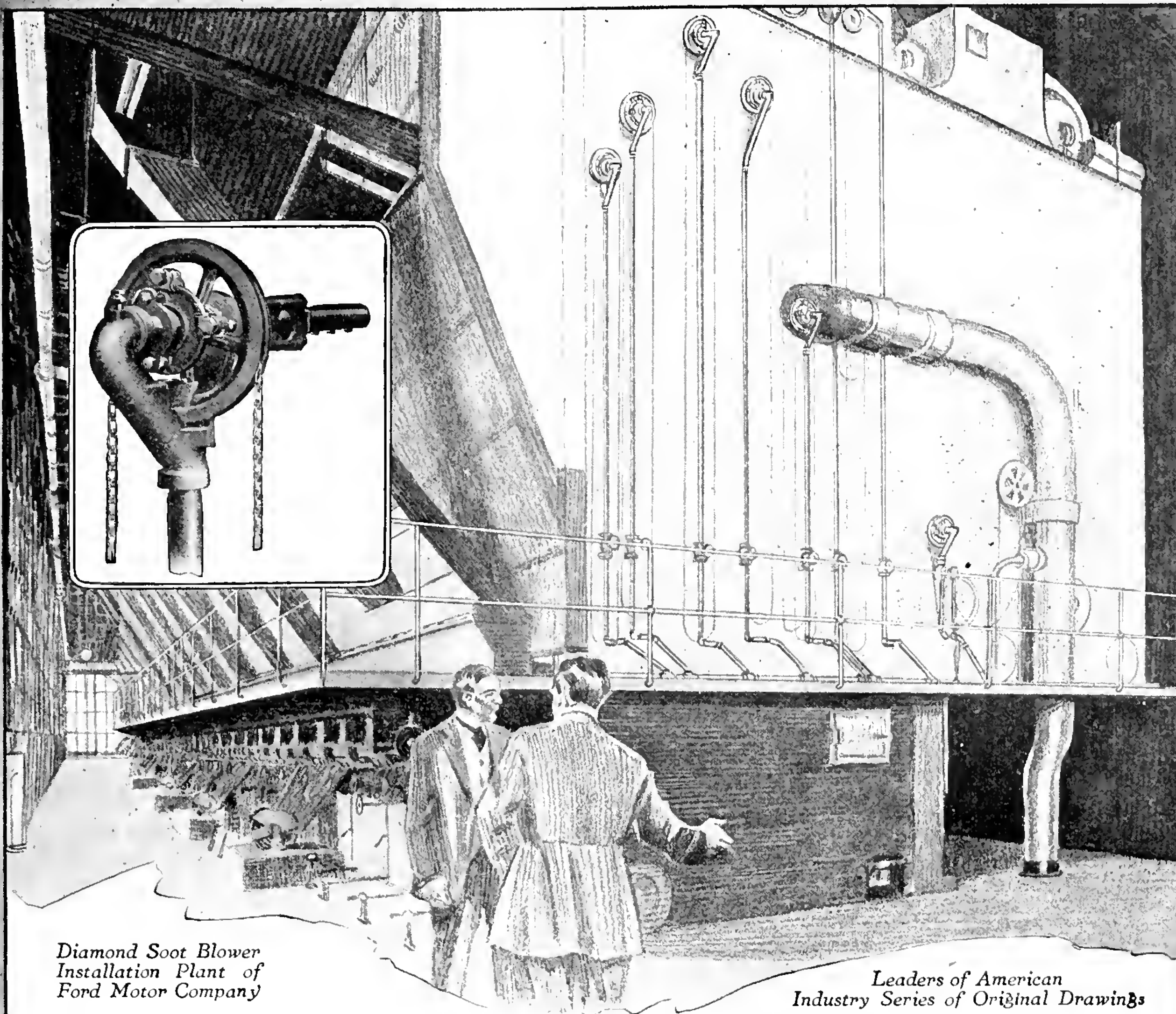
The Building of Factories—IV, Arthur F. Wickenden. Eng. & Indus. Management, vol. 1, no. 17, June 5, 1919, pp. 528-529, 1 fig. Methods of construction; choosing between brick structure with timber or concrete floors and with timber or steel roofs; composite buildings of steel and brickwork, with similar varieties of roofs and floors as above; steel-framed structures; reinforced-concrete buildings.

Foundry

A Model Brass Foundry Building, Charles Vickers. Brass World, vol. 15, no. 6, June 1919, pp. 187-191, 6 figs. Structure providing facilities for comfort of workers both in summer and winter.

Plumbing

Back Venting versus Simplified Plumbing.



Diamond Soot Blower Installation Plant of Ford Motor Company

Leaders of American Industry Series of Original Drawings

Am. Architect, vol. 115, no. 2267, June 4, 1919, pp. 795-804, 6 figs. Various systems are illustrated, notably those in use in U. S. Government buildings and conforming to N. Y. City regulations.

Stacks

Reinforcing Steel Stacks with Gunite Concrete. M. C. Sherman. Power, vol. 49, no. 21, May 27, 1919, pp. 808-809, 4 figs. Work carried out by building reinforcing self-supporting shells around the stacks and then employing cement guns.

Steel Structures

The Design of Steel Structures. Albert S. Spencer. Surveyor, vol. 55, no. 1424, May 2, 1919, pp. 326-327. General remarks on various points which writer advises to consider carefully in applying theory of structures. Paper read before Concrete Inst.

Tanks

Tank Construction—XXVIII. Ernest G. Beck. Mech. World, vol. 65, no. 1692, June 6, 1919, p. 270, 6 figs. Side walls of rectangular tanks. (Continuation of serial.)

Vibrations

Methods of Preventing the Transmission of Vibrations in Buildings. A. B. Eason. Electrical Review, vol. 84, no. 2168, June 13, 1919, pp. 684-685, 7 figs. Suggests that when different materials are being used for supports, hard materials, such as iron, be placed next soft ones, such as felt and cork.

Walls

Wall Construction at Norfolk Army Supply Base by Cement Gun Process. Eng. & Contracting, vol. 51, no. 22, May 28, 1919, pp. 574-575, 4 figs. Over 500,000 sq. ft. of walls, fire stops, roofs, etc., are said to have been built by this process.

Wind Pressure

Wind Pressure on Arched Roofs (Calcul de l'effort du vent dans les toitures en arcs). F. Grua. Genie Civil, vol. 74, no. 22, May 31, 1919, pp. 441-443, 5 figs. Equations.

CEMENT AND CONCRETE

Aggregate Testing

Concrete in Roads, Bridges and Culverts. H. Eltinge Breed. Can. Engr., vol. 36, no. 22, May 29, 1919, pp. 493-495, 1 fig. Recommends that fine aggregate be tested for (1) organic impurities, (2) gradation, (3) mortar strength, and (4) volume of silt or loam.

Tests Do Not Bear Out Surface-Aggregate Method. Duff A. Abrams. Eng. News-Rec., vol. 82, no. 25, June 19, 1919, pp. 1203-1207. Research conducted at Lewis Inst., Chicago.

Grading

The Surface Area and Fineness Modulus Methods of Grading Concrete Aggregates. Duff A. Abrams. Eng. & Contracting, vol. 51, no. 26, June 25, 1919, pp. 673-676. Tests at Lewis Inst., Chicago said to have shown that with given materials and conditions of test, quantity of mixing water determines strength of concrete, so long as (1) concrete is plastic with method of placing used, (2) aggregate not too coarse for quantity of cement used, and (3) mixture not so wet that all water cannot be held by concrete.

Gunite Concrete

See Building and Construction (Stacks, Walls).

Pipe

Concrete Pipe Made and Laid for Winnipeg Aqueduct. Concrete, vol. 14, no. 6, June 1919, pp. 209-213, 16 figs. Eighty-five miles of it built of monolithic concrete and 12½ miles of reinforced concrete pipe.

Portland Cements

Portland Cements (Les Ciments Portland). E. Candlot. Chimie & Industrie, vol. 2, no. 4, Apr. 1, 1919, pp. 371-384, 19 figs. Account of manufacture with reference to practices followed at Roche, Switzerland.

Proportion in Concrete Tests

Tests of Two Recent Theories for Proportioning Concrete. Eng. News-Rec., vol. 82, no. 24, pp. 1142-1147 and (discussion) 1147-1149, June 12, 1919, 6 figs. Fineness-modulus and surface-aggregate methods, both of which depend on water-cement ratio, are said to have been found not to insure necessary workability of mix. Tests were made at U. S. Bureau of Standards

Slag Aggregate

Slag Aggregate in Concrete and Mortar. Em. Mavant. Concrete, vol. 14, no. 6, June 1919, pp. 239-240, 4 figs. Crushing-strength tests made of basic steel slag, limestone and bane rouge as coarse aggregates.

Slag Cement

Manufacture of Cement from Blast-Furnace Slag. Wm. Poole. Proc. Australasian Inst. Min. Engrs., no. 31, Sept. 30, 1918, pp. 81-97 and (discussion) pp. 97-100. Also Queensland Gov. Min. Jl., vol. 20, no. 227, Apr. 15, 1919, pp. 157-161. Processes of manufacturing, (1) puzzolan, (2) slag Portland ceme, (3) iron cement, and (4) special varieties of cement.

Tunnel Lining

Concrete Tunnel Lining by Steam Jet. Ry. Rev., vol. 64, no. 23, June 7, 1919, pp. 818-820, 3 figs. Nozzle car mounted on truck carried by ordinary flat car and controlled by two hand winches.

Underground Work

Use of Concrete in Underground Works. Eng. & Min. Jl. vol. 107, no. 25, June 21, 1919, pp. 1071-1073, 4 figs. Swelling ground and consequent crushing of shaft timbers led to experiment of lining section of shaft with reinforced concrete at mine in South Australia. From Chem. Eng. & Min. Rev.

EARTHWORK, ROCK EXCAVATION, ETC.

Aqueduct

Italian Aqueduct (L'Acquedotto Pugliese), Ingegneria Italiana, vol. 3, no. 57, May 30, 1919, pp. 67-70, 7 figs. Total length 2602 kilometers.

Caissons

Pneumatic Caissons Sunk Through Moving Ground. Eng. News-Rec., vol. 82, no. 24, pp. 1160-1162, June 12, 1919, 4 figs. Constant movement of earth forced contractor to face problem of sinking pneumatic caissons in such a way that allowance could be made for possible movement of ground through which they were to be lowered.

Causeways

Construction of New Arch Section of Galveston Causeway. Eng. News-Rec., vol. 82, no. 25, June 19, 1919, pp. 1190-1192, 7 figs. Centrifugal and jet pumps mounted on derrick platforms. Old causeway walls used for cofferdam.

Dams

Weighing Concrete Materials Saved Cement on Three Big Dams. H. H. Hunt. Cement & Eng. News, vol. 31, no. 6, June 1919, pp. 36-38, 2 figs. Proportioning by weight claimed to have given better concrete with less cement and without loss of speed.

Excavators

United Fuel & Supply Co.'s Plant. Cement, Mill & Quarry, vol. 14, no. 11, June 5, 1919, pp. 13-15, 6 figs. Arrangement used permits separate operation of excavator and main plant.

Reservoirs

Economics of Reinforced Concrete Walls for Uncovered Reservoirs. H. E. Babbitt. Eng. & Contracting, vol. 51, no. 24, June 11, 1919, pp. 618-620, 16 figs. Designs said to be based on factors of safety of two against overturning. Formulæ used for details of walls are given.

Retarding Basin

Delivering Mixed Concrete by Industrial Railway. Paul Teas. Concrete, vol. 14, no. 6, June 1919, pp. 218-221, 6 figs. Constructing retarding basins to prevent recurrence of Dayton's flood of March 1913.

Tunnels

Proposed Vehicular Tunnel under the Hudson at New York. Ry. Rev., vol. 64, no. 25, June 21, 1919, pp. 926-938, 11 figs. From discussion of "The Proposed New York and New Jersey Vehicular Tunnel" at meeting at Am. Soc. Civil Engrs., proc., May.

Tosas Tunnel. Jose M. Fuster. Revista de Obras Publicas, vol. 67, no. 2275 and 2277, May 1 and 15, 1919, pp. 205-210 and 233-237, 13 figs. Shows methods of timbering.

Utilization of Waste Heat of Tunnels. F. J. Postel. Heat & Vent. Mag., vol. 16, no. 5, May 1919, pp. 26-30, 6 figs. Test made at Chicago State Hospital using hot air from pipe-tunnel system.

The Catskill Tunnels—III. Railway Engineer, vol. 40, no. 473, June 1919, pp. 115-118, 6 figs. Bonticou and Eastview tunnels. (Continuation of serial.)

Chicago's Tunnels for Electric Light and Power Cables. G. B. Springer. Elec. Rev., vol. 74, no. 25, June 21, 1919, pp. 1019-1023, 10 figs. Of standard size 6 ft. 6 in. high and 6 ft. wide, top half being semi-circular. Construction methods employed.

Underwater Construction

Underwater Construction of Outshore Launching Ways. E. D. Buel. Eng. News-Rec., vol. 82, no. 23, June 5, 1919, pp. 1121-1123, 3 figs. Speed and economy of work are said to have justified choice of diver method in place of cofferdam construction at Government fabricated shipyard at Bristol, Pa.

MATERIALS OF CONSTRUCTION

Brick, Paving

See Road Materials.

Building Materials

Second Report on the Work of the Underwriters' Laboratories. Am. Architect, vol. 115, no. 2268, June 11, 1919, pp. 829-834, 9 figs., also Safety Eng., vol. 37, no. 4, Apr. 1919, pp. 163-170, 8 figs. Committee was appointed at convention of Am. Inst. of Architects "for the purpose of observing tests made on building materials at the Underwriters' Laboratories at Chicago, and reporting to the architects such data and results as might be of value."

Road Materials

Road Material in New Hampshire. J. W. Goldthwait. Good Roads, vol. 17, no. 22, May 31, 1919, pp. 233-234. Report of State Highway Dept. on materials available with discussion of their value.

What Paving Brick Should Be and Do. C. C. Wiley. Brick & Clay Rec., vol. 54, no. 12, June 17, 1919, pp. 1067-1070, 4 figs. Comparative tests made with monolithic brick road having bottom course of 1:3:5 concrete and with concrete slabs proportioned 1:2:3, are quoted as having demonstrated that equal strength is possessed by such brick and concrete roads.

RECLAMATION AND IRRIGATION

Drainage System, Moore Park

Drainage System for Moore Park, Toronto, W. G. Cameron and R. W. Dickie, Contract Rec., vol. 33, no. 24, June 11, 1919, pp. 541-544, 6 figs., also Can. Engr., vol. 36, no. 23, June 5, 1919, pp. 510-511, 4 figs. About 2,000 ft. of 4 ft. 3 in. and 3 ft. 9 in. two-ring brick sewer laid. Total length, 2,500 ft. Costs of operations quoted, capacity believed to be required was 173 c. f. s.

Irrigation, Egypt and Sudan

Irrigation Schemes in Egypt and the Sudan—II, II and III. Engineer, vol. 127, nos. 3306, 3309 and 3310, May 23 and 30 and June 6, 1919, pp. 497-499, p. 536, and pp. 556-558, 11 figs. Proposed Sennar dam on the Blue Nile. Scheme to effect combination irrigation and protection works. Irrigation schemes in lower Egypt.

ROADS AND PAVEMENTS

Asphalt

A Treatise on Hot Mix Asphalt Pavements, Francis P. Smith. Contract Rec., vol. 33, no. 23, June 4, 1919, pp. 529-534. Remarks on foundation, sub-grade and mineral aggregate requirements. Construction and properties of various types.

Bituminous Pavements

Hot Mix Bituminous Pavements. F. P. Smith. Eng. & Contracting, vol. 51, no. 23, June 4, 1919, pp. 599-601. General considerations regarding foundations. Paper presented before Can. Good Roads Congress.

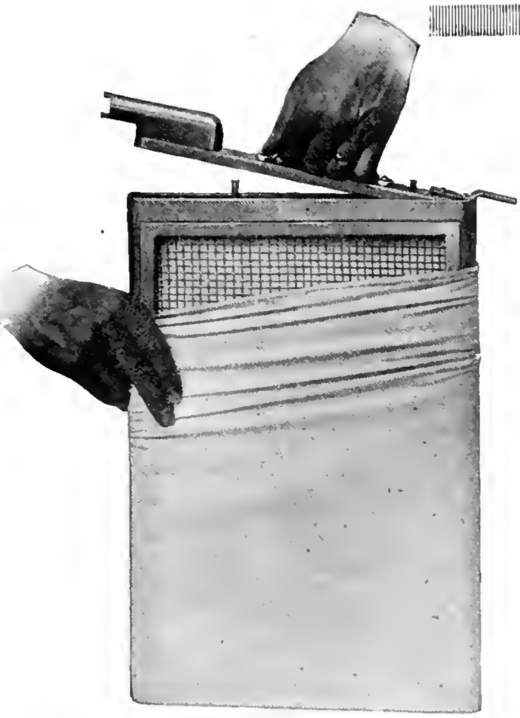
Suggestions for Concrete Pavement Construction. Clyde E. Learned. Mun. Jl. & Public Roads, vol. 46, no. 24, June 14, 1919, pp. 434-436, 2 figs. Based on writer's experience on concrete road construction in Southwest. (To be continued.)

Drainage

Drainage of Roads and Streets—I & II, (Wasserbeseitigung von Strassen und Wegen). Eduard Schneider. Zeitschrift für Transportwesen & Strassenbau, vol. 35, nos. 19 and 20, July 1 and 10, 1918, pp. 219-220 and 231-232, 3 figs. Writer recommends drainage by means of open ditches, where possible, or conduits discharging into a pond built for the purpose.

Financing

Methods of Financing Highway Improve-



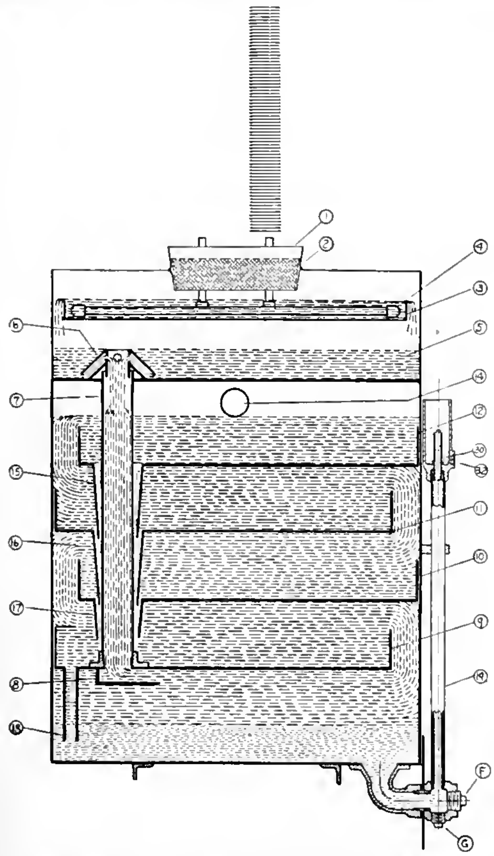
Showing method of placing filter bag over the frame. Note that the edges are smooth, making it easy to slip the bag on and off.

All Impurities Are Removed By A Peterson Power Plant Oil Filter

Look again at the illustrations to the left of this page! Fig. 1 shows a Peterson Filter Unit. There are several in each filter. Each unit can be removed and cleaned in one minute without interfering with the operation of the filter. The Peterson Filter Unit is the most scientifically designed and practical filter unit in the world.

An oil filter is as efficient as its ability to remove entrained water. Figure 2 shows the scientific design of the water separation compartment of the Peterson Oil Filter. All entrained water precipitated from the oil is automatically ejected from the filter.

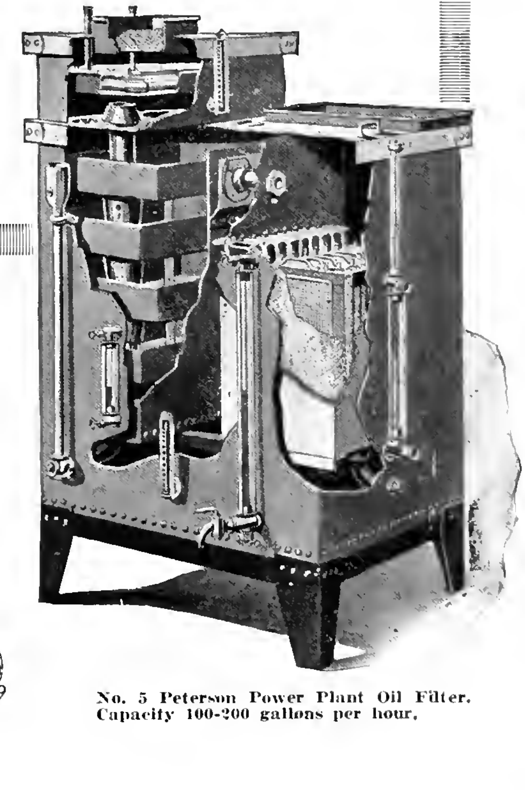
Peterson Power Plant Oil Filters are built in capacities from 100 to 2500 gallons per hour. They are essential for economical and efficient lubrication in the modern power plant.



Cross Section of water precipitation compartment. The separated water collects in the bottom of the different trays and is by-passed directly to the bottom of the precipitation compartment by means of funnels (15), (16), (17) and (18) does not have to come in contact with the traveling oil where it might be picked up again.

The catalog we have prepared for you on this filter is complete in information.

We want to put a copy of it in your hand—just send your address on a postal.



No. 5 Peterson Power Plant Oil Filter. Capacity 100-200 gallons per hour.

THE RICHARDSON-PHENIX CO.

LUBRICATION ENGINEERS AND MANUFACTURERS

WORKS 130 RESERVOIR AVE., MILWAUKEE, WIS.

ments. Eng. & Contracting, vol. 51, no. 23, June 4, 1919, pp. 608-609. Summary of various methods that have been used in this country. From committee report at convention of Am. Road Builders' Assn.

France

War-time Highways of France, John B. Woods. Power Wagon, vol. 22, no. 175, June 1919, pp. 31-32, 3 figs. How they were maintained.

Grading

Grading with Tractors and Heavy Blade Graders. Am. City, Town & Country Ed., vol. 20, no. 6, June 1919, pp. 521-526, 4 figs. Combination said to have proven satisfactory in Wisconsin county road work.

Gravel Roads

The Place and Possibilities of Gravel Roads. Chas. Talbot. Contract Rec., vol. 33, no. 22, May 28, 1919, pp. 509-511. Writer does not consider advisable to screen or in any way attempt to treat ordinary pit gravel.

Surface Treatment of Gravel Roads with Refined Tar, Philip P. Sharples. Good Roads, vol. 17, no. 22, June 7, 1919, pp. 241-242, 2 figs., also Contract Rec., vol. 33, no. 24, June 11, 1919, pp. 550-551, 1 fig. It is reported that with this treatment State highway laid between Kittery and Portland has carried as high as 200 to 2,000 vehicles per day during summer months without requiring too high upkeep costs. Paper presented before Sixth Can. Good Roads Congress.

Gravel Roads, Chas. Talbot. Can. Engr., vol. 36, no. 22, May 29, 1919, pp. 499-502, 1 fig. Specifications of gravel road construction employed in building Middlesex roads in 1854. The surfaces of these roads are said to be still maintained in serviceable condition.

Integraph

Predhumeau-Secretan Integraph (Intégraphe Predhumeau-Secretan), M. Predhumeau. Annales des Ponts et Chaussées, partie technique, vol. 48, no. 1, Jan.-Feb. 1919, pp. 54-76, 9 figs. Apparatus which is said to determine directly profile changes to be effected in road project and extent of work required by construction of embankments and cuts.

Level Raising

Road Building—I, II & III (Strassenbau), Curt Merckel. Zeitschrift für Transportwesen & Strassenbau, vol. 35, nos. 10, 11, 12, Apr. 1, 10, 20, 1919, pp. 111-114, 123-126 and 135-137, 6 figs. Niveau raising. Refers especially to experience of city of Hamburg.

Macadam

Bituminous Macadam Road Construction, A. W. Dean. Am. City, Town & Country Ed., vol. 20, no. 6, June 1919, pp. 517-520, 2 figs., also Good Roads, vol. 17, no. 22, May 31, 1919, pp. 231-232, and Contract Rec., vol. 33, no. 25, June 18, 1919, pp. 566-568. Regulations in regard to drainage, sub-grade, foundation, using dumping platform and patching holes. It is advised that bottom course should not be less than 4 in. in thickness after rolling, and, if heavy loads are to be sustained, a thickness of 6 in. is desirable. Paper read before Can. Good Roads Congress.

Maintenance

Highway Maintenance, J. A. Duchastel. Can. Eng., vol. 36, no. 22, May 29, 1919, pp. 497-499. Advises establishing and continuing system of maintenance beginning from day road has been completed.

Road Machinery

Road Machinery, Arthur H. Blanchard. Good Roads, vol. 17, no. 22, June 7, 1919, pp. 243-245, also Can. Engr., vol. 36, no. 22, May 29, 1919, pp. 502-504, and Eng. & Contracting, vol. 51, no. 23, June 4, 1919, pp. 605-606. Factors on which writer advises selection of equipment. Paper presented at Sixth Can. Good Roads Congress.

Stone Pavement

Building a Stone Road (Die Herstellung des Steinpflasters), George Klose. Zeitschrift für Transportwesen & Strassenbau, vol. 35, no. 17, June 10, 1918, pp. 195-197, 2 figs. Writer claims that replacement of stone pavements by compressed asphalt is for purpose of reducing noise and not because stone pavements are not able to carry increased traffic.

Street Cleaning

Street Cleaning (Strassenreinigung), Zeitschrift für Transportwesen & Strassenbau, vol. 35, no. 10, Apr. 1, 1919, pp. 114-115, 3 figs. The automobile sprinkler and cleaner.

Surfacing

Road Surfacing with Sand Clay from Salt Flats. Eng. & Contracting, vol. 51, no. 23, June 4, 1919, pp. 595-596. Data covering use of sand clay in Aransas County, Tex.

Tarred Roads, Poisoning Streams by

The Poisoning of Fish by Road Washings, W. J. A. Butterfield. Surveyor, vol. 55, no. 1423, Apr. 25, 1919, pp. 307-308. Tarred roads are said to be dangerous to fish life where river runs through valley and is crossed by road which drains from inclines from either side of river.

SANITARY ENGINEERING

Sewer Flushing

The Flushing of Sewers—I, II, & III (Die Spülung der Kanäle), W. Schwaab. Zeitschrift für Transportwesen & Strassenbau, vol. 35, nos. 29, 30 and 31, Oct. 10, 20 and Nov. 1, 1918, pp. 339-342, 351-353, 365-367, 28 figs. Flushing, in order to clean the pipes of slime and mud deposits, requires higher water velocity than that which caused these deposits. Best results are obtained if flushing is done at frequent intervals. In order to keep sewers free of solid waste particles, a constant water velocity of 0.6 to 0.7 m. per sec. is necessary. (Concluded.)

Sewer Pipe

Ground Water Disintegrates Sewer Pipe, Arthur George Dalzell. Contract Rec., vol. 33, no. 23, June 4, 1919, pp. 522-524. Investigations into causes of internal incrustation and scale on machine-made pipes. Paper presented at Can. Nat. Clay Products Conv.

Sewers

Chicago's Standard of Sewer Construction, C. D. Hill. Eng. World, vol. 14, no. 11 and 12, June 1 and 15, 1919, pp. 17-23 and 21-23. With 2467 miles of sewer costing $50,000,000, total cost of maintenance is said to have been $79,000,000, which includes expenditures for new manholes, catch basins and similar items. Considerations made in determining location of relief sewers.

SURVEYING

Geometric Leveling

Geometric Leveling by Dr. Wilhelm Seibt's Method (Nivelación geométrica por el método del Dr. Wilhelm Seibt), Tomás González Roura. Ingeniería, vol. 23, no. 8, Apr. 16, 1919, pp. 516-523. Concerning approximate error of single observation. (Continuation of serial.)

WATER SUPPLY

Brantford

The Brantford Waterworks System. Power House, vol. 12, no. 9, June 20, 1919, pp. 240-244, 9 figs. Mechanical features.

Chlorination

Progress of Water Disinfection in Maryland, Robert B. Morse. Mun. Jl. & Public Works, vol. 46, no. 23, June 7, 1919, pp. 405-407. General description of plants and of results of chlorination. Paper presented before New England Water Works Assn.

Cool-Drinking-Water Systems

Cool Drinking Water Systems, Charles L. Hubbard. Power Plant Eng., vol. 23, no. 11, June 1, 1919, pp. 489-494, 8 figs. Systems in use and data for computing dimensions of equipment, piping, etc.

Factories

What It Pays to Know About Factory Water Supply—IV, Charles L. Hubbard. Factory, vol. 22, no. 6, June 1919, pp. 1165-1168, 7 figs. Concerning amount of water to be heated.

Buffalo Water Supply, with Special Reference to the Filtration Problem, H. F. Wagner. Can. Engr., vol. 36, no. 25, June 19, 1919, pp. 551-552 and 559. Contamination by excursion boats passing near intake crib in Emerald Channel necessitates addition of maximum amount of chlorine at all times. Question is whether under such conditions and after reducing waste to minimum, building of filtering plant should be advisable. Paper read before Am. Water Works Assn.

Filters

Desrumaux Drinking Water Filter of Large Capacity and Automatic Cleaning (Filtres à grand débit et à nettoyage automatique pour l'épuration des eaux potables. Système Henry Desrumaux), A. Bidault des Chaumes. Génie Civil, vol. 74, no. 23, June 7, 1919, pp. 460-461, 6 figs. Turbine rotates sand rakes.

Garages

A Typical Complete Water Supply System for Installation in Garage Basements, J. Albert Deyo. Am. Architect, vol. 115, no. 2269, June 18, 1919, pp. 861-865, 5 figs. Installation of one 6-ft. by 36-ft. pneumatic tank having working capacity of 5,140 gal.

Hamilton

Hamilton Waterworks; Some Features of Design, F. C. Perkins. Power House, vol. 12, no. 8, June 5, 1919, pp. 203-205, 4 figs. High-head electric pumping station with four motor-driven units.

Meters

Reduction of Water Consumption by Means of Pitometer Survey and Constant Inspection, George C. Andrews. Can. Engr., vol. 36, no. 25, June 19, 1919, pp. 555-557. Experiences which led Buffalo Bureau of Water to adopt pitometer work as special department. Paper read at convention of Am. Water Works Assn.

Water Meter Data. Mun. Jl. & Public Works, vol. 46, no. 23, June 7, 1919, pp. 407-421. Tables showing data gathered by means of questionnaire sent out to 450 water-works superintendents. Data deal with location, reading, testing and maintenance of meters.

Study of Revenue from Sale of Water to Metered Domestic Consumer, Philip Burgess. Eng. News Rec., vol. 82, no. 23, June 5, 1919, pp. 1116-1119, 3 figs. New England Water Works Assn. form based on service and output charge.

Sooke Lake, B. C.

Sooke Lake Water Supply, Victoria, B. C., C. H. Rust. Jl. Eng. Inst. Can., vol. 2, no. 6, June 1919, pp. 446-450, 9 figs. Construction of six siphons and necessary concrete trestles, and temporary wooden trestles to carry track is specially taken up in outline of project for utilizing lake, which is 4 miles long and about half a mile wide.

Tastes and Odors

Coal Tar Derivative Waste Products Cause of Obnoxious Taste of Milwaukee Water Supply. Eng. & Contracting, vol. 51, no. 24, June 11, 1919, pp. 629-630. Investigation conducted by Water Works disclosed that taste and odor were not due to use of chlorine alone, but to action of chlorine on some of the organic matter present in polluted lake water, which formed compound producing taste and odor.

WATERWAYS

Coast Erosion

Lake Michigan's Encroachment on its Coast, Hu Maxwell. Sci. Am., vol. 120, no. 26, June 28, 1919, pp. 687 and 699-700, 4 figs. How currents are stealing land from western shore and giving it back at Southern end.

Flood Waters

Impounding Flood-Waters, E. Parry. New Zealand Jl. of Sci. & Technology, vol. 2, no. 2, Mar. 1919, pp. 121-127, 4 figs., partly on supp. plate. Deals only with rise and fall of water level in lake reservoir as flow in river increases and decreases. Charts of h/H for various cases are presented.

Maas Canalization

The Maas Canalization (Eenige mededeelingen over de Maaskanalisatie), F. L. Schlingmann. De Ingenieur, vol. 34, no. 17, Apr. 26, 1919, pp. 305-313, 5 figs. Canalization started 1915 from Linne to Grave; including the Wessen-Nederweert and Maas-Waal canal, the costs were estimated at about $30,000,000, but in writer's opinion this sum will be materially surpassed on account of general rise in prices.

VARIA

Oversea War Work

Civil Engineering in the War, George K. Scott-Moncrieff. Times Eng. Supp., vol. 15, no. 535, May 1919, p. 156. Work overseas.

Salonika, Rebuilding of

The Rebuilding of Salonika. Times Eng. Supp., vol. 15, no. 535, May 1919, pp. 158-159, 1 fig. Project involves expenditure of $100,000.

Mining Engineering

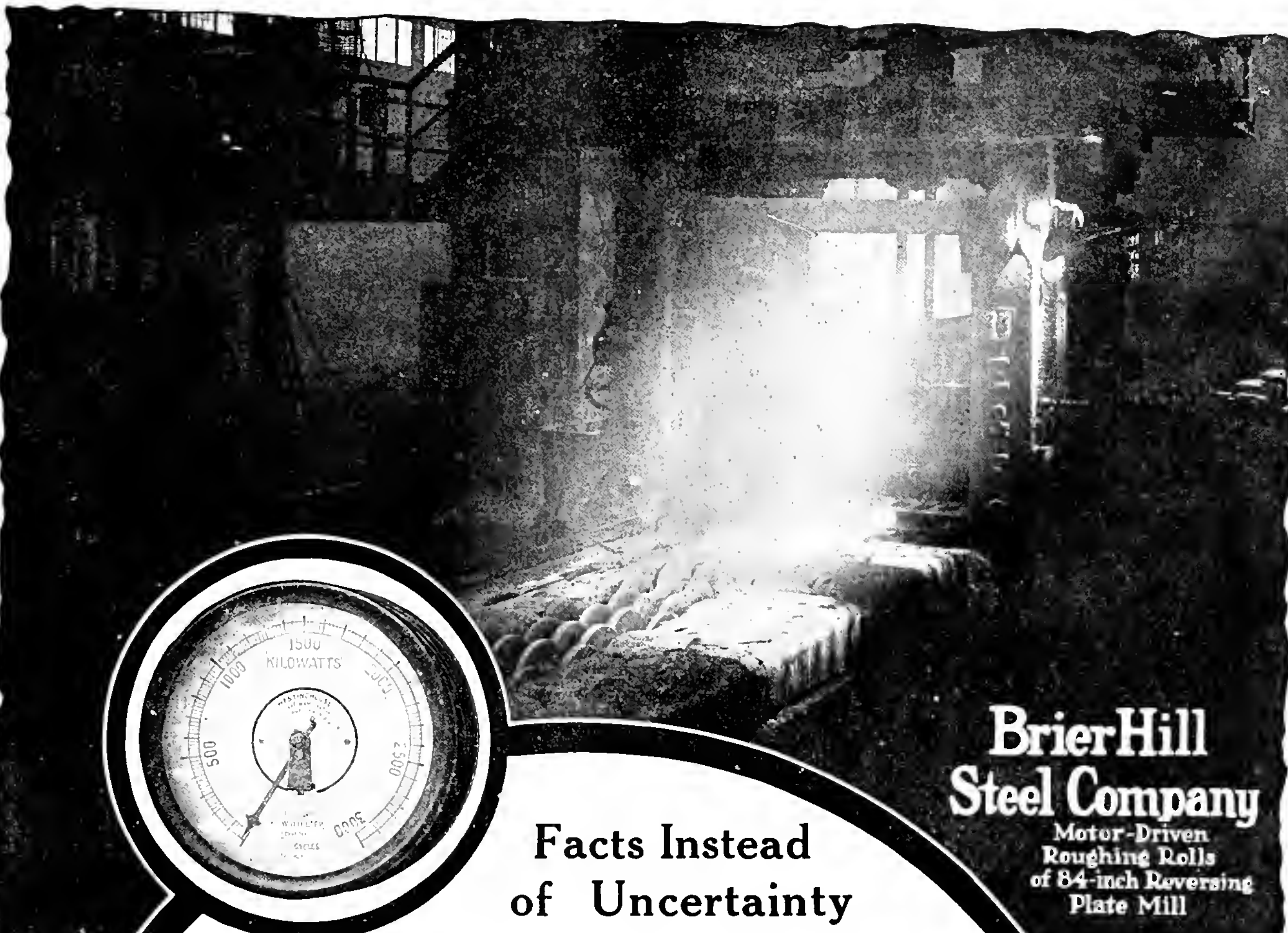
BASE MATERIALS

Bauxite

Bauxite Mining in Arkansas, Tom Shiras. Eng. & Min. Jl., vol. 107, no. 25, June 21, 1919, pp. 1074-1075, 5 figs. Ore comes from ground in pieces weighing from few ounces to several hundred pounds and is crushed to a maximum size of 1½ in.

Limestone

The Chart of the Wreford and Foraker Limestones along the State Line of Kansas



Facts Instead of Uncertainty

In the steam-driven mills, it is difficult accurately to ascertain the cause, or causes, for excessive steam consumption. Hence, wastes are tolerated in a steam plant that are promptly detected and checked in the motor-driven mill.

The electric meter is the most accurate means of measuring power consumption over long periods of time and where load fluctuations are sudden and severe.

The electric meter instantly shows when the mill is taking more power than normally required.

The electric meter warns the roller of friction losses, of inaccuracies in alignment, or of other objectionable conditions, and opens the way to important savings through better care, lubrication and adjustment of the mechanical equipment of the mill.

The benefits, therefore, extend beyond the greater flexibility, adaptability and dependability of the motor-driven roll itself. The improvement in plant operation is general, and directly or indirectly traceable to the superior facilities afforded by electric operation.

Westinghouse engineers will gladly give you the benefit of their broad experience in the solution of any power problem.

WESTINGHOUSE ELECTRIC & MANUFACTURING CO.
East Pittsburgh, Pa.

W
WESTINGHOUSE ELECTRIC

Westinghouse

and Oklahoma, W. H. Twenhofel. Am. Jl. of Sci., vol. 47, no. 282, June 1919, pp. 407-429. Claims that observed facts do not harmonize with theories postulating an origin for these charts consequential to weathering, or one of replacement, or of cavity-filling in solid rocks.

Quarries

Modern Methods at McCook Quarry, William B. Eastwood. Cement, Mill & Quarry, vol. no. 10, May 20, 1919, pp. 11-14, 4 figs. Plant of U. S. Crushed Stone Co. Output is 500 tons of crushed rock per hour.

Labor Saving in Limestone Quarrying, Oliver Bowles. Dept. of Interior, Bur. Mines, War Minerals Investigation Series no. 1, Sept. 1918, 18 pp. Using labor-saving devices. Consideration is given only to methods and type of equipment that are represented as having been tried and approved by quarry operators.

An Electrically-Operated Quarry and Plant for Production of Broken Stone at Gary, Ill. Cement & Eng. News, vol. 31, no. 5, June 1919, pp. 24-26, 5 figs. Electrical operation includes that of loading shovels and haulage system in quarry, and equipment of crushers, rolls, screens and conveyors.

COAL AND COKE

Belgium

Coal Deposits of Belgium (Les Gisements de la Belgique), Armand Renier. Annales des Mines de Belgique, vol. 20, no. 2, 1919, pp. 433-540. Stratigraphic studies of mode of formation. (Third installment.)

Boring

Intensive Boring on the Wonthaggi Coal Field, Victoria, H. Herman. Australasian Inst. Min. Engrs., Proc., no. 32, Dec. 31, 1918, pp. 145-154, 12 figs. partly on 3 supp. plates. Mining under difficulties due to sudden changes in thickness and quality, and presence of dirt bands in seams.

By-Product Plants

Coppee Coal washing and By-Product Coking Installation in Course of Erection at Burnside Colliery. South African Eng., vol. 30, no. 4, Apr. 30, 1919, pp. 66-68, 5 figs. By-product plant designed to deal with gases from 2100 tons of coal per week.

Clarion County, Pa.

Recovering the Neglected Coal Fields, J. O. Durkee. Coal Industry, vol. 2, no. 6, June 1919, pp. 221-224, 4 figs. Deposits in Clarion County, Pa.

Coke Plants

Late Addition to Youngstown Coke Plant. Iron Age, vol. 103, no. 26, June 26, 1919, pp. 1691-1695, 9 figs. Two new batteries, each consisting of 51 Koppers cross-regenerative ovens of 500 cu. ft. capacity.

Mammoth Coke Plant, Frank F. Marquand. Coal Industry, vol. 2, no. 6, June 1919, pp. 224-231, 6 figs. Construction, organization, operation and recovery of by-products at Clairton by-product coke works of Carnegie Steel Co. Paper read before Am. Iron & Steel Inst.

Composition

The Chemistry and Constitution of Coal, A. C. Fieldner. Coal Age, vol. 15, no. 26, June 26, 1919, pp. 1150-1158, 22 figs. Principally from microscopic investigations carried on in Bur. of Mines Experimental Station.

On the Four Visible Ingredients in Banded Bituminous Coal: Studies in the Composition of Coal, no. 1, Marie C. Stopes. Proc. Roy. Soc., Biological Sciences, vol. 90, no. B-633, May 15, 1919, pp. 470-487, 17 figs. partly on separate plates. Concerning macroscopic and microscopic recognition and separation of Fusain, Durain, Clarain and Vitrain bands.

Costs, Mining

Anthracite Mining Costs, R. V. Norris. Coal Age, vol. 15, no. 25, June 19, 1919, pp. 1124-1128, 5 figs. Based on reports for six months, Dec. 1917 to May 1918 inclusive, as compiled by Federal Trade Commission.

Electrical Apparatus

Routine Examinations and Testing of Colliery Electrical Apparatus, L. Fokes. Colliery Guardian, vol. 117, no. 3043, Apr. 25, 1919, pp. 953-955, 4 figs. Divides general examination under headings of (1) power house, (2) transformers, (3) motors, and (4) cables, and offers suggestions to accomplish each of these.

Formation

The Formation of Coal, J. D. Kendall. Can. Min. Inst. Bul., no. 86, June 1919, pp. 600-606, 5 figs. Writer presents arguments in support of his theory that coal has been produced from woody matter that was drifted into position by water and afterward altered by pressure, heat and chemical change in its present substance. (To be continued.)

Geology

The Geology and Economics of Coal, J. R. Finlay. Eng. & Min. Jl., vol. 107, no. 22, May 31, 1919, pp. 945-950. Geological aspects of coal formation, occurrence and location of peat swamps, extent of existing deposits and main features of coal-forming period; statistics on coal consumption and distribution.

Kent Coalfields

The Evolution and Development of the Kent Coalfield, A. E. Ritchie. Iron & Coal Trades Rev., vol. 98, nos. 2672, 2673 and 2674, May 16, 23 & 30, 1919, pp. 665, 700-701, and 735-736, 2 figs. From 1913-1918. From 1907-1918. Establishment and growth of South Eastern Coal Field Extension, Ltd. Plan showing comparative positions of the Greensand and Hastings strata and the "junction" sand bed at three important points of the coalfield.

Mixing Plant

Coxton Coal Mixing Plant, Lehigh Valley R.R. Ry. Rev., vol. 64, no. 24, June 14, 1919, pp. 885-887, 4 figs. General plan and elevation. Plant mixes bituminous and anthracite silt.

New South Wales

The Coal Industry of New South Wales, A. A. Atkinson. Proc. Australasian Inst. Min. Engrs., no. 31, Sept. 30, 1918, pp. 41-70 and (discussion) pp. 71-80. "Bord and pillar" is adopted method of working, removal of coal effected by aid of electrically-operated coal-cutting machines and ventilation produced by means of exhaust fans.

Preparation

Preparation of Bituminous Coal—I, III, IV & V, Ernst Prochaska. Coal Age, vol. 15, nos. 21, 23, 24 & 25, May 22, June 5, 12 & 19, 1919, pp. 943-945, 1030-1035, 1080-1085, and 1118-1122, 19 figs. Writer believes that for best results final screening should be done after washing. Chart showing comparative efficiency of different types of washers. Size of jig screen, comparative size of plunger, length of plunger stroke, rapidity of stroke and thickness of jigging bed considered as factors that influence efficiency in washing. Methods of drives, apparatus for discharge of products and arrangement of jigs.

Pyrites

Coal Pyrite Resources of Tennessee, E. A. Holbrook and Wilbur A. Nelson. Coal Age, vol. 15, no. 24, June 12, 1919, pp. 1077-1079, 3 figs. Experiments are believed to have indicated that pyrite occurring in coal may be commercially extracted.

Sealing Up

Sealing Up Old or Abandoned Workings in Gaseous Mines, C. Thompson. Coal Age, vol. 15, no. 25, June 19, 1919, pp. 1110-1111. Method proposed for securing proper ventilation. Paper presented before Ill. Min. Inst.

COPPER

Blast Furnaces

Exit the Blast Furnace, Oliver E. Jager. Min. & Sci. Press, vol. 118, no. 25, June 21, 1919, pp. 843-844. Disadvantages that have been urged against blast and reverberatory furnaces under Anaconda conditions.

Monel Metal

Monel Metal and Its Uses, Hugh R. Williams. Iron Age, vol. 103, no. 26, June 26, 1919, pp. 1703-1704, 2 figs. Chemical composition is nickel 67 per cent, copper 28 per cent, and other elements 5 per cent (latter chiefly iron from original ore, and manganese, silicon and carbon added during process of refining metal matter).

Native Copper

Native Copper and Silver in the Nonesuch Formation, Michigan, Keijiro Nishio. Economic Geology, vol. 14, no. 4, June 1919, pp. 324-334, 6 figs. Their association with carbonaceous matter in sandstone explained by reaction of acetylene gases or like gases upon metallic solutions.

Deposits of Native Copper in Arctic Canada, J. J. O'Neill. Min. & Sci. Press, vol. 118, no. 24, June 14, 1919, pp. 807-811, 5 figs. Outlines conditions to be met in carrying out examination of deposits, such as (1) means of access, (2) amount of time available for actual work, together with time consumed in travel and enforced idleness, (3) climate and general working conditions.

GEOLOGY AND MINES

Brecciation

Brecciation in the Niagara Limestone at Rochester, New York, Albert W. Giles. Am. Jl. of Sci., vol. 47, no. 281, May 1919, pp. 349-354, 2 figs. Attributed to irregular cavities distributed through strata.

Chester Emery Mine

Famous Mineral Localities: The Chester Emery Mine, Earl V. Shannon. Am. Mineralogist, vol. 4, no. 6, June 1919, pp. 69-72. Notes on field gathered during writer's expedition.

Colorado Rockies

The Building of the Colorado Rockies, Rollin T. Chamberlin. Jl. Geology, vol. 27, no. 3, Apr-May 1919, pp. 145-164, 3 figs. By application of method given in Chamberlin and Salisbury's Geology for deducing thickness of earth shell involved in given case of folding. (To be continued.)

Earthquakes

The Mechanics of Earthquakes, Carlo Somigliana. Sci. Am. Supp., vol. 87, no. 2269, June 28, 1919, pp. 402-403 & 407. Summary of attempts to explain nature of seismic disturbances. From Scientia.

Georgia

Notes on the Geology of Georgia, S. W. McCallie. Jl. Geology, vol. 27, no. 3, Apr-May 1919, pp. 165-179, 4 figs. Classification of geological systems.

Gnomonic Projection

On the Use of the Gnomonic Projection in the Calculation of Crystals, G. F. Herbert Smith. Mineralogical Mag., vol. 18, no. 86, May 1919, pp. 317-323, 5 figs. Composite gnomonic production suggested.

Hydrated Ferric Oxides

The Hydrated Ferric Oxides, Eugen Posnjak and H. E. Merwin. Am. Jl. of Sci., vol. 47, no. 281, May 1919, pp. 311-348, 4 figs. Compilation of synthetic chemical work leads to assertion that no series of hydrates of ferric oxide exists among natural minerals.

Minerals, Determination in Rock

On the Accuracy of the Rosiwal Method for the Determination of the Minerals in a Rock, Albert Johannsen and E. A. Stephenson. Jl. Geology, vol. 27, no. 3, Apr-May 1919, pp. 212-220. Repetition of experiments made by Ira A. Williams (Amer. Geol., XXV, 1905, pp. 34-36) in order to compare accuracy of various methods.

Missouri

Geology of Missouri, E. B. Branson. Univ. of Missouri Bul., vol. 19, no. 15, May 1918, 172 pp., 58 figs. Compilation of reports of Missouri geological surveys and those of State Bur. of Geology and Mines, including extensive series of references to articles in scientific journals treating various phases of Missouri geology.

Pre-Cambrian

Some Stratigraphic and Structural Features of the Pre-Cambrian of Northern Quebec—II, H. C. Cooke. Jl. Geology, vol. 27, no. 3, Apr-May 1919, pp. 180-203, 12 figs. Detailed areal descriptions. (To be continued.)

Pyrite Crystals

Pyrite Crystals from Bald Mountain, Colorado, Herbert P. Whitlock. Am. Mineralogist, vol. 4, no. 6, June 1919, pp. 67-68, 2 figs. Measurements made on a Fuess No. 2 goniometer.

Sedimentary Formations

The Sedimentary Formations of the Panama Canal Zone, with special Reference to the Stratigraphic Relations of the Fossiliferous Beds, Donald Francis MacDonald. Smithsonian Instn., U. S. Nat. Museum, bul. 103 (extract), 1919, pp. 525-545, 2 figs.

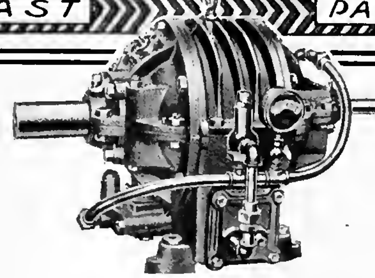
The Biologic Character and Geologic Correlation of the Sedimentary Formations of Panama in their Relation to the Geologic History of Central America and the West Indies, Thomas Wayland Vaughan. Smithsonian Inst., U. S. Nat. Museum, bul. 103 (extract), 1919, pp. 547-612. Including tabular statement of age relations to formations.

Septarian Structure

On the Origin of Septarian Structure, W. Alfred Richardson. Mineralogical Mag., vol. 18, no. 86, May 1919, pp. 327-338, 9 figs., partly on supplemental plate. Endeavor is made to establish that septarian structure consists of polygonal system of cracks corresponding to a mud desiccation structure and that cracking of nodule is due to desiccation by chemical means of a colloidal center.

TURBOGEAR

FAST PATENTS



The Ideal Drive
Capacities
1 to 20,000 HORSE POWER

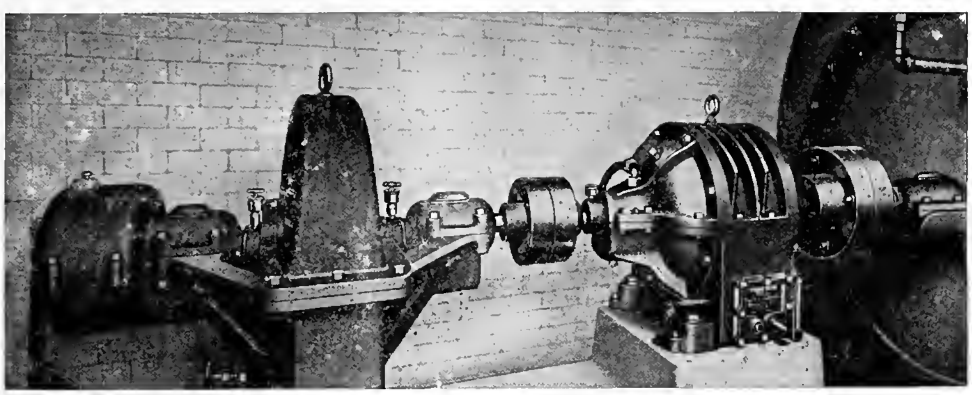
The Modern Way
to connect
DRIVING and DRIVEN UNITS

Modernized Transmission

"Turbo-Gear," the ideal drive—because of its simplicity, low upkeep and supreme reliability—has been adopted by many representative plants of the leading industries of America.

Because of simplicity of construction of "Turbo-Gear" and elimination of trouble producing equipment, there is a remarkable decrease in operating and maintenance expense.

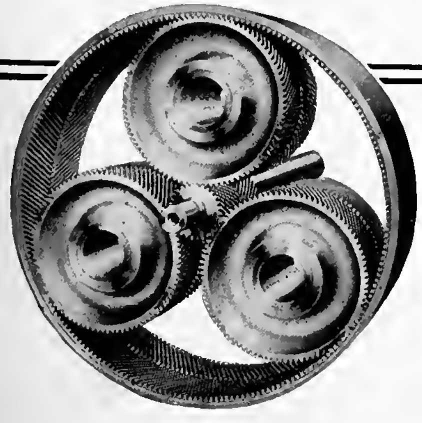
Because of positive transmission of power by "Turbo-Gear"—uniform and certain—there is a remarkable decrease in trouble due to faulty transmission and variation of speed.



50 H. P. Turbo-Gear direct connected to Turbine Drive Jet Condenser.
Speed Reduction 3400 to 425 R. P. M.

Durability, maximum service and continuous performance make "Turbo-Gear" the ideal drive. Hundreds of Turbo Gears are serving today to provide low cost power transmission.

Let us give you facts concerning some of these installations—send for these facts and our "Turbo-Gear" Bulletin No. 101.



POOLE ENGINEERING and MACHINE COMPANY

Manufacturers of Gears and Power Transmission Machinery since 1843

BALTIMORE, MD., U.S.A.

General Sales Office: 50 Church St., New York, N.Y.

Tridymite Crystals in Glass

Tridymite Crystals in Glass, N. L. Bowen. Am. Mineralogist, vol. 4, no. 6, June 1919, pp. 65-66, 2 figs. on supp. plate. Formation which took place in French works where, by reason of temporary German occupation and workmen having left fires burning in expectation of returning shortly, glass was maintained at temperature in the neighborhood of 800 deg. cent. for twenty days.

IRON

Canada

Making Steel in Canada. Can. Machy., vol. 21, no. 23, June 5, 1919, pp. 567-572, 7 figs. With special reference to ore deposits in Eastern section. (To be continued.)

LEAD, ZINC, TIN

Spelter Statistics

Spelter Statistics for 1918, W. R. Ingalls. Eng. & Min. Jl., vol. 107, no. 22, May 31, 1919, pp. 958-962. Total production of spelter by ore smelters in 1918 was 525,350 tons against 682,411 tons in 1917.

MAJOR INDUSTRIAL MATERIALS

Manganese

Cost of Producing Ferro-Grade Manganese Ores, C. M. Weld. Dept. of Interior, Bur. Mines, Minerals Investigation Series, no. 13, Mar. 1919, 22 pp. Figures compiled with point of view of probable competition between domestic production and Cuba and Brazil.

Uses of Manganese Other Than for Steel Making, W. C. Phalen. Dept. of Interior, Bur. Mines, Minerals Investigating Series, no. 16, May 1919, 14 pp. Divided into (1) uses of manganese dioxide ore and (2) uses of manganese bronze.

MINES AND MINING

Cyanidation and Chlorination

A Metallurgical Journey to Shasta, California—II, Herbert Lang. Min. & Sci. Press, vol. 118, no. 24, June 14, 1919, pp. 812-818, 1 fig. Further historical notes particularly on cyanidation and chlorination.

Drills

Notes on Economics in Hand Drill Steel, H. A. Read. Jl. Chem., Metallurgical & Min. Soc. of South Africa, vol. 19, no. 9, Mar. 1919, pp. 168-177, 6 figs. One of principal losses in hand drilling at Witwatersrand was believed to be that due to shanking of steel under blows of hammer.

Progress in the manufacture of Stoping Drills. Eng. & Min. Jl., vol. 107, no. 22, May 31, 1919, pp. 964-966. New designs are said to conform to essential conditions required in field which are said to be: Light weight and small size, automatic rotation, satisfactory regulation of strength of feedwater when drilling in sulphur-bearing ores.

New Type of Stoping Drills. Min. & Sci. Press, vol. 118, no. 23, June 7, 1919, pp. 797-799, 4 figs. Sullivan types.

Drives, Depth

The Increase in the Average Length of a Round in Modern Development, Jas. H. P. Bilbrough. Jl. South African Instn. Engrs., vol. 17, no. 10, May 1919, pp. 211-217. Vertical depth of drives referred to ranged between 5280 ft. below datum for the 24th drive and sea level for the 29th drive.

Explosives

The Use of Explosives in Mines, H. Y. Russel. Can. Min. Inst. Bul., no. 86, June 1919, pp. 589-600. Practices of various mines. Employing special blasters is considered advantageous even in small mines.

Mining Laws

Acquisition of Rights and Powers in Connection with Mines and Minerals. Iron & Coal Trades Rev., vol. 98, no. 2674 & 2675, May 30 & June 6, 1919, pp. 730-731 and 770-771. Report of Acquisition and valuation of Land Committee of Ministry of Reconstruction. Committee does not think it is in national interest that question, whether minerals should be worked or not, should be left to decision of adjoining owner or mineral worker. (Concluded.)

Some Common Violations of the Mining Laws, W. J. Heatherman. Coal Age, vol. 15, no. 26, June 26, 1919, pp. 1159-1160. Recklessness and ignorance believed to be chief obstacles to mine safety. Many mine officials, according to writer, lack proper conception of their responsibility and do not attempt to enforce precautionary measures.

Waste in Working Minerals. Colliery Guardian, vol. 117, no. 3048, May 30, 1919, p. 1290, also Quarry, vol. 24, no. 268, June 1919, pp. 156-159. Recommendations of Land Committee for acquisition and valuation. (Continued.)

Prospectors

Returned Soldiers as Prospectors, C. M. Harris. Queensland Government Min. Jl., vol. 20, no. 227, Apr. 15, 1919, pp. 149-151, 7 figs. Scheme arranged jointly by Mines Dept. of Western Australia and Federal Repatriation Board.

Shafts

The Advantages of Circular Shafts—II, H. Stuart Martin. South African Min. & Eng. Jl., vol. 28, part 2, no. 1438, April 19, 1919, pp. 217-218. Effect of area and friction resistance; circular vs. rectangular shafts. First part appeared in issue of January 18.

Shaft Sinking

A Peculiar Experience in Shaft-Sinking, Arthur Jarman. Min. & Sci. Press, vol. 118, no. 25, June 21, 1919, pp. 851-854, 4 figs. Sinking made difficult by pocket of mud encountered at depth of 35 ft.

Squeeze Prevention

Method Employed in Working the Crescent Mine, Ralph W. Mayer. Coal Age, vol. 15, no. 23, June 5, 1919, pp. 1028-1029, 3 figs. Prevention of squeeze accomplished through combined use of machine and pick mining.

Timber

Preservation of Mine Timber, Noah Williams. Colliery Guardian, vol. 117, no. 3046, May 16, 1919, pp. 1145-1146. Decay and insects are estimated to cause 50 per cent of loss of timber used in mines; as much of this loss is considered preventable by adoption of preservation treatment. American method of treating wood with sodium fluoride is recommended as efficient and economical.

Ventilation

The Ventilation of Coal Mines, H. W. Chadbourne. Gen. Elec. Rev., vol. 22, no. 5, May 1919, pp. 341-347, 7 figs. Natural, furnace and mechanical methods of ventilation; electric-motor-driven fan equipment and air courses.

Washington (State)

A Summary of Mining in the State of Washington, Arthur Homer Fischer. Eng. Experiment Station, Univ. of Wash., bul. no. 4, Nov. 1918, 124 pp. Including bibliography of 547 articles relating to mining and mineral resources in State of Washington.

MINOR INDUSTRIAL MATERIALS

Saltpeter

Saltpeter in Guatemala, Hoyt S. Gale. Eng. & Min. Jl., vol. 107, no. 24, June 14, 1919, pp. 1025-1031, 6 figs. Made from leachings of soils about native villages, work of separating and refining salt being performed mostly by women.

Magnesium

Magnesium Sulphate Deposits at Basque, B. C., George C. Crux. Can. Chemical Jl., vol. 3, no. 6, June 1919, pp. 179-181, 3 figs. Salts occur in solidified masses of various shapes and sizes, surrounded by mud rings.

Natural Deposits of Salts of Magnesium and Sodium near Clinton, B. C., L. Reinecke. Can. Chemical Jl., vol. 3, no. 6, June 1919, pp. 182-186, 4 figs. Texture and structure, topographical and geological relations, composition, origin, commercial value. Deposits consist of calcium carbonate, magnesium carbonate, gypsum and epsomite.

OIL AND GAS

Asphaltum

Physical Tests of Asphaltum, John W. Newton and F. N. Williams. Petroleum Age, vol. 6, no. 6, June 1919, pp. 241-245, 1 fig. Discusses value of such tests as pliability, volatility, penetration, melting point, etc. Fourth article. Previous articles detail tests for gasoline, illuminating oils and fuel oil respectively.

California

Proposed Safety Orders for Petroleum Industry in California. Min. & Oil Bul., vol. 5, no. 6, May 1919, pp. 331-332 & 351, 2 figs. As revised by Safety Orders Committee of Industrial Accident Committee.

Crude-Oil Statistics

Summary of the Crude Oil Situation. Oildom, vol. 10, no. 6, June 1919, p. 9. Statistics of production during February and March 1919.

Ecuador

Petroleum in Ecuador, Walter M. Brodie. Eng. & Min. Jl., vol. 107, no. 22, May 31, 1919, pp. 941-944, 3 figs. Account of geology and occurrence, together with data as to legal aspects of concessions in that republic.

Florida

Observations of a Florida Sea-Beach with Reference to Oil Geology, J. F. Kemp. Economic Geology, vol. 14, no. 4, June 1919, pp. 302-323, 7 figs. Tests and surveys conducted in order to explain what appeared to writer puzzling accumulation of land and marine organic remains.

Gasoline

Status of Refinery Practice with Regard to Gasoline Production, E. W. Dean. Jl. Soc. Automotive Engrs., vol. 4, no. 5, May 1919, pp. 372-374. Estimates made by Bur. of Mines apparently indicate that refiner may be able to augment his production of gasoline from crude petroleum by from 35 to 40 per cent.

Microscope

Petroleum Under the Miscroscope, James Scott. Petroleum World, vol. 16, no. 224, May 1919, pp. 194-197, 3 figs. In reference to geological aspect of search for oil. (Concluded.)

Natural Gas

Safeguarding the Future Natural Gas Supply, Clifton W. Sears. Gas Age, vol. 43, no. 11, June 2, 1919, pp. 588-590. Discusses effect of price for gas upon quantity consumed. Paper presented before Natural Gas Assn.

Oil Pools

Petroliferous Provinces, E. G. Woodruff. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 150, June 1919, pp. 907-912, 1 fig. Analyses, from regional standpoint, conditions that control presence or absence of oil pools.

Roumania

Roumanian Oil Fields. Universal Engr., vol. 29, no. 5, May 1919, pp. 37-46, 8 figs. Problems presented to producers by conditions arising from extensive subdivision of fields. Oil produced is of high gravity with paraffine base.

Shales

Value of American Oil Shales, Charles Baskerville. Bul. Am. Inst. Min & Metallurgical Engrs., no. 150, June 1919, pp. 957-960. Discusses fundamental features concerning economic development of shale-oil industry.

The Winning of Oil from Rocks, Arthur J. Hoskin. Min. & Sci. Press, vol. 118, no. 21, May 24, 1919, pp. 697-707, 10 figs. Practices followed in oil-shale industry in Scotland, France and Germany are quoted and conclusions drawn as to what writer believes we may and should accomplish with similar shales in this country.

Oil-Shales, Dean E. Winchester. Jl. Franklin Inst., vol. 187, no. 6, June 1919, pp. 689-703. Optimism is expressed concerning capability of furnishing from shales the oil needed for future operation of motors; it is observed, however, that before this raw material can be used some treatment must be devised that will permit efficient and economical elaboration.

Statistics

Statistical Treatise on Petroleum, Fred A. Lichtenheld. Colorado School of Mines Mag., vol. 9, no. 6, June 1919, pp. 143-150, 1 fig. Stratigraphic distribution of petroleum production and notes on early history. (To be continued.)

Water in Petroleum

The Evaporation and Concentration of Waters Associated with Petroleum and Natural Gas, R. Van A. Mills and Roger C. Wells. Dept. Interior, U. S. Geol. Service, bul. 693, 1919, 104 pp., 9 figs. Conclusion arrived at as result of investigation in regard to association of saline waters with petroleum and natural gas is that brines are result of a complex and long-continued evolution in which waters of sedimentation, together with ground waters from other sources have undergone deep-seated evaporation and concentration accompanied by chemical changes.

Water in Oil and Gas Wells, F. B. Tough. Petroleum Times, vol. 1, nos. 17 & 18, May 3 & 10, 1919, pp. 357-358 & 391, 1 fig. Dump-bailer method for cementing hole. Remarks on tubing method. (Concluded.)

PRECIOUS MINERALS

Gold, British Columbia

Notes on the Placer Mines of Cariboo, British Columbia, J. B. Tyrrell. Economic Geo-

FAFNIR

BALL BEARINGS

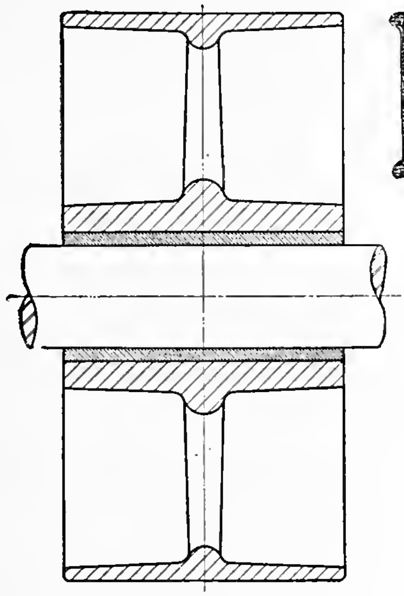


Figure 1

How to Re-equip a Standard Plain Bushing Loose Pulley With Ball Bearings

To convert a standard plain bushing loose pulley into a ball bearing pulley—as illustrated in figures 1 and 2—first, remove plain bushing. Then face back each end of pulley hub sufficiently to make room for ball bearing and cap. Turn outside diameter of hub and square up shoulders at the spokes on each end.

Next, fit ball bearing housing over turned section at each end of hub. It is important that the housing be made a press fit on hub and pinned in place, in order to prevent slippage.

After they are in place on hub, bore out the housings to a press fit for outer rings of ball bearings selected. If pulley is very large, the housings can be bored out before fitting them to pulley, but in that case caution must be used to insure perfect alignment of bearing sections—otherwise, pulley will not run true.

Assemble ball bearing in housing at each end of pulley. Then insert cap which should be provided with grease or felt groove to prevent escape of lubricant. Finally, snap into place ⅛-inch spring wire, which acts as a holding unit.

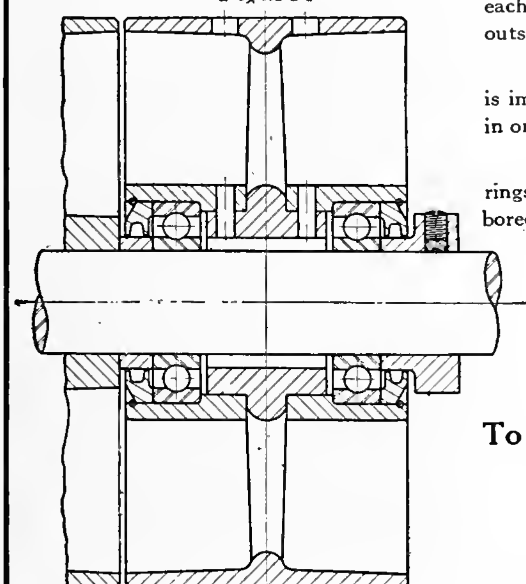


Figure 2

To Mount Pulley On Shaft—

(1) Slide spacer bushing over shaft against tight pulley.
(2) Slide assembled bearings and pulley as a unit over shaft against spacer bushing.
(3) Finally, slide thrust collar into position against outside inner ring—but do not crowd—and tighten set screw.

A Loose Pulley Originally Designed For Ball Bearings

Figure 3 illustrates a loose pulley designed by our Engineering Department especially for ball bearings. This particular pulley is easily constructed and has many fine qualities to recommend it. It will be observed that there are no shoulders and that it is only necessary to bore a straight hole through the hub and make grooves for cap retaining wires.

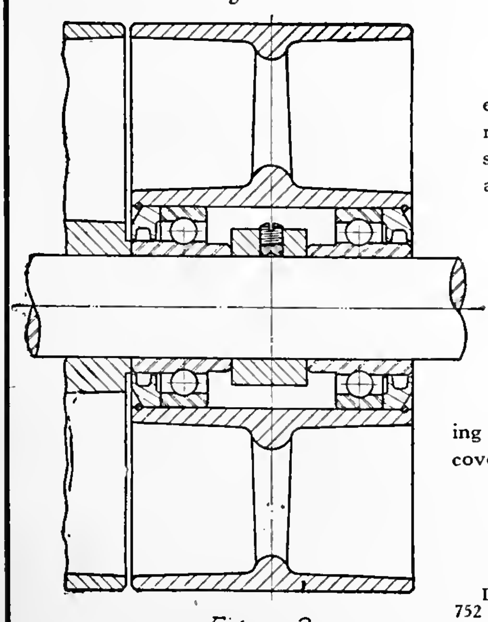


Figure 3

To Mount Pulley On Shaft—

(1) Locate thrust collar on shaft and tighten set screw.
(2) Slip pulley over shaft.
(3) Slide left hand bearing into position; put cap in place, and insert retaining wire.
(4) Install opposite bearing in same way.

On receipt of blue print or sketch and sufficient working data, our Engineering Department will be glad of the opportunity to make recommendations covering in detail any specific application.

THE FAFNIR BEARING COMPANY

Conrad Patent Licensee

DETROIT Office: 752 David Whitney Bldg. | **New Britain, Conn.** | CHICAGO Office: 1301 So. Michigan Ave.

logy, vol. 14, no. 4, June 1919, pp. 335-345, 4 figs. Historical account, topography, conditions and development of drainage.

Gold, Ontario

The Origin of the Gold Deposits of Matachewan District, Northern Ontario, H. C. Cooke. Economic Geology, vol. 14, no. 4, June 1919, pp. 281-301, 6 figs. Internal structure of ore bodies, described as pegmatic vein, middle zone of mineralized and altered rock on each side, and outer zone of altered rock without mineralization, which grades into unaltered country rock with irregular and embayed contacts, assumed as evidence that deposits in schist have been formed by alteration and mineralization of country rock by solutions coming up along Central vein.

Silver Mining, Nevada

Revival of Silver Mining at Cherry Creek, Nevada, Geo. H. Ryan. Salt Lake Min. Rev., vol. 21, no. 4, May 30, 1919, pp. 19-22, 4 figs. Geology of ore deposits and remarks as to possibilities of camp.

South Wales

Sulphide Corporation Limited Works, Cockle Creek, S. W. Proc. Australasian Inst. Engrs., vol. 31, Sept. 30, 1918, pp. 2-39, 27 figs. Nine articles covering various phases of treatment and manipulation of ore. Upwards of 200,000 tons of various materials are dealt with annually, there being produced from treatment of this tonnage about 31,000 oz. of gold, 2,500,000 oz. of silver, 28,000 tons of lead and 320 tons of antimonial lead.

TRANSPORTATION

Locomotive Headlights

Headlights for Locomotives in Mines, K. W. Mackall. Coal Industry, vol. 2, no. 6, June 1919, pp. 232-233, 3 figs. Spring suspension claimed as principal feature of new type described.

Mine Haulage

Vesta Coal Co.'s Modern System of Mine Haulage, Ralph W. Mayer. Coal Age, vol. 15, no. 24, June 12, 1919, pp. 1072-1076, 5 figs. System includes electric-motor transportation from coal face to central underground station where motors leave their loads, and tailrope which handles the cars from this point to tipple.

Metallurgy

ALUMINUM

Aluminum Alloys

Special and Commercial Light Aluminum Alloys, Robert J. Anderson. Dept. of the Interior, Bur. of Mines. Minerals Investigation Series, no. 14, April 1919, 22 pp. Description with chemical analyses and enumeration of physical properties of various alloys submitted to government bureaus. Writer does not feel that the majority of so-called "new" alloys possess properties claimed for them, or that it is economical to manufacture them.

BLAST FURNACES

British 800-Ton Plant

800-Ton Blast Furnace Plant at the Park Gate Works, Rotherham, and the Staveley Works, Chesterfield. Iron & Coal Trade Rev., vol. 98, no. 2675, June 6, 1919, pp. 759-760, 12 figs. partly on supp. plates. Also Engineer, vol. 127, no. 3310, June 6, 1919, pp. 564-566, 10 figs. on supp. plates. Furnace said to have been designed with a view to secure even distribution around large bell, equal distribution of large and fine, gas-tight top, means for changing bell rods and other gear with minimum loss of time.

Charging

Charging Raw Material into Blast Furnaces, J. A. Mohr. Iron Age, vol. 103, no. 22, May 29, 1919, pp. 1432-1434 and (discussion), pp. 1434-1436, 3 figs., also Iron Trade Rev., vol. 64, no. 22, May 29, 1919, pp. 1413-1415, 1 fig., and Blast Furnace and Steel Plant, vol. 7, no. 6, June 1919, pp. 298-305, 6 figs. On coördinating and arranging different phases of charging and mixing of raw material so as to achieve uniformity in their disposition and arrangement that will best suit conditions of individual plant.

Electric Smelting

Commercial Feasibility of Electric Smelting of Iron Ores in British Columbia, Alfred Stansfield. Chem. & Metallurgical Eng., vol. 20, no. 12, June 15, 1919, pp. 630-636. Also Iron & Steel of Can., vol. 2, no. 5, June 1919, pp. 132-145. Excerpts from bul. no. 2, 1919, British Columbia Department of Mines. Electric pig iron.

Cleveland (England) Ore Smelting

The Smelting of Cleveland Iron-Stone, S. G. Smith. Foundry Trade Jl., vol. 21, no. 208, Apr. 1919, pp. 229-232. General outline of process of converting ore into pig iron, as followed at district embracing coast from Saltburn to Whitby, also Normandy and Eston Hills. Paper read before Lancashire Branch British Foundrymen's Assn.

Steel Turnings

Utilization of Steel Turnings in the Blast Furnace (L'emploi des tournures d'acier au haut fourneau), M. Tripier. Bulletin et comptes rendus de la Société de l'Industrie Minerale, vol. 15, no. 5, 1919, pp. 275-297. Experience acquired in munition works.

FERROUS ALLOYS

Ferro-Alloys

Ferro-Alloys in Alloy Steel Production. Raw Material, vol. 1, no. 3, May 1919, pp. 177-181, 8 figs. Survey of situation, specially of impetus given to alloy industry during the war.

Iron-Cobalt Alloys

On Some Physical Constants of Iron-Cobalt Alloys, Kōtarō Honda. Science Reports of the Tōhoku Imperial University, vol. 8, no. 1, Apr. 1919, pp. 51-59, 4 figs. Experimental. Measurement of thermal and electrical conductivity, moduli of elasticity and rigidity, and intensity of magnetization.

FLOTATION

Copper

Recovery of Copper from Flotation by Leaching, Percy R. Middleton. Min. & Sci. Press, vol. 118, no. 23, June 7, 1919, pp. 771-772. Results of roasting and leaching flotation concentrate.

Hardwood Tar Oils

Flotation Experiments on Hardwood Tar Oils, L. F. Hawley and O. C. Ralston. Chem. & Metallurgical Eng., vol. 20, no. 11, June 1, 1919, pp. 586-587. Experimental tests. It is concluded that a mixture of different oils is more likely to do good flotation work than any one product alone.

Practice

Flotation for the Practical Mill Man, Frederick G. Moses. Chem. & Metallurgical Eng., vol. 20, no. 11, June 1, 1919, pp. 571-577. Suggestions in regard to overcoming factors tending to produce unsatisfactory results in flotation plant.

Sulphur

Concentration of Native Sulphur Ores by Flotation, James M. Hyde. Dept. of the Interior, Bur. of Mines, Minerals Investigations Series, no. 18, April 1919, 18 pp. Reported that ores from several districts were treated successfully by flotation. It is claimed that under favorable conditions better than 80 per cent of sulphur should be recoverable as concentrate containing more than 80 per cent of sulphur.

FURNACES

Electric

Electric Furnace for Melting Non-Ferrous Metals—II, E. F. Collins. Foundry, vol. 47, no. 324, June 1, 1919, pp. 329-333, 4 figs. Statement of melting cost of electric and fuel-fired furnaces.

A New Electric Rotating Brass Furnace, Carl H. Booth. Iron Age, vol. 103, no. 26, June 26, 1919, pp. 1699-1702, 4 figs. Booth in which door has been placed in one end of furnace and tapping hole in other end in order to overcome difficulty which is said to have been experienced in previous models in maintaining lining around combination spout and door.

Powdered Fuel

Powdered Fuel for Firing Metallurgical Furnaces and Steam Boilers, J. S. Atkinson. Iron & Coal Trades Rev., vol. 98, no. 2672, May 16, 1919, pp. 651-652, 15 figs. on supp. plate. Success in burning powdered coal secured, writer believes, by first drying coal down to a point where there is not more than one per cent of moisture left in it, pulverizing to such a degree of fineness, that 95 per cent of coal will pass through a 100-mesh sieve, and intimately mixing powdered coal with air before admitting it to combustion chamber. Paper read before Sheffield Soc. of Engrs. and Metallurgists.

Use of Pulverized Coal, with Special Reference to Its Application in Metallurgy, L. C. Harvey. Colliery Guardian, vol. 117, no. 3046 & 3047, May 16 & 23, 1919, pp. 1146-1148 & 1228-1229, 16 figs. "Holbeck" (Bonnot) system, "Quigley," "Fuller," "Bergman," "Covert" and "Stroud" systems. Graphs showing comparison of approximate utilization and waste of fuel supplied to locomotive boiler with hand and powdered-coal firing, taking fuel as delivered to engine tender.

Recuperative Furnace

A New Type of Recuperative Furnace, Walter Rosenhain. Engineering, vol. 107, no. 2787, May 30, 1919, pp. 702-704, 8 figs. Recuperator consists of nest or battery of tubes through which incoming air is drawn while products of combustion circulate about interior of tubes.

IRON AND STEEL

Aircraft Steel

Shop Practice in Respect to Aircraft Steel, H. P. Philpot. Aeronautical Jl., vol. 23, no. 99, Mar. 1919, pp. 112-129, 45 figs. Equilibrium diagrams of solutions of sodium nitrate and water, also iron-carbon equilibrium diagram and graphs indicating variations and physical properties of nickel-chrome steel with varying quenching temperatures.

Allotropy of Metals

The Allotropy of Metals in the Light of Recent Research—II, Clifford W. Nash. Chem. Eng. & Min. Rev., vol. 11, no. 127, Apr. 5, 1919, pp. 192-194. Evidence in favor of existence of allotropic forms of iron. (Concluded.)

Borax

See Fluxes.

Cast Iron, Impurities in

Cast-Iron Under Heat Influences, E. Adamson. Jl. of West of Scotland Iron & Steel Inst., vol. 26, part 6, Feb., session 1918-1919, pp. 80-84 and (discussion) pp. 84-88, 2 figs. partly on supp. plate. Experimental tests in regard to separation of impurities.

Cast Iron, Oxygen in

Oxygen in Cast Iron and Its Application, Wilford L. Stork. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 150, June, 1919, pp. 951-956. Also Iron Age, vol. 103, no. 25, June 19, 1919, pp. 1636-1637. Purports to give further evidence in support of theories advanced by J. E. Johnson, Jr., in regard to influence of oxygen on strength of cast iron, and to show their application to cupola mixtures.

Cooling of Hypoeutectic Steels

Effect of Cooling on Micrographic Structure of Hypoeutectic Steels and Alloys of Similar Constitution (Effet du revenu sur la structure micrographique des aciers hypoeutectiques et des alliages de constitution similaire), M. A. Portevin. Revue de Metallurgie, vol. 16, no. 2, Mar.-Apr., 1919, pp. 141-148, 16 figs. Examination of photomicrographs of various specimens.

Duplexing

Metallurgical Considerations of Duplexing,—II, Richard S. McCaffery. Blast Furnace & Steel Plant, vol. 7, no. 6, June 1919, pp. 287-288 and 297. Suggestion for removal of sulphur and phosphorus.

Fluxes

Boron Derivatives in Relation to Metallurgy. Metal Industry, vol. 14, no. 18, May 2, 1919, pp. 367-369. Uses of borax glass for fluxing purposes at South African, American and Australian gold mines and other applications of borax.

Gathman Process of Ingot Production

Commercial Production of Sound Steel Ingots, Emil Gathman. Raw Material, vol. 1, no. 4, June 1919, pp. 213-216, 5 figs. Gathman process.

Grain Size and Rolling

The Grain Size in Steel as Influenced by Rolling. Iron & Steel of Can., vol. 2, no. 2, Mar. 1919, pp. 42-43, 4 figs. Experiments at Welland Plant of Can. Steel Foundries. It is concluded that composition of all unhardened steel is either pearlite alone, or pearlite associated with ferrite or cementite.

Heat Treatment

Alteration of Steels at Temperatures in the Neighborhood of 500 Deg. Cent. (Sur l'Alteration des aciers aux températures voisines de 500°), M. Grenet. Bulletin et comptes rendus de la Société de l'Industrie Minerale, vol. 15, no. 5, 1919, pp. 339-353, 4 figs. These temperatures were found to be particularly harmful to nickel-chrome steels containing carbon and

manganese; while not so injurious to other steels, it is nevertheless advised not to keep unnecessarily any steel at this temperature.

Impurities, Non-Metallic

Non-Metallic Impurities in Steel, Henry D. Hibbard. Iron Age, vol. 103, no. 22, May 29, 1919, pp. 1427-1429 & (discussion) pp. 1429-1432. While admitting that to forecast effect of sonims on the properties of steel much work is required to be done and interpreted, writer believes that quantity and composition must be ascertained by chemical means, and mode of occurrence as far as possible be by the microscope.

Open Hearths, Cooling Devices for

Cooling Devices for Open Hearths, Wm. C. Coffin. Iron Trade Rev., vol. 64, no. 21, May 22, 1919, pp. 1356-1358, 3 figs. States that furnace life is increased by installing water-cooling equipment having brick covering. Recent developments in door, buckstay, skewback, port and bulkhead coolers are indicated.

Rolling Mills

The New Steel Works and Rolling Mill at Witkowitz (Die neue Stahl- und Walzwerksanlage des Eisenwerkes Witkowitz). Montanistische Rundschau, vol. 11, no. 6, Mar. 16, 1919, pp. 156-162, 9 figs. Plant completed in 1916 consists of a 300-ton mixer, three 200-ton Talbot furnaces and thirty-three 60-ton Martin stationary type furnaces. (To be continued.)

Soaking Pit, Electrically Heated

Electrically Heated Soaking Pit, Thaddeus F. Baily. Iron Age, vol. 103, no. 22, May 29, 1919, pp. 1419-1421 and (discussion) pp. 1421-1422, 4 figs., also Iron Trade Rev., vol. 64, no. 22, May 29, 1919, pp. 1416-1418, 1 fig. Writer sees coming acceptance of electric soaking pits in commercial operations.

Steel, High-Speed

The Manufacture and Working of High Speed Steel, J. H. Andrew. Engineering, vol. 107, no. 2787, May 30, 1919, pp. 715-720, 36 figs. It is believed that improvement in casting might be made by increasing a thickness of mold walls and lowering the pouring temperature of the metal; also it is recommended that forging temperatures be increased considerably. Similarly other suggestions are offered and various defects occurring in high-speed steel are reviewed and commented on. (Concluded). Paper read before Iron & Steel Inst.

High-Speed Tool-Steel Efficiencies, John O. Arnold and Fred Ibbotson. Iron Trade Rev., vol. 64, no. 22, May 29, 1919, pp. 1419-1421, 3 figs. Determined by lathe operations and chemical analyses. Micrographic study of difference between annealed and quenched specimens. Paper presented before Iron & Steel Inst.

Steel, Liquid and Solid

On the Solid and Liquid State of Steel, Cosmo Jones. Engineering, vol. 107, no. 2787, May 30, 1919, pp. 721-722. The properties of an optically clean surface of liquid steel described and similarity to that of polished metallic surface with vitreous film pointed out. Preservation of this surface of liquid steel attributed to presence of atmosphere of iron vapor. Means to determine surface tension qualitatively suggested and it is said that surface tension value varies largely with volume of gases occluded. From lecture delivered to West of Scotland Iron & Steel Inst.

NON-FERROUS ALLOYS

Bronzes, Aluminum

Aluminum Bronzes (L'Etude des propriétés des bronzes d'aluminium), Jean Durand. Génie Civil, vol. 74, no. 16, Apr. 19, 1919, pp. 315-317. Warns against complicating composition of alloy. It is claimed that in all cases a simple alloy can be found of better known properties and possessing advantages equal to those of the complicated alloy.

Bronze and Brass, Inclusions in

Non-Metallic Inclusions in Bronze and Brass, G. F. Comstock. Metal Industry, vol. 14, no. 16, Apr. 18, 1919, pp. 330-333, 21 figs. Photomicrographs. Method employed consists in overheating and oxidizing small charge of copper, then cooling it and adding a suitable amount of the element whose oxide it was desired to observe.

Cupro-Nickel, Decarbonization of

Notes on Carbon in 80/20 Cupro-Nickel Melted in the Electric Furnace, F. C. Thompson and W. R. Barclay. Jl. Soc. Chem. Indus., vol. 38, no. 10, May 31, 1919, pp. 130T-132T, 4 figs. Account of trouble experienced before decarbonizing process was included in melting.

Gold-Copper Alloys

Hardness and Resiliance of Gold-Copper Alloys (Note sur la dureté et le résilience des alliages or-cuivre), A. Portevin and Jean Durand. Revue de Métallurgie, vol. 16, no. 2, Mar.-Apr. 1919, pp. 149-151, 3 figs. Results of experiments.

Monel Metal

Monel Metal the Natural Alloy, Hugh R. Williams. Raw Material, vol. 1, no. 4, June 1919, pp. 217-221, 4 figs. Alloy contains 67 per cent nickel and 28 per cent copper and is said to be non-corrodible by ordinary atmospheric agencies and to have unparalleled resistance to chemicals.

OCCLUDED GASES

Degasified Steel

Safeguarding Steel Ingot Production. Raw Material, vol. 1, no. 3, May 1919, pp. 172-176, 5 figs. Process outlined consists of production of a "degasified" steel before teeming into mold, by means of ferro-silicon, aluminum or titanium added for purpose of "scavenging" oxides and reduction of size of ingot pipe to minimum by giving lower portion of mold greater heat-absorbing and radiating capacity than top.

METALLOGRAPHY

Non-ferrous Metals

Metallography Applied to Nonferrous Metals—V & VI, Ernest J. Davis. Foundry, vol. 47, no. 8 & 9, June 1 & 15, 1919, pp. 345-349 & 395-398, 19 figs. Lead alloys and bearing metals discussed from viewpoint of their microstructure; also equilibrium diagram of lead-tin, lead-antimony, copper-lead, nickel-copper and nickel-silver series, and micrographs of various alloys.

Photomicrography

The Study of Alloys (L'Etude des Alliages). Métaux, Alliages et Machines, vol. 12, no. 4, Apr. 1919, pp. 7-12, 9 figs. After discussing what is termed irrational order of conducting investigations of these structures, applications of photomicrography and the thermic analysis are taken up. Extracts from book published by Witold Broniewski at Librairie Delagrave.

Radio Metallography

Radio Metallography. Times Eng. Supp., vol. 15, no. 535, May 1919, p. 165. Methods of examining metals and various types of material by means of X-ray photography.

The X-ray Examination of Metals, E. Schneider. Engineering, vol. 107, nos. 2784 & 2785, May 9 & 16, 1919, pp. 613-614, and 641-644, 23 figs., also Elecn., vol. 82, no. 20, May 16, 1919, pp. 568-569. Research into industrial X-ray examination of metals at laboratory of Schneider Works is represented as demonstrating that radio-metallography enables visual examinations to be made of ordinary steels, provided their thickness does not exceed 45 mm., this limit in thickness being reduced when steel contains at least one constituent of higher atomic weight. Method developed at Hatfield research laboratory in Sheffield. German work on subject. (Concluded.)

Aeronautics

AIRCRAFT

Cemented Seams

See Balloon Construction.

Balloon Construction

Notes on Cemented Seams and Rubber Cements with Reference to Balloon Construction, J. D. Edwards. Aerial Age, vol. 9, no. 14, June 16, 1919, pp. 688-690, 8 figs. Concluded from tests and examination of microsections of cemented seams that next to a good cement it is necessary to smooth and clean surfaces to be cemented and to apply cement in fine coat of uniform thickness, in order to secure satisfactory results.

Balloons and Solar Radiation

Effect of Solar Radiation Upon Ballons, Junius David Edwards and Maurice Blaine Long. Technologic Papers of Bur. Stand., Dept. Commerce, no. 128, June 13, 1919, 29 pp., 6 figs. Measurements said to have shown absorption power of radiation to vary from 45 to 95 per cent.

APPLICATIONS

Cape-to-Cairo Air Route

Cape-Cairo Air-Way. Flight, vol. 11, no. 24, June 12, 1919, pp. 775-776, 1 fig. Scheme for organizing route.

Mapping

See Surveying.

Speed

Making the Airplane a Utility, Grover C. Loening. Jl. Soc. Automotive Engrs., vol. 4, no. 6, June 1919, pp. 489-493, 2 figs. Speed considered as element needed to give real sound utility to airplane.

Surveying and Mapping

The Aeroplane in Surveying and Mapping, E. Lester Jones. Flying, vol. 8, no. 5, June 1919, pp. 438-441, 2 figs., also Science, vol. 49, no. 1277, June 20, 1919, pp. 575-582, and Sci. Am. Supp., vol. 87, no. 2268, June 21, 1919, pp. 386-387 and 391. Value expected chiefly in reconnoissance surveys and maps. Past experiments considered as forecasting successful development of revising charts by airplanes. Address delivered before Second Pan-American Aeronautic Convention.

AUXILIARY SERVICE

Hangars

The Heating of Hangars (Die Heizung van Flugzeughallen), F. Kaiser. Zeitschrift des Bayerischen Revisions-Vereins, vol. 23, nos. 1, 2 & 3, Jan. 15, 31 & Feb. 15, 1919, pp. 2-4, 11-13, and 19-22, 8 figs. Compares systems of heating with a stove, by hot air, steam, and a combination of these.

Reinforced-Concrete Hangars for the Hyroplanes of the Port of Algiers (Hangar en béton armé pour les hydravions du centre maritime d'Alger), E. Carret. Génie Civil, vol. 74, no. 21, May 24, 1919, pp. 409-413, 15 figs., partly on supp. plate. Dimensions are 104 ft. free opening by 130 ft. useful depth.

Landing Stations

Finding Aircraft Landing Stations by Means of Audio Frequency Receivers, Earl C. Hanson. Flying, vol. 8, no. 5, June 1919, pp. 442-443, 6 figs. Scheme suggested comprises combination of radio directive transmission system to guide aircraft at high speed in direct course between separated cities or other points, audio frequency signal means to project audio frequency energy to predetermined altitudes, but restricted to area of landing field, and indirectly illuminated zone in center of landing field.

Motorship

The Seaplant Carrier "Argus." Sci. Am., vol. 120, no. 24, June 14, 1919, pp. 630-631, 7 figs. Ship with 500 ft. starting and landing platform for seaplanes. It carries 20 seaplanes in hangar below deck, and has upper flying deck for launching and landing, which is clear of masts, smokestacks and deck structures.

Radio Telephones

The Radio Telephone Equipment of the NC-4, Edgar H. Felix. Aerial Age, vol. 9, no. 13, June 9, 1919, pp. 638-639 & 652, 5 figs. Design is said to permit transmission of three types: (1) voice currents, (2) continuous or undamped waves, (3) damped waves of audio frequency.

DESIGN

Air Mileage

See Cruising Radius.

Cruising Radius

Air Mileage of Aeroplanes Intended for Long Distances and for Transport, J. Dennis Coales. Engineering, vol. 107, no. 2785, May 16, 1919, pp. 621-622, 1 fig. Effect of winds on air mileage. (Concluded.)

Cooling System

The Loomis Cooling System for Aircraft. Aeronautics, vol. 16, no. 290, May 8, 1919, pp. 479-480, 3 figs. Expansion tank surrounds core and injector is located in water connection between main and booster radiators for keeping constant volume of water in circulating system. From Bul. U. S. Experimental Dept., Aeroplane Eng. Div.

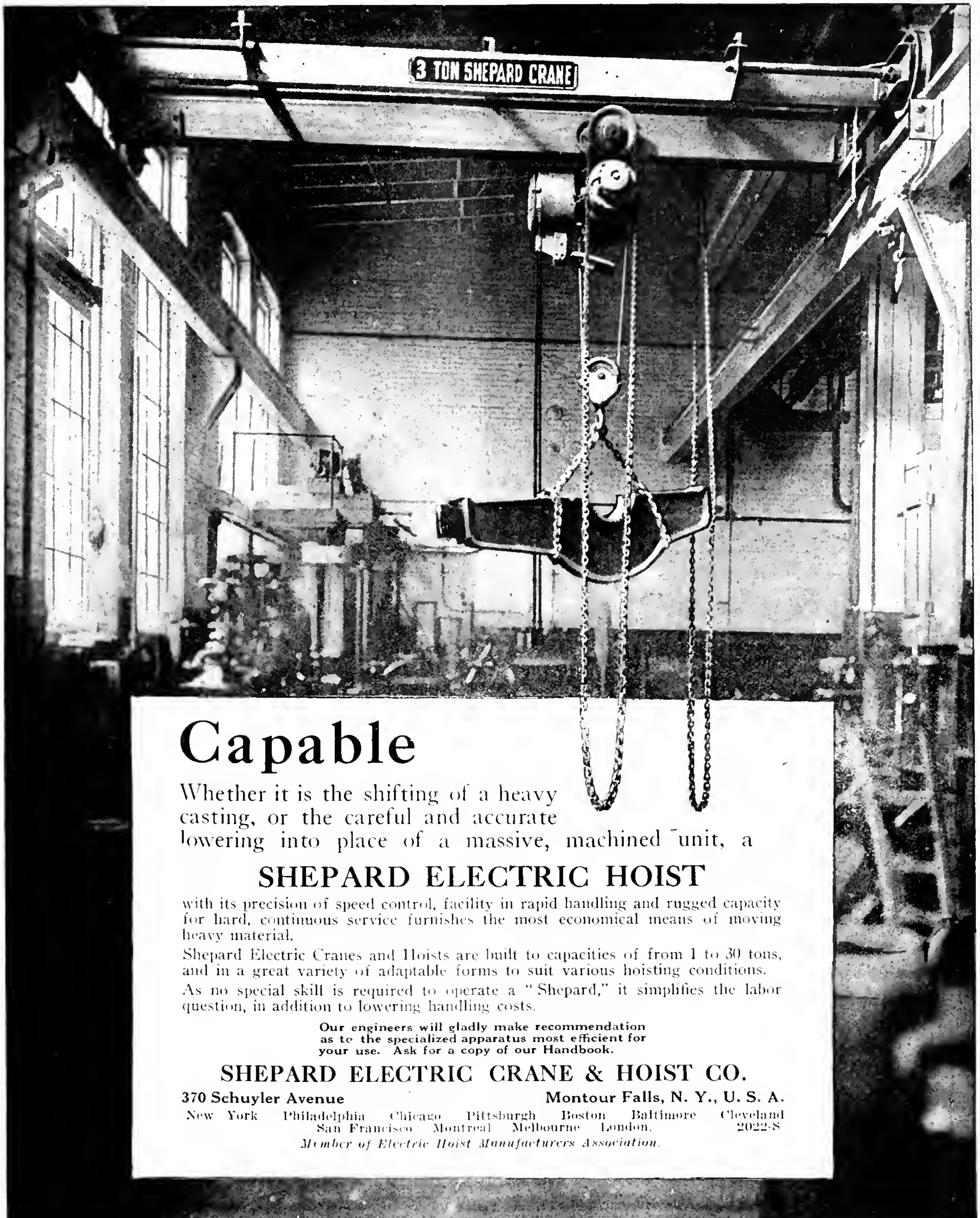
Flying Boats

The Construction of the Navy-Curtiss Flying Boats. Jl. Soc. Automotive Engrs., vol. 4, no. 6, June 1919, pp. 439-442, 4 figs. Radical alterations from past designs quoted as distinctive features of N-C boats are shortened hull and mounting of tail surfaces on outriggers.

Design and Construction of Flying Boats, David Nicolson. Engineering, vol. 107, no. 2786, May 23, 1919, pp. 684-686, 16 figs. Deals particularly with larger types known officially as F-2a, F-3, F-5, P-5 and N-4.

Large Aeroplanes

Some Considerations of the Design of Large Aeroplanes, Leslie V. Spencer. Aerial Age, vol.



Capable

Whether it is the shifting of a heavy casting, or the careful and accurate lowering into place of a massive, machined unit, a

SHEPARD ELECTRIC HOIST

with its precision of speed control, facility in rapid handling and rugged capacity for hard, continuous service furnishes the most economical means of moving heavy material.

Shepard Electric Cranes and Hoists are built to capacities of from 1 to 30 tons, and in a great variety of adaptable forms to suit various hoisting conditions.

As no special skill is required to operate a "Shepard," it simplifies the labor question, in addition to lowering handling costs.

Our engineers will gladly make recommendation as to the specialized apparatus most efficient for your use. Ask for a copy of our Handbook.

SHEPARD ELECTRIC CRANE & HOIST CO.

370 Schuyler Avenue **Montour Falls, N. Y., U. S. A.**

New York Philadelphia Chicago Pittsburgh Boston Baltimore Cleveland San Francisco Montreal Melbourne London. 2022-S

Member of Electric Hoist Manufacturers Association.

REG. U.S. PAT.OFF.

SHEPARD

ELECTRIC CRANES & HOISTS

9, no. 16, June 30, 1919, pp. 774-776, 7 figs. Urges that aeronautical engineers prepare their designs along new and original lines, as writer sees that large aerial liner is far from having reached a standard or final stage.

Lift-Angle of Incidence

The Economics of Flight. H. B. Irving. Automotive Industries, vol. 40, no. 24, June 12, 1919, pp. 1306-1308, 2 figs. Showing variation of lift-drag ratio with angle of incidence and chart for determining most economical speed of flight.

Lift Charts

Chart for Performance Computations. Richard I. Elliot. Aviation, vol. 6, no. 7, June 1, 1919, p. 488, 1 fig. Prepared for solving graphical equations involving lift data.

Loads

The Loads and Stresses on Aeroplanes. John Case. Aeronautics, vol. 16, no. 289 and 291, May 1 & 15, 1919, pp. 445-448 and 502-506, 20 figs. Formula for computing loads that come upon machine as a whole under various conditions of flight. Estimation of movement of air forces on wings about center of gravity or other given point. (Continuation of serial.)

Metal Construction

Metal Construction of Aircraft. A. P. Thurston. Flight, vol. 11, nos. 21 & 22, May 22 & 29, 1919, pp. 680-684, and 710-714, 29 figs., also Aeronautics, vol. 16, no. 292, May 22, 1919, pp. 534-537. Requirements of metal used for aircraft construction and methods of attaching fittings. Boulton and Paul spars; Humber spars; types of struts; methods of design and calculation of girder spars. Preparation and possibilities of steel and duralumin. (Continuation of serial.)

Struts

Some Useful Fuselage Strut Curves. A. J. Sutton Pippard. Aeronautics, vol. 16, no. 288, Apr. 24, 1919, pp. 426-427, 5 figs. To determine weight of members from a knowledge of their length and the loads in them without determining actual sizes required.

The Effect of a Side-Wind on Interplane Struts. A. J. Sutton Pippard. Engineering, vol. 107, no. 2788, June 6, 1919, p. 727, 1 fig. Formulæ and curves based on Euler's formula.

ENGINES

Basse-Selve

The Bassé-Selve 270-300 Horsepower German Airplane Engine. Automotive Engrs., vol. 4, no. 5, May 1919, pp. 222-227, 12 figs., also Automobile Engr., vol. 9, no. 127, June 1919, pp. 178-184, 18 figs. Similar in most of leading details of construction to 260-hp. Mercédes and 230-hp. Benz, on which design is believed to have been based.

Crankshafts

Airplane Engine Crankshaft Design. Glenn D. Angle. Aviation, vol. 6, no. 10, June 15, 1919, pp. 525-528, 2 figs. In its relation to engine design in general.

Curtiss

The Curtiss Model K-12 Aero Motor. Aeronautics, vol 16, no. 288, Apr. 24, 1919, pp. 428-430, 3 figs. Also Automobile Eng., vol. 4, no. 5, May 1919, pp. 217-220, 7 figs. Form of construction adapted said to give minimum center distance between cylinders. Pistons are of aluminum alloy flat head type. Motor said to develop 400 hp. on fuel consumption of 0.55 lb. per b.hp. hr.

Hispano-Suiza

Aviation Motors (Les moteurs d'aviation). Aérophile, vol. 27, nos. 7-8, Apr. 1 & 15, 1919, pp. 112-114, 6 figs. Carburation, cooling water circulation and lubrication of Hispano-Suiza (150 hp.) motor. (Continued.)

Jupiter

See Radial Types.

Liberty

The Liberty Aircraft Engine. J. G. Vincent. Jl. Soc. Automotive Engrs., vol. 4, no. 5, May 1919, pp. 383-401, 14 figs. Historical and descriptive account.

Maybach

Details of the Maybach 300-Horsepower Airplane Engine—II. Automotive Eng., vol. 4, no. 5, May 1919, pp. 228-233, 13 figs. Connecting rod and valve systems, lubrication, carburation and cooling. (To be continued.)

Mercedes

Mercedes 180 HP. (Le moteur Mercedes 180 hp.). Aérophile, vol. 27, nos. 7-8, Apr. 1 & 15, 1919, pp. 114-117, 5 figs. Comparison of horsepower and consumption of the 160-hp. and the 180-hp. at different velocity.

Mercury

See Radial Types.

Napier "Lion"

The Napier "Lion" 450 HP. Aero Engine. Aerial Age, vol. 9, no. 15, June 23, 1919, pp. 730-733, 10 figs. Engine has three groups of four cylinders each, mounted "broad-arrow."

Naval Aircraft

Characteristics of Leading Aero Engines Used in Allied Naval Aircraft. Aerial Age, vol. 9, no. 11, May 26, 1919, pp. 542-543. Supplements tables of characteristics published in issue of Mar. 3, 1919. Forty-five engines are recorded in present set.

Pistons

Elements of Piston Design and Their Particular Application to Airplane Engines. Richard Vosbrink. Pac. Mar. Rev., vol. 16, no. 6, June 1919, pp. 115-119, 10 figs. Particularly in reference to piston design. In this connection investigation and analysis undertaken as preliminary to designing standard piston used by Hall-Scott Motor Co. are referred to.

Radial Types

Some Fixed-Radial Aero-engines. Engineer, vol. 127, no. 3309, May 30, 1919, pp. 530-532, 6 figs. Jupiter and Mercury types.

Renault

Industrial Uses of Renault Motors (Groupes industriels actionnés par moteurs à explosion, système Renault). Génie Civil, vol. 74, no. 20, May 17, 1919, pp. 393-396, 7 figs. Installation of 190-hp. 8-cyl. aviation-type motor given as example.

Sturtevant

The Sturtevant Aeroplane Engines. Aerial Age, vol. 9, no. 11, May 26, 1919, pp. 536-538 & 556, 7 figs. Eight-cylinder "V"-type water-cooled. Made in two models.

Volumetric Efficiency

Increasing the Engine's Volumetric Efficiency—VI. Emil Schimanek. Automotive Eng., vol. 4, no. 5, May 1919, pp. 235-237, 7 figs. Writer expresses reasons why he believes more and less strokes than usual four increase or decrease power development. From Zeitschrift des Vereines Deutscher Ingenieure. (To be concluded.)

MATERIALS OF CONSTRUCTION

Balsa Wood

The Properties of Balsa Wood. R. C. Carpenter. Aerial Age, vol. 9, no. 13, June 9, 1919, pp. 640-641, 5 figs. Tabulated results of tranverse tests.

Coatings

Tests of Moisture and Water Resistant Coatings. Henry A. Gardner. Aviation, vol. 6, no. 10, June 15, 1919, pp. 539-540. Collodion dopes proved inferior to spar varnish as water excluders.

Metal Construction

See Design.

Plywood

The General Properties and Uses of Plywood. B. C. Boulton. Aerial Age, vol. 9, no. 15, June 23, 1919, pp. 724-727, 6 figs. Examples of distortion caused by improper construction.

Waterproof Plywood for Airplanes. Automotive Industries, vol. 40, no. 24, June 12, 1919, pp. 1331-1333 and 1359, 5 figs. Strength tests for ascertaining resistance of glue.

Standards, British

British Standards for Aircraft Materials. India-Rubber Jl., vol. 57, no. 16, Apr. 19, 1919, pp. 1-2 and 5-6, 4 figs. Specifications prepared by British Eng. Standard's Assn. for rubber tubing for use with gasoline, paraffin, lubricating oil or hot water, and for rubber shock-absorber cord for aircraft.

Veneer Construction

Veneer Body Construction. Aviation, vol. 6, no. 7, June 1, 1919, pp. 485-486, 4 figs. Test of USXB-1 bodies. (Concluded.)

METEOROLOGY

Barometric Variation Forecast

Forecasting Barometric Variations (Sur la prévision des variations barométriques). Gabriel Guilbert. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 18, May 5, 1919, pp. 899-902. Additional observations to note presented in Comptes rendus, vol. 168, 1919, p. 356.

Physics of Upper Air

Air Navigation. H. A. Wimperis. Aeronautics, vol. 16, no. 290, May 8, 1919, pp. 482-487, 10 figs. Advises supporting in every possible way development in scientific work in meteorology in every part of the world, and especially for the study of physics of upper air.

Tides

See Winds and Tides.

Weather Forecast

Meteorology and Transatlantic Fight. A. Zaiman. Flight, vol. 11, no. 20, May 15, 1919, pp. 641-642, 3 figs. Necessity of coöperation between various meteorological stations in forecasting weather conditions emphasized.

Winds and Tides

Practical Study of Winds and Tides (Estudio práctico de vientos y mareas), Jose Debenedetti. Ingenieria, vol. 23, no. 8, Apr. 16, 1919, pp. 496-515. Comparison of values of harmonic constants obtained by process outlined in Indian Survey with those obtained by Prof. G. H. Darwin, based on period of thirty days.

The Lunar Tide in the Atmosphere. S. Chapman. Nature, vol. 103, no. 2584, May 8, 1919, pp. 185-187. Diagram showing lunar semidiurnal tide in atmosphere at Greenwich, as determined from Greenwich Records of barometric pressure, 1854-1917.

MILITARY AIRCRAFT

Air Ministry of Great Britain

Great Britain's War Work in the Air. Aeronautics, vol. 16, no. 289, May 1, 1919, pp. 456-462. Particularly in regard to coöperation of Air Ministry with army and navy.

Naval Aircraft

Operations of Naval Aircraft. J. H. Towers. Jl. Soc. Automotive Engrs., vol. 4, no. 5, May 1919, pp. 368-371, 7 figs. Statistics quoted as examples of work done.

Tactics, Aerial

Aerial Tactics and Defence Against Airships (La tactique aérienne et la défense contre avions). J. A. Lefranc. Aérophile, vol. 27, nos. 7-8, Apr. 1 & 15, 1919, pp. 102-107, 5 figs. Organization of airplane pursuit; bombarding enemy airdromes; anti-aircraft guns. Experiences during the war are quoted and scientific aspect of these tactics is discussed. Second article.

MODELS

Fuselage

Model Aeroplanes—XXVI. F. J. Gamm. Aeronautics, vol. 16, no. 292, May 22, 1919, pp. 532-533, 20 figs. T-frame of fuselage as it is being used for twin screw canard models. (Continuation of serial.)

Lauder Racing Model

Elementary Aeranutics. John F. McMahon. Aerial Age, vol. 9, no. 14, June 16, 1919, p. 697, 2 figs. Dimensions of Lander racing models.

Loening Monoplane

Elementary Aeronautics and Model Notes. John F. McMahon. Aerial Age, vol. 9, no. 13, June 9, 1919, p. 647, 3 figs. Scale model of Loening monoplane.

Model Results and Full Scale Achievement

Model Experiments in Aeronautics. Engineering, vol. 107, no. 2786, May 23, 1919, pp. 657-658, 5 figs. Mathematical analysis of conditions which must be satisfied to obtain exact correspondence between model results and full-size achievements in regard to forces brought into play by motion of a body in a fluid medium.

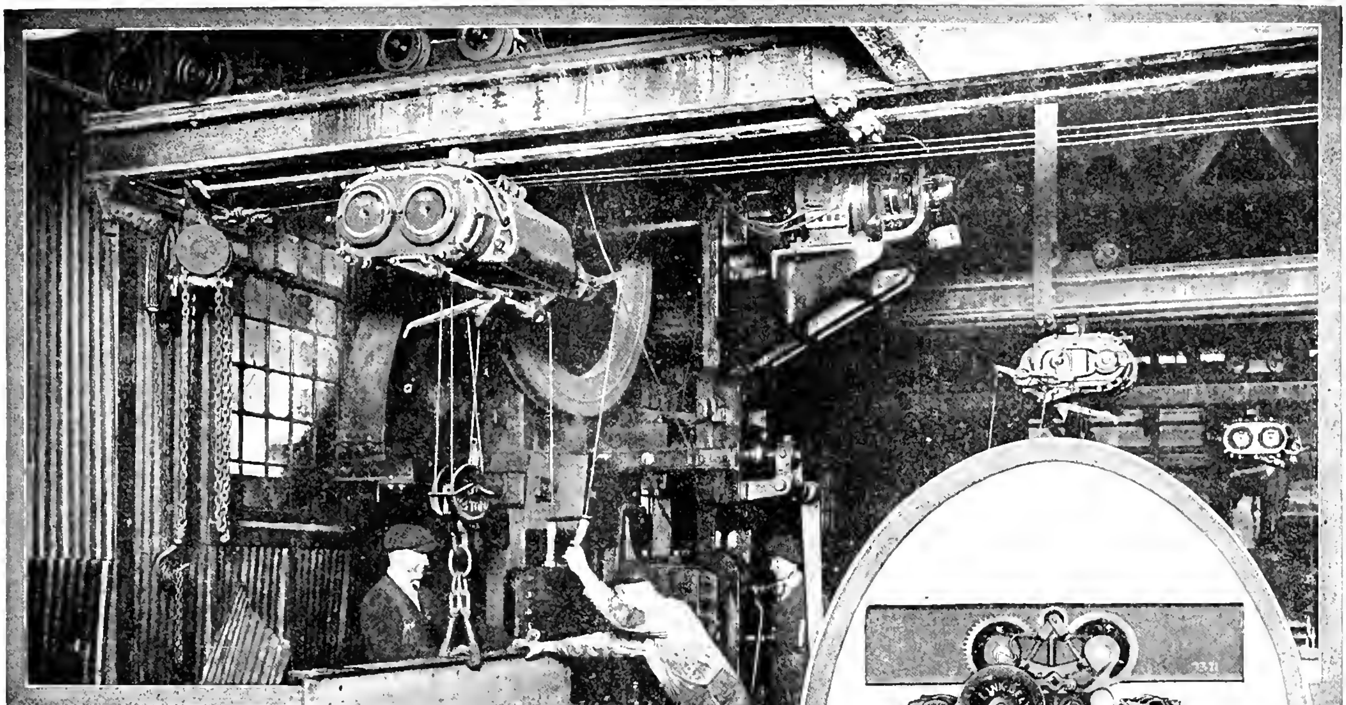
PLANES

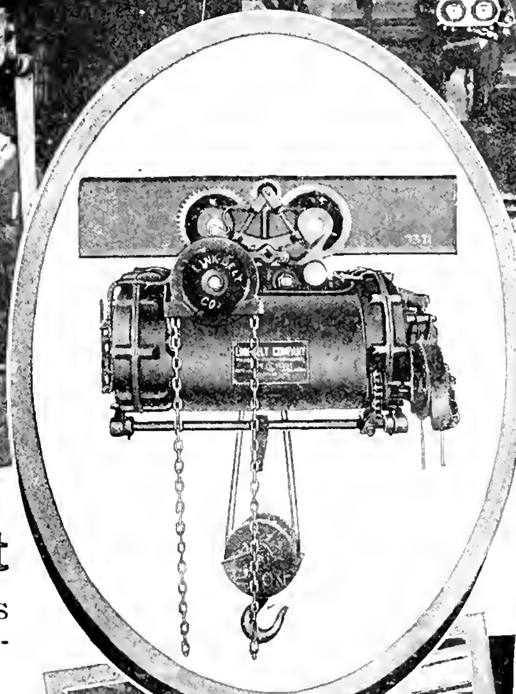
Bantam

The B. A. T. Bantam. Fight, vol. 11, no. 21, May 22, 1919, pp. 662-667, 12 figs. Fuselage construction consists essentially of light framework, comprising six longitudinal members and a number of transverse formers built up of three-ply wood, the whole covered by a three-ply skin put on in bands some 3 ft. wide, lap-jointed where they meet.

Curtiss Biplane

The Curtiss Model 18-B Biplane. Aerial Age, vol. 9, no. 14, June 16, 1919, pp. 676-677 and 701, 4 figs. Peculiarity of machine is employment of ailerons on lower plane only, which are operated by steel tubes running through





Save Time Hoist It—

With a Link-Belt Electric Hoist

A LINK-BELT Electric Hoist is not an expense—it's an investment—one of the most profitable investments you can possibly make.

The hours of time it saves every day in any shop soon pays for the hoist. After that its daily savings are pure velvet for you.

Remember, it's not only the saving of human time and energy that counts—it's the reduction of idle time of expensive and important machinery while waiting for work and its proper placement on the machine bed.

Write us. Let us send you our 44 page Electric Hoist Book No. 246. Shows many types of hoists one of which will no douht meet your requirements exactly. Let our engineers help you solve your handling problems. No charge.

LINK-BELT COMPANY

216

PHILADELPHIA CHICAGO INDIANAPOLIS

New York	299 Broadway	Kansas City, Mo.	306 Elmhurst Bldg.
Boston	49 Federal St.	Seattle	576 First Ave., S.
Pittsburgh	1501 Park Bldg.	Portland, Ore.	First and Stark Sts.
St. Louis,	Central National Bank Bldg.	San Francisco	582 Market St
Buffalo	547 Ellicott Square	Los Angeles	163 N. Los Angeles St.
Wilkes-Barre	2d National Bank Bldg.	Toronto, Can.	Canadian Link-Belt Co., Ltd.
Cleveland	429 Rockefeller Bldg.	Denver	Lindrooth, Shubart & Co., Boston Bldg.
Detroit	732 Dime Bank Bldg.	Louisville, Ky.	Frederick Wehle, Starks Bldg.

New Orleans C. O. Hinz, Hibernia Bank Bldg.

We Also Make

- ☐ Elevators and Conveyors
- ☐ Link-Belt and Sprockets
- ☐ Silent Chain Drives
- ☐ Truck and Tractor Chains
- ☐ Electric Hoists
- ☐ Locomotive Cranes
- ☐ Wagon Loaders
- ☐ Coal and Ashes Systems

Write for Catalogs
Place X in Square

LINK-BELT

ELECTRIC HOISTS

lower plane and directly connected to pilot's control stick.

Curtiss Triplane

The Curtiss Model 18-T Triplane. Flight, vol. 11, no. 22, May 29, 1919, pp. 698-700, 5 figs. Some of dimensions are: Wing span (all planes) 31 ft. 11 in.; overall length, 23 ft. 3 3/16 in.; overall height, 9 ft. 10⅝ in.

Graham-White

The Graham-White Sporting Aeroplane. Aerial Age, vol. 9, no. 15, June 23, 1919, pp. 728-729 & 733, 7 figs. Span, upper plane, 20 ft.; lower plane, 18 ft. 4 in.; overall length, 16 ft. 6 in.

Navy, U. S.

The U. S. Navy Flying Boat, NC-1. Flight, vol. 11, no. 20, May 15, 1919, pp. 637-639, 8 figs. Flying boat of short-hull type with tail planes carried from hull and top main planes by means of outriggers. Hull is 44 ft. 8¾ in. overall length with maximum beam across side fins of about 10 ft.

Development of the NC Seaplanes. Aviation, vol. 6, no. 7, June 1, 1919, pp. 468-471, 5 figs. Historical account, with particular reference to technical engineering research leading up to adoption of constructional features as ultimately developed.

Radiators

Aircraft Radiators, Archibald Black. Jl. Soc. Automotive Engrs., vol. 4, no. 6, June 1919, pp. 445-461, 24 figs. Brief description of various types.

Tarrant

The Tarrant Giant Triplane, the "Tabor." Flight, vol. 11, no. 20, May 15, 1919, pp. 626-632, 11 figs. Also Aeronautics, vol. 16, no. 291, May 15, 1919, pp. 507-514, 22 figs. Aerodynamically striking features of machine, apart from its great size, are overhanging middle plane, with top and bottom plane of shorter span (span is 131 ft. 3 in., height 37 ft. 3 in.) and disposition of various thrust lines in relation to center of resistance. History of Development with notes on principal features of design and construction.

The Tarrant Triplane. Flight, vol. 11, no. 22, May 29, 1919, pp. 702-703, 2 figs. Accident attributed to sudden starting of two top engines after machine had traveled along ground at high speed with four lower engines running.

Vickers-Vimy

The Vickers-Vimy Passenger-Carrying Aeroplane. Engineering, vol. 107, no. 2788, June 6, 1919, pp. 736-738, 8 figs.; also in Engineer, vol. 127, no. 3310, June 6, 1919, pp. 555-530, 7 figs. Machine as built for traffic service differs from design as originally adopted for bomber purposes, principally in greater depth of fuselage, which, in the passenger class, is of elliptical section and stream-line form.

Whittemore-Hamm

The Whittemore-Hamm Model-L Bibplanes. Aerial Age, vol. 9, no. 16, June 30, 1919, p. 770, 2 figs. Tractor biplanes using Curtiss, Hall-Scott and Hispano-Suiza engines.

PROPELLERS

Bothezat Theory

General Summary of the de Bothezat Blade-Screw Theory, George de Bothezat. Aviation, vol. 6, no. 10, June 15, 1919, pp. 520-524, 6 figs. Expressions for slip and race velocities in slip stream solely in function of dimensions of screw blades, coefficient of fluid resistance of different blade sections and working conditions. From memoir published by Nat. Advisory Committee for Aeronautics.

TESTING

Balloons Fabrics

Use of Ultra Violet Light for Testing Ballon Fabrics, Junius David Edwards and Irwin L. Moore. Aerial Age, vol. 9, no. 15, June 23, 1919, pp. 734-735. Tests made at Bur. of Standards reported to have shown that relative deterioration of fabrics under ultra-violet light is not strictly comparable with deterioration experienced in outdoor exposure.

Metal Parts

Metal Construction of Aircraft, A. P. Thurston. Flight, vol. 11, no. 23, June 5, 1919, pp. 741-745, 12 figs. Testing specimens. Appendix on metal airplane construction. (Concluded.)

Wind Tunnel

The New Curtiss Wind Tunnel. Aerial Age, vol. 9, no. 16, June 30, 1919, pp. 768-769, 3 figs. Employed by Curtiss organization as a means of verifying aeronautical design.

TRANSATLANTIC FLIGHT

Airship vs. Airplane

Airship vs. Airplane for Transatlantic Service (Discorso intorno al dirigibile, all'aeroplane ed alla traversata aerea dell'altlantico), Silvio Bassi. Industria, vol. 33, no. 9, May 15, 1919, pp. 263-267, 6 figs. Technical considerations of limitations of each of these types as at present developed.

The Atlantic Flight, G. Greenhill. Engineering, vol. 107, no. 2787, May 30, 1919, pp. 689-691. Airship versus airplane. Technical.

VARIA

Air-Navigation Rules

The New Air Navigation Regulations. Aeronautics, vol. 16, nos. 290, 291 and 292, May 8, 15 & 22, 1919, pp. 488-491, 516-517 and 538-541. Rules as to lights and signals. Text of order issued by Secretary of State for Air. It deals with general conditions of flying, safety provisions, licensing of personnel, log books, and aerodromes in reference to civil aviation. Rules as to air craft arriving in or departing from United Kingdom. (Continuation.)

Astronomical Determination of Direction

Astronomic Determination of Direction, Edward M. Burd. Jl. U. S. Artillery, vol. 50, no. 4, June 1919, pp. 390-416. Results of comparative observations for determining y-azimuth of a line (Concluded.)

Nomenclature

Nomenclature for Aeronautics, Aviation, vol. 6, no. 10, June 15, 1919, pp. 529-532. From reports issued by Nat. Advisory Committee for Aeronautics.

Physiology of Flying

The Physiology of Flying, W. Guy Ruggles. Aerial Age, vol. 9, no. 16, June 30, 1919, pp. 772-773 and 787-788, 6 figs. On the origin of orientation and equilibration with reference to various types of Ruggles orientators.

Marine Engineering

AUXILIARY MACHINERY

Electrical Auxiliaries

The Electrical Division Aboard Ship, Alex M. Charlton. U. S. Naval Inst. Proc., vol. 45, no. 196, June 1919, pp. 987-1008, 2 figs. Organization, routine and tests developed on U. S. S. "Texas."

Electrically Driven Ships' Auxiliaries. Engineer, vol. 127, no. 3307, May 16, 1919, pp. 478-480, 16 figs. Scott-Bentley load-discriminating device for application to deck winch.

Rudders

The Kitchen Reversing Rudder. Engineering, vol. 107, no. 2785, May 16, 1919, pp. 631-634, 22 figs. Consists of two curved deflectors forming parts of a circular cylinder and partly enclosing the propeller.

SHIPS

American Shipping

The Future of American Shipping, Edwin N. Hurley. Universal Engr., vol. 29, no. 4, Apr. 1919, pp. 21-32, 10 figs. Advises not to concentrate too much upon strength of competition with other nations.

Cargo Vessels

See Freighters.

Concrete Ships

Design and Construction of Navy Concrete Oil Barges, R. M. Burkhalter. Eng. News-Rec., vol. 82, no. 22, May 29, 1919, pp. 1056-1058, 5 figs. Boats have oil holds protected by air compartments and also may carry deck loads. Concrete poured from trestle at rear of boats.

First British-Built Ferro-Concrete Steamship S.S. "Armistice." Steamship, vol. 30, no. 360, June 1919, pp. 275-277, 4 figs. Dead weight capacity 1150 tons. Built on Mouchel-Hennebique system under survey of Lloyd's Registry.

German Views on the Economics of Ferro-Concrete Ships, Carl Commentz. Shipbuilding and Shipping Rec., vol. 13, no. 20, May 15, 1919, pp. 635-636. Table comparing several sizes of steel and reinforced-concrete vessels for both short and long voyages taking prewar prices throughout as basis of comparison. From Hansa.

Form Work and Timbering Details in Concrete Barge Construction. Concrete, vol. 14, no. 6, June 1919, pp. 222-225, 10 figs. Boats have overall length of 112 ft., 36 ft. beam and draft of 9 ft.

Electric Propulsion

See New Mexico.

Freighters

Speed, Dimensions and Form of Cargo Vessels. Shipbuilding & Shipping Rec., vol. 13, no. 21, May 22, 1919, pp. 665-668, 2 figs. Theoretical discussion of best speed, which is defined as the one that will give the largest profit per pound of capital invested, per day invested.

Economical Form and Speed. Shipbuilding & Shipping Rec., vol. 13, no. 23, June 5, 1919, pp. 725-727. Comparison of cost of operating five typical merchant ships.

Cargo Steamers with Rateau Geared Turbines. Shipbuilder, vol. 20, no. 106, June 1919, pp. 327-350, 31 figs. Turbines develop 2500 shaft hp. under ordinary service conditions at 3000 r.p.m. Propeller speed, 70 r.p.m.; total ratio of reduction in speed, 43 to 1.

Leparmentier Unsinkable Ships

Leparmentier System of Building Ships Which Cannot Sink or Capsize (Les Navires inchavirables et insubmersibles Leparmentier), Raymond Lestonnat. Génie Civil, vol. 74, no. 23, June 7, 1919, pp. 453-456, 5 figs. Outlines procedure followed at New Orleans.

Models

Some Experiments on Full Cargo Ship Models, James Semple. Engineering, vol. 107, no. 2788, June 6, 1919, pp. 751-754, 9 figs. To determine effect on performances (1) of fullness, and (2) of longitudinal distribution of displacement. Wake and thrust deduction investigations were also carried out on a number of models, and in addition some comparisons are drawn between results obtained at various establishments.

Motor Ships

The Motor Ship "Santa Margherita." Engineering, vol. 107, no. 2787, May 30, 1919, pp. 691-693 and 706, 8 figs. partly on supp. plates. Equipped with Diesel engiens. Dimensions selected by builders to meet stipulated requirements of British Admiralty in regard to stability, draft and trim, are: length, 440 ft.; breadth, molded, 54 ft.; depth molded (upper deck), 36 ft. 6 in.

Present Position of the Diesel Engine as Applied to Marine Service, Thomas Orchard Lisle. Jl. Soc. Automotive Engrs., vol. 4, no. 6, June 1919, pp. 477-481, 10 figs. Holding that less than 150 hp. per 1000 ton is not of much use as a propelling means, American type of wooden vessel developed during the war is said to have proven unsuccessful because, in addition to other circumstances which are also considered as drawbacks, auxiliary power was insufficient to drive them at a profitable speed without the sails and a favorable breeze and sometimes even with all these.

Motor-Driven Oil-Tank Vessel "Santa Margherita." Shipbuilding & Shipping Rec., vol. 13, no. 23 & 24, June 5 & 12, 1919, pp. 719-721 & 748-750-753, 19 figs. partly on supplement plate. Principal dimensions are: length, 440 ft.; breadth, 54 ft.; depth, 36 ft. 6 in.; draft, normal, 25 ft. 9 in., and maximum, 28 ft. ½ in.; deadweight capacity, 9916 tons. Power supplied by two heavy-oil engines, each of 1250 b.h.p. at 130 r.p.m.

New Mexico

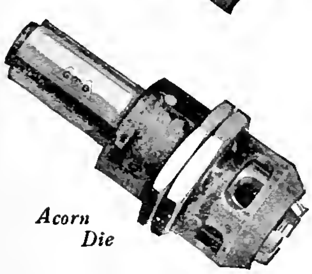
General Characteristics of Electric Ship Propulsion Equipments, E. F. W. Alexanderson. Gen. Elec. Rev., vol. 22, no. 4, Apr. 1919, pp. 224-232, 8 figs. It is said that simplicity and reliability were aimed at for U. S. S. "New Mexico" by elimination of liquid rheostats, and development of new type of squirrel-cage induction motor.

Electric Propulsion for the U. S. S. New Mexico—I, C. S. Raymond. Sci. Am. Supp., vol. 87, no. 2266, June 7, 1919, pp. 356-358, 5 figs. One feature that differs from land practice is omission of turbine and generator base castings. Turbine casing, generator stator frame and bearing standards are bolted directly to stiff structural-steel foundation which is securely tied in with ship's structure. (To be concluded.)

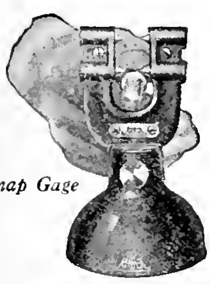
The Turbines of the U. S. S. New Mexico, E. O. Hunt. Gen. Elec. Rev., vol. 22, no. 4, Apr. 1919, pp. 233-243, 10 figs While resembling in many particulars General Electric Co. types built for lamp operation, they possess, it is said, ability to operate over wide range of speed under control of special design governing arrangement.

The New Mexico's Generators, C. S. Raymond. Gen. Elec. Rev., vol. 22, no. 4, Apr. 1919, pp. 244-254, 23 figs. Special feature is said to be arrangement of stator winding in two coils per phase, connected in parallel for low voltage and in "square" for high voltage operation.

Gun Tap



Acorn Die



Snap Gage

Our booklet "Tools and Dividends" suggests ten questions every executive, plant superintendent or purchasing agent ought to ask. Your copy is ready for mailing.

How GTD Helped to Build a Better Marine Engine

THE cooperation of a G T D engineer helped a marine engine manufacturer build a better, more compact, more efficient engine.

American shipping needs demanded an improved American-built product. Foreign engines, especially those of the Diesel type, had been thought superior to ours.

As his first problem this manufacturer saw that the best engine he could build might become useless, if vital bolts or nuts should jar loose under pressure and strain. He knew that upon the precise fit of the thousand threaded parts in his product depended its success.

He sent for a G T D engineer—who recommended tools which would cut threads, if need be, to the limits of a ten thousandth of an inch.

These tools reduced the manufacturer's assembly costs. They made the work easier for his workmen, at the same time helping him to produce a better and stronger engine.

They made it possible for him to use smaller bolts, nuts and screws, thus reducing the amount of metal in the engine, while each thread had been made to fit the other so accurately that the possibility of their jarring loose was reduced to a minimum.

Whether you manufacture engines, machines, implements or appliances, the fit of the threaded parts in your product is of supreme importance to you.

It will pay you to let a G T D engineer look over your blue prints, as was done by this marine-engine builder.

The time and service of our men, based on forty years of experience, is freely offered—and their suggestions may save you thousands of dollars in producing a better and more efficient product.

GTD

GREENFIELD TAP & DIE CORPORATION

Greenfield, Massachusetts, U.S.A.

World s Largest Manufacturers of Screw Cutting Tools

U. S. S. New Mexico. Description and Official Trials. S. M. Robinson and Henderson B. Gregory. Jl. Am. Soc. Naval Engrs., vol. 31, no. 2, May 1919, pp. 345-404, 28 figs., partly on supp. plates. Trials referred to were conducted after ship had been out of dry dock about seven weeks, which is said to have increased by 4000 the shaft hp. necessary to make guaranteed speed of 21 knots.

The Main Control Equipment of the New Mexico, C. T. Hentchel. Gen. Elec. Rev., vol. 22, no. 4, Apr. 1919, pp. 261-271, 16 figs. Construction and interrelationship of units of control apparatus.

Controlling the Propulsion of the New Mexico, H. Franklin Harvey. Gen. Elec. Rev., vol. 22, no. 4, Apr. 1919, pp. 272-292, 10 figs. Refers specially to features permitting interconnection for obtaining direct-current supply at switchboard for turbine-generator excitation, this interconnection providing for contingencies in case of damage to equipment.

A Review of the Propelling Equipment and Operation of the New Mexico, Eskil Berg. Gen. Elec., Rev., vol. 22, no. 4, Apr. 1919, pp. 293-298, 2 figs. Circulating air, hot-well, and lubricating pumps, ventilating fans and other auxiliaries.

Ore Carriers

Geared-Turbine-Engined Ore and Coal Carrier "Conde de Zubiria." Shipbuilding & Shipping Rec., vol. 13, no. 21, May 22, 1919, pp. 659-660, 5 figs. on supp. plate. Principal dimensions are: Length, 314.1 ft.; breadth, 47.9 ft.; depth, 24.3 ft.; gross tonnage, 3278 tons and net tonnage, 2083 tons.

Patrol Boats

The "P" Boats. Engineer, vol. 127, no. 3308, May 23, 1919, pp. 512-513, 2 figs. Patrol boats fitted with 4000-hp. Parsons geared turbines.

Removable Propelling Machinery

Removable Propelling Machinery for Ships (Mécanismes amovibles pour la propulsion des navires), M. Tayon. Génie Civil, vol. 74, no. 16, Apr. 19, 1919, pp. 308-312, 9 figs. Points out that the propelling machinery of a ship is effective only during actual navigation. More economical navigation is, therefore, obtained, it is concluded, by a system which will permit adaptation of machinery set to various hulls.

Tonnage

The Tonnage of Modern Steamships, A. T. Wall. Steamship, vol. 30, no. 360, June 1919, pp. 278-280. Effect of recent legislation and modern machinery on tonnage measurement. Paper read before Instn. Naval Architects.

TERMINALS

Port Management

Some Problems of Port Management, Hamilton Higday. Freight Handling & Terminal Eng., vol. 5, no. 5, May 1919, pp. 186-191. Deals particularly with labor problem, development of industrial areas, and levying of port charges.

Peru

The Ports of Peru, Grosvenor M. Jones. Freight Handling & Terminal Eng., vol. 5, no. 5, May 1919, pp. 170-174. Lobitos, Talara, Callao, Paita, Eten, Salaverry and Chimbote. Description is confined to extent of foreign trade at each.

YARDS

American Shipbuilding

Shipbuilding Development in the United States and Canada, W. R. Gray and Edward F. Clarke. Trans. Northeast Coast Instn. of Engrs. & Shipbuilders, vol. 35, no. 4, June 1919, pp. 151-162 and (discussion) pp. 162-178. Notes gathered on writer's visit to U. S. A.

American Shipbuilding Costs. Shipbuilding & Shipping Rec., vol. 13, no. 20, May 15, 1919, pp. 630-631 & 335-634, 6 figs. Swedish ship of 440 ft. in length with d.w. tonnage of 9500. Engines are 6-cyl., 4-stroke single-action Diesel motors.

Concrete Ships

Concrete Shipbuilding at Barrow-in-Furness, W. Noble Twelvetrees. Engineering, vol. 107, no. 7285, May 16, 1919, pp. 624-627, 14 figs., partly on four separate plates. Site is adapted for building vessels up to 250 ft. in length.

Ford Methods

Ford Methods in Ship Manufacture VI. Fred E. Rogers. Indus. Management, vol. 57, no. 6, June 1919, pp. 456-464, 14 figs. Details of launching scheme and of achievement claimed to have been made in erecting Eagle No. 59 in ten days.

Redesigning

Commerce Absorbs Transport Ships. Mar. Rev., vol. 49, no. 7, July 1919, pp. 326-329, 9 figs. Redesigning of thirteen vessels planned for war emergency to carry freight and passengers.

Standardization of Ship Material

Standardizes Steel Ship Materials, Fred T. Llewellyn. Iron Trade Rev., vol. 64, no. 24, June 12, 1919, pp. 1549-1551. Remarks on standards adopted by Emergency Fleet Corporation which were modeled after British standards. Paper read before Am. Iron & Steel Inst.

Wisconsin Yards

Wisconsin Shipbuilding, Richard S. McCaffery. Wisconsin Engr., vol. 23, no. 8, May 1919, pp. 275-280, 3 figs. Importance of ocean tonnage delivered from Wisconsin shipyards emphasized by remark that if vessels built at these shipyards during last year were placed in line, the line would be two miles long.

SALVAGE

How the "Lake Weston" was Salved. Shipbuilding & Shipping Rec., vol. 13, no. 24, June 12, 1919, pp. 747-749. Vessel ran ashore in Bristol Channel.

Industrial Technology

Ammonia, Oxidation of

See Nitric Acid.

Celluloid

Celluloid in the Industrial Field, John H. Stevens. Raw Material, vol. 1, no 4, June 1919, pp. 227-232, 7 figs. Showing widely differing characteristics celluloid is capable of possessing.

Chemical Engineering

Chemical Engineering, J. A. Wilkinson. Jl. Chem., Metallurgical and Min. Soc. of South Africa, vol. 19, no. 9, Mar. 1919, pp. 159-165, and (discussion) pp. 165-168. Points out that days of haphazard production, unaided by scientific investigation are past.

Physical Chemistry and Its Bearing on the Chemical and Allied Industries, James C. Philip. Chem. News, vol. 118, nos. 3079 & 3082, Apr. 17 & May 9, 1919, pp. 181-183 & 215-222, 2 figs. Apr 17: Influence of temperature and pressure on ammonia equilibrium. May 9: Review of prominent cases of industrial catalysis. (Concluded.)

Fertilizers

The Setting of Mixtures of Superphosphate and Ammonium Sulphate, F. Scott Fowweather. Chem. Industry, vol. 38, no. 9, May 15, 1919, pp. 110T-112T. Experimental. Concluded that rate of setting of such mixtures is increased by reduction of free acid in them.

Gas

Manufacture of Gas from Wood, Adolphe Molin. Gas Jl., vol. 146, no. 2921, May 6, 1919, pp 301-302, 3 figs. Experiences at Stockholm Gas Works in distillation of wood. From Journal des Usines à Gaz.

Glass

The Attack of Pots for Glass Melting. Engineering, vol. 107, no. 2788, June 6, 1919, pp. 725-727, 10 figs. Results of experiments conducted at Nat. Physical Laboratory.

Divitrification of Glass, N. L. Bowen. Jl. Am. Ceramic Soc., vol. 2, no. 4, Apr. 1919, pp. 261-278 and (discussion) pp. 278-281, 3 figs. Experiments interpreted as indicating that divitrification of glass is result of its tendency to reach stable crystalline conditions and that it takes place whenever glass is held for sufficient length of time within temperature where its crystallizing power is great.

Development of Improved Gold Ruby Glass, H. T. Bellamy. Jl. Am. Ceramic Soc., vol 2, no. 4, Apr. 1919, pp. 313-319 and (discussion) pp. 319-322. No conclusive deductions are made from research undertaken, but it is considered that a stable, reliable gold ruby glass can be econmically produced and that the presence of other colors is not a natural phenomenon of gold ruby glass.

Graphite

Refining Alabama Flake Graphite for Crucible Use, Fred G. Moses. Dept. of Interior, Bur. Mines, War Minerals Investigation Ser., no. 8, Dec. 1918, 35 pp., 5 figs. Results obtained in finishing crude graphite concentrate are said to be dependent largely on character of crude flake contained in ores.

Kingsport, Tenn.

Kingsport, Tennessee, and Its Chemical Industries—I & II. Chem. & Metallurgical Eng., vol. 20, nos. 11 and 12, June 1 and 15, 1919, pp. 565-570 and 639-644, 10 figs. Technical description of ceramic and cement plants; also historical survey of growth of city. Coal-tar dyestuffs and intermediates; tannery and tanning extract plant.

Nitric Acid

Commercial Oxidation of Ammonia to Nitric Acid, Charles L. Parsons. Jl. of Indus. & Eng. Chemistry, vol. 11, no. 6, June 1919, pp. 541-552, 13 figs. Methods and apparatus which have been used or are being used for oxidation of ammonia to nitric oxide which, absorbed in water, yields nitric acid.

The Evolution of the Oxidation of Ammonia, W. S. Landis. Chem. Engr., vol. 27, no. 5, May 1919, pp 113-117, 5 figs. Contributions made to process by American chemical engineers in last year of war. (Concluded.)

Nitrogen Fixation

How the Nitrogen Problem Has Been Solved, Henry Jermain Maude Creighton. Jl. Franklin Inst., vol. 187, no. 6, June 1919, pp. 705-735, 4 figs. Outline of principles underlying oxidation of ammonia by air in the presence of catalyst. A bibliography of literature on and relating to nitrogen fixation and oxidation of ammonia. Sixth article.

Nitroglycerin

The Behavior of Nitroglycerin When Heated, Walter O. Snelling and C. G. Storm. Dept. of Interior, Bur. of Mines, technical paper 12, 1912, 14 pp., 3 figs. Experiments interpreted as establishing that nitroglycerin begins to decompose at temperatures of 50 or 60 deg. cent., decomposition being accompanied by evolution of heat.

Nitrous Acid

The Decomposition of Nitrous Acid, Joseph Knox and Douglas M. Reid. Chem. Industry, vol. 38, no. 9, May 15, 1919, pp. 105T-108T, 4 figs. Investigation undertaken to determine influence of surface, shaking, excess of air, temperature and other factors on decomposition.

Peat

Distillation of Peat (La distillation de la tourbe). Journal des Usines à Gaz, vol. 43, no. 11, June 5, 1919, pp. 172-173. Description of installation.

Platinum Substitutes

Comparative Tests of Palau and Rhotanium Ware as Substitutes for Platinum Laboratory Utensils, L. J. Gurevich and E. Wichers. Jl. of Indus. & Eng. Chemistry, vol. 11, no. 6, June 1919, pp. 570-573. It is concluded that rhotanium A ware is superior to platinum ware, both of high (2.4 per cent) and low (0.6 per cent) iridium content in respect to its resistance to loss on heating.

Potash

The Potash Situation, A. W. Stockett. Dept. of Interior, Bur. Mines, War Minerals Investigation Ser., no. 2, Oct. 1918, 13 pp. Summarizes conditions as follows: Normal requirements of country 250,000 tons or K_2O per year; total production of 1917—32,573 tons. Promising sources of permanent supply sufficient for future requirements, brines of Searles Lake and dust from blast furnaces and cement kilns.

Rubber

Effect of Certain Accelerators Upon the Properties of Vulcanized Rubber, G. D. Kratz and A. H. Flower. India-Rubber Jl., vol. 57, nos. 19 & 20, May 10 & 17, 1919, pp. 1-2 and 1-5, 5 figs. Experimental data on activity of certain organic and inorganic accelerators. It is found that magnesia in small amount is less active than certain organic accelerators and does not impart to mixtures the physical improvement characteristic of the latter. (Concluded.)

The Manufacture of Synthetic Rubber, H. Duisberg. Chem. Eng., vol. 27, no. 5, May 1919, pp. 111-112. Compound used at Leverkusen works is said to have been dimethylbutadiene. Paper read before German Bunsen Soc.

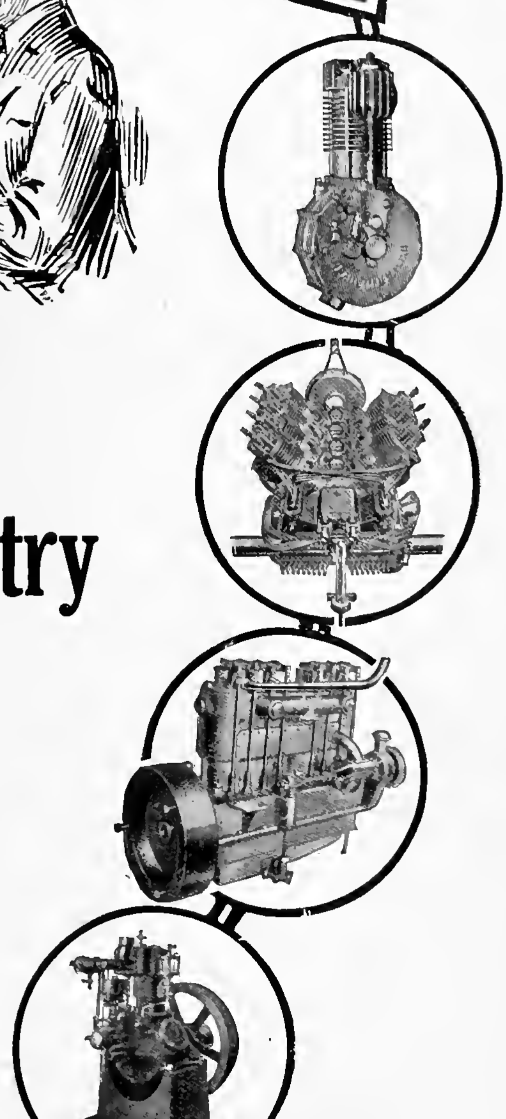
Sugar

The Loss of Moisture from Sugar Samples Under Different Methods of Preservation, C. A. Browne and G. H. Hardin. Sugar, vol. 21, no. 6, June 1919, pp. 294-295. Manner of testing and results obtained at N. Y. Sugar Trade Laboratory. Paper read before Division of Agriculture and Food Chemistry, Am. Chem. Soc.

The Problems of The Automotive Industry

are like the problems of every industry in the Nation's great fields of achievement. Many of the problems of the automotive industry have been taken to Taft-Peirce. The Taft-Peirce organization has developed or co-operated in the development of countless machines and tools (from the typewriter to heavy machinery) involving exceptional ingenuity and requiring great engineering experience and ability.

If you have a designing or manufacturing problem, let the cumulative experience of the Taft-Peirce organization help you solve it. Ask for Bulletin 108-N.



Taft-Peirce Engineering Experts are at Your Service

TAFT-PEIRCE

Woonsocket, R.I., U.S.A.

2076

New York: Woolworth Bldg. Cleveland: 10708 Hampden Ave. Chicago: 1211 E. Marquette Rd. Detroit: Majestic Bldg.

Sulphuric Acid

The Effects of Cooling Burner Gases on the Catalytic Action of Platinum in Sulphuric Acid Contact Plants, S. T. T. Geary. Jl. Soc. Chem. Indus., vol. 38, no. 10, May 31, 1919, pp. 133T-136T, 1 fig. Claims that an average conversion of 98 per cent is obtained when reaction in platinum chamber is allowed to run its course with no attempt at cooling.

Tar Distillation

The Sulzer Process of Tar Distillation. Gas Jl., vol. 146, no. 2923, May 20, 1919, pp. 433-434, 6 figs. Tar passes constantly through apparatus in successive portions, various constituents of which are removed until final residue of pitch is obtained. From Journal des Usines à Gaz.

Tellurium

A Contribution to the Chemistry of Tellurium Sulphide. Aaron M. Hagemin. Chem. News, vol. 118, no. 3082, May 9, 1919, pp. 217-219, 1 fig. Concludes from investigation that introduction of hydrogen sulphide into an aqueous tetravelent tellurium solution at room temperatures or below causes immediate production of a red-brown precipitate represented by formula TeS^2. (Concluded.)

Zinc Oxide

The Manufacture of Zinc Oxide. Chem Eng. & Min. Rev., vol. 11, no. 127, Apr. 5, 1919, pp. 190-191, 1 fig. Plant installed by Broken Hill Associated Smelters Pty. Ltd., Port Pirie

Railroad Engineering

Developments

Railway Developments in Foreign Countries. Ry. Age, vol. 66, no. 23, June 6, 1919, pp. 1371-1375. Materials required for Mexican and Siberian railways; transportation in Italy.

Great Britain

Railway Transport in the United Kingdom. H. Kelway-Bamber. Jl. Roy. Soc. Arts, vol. 67, no. 3470, May 23, 1919, pp. 426-438 (discussion) pp. 438-442, 7 figs., also Iron & Coal Trades Rev., vol. 98, no. 2673, May 23, 1919, pp. 696-697. Considering that welfare of a country largely depends upon provision of cheap and efficient system of transportation, writer endeavors to show how, in his opinion, this could best be effected. Statistical data of track mileage, costs and traffic.

Speeds, Train

European Train Speeds. Ry. Gaz., vol. 30, no. 20, May 16, 1919, pp. 836-838, 3 figs. Survey of highest, longest and fastest non-stop runs, speed of trains between two places and geographical distribution of important services German railways. (Continuation of serial.)

CONSTRUCTION

Track

Using Modern Appliances in Track Construction. W. L. Whitlock. Elec. Ry. Jl., vol. 53, no. 21, May 24, 1919, pp. 995-998, 10 figs. Illustrating how equipment served in Denver construction to increase speed and economy.

ELECTRIC RAILROADS

Locomotives

Brown Boveri Locomotives for the Swiss Federal Railways. J. Buchi. Engineering, vol. 107, no. 2784, May 9, 1919, pp. 589-592, 8 figs. Electric locomotive with single-axle drive, Tschanz system. (Concluded.)

Oerlikon Locomotives for the Swiss Federal Railways. Engineering, vol. 107, no. 2788, June 6, 1919, pp. 727-729 and 740, 7 figs. partly on supplement plates. Two types, 2-6-2 and 2-4-4-2, both single-phase. Some of the dimensions are: voltage, 15,000; maximum drawbar pull, 30,000 lb. and 40,000 lb., respectively; maximum speed, 47 m.p.h.; total weight, 91 and 113 tons, respectively.

Electric Locomotives of Moderate Weight and Power. A. B. Cole. Elec. Ry. Jl., vol. 53, no. 24, June 14, 1919, pp. 1152-1154, 4 figs. With reference to freight-handling requirements on electrified steam-road branch lines and interburban electric railway lines.

New York Central's Latest Motor Cars. Elec. Ry. Jl., vol. 53, no. 24, June 14, 1919, pp. 1134-1138, 10 figs. Design follows steam railroad standards in so far as electrical equipment permits.

Regenerative Braking

Regenerative Direct-Current Electric Railways, E. Austin. Electrical Review, vol. 84, no. 2168, June 13, 1919, pp. 705-707, 3 figs. Principle involved and schematic diagram for connections used in systems installed in locomotives of Chicago, Milwaukee & St. Paul R.R. and on those of the Metropolitan underground, Paris.

Regenerating Braking as Applied to Electric Locomotives. What it Realy Is, H. Ry & Locomotive Eng., vol. 32, no. 6, June 1919, pp. 186-187, 1 fig. Schematic diagram showing single-phase regulation connections.

Third Rail

Types of Third-Rail Used in Railway Electrification. Elec. Ry. Jl., vol. 53, no. 24, June 14, 1919, pp. 1143-1148, 19 figs. Considerations involved in selecting rail section, location and protective covering. Leading types are described and their relative advantages and disadvantages are discussed.

Methods Used in Third-Rail Bonding, G. H. McKelway. Elec. Ry. Jl., vol. 53, no. 24, June 14, 1919, pp. 1154-1156, 8 figs. It is observed that high conductivity is first essential, and ease of installation and maintenance are important considerations.

Track Circuit

Some Things Learned About the Track Circuit, A. R. Fugina and J. B. Weigel. Ry. Signal Engr., vol. 12, no. 6, June 1919, pp. 195-199, 1 fig. Ballast leakage, rail bonding and minimum working voltage of battery are some of the factors that require further study.

ELECTRIFICATION

Contact Shoes

Electrification Facts and Factors, A. J. Manson. Elec. Ry. Engr., vol. 10, no. 6, June 1919, pp. 189-191, 3 figs. Construction details of contact shoes used on over-running and under-running third rails.

France

Partial Electrification of French Railways; Experience Acquired in France and in Other Nations in Regard to Electrification of Extensive Systems (Programme d'électrification partielle des chemins de fer français; expérience actuellement acquise en France et à l'étranger dans l'électrification des grandes lignes—III & IV), M. A. Maudit. Bul. de la Société Française des Électriciens, vol. 9, nos. 79 & 80, Apr. & May 1919, pp. 273-303, 333-360 16 figs. Single-phase, three-phase and mono-phase-three-phase and direct current systems Oerlikon and Brown-Boveri regenerative braking systems. (Concluded.)

Fuel Saving

Methods for More Efficiently Utilizing Our Fuel Resources—XXVI & XXVII, W. J. Davis, Jr., and F. Parkman Coffin. Gen. Elec. Rev., vol. 22, no. 3, Mar. 1919, pp. 196-199, and 212, 4 figs. Possible saving of fuel by railway electrification. Estimates and comparisons. Problems involved in connection with preparation, handling, and burning of powdered fuels on shipboard.

Great Britain

British Railway Electrification. Philip Dawson. Times Eng. Supp., vol. 15, no. 535, May 1919, pp. 153-154. Governing conditions of future extension.

Switzerland

The Electrification of the Swiss State Railways (Die Elektrifizierung der Schweiz Bundesbahnen), E. Huber-Stockar. Schweizerische Bauzeitung, vol. 73, no. 16, Apr. 19, 1919, pp. 181-184, 5 figs. Writer believes that electrification will hardly reduce fares, since it has become very expensive to electrify roads.

EQUIPMENT

Axle Generators

A Discussion of Axle Generators and Pulleys. Ry. Elec. Engr., vol. 10, no. 6, June 1919, pp. 175-178, 5 figs. New York Car Lighting Club debates on truck-hung vs. body-hung machines and solid vs. perforated pulleys.

Headlights

Care of Locomotive Electric Headlights. Elec. Ry. Engr., vol. 10, no. 6, June 1919, pp. 186-188, 3 figs. Rules, regulations and system of records adopted for maintenance of Big Four Railroad's equipment.

Train Lighting

Report on Train Lighting and Equipment Ry. Age, Daily Edition, June 23, 1919, pp. 1667-1670 and (discussion) pp. 1671-1673, 9 figs. Tests conducted by Committee of Am. R.R. Assn. to determine (1) rating of axle generators, (2) method of testing to determine this rating, and (3) relation between capacity as found on the stand test as compared to capacity in actual service.

LABOR

Suitability Tests

Suitability Tests for Railway Men, A. Schreiber. Eng. & Indus. Management, vol 1, no. 16, May 29, 1919, pp. 491-493, 4 figs. Tests applied at Dresden aim to determine how far individual is endowed with four characteristics—intelligence, decision, tranquility and endurance. From Umschau.

LOCOMOTIVES

British

New 2-8-0 Type Locomotive for Mixed Traffic, Great Western Railway. Railway Gazette, vol. 30, no. 23, June 6, 1919, pp. 934-935, 4 figs. Coupled wheels have a size of 5 ft. 8 in.

Carbonization in Valve Chambers

Carbonization in Valve Chambers and Cylinders of Superheated Steam Locomotives, F. P. Roesch. Ry. Age, daily edition, vol. 66, no. 25e, June 25, 1919, pp. 1762-1765, 4 figs. Review of practices of various railways to remedy effects on lubrication and maintenance.

Maintenance

New Locomotive Maintenance Program Pennsylvania Lines West. Ry. Rev., vol. 64, no. 25, June 21, 1919, pp. 913-922, 24 figs. Work involves many new shop structures and much new equipment.

Mallet

Simple Mallet Locomotive with Short Maximum Cut-Off. Ry Age, Daily Edition, June 23, 1919, pp. 1675-1681, 11 figs. Boiler in three parts: Conical course with minimum outside diameter at front end of 96 in., straight combustion chamber 110 in. in outside diameter, and firebox. Two sets of simple cylinders. Longest port opening 50 per cent of stroke. Tractive effort estimated at 135,000 lb.

Meter Gage

New Meter Gauge Locomotives; Bombay, Baroda & Central India Railway. Ry. Gaz., vol. 30, no. 21, May 23, 1919, pp. 868-869, 3 figs. Engines are of 4-6-4 and 4-4-4 types and are equipped with superheating apparatus and piston valves, the latter actuated by Walschaerts valve gearing.

Pacific

Pacific Type Locomotive, Lehigh Valley R.R. Ry. Rev., vol. 64, no. 22, May 31, 1919, pp. 785-786, 1 fig. Designed to utilize mixed anthracite and bituminous fuel.

Three-Cylinder

Three-Cylinder Locomotives, H. Holcroft. Engineer, vol. 127, no. 3307, May 16, 1919, pp. 485-489, 19 figs. General survey of development of locomotives with reference to characteristics in Great Britain, France and America, together with presentation of valve gears for three-cylinder locomotives.

Valve Motion and Fuel Consumption

Fuel Conservation Section of the United States Railroad Administration Tests of Locomotives for Fuel Losses. Ry. & Locomotive Eng., vol. 32, no. 6, June 1919, pp. 169-172, 2 figs. Concluded that condition of valve motion vitally affects fuel consumption, and irregular steam distribution makes proper adjustment of draft apparatus impossible.

MAINTENANCE

Derails

Wide Variety of Practices Shown in Use of Derails. Ry. Maintenance Engr., vol. 15, no. 6, June 1919, pp. 199-203. Tabulation of practice in use on various American railroads.

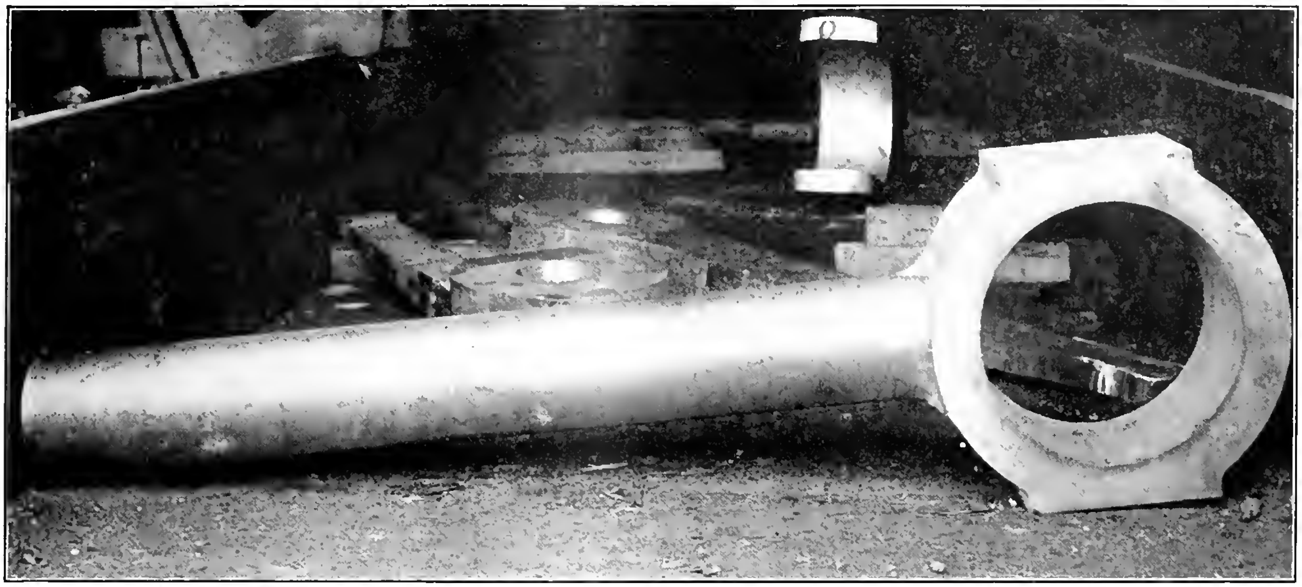
Derails and Where They Should Be Used. Ry. Age, vol. 66, no. 23, June 6, 1919, pp. 1361-1367, 2 figs. Tabulated data covering practices on 48 representative railroads in United States and Canada in regard to conditions governing installation of derails at other than interlocking plants.

Use of Derails Varies Greatly on Railroads. Ry. Signal Engr., vol. 12, no. 6, June 1919, pp. 203-209, 3 figs. Table showing general practice on various American railroads.

Freight-Car Equipment

Maintenance of Freight Car Equipment, H. E. Shipman. Ry. Rev., vol. 64, no. 24, June 14, 1919, pp. 894-896. Recommends more uniformity between roads in freight-car repairs and proposes their classification. Paper read before Western Ry. Club.

CAMDEN



LOST OPPORTUNITIES

Of having your forging orders placed in our shops are regrettable to us, as it is evidence of our not having sufficiently impressed you with the significance of the term

CAMDEN FORGINGS

Our steam hammer and hydraulic press shops, our heat treatment plant and extensive machine shop, our laboratories and Sales Departments are all interested in knowing of your forging requirements and are always ready to answer your inquiries with the purpose of making it possible for you to become our permanent and satisfied customer.

BUYERS' MEMO

High and Low Carbon Bars
Press Columns and Rams
Pull Back Cylinders
Water Cylinders
Valve Bodies
Plungers
Weldless Steel Rings
Lathe Spindles, solid and hollow bored
Long Feed Screws
Power Press Crank Shafts
Rudder Arms

Rudder Stocks
Cam Shafts
Eccentric Shafts
Crusher Shafts
Gear and Pinion Blanks
Locomotives: Side and Main Rods; Crank Pins; Axles; Rod Straps; Guides; Parts of frame both in iron and steel

Hammered Iron Bars for locomotive repairs
Marine Shafts
Marine Connecting and Eccentric Rods
Rolls: Bending; Feed; Straightening; *Embossing*
Large Wrenches
Saw Arbors

Steam Engine Forgings
Pump Crank Shafts
Pump Connecting Rods
Large Nuts
Turbine Shafts
Mill Shafting
Trolley Car Axles
Electric Motor Axles
Any forging to your print, and specifications, in either iron or steel

CAMDEN FORGE CO.
CAMDEN, N.J., U.S.A.

Lighting

Some Notes on Railway Lighting and Maintenance. A. Cunnington. Illum. Engr., vol. 12, no. 3, Mar. 1919, pp. 59-76 and (discussion) pp. 76-86, 11 figs. Advocates adopting standard minimum of illumination in each class of lighting which shall insure comfort for the passenger, efficient working conditions for the railway man and safety for both.

NEW CONSTRUCTION

Big Four

Big Four Increases Capacity at Congested Points. Ry. Age, vol. 66, no. 25, June 20, 1919, pp. 1545-1548, 8 figs. Concerning construction of 87 miles of second track and reduction of grades.

OPERATION AND MANAGEMENT

Bridge Reconstruction and Traffic Maintenance

Maintaining Traffic During Erection of Louisville Bridge. Eng. News-Rec., vol. 82, no. 22, May 29, 1919, pp. 1061-1064, 7 figs. By bunching trains to pass over bridge at noon hour or about 4 p. m. and diverting some trains to other bridges at critical stages in work, operation was maintained throughout two years, during which time about one mile of steel superstructure was erected.

Connectors, Automatic

Train Line Connectors on the Copper Range R.R. Ry. Rev., vol. 64, no. 25, June 21, 1919, pp. 941-943, 4 figs. Report of tests with automatic connectors.

Drawbar Pull-Cut-Off Calibration

Drawbar Pull-Speed-Cut-Off Calibration as an Adjunct to Efficient Locomotive and Train Operation. B. B. Milner. Ry. Age, daily edition, vol. 66, no. 25e, June 25, 1919, pp. 1766-1768, 3 figs. Tests conducted to determine precise cut-off which must be used at various speeds in order to develop maximum drawbar pull.

Fuel Economics

Locomotive Fuel Losses at Terminals. J. M. Nicholson. Ry. Rev., vol. 64, no. 21, May 24, 1919, pp. 752-754, also Railroad Herald, vol. 23, no. 7, June 1919, pp. 36-37. Suggests when locomotive is brought to terminal that fire be turned down to such a point that it will not be necessary to rebuild it in order to get water level in boiler to proper heat before knocking fire. Points out practices which are said to result in useless waste. Paper read before Int. Ry. Fuel Assn.

Reducing Fuel Combustion, Northern Pacific R.R., M. A. Daly. Ry. Rev., vol. 64, no. 24, June 14, 1919, pp. 868-869. Practice of road in schooling enginemen and others in elementary technology of combustion.

Transportation Department and Fuel Economy. H. C. Woodbridge. Ry. Rev., vol. 64, no. 24, June 14, 1919, pp. 865-868, 8 figs. Recommendations to transportation department officials.

Locomotive Operators, Instruction of

Locomotive Operation—Uniform Instructions. J. R. Alexander. Ry. Club of Pittsburgh, vol. 18, no. 4, Mar. 27, 1919, pp. 86-128. Suggestions intended to bring about concerted action in eliminating waste.

Lubrication

Lubrication and Care of Journal Boxes Under Passenger and Freight Equipment. M. J. O'Connor. Off. Proc. Car Foremen's Assn. of Chicago, vol. 14, no. 7, Apr. 1919, pp. 22-32. Suggests establishing standard instructions and practices on all points on any one railroad; for the observance of these writer proposes assignation of experienced men to follow up the work exclusively.

Office Management

Mechanical Appliances in Railway Offices. Railway Gazette, vol. 30, no. 22, May 30, 1919, pp. 900-906, 9 figs. Great Western Railway's method for preparing accounts for goods train traffic.

Power Plants

Management of Railway Power Plants. William Olsen. Ry. Rev., vol. 64, no. 24, June 14, 1919, pp. 858-859. Suggestions in regard to securing fuel economy.

Statistical Department

Checking Percentages by Chart. William Wyer. Ry. Age, vol. 66, no. 26, June 27, 1919, pp. 1826-1828, 1 fig. Practice of operating statistical section of Railroad Administration.

Compilation of Operating Statistics Report. Ry. Age, vol. 66, no. 23, June 6, 1919, pp. 1353-1360, 17 figs. Standard forms for all roads and methods used by various roads in gathering figures.

Viaducts, Smoke Under

Tests to Free Under Side of Railroad Viaducts from Smoke. Robt. H. Moulton. Eng. News-Rec., vol. 82, no. 24, pp. 1162-1164, June 12, 1919, 2 figs. Special arrangement of ducts, air chambers and fans are believed to promise solution of problem of low headroom.

War Operation

The Operation of Federalized Railways Under War Conditions. Carl R. Gray. Off. Proc. St. Louis Ry. Club, 24, no. 1, May 9, 1919, pp. 14-29. Difficulties which, writer believes, caused congestion of railways. Chaotic conditions are said to have resulted from "Lane Commission" taking mens' earnings instead of their ratings as basis for equitable arrangements and relationships between wages.

Wind Resistance

The Wind Resistance on a Train. C. F. Dendy Marshall. Engineer, vol. 127, no. 3307, May 16, 1919, pp. 473-474, 4 figs. Graphs showing ratio of train speed to wind speed, also horsepower requirements for every square foot of transverse surface for various speeds.

PERMANENT WAY AND BUILDINGS

Ties

Reinforced-Concrete Railway Ties (Un nuvvo esperimento di traverse in cemento armato). Rivista Tecnica della Ferrovie Italiana, vol. 15, no. 4, Apr. 15, 1919, pp. 134-143, 19 figs. partly on two supplement plates. Enclosed wire frame forming two circular ends connected by series of straight bars constitutes reinforcement. Blocks of wood to which rails are fastened are embedded in circular ends. Patented.

Track

The Best Methods of Raising Railway Track. Can. Ry. & Mar. World, no. 256, June 1919, pp. 294-295, 5 figs. Report of committee of Road Masters and Maintenance of Way Assn.

Turntable

A Turntable of Unique Design. Ry. Mech. Engr., vol. 93, no. 6, June 1919, pp. 329-332, 6 figs., also Elec. Ry. Engr., vol. 10, no. 6, June 1919, pp. 193-197, 5 figs., and Ry. Age, vol. 56, no. 24, June 13, 1919, pp. 1415-1418, 6 figs. Pennsylvania 110-ft. turntable designed for three-point support and adjustable center.

PUBLIC REGULATION

A Suggested Plan for Control and Operation. Railroad Herald, vol. 23, no. 7, June 1919, pp. 14-16. Suggestion contemplating private ownership and operation under government control.

RAILS

Bonding

The Importance of Rail Bonding. E. Steck. Coal Age, vol. 15, no. 26, June 26, 1919, pp. 1167-1168. Poor track bonding considered as chief difficulty in coal operation, because it cuts down voltage delivered to mine motors.

ROLLING STOCK

Draft Gears

Draft Gear Tests by the United States Railroad Administration. Ry. Rev., vol. 64, no. 18, May 3, 1919, pp. 641-644, 6 figs. Testing arrangement consists of piece of straight track on which are operated two 50-ton gondola cars, equipped with draft gears to be tested.

When Freight Cars Bump. Prof. J. Hammond Smith. Sci. Am., vol. 120, no. 23, June 7, 1919, pp. 602 & 615. Recent tests of draft gears, and the resulting developments.

Dumpers

Car Dumpers. Jas. A. Jackson. Gen. Elec. Rev., vol. 22, no. 5, May 1919, pp. 366-372, 12 figs. Explains operation of two principal types: Turn-over, and lift and turn-over, both of which dump sidewise.

Hopper and Gondola Cars

P. R.R. Maximum Tonnage Hopper and Gondola Cars. Ry. Age (Daily Ed.) vol. 66, no. 24a, June 18, 1919, pp. 1461-1466, 12 figs. Designed for maximum loading of six 6-in. by 11-in. M.C.B. axles. Said to be able to carry 120 tons.

SAFETY AND SIGNALING SYSTEMS

Flagging

Flagging and Its Relation to Railroad Accidents. C. C. McChord. Ry. Age, vol. 66, no. 25, June 20, 1919, pp. 1528-1530. Urges making position of flagman a preferred job investing it with more importance and dignity than is at present the case. Review of American experiences with flagging rule represented as evidencing that most accidents are due to inefficiency and carelessness of flagmen.

Great Britain

Signalling at Southport, Lancashire & Yorkshire Railway. Ry. Gaz., vol. 30, no. 21, May 23, 1919, pp. 871-881, 14 figs. Power-operated signal boxes containing 160 levers.

Block Signalling Practice on a British Railway. F. B. Holt and A. B. Wallis. Ry. Signal Engr., vol. 12, no. 6, June 1919, pp. 188-191, 3 figs. Use of track circuits, signal repeaters and lamp indications. Position of arm shown while pyrometer indicates if lamp is lighted. Second of three articles.

Soda Cells

Testing Soda Cells for Railway Signaling. R. W. Erwin. Ry. Signal Engr., vol. 12, no. 6, June 1919, pp. 201-202, 1 fig. Test consists of discharging a soda cell at one ampere continuously, except during short period each day when a set of intermittent readings are taken.

Transmission Mains

Supply and Transmission for Modern Railway Signalling—II. A. E. Tattersall. Railway Engineer, vol. 40, no. 473, June 1919, pp. 127-130, 4 figs. Formulæ to calculate sags and stresses on transmission mains.

SHOPS

Automatic Machinery

Automatics in Railroad Shops. M. H. Williams. Ry. Mech. Engr., vol. 93, no. 6, June 1919, pp. 303-310, 21 figs. Description of typical machines of the three primary types; set-ups for a variety of jobs.

Cost—Output Formula

Locomotive Repair Shop Output. Henry Gardner. Ry. Mech. Engr., vol. 93, no. 6, June 1919, pp. 335-337, 6 figs. Proposed formula for measuring and comparing cost of repairs in relation to output.

Enginehouse Design

Modern Tendencies in Enginehouse Design. Edwin M. Haas. Ry. Rev., vol. 64, no. 22, May 31, 1919, pp. 787-791, 8 figs. General considerations governing selection of types with illustrations of structures in use by principal railroads. Paper read before Western Society of Engineers.

Rectangular Engine House, Long Island R.R., L. V. Morris. Ry. Rev., vol. 64, no. 22, May 31, 1919, pp. 796-797, 4 figs. Built for rapid handling of equipment. Structure is of reinforced concrete.

Erie Avenue Shop, P. & R.

Erie Avenue Engine Terminal, Philadelphia & Reading Ry. Ry. Rev., vol. 64, no. 24, June 14, 1919, pp. 859-865, 13 figs. In conjunction with plant concrete coaling station has been erected, and a system of electric precipitation wherewith to clarify smoke issued from locomotives is to be installed.

Glenwood Shops, B. & O.

Glenwood Shop Improvements, Baltimore & Ohio R.R. Ry. Rev., vol. 64, no. 21, May 24, 1919, pp. 747-752, 8 figs., also Ry. Mech. Engr., vol. 93, no. 6, June 1919, pp. 288-296, 13 figs., and Ry. Age, vol. 56, no. 24, June 13, 1919, pp. 1401-1404, 6 figs. Site selected for new plant is occupied by old shop building and it was required that shop services should be continued in these buildings during erection of new shops. Shop is of longitudinal type with 21 pits and space is provided for storehouse for mechanical stores.

Steel Car Shops, N. Y. C.

New York Central Steel Car Shop. Ry. Mech. Engr., vol. 93, no. 6, June 1919, pp. 315-319, 10 figs. Brick building, 431 ft. 3 in. long and 243 ft. 6 in. wide.

Tools for Locomotive Valve Parts

Tools for Locomotive Valve Parts, Frank A. Stanley. Am. Mach., vol. 50, no. 24, June 12, 1919, pp. 119-122, 11 figs. Equipment is made up of box tools, boring tools, valve-seating reamers, taps, dies, etc.


Perfected
Die-Casting
Every Stewart die-casting has a smooth, clean surface. Teeth in small gears and pinions made by the Stewart process, are correct in shape and perfect in finish. Holes are true, of exact size and are clean inside. Stewart die-castings are absolutely uniform, not only in size and shape but in composition of metal.
Look over these illustrations of Stewart craftsmanship. Possibly you have been told that parts of your product cannot be die-cast. If so, just send us a sample or blue-print of any part that can be made up in quantities of five thousand or more. The report that the Stewart engineers will make to you may save you time, money and trouble and there is no charge for that service—take advantage of it.
Stewart Manufacturing Corporation
45th Street and Fullerton Ave.
Chicago
Stewart

Water-Gage Fittings

Making Water-Gage Fittings in a Railroad Shop, Frank A. Stanley. Am. Mach., vol. 50, no. 25, June 19, 1919, pp. 1171-1173, 5 figs. Set of tools for turning, boring, facing, threading and otherwise machining various parts entering into construction of gage cocks and fittings, used at California shops of Southern Pacific R. R.

Munitions and Military Engineering

Army Base Service

Military Stores at Port of New York (Entrepots Militaires du Port de New York), P. Calfas. Génie Civil, vol. 74, no. 20, May 17, 1919, pp. 385-391, 13 figs. Description of Brooklyn Army Base.

Ballistics

A Method for Computing Differential Corrections for a Trajectory, Gilbert Ames Bliss. Jl. U. S. Artillery, vol. 50, no. 4, June 1919, pp. 455-460, 1 fig. To account for disturbances in flight of projectiles of magnitude of those caused, for example, by wind.

High Burst Ranging, C. H. Birdseye. Jl. U. S. Artillery, vol. 50, no. 4, June 1919, pp. 417-453, 8 figs. Explanation of methods now in use and suggestions in regard to changes which writer deems desirable.

Camps

The Operation and Maintenance of Utilities at Army Camps and Cantonments, George A. Johnson. Boston Soc. Civil Engrs., vol. 6, no. 5, May 1919, pp. 181-224 and (discussion) pp. 224-233. Special reference is made to conditions brought about by shortage of labor and materials and congestion of transportation facilities.

Guns

The British Eight-Inch Howitzer—I. William Chubb. Am. Mach., vol. 50, no. 25, June 19, 1919, pp. 1189-1194, 11 figs. Consists of A-tube, wire-wound over chamber and portion of bore, inner A-tube of practically same length, and jackets shrunk over wire and a portion of A-tube.

Motor-Transport Service

Keeping 40,000 Army Motor Trucks in Operation, G. E. Rundles. Jl. Soc. Automotive Engrs., vol. 4, no. 6, June 1919, pp. 497-499, 1 fig. Floor plan and layout of mechanical repair shop for Motor Transport Corps.

Navy

The New Navy, VI, Mar. Engr. & Naval Architect, vol. 4, no. 505, June 1919, pp. 265-268, 4 figs. General features of battle cruisers "Renown" and "Repulse."

Railway Artillery

New American Railway Artillery, E. D. Campbell. Ry Rev., vol. 64, no. 294, June 14, 1919, pp. 869-874, 9 figs. Sixteen-inch howitzer railway mount; sliding railway mount for 12-in. and 14-in. guns; 12-in. seacoast mortar on railway mount.

Railway Engineers

Work of a Regiment of Railway Engineers in France, R. F. Fowler. Nat. Service, vol. 6, no. 1, July 1919, pp. 16-20, 3 figs. 100,000 cu. yards of rock were removed from one cut.

Sanitation

Sewage and Wastes Disposal for the United States Army, Leonard S. Doten. Proc. Am. Soc. Civil Engrs., vol. 45, no. 5, May 1919, pp. 233-248, 9 figs. Review of work undertaken by Sanitation Section of Construction Division, U. S. Army.

Shells

Manufacturing the 9.2-In Howitzer Shell—III, S. A. Hand. Am. Mach., vol. 50, no. 23, June 5, 1919, pp. 1089-1093, 10 figs. Washing, fitting and riveting base plug, varnishing, baking and final inspection both by shop and government inspectors. Last article.

Shop Trains

Engineer Portable Shop Train, Philip C. Nash. Power Plant Eng., vol. 23, no. 11, June 1, 1919, pp. 511-513, 3 figs. Equipment furnished U. S. Engineering troops in France.

Target Practice Rod

Making the Hollifield Target Practice Rod, Donald A. Hampson. Can. Machy., vol. 21, no. 26, June 26, 1919, pp. 651-658, 8 figs. Device said to give army recruit all of actual rifle practice without either recoil or noise.

Tunneling

Tunneling at the Front, R. W. Coulthard. Can. Min. Inst. Bul., no. 86, June 1919, pp. 606-620. Best arrangement said to have been found was to divide tunnelers into five sections. Every two days a relief was sent into trenches, where it remained for six days, then returned to rest billets for four days.

General Science

CHEMISTRY

Analysis, Air

The Estimation of Small Quantities of Acetone, Alcohol, and Benzene in Air, Major Elliot and J. Dalton. Analyst, vol. 44, no. 517, Apr. 1919, pp. 132-136, 1 fig. Apparatus consists of four narrow measuring cylinders fitted with Folin tubes. Experiments said to have shown that when air was drawn through at rate of about 10 liters an hour, only one cylinder was necessary for complete absorption in each case.

Analysis, Alcohol

Determination of Small Amounts of Benzene in Ethyl Alcohol, F. W. Babington and Alfred Tingle. Jl. of Indus. & Eng. Chemistry, vol. 11, no. 6, June 1919, pp. 555-556. Standard method adopted by Canadian Revenue Dept.

Analysis, Brass

The Analysis of Brass Ingots from Swarf, R. H. Deakin. Chem. News, vol. 118, no. 3080, Apr. 25, 1919, pp. 193-194. Process for estimating Cu, Zn, Pb, Sn, Fe, Al, Ni.

Analysis, Gas

The Accurate Determination of Carbon Monoxide in Gas Mixtures, J. Ivon Graham. Colliery Guardian, vol. 117, no. 3043, Apr. 25, 1919, pp. 955-956, 1 fig. Writer suggests improving his apparatus (see Trans. Chem. Soc. 1914, 105, 1996), by replacing beaker of water, used for heating purposes, by small steam bath.

Analysis, Steel

Determination of Uranium, Zirconium, Chromium, Vanadium and Aluminium in Steel—II, Charles Morris Johnson. Chem. & Metallurgical Eng., vol. 20, no. 11, June 1, 1919, pp. 588-589. Suggested laboratory methods.

Analysis, Wood

The Proximate Analysis of Wood, W. H. Dore. Jl. of Indus. & Eng. Chemistry, vol. 11, no. 6, June 1919, pp. 556-563. Methods of analysis of woods are described and analysis of five Californian wood samples by these given. It is said that sawdust was found most satisfactory for analysis.

Emulsions

The Modern Conception of Emulsions, W. Clayton. Jl. Soc. Chem. Indus., vol. 38, no. 10, May 31, 1919, pp. 113T-118T. Emulsion of oil in water is produced according to writer, if emulsifying agent is a colloid soluble in water, or more easily wetted by water than oil.

MATHEMATICS

Errors, Law of

Bravais' Law of Errors (Sur la loi des erreurs de Bravais), A. Guldberg. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 16, Apr. 22, 1919, pp. 815-817. Its derivation in space of P dimensions by method of continuous probabilities.

Green's Theorem

A General Form of Green's Theorem, P. J. Daniell. Bul. Am. Math. Soc., vol. 25, no. 8, May 1919, pp. 353-357. Form relates to potential functions which satisfy general integral form of Poisson's equation.

Integrals

True Value of Definite Integrals (Sur la vraie valeur des intégrales définies), Arnaud Denjoy. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 17, Apr. 28, 1919, pp. 848-851. Gives theorem assigning Cauchy's value to function which is measurable and limited to function satisfying various conditions.

Summability, Theory of, Applications

Application of the Theory of Summability to Development in Orthogonal Functions, Charles N. Moore. Bul. Am. Mathematical Soc., vol. 25, no. 6, Mar. 1919, pp. 258-276. Summary of theory and examples of its application to flow of heat and electricity.

PHYSICS

Ether of Space

On a Possible Means of Determining the Two Characteristic Constants of the Ether of Space, Oliver Lodge. Lond., Edinburgh, and Dublin Phil. Mag., vol. 37, no. 221, May 1919, pp. 465-471. Suggests splitting beam of light and sending each half in opposite directions around closed optical circuit in such a way that when they meet, they shall form interference bands.

Kinetics of Heterogeneous Equilibrium

An Electromagnetic Hypothesis of the Kinetics of Heterogeneous Equilibrium, and of the Structure of Liquids, Wm. D. Harkins. Proc. Nat. Acad. Sciences, vol. 5, no. 5, May 15, 1919, pp. 152-159, 1 fig. Indicating general nature of distribution of a component between a set of phases from a knowledge of the properties of only the pure component and of those of the phases before any of this component has been added to them.

Photoelectrons

The Passage of Photoelectrons Through Metals, K. T. Compton and L. W. Moss. Physical Rev., vol. 13, no. 5, May 1919, pp. 374-391, 11 figs. Experiments mentioned as indicating that photoelectrons, excited with a metal, lose the initial kinetic energy as results of single and definite collisions rather than by a gradual process or succession of small energy losses.

Radiation Measurements

Radiation Detection in X-Ray Work, R. E. Slade. Chem. Engr., vol. 27, no. 6, June 1919, pp. 131-134, 3 figs. Research of relation between photographic action and wave length of radiation. Paper based on work done in laboratory of British Photographic Research Assn., and read before Faraday Soc.

Modification of Fluorometric Method of Measuring X-Rays and Its Application to Measuring Radiation of Coolidge Tubes (Sur une modification à la méthode fluorométrique de mesure des rayons X, et son application à la mesure du rayonnement des ampoules Coolige), R. Biquard. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 17, Apr. 28, 1919, pp. 851-854. Substituting 6-mm. screen for series of screens of 0.2 mm. in thickness each.

Sound Measurements

A Complete Apparatus for Absolute Accoustical Measurements, Arthur Gordon Webster. Proc. Nat. Acad. Sciences, vol. 5, no. 5, May 15, 1919, pp. 173-179, 5 figs. Requisites are: source of sound producing a simple tone of known intensity, instrument for measuring in absolute units a constantly maintained simple tone, and series of experiments on propagation of sound from one to other in order to check theory of two instruments. Combinations embodying forms said to have been found suitable after research work are given.

Sound, Propagation of

On the Propagation of Sound in the Free Atmosphere and the Acoustic Efficiency of Fog-Signal Machinery: An Account of Experiments Carried Out at Father Point, Quebec, September, 1913, Louis Vessot King. Phil. Tran. Roy. Soc., Lond., Series A, vol. 218, 1919, pp. 211-293, 26 figs. Tests described as having demonstrated successful use of Webster phonometer for measuring characteristics of pure-toned sound waves of ordinary intensity.

Tuning Forks

On the Characteristics of Electrically Operated Tuning Forks, H. M. Dadourian. Physical Rev., vol. 13, no. 5, May 1919, pp. 337-359, 12 figs. Experimental determination of changes in period produced by massiveness of base, variation of constants in electrical circuits containing electromagnet increase in length of gaps between contact springs and contact points and temperature changes.

Vibration

On the Resultant of a Number of Unit Vibrations, Whose Phases Are at Random over a Range Not Limited to an Integral Number of Periods, Lord Rayleigh. Lond., Edinburgh, and Dublin Phil. Mag., vol. 37, no. 221, May 1919, pp. 498-515, 7 figs. A number of points is distributed at random in a straight line of finite length. Probability that deviation of center of gravity of points, when their number is very great, lies between x and $x+dx$, is found mathematically.

Water

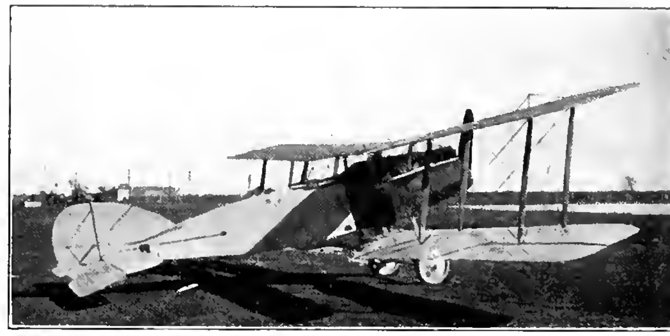
Temperature Coefficient of Tensile Strength of Water, S. Skinner and R. W. Burfitt. Proc. Phys. Soc. Lond., vol. 31, part III, Apr. 15, 1919, pp. 131-136, 1 fig. Liquid was forced under pressure through a capillary constriction between two limbs of a U-tube.

The Horsepower of Resistance in Aeroplane Design

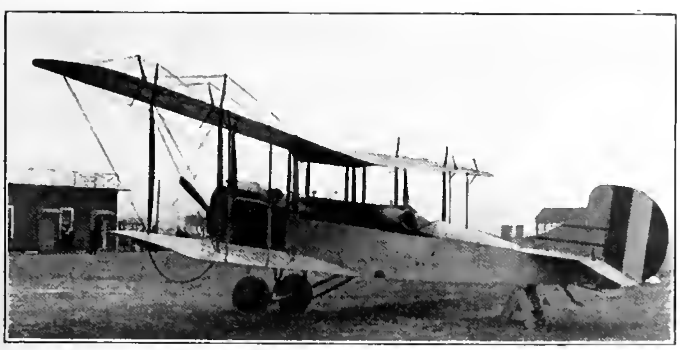
By N. L. Lieberman,[1] Garden City, L. I., N. Y.

The problem of the resistance of an aeroplane has received, directly and indirectly, the analytical attention of many of the celebrated mathematicians and physicists of the last and present centuries. The researches of Newton and Bernoulli have given the general laws of motion and pressure; Euler presented the laws of fluid motion from an investigation of all the points occupied by the fluid, at all instants; while Lagrange explored the same field by investigating the motion of an individual particle. To Lord Kelvin we are indebted for his general dynamical principle. Helmholtz first solved the flow of fluids bounded partly by fixed walls and partly by surfaces of constant pressure and developed the formulæ of vortex flow; then independently and almost simultaneously Helmholtz and Kirchoff established the theory of discontinuity flow. In 1902 Kutta brought forward his vortex sustentation principle, for arched surfaces. A partial explanation of turbulent or eddy motion was presented by Prandtl. The elaborate mathematical analyses of Laplace, Raleigh, Schwartz, Christoffel, Rankine, Stokes, Lanchester and Lamb; and the experiments of Langley, Lanchester, Föppl, Prandtl, Reynolds and Zahm, have all contributed to a directive understanding of the phenomena of fluid motion. No attempt is herewith made to expand any of the above-mentioned theories. Complete discussions, showing the derivations and limitations, are given in Lamb's Hydrodynamics. An excellent résumé showing the salient features of each theory and the mathematical concepts was presented in 1915 by J. C. Hunsaker in his paper, A Review of Hydrodynamical Theory as Applied to Experimental Aerodynamics.[2] It is of interest, however, both academically and for guidance in experimental work, to know the results obtained by these various investigators.

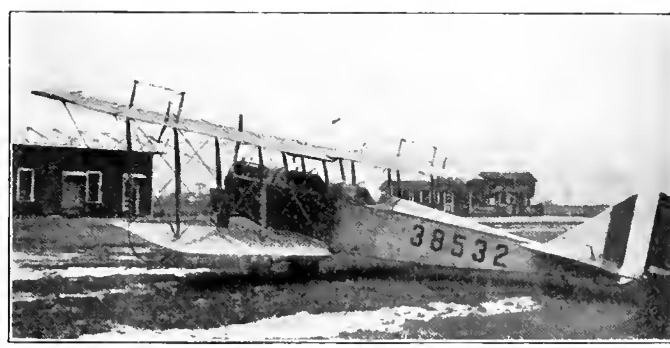
Type No. 4, S.E.-5



Type No. 3, Bristol Fighter



Type No. 2, Curtiss J. IV.-4



Type No. 4, Curtiss R-4

Fig. 1 Four Different Types of Aeroplanes

Model Study and Dynamical Similitudes

The general condition of translational motion in one direction of a solid has been expressed by D'Alembert in the equation

$$M\frac{d^2s}{dt^2} = F \ldots\ldots\ldots\ldots\ldots\ldots\ldots [1]$$

where M = total mass of body

$\frac{d^2s}{dt^2}$ = change of rate of motion of mass M

F = impressed forces

$M\frac{d^2s}{dt^2}$ = effective forces.

Since this equation is independent of any assumption as to the character of the mutual actions and reactions between the particles, it is applicable to fluids as well as to solids. The problem, briefly stated, is the determination of the relations between the impressed forces on a full-scale body, of three dimensions, and its geometrical model.

A detailed examination of the characteristics involved in the complete definition of the body, fluid and motion, shows that only eight are ultimately needed to completely identify the motion for model study. These eight characteristics are—

$M\frac{d^2s}{dt^2} = F$ = force developed

L = span of aerofoil

ε = elasticity of aerofoil

ρ_1 = density of aerofoil

ρ_2 = density of fluid

Abridgment of a paper presented at a meeting of the Buffalo Section of The American Society of Mechanical Engineers, January 29, 1919.

[1] Asst. Mgr., Dept. of Education and Sales Promotion, Curtiss Aeroplane & Motor Corpn.

[2] Presented before the International Engineering Congress, September, 1915.

φ = kinematic viscosity of fluid
C = compressibility of fluid (velocity of sound in fluid)
V = velocity of advance of body (or fluid).

These terms are then treated in accordance with the theory of dimensional homogeneity. The basic principle of this theory is that all terms of an equation must be expressed in the same system of units. The M. L. T. notation is here used.

The physical equation

$$f\left(M\frac{d^2s}{dt^2}, L, \varepsilon, \rho_1, \rho_2, \varphi, C, V\right) = 0$$

yields the final general expression

$$M\frac{d^2s}{dt^2} = F = \rho_2 L V^2 \psi\left[\frac{LV}{\varphi}, \frac{V^2\rho_2}{\varepsilon}, \frac{\rho_2}{\rho_1}, \frac{V}{C}\right] \quad \ldots\ldots\ldots [2]$$

If the velocities of test do not approach the velocity of sound in the medium of test, and further, if the medium of test is the same as the medium of flight, the ψ function reduces itself to a consideration of the L and V factors. Since for any given model

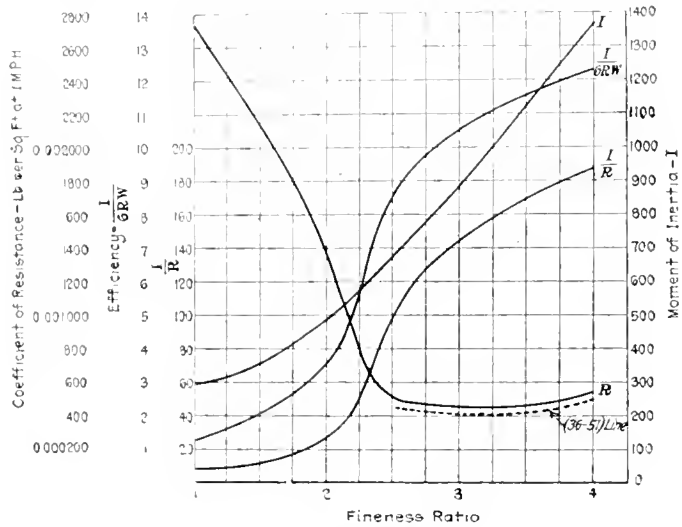


FIG. 2a COEFFICIENTS OF RESISTANCE OF STRUTS

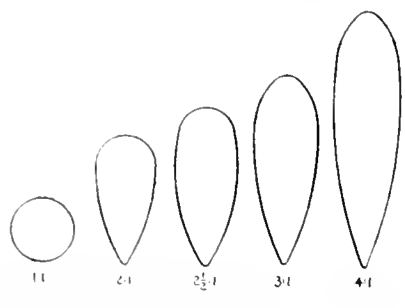


FIG. 2b CROSS-SECTIONS OF STRUTS USED IN PLOTTING CURVES OF FIG. 2a

L is constant, and for critical speed conditions we are governed by the relation $\frac{V}{V_m} = \frac{L_m}{L}$ (where L_m and V_m refer to the line or dimension and velocity of the model), the ψ function becomes a constant. The statement for resistance is then given by the equation—

$$F = K\rho_2 L V^2$$

wherein K combines the effects of cross-section of the body, covering, attitude to flow of medium, etc. It is thus called the "form coefficient." For bodies other than of aerofoil type, interest lies mainly with the coefficient of resistance.

COEFFICIENTS OF RESISTANCE

Struts. In 1912 the N. P. L.[1] tested a series of proposed strut sections submitted by Mr. Ogilvie and obtained interesting results. In Fig. 2a the writer has assumed that a condition of continuity exists between struts of the same form-class, but of different actual length dimensions. In all cases the data plotted are always referred to the fineness ratio (length of cross-section divided by maximum width of cross-section). Fig. 2b shows the sections, dimensioned as to fineness ratio, that were used in plotting the curves of Fig. 2a.

Stream-Line Wires. When members are subject to vibration and movement so that they do not at all times present a head-on view to the wind, the effect on the resistance is similar to that experienced in a turn. Interplane wires are particular offenders in this respect.[1] Hence when stream-line wires were adopted, it was not sufficient merely to decide on a shape that offered the least head-on resistance.

Experiments with struts showed that for different angles of yaw the resistance of the best shape for head-on wind went up very rapidly with the change in angle. As a result of experiments on different shapes, for differing angles, the present generally elliptic shape was adopted. Fig. 3 shows the correction factor for different degrees of yaw.

Fuselage. The general design of the fuselage is frequently fixed by considerations other than those purely aerodynamic. The early forms with open framework are all now replaced with a continuously surfaced structure. Apertures are kept down to the minimum, since theory indicates and experiments show that these add to the total resistance by disturbing the stream-line flow. The main distinction in fuselages centers about the differences between the "short type plus tail booms," and the "long continuous type." The Farman and Voisin construction in French planes, the Vickers Gun-Bus and all the "FE" derivatives, are of the first class. Most of the fuselage construction, however, is of the long continuous type—even when the extended construction merely serves as a boom to the tail (cf. Caproni). The resistance coefficients now available on these various types are meager and disconnected. That is, knowing the coefficient for one form of fuselage does not materially help in determining the resistance of another form. The forms and coefficients given in Table 1 are

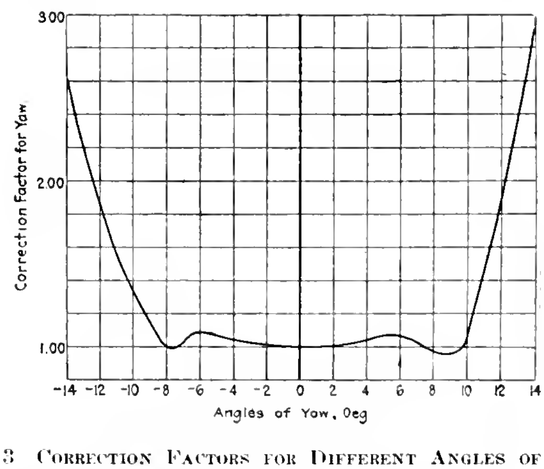


FIG. 3 CORRECTION FACTORS FOR DIFFERENT ANGLES OF YAW

the results of early and recent tests. The coefficients in the table are all for 1 sq. ft. of cross-section at a velocity of 100 m.p.h. (miles per hour), the fuselage inclined 6 deg. to the direction of the wind. The fineness ratio (maximum length divided by maximum depth) is also noted.

PANELS

Extensive experimenting with models and full-scale machines has shown that the factors which for a monoplane form affect a saving are—

1 Wing curve
2 Aspect ratio
3 Plan form.

[1] National Physical Laboratory, Teddington, England.

[1] The vibration of round wires has no effect on the air-resistance—see Comparison of the Air Resistance of Vibrating Wires, by T. E. Stanton, in *Aerial Age*, October 18, 1915.

For multiplane arrangements the saving is a partial function of the monoplane, with increments due to

4 Stagger

5 Gap-chord ratio.

Wing Curve. The lift, drift, movement of the center of pressure and L/D cross-section of two well-known wing curves are shown in Figs. 4 and 5. For comparative study the L/D factors for these and other sections have been plotted in Fig. 6. The choice of a section depends completely on the service. Thus if a high carrying capacity at medium speed is wanted, the curve selected should have an L/D fairly constant over some appreciable range in angle of incidence. If a quick rise is desired at low speed, the lift coefficient at the larger angle of incidence should be high. On the contrary, if a high-speed machine is wanted, but also with a quick get-away (hence fairly low landing and taking-off speed), the L/D factor should be high at both the low and high angles of incidence. Since the weight of the machine is constant, the drift, which is one of the main factors affecting speed, will equal the weight divided by L/D. Hence the larger the L/D ratio, the smaller is the drift, and consequently less horsepower is required to attain, or maintain, a certain high speed.

Aspect Ratio. The more area that can be brought within the province of two-dimensional flow (parallel to the fore-and-aft vertical plane of symmetry), the greater will be the total value of L/D for the entire machine. This is obvious since the end flow of the air at the ends of the panels destroys the lift locally; and by creating probable surfaces of discontinuity within the panel region, still further increases the drift. Tests have shown that the L/D factor increases with the aspect ratio. However, there are both structural and dynamical considerations which limit the aspect ratio. The average practice of today indicates for ordinary

TABLE 1 RESISTANCE COEFFICIENTS FOR VARIOUS TYPES OF FUSELAGES

Fuselage	Length ÷ Depth	Resistance Lb per Sq. Ft.	Fuselage	Length ÷ Depth	Resistance Lb per Sq. Ft.
FARMAN NO. 1. (NO RADIATOR)	3.2	6.53	F.E 2B.	4.6	13.88
FARMAN NO. 2 (NO RADIATOR)	3.2	8.56	F.E.2C	4.6	13.05
FARMAN NO 3 (NO RADIATOR)	4.3	14.69	F.E.B	3.1	10.00
DEPERDUSSIN (OPEN MOTOR)	5.3	10.20	DEPERDUSSIN (COVERED MOTOR)	5.2	7.55
S.E. 4 A	4.7	4.92	S.E.5.	5.6	12.85
B E 2 C	7.2	15.71	B E 3	6.2	8.65
AVRO	6.8	11.10	F.E.7	7.6	5.91
STREAMLINE (ROUND SECTION)	6.4	3.80	STREAMLINE (ROUND SECTION)	6.4	4.98
STREAMLINE (SQUARE SECTION)	6.0	4.08	STREAMLINE (SQUARE SECTION)	6.0	5.35

two-place single-motor machines of velocity 75-90 m.p.h., an aspect ratio of about 7.0 to 7.5; for two-place single-motor machines of velocity about 125 m.p.h., an aspect ratio of about 6.0 to 7.0; for single-place machines, 100 m.p.h., an aspect ratio of about 6.0 to 6.5; and for single-place machines, 125 m.p.h., an aspect ratio of 5.0 to 5.5.

It is customary to run wind-tunnel tests on panels having an aspect ratio of 6. The Report of the British National Advisory Committee for Aeronautics for 1911-1912 published correction factors for different aspect ratios, for individual angles of incidence. Within reasonable percentages these relative factors of correction for each angle of incidence have been found to be constant.

Plan Form. While early aeroplane builders attempted to fol-

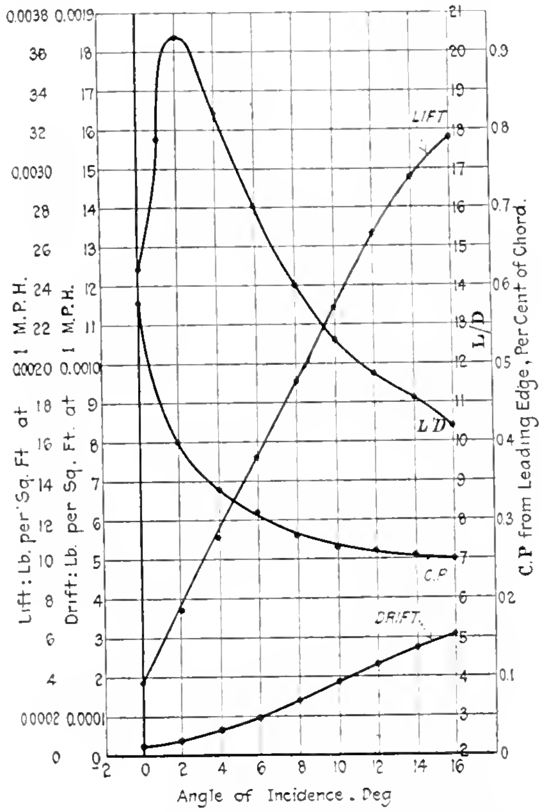


FIG. 4 VARIATION OF LIFT, DRIFT, C.P. AND L/D WITH ANGLE OF INCIDENCE, R.A.F. NO. 15

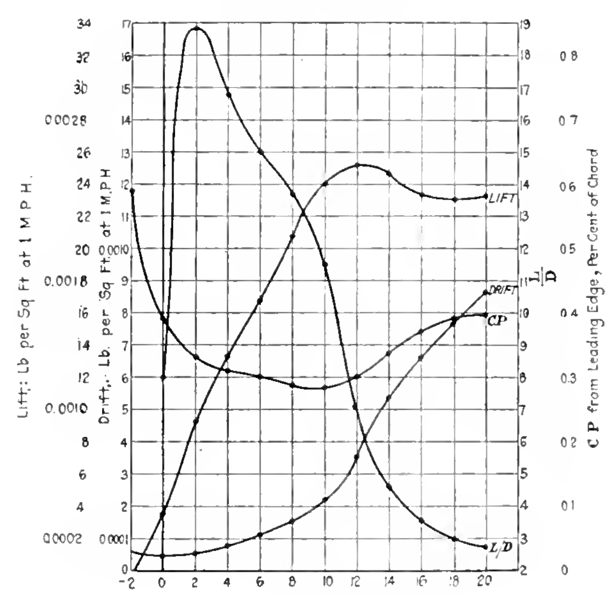


FIG. 5 VARIATION OF LIFT, DRIFT, C.P. AND L/D WITH ANGLE OF INCIDENCE, U.S.A. NO. 16

low the outlines of bird wings, and this still persisted in the early German Taube design, wind-tunnel tests have shown that both stability and good lifting capacity do not always go together for all types of cross-sections tested. Direct comparative tests on all types of plan forms show that the loading on the complete wing is independent of the form of the tip. While it would appear that

for different forms the region of disturbance should vary and hence affect the total loading, undoubtedly the three-dimensional flow masks small regional effects. Tests on a variety of round-ended panels show that a plan form, the end of which is a semi-ellipse, with the major axis normal to the chord and equal to 1.5 times the chord, gives the best results.

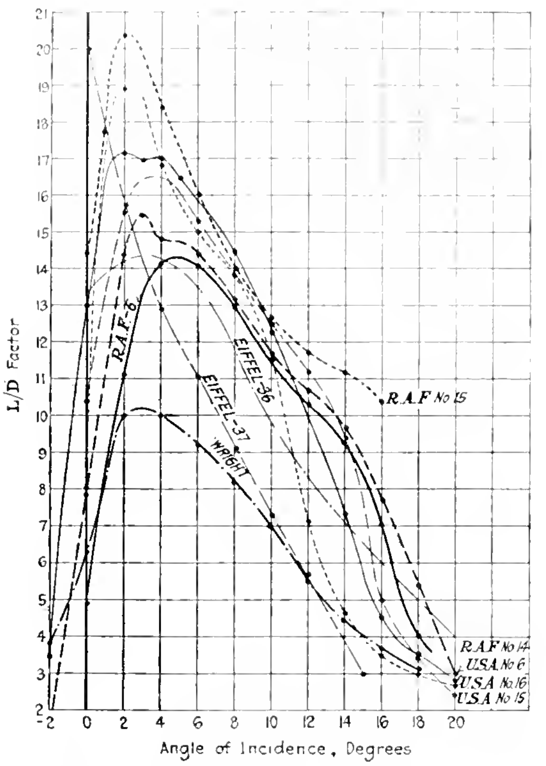


Fig. 6 Variation of L/D Factors of Various Sections with Angle of Incidence

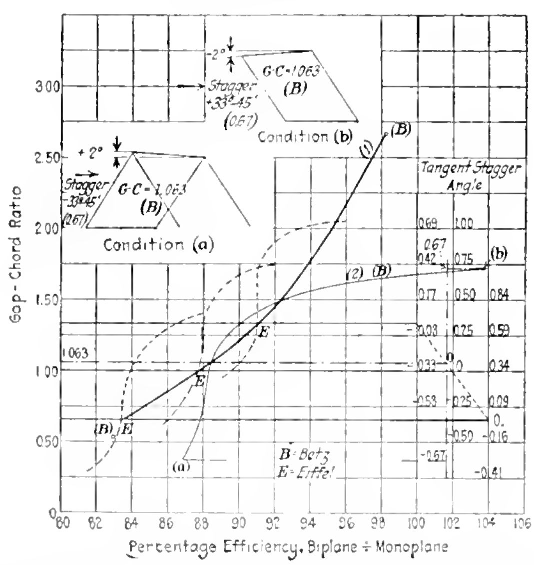


Fig. 7 Efficiency of a Biplane in Terms of an Equivalent Monoplane for Different Values of Gap and Stagger

Stagger and Gap. Many experiments with models and tests on full-scale members have been made in an attempt to reach reliable data showing the effect of the interrelated quantities chord, gap and stagger. M. Eiffel, the N. P. L. and Göttingen have collected considerable data on models in which these quantities were varied singly and readings taken for different angles of incidence.

The writer has taken Eiffel's and Betz' (Göttingen) results and from them constructed a series of curves, Fig. 7, which give the efficiency of a biplane in terms of an equivalent monoplane—permitting variation in both gap and stagger. The abscissæ are always percentage efficiency. The coördinates at the left give the gap-chord ratio. At any specific ratio a horizontal line was drawn, upon which was plotted the specific value of the percentage efficiency found by Eiffel or Betz for condition of "no stagger." The solid curved line (1) thus drawn through these points plotted on the various gap-chord ratio base lines represents the variation in percentage efficiency with changes in gap-chord ratio when the stagger is not considered (i.e., when the stagger is zero). If an auxiliary coördinate line be erected at the right-hand end of any gap-chord ratio base line previously drawn, and the tangents of the stagger angles be marked off as coördinates (positive and negative with respect to the base line), a new set of reference lines are thus established, based on the main set. The point for zero stagger has been set previously and occurs when line (1) intersects the gap-chord ratio base line. This point is now made the origin for another curve showing the variation in efficiency, as the stagger changes—while the gap-chord ratio is held constant. In this manner a series of curves are drawn through curve (1), each showing the variation of efficiency with stagger, for a specific gap-chord ratio. The three values plotted correspond to 1.33, 1.00 and 0.66 gap-chord ratios. Curve (2) shows the variations found by Betz for a gap-chord ratio of 1.063 when the stagger and angle of incidence were changed from condition (a) to condition (b).

In general, the values given by these curves are slightly higher than some of the other tests published; but within the range of ordinary usage the variation will generally be found less than one per cent. One point to be noticed is that for a gap-chord ratio of 1.0 (no stagger) the efficiency is quoted at 87.7 per cent, whereas recent tests have given the efficiency for these conditions at 84 per cent. Figures on the various properties of triplanes were published by J. C. Hunsaker, of the Massachusetts Institute of Technology.

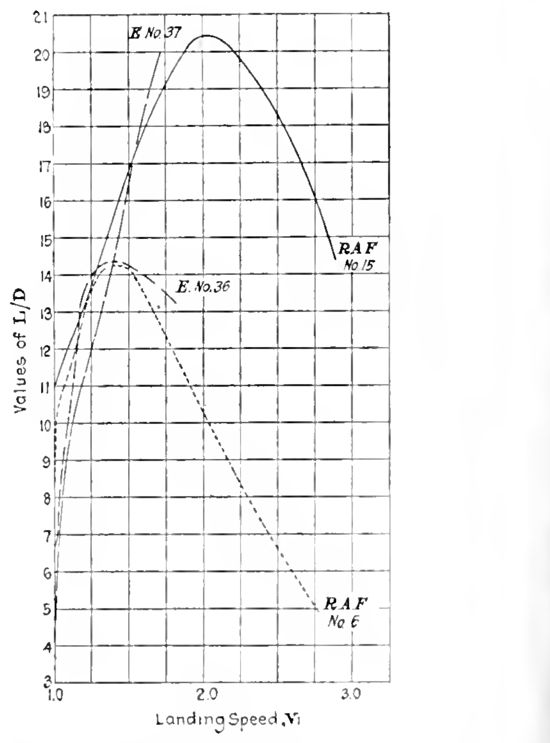


Fig. 8 Curves Showing Relation Between Effectiveness and Landing Speed

Panel Area and Resistance

The total panel area required in any aeroplane is a function of (1) the aerofoil, (2) the weight, and (3) the minimum velocity. The maximum speed, however, is a function of the resistance. Therefore every augmentation in lifting capacity for a given area is a conservation of horsepower and increases the efficiency of the machine (since the "resistance area" will be kept constant).

If the landing speed be called V_1, we have the relation

$$A = \frac{W}{k_1 V_1^2}$$

giving the area that must be furnished in the panels to sustain flight at the given minimum speed. If the minimum velocity be known, the minimum area will be required at the angle of incidence of greatest value of k_1 (k being the lift coefficient of the aerofoil). The maximum speed cannot be predicted until the details of the component parts of the machine are known and the resistance summated. However, assuming that any disturbing moment that would tend to vary the angle of incidence were controlled by the elevators or other means, so that the movement of the aeroplane were horizontal, the velocity at any angle α can be determined by substituting the corresponding value of k_a in the general equation.

$$W = k_a A V_a^2$$

in which W and A are already known, and k_a is selected from the "aerodynamic property" of the aerofoil with which the machine is equipped. Therefore any required velocity for sustentation at any angle other than the landing angle (provided sufficient power is available to overcome the resistance) may be expressed as

$$V_a = \sqrt{\frac{W}{k_a A}}$$

Substituting the value of A as previously found,

$$V_a = V_1 \sqrt{\frac{k_1}{k_a}}$$

Thus the maximum attainable velocity depends on the sum total resistance of the machine and the available power delivered through the propeller. That aerofoil which will sustain the total weight at the given minimum velocity and which will offer the least resistance at the maximum velocity, is therefore the economical one.

From the preceding equation and the aerodynamic coefficients of lift and drift of aerofoils, the effectiveness (L/D) of aerofoils at various speeds for any machine of known weight can be compared.

The resistance of the panels at any speed is equal to the total weight of the machine divided by the L/D factor for the angle of incidence that yields the given speed; or

$$R_a = \frac{\text{Weight}}{\left(\frac{L}{D}\right)_a}$$

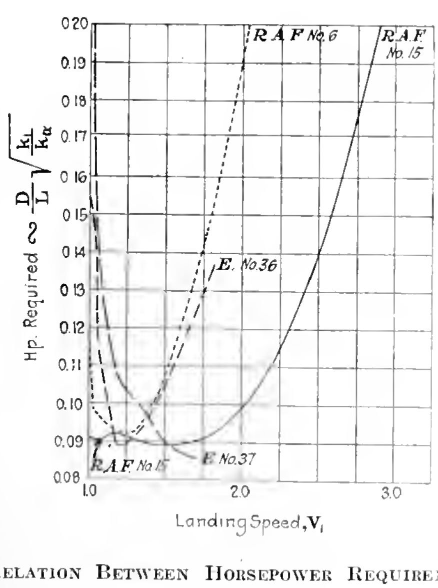


FIG. 9 RELATION BETWEEN HORSEPOWER REQUIREMENTS AND LANDING SPEED

Since the required horsepower $= RV/375$, where R is stated in pounds and V in miles per hour,

$$\text{HP}_a = \frac{\left[\frac{W}{\left(\frac{L}{D}\right)_a} \times V_1\sqrt{\frac{k_1}{k_a}}\right]}{375}$$

which may be written

$$\text{HP}_a \sim \left(\frac{D}{L}\right)_a \sqrt{\frac{k_1}{k_a}}$$

The horsepower required for any type of wing curve can thus be plotted for various speeds (in terms of the landing speed). Fig. 8 shows the relation between the effectiveness (L/D) and

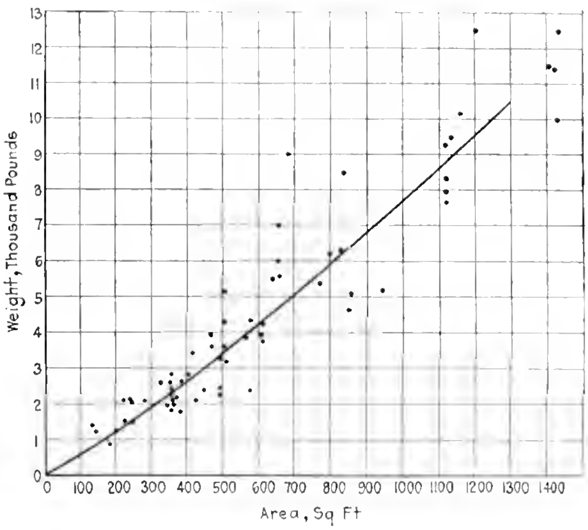


FIG. 10 VARIATION OF AEROPLANE SIZE WITH WEIGHT

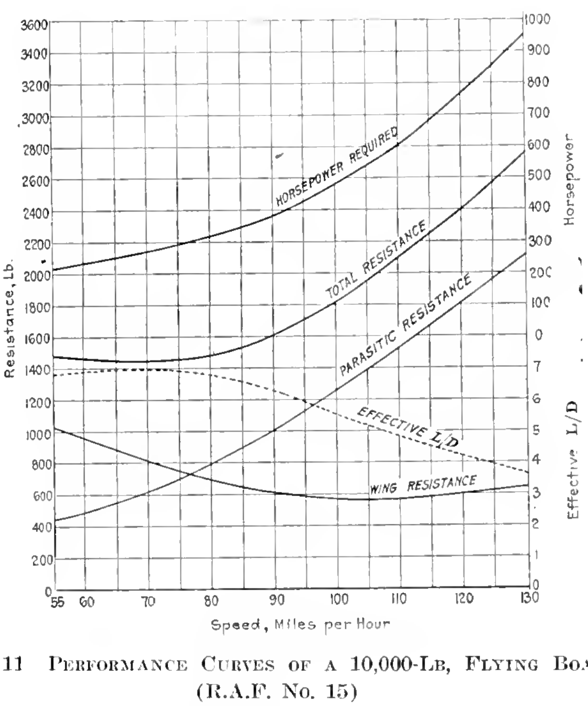


FIG. 11 PERFORMANCE CURVES OF A 10,000-LB. FLYING BOAT (R.A.F. No. 15)

various speeds for different types of curves; Fig. 9 shows the relation between the horsepower requirements and various speeds for the same types of wing curves.

A graphic method is thus presented which permits a direct comparison of the performance of several wing curves, both as to lifting capacity and horsepower consumption at various speeds. Fig. 8 shows that for high speeds the R. A. F. No. 15 wing curve has the greatest L/D; hence for any given machine weight, at high speeds, it will offer the least resistance. Fig. 9 shows that for practically all speeds the horsepower consumption of the R. A. F. No. 15 is least. Hence this wing curve is the most

economical of the four presented at high speeds. The same superiority is evident at low speeds, hence this wing curve is the best all-around curve.

Fig. 8 shows that for low speeds the L/D values of the R. A. F. No. 6 are greater than for the E. No. 36; whereas at the higher speeds the E. Nos. 36 and 37 are superior (the R. A. F. No. 15 excepted).

The curves of Fig. 9 show that for the lower speeds the R. A. F. No. 6 consumes less horsepower than either the E. No. 36 or No. 37. The reverse condition obtains at the higher speeds. Hence for heavy machines the high speed of which will not exceed 1.5 V (V = low or landing speed), the R. A. F. No. 6 curve is preferable to that of either the E. No. 36 or No. 37. Of these last two the E. No. 36 is better at lower speeds but inferior at higher speeds. Unless considerable excess horsepower be available with the E. No. 37 at getting-off speed, this curve is uneconomical.

Distribution of Horsepower Consumption

There is no fixed ratio in accordance with which the total horsepower requirements can be resolved for the component parts of an aeroplane. The following, however, appears to be true for four types studied (see Fig. 1):

1 The percentage of total horsepower consumed by each component group is dependent on the type of group and machine
2 The percentage of total horsepower consumed by each component group is generally independent of the weight of the machine
3 The panels show a decrease in requirement with increasing speeds
4 The remaining component groups show increasing requirements with increasing speed
5 The panel percentage requirement increases in any given type for increases in weight, whereas the percentages of the remaining groups decrease
6 The range of percentages of total horsepower requirements for the different groups, at increasing speeds, is of the following order:

		Per Cent
a	Panels	80 to 25
b	Panel accessories	5 to 25
c	Landing gear	3 to 17
d	Tail units	2 to 15
e	Fuselage	10 to 45

A general statement of "parts resistance," or horsepower requirements, cannot logically be made without considering both type and velocity.

Burden Distribution

The preceding figures have given the actual percentages of total horsepower per group without regard to the weight of the group with respect to the machine. In Table 2 it will be noticed that the percentage weight (of total machine weight) varies for each group, both for machines of the same type and for machines of different types. This variation may be due (*a*) to construction, (*b*) to loading of machine, or (*c*) to both. A curve which will show the relative horsepower expense of each group for its weight the writer has called a "burden curve." Thus a part or group which constitutes a very small percentage by weight may be very expensive in horsepower consumption in proportion to its weight. This curve is obtained by plotting as ordinates the values obtained in dividing the "percentage horsepower consumption," of each group, at various speeds, by the percentage weight of the part or group; and as abscissæ, the speed in m.p.h. Such curves show that:

1 The burden of the panels decreases with increasing speeds
2 The burdens of the other groups increase with increasing speeds
3 The panel accessories have generally the largest burden-figure of all groups

TABLE 2 DATA ON WEIGHTS, SPEEDS AND PANEL AREAS OF AEROPLANES

Machine		Gross wt., lb.	Gross panel area, sq. ft.	Speed range, m.p.h.		Parts, Percentage of Total Weight					Wing Curve No.
No.	Type			Low	High	Panels	Panel accessories	Landing gear	Fuselage	Tail	
3	2	2100	352.0	50	95	14.35	4.87	3.43	75.0	2.41	Eiffel No. 36
4	2	2400	352.0	50	95	12.55	4.20	3.00	78.1	2.11	Eiffel No. 36
5	3	2750	416.0	55	125	11.50	2.07	5.45	78.8	2.16	R.A.F. No. 15
6	3	3650	416.0	55	125	8.66	1.56	4.11	84.0	1.63	R.A.F. No. 15
7	4	3650	505.0	55	105	11.40	2.74	4.60	79.6	1.67	R.A.F. No. 6
8	4	4300	505.0	55	105	9.66	2.33	3.91	82.5	1.41	R.A.F. No. 6
1	1	1800	246.0	55	125	10.30	2.78	5.00	79.8	2.00	R.A.F. No. 15
2	1	2050	246.0	55	125	9.06	2.44	4.39	82.2	1.76	R.A.F. No. 15
9	2	2100	280.0	50	110	9.33	3.10	4.56	80.2	2.52	R.A.F. No. 15

4 The burden of the fuselage is practically constant for different speeds
5 In any one type an increase in weight increases the burden of the panels and decreases the burden of the remaining groups.

In interpreting "burden curves" the precaution should be borne in mind that these curves are functions of the percentage weight of a part besides the resistance. Thus, while the form of a group may be unchanged (hence the aerodynamic property unaltered, and the horsepower requirement kept constant), the internal construction may be altered to reduce its weight. The weight percentage of the group thus decreases and the burden figure increases (burden = per cent hp. ÷ per cent weight). A high burden figure may thus be due to either (*a*) a high resistance or (*b*) a low weight. In either event it serves as an index to the relative horsepower expense of the groups and shows where improvement may be centered.

Flight at High Altitude

The general formula [2] obtained in the discussion on dynamic similitudes showed that the density of the medium affected the dynamic reaction:

$$F = \rho_2 L V^2 \psi [\ldots.]$$

The density of the atmosphere decreases as the altitude increases. The weight of the machine remains practically constant with increases in altitude within the field of operation, hence if ρ_0 = density at sea level and ρ_h = density at altitude h,

$$W = \rho_h k A V^2_0 = \rho_h k A V^2_h$$

from which

$$V_h = V_0 \sqrt{\frac{\rho_0}{\rho_h}}$$

that is, the velocity at altitude h increases in the proportion $\sqrt{(\rho_0/\rho_h)}$ over the velocity at sea level. Also

$$D_h = \rho_h k A V^2_h = \rho_h k A \left(\frac{\rho_0}{\rho_h}\right) V^2_0 = \rho_0 k A V^2_0 = D_0$$

that is, the drifts (hence thrusts) remain constant at the respective velocities for any given altitude of the machine. Again,

$$\mathrm{HP}_h = \mathrm{HP}_0 \sqrt{\frac{\rho_0}{\rho_h}}$$

or the horsepower requirements at altitude h increase in the proportion $\sqrt{(\rho_0/\rho_h)}$ over the horsepower requirements at sea level.

Recent motor tests conducted under reduced pressure to obtain the equivalent condition to altitude, showed a decrease in power in the motor proportional to $(\rho_h/\rho_0)^{1.2}$. The efficiencies of propellers at different altitudes by tests were found to be

$$\eta_h = \tfrac{1}{2}\left[1 + \sqrt{\frac{\rho_0}{\rho_h}}\right]\eta_0$$

The motor output or available thrust at altitude h is $P_h \times \eta_h$,

therefore

$$P_h = \tfrac{1}{2}\left(\frac{\rho_h}{\rho_0}\right)^{1.1}\left[1+\sqrt{\frac{\rho_0}{\rho_h}}\right]\eta_0 P_0$$

$$= \tfrac{1}{2}\left[\left(\frac{\rho_h}{\rho_0}\right)^{1.1}+\left(\frac{\rho_h}{\rho_0}\right)^{0.6}\right]\eta_0 P_0$$

The quantities P_0 and P_h represent the motor horsepower, as indicated in power curves; HP_0 and HP_h represent the horsepower requirements for motion. Hence such value of ρ_h as makes $HP_h = P_h$, indicates the limit of climb, or ceiling of the machine. Combining the foregoing "available horsepower" statement with $HP_h = HP_0\sqrt{(\rho_0/\rho_h)}$,

$$HP_0 = 0.5\left[\left(\frac{\rho_h}{\rho_0}\right)^{1.6}+\left(\frac{\rho_h}{\rho_0}\right)^{1.1}\right]\eta_0 P_0$$

which is an expression for the ceiling of a machine when the available power and required power at sea level are known.

Transatlantic Flights

Recently aeronautical activities have been centered on large flying boats as a means for crossing the Atlantic. What follows, therefore, constitutes a study on the probable size of craft, fuel load and power equipment necessary to accomplish this trip, based on the data and performances of similar craft.

If η = efficiency of the propeller system
P_0 = motor output in horsepower
n = number of motors

the available power $= \eta n P_0$, which in flight equals the power required, or $VD/375$. Since $D = W/(L/D)_e$, where the subscript e denotes "effective,"

$$\text{Available power} = \eta n P_0 = \frac{VW}{375}\left(\frac{D}{L}\right)_e$$

By definition, the total weight is

$$W = nM + L_a + 160p + 6.15\lambda$$

where nM = weight of n motors
L_a = weight of aeroplane
$160p$ = weight of crew numbering p
6.15λ = weight of λ gal. of fuel.

If the motor consumption in gasoline and oil be γ lb. per b.hp., for n motors of P_0 hp. each the consumption per hour will be $\gamma P_0 n$ and the fuel will then last $(6.15\lambda/\gamma P_0 n)$ hours at full throttle and maximum speed. The range of flight, with all n motors going, is in general terms $6.15\lambda V/\gamma P_0 n$. If in this expression the values of $P_0 n$ and W be substituted,

$$\text{Range (in miles)} = \frac{6.15\lambda V}{\gamma\dfrac{WV}{375\eta}\left(\dfrac{D}{L}\right)_e} = \left(\frac{L}{D}\right)_e\frac{6.15\lambda V\times 375\eta}{\gamma WV}$$

$$= \left(\frac{L}{D}\right)_e\frac{2306.25\lambda\eta}{\gamma(nM+L_a+160p+6.15\lambda)}$$

From Fig. 10, if the equivalent linear dimension be designated by $A^{0.5}$, where A = area, the weight will be proportional to $A^{2.6/2.0}$. The weight of the aeroplane can then be expressed as $L_a = \mu W^{2.6/2.0} = \mu W^{1.3}$. The motor weight, when expressed in terms of the available power, is $nM = vP_0 n$, where v is the unit weight per b.hp. Therefore,

$$W = v\left(\frac{D}{L}\right)_e\left(\frac{WV}{375\eta}\right) + \mu W^{1.3} + 160p + 6.15\lambda$$

If now cW be substituted for $(160p + 6.15\lambda)$, the following complete expression in W will result:

$$W = \frac{v}{\eta}\left(\frac{D}{L}\right)_e\left(\frac{WV}{375}\right) + \mu W^{1.3} + cW$$

Dividing this equation by W,

$$1 = \frac{v}{\eta}\left(\frac{D}{L}\right)_e\left(\frac{V}{375}\right) + \mu W^{0.3} + c$$

hence $c = 1 - \dfrac{v}{\eta}\left(\dfrac{D}{L}\right)_e\left(\dfrac{V}{375}\right) - \mu W^{0.3}$

In flying-boat construction the dead load of the hull, panels, etc., will constitute at a minimum about 35 per cent of the total load, or $L_a = 0.35W$. But as L_a has been shown to be equal to $\mu W^{1.3}$, $0.35W = \mu W^{1.3}$, from which

$$\mu = \frac{0.35}{W^{0.3}}$$

Assuming for W the approximate value of 25,000 lb.,

$$\mu = 0.0015$$

The propeller efficiency may be taken at about 80 per cent and a current value of 2 lb. per b.hp. for v. For the complete machine the L/D value will be of the order of 6.9 for the maximum values.

If a velocity of about 115 m.p.h. be approximated and the foregoing values substituted in the expression for c,

$$c = 1 - \frac{2.00}{0.80}(.145)\left(\frac{115}{375}\right) - 0.35$$

$$= 0.54 \text{ maximum to } 0.50 \text{ average}$$

If a crew of four men be included $= 640$ lb. $= 0.026W$, the fuel may be regarded as $0.475W$ to $0.50W = 6.15\lambda$.

Range of operation (miles)

$$= \left(\frac{L}{D}\right)_e\frac{375\eta\times cW}{\left[v\left(\dfrac{D}{L}\right)_e\left(\dfrac{WV}{375\eta}\right)+\mu W^{1.3}+0.026W+cW\right]\gamma}$$

$$= \left(\frac{L}{D}\right)_e\frac{375\eta c}{\left[\dfrac{v}{\eta}\left(\dfrac{D}{L}\right)_e\left(\dfrac{V}{375}\right)+\mu W^{0.3}+0.026+c\right]\gamma}$$

$$= \left(\frac{L}{D}\right)_e\frac{375\eta c}{\gamma}$$

The highest (present design) theoretical value of the effective L/D is of the order of 9.0. For flying boats the value of this factor is considerably lower—more generally of the order 6.8 to 7.0. If an average value of 6.9 be assumed, with $\eta = 0.80$, $c = 0.50$, and $\gamma = 0.525$, the range of operation becomes

$$6.9\,\frac{375\times0.80\times0.50}{0.525} = 1975 \text{ miles}$$

The distance between Newfoundland and Ireland is in round figures 2000 miles, and preceding computations show that a machine of the given characteristics would just be able to cover the flying distance.

If an increase in size be contemplated so that c may attain a value of about 0.52 and the efficiency of large-diameter propellers be reckoned at 0.82 (this value has been consistently obtained in recent designs by the writer),

$$\text{Radius} = 6.90\,\frac{375\times0.82\times0.52}{0.525} = 2100 \text{ miles}$$

If all quantities be taken at their extreme values, a maximum range of 2300 miles is obtainable, giving an excess for deviation in flight of 15 per cent.

The results obtained in the foregoing calculations will now be compared with the performance curves of a 10,000-lb. flying boat, Fig. 11, and deductions as to size, capacity and flying speeds will be made. The model in question carries 330 U. S. gallons of gasoline. Equipped with two Liberty motors it would have a maximum speed of about 110 m.p.h. This gives a straight-ahead flying range of 550 miles, both motors working. It is thus obvious that at least 4.5 to 5.0 times as much fuel must be carried in a craft of this type to make the trip possible. Hence the fuel load must be $330\times5.0 = 1650$ U. S. gallons of gasoline on a two-motor assumption. This corresponds to a load of 10,150 lb. (on the assumption of two motors). Hence if the machine be equipped with n motors the total gasoline load will be 10,150 $(n/2)$ lb.

From the above considerations the indications are that the new machine will be roughly 2.5 times the weight of the first, and about 1.75 times as large. Hence the horsepower requirements may be estimated at $\dfrac{m\sqrt{m}}{N}\,HP_b = 2.25$, say, 2.0, where m = ratio of weights, and $HP_a = 2.0HP_b = 2\times2$ motors. We can thus

(*Continued on page 792*)

ELEMENTS OF A GENERAL THEORY OF AIRPLANE-WING DESIGN

By WALTER C. DURFEE,[1] BOSTON, MASS.

This paper presents in brief outline form ten subjects which have reference to the theory of fluid motion around the wings of airplanes. These are: the vortex theory of lift; the theory of initial motion around wings; vortex theory of shape; hydrodynamic-electromagnetic analogy; action of vortices with reference to each other; action on vortices with reference to their images; influence of the local wind; laws of energy content in trailing vortex; friction and head resistance; and explosion of eddies. These various subjects are not discussed but are merely brought forward for the purpose of providing a starting point for discussion.

THERE are several subjects which seem so interesting in connection with a study of the action of wings upon the air that the writer has thought it valuable to the Society to place them on record, in brief outline and in such a way as to provide a starting point for discussion and the addition of any data which members of the Society may wish to contribute. These subjects which have reference to the theory of fluid motions around the wings of airplanes are as follows:

a The vortex theory of lift, which states that the air which passes the wing of an airplane, or the blade of a propeller, contains a component of circulation around that wing or blade, in such a direction that there is a comparatively high velocity and low pressure on the upper surface of a wing, and a comparatively low velocity and high pressure on the under surface.

b A theory which states that an imperfect fluid will act like a perfect one momentarily; from which it may be inferred that the circulation around a wing cannot exist at the first moment or beginning of its motion of advance but must develop at some time after the first beginning of the motion, since there is no circulation in the beginning.

c The vortex theory of shape, which treats of a solid body in motion as being somewhat similar to the core or kernel of a group of vortices.

d The hydrodynamic-electromagnetic analogy, which states that distributions of fluid motion are very similar to distributions of magnetic flux; so that one may calculate the fluid motion around a supposed vortex or group of vortices mechanically, by arranging electric currents or groups of currents in a manner analogous to the supposed vortices, and measuring the magnetic forces which result.

e The laws of vortex motion with reference to the action of vortices on each other, by which it seems possible to estimate the circulation or strength of the trailing vortex loop which is generated by a wing in flight.

f The laws of the actions of vortices with reference to their images in solid surfaces combined with the laws, so far as known, concerning the generation of eddies and vortices by friction, especially near sharp edges.

g The concept of a local direction of the wind as due to the effects of all vortices existing in the neighborhood of a wing —such as its own trailing vortices and the influence of neighboring circulations.

h Laws concerning the energy contained in various distributions of vortex motion by which one may estimate favorable arrangements of the trailing vortex systems in terms of the load carried by various parts of the wing span, and from which the drag might be estimated.

i Coefficient of friction and head resistance representing losses of energy which can be added to the losses attributed to the energy of the trailing vortices.

j Experience concerning the explosion of eddies and vortices and the causes and effects of such disturbances.

Presented at the Spring Meeting, Detroit, Mich., June 16 to 19, 1919, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

[1] Consulting and Manufacturing Chemist. Mem.Am.Soc.M.E.

It is the writer's belief that there are engineers, mathematicians and experimenters in the Society who can give illuminating and interesting statements concerning the subjects mentioned; and that a group of such statements assembled in the form of a discussion would constitute almost a complete and classical theory of the action of wings in steady flight. This paper therefore outlines in a preliminary way the bearing of these various theories and indicates their approximate exactitude.

a The Vortex Theory of Lift. It is not difficult to believe that a component of circulation exists around a wing in flight. If it is granted that the wing carries any load at all, as wings evidently do, there is certainly a difference of air pressure between the lower and the upper surface. Consequently there are accelerations in the neighboring fluid from the under surface around in various circuits to the top surface; corresponding to the fall in pressure from one surface to the other. The quiet or still air into which a wing advances, experiencing these accelerations, must accumulate an upward velocity in front of the wing, and disturbances of a similar nature evidently must occur not only in front of the wing but also to the right hand and to the left hand. Since an upward motion in one region involves a downward motion in another, there must be a downward motion in the rear of the wing. This is a sort of circulation up in front and down behind; and consequently to the rear above and in a forward direction below.

In practice such motions can sometimes be seen in the form of little jerks or jumps of a fluid in the neighborhood of a model wing passing through it. It is not difficult to believe that this disturbance around a wing is rather similar in arrangement to the distribution of velocity around a vortex or group of vortices —their axes parallel to the span of the wing, and perpendicular to the direction of advance. The intensity of motion is very likely greatest near the seat of the disturbance.

According to mathematical theory the lifting force would be in proportion to the strength of the vortex and to its rate of advance, just as the lifting force on a wire in the armature of an electric motor is in proportion to the strength of the current and to the intensity of the magnetic flux from the pole pieces. A formula is given in the Encyclopedia Britannica for the theoretical action of a vortex which surrounds a circular rod which is projected sideways. A force develops perpendicular to the axis of the rod and vortex and at right angles to the motion of advance. This is very similar to the lift of a wing in flight.

Practical examples, however, suitable for mathematical analysis seem to be very rare, nevertheless the writer found one case which seemed to be reasonably free from objectionable complications. This was a wing tested by Eiffel (Eiffel No. 8, at 9 deg. center section). From the measured pressures in this case the probable approximate velocities of the air near the wing surface were estimated, using Bernoulli's theorem. From these velocities a calculation was made of the circulation around the wing, which is the line integral of the tangential component of the velocity vector in a circuit around the wing. The result agrees with the theoretical formula for lift, or $L = \rho Vml$, in which L = force perpendicular to advance; ρ = density of air; V = velocity of advance; m = circulation of the vortex; and l = length taken along vortex axis. It would be interesting to have more measurements of the circulation around wings.

b Theory of Initial Motion Around Wings. It is very evident that no circulation exists around a wing when it is standing still in quiet air on the ground. Mathematical theory further declares that circulation cannot be expected to develop immediately at the beginning of the advance. In the first instant of motion conditions are supposed to be very much as they would be in a perfect fluid. The amount of circulation if zero at the start would be zero immediately afterward. For example, imagine, for simplicity's sake, an inclined plane moving from the position AA' to BB' in Fig. 1, starting suddenly from rest. The

volume equivalent to the space AA'-BB' can be expected to be displaced and to go around the edges in such a manner that there is no net circulation around the section. Very soon after this beginning of motion, however, in the case of a real wing suddenly started in a real fluid, a very violent eddy or vortex is left behind at $A'B'$. When the wing has advanced to a further position CC' the conditions are as sketched in perspective in Fig. 2. There is a vortex loop stretching rearward from near the wing tips and joined together by the eddy generated at the starting point.

c Vortex Theory of Shape. Suppose that the axes of a number of equal-sized vortices are arranged as the black circles in Fig. 3. Then the direction of motion in the fluid due to their combined action in almost exactly[1] in the direction indicated by the full-line arrows. Suppose that a certain motion of translation is added to this particular arrangement of vortex motion. Then the resultant velocity of total result may be in the directions indicated by the dotted arrows. This particular kind of fluid motion corresponds to a certain velocity of motion added to a certain arrangement of vortices.

Now it is a fact that the shape of the curved line of circles shown in the diagram is, as nearly as may be judged, the effective shape of a cross-section of a certain real wing (Eiffel No. 8 at 9 deg.), deducting an allowance for the thickness of the section. Also it is a fact that the spacing of the circles indicates the actual distribution of lifting force experienced by that wing between the front and the rear of the wing section. Also the component of horizontal velocity added to produce the dotted arrows is the velocity used in the published tests of this real wing, and the vortex strength used in preparing the diagram agrees with the vortex theory of lift and the estimated circulation around the

FIG. 1 DIAGRAM ILLUSTRATING THEORY OF INITIAL MOTION AROUND WINGS

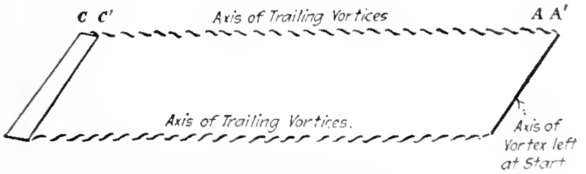


FIG. 2 DIAGRAM FURTHER ILLUSTRATING THEORY OF INITIAL MOTION AROUND WINGS

wing mentioned. Altogether, it is evident from these figures that there is a close connection between the factors of lift, distribution of lift, strength of circulation and distribution of fluid motion and shape.

d Hydrodynamic-Electromagnetic Analogy. Diagrams like Fig. 3 are easily obtained, not by mathematical calculation but by arrangements of electric currents and magnetic fields representing vortices and velocities, choosing any desired amount of flux to represent a standard velocity.

e Action of Vortices With Reference to Each Other. The Encyclopedia Britannica gives formulæ for the action of groups of parallel columnar vortices upon each other, in terms of the strength of these vortices and their distance apart. It is interesting to estimate the strength of the trailing vortices from a biplane by observing their actions on each other. The pairs from the right-hand wing tips are of one kind or direction and revolve around each other in approximate circles. Those from the left-hand tips also revolve around each other, but in the reverse direction from the first-mentioned pair. Very careful experiment would be required to detect any error in the vortex theory of flight in terms of the action of these pairs of trailing vortices.

f Action on Vortices With Reference to Their Images. Many peculiarities of fluid motion are roughly explainable in terms of the action of eddies as if under the influence of their images in solid surfaces. For example, there is a remarkable difference in the circumstances surrounding the eddies formed at B and B' in Fig 1 on the upper surface of the plane. One at the rear B' should tend to roll off if considered as under the influence of its image. Conversely, the one at A should tend to remain with the plane.

g Influence of the Local Wind. Vortices, although regarded as having their axes in some particular location, are usually con-

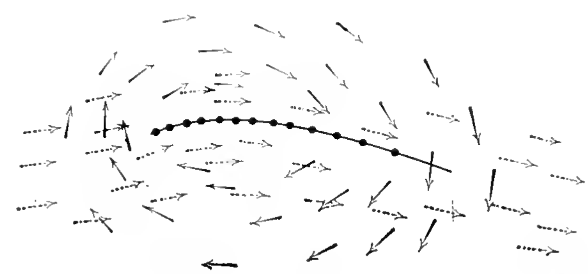


FIG. 3 DIAGRAM ILLUSTRATING HYDRODYNAMIC-ELECTROMAGNETIC THEORY

sidered as having an influence through the fluid in which they exist, just as the magnetic effect of a direct current is considered as having an effect at remote distances. It is interesting to calculate the effect of this influence on a wing of short span. Such a wing in horizontal flight does not act as if encountering a horizontal onrush of the atmosphere. It acts as if there were a downward component of motion in the air around the wing, of very much the same amount that might be calculated from the strength of its own trailing vortices. This is manifest in a relatively poor lift, as if something were reducing the angle of attack, and in a greater resistance as if climbing up through a descending wind.

h Laws of Energy Content in Trailing Vortex. Mathematically it would appear to be as easy to calculate the energy of vortex-motion lift in the wake of an airplane as it is to calculate electrical self-inductance. The arrangement of trailing vortices behind an airplane evidently depends considerably on the distribution of the loading along the wing span, because a wing can terminate in effect considerably short of the actual tip by an easing up of the lift. Calculations concerning the best arrangements would be interesting. The writer has made some approximate computations by assuming the trailing vortices to be a group of parallel columnar vortices: a sort of vortex sheet constituting the wake of the wing. This method of calculation applied to a monoplane gives the usual values of the lift-drag ratio when friction is taken into account.

i Friction and Head Resistance. In a practical way friction is a very large item and it would be very interesting to have separate tests for the friction losses of wings. For example, tests might be made of the resistance of a hoop or endless ring having the cross-section of a good wing.

j Explosion of Eddies. Frequently the low pressure at the center of a vortex or eddy in real air appears to be penetrated by a rush of air along the axis. Knowledge about this, especially with reference to the effect, cause and control of such disturbances in the wake of wings, would be interesting.

DISCUSSION

JOHN R. FREEMAN[1] (written). The writer is hardly competent to discuss Mr. Durfee's paper in the language and symbols of mathematics, but a possible line of investigation of these phenomena occurs to him which may perhaps be useful.

[1] "Almost exactly," because the diagram contains an almost imperceptible allowance for the termination of the sustaining vortices within the lengths of the wing span and for the influence of their rearward extensions as trailing vortices.

[1] President, Manufacturers Mutual Fire Insurance Co., Providence, R. I. Past-Pres. Am.Soc.M.E.

About ten years ago when members of our Society were guests at a meeting in England of the Institute of Mechanical Engineers, the eminent mathematician, Dr. Hele-Shaw, presented an illustrated discussion on stream-line problems in air currents relating to airplanes, in which he showed the disturbing effect upon the streamline of models designed to represent various forms of wings. The fluid in that case was a liquid and the stream lines were represented by ingeniously colored liquid filaments. The investigation was along lines of previous investigations of the distribution of velocities in flowing liquids containing colored liquid threads which showed the eddy currents caused by such obstructions as bridge piers.

At that time it seemed to the writer that the difference in compressibility of air and water, and also the difference in inertia effect, impaired the analogy, and on further thought he laid out a line of experiments for tracing the motion of liquids around obstructions in channels by a combination of methods borrowed from the ultra-microscope and the moving-picture machine, although he has never found time to carry out the experiments. This method seems admirably adapted to experiments on air currents in connection with airplanes.

The method in brief is to make an optical cross-section in any desired plane by means of a thin, broad beam of intense light put into appropriate shape and parallel rays by proper condensing lenses and an optical slit, analogous to that used with the ultra-microscope. By means of dust particles of proper density introduced in the air current, one can render visible the direction and velocity of the currents set up somewhat as he sees the air currents in his living rooms made evident by a sunbeam acting upon the suspended dust particles.

The narrow slit of light reveals only the motions in one plane and simplifies the observation by rendering the particles visible only while traveling in this optical plane.

In the case of the airplane, these motions would mostly be too rapid for the eye to follow, but within limits it is possible to observe them and to record them by a motion-picture apparatus which can be so constructed as to make 30 or 50 exposures per second instead of the customary 16. It is indeed possible to obtain exposures of much shorter frequency by means analogous to the shutter-testing device developed in Dr. Mees' Research Laboratory at Kodak Park, in which a rapidly revolving polygon of mirrors serves to catch and record the fleeting image. Also there have been devised and patented means of revolving polygonal prisms of glass, so adjusted that their reaction holds the image approximately stationary on the screen or film for the fraction of a second.

Such a series of photographs recorded in a short reel of film can be rotated for purposes of study at a much slower speed than that at which they were taken.

By these means the writer believes the actual pathway of the particles of air as they pass either wing plane or propeller can be made evident and precisely recorded at velocities far higher than can be observed in any other known way, and a series of optical sections, analogous to those of the ultra-microscope or the sunbeam, will simplify the hopeless complexity of a dense mass of particles traveling in various directions.

EDWARD P. WARNER[1] (written). It is manifest that any considerable development of the theory of wing action beyond the point already reached must be conditional on the use of new and more powerful and logical methods of attack. In most of the work so far done, whether by the simple assumption of plane impact and reflection or by such more elaborate methods as that of Kirchhoff and Helmholtz, the continuity of the air has been ignored, and the results have consequently been far from the truth.

The work of Lanchester, Kutta, and others on a vortex theory of sustentation seems to offer the most promising path to an analysis of wing action which shall be of real practical use. It leads to the only method which takes due account of the fact that there can be no actual acquisition of downward momentum by the air as a whole, since the center of gravity of the atmosphere cannot shift, and any downward motion imparted to the air in the neighborhood of the wing must be counterbalanced by an equal upward motion imparted to an equal mass at some other point.

Promising as the vortex theory is, however, it should not be overrated. There are many factors in the action of wings for which it does not appear to account, and the mathematical weapons are not at hand for applying it, except in the simplest cases. The electromagnetic analogy proposed by Mr. Durfee is very interesting, but it must be handled with care, particularly in connection with thick wings, where the air flow changes from stream-line to turbulent types and back again with the greatest suddenness and in response to the minutest alterations of wing form or conditions of operation. It is doubtful if this analogy could be extended to any cases beyond those of the flat plate and the simplest forms of thin, cambered sections.

[1] Chief Physicist, National Advisory Committee for Aeronautics Research Laboratory, Langley Field, Hampton, Va. Jun. Am.Soc.M.E.

GEORGE DE BOTHEZAT[1] (written). The statement "*a*" of Mr. Durfee's paper constitutes in reality the well-known "Kutta theorem," discussed by Kutta himself (*Illustrirte Aeronautische Mitteilungen*, 1902; Sitzungsberichte der Königlichen Bayerischen Akademie der Wissenschaften, 1910 and 1911), by Joukowski (*Aérodynamique*, Paris, 1916) and by Dr. de Bothezat (Report No. 28, Note I, from Fourth Annual Report, National Advisory Committee for Aeronautics).

The statement "*c*" was first made by Lord Kelvin with reference to an example actually classical (the so-called atmosphere around a system of two rectilinear and parallel vortices rotating in inverse sense).

The statement "*d*" of the hydrodynamic-electromagnetic analogy is well known. But the suggestion to study the flow around an airfoil by this method is of interest, and such experiments conducted in a suitable manner could bring out valuable results.

A solution of the question proposed in statement "*e*" is directly obtained by the successive application of the Kutta theorem, Lord Kelvin theorem on the constancy of circulation, and the Stokes theorem connecting circulation with vortex intensity. (See Report No. 28 of the Fourth Annual.)

The statement "*g*" is not quite clear; if local wind means only the instantaneous value of the fluid velocity at a given point around the airfoil, it is only a regular conception.

The statements "*h*" and "*i*" demand very careful consideration, because it seems that in the case of hydrodynamic phenomena some special conditions may occur which we do not meet in electromagnetic phenomena.

F. W. CALDWELL[2] (written). This paper is very timely, particularly in view of the growing tendency among aeronautical engineers to regard the classical coefficients K_x and K_y as inadequate.

It has been almost universally the practice to write $L = \frac{\rho}{g} \times K_y S V^2$ and $D = \frac{\rho}{g} K_x S V^2$, where L is the lift, D the drag, S the area of the supporting surface, V the velocity of advance, ρ the density of the air in weight units, and g the acceleration due to gravity, hence $\frac{\rho}{g} =$ density of the air in slugs.

It is well known as the result of experience that the values of K_y and K_x vary somewhat with velocity and also with the size of the surface under consideration. If l represents one of the linear dimensions of the surface it is assumed that the values of K_y and K_x are functions of the product Vl. This is known as the scaling effect.

Information on the scaling effect is very meager. In the case of propeller sections we have been forced to make use of characteristics obtained at a speed of 30 miles per hour and apply them to conditions where the speed obtained is as great as

(*Continued on page 787*)

[1] Aerodynamical Expert, National Advisory Committee for Aeronautics, Washington, D. C.

[2] Aeronautical Engineer, 330 Edgewood Ave., Dayton, Ohio.

Fatigue Phenomena in Metals

A Report Summarizing the Available Facts and Theories Relating to Fatigue Failure and a Discussion of Some of the Unsolved Problems

METAL parts of machines, such as springs, shafts, crankpins and axles, occasionally fail suddenly while only subjected to conditions of ordinary service. Not only does failure occur suddenly, but the part about to fail shows no ordinary evidence of weakness. The broken parts when examined are seen to be broken off short, and without general distortion, even though the material may show high ductility in ordinary tests. Such failures are found only in parts subjected to stress repeated many times—to "vibration," as it is sometimes stated—and the phenomena which are involved in the final failure of metal through oft-repeated loading are known as "fatigue" phenomena of metals.

The phenomena of fatigue failure have recently given rise to some perplexing problems in connection with the design and service of airplane-engine crankshafts, the hulls of steel ships, axles and shafts in railway cars, motor cars and trucks, and other machine parts. The question whether structural parts subjected to repeated stress are in danger of fatigue failure has been discussed at considerable length. The danger of fatigue failure seems to be an unimportant factor in determining the safety of structural parts, with the possible exception of parts subjected to reversal of stress. The reason for this is probably found in the relatively small number of loadings which most structures are called upon to withstand, and in the fact that most of the loadings are below the maximum working value. On the other hand, the danger of fatigue failure is a major factor in determining the safety of many machine parts.

The problem of fatigue of metals engaged the attention of engineers seventy years ago, in connection with car axles and members of iron railway bridges. It was early recognized that high stress tends to cause, or at least to hasten, fatigue failure, and about 1860 Wöhler's famous investigations[1] were undertaken to determine the relation between intensity of fiber stress and the ability of materials to resist fatigue under repeated stress. Wöhler's tests occupied some eleven years, and remain to this day the most thorough tests on record. Wöhler investigated metals under direct tension, under bending, and under torsion (shear). For some of his tests the stress varied from zero to a maximum, and for others the stress was reversed. The results of Wöhler's tests may be summarized as follows:

1. A machine part or structural member may be ruptured by the repeated application of a load which produces a computed fiber stress less than the ultimate strength of the material as determined by a static test
2. The greater the range of stress, the lower the limiting fiber stress to insure against rupture after a very large number of repetitions
3. To insure against rupture after a very large number of repetitious of loading causing complete reversal of stress, the limiting fiber stress is but little greater than one-half the limiting fiber stress for a very large number of repetitions of stress varying from zero to a maximum.

Following Wöhler the famous Bauschinger[2] published a series of conclusions on fatigue, and various other investigators, notably Gerber,[3] and Weyrauch and Launhardt,[4] gave early interpretations of the experimental results of Wöhler and Bauschinger.

In these earlier experiments several facts seem noteworthy. The prime object of the investigators was to deduce laws of fatigue for railway bridges and car axles. The problem of fatigue in high-speed machine parts had not then appeared. These investigators carried their tests far enough to cover the number of repetitions required by the structures of their day and assumed that having done so they had established an endurance limit. Reading their conclusions carefully, the statement does not seem to be made that material which passed their tests would stand an *infinite* number of repetitions. The term generally used is "indefinite" or "very large," and the number corresponding is from ten to fifty millions. For the problem which they investigated their tests seem to give safe guides for practice, but today, with the advent of modern high-speed machinery, some parts of which must be as light as possible, and the extension of the fatigue problem to such members as the cranks and the connecting rods of gas engines and the shafts of steam turbines, the number of repetitions of stress which a machine member may be called upon to undergo is very much increased. This fact is illustrated by Table 1, which gives a statement of the approximate service required from various structural and machine members.

Investigations have been made in recent years by Howard,[5] Stanton,[6, 7, 8] Basquin,[9] Smith,[10] Eden, Rose and Cunningham,[11] Kommers,[12] Mason,[13] Moore and Seely,[14] and others. The efforts of these investigators have been directed toward the study of modern materials, refinements in methods of testing, and interpretation of results. The limits of actual tests have not been extended to modern requirements, and the problem still remains of obtaining test data for much longer endurance of fatigue than was contemplated by Wöhler. Under the most favorable conditions conceivable such data will be obtained very slowly, and meanwhile there must be faced the problem of determining safe stresses for very large numbers of repetitions by extrapolation from previous test results.

TABLE 1 APPROXIMATE SERVICE REQUIRED OF VARIOUS MEMBERS OF STRUCTURES AND MACHINES SUBJECTED TO REPEATED STRESS

Part of structure or machine	Approximate number of repetitions of stress in the "lifetime" of the structure or machine
Railroad bridge, chord members	2,000,000
Elevated-railroad structure, floor beams	40,000,000
Railroad rail, locomotive wheel loads	500,000
Railroad rail, car wheel loads	15,000,000
Airplane-engine crankshaft	18,000,000
Car axles	50,000,000
Automobile-engine crankshaft	120,000,000
Lineshafting in shops	360,000,000
Steam engine, piston rods, connecting rods and crankshafts	1,000,000,000
Steam-turbine shafts, bending stresses	15,000,000,000

Machines for Testing Fatigue Strength

Fatigue tests cannot readily be carried out with ordinary "static" testing machines. It is, of course, possible to repeat loadings on a test specimen in such a machine, but the process is very slow. Such a machine equipped with an ingenious auto-

---

A progress report of the Committee on Fatigue Phenomena in Metals, which is acting under the joint auspices of the Engineering Foundation and the Division of Engineering of the National Research Council. The society contributes toward a portion of the cost of this research and the report is presented to the membership through the Research Committee of the A. S. M. E., Prof. Arthur M. Greene, Jr., *Chairman*. The personnel of the Committee on Fatigue Phenomena is as follows:

H. F. Moore, *Chairman*, Research Professor of Engineering Materials, Engineering Experiment Station, University of Illnois, Urbana, Ill.

O. H. Basquin, Professor of Applied Mechanics, Northwestern University, Evanston, Ill.

Zay Jeffries, Director of Research, Lynite Laboratories, Aluminum Castings Co., Cleveland, Ohio.

T. R. Lawson, Professor of Rational and Technical Mechanics, Rensselaer Polytechnic Institute, Troy, N. Y.

J. H. Nelson, Engineer of Tests, Wyman-Gordon Co., Worcester, Mass.

W. E. Ruder, Research Department, General Electric Co., Schenectady, N. Y.

H. L. Whittemore, Chief, Section of Metal Testing, U. S. Bureau of Standards, Washington, D. C.

[1] For this and following references see page 738.

matic arrangement for applying and releasing load was used by Van Ornum[15] in fatigue tests of concrete in compression, but the time required for even a hundred thousand cycles of stress was very great.

A very simple repeated-stress testing machine acts by the application and removal of a weight to the end of the long arm of a simple or compound lever, the specimen carrying load at the short arm. Such a machine was used by Berry[16] in fatigue tests of concrete in compression. In a machine of this type the load must be applied slowly, else there will be inertia forces set up by the impact of the weight as it is let into place.

A common type of repeated-stress testing machine is one in which a calibrated set of springs resist the tensile, compressive, flexural, or torsional stress set up in the specimen, and the deformation of the calibrated set of springs gives a measure of the force or moment acting on the specimen. Fig. 1 diagrammatically illustrates this type of machine which was used by Wöhler and has since been used by many other experimenters. The Upton-Lewis machine is of this type and extensive use was made of

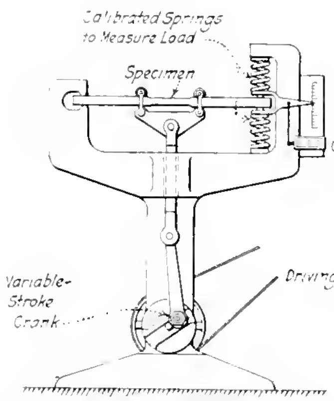


FIG. 1 A TYPE OF REPEATED-STRESS TESTING MACHINE

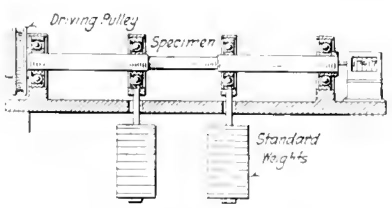


FIG. 2 TYPE OF MACHINE FOR DETERMINING REVERSE BENDING STRESSES

it in torsion tests carried on by McAdam.[17] This type of machine permits a fairly high rate of repetition of cycles of stress, and machines which have been run at 1000 repetitions per minute have given results apparently trustworthy.

The most common type of machine for reversed bending stresses uses a circular specimen acting as a rotating beam. This type was used by Wöhler, and also by many later investigators. Fig. 2 illustrates such a machine. The specimen is in the form of a bar of circular section, to which bending stress is applied by weights. The specimen is rotated by means of a pulley. At any instant the outer fibers are subjected to a stress varying from tension on one side to compression on the other, and the fiber stress at any point passes through a cycle of reversed stress during each revolution. As shown, the specimen is loaded at two symmetrical points of the span, and between these two points the extreme fiber stress is constant for each element along the bar. This type of machine permits high speed of reversal of stress, speeds up to 2000 r.p.m. having been successfully used.

British experimenters have used repeated-stress testing machines in which varying stress was applied to a specimen by means of the inertia of reciprocating parts. Fig. 3 shows such a machine, which can be used at high speeds. However, the speed must be very closely controlled, as the inertia forces vary with the square of the speed. Moreover, friction on the guides causes some slight uncertainty as to the magnitude of stress set up at each stroke of the crank.

A repeated-stress testing machine depending on centrifugal force to produce cycles of stress is shown in Fig. 4. It is evident that as the eccentric weights revolve the specimen will be placed alternately in tension and in compression. This machine has been used by J. H. Smith.[10] Its characteristics are much like those of the inertia type; in fact, it is a special form of inertia machine.

A type of machine used by Arnold and later by other experimenters is shown in Fig. 5. In this machine a specimen is repeatedly given a certain deflection. Usually this deflection is sufficiently large to stress the material well beyond the yield point, and no very definite stress can be computed. This machine is used mainly for short-time tests.

Another short-time-test machine uses the repeated impact of a small hammer. The claim is made that impact loading emphasizes local flaws better than a load which is more gradually applied, and that thus it *indirectly* gives a better index of fatigue strength. Data, however, are lacking to prove or disprove this claim.

Various repeated-stress testing machines have been constructed in which the cycles of stress were set up by the action of an electromagnet energized by alternating current. Usually the stress was measured either by the deflection of a spring or by the deformation of a standard test bar attached to the specimen. The speed of such a machine, however, is usually so high that there seems to be some uncertainty as to whether the successive waves of stress pass through the specimen without interference.

While the microscope can hardly be classified as a testing machine, it has, nevertheless, been of such vital importance in studying fatigue phenomena that it may well be mentioned in

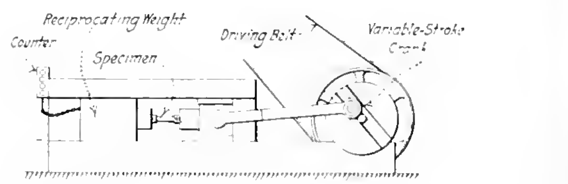


FIG. 3 BRITISH FORM OF REPEATED-STRESS TESTING MACHINE

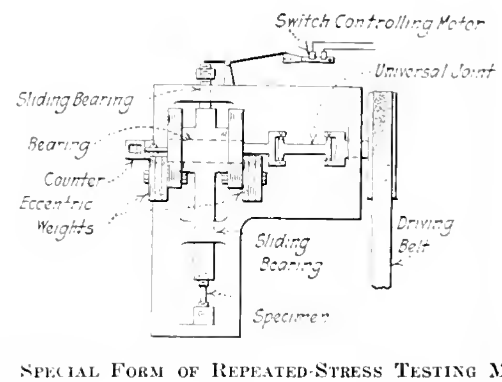


FIG. 4 SPECIAL FORM OF REPEATED-STRESS TESTING MACHINE

this place. Space will not permit of a detailed description of the methods employed in the microscopic examination of metals, but the process involves polishing a small area of the metal, etching the surface with some reagent to bring out the lines of the crystalline structure and examining and photographing the surface through a microscope, the surface of the metal being illuminated by means of a reflected light.

THE PHENOMENA OF FATIGUE FAILURE

A fatigue failure of a metal, whether it occurs in a test speci-

men or in a machine part, is characterized by suddenness, lack of warning, apparent brittleness of material, and, in many cases, a fracture with a crystalline appearance over a part of its surface.

This crystalline appearance led to the old theory that under repeated stress metal "crystallized," changing from a ductile "fibrous" structure to a brittle "crystalline" one. This theory, however, has been quite thoroughly demolished as a result of study of the structure of steel under the microscope. As revealed by the microscope the structure of all metals used for structures and machines is crystalline, any "fibrous" structure being caused by inclusions of non-metallic impurities (for example, slag in wrought iron). Microscopic examination of metals under stress shows no change of the general scheme of internal structure, but under sufficiently heavy stress there appears gradual breakdown of the crystals in the structure.

When a ductile metal is deformed cold, the first deformation occurs in the particular grains which either take the most stress or have the lowest elastic limit. Deformation takes place by the slipping of one portion of the grain with reference to other portions. This slipping is shown by the appearance of lines called "slip bands" or "slip lines" extending across crystals and indicating planes of cleavage, as shown in Fig. 6. As the load is increased deformation proceeds and other slip bands are formed, the law being that the most easily deformable grains first show slip bands. Gradually the most favorable planes of slip are exhausted, and further slippage can take place only with the addition of more load.

The failure in ductile metals subjected to repeated stress takes place with substantially no general deformation There is, however, considerable local deformation over microscopic areas, evidenced by the appearance of many slip bands on a polished surface of the metal after the application of repeated stress. These slip bands appear after a small number of reversals of stress with relatively large loads, and may not appear at all with slight loads. The slip bands may first appear either in the interior of a grain or at the grain boundary. As the number of applications of stress increases more slip bands appear, and those first appearing usually lengthen and widen. Under the microscope and with normal illumination the general surface becomes blacker as the number and width of the slip bands increase. In ductile metals fatigue failure is almost exclusively through the grains themselves rather than at the grain boundaries, and the first slip bands to appear do not necessarily form a part of the final path of rupture. Failure seems to take place by the uniting of slip bands into cracks. When the first grain develops a crack extending across its entire width, added stress promotes the extension of this crack into adjacent grains on both sides, although the orientations of these grains may be and usually are such that the crack must extend itself at an angle to that in the initial grain. The general tendency is for these slip bands to follow the lines of cleavage of the particular grain in which they occur. Often incipient fracture is found in many grains adjacent to the final path of rupture, indicating that had rupture not taken place where it did, it would have soon taken place in some other adjacent part.

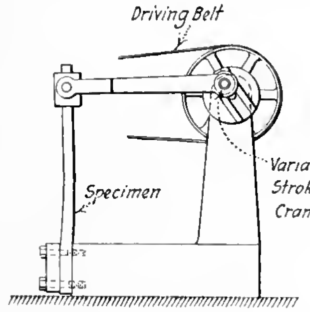


FIG. 5 SHORT-TIME REPEATED-STRESS TESTING MACHINE

Such observations by means of the microscope indicate that *localized deformation* is the primary cause of fatigue failure in ductile metals, but it does not necessarily follow that the formation of one slip band under repeated stress will indicate eventual fracture if the loading is continued; one grain may appear to have a greatly reduced elastic limit because of internal strains or peculiarly unfavorable orientation. It is not certain that there is a limiting load below which fatigue failure will never take place.

Materials classified as brittle have very little permanent deformation under static stress, and under repeated stress the progressive fracture of brittle material might take place, not by slipping within crystals, but by tensile fracture of crystals. There has been practically no study made of the fracture of brittle materials under repeated stress, and it would be instructive to have tests carried out on brittle amorphous materials such as fused silica and on brittle crystalline materials like marble or tungsten. It is gradually being recognized that the breaking load of a specimen is a complex matter, and depends, among other things, on the time of application of the load. Mere duration of static loading, however, does not have an effect at all comparable with repetition of loading in reducing the breaking load. It seems evident that the distribution of stress in some brittle materials is very much less uniform than in ductile materials, and that fractures in brittle materials start on areas of high stress, whereas in ductile materials the high stresses are relieved by local yielding. A more complete understanding of the mechanism of rupture in brittle materials would doubtless be of great value.

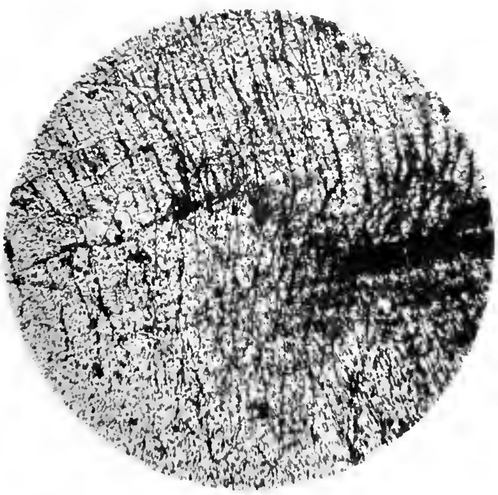


FIG. 6 APPEARANCE OF "SLIP BANDS" INDICATING PLANES OF CLEAVAGE

When the action of metal under repeated stress is considered from the viewpoint of the internal strains and accompanying stresses in the material, a radical difference is seen in the behavior of material under static load and under repeated load. In a general way we may consider any structural or machine part as subjected to static conditions if the load on it is applied gradually and is not repeated more than a few hundred times; the part may be considered as subjected to fatigue if the load on it is applied, say, one hundred thousand times or more; and for intermediate conditions of loading the phenomena characteristic of both kinds of loading would be present.

We must look upon steel as filled with a multitude of minute flaws. These flaws are developed in the solidification of the material. In static testing, steel under stress of about half its ultimate strength passes into a semi-plastic condition, in which there is a gradual flow of the material. Under such conditions the small flaws have almost no effect upon the flow or upon the static strength. When steel is loaded to moderate stresses the yielding is almost entirely elastic, but in general a small portion of it is inelastic, energy being taken up by the steel itself. If the specimen can be loaded a great number of times without heat loss its temperature will increase. If it is set vibrating in a chamber free from air it will stop vibrating in a short time, due to the absorp-

tion of energy. In such cases the stress-strain curve appears to be straight and the curve for the removal of the load may be practically identical with that for the application of load, but still these other effects show loss of energy in the steel itself.

This loss of energy is doubtless due to small displacements at these flaws, which are not reversible. Under alternate loadings these displacements are made back and forth. Energy is continuously being absorbed in the location of these small flaws, and it is perfectly natural that they should increase in size. We must look upon these extensions of the flaws as occurring in a great many parts of the steel. If the stresses are small the increase in size of these flaws is practically negligible, but if the stresses are larger the increase is rapid, and later on in the history of the piece under test, very rapid, and finally the strength of the piece is terminated when a sufficient number of these flaws have connected so as to form an area of very great weakness.

For static loads all the above is of little consequence with a ductile metal; but it is of consequence in the case of a brittle metal like cast iron, which has a remarkably low strength in tension in comparison with its compressive strength. Ductile metals may be considered as having a very high value for cohesion with a rather low coefficient of friction—or whatever corresponds to that—so that these metals begin to slide on diagonal planes without actual fracture under high local stress.

When a ductile material is loaded it may be subjected to stresses whose average values for small areas are not very different for parts that are a tenth of an inch apart; but there is a multitude of tiny spots whose fiber stresses are 2, 3, 4 or 10 times the average value.[23, 24, 25] This holds so long as elastic conditions obtain. As the applied stress increases some of these stresses increase in like ratio, but not in like increments. At moderate applied stresses these special stresses reach inelastic conditions and slipping occurs. If the average stress is now entirely removed, we may assume that the unloading takes place in a similar manner. The small spots unload first in an elastic manner, but at a different rate than the remainder of the material. They will unload approximately at the same rates as they used in taking stress, namely, 2, 3, 4 or 10 times the normal rate. For the unloading they have about twice the range of stress that they had in the loading before inelastic action is set up. Some of them will reach the opposite limit and slip part way back again, while some of them may not be subject to this return slip of inelastic action, but will retain in the unloaded state a stress distribution of the opposite kind. Either of these actions will give rise to hysteresis and to slight change of dimensions, usually, however, too small to be detected.

In all of the foregoing the main parts of the material have not been subjected to stresses which give inelastic action. If the loading is repeated without reversal, the spots that slipped on the first unloading will be subjected to further slipping both on loading and on unloading, but the areas that suffered no slipping on the first unloading should show no further inelastic action unless the loading is reversed. If the loading is reversed, however, all the particles that slipped in the first loading will slip on the reverse loading, so that with repetition a larger number of spots undergo this slipping action than is the case with loading which is not reversed. This explains the shorter life under reversed stress than under repeated stresses in one direction only.

If the fractured surface of a "rotating beam" specimen made of ductile metal and broken by repeated stress is examined, it is usually seen to be made up of two parts: (1) near the extreme fibers there is a dark surface with a dull, lusterless appearance, while (2) the remainder of the surface has a bright crystalline fracture. If these are examined more carefully it is found that their principal difference is in the size of the small flat surfaces that constitute the fracture. The center portion of the area has comparatively large surfaces, giving a crystalline effect, while the dull gray portion has very small surfaces of fracture.

An explanation of this is that the flaws in the outer portion of the surface have connected to form an annulus, whose rugged face is roughly at right angles to the axis of rotation. This has doubtless occurred slowly, and has started from many centers, thus giving the rough face. After this slow growth of flaws into an annular fracture has been accomplished the specimen has become very weak and the stresses have become so large at the fracture that they suddenly tear the metal in two on the natural surfaces of cleavage of the crystal grains.

The center portion of this fractured surface does not differ from the crystalline surface at the bottom of a cup in an ordinary static tension fracture, except that the crystalline surfaces are somewhat larger. This is to be explained by the fact that in an ordinary tensile test the material at the fracture has elongated something like 100 per cent, so that the crystal grains have become of smaller cross-section and will naturally show smaller facets on fracture, whereas, in a fracture of the endurance specimen, the material has had no chance to elongate and the crystalline grains have their normal size, which will be shown in fracture. It is not the crystalline portion of the broken specimen which has failed primarily by repeated stress, but the dull portion. In the crystalline part of the fatigue fracture and in the crystalline part of the static tension fracture the failure seems to be of the same nature, namely, a failure in cohesion.

In considering the phenomena of fatigue failure it may be well to call attention to the fact that there is an intermediate type of failure of ductile material in which both plastic action and the development and spread of microscopic flaws are present. Such failures sometimes occur in staybolts, boiler sheets between rivet holes, and other parts occasionally subjected to very severe local distortion.

Localized Stresses Under Static Loading and Under Impact Loading

When a machine member or structural part is loaded gradually a state of strain and accompanying stress is set up throughout it. In a general way the distribution of stress is similar to that given by the theory of elastic action which serves as a basis of our formulæ for computing stress and strain. There are, however, many deviations from this distribution due to non-homogeneity of the material and to irregularities in outline such as projecting corners, scratches and tool marks. When load is applied the general behavior of the piece as indicated by careful measurements of stretch, compression, twist, or flexure conforms to that required by the common theory of elastic action, but there are doubtless many localized strains which cannot be detected, even by the use of delicate micrometer measurements. It is to be recalled that in measuring strains it is necessary to use a gage line of considerable length, with the result that the observed strain is an average value along a relatively long line. The localized stresses, corresponding to these undetected localized strains, are not of any great importance under static load. When the load is increased to such an extent that a considerable portion of the piece is stressed beyond the elastic limit, the distortion of the piece increases abnormally and the piece may be considered to have reached its yield point. After this limit is passed the distribution of stress is much modified, and for parts made of ductile material the abnormal distortion at the yield point usually gives warning of structural damage before complete failure occurs.

Under impact loading, which is merely loading applied in a very short space of time, the action is somewhat similar to that under static loading, except that ductile material may offer a higher resistance to very rapid fracture than it does to fracture occurring gradually through a period of several minutes. Impact fracture, moreover, may emphasize somewhat the localized stresses set up at places where the structure of the material is non-homogeneous, or at places where there are sharp notches or deep scratches in the surface of the piece. Under slowly applied load there is opportunity for considerable adjustment and equalization of stress after the yield point is passed; under impact load there is probably less equalization on account of the rapidity of the action, and hence the localized stresses are higher and more effective in causing failure. This explanation of the action under impact is given here because repeated stresses also emphasize the effect of high localized stress, though for an entirely different reason.

Tests and Criteria for Fatigue Strength

It was formerly the common opinion that the determination of the elastic limit of a material by means of a static test in a testing machine gave a reliable test for the fatigue-resisting qualities of the material, and that the material could withstand an infinite number of repetitions of stress lower than this elastic limit. Tests at various laboratories, however, have quite thoroughly disproved this idea, and have thrown grave doubts on the reliability of the elastic limit as an index of fatigue strength. The term "elastic limit" has always been rather loosely used, and covers several quite different stresses.[18] The value determined for the elastic limit for any material depends on the sensitiveness of instruments used and the accuracy of plotting results, and the elastic limit as determined by such a test in a testing machine is determined by the average behavior of the material over a considerable length, while the process of fatigue failure may be going on over a section so small that it does not appreciably affect the readings of the measuring instruments used. In several laboratories comparative repeated-stress tests of different materials have shown higher fatigue resistance for the material with the lower elastic limit.[19, 20, 27]

Bauschinger in his classic experiments showed that the elastic limits in tension and compression as determined by ordinary testing-machine tests were variable limits, their value depending on the treatment of the material during fabrication. He called such limits "primitive" elastic limits, and showed that when a specimen is subjected to gradually increasing range of alternating stress there are soon set up two elastic limits in the bar—one in tension and one in compression. He called these limits, which may have values widely different from the "primitive" elastic limit, the "natural" elastic limits, and the range between them the "elastic range." He also showed that a test specimen will stand several million repetitions of this elastic range of stress without failure, and proposed the "natural" elastic limits as indices of the fatigue-resisting strength of the material. J. H. Smith[10] has developed a somewhat simplified process of determining the elastic range. This elastic range seems a more reliable index of fatigue strength than the ordinary "primitive" elastic limit, but the reliability of indices of fatigue strength based on determinations of any elastic limit by testing-machine tests is open to question on account of the possibility that localized fatigue failure may be in progress without affecting the readings of the instruments used in static tests.

Wöhler used as an index of fatigue strength the "endurance limit" of material as determined from a series of fatigue tests with different intensities of stress. He used the method of plotting values of stress (S) against numbers of repetitions required for fracture (N) and determining by eye where this S-N curve became "practically horizontal." Other investigators have plotted values of S against values of $1/N$ or of $(1/N)^n$ and by extending the diagram till it intersected the axis of ordinates have determined an assumed endurance limit for an infinite number of repetitions of stress. Both of these methods involve enormous extrapolation of test data. Moreover, widely different endurance limits can be determined from the same test data by different methods of plotting values.[14] The tendency to irregularity of test results under low stresses makes the decision whether the S-N curve is horizontal or slightly sloping downward one of very considerable uncertainty.

It has been proposed by various experimenters to compare the fatigue-resisting qualities of different metals by short-time tests with stresses well beyond the yield point of the material. Such tests are quickly and easily made. Under such stresses, however, the action of the material is partly a plastic flow. Such tests give good promise of determining fatigue strength and toughness under occasional overload for parts such as staybolts, which in their ordinary service are subjected to rather severe distortion, but it is not at all certain that such tests give a reliable index of resistance of machine parts under ordinary working stresses.[20]

It has been proposed by various laboratories to compare the fatigue strengths of various materials by comparing their life under repetitions or reversals of some standard stress, usually less than the elastic limit of the material as determined by a static test. A somewhat similar standard proposed is to determine the stress which will cause failure under a given number of reversals. Standard stresses proposed for steel are 38,000 lb. per sq. in. (reversal) and 25,000 lb. per sq. in. (reversal). One million reversals has been proposed as a standard "life." These two types of test approach working conditions more closely than do the short-time, high-stress tests described above. However, they determine only one point on a S-N diagram for a material and do not indicate how fatigue endurance changes with change of stress.

A comparative study of fatigue strengths of various materials can be made from a S-N diagram plotted on logarithmic paper. Up to about 1,000,000 repetitions of stress logarithmic S-N diagrams fall quite closely along straight lines, and from the ordinates and slopes of these lines the behavior of materials under various intensities of stress can be studied. Tests may conveniently be made with stresses at about the yield point of the material, at stresses about 20 per cent lower, and at one or two intermediate stresses.

Various other possible tests have been proposed for determining the fatigue-resisting strength of a material, but no test has been proved to be of sufficient reliability to be accepted as a standard. A number of tests, however, seem worthy of experimental study.

The rate of dying out of vibrations in a "tuning fork" specimen of the material has been suggested as a possible index of fatigue strength.[21] It is assumed that the gradual dying out of vibration is due largely to loss of energy spent in inelastic action in the material, and that such inelastic action is a measure of the fatigue weakness of the material. Test data are lacking to determine the value of this test, but it seems worthy of study.

Tests of magnetic permeability have also been proposed to locate internal flaws in the material and thus indicate its relative fatigue strength. The entire subject of the correlation of the magnetic and the mechanical properties of iron and steel is a promising field of investigation.[28]

The rise of temperature under repeated stress has likewise been proposed as a measure of fatigue resistance.[22] Theoretically, if a specimen is subjected to reversed elastic stress no change in temperature should take place, and it has been proposed to determine the endurance limit for metals at that stress which causes the first noticeable rise in temperature after some thousand or more reversals. A practical difficulty in using this test is to secure proper heat insulation for the specimen. This test seems worthy of study, however, especially if employed in an inertia type of testing machine (see Figs. 3 and 4).

The detection of the appearance and growth of "slip lines" in a specimen subjected to repeated stress gives some promise of furnishing a reliable test for fatigue strength. Slip lines appear long before fracture occurs, and if their appearance or the rate of their spread can be shown to be an index of fatigue strength it seems possible that a feasible laboratory test may be devised. The search for slip lines over any considerable area would, however, be very tedious.

Impact tests, usually on notched bars in bending, have been proposed as an index of fatigue strength. The actions under impact failure and under repeated stress are very different, the first giving a sudden break of the entire cross-section of the specimen, and the second a gradually developing fracture. Both failures, however, seem to be affected by localized flaws or irregularities in outline, and though no definite correlation between fatigue strength and strength to resist impact has been established, yet such tests are worthy of study. Repeated-impact tests have also been proposed to determine fatigue strength, but whether such tests have any advantage over short-time tests under non-impact loads is not known.

In all tests to determine fatigue strength it is of the highest importance to secure uniformity of surface finish between the different specimens to be compared. Probably this can best be done by polishing the surface of the specimens where failure is expected.

There is today no short-time test accepted as a standard test

for fatigue strength; but the development of such a test, and the establishment of its reliability, would unquestionably be of very great service to testing engineers.

Localized Stress and Its Influence in Producing Fatigue

The ordinary formulæ and methods of analysis used in computing the fiber stress in a machine part or structural member are based on the assumption that the material is homogeneous throughout, and that the cross-section of the member is either constant or that it changes its dimensions so regularly and gradually that there is no appreciable localized fiber stress at sections of rapid change. For structures and machines of ductile material subjected to not more than a few hundred loadings, such assumptions are reliable, because localized stresses do not appreciably affect the general deformation of a member, nor do they under ordinary working conditions cause trouble before the member has been subjected to some thousand or more repetitions of load. For nearly all parts, however, high localized stresses are present. Internal flaws may cause such localized stresses. This is shown by mathematical analysis of stress in plates with holes in them[23] and by direct experiment on such plates.[24, 25] External irregularities of outline may cause localized stress. Under bending or twisting a member with a sharp reëntrant angle in its outline theoretically develops an infinite stress at the root of the angle,[29] and actually both mathematical analysis and direct experiment show that very high localized stress may be caused by sharp grooves or scratches on the surface of a machine part or structural member.

It has been stated above that for parts subjected to a few loadings localized stresses are not of great significance. The case is quite different, however, for parts subjected to thousands of loadings. High localized stress may cause a crack to start, either directly or by "cold-working" the material where the localized stress exists until the material becomes brittle. This crack forms an extension of the discontinuity of the material which caused it, and under repeated stress tends to spread still more rapidly. This tendency is illustrated by the action of a piece of plate glass in which a crack has started. In most cases under any repetition of load the crack spreads, and will cause final fracture of the glass. A fatigue failure under repeated stress is a progressive failure. This spreading of cracks to cause failure explains why under fatigue even ductile materials snap short off. Failure does not involve plastic flow of considerable masses of metal, but only of microscopic masses near the crack, and final fracture comes suddenly just as if the member were cut half off by means of a saw cut and then bent. The importance of avoiding localized high stress in members subjected to repeated stress can hardly be overemphasized. Homogeneity of internal structure, smoothness of external surface, and avoidance of sudden changes of cross-section may be more important in the construction of machine parts subjected to repeated stress than is high static strength of material.

Shoulders of crankshafts and of axles, keyways in shafts, screw threads, and rivet holes are examples of locations where high localized stress is liable to occur.

Relation Between Microscopic Structure and Fatigue

A very large field of investigation and one in which very little systematic work has been done is the study by means of the microscope of fatigue failures in various characteristic structures of metals, especially steels. The following paragraphs are given as a summary of the theory held by present-day metallographists of the relation of microstructure of metal to its fatigue strength. Many of the details of this theory, however, lack adequate experimental verification.

Annealed steel consisting of ferrite (pure iron) and cementite (iron carbide, Fe_3C) seems to increase in resistance to fatigue with the increase in carbon content, especially when the cementite is present in the form of plates as in lamellar pearlite and as long as the cementite does not surround the grains of pearlite.[27] When the cementite is spheroidized, the elastic limit is greatly decreased and probably the resistance to fatigue is also decreased. As a structural material, therefore, a steel with considerable carbon in the form of spherical globules of iron carbide would have practically no advantages over wrought iron. When, however, the iron carbide is in plates it seems to have a marked effect in raising the elastic limit, and probably increases the resistance to fatigue. We would also expect that complete and large networks of ferrite would lower fatigue resistance.

The same arguments regarding grain size of single constituent metals hold to a certain extent for two component alloys. For example, such experimental evidence as is available indicates that the sorbitic structure in steel is the one which resists fatigue best. This structure is supposed to represent an extreme refinement of grain in which the particles of iron carbide are very small, and hence the particles of ferrite must also be very small. It is true that some of the iron carbide may be in solution in the iron, but it is more probable that the mechanical properties observed can be accounted for by an extreme reduction in the size and by the dispersion of ferrite and cementite particles. When these globules are made larger by heating to a higher temperature than that at which the sorbite was formed, granular pearlite results with reduced fatigue resistance.

When a high-carbon steel is quenched from above the critical range to form martensite, the metal becomes extremely brittle. The normal path of static rupture in brittle martensite is at the old austenite (solid solution of Fe_3C in gamma iron) grain boundaries. The path of rupture in fatigue has, so far as is known, not been ascertained. From certain tests on the resistance to fatigue of chrome-vanadium steel after various heat treatments, Dr. C. M. Olmstead, of the C. M. O. Physical Laboratories, Buffalo, found that the steel in the martensitic state, that is, as quenched, had a very much lower resistance to fatigue than after reheating to about 1100 deg. fahr. The maximum resistance to fatigue occurred by quenching and reheating to 1000-1200 deg. fahr. (538-648 deg. cent.), and there was very little difference between the specimens tempered at 1000 deg. and at 1200 deg. There was a marked difference, however, between these and the samples tempered at lower temperatures or those not tempered at all. This is the heat treatment that is commonly given to automobile parts which must withstand fatigue stresses, and which may be subjected to shock. The tempering of springs is done at a little lower temperature, but it is not certain that the spring structure is the one having the highest resistance to continued repetition of stresses.

It seems from the above that martensite is not a suitable material to withstand fatigue stresses, and that some intermediate structure between martensite and the annealed or normalized structure will have the maximum resistance to fatigue. This structure is called the sorbitic structure and corresponds to that used in automobile springs and other parts of automobiles which must resist fatigue and shock stresses.

Formulæ for Designing Parts Subjected to Repeated Stress

All formulæ which have been proposed for designing parts subjected to repeated stress depend upon extrapolation from test results and should therefore be regarded as tentative. Their use is justified only on the ground of necessity. Parts must be designed to resist repeated stress, and even formulæ derived from a confessedly inadequate experimental basis seem better than mere guesswork. Two types of formula have been used.[30]

In many discussions of data of repeated-stress tests, it is assumed that there exists some definite "endurance limit," that is, some stress, greater than zero, which can be repeated an infinite number of times without causing failure of the material. If such a limit exists it is certainly lower than the elastic limit of the material as determined by static tests, for actual failures of materials have occurred under repeated nominal stresses as low as one-quarter of the elastic limit as determined by a static test. Examination of test data indicates that the endurance limit is an assumption rather than a proved fact. It is usually determined by plotting a diagram with stresses as ordinates and number of

repetitions producing failure as abscissæ and estimating the stress for which the diagram seems to become horizontal. Various other methods have been proposed, but all involve this assumption.[14]

In 1910 a paper [9] presented before the American Society for Testing Materials pointed out that an examination of the results of numerous series of repeated-stress tests indicates that for nearly all the range covered the law of resistance to repeated stress may be expressed by the equation:

$$S = KN^{-m} \dots\dots\dots\dots\dots [1]$$

in which S is the maximum unit stress developed in the test piece, N the number of repetitions of stress necessary to cause failure, and K and m are constants depending on the material and somewhat on the manner of making the test. This is known as the "exponential equation for repeated stress."

Another form of expression for the above equation, and frequently more convenient, is:

$$\log S = \log K - m \log N \dots\dots\dots\dots [2]$$

If the logarithms of S and N are plotted, or if the values of S and N are plotted on logarithmic cross-section paper, Equation [2] is represented by a straight line. Fig. 7 shows the S-N diagram given by a series of repeated-stress tests. In Fig. 7*a* ordinary coördinates are used, but in Fig. 7*b* the coördinates are logarithmic. For large values of N the exponential equation gives in many cases values of S smaller than the observed values; in other words, the exponential formula seems to err on the side of safety.

It will be noted that the use of the exponential formula involves the assumption that any stress if repeated often enough will eventually produce failure of the material. Thus while both the endurance limit and the exponential formula are based on extrapolation from known data, the exponential formula seems to be an assumption on the safe side. The working stresses as developed by the two methods do not differ greatly except for members subject to more than ten million repetitions of stress. Above that number the exponential formula requires lower working stress, but even then the stresses given by the exponential formula are not impracticably low.

While nothing but tentative formulæ can be proposed now,[30] some features which a satisfactory formula for fatigue strength should include may be noted. It is probable that such a formula for any material will not depend on ordinary static qualities of the material such as elastic limit or tensile strength. It may depend on some form of elastic limit determined after the material has been put in a "cyclic" or "normalized" state by a number of reversals of stress. Such a formula will quite probably contain factors dependent on the surface finish of the part and upon the uniformity and regularity of its crystalline structure. It will contain a factor dependent on the range of stress during a cycle. Such a formula may contain a factor dependent on the probable number of repetitions of stress which the part may be expected to withstand during a normal period of service, or the result may be an "endurance limit"—a stress which the part is capable of withstanding so many times that even for modern high-speed machinery the number of repetitions may be regarded as infinite.

Special Subjects Needing Investigation

Long-Time, Low-Stress Fatigue Tests of Metals. It is not known today whether machine or structural parts can withstand an infinite number of repetitions of any stress, however small. It is not known what share of blame for the occasional failures of test specimens or of actual parts in service under low nominal stress should be attributed to weaknesses in the metal structure: to localized damage to the surface with resulting increase of localized stress over nominal stress, or to "harmonies" of high stress due to interference of waves of stress traveling through the part. There should be undertaken an extensive series of long-time, low-stress tests on typical irons, steels, and other metals. It is doubtful whether any series of tests can settle the question of the existence of an endurance limit, but a considerable amount of test data for endurances up to, say, 100,000,000 repetitions will give a better basis for working formulæ than is now available.

Study and Comparison of Different Testing Machines for Fatigue Tests. Different testing machines for determining fatigue-resisting qualities do not always give consistent results. A series of tests of samples of several typical metals run on various testing machines should give some indications of the reliability of various types of testing machines and perhaps enable correlation to be made between tests on different machines. For all series of fatigue tests careful chemical and microscopic tests of the material should be made to insure uniformity both of chemical content and of structure. Careful tension, compression, and torsion tests should also be made so as to insure uniformity of static strength qualities, and to give data for the study of correlation between static strength and fatigue strength. Short-time, high-strain, repeated-stress tests and impact tests should likewise be made to give data for the study of correlation between toughness, impact resistance and fatigue strength. All test specimens should be prepared with great care and surface conditions be kept as uniform as possible. It appears that this uniformity could be best secured by giving the surface a high polish.

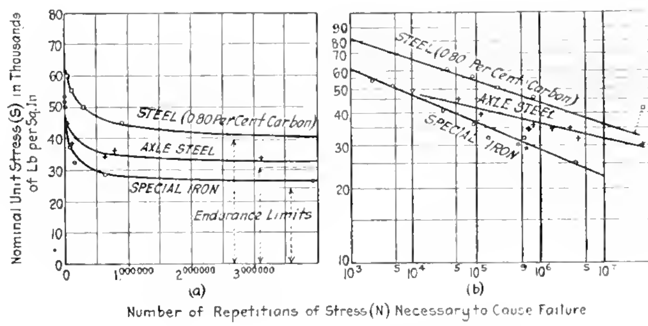


FIG. 7 STRESS-STRAIN DIAGRAMS

Relative Importance of Surface Condition and Structural Characteristics as Shown by the Microscope. It seems practically certain that fatigue fractures may be started either at a surface imperfection or at an internal flaw, such as a "snowflake" or a "transverse fissure." The importance of these two types of defect might well be the object of experimental study. In connection with such a study there should be a study of methods of detecting internal flaws, such as deep etching [31], and a study of methods of indicating the degree of perfection of surface finish.

Effect of Grain Size of Metal on Fatigue Strength. On this subject Rosenhain [26] says:

> The question then arises whether the increased size of crystals produced in a simple metal by prolonged heating is injurious or otherwise, so far as the useful properties, and more especially the mechanical properties, of the metal are concerned. There can be little doubt that within reasonable limits the mechanical properties of a simple metal are better the smaller the constituent crystals of which it is built up. Under the tensile test, coarseness of structure usually results only in a slightly lowered yield point, while the ultimate stress and the elongation are little impaired, although the reduction of area at fracture is sometimes markedly less. On the other hand, under both shock and fatigue tests, a coarse structure, even in a simple metal, gives unsatisfactory results.

Tests and service records quoted by Jeffries and by Ruder tend to confirm this opinion in the case of copper. Fine-grained copper is very much more resistant to repeated stresses than coarse-grained copper. Also if the elastic limit of fine-grained metals is determined by delicate instruments, it is generally found to be greater than that of the same metals in the coarse-grained state. Systematic tests should give us a firmer basis for conclusions in this important phase of fatigue phenomena.

There have been found no records of microscopic analyses dealing with the path of rupture under repeated stress in steels having various structures from martensite to the normalized state. A study of the path of rupture and the manner of rupture in these samples would be most interesting.

Development of Special Tests for Fatigue Strength. At present there is no short-time test for fatigue strength which has been proved to give reliable results. Some tests which give promise of usefulness are:

1 The Rise-of-Temperature Test used by Mr. Stromeyer.[22] In this test the highest reversed stress which a specimen can stand without appreciable rise of temperature is taken as an index of fatigue strength.

2 The Development of "Mechanical Hysteresis." If a fatigue failure is in progress in metal subjected to repeated stress, very small amounts of energy are lost during every cycle of stress. The energy lost during each cycle may be too small to measure, but after some hundreds or thousands of cycles the cumulative effect of the losses may become appreciable. This loss may appear as a "loop" in the stress-strain diagram for a complete cycle of stress, and this indication may be detected at a comparatively early stage of the fatigue failure. Dr. Stanton of the British National Physical Laboratory has made some experimental study of this development of "mechanical hysteresis," as this loss of energy is called.[7] It is possible that mechanical hysteresis may be studied by the dying out of vibrations set up in a test piece, as has been proposed by Boudouard.[21]

3 Magnetic Testing of Steel for Fatigue Strength. The structural damage done while a progressive fatigue failure is occurring may, possibly, be detected and measured by the change in magnetic permeability of the steel. Burrows, Dudley, and Sanford[28] have done some experimental work on this subject, and magnetic analysis seems worthy of study as an index of fatigue strength.

4 Impact Tests and Repeated-Impact Tests. Although the action of metal under impact is very different from its action under repeated stress, yet both impact and repeated stress seem to emphasize local irregularities and imperfections of surface or structure. It may be that a repeated-impact test may be devised which will give a reliable measure of fatigue strength, and which will do so in a comparatively short time. Such tests seem worthy of study, though their value as tests of fatigue strength cannot be said to be established.

It is believed that the foregoing paragraphs outline fundamental investigations, many of which should be undertaken at an early date. Experimental study of typical metals under long-time, low-stress tests; study by means of the microscope of the phenomena of fatigue failure in metals of various crystal structures; and study of reliable test methods of determining fatigue strength constitute, in the opinion of the Committee, the fundamental line of research in fatigue phenomena. Once such fundamental tests have made fair headway, especially the determination of a reliable test for fatigue strength, a large number of problems call for study, among which may be mentioned: the effect of surface finish; the effect of various heat treatments on fatigue strength; the effect of cold-working and of hot-working of metal on fatigue strength; the effect of intervals of rest in restoring fatigue strength; the effect of range of stress; the effect of compound stresses; the effect of speed of repetition of stress; a study of waves of stress in machine members; and fatigue studies of full-sized members, such as railroad rails, riveted joints, wire ropes, car and truck axles, crankshafts, and power-transmission shafting.

List of References

1 Wöhler, Ueber die Festigkeitsversuche mit Eisen und Stahl. A good account of these results is given in English in *Engineering* (London), vol. II. A summary of Wöhler's work is given in The Testing of Materials of Construction, by Unwin. The original publication of Wöhler's results was in *Zeitschrift für Bauwesen*, vols. X, XIII, XVI, and XX.

2 Bauschinger, Mittheilungen des Mechanisch-Technischen Laboratoriums der kgl. techn. Hochschule, München, Heft 13; also, *Dingler's Journal*, Bd. 224, and *Civilingenieur* for 1881.

3 Gerber. See, The Testing of Materials of Construction, by Unwin, p. 388.

4 Weyrauch and Launhardt. See Johnson's Materials of Construction, (Fifth edition, rewritten by Withey and Aston) pp. 780, 781.

5 Howard, Notes on the Endurance of Steels under Repeated Alternations of Stress, Proceedings, American Society for Testing Materials, vol. VII, p. 252 (1907); compiled from, Tests of Metals, Watertown Arsenal Reports (1898-1910).

6 Stanton, A New Fatigue Test for Iron and Steel, Journal, Iron and Steel Institute, no. 1, p. 54 (1908).

7 Stanton and Bairstow, On the Resistance of Iron and Steel to Reversals of Direct Stress, Proceedings, Institution of Civil Engineers (British) vol. 166, p. 78 (1906); also *Engineering* (London), vol. LXXIX, p. 201 (1905).

8 Stanton and Bairstow, Appendix III of the report of the (British) Committee on Stress Distribution in Engineering Structures reported in *Engineering* (London) Sept. 15, 1916.

9 Basquin, The Exponential Law of Endurance Tests, Proceedings, American Society for Testing Materials, vol. X, p. 625 (1910).

10 J. H. Smith, Experiments on Fatigue of Metals, Journal, Iron and Steel Institute (British), vol. 82, p. 246 (1910).

11 Eden, Rose and Cunningham, The Endurance of Metals, Proceedings, Institute of Mechanical Engineers (British) p. 839, parts 3 and 4 (1911).

12 Kommers, Repeated Stress Tests of Steel, *American Machinist*, p. 551, April 1, 1915; also, Repeated Stress Testing, Proceedings, International Association for Testing Materials, Arts. V4a and V4b (1912).

13 Mason, Alternating Stress, Experiments, *Engineering* (London) Feb. 23, 1917 and succeeding issues. The same, Appendix II of the report of the (British) Committee on Stress Distribution in Engineering Materials, reported in *Engineering* (London) Sept. 15, 1916.

14 Moore and Seely, The Failure of Materials under Repeated Stress, Proceedings, American Society for Testing Materials, vol. XV, part II, p. 438 (1915). See also Proceedings, American Society for Testing Materials, vol. XVI, part II, p. 471 (1916), in which a numerical error in the 1915 paper is corrected.

15 Van Ornum, The Fatigue of Cement Products, Transactions, American Society of Civil Engineers, vol. 51, p. 443 (1903), and vol. 58, p. 294 (1907).

16 H. C. Berry, Apparatus for Repeated Loads on Concrete Cylinders and a Typical Result, Proceedings, American Society for Testing Materials, vol. X, p. 581 (1910).

17 D. J. McAdam, Jr., Endurance and Impact Tests of Metals, Proceedings, American Society for Testing Materials, vol. XVI, part II, p. 292 (1916). An Alternating Torsion Testing Machine, ibid., vol. XVII, part II, p. 559 (1917).

18 H. F. Moore, The Physical Significance of the Elastic Limit, Proceedings, International Association for Testing Materials, Art. XXVIII, 1912). T. D. Lynch, Elastic Limit, Proceedings, American Society for Testing Materials, vol. XV, part II, p. 415 (1915).

19 W. M. Corse and G. F. Comstock, Aluminum Bronze, Some Recent Tests and Their Significance, Proceedings, American Society for Testing Materials, vol. XVI, part II, p. 117 (1916).

20 H. F. Moore and A. G. Gehrig, Some Fatigue Tests of Heat-treated Nickel Steel and Chrome-Nickel Steel, Proceedings, American Society for Testing Materials, 1919 meeting.

21 Boudouard, Break-Down Tests of Materials, Proceedings, International Association for Testing Materials, Article V_3 (1912).

22 Stromeyer, Memorandum of the Chief Engineer of the Manchester Steam Users Association, for 1913; Elasticity and Endurance of Steam Pipes, Transactions, Institute of Naval Architects (1914).

23 C. E. Inglis, Stresses in a Plate Due to the Presence of Cracks and Sharp Corners, Transactions, Institute of Naval Architects (British), vol. LV, part I, p. 219 (1913).

24 E. Preuss. *Zeitschrift Vereines deutscher Ing.*, 1913, part I, p. 664, *Mitteil über Forschungarsbeiten auf dem Geb. des Ingw.*, vol. 126, p. 54; see also *Zeitschrift Vereines deutscher Ing.* 1912, p. 1780; 1913, part I, p. 664.

25 E. G. Coker, *Engineering* (London), Jan. 6, 1911, March 3, 1912, Dec. 13, 1912, March 28, 1913. *Journal of the Society of Arts*, Cantor Lecture, 1913.

26 W. Rosenhain, Introduction to Physical Metallurgy (1914).

27 Moore and Putnam, Bulletin 146, American Institute Mining and Metallurgical Engineers, p. 401, (Feb. 1919).

28 C. W. Burrows, Some Applications of Magnetic Analysis to the Study of Steel Products, Proceedings, American Society for Testing Materials, vol. XVII, part II, p. 88 (1917), especially p. 109. Also Bureau of Standards, Scientific Paper No. 272. See also papers by Burrows and Fahy, P. H. Dudley, Sanford and Fischer, Sanford and Kouwenhoven, and Nusbaum in a Topical Discussion of Magnetic Analysis at the 1919 meeting of the American Society for Testing Materials (to be published in the 1919 Proceedings of that society).

29 Slocum and Hancock, Text-book on the Strength of Materials, Chapter on, Curved Pieces: Hooks, Links, and Springs, 1906 edition p. 155.

30 Proposed formulæ for working stress under repeated load include Gerber's, see The Testing of Materials of Construction, by Unwin, 1910 edition, p. 388; Mechanics of Materials, by Merriman, 11th ed., p. 356; The Johnson-Barr formula (founded on the work of Weyrauch and Launhardt) see, Johnson's Materials of Construction, fifth edition, rewritten by Withey and Aston, p. 783; Moore and Seely formula (founded on an exponential equation) see Text-book of the Materials of Engineering, by Moore, p. 169.

31 Waring and Hofammann, Deep Etching of Rails and Forgings, Paper presented before the 1919 meeting of the American Society for Testing Materials (to be published in the 1919 Proceedings of that Society).

Under the sundry civil service bill the Council of National Defense has had its unexpended balance for the fiscal year ended June 30, 1919, reappropriated to it. Plans are now being matured for the return of the Council to its peace-time functions, which, according to the Act of Congress creating it, are "the coördination of industries and resources for the national security and welfare and the creation of relations that will render possible in time of need the immediate concentration and utilization of the resources of the nation." It is the intention of the Council to collect, study and centralize in a scientific way all information bearing upon the national defense, particularly with regard to the mobilization of industries, science and labor in time of war.

The entire expenses of the Council up to May 1, 1919, were only $1,500,000. It is estimated that more than $3,000,000,000 was saved to the Government by the prices which the Council's experts on raw materials, minerals and metals made in the procurement of iron and steel products.

Torpedo-Boat Destroyers in the Making

By COMMANDER JAMES REED,[1] U. S. N., MARE ISLAND, CAL.

The American destroyer and the spectacular part which it played during the war in convoying troops and combating the submarine are subjects of almost universal knowledge and interest. The destroyer has fully justified its existence as a distinct naval type, not only because of its value for scouting, screening, convoy service, and coastal attack, but also on account of its use in major engagements between fleets. The development of the destroyer has been a logical one and Commander Reed first presents in his paper a brief historical review of modern American torpedo craft. This review is followed by a non-technical description of the construction of the so-called "Liberty Destroyer," the Ward, which was launched on June 1, 1918, 64 per cent complete, and only 17½ days after the laying of the keel. This is a record in ship construction and one that has never even been approached. It is a remarkable achievement and when contrasted with the two to four months required to complete some of the earliest torpedo vessels it brings a realization of the great advances that have occurred in the art of shipbuilding.

THE torpedo-boat destroyer, or more briefly, the "destroyer," as the type is generally known, is strictly a logical development of the torpedo boat of Cushing, just as the modern superdreadnaught is a development of the *Monitor* of Ericsson. The destroyer is the answer to the torpedo boat; but as the destroyer proved capable of performing all the functions of her smaller prototype and also possessed more speed, seaworthiness, comfort, radius of action and power of attack and defence, it soon forced out the smaller torpedo boat, which at best was but a small, dirty, uncomfortable and weak unit.

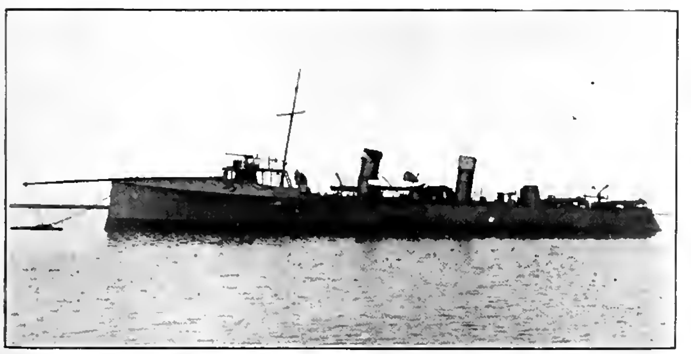


Fig. 1 U. S. Torpedo Boat *Farragut*
This vessel made a mile during its trial run in 1899 at the rate of 31.7 knots

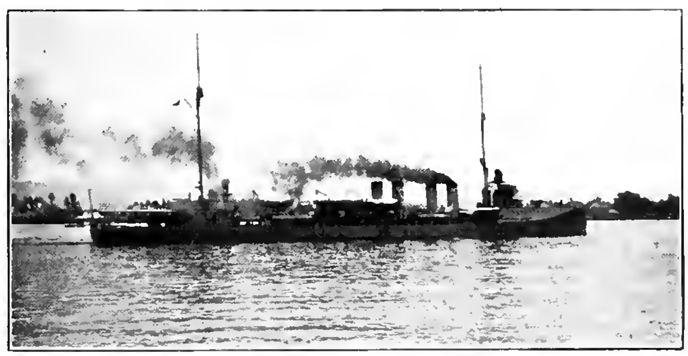


Fig. 2 U. S. S. *Shaw*

The demands for higher and higher speeds—and sustained sea speeds at that—have resulted in great increases in horsepower, structural strength, and freeboard. The latest types of United States destroyers have a speed of 35 knots in cruising trim, which means practically in war condition, and not over a measured mile in stripped condition and with favorable wind and tide, under which circumstances certain marvelous foreign speed records are known to have been made. It is accordingly satisfying to learn that in joint operations during the war our destroyers compared more than favorably with the British and French as regards strength, seaworthiness, speed, armament, and comfort in accommodations for both officers and men.[2]

The designing and building of a successful type of modern destroyer brings into play the highest skill of the naval architect, the marine engineer, and the shipbuilder, due to the sacrifice of all other considerations to those of speed, armament, seaworthiness, strength and cruising radius. The destroyer is really an overgrown racing motorboat, and her lines are therefore radically different from any other type of sea-going vessel. For example, the ratio of beam to length is less than 1:10, and her draft is very shallow for her length, being only 9½ ft. for the latest 315-footers.

Conclusions drawn from the world war have not terminated the long discussion upon that favored topic among all naval authorities—as well as interested laymen—in regard to the relative value of the superdreadnaught type of warship. However, all authorities are agreed that the torpedo-boat destroyer has come into its own and has fully justified its existence as a distinct naval type, not only for submarine hunting but also for efficient use in convoy service, in scouting and screening, in coastal attacks, both alone and in conjunction with ships of heavier type and with aircraft, and even in major engagements between fleets.

Early Types of Destroyers

The early torpedo boats carried the torpedo on a spar extending from the bow of the vessel, and the method of attack consisted in steaming head-on for the enemy vessel and exploding the "spar" torpedo on contact. Of course such a torpedo would be practically harmless to a modern superdreadnaught with its extravagant protection against torpedo attack. These boats were small and not very fast according to present-day standards, but with the inefficiency of gunfire in those days they could have probably been successfully used for night attack at least, if one were reconciled to the probable loss of the attacking boat and crews. War service on board one of these torpedo craft would have proved highly hazardous, especially since this was long before the invention of the wonderful non-sinkable life-preserver suits which have been popular for Atlantic travel during the past three years, and in which it is reputed one can float around until death from starvation occurs.

With the development of a more or less satisfactory self-propelled torpedo by Whitehead about 1880, the spar-torpedo boat—which was really not much more than a picket boat—gave place to a larger, speedier, and more seaworthy type of vessel, with corresponding increases in complement and cruising radius. These boats launched their torpedoes from single tubes on deck, and their power of attack was limited to their torpedo equipment as the remainder of their armament consisted only of machine guns or rapid firers of the smallest caliber.

The first torpedo boat in the United States Navy using self-propelled torpedoes was the *Stiletto*, a little wooden yacht 88 ft. 6 in. long by 11 ft. beam by 3 ft. draft, purchased from Herreshoff for $25,000. She was single-screw, of 350 hp. and

Presented at a meeting of the San Francisco Section of The American Society of Mechanical Engineers, April 16, 1919.

[1] Construction Corps, U. S. Navy Yard. Mem. Am. Soc. M. E.

[2] During the whole period of their operations abroad no American destroyer ever returned to port because of stress of weather.

developed a speed of 18.2 knots. For many years she was employed at the Torpedo Station, Newport, R. I., for practice firing of torpedoes.

The first steel torpedo vessel for our service, very appropriately named the *Cushing*, was authorized August 3, 1886, and built by Herreshoff for $82,750. She was 138 ft. 9 in. long by 14 ft. beam by 4 ft. 10 in. draft and displaced 105 tons. Her engines were twin-screw, vertical, quadruple-expansion, and her speed 22.5 knots. Her armament consisted of three 18-in. Whitehead torpedo tubes and three 1-lb. rapid-fire guns, and her complement was three officers and twenty men, the same complement, it may be noted, as that of the famous little submarine chasers of the present war.

The *Cushing* was followed by the *Ericsson, Foote, Rodgers, Winslow, Du Pont* and *Porter*, all of which saw service in the Spanish-American War, and hard service at that, as any of

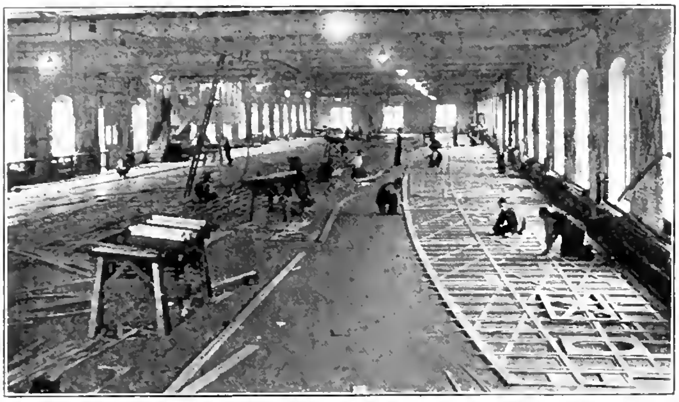


FIG. 3 THE MOLD LOFT
During the laying out of the molds for the main deck of a destroyer.

the officers who were on duty on board them will testify, even though they did not operate in the cold, foggy and boisterous North Sea in pursuit of the elusive "tin fish."

In the group of torpedo boats placed in commission shortly after the Spanish-American War, the *Farragut* (Fig. 1), designed and built at the Union Iron Works, San Francisco (now the Union Plant, Bethlehem Shipbuilding Corpn., Limited), is worthy of mention. This little vessel on one trial attained a speed over a measured mile of 31.7 knots, which was an extremely high speed for any war vessel at that date (1899). It is of interest to note that the *Farragut* still holds the record from Mare Island Navy Yard, Cal., to San Diego, a distance of 500 miles, which she covered in 1910 at an average speed of 27.3 knots, a remarkable performance for a coal-burning vessel of her size. She served throughout the present war and on one occasion in 1918 made over 26 knots in service while heavily loaded.

About 1902 the first of a group of sixteen destroyers for the American Navy were completed and these boats have been in continuous service ever since, all having done good work in the war zone. Their dimensions were practically identical: namely, displacement (actual), about 560 tons; speed (average), 28 knots; armament, two 3-in. guns, five 6-pounders and two single torpedo tubes.

These boats were followed by several classes of destroyers gradually increasing in size and power until the United States entered the present war. At that time the latest destroyers were of about 1000 tons displacement, 30 knots speed, carried four 4-in. rapid-fire guns, and four double torpedo tubes. (The depth-charge armament was installed afterward.) These were "high bow" boats, with a forecastle deck ending at the bridge, as will be seen in Fig. 2. Soon after we entered the war the first of the "flush deck" type of destroyers was produced and this type has now been standardized for our Navy.

THE NAVY'S LATEST TYPE OF DESTROYER

The general characteristics of the latest destroyer, as compared to the little *Stiletto* previously mentioned, will possibly be of interest. The new type has a length of 315 ft., a beam of 30 ft. 10 in., and a draft of 9 ft. 4 in., with a displacement of about 1200 tons. The armament consists of four 5-in. rapid-fire guns, two 3-in. anti-aircraft guns, three machine guns, four triple torpedo tubes, and large numbers of depth charges.

The inboard profile of one of our modern destroyers reveals the fact that an enormous amount of space is given over to machinery. The crew of 130 men sleep in wire-mattressed folding bunks instead of in hammocks as on the larger ships, and each man has a metal locker for his effects. The men mess and sleep in the same compartment. The officers' quarters are roomy and comfortable and equipped with metal furniture throughout.

Forced ventilation is provided in all living spaces by means of electric blowers. Other electric equipment consists of laundry machines, refrigerating unit, and a coffee percolator, toaster and warming oven for the pantry. The galleys have oil-burning ranges, also steam coffee urns and steam cookers. Running water and showers are also provided for both officers and men, but tubs are not installed because of the space required, the larger consumption of fresh water, and the weight involved.

This question of weight is a most serious one in vessels of such high speed and most careful designing is necessary in order to secure the maximum strength with the minimum weight. In

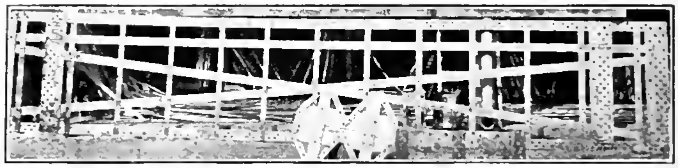


FIG. 4 SHELL MOLDS
Full instructions for the "layer out" are painted on each mold.

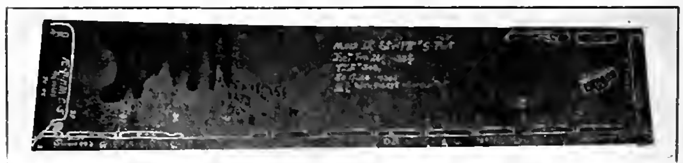


FIG. 5 A PLATE LAID OFF READY FOR FABRICATION

recent years great advances have been made possible through the generous use of high-tensile steel, for by its use radical reductions in scantlings throughout the vessel have been effected. Attention is invited to the extreme lightness of plating and shapes throughout a modern destroyer. The lightest plating on bulkheads is only 5 lb., or 3/20 in., approximately. Deck thicknesses vary from 5 to 20 lb. per sq. ft., and shell plating from 7 to 18 lb. per sq. ft. (7/40 in. in thickness).

In addition to the use of extremely light materials throughout, holes for lightening purposes are punched or burned by oxy-acetylene in all floors, web frames, girders, brackets, etc., and wherever practicable corners are snipped off beams and frames; butt straps are also scalloped between rivet holes, etc., and all this is done to save a few pounds. In connection with the light scantlings of torpedo craft, the annual report of the Chief Constructor of 1897 bears this remarkable recommendation: "The remaining boats will be in reserve and must be kept in good condition ready for service at short notice. To do this most economically and to prolong the life of the boats as far as possible, they should be *kept out of the water and under cover.*"

In spite of all this cutting down in weight throughout the whole structure these vessels have proved wonderfully strong in service, as is demonstrated by several serious casualties experienced in the war zone, notably the one where the stern of the *Manley* was blown off by the explosion of her own depth charges, and the case of the *Shaw* (Fig. 6), where the entire bow from the bridge forward was cut off by a collision with the mammoth Cunarder *Aquitania* while zigzagging at a speed of 24 knots. The *Manley* was towed into port, but the *Shaw*

proceeded under her own steam, and both have since been repaired and placed in service. Due to the intricate watertight subdivision of these boats, they are practically immune from sinking as a result of any ordinary casualty in service.

Another way to reach an appreciation of the exceptional strength of these light craft is to consider the tremendous horsepower installed in them in order to secure the speed demanded. In the latest boats upward of 30,000 shaft hp. has been developed on trial, which power approximates closely to that of many of the latest superdreadnaughts. This power is carried on a displacement only one-twenty-fifth as great as in the battleship, and in a space of less than 4200 sq. ft. for boilers, engines and all auxiliaries. Hence, it will be seen that although to provide sufficient power for these destroyers is comparatively easy, to house it in the hull to be driven, and to design and fit proper foundations and strength members to hold it are serious problems in such a small hull where weight saving is of such vital importance.

Only those who have been on board of one of these destroyers while it was tearing into a head sea at a speed above 36 knots per hour can sense the tremendous power their slender, quivering hulls contain. Their main engines consist of steam turbines connected through reduction gears to two shafts driving twin screws up to 480 r.p.m. Skill in balancing all rotating parts has reached such a high degree that there is practically no vibration due to the engines or propellers even at the highest speeds, and with regard to cruising radius the latest class of destroyers carry sufficient fuel oil to cross the Atlantic at a speed above 20 knots.

Modern Methods of Building Destroyers

After the general characteristics for a proposed class of destroyers are determined by the General Board of the Navy, and approved by the Secretary, tentative plans and estimates are prepared by the Bureaus of Construction and Repair, Steam Engineering, and Ordnance, and these form the basis of the recommendations of the Secretary for the necessary Congressional appropriations. When the appropriations are made the Bureaus concerned get out contract plans which, after approval by the Secretary of the Navy, are forwarded to various shipbuilding firms and navy yards for bids. These plans are general in character, and contain no details. After the acceptance of a bid, which frequently offers a modified design embodying the builder's ideas, the following steps are involved in the building of the destroyer:

1. Ordering of the material
2. Preparing detail plans for both hull and machinery
3. Laying down lines in the mold loft and preparing the molds (construction of machinery is usually started at about this time)
4. Laying off and fabricating structural material
5. Assembly of fabricated material
6. Erection of fabricated material (hanging and bolting up)
7. Riveting and calking
8. Testing
9. Launching
10. Installing of machinery, armament and outfit complete
11. Dock, builders' and acceptance trials of the vessel
12. Commissioning and fitting out.

Ordering of Material. Orders for material are made up from Material Schedule Sheets, which show the type, dimensions, weight, and distinctive marks of each piece entering into the structure, and when required the assembly drawing on which it appears. The main orders to the steel mills do not, of course, go out in such detail as the various weights and sizes are grouped for the mills, wherever practicable, into classes of more or less standard dimensions, and the detailed schedules follow later. Orders for main and auxiliary machinery not supplied by the shipbuilder from his own works are placed as early as possible, since it is machinery, not hull completion, that determines the date of delivery of the finished vessel.

Preparing Detail Plans. There are about 1100 plans required to cover all the work on one of our latest type destroyers and a great saving in both time and expense has been effected by the Navy Department in the use by several contractors of prints from one set of the detail plans, instead of each contractor developing his own plans, as was the former custom.

Laying Down Lines and Preparing Molds. This consists in striking in on the smooth floor of the mold loft the lines of the vessel in full size. The forms of all naval vessels are determined by towing actual models in the Model Tank at the Washington Navy Yard and recording the resistance of each. These lines are the intersections of the hull and decks of the vessel at certain regular stations with three different planes at right angles to each other as follows:

a The vertical longitudinal plane (sheer plan)
b The horizontal longitudinal plane (half breadth)
c The vertical transverse plane (body plan).

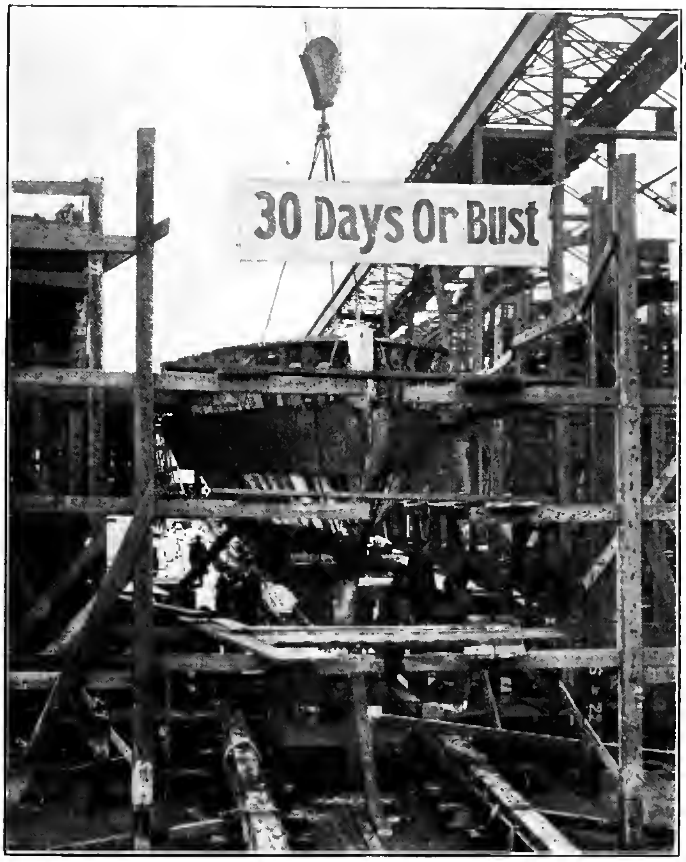


Fig. 6 The *Ward*—First Day
Lowering the "assembled stern" into place.

From these lines, together with certain additional ones that are used in those parts of the ship where extreme curvature occurs, the expanded dimensions as well as the shape of every piece entering into the ship's structure may be obtained, and a wood, paper or metal pattern, as shown in Fig. 3, can be made up showing all the details of the fabrication of the piece.

Every seam, butt, lap, cut and bevel of the plate or shape, as the case may be, is indicated on its proper mold (Fig. 4), which also usually carries the piece number (from the Material Schedule), the location in the ship, the description, and the job order number on which the work is to be performed. Heavy paper is used for some molds, and by certain shipbuilders even to the exclusion of wood. At the Mare Island Navy Yard, in order to keep out moisture and avoid shrinkage, all wooden molds are shellacked by the use of a pneumatic painting machine.

The loftsman is a real practitioner in analytical and descriptive geometry, and upon the accuracy of his work depends much

of the success or failure when the fabricated material comes to the shipfitter for erection. Half-holes, unfairness, etc., result from inaccurate mold-loft work and these errors are very serious in a destroyer where all structural members are thin, and where fairness of holes and of form throughout is essential.

Laying Off and Fabricating Material. The molds go from the mold loft to the shipfitter, who lays off the structural material by clamping the mold in its proper position upon the steel plate or bar and then marks up the piece according to the instructions on the mold, which is really his pattern for cutting the goods. There are 411,252 rivets by actual count in one of these destroyers, and it will be noted that each rivet hole is indicated on a

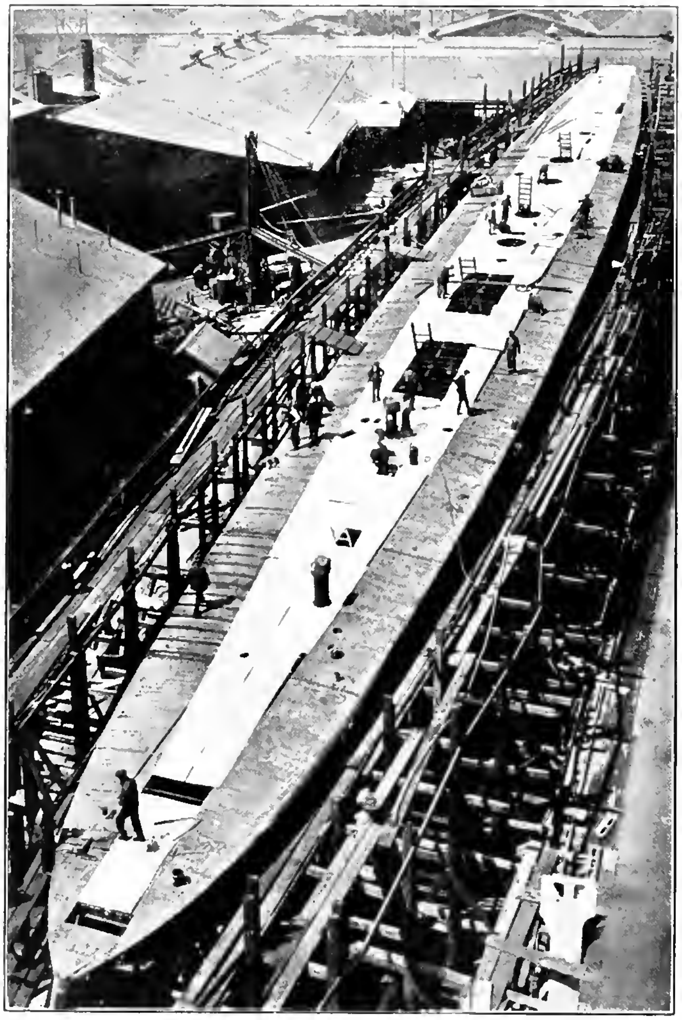


Fig. 7 The *Ward*—Fifth Day

mold where the universal system is used, as at Mare Island, and the location of each hole is punchmarked on to the plate or bar in laying them off as shown in Fig. 5. The material then goes to the shop for fabrication, that is, rolling (if required), shearing to dimensions, punching rivet holes, edge planing, punching or burning out lightening holes by the use of oxy-acetylene torch, and weighing. The weight of every piece entering into the structure of the ship is carefully estimated in advance in order that the displacement of the vessel may not exceed that for which it was designed, and a constant check is kept on this by actually weighing everything prior to placing it on board the vessel. It is not unusual for a destroyer to actually displace on completion a tonnage of water which will vary less than five tons from the displacement which was estimated in connection with her design. This is an accuracy of 0.4 per cent for a 1200-ton vessel.

Assembly of Fabricated Material. Prior to laying the keel practically every piece of structural material is laid off and fabricated, ready for assembly, and in the case of the *Ward* the following preliminary assembly and riveting was performed:

a Keel in sections with clips for floors and frames attached
b All main structural bulkheads complete with bounding angles
c Web and belt frames and beams
d Frames with floors and bulkheads attached
e Deck houses
f Stern of ship including stern post and frames to bulkhead.

Erection of Fabricated Material. Having assembled the material as outlined in preceding paragraph, the keel of the *Ward* was laid at 7.45 a. m. on May 15, 1918. As soon as the keel was in place riveting the various sections together proceeded, and the various frames with floors attached were bolted to the clips on the keel, while the main structural bulkheads were dropped into place complete. The frames were temporarily held in proper register by a longitudinal rib-band shore at the turn of the bilge and another support from the scaffolding at the top of the sheer strake near the deck edge. The bottom plating was then placed in proper position and bolted to the frames, and the stem erected and the fabricated stern of the ship placed in position, as indicated in Fig. 6. Next the plating of the platforms and decks was laid on (Fig. 7), and as the bolting-up throughout the structure proceeded rivet holes were reamed throughout and riveting gangs followed. The deckhouses were placed in position as were all other deck erections (Fig. 8), such as ventilation trunks, foundations, skid beams for carrying boats, davits, etc., as fast as the deck was ready to receive them.

Riveting and Calking. In the assembly of the fabricated material 183,000 rivets were driven prior to laying the keel of the vessel, and 165,000 were driven thereafter before launching. Eighteen riveting gangs were employed, and the average number of rivets of all kinds per day per gang was 587.5. Work on the vessel was not continuous, averaging only eighteen hours out of each twenty-four. Overtime in general was restricted to two hours, but a few trades worked three hours over eight hours during part of the 17-day period. The ordinary rough-fisted riveter, trained in structural-steel riveting, or on merchant work, makes a sorry job of destroyer riveting, where the greatest care and skill are necessary to insure a tight, well-shaped joint without hammering of the light high-tensile plating adjacent to the rivet hole. Careful packing and thorough bolting up are essential to a properly watertight or oiltight job. The calking must also be skilfully performed on these light vessels or the very object of this work will be defeated.

A few of the records of the best Mare Island riveters on the *Ward* may be of interest and Table 1 is accordingly given.

Testing. The strict requirements of the Navy specifications in regard to bulkhead strength, water and oiltightness, are insured by actually testing the various compartments under a head of water, while others are tested under air pressure. Of course the fire rooms must be airtight to meet the demands of forced-draft operation in service, these spaces being under pressure at all times while steaming. Decks, hatches, airports, deckhouses, etc., are tested for tightness by playing a hose on them.

Launching. The operation of launching consists essentially of simply transferring the weight of the hull from the blocking, cribbing and shores, upon which it has been supported during construction, to two parallel launching ways, one running each side of the keel for a portion of the vessel's length. These ways are in two parts, the lower fixed section comprising the ground ways, the upper, which carries the cradle in which the ship rests, the sliding ways. The ways are laid at an inclination to the horizontal, usually about 25/32 in. to the foot and the smooth facing surfaces of the ground and sliding ways respectively are thoroughly greased. Upon releasing a trigger, dropping a "dog shore," or sawing through a timber holding the sliding ways to the fixed ways, the vessel starts on her journey down the ways. Actually, there is a great deal of careful calculation necessary preliminary to this launching operation, which unfortunately does not always pass off smoothly. Sometimes the ship balks, refusing to start, or goes so slowly that she sticks, in which cases recourse is had to jacks, towlines, vibration by running on deck,

TABLE 1 RECORDS OF INDIVIDUAL RIVETERS DURING CONSTRUCTION OF DESTROYER *WARD*

Riveter	No. of rivets	Size of rivet, in.	Hours
May 18;			
Towers[1]	1062	5/8–3/4	9
Blount	838	3/4	9
Posedel	811	3/4	9
May 19;			
Blount	1165	5/8–1/2	8
Towers	1016	5/8–1/2	8
Swanson	901	5/8–1/2	8
May 20;			
Towers	1245	5/8–1/2	10
Blount	1165	5/8–1/2	10
Gaarder	1147	5/8–1/2	8
Swanson	1043	5/8–1/2	10
May 21;			
Towers	1349	5/8–1/2	10
Schnerdewind	1278	5/8–1/2	10
Powell	1203	5/8–1/2	10
Blount	1165	5/8–1/2	10
Swanson	1073	5/8	10
Gaarder	997	5/8	8
May 22;			
Towers	1500	5/8–1/2	10
Blount	1302	5/8–1/2	10
Schnerdewind	1129	5/8–1/2	10
Beab	1090	5/8–1/2	10
Gaarder	1060	5/8–1/2	8
Powell	912	5/8–1/2	10
Swanson	800	5/8–1/2	8
May 23;			
Towers	1800	3/8–1/2	10
Gaarder	1333	5/8–1/2	10
Powell	1095	3/4–5/8	10
Schnerdewind	989	3/4–5/8	10
Blount	879	3/4	10

[1] L. A. Towers' record was 13,343 shell rivets (1/2 in. to 3/4 in.) driven in ten working days, or a total of 97 hours.

FIG. 8 THE *Ward*—TENTH DAY

etc. If all means fail, it is necessary to jack her up and start over again.

Installation of Machinery. The installation of machinery and miscellaneous fittings is usually begun before launching, and completed after the vessel has been launched, but in the case of the *Ward* this work was performed overboard, her boilers, gears, main turbines and auxiliary machinery all being placed on board at the fitting-out pier. The controlling feature in the completion of a destroyer nowadays is the expedition with which the coppersmith performs his work. The country was scoured for skilled men in this trade, but the demands were never met, either as regarded the Navy or the Shipping Board.

Trials. Dock trials are held as soon as the machinery installa-

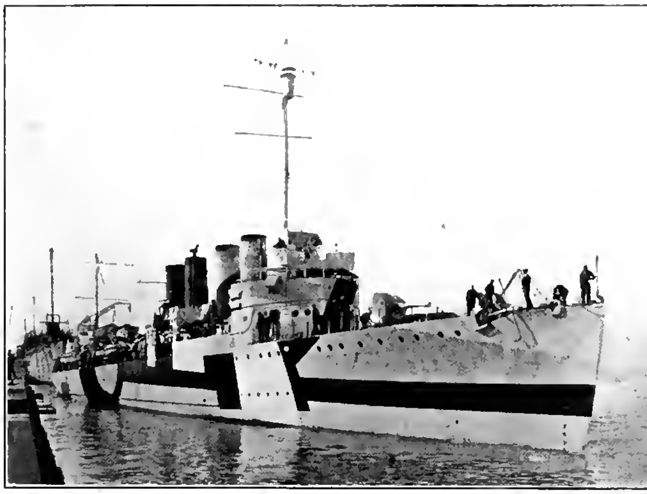


FIG. 9 THE *Ward* COMPLETE AND READY FOR TRIAL TRIP

tion is complete, and if everything functions satisfactorily, the vessel proceeds on a "builder's trial," in order to "run in" her machinery and insure that everything will operate smoothly on the official trials before the Naval Trial Board, composed of officers experienced in naval construction, engineering and ordnance. These trials are very severe and consist of continuous runs, of several hours' duration each, at various speeds up to the maximum. At least one vessel from each class is carefully "standardized," that is, the vessel is run over a measured-mile course both with and against the tide at varying speeds up to the maximum, both the revolutions per minute and the horsepower required being carefully observed during each run. From these results curves are plotted, which give a ready means of ascertaining the horsepower or revolutions required for any given speed.

All of the above trials are held at the vessel's normal displacement, which was specified in the contract. Additional tests carried out during the trials are on the steering gear, anchor gear, and gun firing (to test foundations). A thorough report, embodying the observations of the Board on the design, construction and performance of the vessel, is submitted to the Department and any weaknesses or alterations are corrected in the boat under trial, also in future boats. By this system a continual improvement in design and construction has resulted.

Commissioning. Navy-yard-built destroyers are placed in commission before the trial runs are held, these being conducted by Navy personnel. The *Ward* was placed in commission on July 28, 1918, 74 days after the laying of the keel. Her machinery installation was not complete on this date, but she was commissioned so that stores could be placed on board, the ship's organization perfected, and the vessel in all respects made ready for departure the moment her machinery installation was completed, which was on September 1, 1918, as per schedule.[1]

(*Continued on page 781*)

[1] The fact that serious difficulties developed with certain auxiliaries supplied by private contractors in no way detracts from the merit of the performance represented by the completion of this vessel, ready for sea in 104 working days, especially when the intricacy of her design and the enormous power she carries are considered. Our earliest torpedo vessels, smaller, simpler and of relatively low powers, took from two to four years to complete.

Pulverized Coal as a Fuel for Boilers

A General Study of Its Characteristics and the Operating Conditions Met With in Its Commercial Applications; also a Discussion of the Nature of Flame, Types of Burners and of a Design of a Pulverized-Fuel Furnace for a 500-Hp. Boiler

By EDWARD R. WELLES[1] AND W. H. JACOBI[2], NEW YORK, N. Y.

BEFORE entering into details concerning pulverized coal, it is not out of place to emphasize that in the process of burning fuels certain very definite operations take place which depend strictly on the physical and chemical properties of the fuels. The reactions occurring, the quantity, quality, density and the temperature of the gases that result during combustion, and their effects, as well as the practical rate of burning to secure perfect or nearly perfect combustion, have all been defined and clearly enough so for practical application. Unfortunately, however, because of the cheapness of all fuels, these matters have not received the attention their importance deserves. We are more interested in the calorific value of fuels per unit weight, regardless of whether they are solid, liquid, or gaseous; that is, we consider a pound of fuel as the container of a given number of British thermal units and on that basis are prone to use one form of fuel or another in any service and to expect equal results.

Our conception of the thermal form of energy is still that of an imponderable fluid instead of a condition of matter. The common conception is that radiation does more heating than convection and conduction, whereas in reality the opposite is the case. We speak freely of heat transfer from one body to another instead of its propagation, and almost without regard to the relative value of specific temperatures, conduction, convection and radiation. We overlook the fact that the available heating capacity of a fuel is the surplus left from that developed in its conversion to the ultimate gaseous oxides, and that we can use only a portion thereof, depending not on the temperature that develops during combustion, but on the nature of the work to be done and the temperature at which that work can best be done. The energy consumed by combustible materials in the transition from the gaseous, the liquid and solid forms into the ultimate gases is different for the same quantity of combustible constituents. Each case involves a different time element, which is comparatively short with gases, longer with liquids and longest with solids. The presence of elements other than carbon and hydrogen, and their more or less complex formation, increase the endothermal losses, and affect directly the temperatures that develop. In consequence, not only is the heating value of each kind and form of fuel different from that expected from preliminary analysis, but the effects of the resulting properties are different. In burning lump coal, on account of the slow rate of combustion sufficient time is allowed to compensate for its variable structure and impurities. Liquid and gaseous fuels, on account of their uniform structure, give constant deflagration regardless of the rate of burning, and the effects of the actions that take place in burning are of less consequence.

With pulverized coal, on account of its rapid combustion, the effects due to the structure and amount and nature of the impurities are conspicuously manifested by the varying high temperatures and the unsteadiness of deflagration. The necessity of carefully considering the actions that take place in the combustion of powdered coal to adequately provide for their efficient utilization is thus made apparent. When dealing with the combustion of fuels and with heating we are confronted with problems concerning the molecular structure of materials in all their possible forms, and as such we should treat the matter on a different basis than mere B.t.u. considerations.

[1] Chief, Mechanical Division, The J. G. White Engineering Corporation. Mem.Am.Soc.M.E.

[2] Mechanical Division, The J. G. White Engineering Corporation.

Advantages and Disadvantages of Pulverized Coal as a Fuel

The merits of pulverized coal as a fuel, briefly stated, are as follows:

a If ground sufficiently fine the entire combustible content of the coal can be burned, thereby effecting fuel economies hitherto not attainable even with the better grades of coals burned under favorable conditions.

b It permits the use of all grades of coal, including peat and lignite, with an approximately equal degree of thermal efficiency for the same service, and increases very materially the energy that can be derived from the world's supply of coal

c It possesses very largely the facility of control and combustibility of oil and gas fuels, thereby placing coal on a parity with these fuels.

The limitations of pulverized coal are:

a The very high temperatures attending its efficient combustion (see Table 1) and the unsteady mode of its deflagration, necessitating special furnace construction to secure reliable service and to realize the possible economies it affords, preclude its ready application to existing equipment

b The operating cost and attention required to maintain the necessary apparatus for its use may more than offset the fuel economies that can be effected in small independent services

c The presence of ash, which may not always be collected and held under control

d The human element, which will not submit to the peculiarities of its nature.

TABLE 1 APPROXIMATE COMBUSTION TEMPERATURES OF CARBON AND BITUMINOUS COAL AND THE RESULTING PERCENTAGES OF CO_2

Percentage of excess air	0	25	50	75	100	125
Combustion temperature, deg. fahr.:						
Carbon	4000	3450	3000	2625	2350	....
Average bituminous coal	4860	4000	3325	2860	2500	2220
CO_2 per cent	20.8	16.5	13.8	11.8	10.2	....

For flexibility and nicety of operation gaseous fuels rank first, being followed respectively by liquid fuels (oils), powdered coal and solid (lump) fuels. On the basis of cost they assume exactly the reverse order. Economy depends on the nature of the service and local conditions.

Preparation of Pulverized Coal

The valuable feature of pulverized coal is that by reason of its divided state it can be brought en masse into intimate contact with the air necessary for its combustion, and in consequence, when injected into a suitably heated hearth it burns completely, deflagrating almost as readily as atomized oil.

Obviously the first requisite is to render the fuel into as fine particles as is possible, so that when mixed with air the mixture shall assume the form of a homogeneous gas. This analogy is comparative only, for no matter how finely broken and thoroughly mixed with air the coal particles are, they retain their solid structure and are therefore subject to a very arduous process of combustion, which is responsible for the attendant high temperatures that result.

The standard established in cement-mill practice, generally adopted for all purposes, is that 85 per cent of the powder shall

pass through a 200-mesh screen, and 95 per cent through a 100-mesh screen. Coal so ground weighs from 35 to 45 lb. per cu. ft. and 1 lb. of it can be carried in suspension through smooth piping in about 5 lb. of air moving at low velocities. Experience shows that under favorable conditions 100 per cent 60-mesh powder can be burned satisfactorily. This coarse fuel necessarily requires a longer time for its complete combustion and it can only be carried in suspension at high velocities. Its use, therefore, would be permissible only in furnaces which provide a long path for the resulting flame. In short chambers operating at low velocities these large particles fall to the bottom of the chamber before being consumed and coke, the result being a loss of fuel.

Granulated coal ranging in size from 1/4 in. to powder has been used as fuel for boilers aboard ship, it being blown into specially constructed hearths. This method has given good results in forcing the generation of steam, but it is not strictly in the class of burning pulverized coal in suspension and does not possess the same range of possibilities.

Coarsely pulverized coal has the redeeming quality of damping the temperature of the furnace and may be resorted to for the purpose of cooling overheated hearths without chilling; nevertheless, pulverized coal larger than the 80-mesh grade should be avoided in ordinary operation for best results. A uniform mixture averaging 100 per cent 150-mesh or finer should be employed, especially in the case of low-grade coals.

Pulverizing mills ordinarily produce powder of the cement-mill standard, and on the basis of fairly dry coal the average cost of pulverizing runs from 15 to 30 cents per ton ground at the rate of 2½ to 1/4 tons per hour, respectively.

Qualities Desirable in Coals to be Used in Pulverized Form

In burning pulverized coal there is no restriction on the variations in quality found in commercial grades. Low-grade coals perform better than high-grade on account of the large proportion of impurities they contain, resulting in less destructive temperatures and thereby in lower combustion losses. Generally it is necessary to dilute with air the gases resulting from the combustion before they are used, but less dilution is required with low-grade coals and in consequence more economical operation is obtained through their use.

A large proportion of volatile matter has heretofore been regarded as a leading requirement for pulverized fuel on account of its combustibility, but experience does not support this; on the contrary, there are those who consider it expedient and beneficial to drive off a portion of the gaseous content of a coal before burning it.

The temperatures of combustion hearths for pulverized coal range from 2200 to 3000 deg. fahr. depending on the design of furnace, the service, and the fusibility of ash and refractories employed. With these temperatures predominating the deflagration of all commercial coals is assured, and the restriction on any particular kind of coal for powdered fuel on account of combustibility is eliminated.

The suitability of coal for use as powdered fuel is to be gaged by its pulverizing qualities, and the soft grades, which incidentally contain a large proportion of volatiles, are to be preferred. Hard coals and coke are very severe on the mills. For pulverizing, slack coal and all small sizes under 3/4 in. are desirable in that they eliminate the necessity of crushing. Screenings, which usually are fragments of the more combustible portions of coal, are excellent for pulverizing on account of the lesser amount of impurities present.

Uniformity in the quality of pulverized coal is as essential as uniformity in the fineness of the powder, and for continuous reliable service as essential as its calorific value. In preparing the powder it is extremely important to mix and blend the coal so as to uniformly distribute its impurities. The ill effects of the irregular presence of impurities are felt more as the quantity of fuel burned becomes smaller. When burned in large quantities—necessitating larger combustion space—there is a chance for equalizing the variations of the impurities. To obtain a uniform quality of fuel wherever the coal supply is of varying kind the various grades of coal may be blended to advantage by pulverizing, thereby effecting economies which might not otherwise be realized.

Effect of Moisture in Coal

Moisture in coal is objectionable not so much on account of the apparent thermal losses but because it renders pulverization difficult and more costly. For this operation 5 per cent moisture may be regarded as the permissible limit, and air-dried coal is entirely satisfactory for the efficient operation of the mills. However, in cases where the storage of pulverized fuel is necessary, coal should not contain more than 1.5 per cent moisture as a greater amount tends to cake the powder, and in the event of iron pyrites being present, their oxidation by water may be the origin of spontaneous combustion. It has also been considered necessary to dry the coal before grinding and experience has shown that this practice brings about losses of volatile combustible and adds from 8 to 12 cents per ton to the cost of preparation. Furthermore, with reasonably protected storage and handling facilities it is possible to render the raw coal sufficiently dry, thus doing away with the separate drying operation. The present tendency in drying coal is to confine this process to central distribution plants, such as will be required for railroad or large service. For stationary work, self-contained pulverizing units in which grinding, air mixing, and feeding of the combustible mixture directly to the furnaces are progressively accomplished are more desirable, especially so since preheated air—a by-product of the furnace—can be used in their operation, thereby conditioning the mixture for better combustion performance.

In the combustion of pulverized coal a certain amount of moisture is beneficial rather than detrimental in that it tends to maintain the temperature of combustion constant and thereby renders deflagration more steady. The explanation of this effect is that the normal temperature of dissociation of the solid particles of coal is greater than that of water, and in the process of combustion some of the moisture that may be introduced with the charge breaks up, absorbing thermal energy and thereby lowering the combustion temperature.

Powdered coal containing as much as 15 per cent of moisture has been burned satisfactorily.[1] This amount is no doubt excessive, but by introducing preheated air for combustion through the self-contained pulverizing units or otherwise it is possible to absorb large proportions of moisture from coal and use this to advantage in the process of combustion.

Ash—Sulphur—Spontaneous Combustion

The ash resulting from burning solid fuels has been and always will be a problem for each particular case. With pulverized coal the ash from particles consumed in suspension is a light powder. This powder is carried along with the gases and deposited on all surfaces beyond the hearth, making removal more or less difficult. In the case of boilers this kind of ash accumulates on the tubes, lessening the evaporating efficiency and necessitating periodical removal by steam or air sprays. The dissemination of this ash can be somewhat reduced by proportioning the combustion space so that after combustion is completed the gases expand rapidly, decreasing their velocity and density and depositing the ash particles in a suitably located pit. If the powder is too coarse, or the amount of fuel injected into the hearth is greater than can be fully consumed therein, the coal particles while in the distillation stage are impelled against the walls and there coke. The continuous supply of these unconsumed particles builds up and burns slowly, leaving ash of a pumice-stone formation, which, if in the proximity of the zone of deflagration, slags and becomes very difficult of removal. The remedy for this is the continuous production of uniformly fine powdered fuel and the proper design of the combustion space to consume completely all the particles of the fuel charge.

On the whole, compared with lump-coal burning on grates,

[1] Firing Boilers with Pulverized Coal (Henry Phipps Plant), W. S. Worth, *Power*, vol. 33 (1911), pp. 267-269.

experience shows that with reasonable precaution ash from pulverized coal is less troublesome in every way. Slagging of the ash and brickwork occurs only when these are too near the deflagration zone, which naturally is several hundred degrees higher in the temperature than their fusion points. This difficulty is eliminated by designing the combustion hearth so that the side walls and top arch attain a temperature lower than the slagging point and the bottom is no higher than about 2000 deg. fahr., which avoids melting of the low-fusible ash.

The presence of sulphur is to be looked upon with less concern in the case of pulverized coal, since, as mentioned before, the high temperatures attending the combustion of this fuel dissociate water into its elements and hold these in a condition less liable to combine with sulphur. Pulverized coal containing over 5 per cent sulphur has been used in boiler settings without giving evidence of corrosion.

In regard to safety, it may be said that while mine explosions attributed to coal dust indicate its combustibility and the testing station of the U. S. Bureau of Mines in Pittsburgh has painstakingly shown that coal dust in suspension can be made to explode, pulverized coal, nevertheless, is an excellent fire extinguisher. To ignite it in any form, coal must be brought to the temperature of its ignition, 1000 deg. fahr. and above. This is greatly in favor of pulverized coal since it permits its being conditioned for better combustion performance by heated air before using.

Importance of Preheating Combustion Air

Combustion air for pulverized coal has variously been applied under different pressures and usually at ordinary temperatures. No judgment has yet been passed on the condition of the necessary air bearing either on the flame-propagation qualities of powdered coal or on the dimensions of the combustion chamber, and in the absence of definite experimental data one conjecture is as good as another. Although the relatively low deflagrability of the powder suggests it, it is only through costly experience that we have learned the advantage of low air pressures and velocities for combustible mixtures.

The function of air in connection with burning pulverized coal is not only to provide the proper amount of oxygen to hold and convey the powder or supply a dilution element, but also to carry the flame—zone of oxidation—in suspension throughout its path; that is, away from the brick walls. The importance of this requirement is obvious, in that it eliminates destructive temperatures and the accumulation of ash and semi-burnt particles on the brick walls, and secures more perfect burning of the fuel particles "in suspension".

The value of heated air for mixing and dilution purposes cannot be overestimated. It prepares the fuel for quicker deflagration, thereby permitting a larger quantity of fuel being burned in a given space, it maintains the powder in better state of separation, and in general promotes steadier combustion. Furthermore, in conjunction with a suitably designed furnace it is possible to attain a better heat balance by utilizing waste gases and radiation for heating the combustion air required for the treatment of the powder.

For mixing purposes the air temperature should not exceed that of the coking point of the particular coal used, and for dilution the higher the temperature of the air the better.

Comparative tests on a 250-hp. boiler using combustion air at 65 deg. fahr. and 750 deg. fahr. with powdered bituminous coal showed that, other things being equal, with air at 65 deg. the evaporation was 7.7 lb. per lb. of fuel and the temperature of escaping gases 528 deg., while with the 750-deg. air the evaporation was 9.17 lb. per lb fuel and the temperature of the escaping gases 475 deg. On the basis of the normal boiler rating this performance indicated a gain of 15 per cent. with hot air and a loss of 12.2 per cent with air at the ordinary temperature.[1]

At the present time air pressures from 0.5 oz. for small furnaces to 10 oz. and above for cement kilns are being used with success, while pressures of 3 oz. and under for boilers have given good results. As mentioned above, pulverized coal should be burned in suspension and with excess air on account of the high temperatures that develop in its combustion (see Table 1). The pressure and distribution of the air necessary to secure this condition vary with each case and demand careful consideration to obtain best results.

In general, the finer the powder and the warmer the air the lower will be the pressure necessary to inject the combustible mixture into the furnace, and the better will the powder be held in suspension; also, other things being equal, the larger the amount of fuel that can be burned in a given space. This implies lower furnace losses.

Comparison of Stoker and Pulverized-Fuel Plants

Economy in connection with fuels is a term which must be used with caution and depends upon the purpose for which fuels are employed. If pyrometric effects are sought, as in metallurgical furnaces, the conditions and rate of burning fuel are such that thermal efficiency is out of the question and economy can only be expressed directly in dollars, regardless of the kind of fuel used and its performance. If calorific or straight heating effects are desired, as in steam generation, thermal efficiency plays the all-important part, and in this connection two factors are to be considered; one involving the furnace performance and combustion losses, and the other the means provided to absorb the thermal charge in the products of combustion. These two conditions go hand in hand, and maximum economy is therefore a function of the two.

With pulverized coal the furnace and combustion losses can be greatly decreased as compared with those incurred in burning lump coal over grates, by reason of its manner of burning, and it is to that condition alone that very acceptable fuel economies can be effected by its use. Instances are recorded showing that 10,500-B.t.u. coal fired as powder in a given boiler setting has evaporated a larger amount of water than 12,090-B.t.u. coal fired by hand.[1] Invariably records of tests made in steam plants of various capacities using pulverized coal as fuel indicate boiler thermal efficiencies of 75 to 80 per cent and over, which parallel the best efficiencies obtainable with modern stokers in large installations. The consensus of opinion is that with the better methods of firing pulverized coal the high efficiencies observed both in the hearth and in the boiler remain fairly constant throughout a wide range of quantities of fuel burned, whereas with stokers, which permit only a rigid design of combustion hearth, beginning with the higher efficiencies in large boiler installations the efficiencies drop as the installations become smaller. This is self-evident in part, since in stoker practice only the better coals can be used to advantage and a certain amount of fuel loss cannot be prevented, whereas by pulverizing, all grades of commercial coals are admitted to the same service with equal merits and fuel losses may be avoided. And since deflagration, and therefore the combustion space necessary, becomes a measure of the actual amount of combustible present in the coal, the hearth losses remain practically constant for all conditions encountered in actual service.

The conclusion to be derived is that, other things being equal, the competition between the use of pulverized-coal firing and stokers for large boiler plants will be a matter of flexibility of service, convenience in operating, and maintenance cost; while in small plants fuel economy will be the deciding feature along with the other advantages, and pulverized coal will obtain the preference, not only on the basis of combined first and operating costs, but especially so after the greater convenience and flexibility of service resulting from its use have been sufficiently demonstrated.

Conclusive figures on the operating and maintenance costs of pulverizing equipment have not yet been obtained from actual practice, since no specific standards have been established. With

[1] J. H. Travis, *Power*, vol. 24, pp. 168-196 and 271

[1] G. F. Gasbe, *Railroad Gazette*, vol. 34.

self-contained pulverizing units, however, it is thought that, totalizing all the items of expense, the operating costs of an equivalent stoker equipment are approximately the same.

Considered as a gas, pulverized coal when mixed with 100 per cent of combustion air produces a fuel mixture having a calorific value of from 90 to 120 B.t.u. per cu. ft. Fig. 1 gives the relative costs of fuels on the basis of their calorific values.

Where it is desired to determine the maximum price which could be paid for a low-grade coal for pulverizing to place it on a basis comparable with higher-grade fuel for stoker firing, the formula

$$P_1 = \frac{P_2 H_1 E_1}{H_2 E_2}$$

may be used, in which P_1, P_2 = price per ton, delivered, dollars; H_1, H_2 = B.t.u. per lb. of coal; E_1, E_2 = combined boiler efficiency; and the subscripts 1 and 2 refer respectively to low-grade and high-grade fuels. The price P_1, however, does not include the cost of pulverizing.

Burners

Under the name of "burners" the devices that have been used to mix the necessary air and coal powder and feed the mixture to the hearth are numerous. Their merits are relative at best and each has its limitations, their only function being to convey, mix thoroughly and deliver the fuel charge to the hearth in the required quantity. Much ingenuity has been exhibited in the development of these devices, but little attention has been paid to what is more essential, namely, the correct design of the furnace for burning the combustible mixture.

Fig. 2 illustrates diagramatically the schemes generally employed in the devices now used. Scheme 1 shows a device which depends entirely on the induced chimney draft for the air supply. Naturally its capacity is limited by the chimney draft and its regulation is restricted to a small margin. This method would be suitable for service in which steadiness is a minor consideration. Scheme 2 shows a combination of natural and forced draft which permits wider application than Scheme 1; its regulating features are better, but it is still subject to the fluctuations of the natural draft. Scheme 3 shows an arrangement which affords full control of the fuel and the air, and in consequence greater flexibility in its operations, being less affected by external variables. It lends itself admirably to the application of

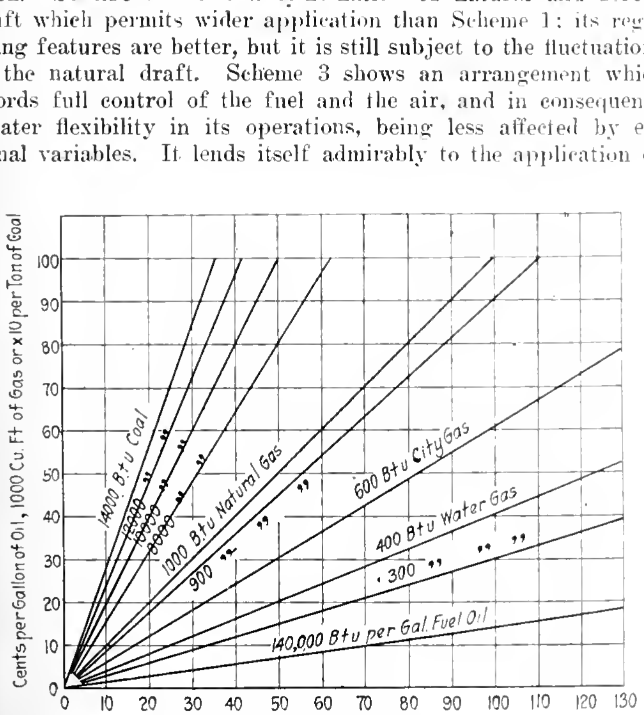


Fig. 1 Relative Cost of Fuels

heated air for combustion through the secondary blower f, a method which should be adopted exclusively for burning pulverized coal. It also makes it possible to automatically control the fire in response to varying load conditions, something particularly desirable in steam generation. Schemes 4 and 5 illustrate arrangements in which self-contained pulverizing units are employed, simultaneously preparing and feeding the fuel to the hearth. These machines are usually provided with a fan for the double purpose of separating the powder in the process of grinding, and mixing and supplying part or all of the combustion air. Schemes 3 and 5 possess the same merits as to flexibility, regulation and usefulness and should be adopted wherever possible.

Equipment for Preparing Pulverized Coal

Two distinct methods are in use to prepare pulverized coal. One of these involves a plant in which the fuel is treated independently of the rate of its consumption and comprises, beginning with the coal bunker and in the order of the operations: crushers, crushed-coal hoppers, driers, magnetic separators, pulverizers, powdered-coal storage hoppers, distributing conveyor feeding individual hoppers at each furnace which are fitted with feeding devices, and a blower or separate blowers operating in conjunction with the feeding devices to mix and feed the fuel to the furnaces. This various equipment is interconnected with suitable elevating or conveying means to conveniently carry out the cycle of operations and permit of multiple arrangements to suit local conditions. The advantages of pulverizing plants are:

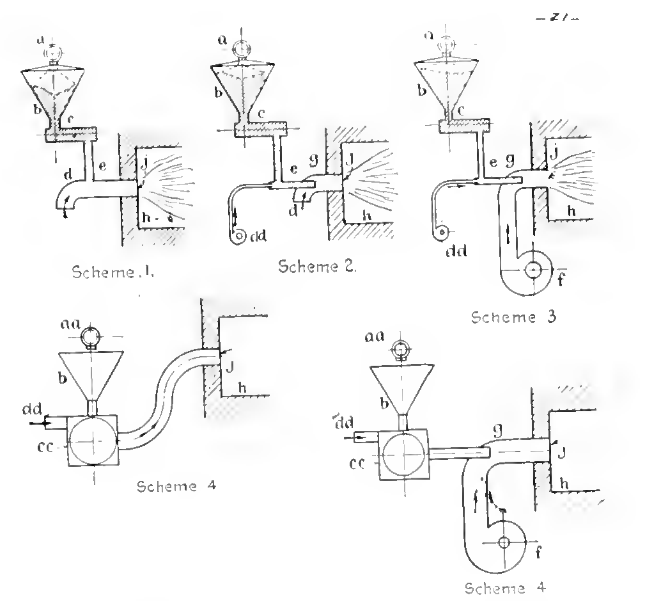


Fig. 2 Pulverized-Coal Feeding Devices

a, Screw conveyor for pulverized coal; *aa*, Screw conveyor for crushed coal; *b*, Hopper; *c*, Feeding device; *cc*, Self-contained pulverizing, mixing and feeding machine; *d*, Induced-draft combustion air; *dd*, Primary mixing air blower; *e*, Primary mixing chamber; *f*, Secondary air blower; *g*, Secondary mixing chamber; *h*, Hearth; *j*, Nozzle. The delivery outlet or outlets are arranged and shaped to suit the hearth, which in turn depends on the nature of the service.

a Uniformity in the quality of the powder
b Ample fuel supply to provide for varying loads and starting without taxing the normal operation of the equipment
c Suitability for large installations where uniform service and a central point of distribution are necessary.

The disadvantages are:

a High first and operating costs
b Large floor space required
c Multiplicity of equipment and parts.

The other method employs self-contained pulverizing units, conveniently located near the point of fuel consumption, which prepare the powder as required. Beginning with the coal bunker, the equipment comprises: crushers, magnetic separators, crushed-coal storage hoppers, distributing conveyor feeding individual hoppers at the pulverizers, pulverizers, blower for combustion air, and feeding devices leading to the furnaces. In the event of a single pulverizer feeding finished fuel to various furnaces the conveyor is eliminated, the distribution being accomplished by air as a part of the feeding devices for the furnace.

The advantages of this arrangement are:

a Simplicity of equipment and therefore low first and operating costs
b Individual control of each furnace
c Adaptability to existing plants
d Good regulation without altering the quality of the powder.

The disadvantages are:

a Necessity of carrying spare units, on account of severe wear and tear when in continuous service
b Absence of storage of powder for starting.

As a general proposition, if conditions permit ample storage and suitable handling facilities to air-dry and mix the raw coal thoroughly, the self-contained equipment offers greater possibilities both in flexibility of service and arrangement and economy.

II FLAMES[1]

The flame resulting from the deflagration of pulverized coal differs from that of other fuels in the larger combustion space required on account of its low combustibility, and the higher temperature due to the rapid breaking up of the solid structure of the coal particles.

In general, the more inflammable the material or the lower the rate of oxidation, the smaller the space required for its combustion and the lower the average temperature that develops.

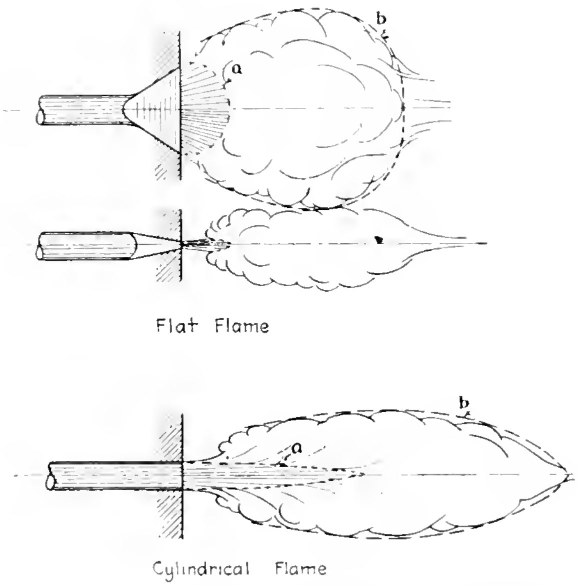


Fig. 3 Approximate Shapes of Flat and Cylindrical Flames of the Same Capacity and Under Similar Conditions

a, Zone of initial oxidation; *b*, Zone of complete oxidation. Note the length of zone *a* in the cylindrical flame. Coking of powder has been observed to take place within this zone through baking.

This condition is shown by the performance of explosives and the slow burning of gas, oxidation of iron, etc. The average temperature of combustion of gases in ordinary air is from 1500 to 2000 deg. fahr., and, for a given amount of fuel consumed, the combustion takes place in a smaller space than that required for atomized oils, which begin to burn steadily at about 2000 deg. Experience shows that the deflagration of pulverized coal requires a still larger space and that the average temperatures developed by its combustion are much higher—2500 deg. and above.

Fuels are rendered more inflammable as they are brought to or carried beyond their ignition temperature and are more thoroughly mixed with the necessary oxygen.

[1] Flame is usually defined as the luminous or visible portion of the zone of deflagration. While this is the ordinary conception, in the present case by "flame" is meant the zone of oxidation, that is, the space within which the oxidation of the combustible elements is completed, which is much larger than the luminous zone, especially in the case of blast flames, such as obtain with oil, gas and pulverized coal.

Temperature a Measure of Relative Molecular Activity

Temperature, like voltage and pressure, is a difference of potential and, with reference to burning fuels and heating, is a measure of the relative molecular activity of the materials involved, which can be expressed quantitatively in terms of MV^2. Reference to this phase of the dynamic theory of the formation of matter is made here merely to indicate the fundamental relationship between temperature, mass and the performance of the component material particles; so that for a given mass the measure (temperature) of thermal energy varies as the square of the molecular activity.

The truth of this is evidenced in part by the fact that the specific heat of a substance increases with the temperature, though not in proportion thereto, and in a manner which confirms the law just stated. A long metal bar heated at one end up to melting point is another example showing similar temperature conditions at equal distances apart toward the cold end.

As yet no definite methods have been found to measure thermal energy in terms of MV^2, and for the time being the practical value of the conception of that law lies in the aid it lends in following the actions that take place during combustion and heating to determine with some precision truer thermal conditions and effects that may result.

Assuming then that temperature is a function of the square of the activity of the particles of matter, it is easily conceivable that the greater the molecular or atomic disturbance caused by the combination of oxygen and the combustible elements, the higher will be the temperature of combustion, and that this temperature, though not directly proportional to, will vary as some function of the square of the rate of combination. If we then assign a constant value to the unit increment designated to measure temperature, as our present degrees, the heating of any given mass will vary as some function of the square root of the applied temperature (the temperature difference between the heating medium and the mass to be heated), and inversely as the mass. That is, the heating is not directly proportional to the temperature applied as is ordinarily understood. This fact is conspicuously verified in metallurgical work where a wide range of temperatures obtains.

The influence of mass, however, is not a constant one, since the nature of its structure varies in all materials and this condition must be looked to for the inconsistent results ordinarily observed in all heating operations. But a practical solution of the difficulty is not out of reach, for it may be stated that within the range of temperatures employed in industrial applications, manifestations akin to resistance, inductance and capacity appear in the process of heating, and that it is consequently possible to develop and introduce a term of the order of "power factor" to designate more precisely the amount of useful thermal energy from any one reaction, thereby eliminating prevalent empirical considerations. This method of dealing with the subject of burning fuels and heating in general, however, in the absence of conventional definitions and sufficient experimental data to quantitatively confirm the law, naturally calls for a more technical treatment. For the purpose in hand, however, it is necessary to adhere to existing methods and units, except that we have at our command a more comprehensive conception of the actions that take place, which is a material aid in arriving at practical results.

Coals Should Be Rendered Equally Deflagrable

Profiting by the foregoing considerations and recognizing that the structure of coal chemically and physically is a variable one, the all-important requisite for pulverized coal is that its nature shall be rendered as uniform as possible with reference to a given standard, so that for any given furnace the temperature and operating conditions at the hearth shall be maintained as constant as possible with the various kinds of commercial coals and afford approximately the same regulating qualities.

Assuming a continuous production of powder of uniform fineness and impurities, the inherent weakness of coal for burning

in powdered form is its deflagrability, which varies as its structure varies. It is possible, however, to alter the structure of all coals pyrometrically so they acquire a sufficiently uniform texture before combustion to practically satisfy the requirements. In general, hard and high-ash coals should be heated to a higher temperature than soft and low-ash coals, the coking point of the particular coal being the limit.

By rendering all grades of coal equally deflagrable the precision of other requirements becomes apparent: (*a*) The velocity of the fuel-mixture feed is limited and fixed by the velocity of the flame propagation, which means constant pressure and supply of air for all grades of coals, measurable by the actual amount of combustible content; (*b*) wider regulation by direct fuel control is possible; (*c*) very steady lower hearth temperatures can be secured. The desirability of these conditions is obvious. In general, for constant results the more inflammable the fuel mixture the higher the velocity of discharge and the lower the temperature of the hearth; and conversely, the less inflammable the fuel mixture the lower the velocity of discharge and the higher the temperature of the combustion hearth necessary to burn the same amount of fuel in a given space. For the realization of these conditions it is assumed that the distribution of combustible charge over the hearth is the same in each case.

Proper Velocity for Fuel Mixture

The proper velocity for the fuel mixture as determined by its inflammability can only be found by trial, and the condition to be fulfilled is that the base of the flame shall approach the outlet as closely as possible. A lower velocity may result in backfiring within the feed tubes, which are of appreciable dimensions, and cause a more or less destructive explosion. A higher velocity carries the mixture too far into the hearth before com-

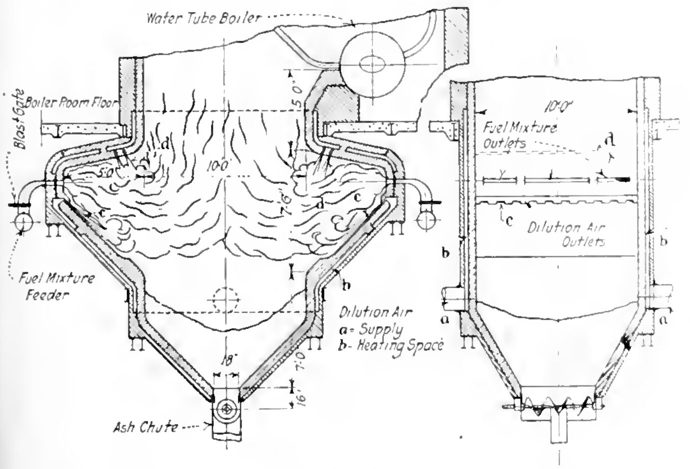


Fig. 4 General Design of Furnace for Burning All Grades of Commercial Coals in Pulverized Form Under a Water-Tube Boiler

bustion begins, and has the effect of coking and consolidating the particles, which drop to the bottom of the hearth in the form of relatively large globules, thereby causing faulty combustion and loss of fuel. Coking of the combustible charge is very perceptible in connection with discharge outlets of large diameter such as are used in cement kilns. The action in this case has been attributed to more rapid combustion on the surface of the combustible jet, which has the effect of baking the core within (see Fig. 3). This difficulty has been overcome by using outlets in the form of a slot of the required cross-section, thereby exposing more surface to the hot gases in the hearth.

Volume of Flame or Zone of Oxidation

The volume of the flame, that is, the zone of oxidation, in general, cannot be predetermined on account of the many uncontrollable variables, and especially because the virtual temperature of combustion cannot be ascertained by present means and the real time element of complete oxidation is not definitely known. Observation and analysis show that, under similar conditions, more inflammable fuels burn with a shorter flame than the less inflammable. In connection with pulverized coal the problem becomes more complex on account of the variable amount of excess air required for its combustion. The values for this excess hitherto suggested vary widely and are so conflicting as to preclude their use. Nevertheless, based on the average temperatures of combustion and the amount and temperature of the gases required, it is possible to arrive at a very satisfactory conclusion regarding the dimensions for the combustion and gas space.

Briefly, though in the combustion of pulverized coal there is a wide margin for regulation by judiciously applying the conditions herein indicated, nevertheless, until more complete ex-

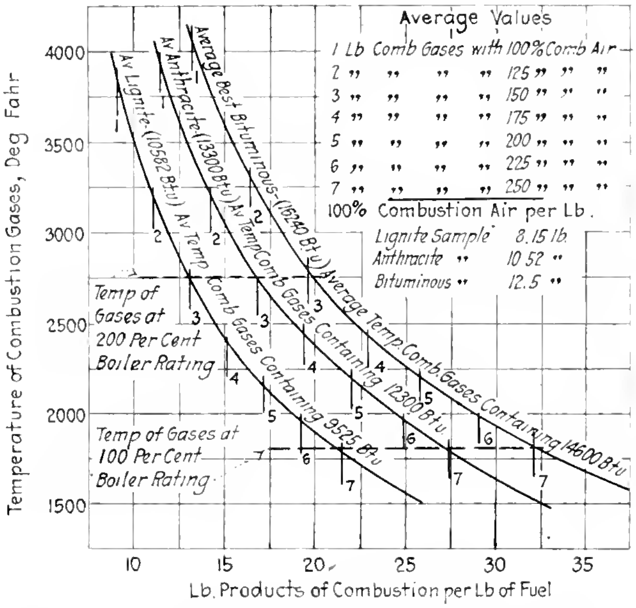


Fig. 5 Gases of Combustion of Typical Coals and Their Average Temperatures

perimental data are available, it is necessary to consider every element entering—from the nature of the coal to the performance of the boiler—and to disregard all precedent existing in the burning of lump coal in order to secure satisfactory results with the powdered fuel.

III FURNACES

Although in general furnaces are more or less special structures and their character is determined by the service they perform, their design and type of construction depend chiefly on the nature of the fuels used in their operation.

The combustion of a fuel results in gases charged with the available useful heat developed during their formation, and ash, in the case of fuels containing solid impurities. The quantity of gases and their temperature depend on the quality of the fuel and the amount of air used for combustion and dilution purposes, which can be varied to suit practical requirements.

In steam-boiler settings the duty of both boiler and furnace is a calorific one, that is, one of straight heating, and is measured by the amount of water evaporated in the boiler by the combustion gases from one pound of fuel.

The amount of water that can be evaporated in any type of boiler by a given quantity of fuel depends on the quality of the steam desired and the ability of the boiler to absorb the heat charge of the gases supplied by the furnace necessary for the generation of the steam required. So that, briefly stated, the boiler is subordinate to the steam requirements and the furnace

(*Continued on page 787*)

Fuel Saving in Industrial Plants

By JOHN F. TINSLEY,[1] WORCESTER, MASS.

Although war-time necessity of saving fuel has happily passed, the conservation of fuel is still as important as ever. During the war the industries of New England benefited in many ways through the suggestions and assistance of Fuel Conservation Committees, and although these are now of the past, their work is still having its effect. Their methods and the recommendations which they made are of value even today and this paper which outlines the campaign of the Worcester Fuel Conservation Committee contains a brief account of the manner in which that committee dealt with the problem.

AFTER the very strenuous winter of 1917, with its distressing "heatless" days and other comfortless evidences significant of a fuel shortage in New England, Massachusetts awakened to a fuller appreciation of the importance of conserving fuel, if her industries were to do the part expected of them in the winning of the war. Under the excellent guidance of the state and local fuel administrations, steps were taken in the early spring of 1918 to point out to the industrial fuel users of Worcester the critical situation that was likely to exist the following winter, and to create an organization that would carry out the work successfully and effectively.

The two things necessary to the accomplishment of any big work—incentive and organization—were quickly apparent, the former through the daily news columns of those dark days when the last great German drive was on, and the latter through the splendid response that has been so characteristic of the people of Worcester in every phase of war activity. At the time of the signing of the armistice, in November, the fuel-saving campaign had been successfully under way for several months with gratifying results and with every indication of an accomplishment in the saving of fuel that would exceed our expectations. But within a short time after that event the committee ceased its official functions, and this paper therefore deals with the work done in a comparatively few months prior to the close of the war.

The work of organizing Worcester's fuel-saving campaign was started in May 1918 with the appointment by the local fuel committee of a Factory Fuel Conservation Committee, consisting of three men selected from the management of three of Worcester's industries. This committee soon realized there were two distinct steps vital to success: First, that the managing heads of the various plants should be aroused to a full appreciation of the critical situation likely to exist in connection with the fuel supply; and second, that the foremen and workmen throughout the factories should be brought to feel that, after all, the real success or failure in meeting the problem rested in large measure with them.

The first part of the committee's program was easily and quickly accomplished. In a series of meetings the plant managers generously pledged their support and coöperation, and by so doing enabled us to vigorously take up the second step with the employees in the various plants. This task, however, was a large one, since it involved not only arousing the interest of upward of 75,000 men in about 260 plants, but also required for effective results that this interest be maintained.

To this end the Factory Fuel Conservation Committee appointed a sub-committee to assist in the work. This sub-committee was composed of practical engineers who could carry the message right to the workmen themselves. It was made up of eleven men chosen from the leading industries of Worcester, and the results accomplished through their fine work proved clearly the wisdom of their selection. Several of these men were technically trained, and all were practical. They were all engaged at the time of their appointment in active engineering work in the various concerns with which they were connected. These men were selected because the fuel problem has been for some time past a greater one with the larger plants than with the smaller ones, and many steps had already been taken by the larger concerns to save fuel. Consequently, through these engineers we wanted to pass along the full advantage of such experience to others.

The next step was to get the various shops organized. The State Fuel Administrator had requested that each factory appoint a Factory Fuel Committee, and the managers of the various industrial plants signed pledge cards agreeing that they would have fuel committees promptly appointed in their plants. Thus we had in a short time fuel committees appointed by factory managements to the number of 258 in Worcester. Some of those committees contained in the case of the smaller plants one man, but in the larger plants several men, who only represented the various lines of work in which fuel economies were possible. More than a thousand men were thus actively organized in Worcester on fuel-saving committees.

This portion of our organization was very effective, and the response on the part of these men whose efforts were exerted among thousands of workmen in Worcester was splendid. The details of factory organization and personnel thereof were left in most cases to factory managements, as we wanted these committees to feel that the responsibility was primarily with them. In this connection it is interesting to note that those plants that accomplished the most specialized in their factory organization to the extent of having specific men for specific jobs.

With an organization thus created that could easily reach the men in the shop, we were ready for business. As the problem was to save fuel, it was necessary at the outset to see that the various factory fuel committees understood the seriousness of the fuel situation, that they were organized to do effective work, and that in every plant the best opportunities for making economies were pointed out and thereafter followed vigorously. To accomplish these objects the various factories, to the number of about 260, were assigned to the Engineers' Committee for inspection, instruction and supervision. Each engineer was given about 25 plants to look after, assignments being made in groups throughout the city to facilitate visiting, though in certain cases all the plants of the same general manufacturing character were grouped together under one engineer.

In a remarkably short time, due to the splendid enthusiasm of these engineers and the generous coöperation of their employers in allowing them the time necessary to do this work, all the factories in the city were visited, the factory committees instructed, and an initial inspection made by the engineers. At the same time those lines offering the best promise were carefully pointed out to each factory committee, and practical suggestions made to meet the needs in each case.

There was one feature of our campaign on which we laid special emphasis. There is likely to be an impression in the average plant that the place to save fuel is where the fuel is used—in the boiler room. In fact, very little organized effort has been made in the past to save fuel anywhere else. There are, of course, many opportunities for saving fuel by efficient firing and by good boiler-room methods, but there is also a large field for fuel economies beyond the boiler room. The boiler room must meet the demands made upon it, and that demand is created outside. It was therefore apparent that if we were to make a favorable showing, the greatest opportunity for so doing was essentially outside of the fire room, and the economies in the fire room would necessarily have to be limited to such matters as could be effected quickly and without radical changes.

The visits and inspections of the engineers gained from every plant the best of coöperation from the start. The instances were few where any pressure had to be exercised to obtain results. In connection with the work certain records and statistics were, of

Abstract of paper presented at a meeting of the Worcester Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, May 28, 1919.

[1] Chairman, Worcester Fuel Conservation Committee.

course, necessary. We established for every plant monthly reports of fuel used, as compared with corresponding months of previous years, and also sufficient statistics as to operating schedules to permit of comparisons being made.

Inspection reports covering specifically all recommendations were also made. On the second and succeeding visits a report was rendered as to previous recommendations put into force, and additional suggestions offered. These reports were for two purposes: first, to give the State and local fuel committees reliable information (the fuel authorities took the position that in case of a critical shortage of fuel it was probable that the allotment of fuel to any plant would depend on the degree of coöperation that was extended by it); and second, to show the factory fuel committees that they were being rated on actual performances and compared with other plants.

Some idea of the value of these visits may be obtained from the records of recommendations made by the engineers. As a result of a single visit to 117 of the larger plants, 547 recommendations were made, or an average of about five per plant. Of these about 85 per cent were carried out before the second and third inspections, a response speaking most eloquently of the fine spirit of coöperation with which our efforts were met.

A few typical recommendations follow:

1 Many unnecessary lights are kept burning. Get everybody to help the cause by turning off unnecessary lights
2 Your belts are not looked after closely enough. You are losing power and money by having belts both too tight and too loose
3 Your motors are underloaded. The loss in efficiency and power is large if your motors run much underload
4 Your shafting should be lined up. Friction load in the average plant is very high, and power is wasted at a terrific rate if shafting is out of line
5 You have a lot of uncovered high-pressure steam pipes. Your losses are high, due to this cause
6 You have many machines running idle and wasting power. Install belt hooks and slip the belts off on machine shut down for long periods. If for short periods, educate your men to shift to loose pulley
7 Fix your doors and windows to prevent undue loss of heat
8 Wash your windows. You have an opportunity to save at least ½ hour of lighting daily by so doing.
9 Your fire-room practice should be improved. Keep fires bright, fire frequently, avoid holes, clean regularly, keep ashpit cleaned out, clean tubes oftener, get better damper regulation, etc.
10 Indicate your engine. We will help you take the card and interpret it.

There were, of course, many others, but all were of the common-sense variety, and it is evident that if all the industrial plants in any community worked concertedly and continuously along these lines, an economy in fuel must of necessity result. Furthermore, the service on the part of the engineers was not merely advice, for often they supplied from their own companies testing instruments, shaft-lining instruments, engine-indicating apparatus, etc., and assisted in making flue-gas analyses, engine indications, etc.

Aside of the work done in connection with the engineers' visits and inspections, the committee also felt that the educational or propaganda side should be emphasized. Literature that could be understood by the average workman relative to all phases of the fuel-economy problem was obtained and was distributed to the various factory committees. To firemen and engineers were issued short pamphlets covering in the simplest terms the fundamentals of economy as far as the generation and application of power were concerned, while to master mechanics and electricians were directed bulletins on belt troubles, power-transmission losses, etc.

We found the language most effective was that which dealt with dollars or tons of coal. The coöperation of a workman in regard to turning off an electric light was forthcoming much more quickly when he learned that, small as it was, in a year's useless burning it consumed several hundred pounds of fuel, and that 100 ft. of 1-in. uncovered pipe conveying live steam at 100 lb. pressure wasted upward of $100 worth of fuel per year, with coal at $7.50 per ton.

In addition to this service, the Factory Fuel Conservation Committee issued for two months a monthly newspaper or news letter which was much appreciated. In this paper were published the names of all factory-committee chairmen—something which was apparently liked—and a number of short, pithy, readable paragraphs giving suggestions for fuel saving. Efforts were made to cover all phases of the subject and thus interest engineers and firemen, master mechanics and electricians, as well as the rank and file of the workmen themselves. A noteworthy feature of this paper was the publishing under the various firms' names of the several steps taken by them to save fuel. This served an admirable purpose in stimulating a spirit of friendly rivalry, and also served to disseminate generally a knowledge of fuel-saving methods that could profitably be followed by other plants than those under which they happened to be reported. In a word, our educational or propaganda service was intended to give all industrial fuel users a knowledge of "what the other fellow was doing."

And now the results. Table 1 gives a comparison between the average monthly coal consumption of 13 of the leading industries in Worcester as between 1917 and 1918. The months under comparison are those of the late summer and early fall. The plants represented include the wire, grinding-wheel, belting, crankshaft, machine-screw, machine-tool and carpet industries, as well as one large public utility.

TABLE 1 AVERAGE MONTHLY BITUMINOUS COAL SAVING

Plant No.	Number of months included in average	Tons of coal consumed in 1917	Tons of coal consumed in 1918
1	3	16,953	14,778
2	3	7,847	7,044
3	3	1,697	1,438
4	3	1,303	1,388
5	3	866	908
6	3	586	200
7	3	367	340
8	3	333	350
9	3	296	144
10	3	293	189
11	2	278	200
12	2	255	15
13	3	132	110
Total......	....	31,232	27,104

The table indicates a general reduction in coal consumption in 1918 of over 13 per cent when compared with the same months of the previous year. There is another interesting point about this table. If it were divided into two parts of six plants each, representing the larger coal-using plants separate from the smaller ones (eliminating plant No. 12 which shows the largest relative variation), the saving is 11.9 per cent for the group of large coal users, as against 21.6 per cent for the group of smaller users. This is apparently as we should expect. The larger coal users had been studying their fuel consumption previously, while in the smaller plants the matter of fuel naturally had not been so prominent a matter of cost with them.

The question will naturally arise in connection with the comparison as given in the table as to whether it represents in both years similar operating capacities. In other words, was the load of these plants as large in 1918 as in 1917? This is an exceedingly difficult matter to determine, but a fair idea of the operating load of the plants may be obtained from the number of employees represented in these concerns in 1917 and 1918 at the time the comparisons are made. The twenty-six concerns included in the two lists report for 1917 at the time the comparison was made approximately 20,200 employees, and in the corresponding months of 1918 these same companies reported an approximate number of employees of 20,350, that is, an increase of approximately three-quarters of one per cent. The inference, therefore, is fair that the figures as given above as to saving are reliable. Succeeding months would also have probably shown even more gratifying results, since the figures reported herein cover months rather unfavorable for effecting the maximum effort in reducing fuel consumption. The movement was conducted, however, in an organized way long enough to show the splendid results that come from the coöperation of fuel users and from an organized effort to save fuel.

DISCUSSION ON PULVERIZED COAL AT THE SPRING MEETING

At the Fuel Session of the Spring Meeting of the Society two papers were presented on the subject of pulverized fuel: namely, Pulverized Coal as a Fuel, by N. C. Harrison, and Pulverized Coal for Stationary Boilers, by Fred'k A. Scheffler and H. G. Barnhurst. Abstracts of these papers were published in the August issue of MECHANICAL ENGINEERING, together with extensive extracts from the large volume of discussion which they elicited. A portion of Mr. J. E. Muhlfeld's discussion, dealing with the performance of pulverized-fuel equipment in locomotive and marine service, which it was not possible to print last month, is given below, followed by the closures of the authors of the papers.

Pulverized Fuel in Locomotive and Marine Service[1]

By J. E. MUHLFELD[2]

FROM a study made of the coal measures in the southern part of Brazil during 1904-06, it was concluded that the native coal was unsuitable for economic use. Later, during 1915-16, at the direction of Dr. Miguel Arrojado Lisboa, then Director of Government-Operated Railways, an investigation was made of the use of pulverized fuel in the United States, with the result that the Central Railway of Brazil decided to install a 15-ton-per-hour capacity fuel-preparing and coaling plant and a stationary boiler equipment at Barra do Pirahy, an enginehouse and shop terminal about 65 miles north of Rio. Plans and specifications were prepared and installation was made of the "Lopulco" system by the International Pulverized Fuel Corporation of New York. Arrangements were also made for the equipping of 250 existing and new locomotives with the same system and by the same company, and since that time twelve ten-wheel-type and two Consolidation-type locomotives have been newly built and so equipped, by the American Locomotive Company, and put into regular use on the Central Railway of Brazil.

The first official run with Brazilian native coal, pulverized, was made on September 9, 1917, with a special train that transported Dr. Wenceslao Braz, President of the Republic of Brazil, and his staff. Ten-wheel-type locomotive No. 282 handled the President's special train from Barra do Pirahy to Cruzeiro, a distance of about 90 miles, and during the greater part of the trip President Braz remained in the locomotive cab and fired the locomotive, on which the steam pressure was fully maintained throughout, without any smoke.

As the result of this performance, President Braz sent a telegram to the Minister of Public Works, as follows:

> From Barra do Pirahy to Vargem Alegre, I traveled on ten-wheel locomotive No. 282, fitted for the use of pulverized fuel, with excellent results. The trip was made with a velocity of 63 kilometers per hour, having a train of 210 units behind it. I take great pleasure to give you this communication which I am certain will be received by all Brazilians interested as solution of one of your most important national problems. Salutation.
>
> WENCESLAO BRAZ.

Barra Mensa, September 9, 1917.

The Central Railway of Brazil locomotives equipped with pulverized-fuel-burning equipment are operating in fast-passenger, mixed-passenger and freight, and freight service, and all are giving excellent results.

In tests recently conducted with Brazilian native coal and lignite the distance traveled during trials was 118 miles and the boiler pressure remained almost constantly at 175 lb., which is working pressure. The results of these tests may be stated as follows:

PERCENTAGE ANALYSES OF FUELS USED

Name	Kind	Moisture	Volatile	Fixed Carbon	Ash	B.t.u. per lb.
Jacuhy.........	Bituminous	6.10	22.40	45.70	19.80	10,851
Santa Catharina.	Bituminous	12.60	36.00	42.10	9.00	10,259
S. Jeronymo.....	Bituminous	3.00	31.00	39.30	26.70	9,565
Cacapava.......	Lignite	19.00	36.00	19.20	25.80	5,249

PERFORMANCE DATA

Fuel		B.t.u. per lb.	Quantity burned per trip, net tons	Evaporation, lb. water per lb. of fuel	Ash found in firebox and pan, lb.
Name	Kind				
Jacuhy......	Bituminous	10,851	4.19	7.2	176
Santa Catharina..	Bituminous	10,259	3.5	7.1	176
S. Jeronymo......	Bituminous	9,565	5.419	7.1	198
Cacapava........	Lignite	5,249	4.41	7.3	220

The only difficulty met with has been in instructing the enginemen, who were not acquainted with this method of combustion, and for this purpose an illustrated instruction book has been issued to each man.

Only by adopting this pulverized-fuel system has the problem of the utilization of Brazilian fuel, which cannot be burned practically or economically on grates or in retorts, or utilized to good advantage for the production of producer gas, been solved, and the development of the native coal fields of the country is now in process through the establishment of steamship and railway means of transportation from the mines, and in the actual mining developments.

In the United States the development work in connection with the use of pulverized anthracite and bituminous coals and lignite for steam locomotives has been carried out by making application to single locomotives of different types which were distributed on five different railroads of the country in order to determine upon a composite and interchangeable pulverized-fuel feeding, burning and furnace equipment that would be adaptable to any kind or size of steam locomotive, as well as to all possible fuels or combination of fuels locally available, and which at the same time would permit of the quick conversion from pulverized fuel to fuel oil, and vice versa.

When it is taken into consideration how many modifications of firebox, grate, ashpan, brick arch, smokebox draft appliances, exhaust nozzle and stack designs and equipments are required to adapt steam locomotives to the various anthracite and soft bituminous coals and lignites as used for fuel, even on a single railway, it can readily be imagined what the development of a single pulverized-fuel-firing mechanism and furnace arrangement for the entire United States has involved, particularly to make it adaptable to existing as well as new designs of locomotives. For example, the time required for the development and the practical use of fuel oil and of a satisfactory superheater is comparable.

During the past year the financial, labor and material conditions on steam railways, brought about by the war, have prevented any appropriations being made for the equipping of operating terminals and divisions in the United States for the extended use of pulverized fuel, but the result of what has obtained may be summed up in the following data applying to The Delaware and Hudson Company and the Atchison, Topeka & Santa Fe Railway:

On The Delaware and Hudson Company a newly built Consolidation type of freight locomotive, No. 1200, with a tractive power of from 61,400 to 64,000 lb., was equipped for experimental purposes, from March 1916 to August 1917, and operated in road freight service between Carbondale and Plymouth, Pa., and Oneonta, N. Y., on runs of from 37 to 94 miles one way. Pulver-

[1] Supplementing Mr. Muhlfeld's discussion of the Spring Meeting papers on pulverized coal, published in MECHANICAL ENGINEERING for August, p. 658.

[2] Vice-President, Railway and Industrial Engineers, New York. Mem. Am. Soc. M. E.

ized fuel was supplied from The Hudson Coal Company's stationary-boiler experimental pulverizing plant at Olyphant, Pa.

This locomotive was designed for a working steam pressure of 195 lb., but the boiler was designed to carry 215 lb. steam pressure. With 195 lb. working pressure the cylinder horsepower rating is 2368 and the boiler horsepower rating 2540, giving a 107.2 per cent boiler.

Pulverized-fuel tests were made with the following adjustments:

Adjustment	Boiler pressure, lb.	Tractive power, lb.	Factor of adhesion	Results
Original	195	61,400	4.36	O. K.
First change	200	63,000	4.24	O. K.
Second change	205	64,600	4.14	O. K.
Third change	210	66,200	4.03	O. K.

The raw coal which was supplied for these tests analyzed about as follows:

Content	Anthracite slush	Anthracite birdseye	Bituminous slack
Moisture, per cent	14.96	......	7.28
Volatile, dry, per cent	6.95	6.75	22.47
Ash, dry, per cent	23.67	75.23	57.21
Calculated B.t.u. per lb.	11,800	12,600	13,700

This raw coal was mixed in the proportion of 60 per cent anthracite and 40 per cent bituminous, which, after drying and pulverizing, produced a fuel of from 15 to 20 per cent volatile content. This was entirely satisfactory for locomotive purposes and yielded an average of one boiler horsepower for each 1.4 sq. ft. of combined firebox and tube heating surface.

Dynamometer-car tests conducted to determine sustained pulling capacity on heavy grades and at starting gave the following results:

Maximum dynamometer drawbar pull, lb.	Speed, miles per hour	Reverse lever cut-off, per cent	Throttle opening, per cent	Boiler pressure, lb.	Grade on line, per cent
64,000	At start	Full	75	200	1.65
59,000	6	66	Full	205	1.65
58,000	8	66	Full	205	0.72
56,000	10½	66	Full	205	0.72

During these tests a fuel mixture of 60 per cent anthracite birdseye and 40 per cent bituminous slack was used, and the apparent evaporation ranged from 7.3 to 9.3 lb. of water per lb. of coal consumed. The coal fired per 1000 ton-miles averaged 202 lb.

In heavy-tonnage-service runs—over ruling grades of from 0.72 to 1.65 per cent—for a distance of 37 miles the following data show typical performance:

Item	Trip No. 1	Trip No. 2
Miles run	37	37
Speed, average, miles per hour	14.5	13.1
Ton-miles, actual	83.147	85.758
Ton-miles, adjusted	88.553	90.113
Coal consumed per 1000 ton-miles	186	202
Steam pressure, average, lb.	199	200

When in heavy-mine-run service between Carbondale and Olyphant, Pa., for the three months' period, March 13 to June 12, 1917, the performance of the No. 1200 was as follows:

Period From	Period To	Days in road service	Hours in road service
1917	1917		
March 13	April 12	28	301 hr. 3 min.
April 13	May 12	27	301 hr. 30 min.
May 13	June 12	25	273 hr. 10 min.
Total....	....	80	875 hr. 43 min.

After the day's work, upon arrival at the Carbondale engine terminal, the locomotive would be run directly into the house, no fire, track or ashpit delays or work being required.

On the Atchison, Topeka & Santa Fe Railway an existing Mikado type of freight locomotive, No. 3111, with a tractive power of 59,600 lb., was equipped for experimental purposes—from May 1917 to July 1918, and operated in road freight service between Fort Madison, Iowa, and Marceline, Mo., on runs of 112.7 miles one way. Pulverized fuel was supplied from the company's experimental pulverizing plants at these points.

Dynamometer-car tests were run with the following average results, using Frontenac, Kan., run-of-mine bituminous coal, averaging in analysis when pulverized as follows:

Moisture, per cent	1.05
Volatile, per cent	32.67
Fixed carbon, per cent	51.57
Ash, per cent	14.71
Sulphur, per cent	3.95
B.t.u. per lb.	12,022
Per cent through 100-mesh	97.8
Per cent through 200-mesh	82.6

The general performance of the locomotive equipped with the Lopulco pulverized-fuel system was as follows:

Date of runs	Mar. 4 to Mar. 22, 1918
Total trips run (112.7 miles each)	14
Total miles run	1578
Average running time	5 hr. 6 min.
Average speed, miles per hour	22.3
Average train tonnage, net tons	2273
Average gross 1,000 ton-miles	256.5
Average coal per gross 1,000 ton-miles, lb	82.4
Average water per gross 1,000 ton-miles, lb.	566
Average boiler pressure, indicated, lb.	188
Average feedwater temperature, deg. fahr.	48
Average flue-gas temperature, deg. fahr.	553
Average smokebox draft, inches of water	11.3
Average firebox draft, inches of water	1.3
Average quality of steam, per cent dry	96.0
Average superheat in steam, deg. fahr.	233
Average lb. of coal per hour of running time, per equivalent sq. ft. of grate area	71.3
Average lb. of coal per hour of running time, per sq. ft. of boiler heating surface	1.01
FUEL PERFORMANCE	
Equivalent evaporation, lb. of water from and at 212 deg. fahr. per lb. of coal for boiler and superheater	9.22
Per boiler horsepower for boiler and superheater	11.15
Combined efficiency for boiler and superheater, per cent	74.5
Thermal efficiency for locomotive, per cent	4.19

An actual evaporation (not corrected for the quality of steam) showed at the rate of 8.46 lb. per sq. ft. of boiler heating surface.

The combined boiler and superheater efficiency showed a gain of 23.2 per cent for pulverized fuel as compared with hand-firing.

Based on the hand-firing performance, the use of pulverized fuel showed a saving of 22.5 per cent in fuel. The combustion was practically smokeless and the pulverized-fuel operating mechanism gave no trouble.

Fig. 1 shows a typical application of a pulverized-fuel-burning furnace as adapted to a modern steam-locomotive type of boiler for the use of any solid fuel having 15 per cent or higher volatile, or for fuel oil, regardless as to the other chemical characteristics.

Marine Service

During September 1918 quite a number of tests were made on the USS *Gem* (SP-41) on Long Island Sound to determine what results could be obtained from the use of Navy Department specification coal in pulverized form as compared with oil and other fuels.

One of the two Normand type of water-tube boilers was equipped with two pulverized-fuel feeders and burners, the furnace being fitted up with firebrick in a manner that would enable the use of either pulverized coal or fuel oil, or a combination of both. On account of the boiler not being equipped with induced draft the pulverized-fuel induced-air burners were connected to the regular air-blast system instead of being open to the atmosphere.

The characteristics of the coal used, after pulverization, were as follows:

Moisture, per cent	1.02
Volatile, per cent	18.70
Fixed carbon, per cent	75.10
Ash, per cent	5.18
Sulphur, per cent	0.65
B.t.u. per lb.	14,975
Fineness:	
Percentage through a 200-mesh screen	83.6
Percentage through a 100-mesh screen	92.0

On September 18, 1918, a four-hour run was made, from 8.30 a.m. to 12.30 p.m., during the last two hours of which the most economical speed for the ship, i.e., 16 knots per hour, obtained, and which enabled the engines to take the steam as fast as generated. This speed was maintained for the two-hour period, and then, as during the entire four-hour test run, the furnace operation was good—there was no heat effect on the refractory—and there was either no smoke, or it was very light; there was no accumulation of slag or ash on the boiler tubes or settings, and had the boiler been equipped with induced draft the efficiency results would have been better and the light smoke that was produced would have been entirely eliminated.

The log of the test for the last two hours of this four-hour continuous run was as follows:

TEST No. 23, SEPTEMBER 18, 1918

Time fired up	8.30 a.m.
Time of test	10.30 a.m. to 12.30 p.m.
Duration of test, hours	2
Average speed, knots	16 approx.
Average boiler pressure, lb.	210
Average superheat, deg. fahr.	67.5 (max. 86)
Average flue-gas temperature, deg. fahr.	541 (max. 570, min. 500)
Average indicated horsepower	751
Average revolutions per minute	261.5
Total pulverized fuel fired, lb.	3,235
Coal per i.hp.-hr., lb.	2.15
Total water evaporated from and at 212 deg. (on basis of 25 lb. per i.hp.-hr.), lb.	37,550
Water evaporated per lb. of coal from and at 212 deg., lb.	11.6
Boiler efficiency, per cent	75 approx.
CO_2, per cent	Avg. 13.5, max. 14, min. 13
Coal	Pocahontas Bituminous
Lopulco system equipment operation	Good
Lopulco system furnace operation	Good
Smoke	Light
Brickwork heat effect	None

This same boiler when using fuel oil of about 18,500 B.t.u. and when operating at a speed of 14 knots, develops an indicated horsepower-hour on 1.68 lb. of such fuel. Therefore, with coal of 14,975 B.t.u., in order to give equivalent results it should use 2.08 lb. per i.hp-hr.; whereas the performance at 16 knots shows 2.15 lb. per i.hp-hr.

A comparison of superheat as obtained with straight pulverized fuel and with fuel oil, respectively, on various test trips, is given in the following table:

Pulverized Fuel			Fuel Oil		
Trip No.	Average knots	Average superheat deg. fahr.	Trip No.	Average knots	Average superheat, deg. fahr.
22	10	43	14	10	45
17	12	73	16	12	70
23	16	66	24	14	58

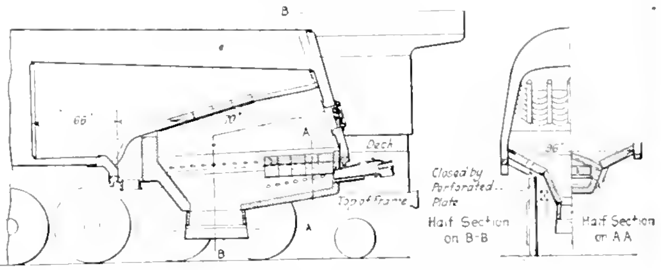


FIG. 1 TYPICAL APPLICATION OF A PULVERIZED - FULL - BURNING FURNACE TO A STEAM-LOCOMOTIVE BOILER

Closure of Messrs. Scheffler and Barnhurst

Mr. Marsh prefaces his remarks with a reference to the desirability of utilizing the by-products from coal. It appears to the authors that this is not pertinent to the discussion and that it will not require consideration until it becomes common practice to remove the by-products from coal before firing on hand grates or stokers. The inference is that pulverized coal cannot be burned after removing the volatile constituents, a supposition which is not borne out by the facts. His statements that pulverized coal is restricted to a field comprising forms that cannot be burned on stokers is an admission that pulverized fuels increase the latitude of combustibility and is not supported by evidence.

In reply to Mr. Marsh's objections to the tests submitted, it should be noted that with pulverized fuels uniformity of operation is obtained and maintained in a short time after firing the furnaces, and the variation in the figures need not be expected by prolonging the tests. In particular in the test made May 18, 1919, on one of the 600-hp. B. & W. boilers at the plant of the Puget Sound Traction, Light and Power Co. at Seattle, during which both the coal and water were weighed, the duration of the test being $13\frac{3}{4}$ hours, the efficiency obtained was 78.99 per cent with coal containing 10,106 B.t.u. per lb. as fired.

In regard to the figures assumed for stoker efficiency, it is submitted that the best information we have been able to obtain shows that an average efficiency of 65 per cent may be expected in modern power houses. Where power is not produced for sale this figure appears to be too high. Mr. Marsh does not substantiate his objections to these figures.

In regard to reliability, it is customary to duplicate a sufficient proportion of the pulverizing equipment to obviate irregular operation in pulverizing plants. This is taken care of in the figures on investment charges given in the paper and makes unnecessary Mr. Marsh's assumption that the investment charges quoted are too low.

In reply to Mr. Marsh's question as to the latitude of pulverized-coal furnaces, it should be stated that a furnace built for high-volatile bituminous coal will not handle anthracite or coke breeze. Where a considerable variation in the grade of available fuels is to be expected, however, the furnace may be designed to burn anthracite or coke breeze and will then be able to handle any grade of bituminous fuel with slight changes in the arrangement of the burners. It is a matter of surprise to the authors that the tests mentioned by Mr. Marsh show that the fire was unresponsive with low-volatile coals, since it has been their experience that the flexibility of all grades of fuels when pulverized exceeds that obtained when burned in lump form. The burner for pulverized fuel is very simple and has a wide range of adjustments, easily meeting any requirements made upon it by a change in the fuel.

In regard to adaptability, the effect of ash in coal is to carry away a small amount of heat as the percentage increases. The excess air required to burn fuels of the highest ash percentage is, however, negligible. It may be stated in regard to the varied efficiencies shown in the tests that pulverized-fuel furnaces require proper design as well as any other type, and that tests in many instances were a part of the experimental development and variations were to be expected.

In regard to the burning of high-ash coal on chain grates, it should be stated that the 28.4 per cent ash fuel mentioned by the authors was tried out on chain grates and was a failure. The stokers were taken out after they had been proved incapable and return was made to hand firing.

In regard to flexibility it is readily admitted that pulverized fuel requires large furnace volumes to burn successfully. It should be noted, however, that other types of fuels, including oil, are burned more efficiently with large furnace volumes, and that the best new stoker installations have furnace volumes as large as required for pulverized coal. The amount of heat that may be developed in a furnace with pulverized fuel is restricted only by the resisting powers of the refractories up to this maximum. The flexibility of control far exceeds that obtained with any other method of burning solid fuels. The upper limit is merely a matter of design and rating.

Under the head of furnace design Mr. Marsh again protests against the inclusion of tests of four or five hours' duration. This has been answered above.

Mr. Marsh objects to the figures used for moisture percentage in coals. It may be stated that our tables were based on a general average moisture content for the entire country. Further, the figures given for pulverizing cost are the result of present information and the best obtainable. They will not vary greatly except under unusual conditions.

We must take exception to Mr. Marsh's statement that three-quarters of the ash goes out of the chimney. Generally speaking, 20 to 25 per cent will remain in the combustion chamber and 30 to 40 per cent in the second and third pass, and the balance in the flues and out of the stacks. Very little settling takes place after the gases leave the boiler. With coal containing 10 to 15 per cent ash the stack discharge is not objectionable, even in cities. With higher ash content it might be necessary to provide dust collectors in the flues in city power plants.

In answer to Mr. Marsh's question, pulverized coal is stored in closed tanks, absorbs moisture very slowly, and under the methods of installation in use does not stay in storage for any considerable period.

Mr. Marsh criticizes the authors' claims for range of fuels, and follows by asking of what value the capacity to handle both anthracite and lignite may be. It is self-evident that with such a range as this many of the intermediate fuels may be burned. His statement that the cost of drying and pulverizing fuel in installations of from 500 to 600 tons daily capacity is over $1 per ton is at variance with figures obtained from hundreds of plants and upon which our estimates are based.

Mr. Diman is correct in stating that there is a limit to the quality of low-grade fuels that can be used in pulverized form. There is no doubt that if the coal is too low in combustible the cost of grinding would overcome any advantage obtained in economy of burning these coals in pulverized form. Success in burning anthracite depends upon the form of the furnace. As the coal lacks volatile, increased temperature must be generated near the burner, and this is accomplished by the use of some of the products of combustion from the furnace itself. This means designing the furnace so that there is a returning flame to ignite the incoming fuel. With this arrangement very satisfactory operating efficiencies are being obtained, and there is no trouble in starting a furnace so designed in but a little more time than that required with pulverized bituminous coal.

In Mr. Peabody's discussion of Mr. Harrison's paper he states that oil is undoubtedly superior to all other fuels for boiler purposes, and that the furnace volume required for oil fuel is only about one-quarter of the furnace volume specified in the paper for pulverized coal. Mr. Harrison recommends a larger combustion chamber than we know is actually required, but we have found that where oil is fired in pulverized-coal furnaces much better efficiency is obtained than is obtained in furnaces designed for oil alone. Larger combustion chambers are constantly being installed under all boilers for the purpose of obtaining better combustion conditions. This is due to the fact that the best mixtures of the air and carbon or coal cannot be made with the present method of oil or lump-coal firing.

The slight extra cost of the larger furnaces required is more than overcome by the increase in efficiency obtained over other methods of firing. It has been mentioned previously that combustion chambers recommended for pulverized coal are no larger than those now being used in a great many stoker installations.

Mr. Hirshfeld has probably not examined very many pulverized-coal-fired furnaces, or he would have found that there is hardly any trace of combustible in the ash in the furnace. We do not agree with his statement that a more uniform flame and temperature can be obtained with stoker practice due to the smooth bed of incandescent fuel. A fuel bed is a very uncertain quantity in the average furnace. It cannot remain of constant thickness or of constant quality. The conditions of the fuel bed are beyond control, and the coal must frequently be redistributed by the fireman. Certain types of stokers must be watched constantly and the holes in the fire bed kept covered with fuel.

In reply to Mr. Hibbard, the authors would state that drying of the coal is necessary for the purpose of properly pulverizing it. The injection of water or steam into the firebox is a dead loss, and is resorted to only as a means to overcome defects in the method of burning fuels. There is no occasion for this with pulverized fuel.

The experiments mentioned by Professor Young have no connection with the subject of pulverized-coal burning, because the quality of the material with which he has been experimenting is thousands of times coarser than the standard pulverized coal as now being used for commercial purposes.

Mr. Frey takes up the cost of pulverizing coal, basing his statements on data obtained from a first-class power house. We are doubtful, however, even in this power house, as to whether the evaporation from the coal that he is using would average 6 lb. of water on the average over a year's operation, and if the evaporation was increased only 50 per cent, certainly the increased efficiency obtained from the fuel would more than counterbalance the extra cost due to pulverizing unless the coal is obtained for practically nothing.

It is evident that the lower the price of the coal the larger must be the plant and the lower the cost of preparation to show economies warranting its application, but the cost of coal is going up steadily on account of the increased demands for fuel for manufacturing purposes.

Mr. Wotherspoon's remarks had no bearing on the subject of the application of pulverized coal to boiler-firing work, with the exception of his reference to the Bettington boiler experiments, which were made a number of years ago, and which were an entire failure so far as practical operation was concerned.

Mr. Snyder's remarks are noted with interest. The question of the adoption of pulverized coal to power houses is only warranted where the cost of operation would show a fair interest on the investment. We admit that stoker plants are operated with high efficiency under careful management, but we believe that pulverized coal will show increased efficiency and lower cost of operation than the average stoker installation, particularly in plants using a large enough quantity of coal to permit obtaining a low cost of preparation.

Mr. Stevens offers information, which he obtained from a prominent engineer, to the effect that 2¼ per cent of unconsumed carbon passes out of the stacks with stokers. This is a condition that is not possible with pulverized coal in furnaces properly proportioned and operated correctly.

Mr. Riley's remarks are particularly gratifying in that he fully realizes that the question of the adoption of pulverized coal is a matter of dollars and cents, and that its application in any installation is a question of which system will give the best returns for the money invested.

Mr. Trump spoke of experiments made in past years, and the writers particularly wish to point out that the furnace was too small for the boiler which he used, or else the quantity of coal fired to the furnace was beyond its capacity for satisfactory service. Furthermore, in the earlier days the fineness of pulverization was so much coarser than that now used in standard practice that there is no comparison, and the results obtained could not possibly have been satisfactory enough for commercial purposes.

Mr. Cary is correct in his statement that the idea of the use of pulverized coal has been in the minds of engineers for many years. Many experiments and thousands of dollars have been spent in an endeavor to accomplish this purpose. It has, however, been an evolution, and the earlier disastrous results were strictly due to the fact that sufficient knowledge of the subject was not at hand. The engineers did not realize that it was not the pulverizing of the coal that caused the trouble, but the fact that they tried to burn this kind of fuel, which is nearly in the form of a gas, in a furnace designed for lump fuels.

We would like to mention in regard to Mr. Cary's statements that today the fineness of pulverized coal is such that it practically all passes through the 50-mesh sieve, which means that the largest particles are less than 0.01 in. in diameter. The velocities are slow enough to insure the complete combustion of the particles of this size, hence it is not necessary to go to the extra cost of pulverizing to any higher degree of fineness than is now practically the standard, which equals 95 per cent through a 100-mesh sieve and 85 per cent through a 200-mesh sieve, all passing through the 50-mesh.

In closing, the authors wish to express their appreciation of the attention and interest accorded them, as evidenced by the discussion. It is not their wish to present the pulverizing of fuels as a modern panacea, but merely to lay before the Society a statement of its possibilities and to remove some of the fallacies in regard to it which have had more or less general circulation.

Mr. Harrison's Closure

I note that Mr. Marsh states in his discussion that I have used pre-war prices for the cost of pulverizing. He has cited the cost used in Table 1, whereas he should have used the cost shown in Table 3, or rates of 40 cents for millers and 35 cents for laborers and $5 a ton for coal. These are not pre-war prices, but are the present-day prices as paid by the Atlantic Steel Company.

Mr. Marsh also speaks about pulverized coal picking up moisture when stored. I thoroughly agree with him on this, but every one who uses pulverized coal has found by experience that this fuel must not be stored. It must be kept moving at all times in the bins, consequently there is very little moisture picked up by the pulverized coal from the air.

I note in several discussions that considerable comment has been made regarding the height of stacks necessary for the use of pulverized coal on boilers, as spoken of in my paper. During February I visited one plant installed in Kansas, and saw boilers working there very satisfactorily with a stack of about 35 ft. in height.

Most of the comment has been that we should have a draft of 0.10 in. in the combustion chamber and a draft of from 0.20 in. to 0.60 in. at the damper. This has not been my experience for the best burning of pulverized coal under boilers. I believe that we should have practically a balanced draft in the combustion chamber and first passage through the tubes, and from 0.10 in. to 0.20 in. at the damper. These figures are based on 150 per cent of rated capacity. Of course, if the boiler is intended to be worked at a larger rating than this, it would be necessary to have larger stacks.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Departments of MECHANICAL ENGINEERING by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in this journal, or brief articles of current interest to mechanical engineers.

Recognition of Engineering Service by the Government

To the Editor:

Those who are fortunate enough to live or work near the trunk-line railroads have grown accustomed to the daily passage of troop trains. For six months these have been homeward bound, to the delight and relief of all. "We are gladder to see them going that way than the other," has been the homely expression of the multitudes who have waved at the boys as they swept by.

And the most highly prized of the possessions of the returned soldier is his discharge. For many years this will be exhibited with pride. Money could not buy it. Long after his friends have forgotten his record of war service and the memory of those days has become dimmed, that bit of paper stands as evidence of the deeds which each man performed for his Government. That discharge is the only concrete form in which his part in the great struggle is preserved—a form that is universally accepted—one that may be of benefit to the holder in many ways in the years to come. No one but admits that this is little enough from his country to compensate for the sacrifice and no one but rejoices in his possession therof.

Turning now to the vast army behind the army, should not service in its forces be recognized by some tangible mark or document? No profession contributed more than that represented by our Society, and yet it seems that after the hour of need has passed its work will go without commemoration. Just as the engineer has not been given the recognition which was his due from the public, so is the engineer being officially slighted, though probably unintentionally.

Engineering services differ from all other purchasable commodities in that they cannot be manufactured or forced—no system of intensive production can glut the market with them; like the mighty oak, they are a product of slow growth. It was the rounding up of the country's resources of engineering that was largely responsible for the "year earlier than expected" result; and the world marvelled at the speed and volume with which the supplies, from bullets to ships, were turned out to back up the boys at the front.

There should be (at least upon request) available some form of recognition for those engineers who gave so freely out of their experience and learning. Such form should hold equal value with other documents in the business world, in politics, as civil-service rating, and in the eyes of the public at large.

Donald A. Hampson.

Middletown, N. Y.

Foreign Coals and Stoker Installations

To the Editor:

American engineers are at an increasing rate being called upon to design and build power plants in many other countries. Successful engineering will establish American engineering practice and will have a similar reflection upon the American equipment. It is therefore important that engineering be based on accurate knowledge instead of any uncertainties as are likely to exist, due to the remoteness of the market.

In power-plant design the one big variable in any location is the fuel. This is a major problem, because no stoker or method of firing so far developed is suitable for all fuels, necessitating a thorough knowledge of the coal and its characteristics for a proper selection of stokers and furnace equipment.

Some fuels are definitely known to be unsuitable for certain stoker types and yet not infrequently installations are made under these conditions, due usually to a lack of actual knowledge of the fuels available to the market.

While we have hundreds of books discussing the chemical analyses and geological formation of our various coals, there is a lamentable lack of knowledge of how to burn these coals as commercially received, considering combustion rates, clinker, attendant labor and other items. No engineer can predict successful installations without such knowledge of the coals of all districts into which he markets his product.

If it is necessary to know the fuel characteristics of American coals to produce successful installations, it is certainly much more imperative to know those of the foreign coals, if failures are to be eliminated and successes assured.

Those of us who have been fortunate enough to work on combustion problems with the fuels of practically every country have accumulated some data relative to the composition and characteristics of foreign fuels, a brief general outline of which is presented. Any discussion must of necessity be general, as it is impossible to become specific regarding fuels without taking them up district by district and seam by seam.

North America. The United States produces the maximum coal tonnage of the world, most of it being bituminous.

Canada has a good production, mostly bituminous and lignite, including coals of wide variation in characteristics as to moisture content, clinkering and coking.

Newfoundland. Some bituminous coals are found, but not extensively developed.

Mexico. The coals of Mexico are found along the northern border, being probably an extension of our own Rocky Mountain fields. Some fairly good bituminous and semi-bituminous coals are found.

Central America. A small amount of coal exists in this country.

South America. Colombia has a small production of bituminous coal, as has Venezuela, Argentine and Chile. Peru has some anthracite deposits in addition to the bituminous coal.

The grade of coal found in South America is not high and it is burned with difficulty. Much Welsh and American coal is now imported, as the native coals offer little competition even with Welsh and American coals selling at thirty to forty dollars per ton in Buenos Aires.

Africa. Bituminous coal is found in the Belgian Congo, Southern Nigeria, Rhodesia and the Union of South Africa. The latter country also has a considerable deposit of anthracite.

While the production of coal in Africa is not large, some very good fuel is mined, and some very creditable stoker installations have been made.

Asia. China and Japan produce coal in considerable quantities and there are many large power stations stoker-fired. China has deposits of anthracite equal to twenty times those of the United States, so it is natural that a good portion of the steam generated in China will be from this fuel.

One sometimes hears the statement that Japanese, Chinese or other coals are suitable for a particular type of stoker. The statement is just as loose and unscientific as to state that the coals of America are suitable for any specific stoker. These countries have coal deposits of every class that we have in the United States and a knowledge of the specific fuel is necessary before it can be positively said that a certain stoker is suitable.

Korea, Manchuria, Siberia, Indo-China, India and Persia have considerable coal, but not extensively produced. In the latter three countries anthracite predominates.

Europe. Great Britain and Ireland stand second in the world production of coal and first in quality. The Welsh coals are the finest and most widely distributed fuels of any in the world. The British merchant marine bring cargoes of food stuffs or merchandise to Great Britain and make the return trips with a cargo of Welsh coal. This is one of the difficulties with which we are confronted in attempting to secure a wider export market for American coals.

Our coals nearest approaching Welsh coal are Pocohontas and New River, but most Welsh coals are superior to all but the choicest samples of our coals. Fifteen thousand to fifteen thousand five hundred B.t.u. per pound is characteristic.

Spain and Portugal do not produce coal extensively. France is a large producer of all grades of coal and should offer a good field for stoker installations.

Italy, Greece, Bulgaria, Denmark, Netherlands, Bosnia, Servia, Roumania, Sweden and Spitzbergen are all small producers of coal—mostly bituminous and sub-bituminous.

Belgium, Germany, Austria and Russia are large producers, the latter country having extensive anthracite deposits (almost double those of the United States).

Oceania. Australia has extensive coal deposits, a large proportion of which are of a very fine quality; the production is fairly large.

New Zealand, British Borneo, Dutch East India and the Philippines all have a small production of various coals of a bituminous, subbituminous and lignite nature.

In practically all of these countries there are some stokers. Some of the installations have been characterized by a wrong selection of stoker types, due to reasons discussed in the foregoing paragraphs.

Chain grates, due to their simplicity of operation and adaptability to burn all grades of bituminous, sub-bituminous and lignite fuel, have produced noteworthy results in most foreign countries and over a wide range of operating conditions.

It is very much to be hoped that in combustion engineering as in other lines of endeavor, American engineers will base their conclusions on accurate knowledge of the fuel and its characteristics and will conscientiously refuse to install stokers for conditions which are for any reasons unsuitable. On any other basis the industry as a whole suffers and our engineering is discredited in foreign markets, to the detriment of future export trade.

T. A. Marsh.

Chicago, Ill.

Discussion of Society Policy Urged

Mr. Calvin W. Rice, *Secretary:*

On page 688 of the August number of Mechanical Engineering there is a letter on Contributions on Society Policy by Mr. Morris Llewellyn Cooke addressed to the Secretary and also a reply by the Secretary.

I wish to urge on the Publication Committee that it find room in the Journal for suggestions on Society affairs and other contributions in this Correspondence section. Particularly contributions on Society affairs are desirable as distinguished from technical matters. Theoretically the Journal is very ready to publish such contributions, but practically its attitude gives the impression that it rather discourages them. Mr. Rice mentions a suggestion by Mr. Crawford and which is: "My reply to that was in effect that we were already doing what he proposed, but nevertheless, if he would condense his letter, we would be glad to publish it. He never came back."

Would it not have been decidedly better to have published Mr. Crawford's communication, if necessary, by condensing it rather than let the impression go abroad that possibly such a contribution was not welcome? As suggestions are undoubtedly wanted and are undoubtedly also welcome, even though that may not seem to be the case, it would be well to give possibly unnecessary space, as that would prove the welcome to be an actual fact and would probably gradually draw out more comment, some of which, no doubt, would be useful and constructive even though a great deal of it might simply be the airing of personal opinions.

Every member who chooses to so air his opinions is entitled to that privilege and it should be unhesitatingly extended to him even though it might, to some extent, crowd out some other matter.

I believe that if a properly worded questionnaire on this point were to be sent out, it would show very considerable interest

among the membership along this line. Everything will, of course, depend upon the wording of the questionnaire, as nothing is easier than to draw out any desired information by skilful phrasing of the questions asked.

Henry Hess.

Philadelphia, Pa.

[The Secretary has frequently told Mr. Hess that he is one of the most useful members of the Society and the Secretary takes satisfaction in again acknowledging the excellence of Mr. Hess's suggestion, and the following is the letter from Lt.-Col. Crawford, published in full.—The Secretary.]

My dear Mr. Rice:

Some little time ago, there came to me a circular letter over the signature of Mr. Walter B. Snow, promoting the circulation of the journal Mechanical Engineering by asking members of the Society to tell young acquaintances something of its undoubted merits.

About the same time there came from a friend a personal letter which advised me that at the present time there are more than twenty local unions of draftsmen and engineers in subordinate capacities already in existence around over the country, claiming a membership of three thousand, who are affiliated with the American Federation of Labor. An unverified rumor of a Civil Engineers' Union somewhere in Connecticut has drifted in.

Every member of our Society worthy of the name is and should be glad to help it or its Journal, but before we make an effort to spread the Journal's circulation widely, might we not be advised in a little introspection for the sake of some of these prospective members whose state of mind is indicated by the facts above mentioned, as well as for ourselves?

In a letter "to the editor" in the February issue, it is suggested that the Society "encourage the publication of letters . . . about the life of the Society in each issue of Mechanical Engineering." So far as I know, there has been no decision upon this, and before it is decided either to do this or not to do it, the implication should be clearly recognized.

Without perhaps intending it, the policy of the A. S. M. E. always has appeared to be to deprecate the open discussion of its affairs—especially after such affairs had reached the controversial stage. This is one well-recognized method of conducting any enterprise and there is much that can be said in favor of it. Most of us practice it as a matter of course in our private affairs. The opposite method and the one evidently advocated by your correspondent is "to take the lid off" and permit members to register complaints freely either by voice or pen whenever they may feel the spirit's urge. The point I wish to emphasize right here is that between these two policies there is no middle course possible.

If it is decided to encourage the fullest possible discussion of the Society's affairs in the Journal and at its meetings, there is implied a willingness to publish any and every criticism that may be received. It would be obviously unfair to the membership to adopt the policy of an open forum and still retain the censor. Since the subscription lists are open to all who can pay the fee, it might not be out of place or even unwise to open the columns of criticism of our Society to any one who can write and has something to say.

Since this letter is written as a suggestion, why is it not a timely one? Why cannot such communications be encouraged by an unequivocal and emphatic statement that all criticisms received will be published? Surely, letters written by members in good standing are entitled to such treatment. There is another phase to this procedure, as it is the testimony of every one of whom I know who has had the experience of adopting such a course that during a short period there may be too many carping and fault-finding letters, but these soon exhaust themselves and the way is open and well paved for the era of constructive suggestions coming from the membership. It is these that we need and for which we can afford to pay the price in introspective housecleaning. Consider what our Society might be if we could induce each of its ten thousand members once in a while to express his views on the purposes of the Society and the methods of their realization.

Can we not wisely decide to encourage in every way at our disposal the freest possible expression of public opinion as to Society activities? If in rare instances there is no foundation for a criticism, it will fail from its own ineptitude and no harm will have been done. But when there is a cause for critical or fault-finding comment, we all want to know about it and see that the fault is corrected while at the same time its cause is removed.

The writer is neither a reformer nor a crusader, as you know, but he does feel that if we were doing all that our pooled intelligence, facilities and experience could make possible for the engineering sciences and the profession at large, crowds of our younger prospective members would not be forming labor unions and there would be no need for members of the Society to solicit subscriptions for its Journal.

With kindest personal regards and my best wishes at all times,

Very sincerely yours,

C. H. Crawford.

Rio de Janeiro, Brazil.
March 13, 1919.

Strengthening of the Patent Office

The Patents Committee of Engineering Council has collaborated with the similar committee of the National Research Council in developing a scheme for the improvement of the method of dealing with patents in this country. The staff of the Patent Office is itself actively engaged in this effort.

Out of the report prepared by the National Research Council, and approved and adopted by Engineering Council as the report also of its Patents Committee, remedial legislation has taken form, and the following bills have been introduced in the House of Representatives:

> House Bill 5011, being a bill "To establish a Patent and Trade-Mark Office independent of any other department and to provide for compensation and infringement of patents in the form of general damages, and for other purposes."
>
> House Bill 5012, being a bill "To establish a United States Court of Patent Appeals, and for other purposes."
>
> House Bill 7010, being a bill "To increase the force and salaries in the Patent Office."

Mr. Edwin J. Prindle, Mem.Am.Soc.M.E., Secretary of the Patents Committee of the National Research Council, has recommended the publication of this notice in Mechanical Engineering to prompt mechanical engineers to write to the chairmen or members of the Patents Committees of the Senate and of the House of Representatives urging passage of the bills approved by the National Research Council. The personnel of these committees is as follows:

Committee of Patents of the Senate

George W. Norris, *Chairman*	Nebraska
Frank B. Brandegee	Connecticut
Philander C. Knox	Pennsylvania
Frank B. Kellogg	Minnesota
William F. Kirby	Arkansas
Ellison D. Smith	South Carolina
Thomas P. Gore	Oklahoma

Committee on Patents of the House of Representatives

John I. Nolan, *Chairman*	California
Florian Lampert	Wisconsin
Loren E. Wheeler	Illinois
Albert H. Vestal	Indiana
William J. Burke	Pennsylvania
Albert W. Jefferies	Nebraska
John C. MacCrate	New York
Guy E. Campbell	Pennsylvania
John B. Johnston	New York
John J. Babka	Ohio
E. L. Davis	Tennessee
John McDuffie	Alabama

The report of the Patents Committee of the National Research Council was published in the February issue of Mechanical Engineering, page 147.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A. S. M. E.

The Bureau of Research of the American Society of Heating and Ventilating Engineers

THE American Society of Heating and Ventilating Engineers has recently issued a Bulletin on their Research Bureau under the Directorship of Prof. John R. Allen, who has resigned from the Deanship of the College of Engineering and Architecture of the University of Minnesota to take up these new duties.

The following regulations have been adopted by the Society for the control of the Bureau of Research:

First: That there be a standing committee known as the Research Committee and consisting of 15 members, each serving for three years, five retiring each year.

Second: *a* That the Council shall nominate, previous to October 1st of each year, five members to fill the vacancies of those retiring at the next annual meeting.

b That the nominations made by the Council shall be published in the October issue of the Society's Journal.

c That prior to December first of any year, any ten members over their own signatures, may nominate one or more additional members of the Research Committee, and such additional nominations shall be placed on the ballot opposite the nominations made by the Council.

d The election shall otherwise conform to the regulations provided for the election of officers.

e Vacancies may be filled by the Council, such persons chosen by the Council to serve until a successor is elected at the next Annual Meeting.

Third: The Research Committee shall be divided into various Sub-Committees, as may be found desirable to carry on the activities of the Bureau of Research.

Fourth: The activities of the Research Committee shall include:

a Investigations of the need for research in any particular subject, and if such need is sufficient to warrant consideration from the standpoint of pure engineering, to appoint a sub-committee to

1. Collect all existing data and records
2. Carefully examine the records and report on the actual need for further work
3. Report on all available laboratories of colleges and other institutions, which might be utilized
4. Make definite suggestions for the line of procedure to be followed in research work and to confer with and advise the Director of Research upon this particular subject.

b Where research work is found necessary and the course of procedure is obvious, to negotiate with laboratories of colleges or other organizations, as offered, or order work handled by the Director of the Bureau. No work should be assigned to the Bureau which can be handled equally well elsewhere.

c If a sufficient amount of existing data appears to be available for analysis by Committee, to present a synopsis of such data to the next regular meeting of the Society for discussion and approval.

d To report all conclusive data, whether originating through the Research Bureau or Committee, or elsewhere, to the next regular meeting of the Society for discussion and approval.

e To report on questions of finance, ethics and commercialism.

Fifth: *a* One of the sub-committees of the Research Committee shall be known as the Research Executive Committee, and shall be composed of four members, one of which shall be the Chairman of the Research Committee. The Research Executive Committee shall conduct all the business of the Research Committee. It shall make the necessary contracts for rental and purchasing of equipment or material. It shall select and employ the director and such assistants of the Bureau of Research as may be required. It shall determine all salaries and approve all expenses incurred. It shall determine the rotation in which the subjects shall be investigated by the Bureau of Research.

b The Executive Committee shall not make contracts in excess of the income to the Research Bureau without the approval of the Research Committee and the Council.

Sixth: The Chairman of the Research Committee shall be ex-officio member of all sub-committees.

Seventh: *a* All acts or reports of sub-committees shall be subject to the approval of the Research Committee.

b All acts of the Research Committee shall be subject to the approval of the Council.

Eighth: *a* Each Chapter of the Society shall appoint a Research Soliciting Committee, which once per year shall conduct a campaign in its locality to procure funds for the maintenance of the Bureau of Research. Committees may be appointed by the Research Executive Committee in other localities not covered by the Chapters to conduct such campaigns in such territories.

b All moneys received for the Bureau of Research shall be kept by the Treasurer of the Society and used only for the purpose specified.

c The Research Bureau shall operate upon the budget plan. All payments from the Research Bureau fund are to be made by the Treasurer in accordance with the existing present plan for payment of the Society's bills, as authorized by the Council meeting of August 16, 1917, excepting that certification of the voucher by the Secretary of the Society is to be replaced by certification by the Chairman of the Research Committee or the Research Executive Committee. All special items are to be approved by the Research Executive Committee instead of the Finance Committee of the Society.

Ninth: Reports of activities of the Bureau of Research shall be sent to all members of the Society and to all subscribers to the Research Bureau Fund.

The Research Committee at its first meeting on March 10, 1919, unanimously passed the following resolution:

Moved, That in order that the activities of the Research Bureau shall be above reproach, it is the sense of the Committee that no tests, experiments, or research shall be conducted for compensation.

At present the Society has had total subscriptions amounting to $18,000 per year. The Bureau of Mines will donate the services of investigators, office space, janitor service, physical and chemical laboratories, use of special laboratory in connection with power house, service in the form of steam at high and low pressure, direct and alternating current, hot and cold water, gas and the use of such apparatus as may be available. It is estimated that this will amount to a money value of $20,000 per year.

The special activities which will be undertaken by the Bureau of Research are the investigation of the various systems of heating and the accessories on the market which are claimed to increase the efficiency or the comfort of present installations. Another problem is the establishment of air standards, based on moisture content in place of temperature.

Past-President Still expresses his ideas as to the function of the Bureau of Research as follows:

One of the first things on which the work will be centered will be an effort to determine what physical condition of the atmosphere must be produced in order to maintain the same perfectly healthful effects as are obtained in pure, clean, fresh outdoor air. This condition is not known today to physicists, thus opening an avenue to constant assaults by physicians and others. Such criticisms are quoted repeatedly to the discredit of this branch of the engineering profession and to the business of the manufacturers and contractors.

Next in order will be a scientific determination of heat losses by the use of various materials employed in building construction.

Then will be investigated the efficiency of various kinds of radiation and the proper place to locate radiation to secure the best and most efficient results in different types of buildings.

The most efficient methods of burning different kinds of coal in different types of boilers and furnaces, warm-air furnaces, and furnace heating, pipe sizes for steam and water mains, and hundreds of other subjects will be investigated.

Many manufacturers have made a practice of conducting private investigations to develop their apparatus to the point of commercial perfection which is to them most desirable, finally submitting their products to the experimental laboratory of some prominent university so as to gain an endorsement having some semblance of impartiality. This never succeeds in convincing the public, as there is no comparison with other makes of the same apparatus, nor does this method establish any standard by which to measure the performance of the apparatus tested. Hence the time and expense thus employed are usually poorly invested if not entirely wasted.

This project is of such importance to every manufacturer, contractor, jobber and specialist in the heating and ventilating field that it should receive his unqualified approbation and financial support. It is a big undertaking and will entail a heavy expense for several years. The financial support of every manufacturer and engineering organization must therefore be enlisted, and such financial support must be supplemented by the personal support of every one concerned.

ARTHUR M. GREENE, JR.,
Chairman Research Committee

A—Research Results

Apparatus and Instruments A5-19 Wire-Testing Extensometer. An extensometer for testing wire and other thin sections has been developed at the laboratory of the Westinghouse Electric and Mfg. Co. It consists essentially of a metal block to which two flexible side pieces are attached, the free ends of these carrying rollers. The wire to be tested is clamped at the block and passes between the rollers. Extensions of the wire between the block and rollers due to loading the wire result in rotation of the rollers, which are held in contact with the wire by the flexibility of the side pieces.

Light from a small, straight-filament galvanometer lamp passes through a collimating lens to a mirror in the axis of one roller. From there it is reflected to a similarly placed mirror on the other roller, and reflected from there to a white scale divided into millimeters. An extension of approximately 0.0001 in. causes a movement of the spot of light to a distance of 1 mm. on the scale. The position of the spot of light could be read to $\frac{1}{5}$ mm.

The instrument has been in constant use over a period of several months with very satisfactory results. Specimens have been tested having sectional areas ranging from one-tenth to twenty-millionths of a square inch, with satisfactory results. A patent application has been made covering this instrument. Address, Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa.

Apparatus and Instruments A6-19 Standard Cement Sample 46-c for checking 200-mesh sieves has been prepared and is ready for distribution. 80.2 per cent passes this sieve. Obtainable in 160-gram samples at the Bureau of Standards for 25 cents per sample; one sample sufficient for three tests. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Apparatus and Instruments A7-19 Picnometer. A new type of picnometer for the determination of density of viscous substances. Viscous liquids, such as molasses and oils, owing to their high viscosity retain innumerable air bubbles. This fact makes accurate determination difficult. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Apparatus and Instruments A8-19 Lime Investigations. A plasticimeter designed to determine the plasticity or spreading properties of lime has been developed by the Bureau of Standards. This simulates the action of the plasterer in spreading the material on the wall. Means are provided for obtaining the effort which the plasterer must exert and for varying at will the base upon which the plaster is spread, the time required and the angle which the trowel makes with the surface. The force required to spread the plaster in conjunction with the time during which this force acts gives the measure of the plasticity. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Apparatus and Instruments A9-19 Gas-Engine Indicators. Comparison tests between three types of compression indicators show that one type varies from 15 to 30 per cent from two more accurate types which agree with each other. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Apparatus and Instruments A10-19 The Measurement of Radii of Profiles. A communication (B519) from the Gage Section of the Bureau of Standards. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Apparatus and Instruments A11-19 The Micrometer Microscope and Its Use in Gage Inspection. A communication (B521) from the Gage Section of the Bureau of Standards. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Apparatus and Instruments A12-19 The Measurement of Taper Gages. A communication (B522) from the Gage Section of the Bureau of Standards. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Boilers A1-19 Boiler Treatment. Technical Paper 3218 of the Bureau of Mines. Address Van H. Manning, Director. Washington, D. C.

Calorimetry, Pyrometry, Thermometry, A1-19 Combustion of Volatile Oils in Bomb Calorimetry. A new method of burning volatile oils in a bomb calorimeter as a check on the results from a Junker Calorimeter. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Calorimetry, Pyrometry, Thermometry A2-19 Naphthalene and Benzoic Acid Samples. The Bureau of Standards has prepared new samples of naphthalene and benzoic acid to be distributed as standard heat samples, and the heats of combustion have been determined. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Cement and Other Building Materials A6-19 Fire Tests of Reinforced-Concrete Columns. Tests indicate that columns of gravel aggregate largely of quartz or quartz and granite showed a strong tendency to spall when subjected to fire, especially with spiral reinforcement. One inch of plaster cement with light metal binder formed almost complete protection. This suggested metal-lath forms, using the concrete which passes the form as plaster. With coarse aggregate little material squeezes out. Three columns were tested in May, in two of which cement plaster was used as protection, while in a third cast tiles of gypsum were used. The outer coat of cement plaster did not remain in place under fire. The inner coat did not give sufficient protection. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Cement and Other Building Materials A7-19 Hardeners for Concrete Floors. At the end of six months' exposure to ordinary laboratory traffic, the applications of magnesium fluosilicates, varnishes and paints, wax preparations, sodium silicate, linseed oil and soap solutions were successful. A solution of commercial sodium silicate seems to be as effective as most of the expensive preparations. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Cement and Other Building Materials A8-19 Stucco Specifications. A tentative stucco specification has been prepared for the Committee on Treatment of Concrete Surfaces of the American Concrete Institute. It will be published in their Proceedings for 1919 and in a Technologic Paper of the Bureau of Standards. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Cement and Other Building Materials A9-19 Calcium Chloride Corrosion Tests. Plaques of 1:2 mortar and 1:3 mortar in which plain and galvanized wire mesh had been imbedded were broken during May at the Bureau of Standards when two years old. Plaques were made without using calcium chloride in mixing water and with 4 per cent calcium chloride. The mesh, both plain and galvanized, where imbedded in 1:2 and 1:3 mortar without the calcium chloride was found to be practically free from corrosion. A 1:3 mortar to which calcium chloride was added had the galvanized mesh badly rusted and the plain mesh disintegrated. The mesh in the 1:2 mortar was attacked, but not to such an extent as that in the 1:3 mortar. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Cement and Other Building Materials A10-19 Unsoundness of Lime Plaster. To prevent unsound lime plaster with its resulting popping, the plaster sand should not contain over 1 per cent of sodium chloride, 2 per cent of magnesium chloride, and 10 per cent of red clay. Inferior quality of clay is responsible for popping. The expansion of small particles of plaster is the cause of this. The experiments have not been completed, but these results are now evident. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Chemistry, General and Physical A1-19 Applications of Critical Solution Temperature Methods. Application of method to determine purity of chemical substances. When two

substances form two liquid layers, the highest temperature at which they can exist and the concentration at this point are the critical solution temperature and critical concentration, respectively. This fixed temperature in any particular case is greatly changed by small quantities of certain impurities. This phenomenon is being applied to the following problems:

1 Determination of the composition and constituents of petroleum products, especially gasoline
2 The quantity of water absorbed by gasoline, transformer oil and other liquids which do not mix readily with water
3 The miscibility relations of the alcohols and hydrocarbon mixtures such as kerosene, as bearing on the utilization of the higher-boiling hydrocarbons as internal-combustion-motor fuels.

Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Dyes and Textile Chemistry A1-19 Ink Tablets and Powders. Analysis of a large variety of permanent inks and powders for important records. Bureau of Standards is in a position to make valuable suggestions to manufacturers and Government agencies. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Electricity, General A2-19 Ignition of Cotton by Static Electricity. The Bureau of Standards has determined that the discharge from a static machine will ignite cotton under certain conditions of humidity, voltage and spark frequency, and that electricity is generated by rubbing dry cotton over a galvanized surface. Experiments were carried on because of considerable fire loss in cotton-ginning districts. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Electric Power A3-19 Relative Capacities of Plates of Storage Batteries. The relative capacity of positive and negative plates are compared, showing material improvement at slight additional cost when plates are of different capacities. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Electric Power A4-19 Impurities in Acid Electrolytes. Batteries affording poorest electrical performance contain largest amount of impurities in electrolytes. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Fuels, Gas, Tar and Coke A2-19 Motor-Gasoline Properties. Laboratory methods of testing and practical applications. Technical Paper No. 214 of the Bureau of Mines. Address Van H. Manning, Director, Bureau of Mines, Washington, D. C.

Fuels, Gas, Tar and Coke A3-19 Gas-Standards Investigation. Report of a Committee to the Public Service Commission of Indiana regarding the heat value of gas to be expected from gas plants using various grades of coal. Address Public Service Commission of Indiana, Indianapolis, Ind.

Glass and Ceramics A1-19 Joints of Glass to Metal. Platinized glass tubes fused into metal tubes will hold pressure up to 3000 lb. per sq. in.; capillary tubes to 6000 lb. per sq. in. Application to laboratory work in connection with glass bulbs and small valves for weighing liquid ammonia, carbon dioxide, and ethyl chloride. Used in determining gas densities by condensing gas and inclosing it within glass bulbs, and in determining the density of volatile liquids and liquefied gases for purification of gases at high pressure. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Glass and Ceramics A2-19 Heat Transfer by Radiation. Tests of plain, ribbed and hammered window glass used for greenhouses show that for a total rise of 50 deg. in temperature, the temperature rise in a given time was the same for all three within 1½ to 2 deg. cent. Aside from screening of plants from the direct sunlight, there is no apparent advantage in the use of special glass. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Glass and Ceramics A3-19 Glasses for the Protection of the Eyes from Injurious Radiation. Technologic Paper No. 119, on The Ultra-Violet and Visible Transmission of Protective Eyeglasses, discusses the results of the visible and ultra-violet transmissions of 82 samples of eye-protective glasses; the infra-red transmission having been covered by an earlier paper. Information is given regarding the approximate color, thickness, transmission between specific wave lengths compared with transmission of a sample of colorless crown glass and with the visibility or sensitiveness curve of the average human eye. The total light transmission is also given. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Internal-Combustion Motors A1-19 Deterioration of Spark-Plug Electrodes. Three phenomena appear to contribute to the sharp fractures which occur in several of the slide or "ground" electrodes of spark plugs: First, selective oxidation along the crystal borders with the formation of eutectic-like network; second, overheating and sudden cooling of one spot by spark gives rise to an intercrystalline network of fissures; third, tension on the hot wire will break it with a very low load with definite transverse intercrystalline cracks. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Internal-Combustion Motors A2-19 Radiator Investigations. Determinations of drop in pressure through air tubes of radiators show that smooth, clean and polished surfaces give higher efficiency than rough or corroded surfaces. The effect of indirect cooling surfaces and the effect of water speed on radiator efficiency have been determined. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Internal-Combustion Motors A3-19 Flame Propagation in Internal-Combustion Engines. The rate of flame propagation in engine cylinders is being measured at the Bureau of Standards, more than 150 individual photographic records being taken. The average value of this rate for aviation gasoline in engine cylinders is 10 meters per second under normal conditions. A velocity of 2.5 meters per second is obtained with lean air-fuel mixture. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Metallurgy and Metallography A6-19 The Microstructure of Very Low-Carbon Steel. Very little information is available regarding the structures which may be produced in steel containing but a few hundredths of one per cent of carbon. W. J. Brooke and F. F. Hunting (*Journal of the Iron and Steel Institute*, 1917, No. 2, p. 233) report an unusual structure found in Armco iron quenched from between 899 and 832 deg. cent. They offer the explanation that it is a eutectoid thrown out of solution between these temperatures. A study was made at Yale University, under the direction of Prof. C. H. Mathewson, to throw some light on the nature of this constituent and to determine the effect of various forms of heat treatment on the structure of very low-carbon steel. The material used was prepared by Dr. T. D. Yensen at the Westinghouse Research Laboratory by fusing electrolytic iron and carbon in a vacuum furnace. A series of exceptionally pure steels was thus made, with the carbon content ranging from 0.02 to 0.100. It was found that the "eutectoid" structures could be produced in this pure material by quenching from within the critical range. Further experiments produced conclusive evidence that the so-called eutectoid is not caused by impurities in the metal, but represents the transformation product of the austenite which is stable at the temperature of quenching.

When very low-carbon steel is quenched from above A_3 a large amount of free ferrite is found, the carbon being present in the form of sorbitic needles scattered throughout the material in the cleavage planes of the original austenite. Annealing at a temperature just below A_1 for a long period of time brings about a separation of the

sorbite needles into minute globules of cementite. Heating to just above A_1, followed by slow cooling, changes the sorbite into very small grains of pearlite uniformly distributed between the small ferrite grains. R. E. Bedworth. Address Westinghouse Electric & Manufacturing Co., Pittsburgh, Pa.

Paints, Varnishes and Resins A1-19 Specifications for Linseed Oil. Circular No. 82, Recommended Specifications for Linseed Oil, has been issued by the Bureau of Standards, this being the first of a series of paint specifications based on recommendations of a Committee composed of representatives of various Government organizations purchasing such materials. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Properties of Engineering Materials A2-19 Mechanical Properties of Materials. The Bureau of Standards has issued a 51-page circular letter giving the various properties of engineering materials such as iron, steel non-ferrous metals, rubber, leather, rope and wood from latest information. The properties include density, specific gravity, tensile and compressive strengths, elongation and reduction of area, modulus of elasticity, modulus of rupture, shearing and transverse strength, ductility, Brinell and scleroscope hardness. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Sugar A1-19 Sugar Technology. An investigation of the method of analysis of sucrose or cane sugar in the presence of other sugars has been completed. The polariscope is unable to differentiate between sucrose and other sugars. As a single observation merely gives the effect of all sugars in the solution, double observations are required in which all substances except sucrose remain unaltered, inversion being brought about by heating with acid. The constants upon which the method which has been hitherto widely used was founded have been found to be considerably in error. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Sugar A2-19 Density of Viscous Liquids. See *Apparatus and Instruments A7-19*. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

B—Research in Progress

Aircraft B1-19 Fuselage Shapes. Curtiss Engineering Corporation, Garden City, L. I.

Aircraft B2-19 New Wing Sections. Curtiss Engineering Corporation, Garden City, L. I.

Aircraft B3-19 New Types of Gasoline Pumps. Curtiss Engineering Corporation, Garden City, L. I.

Aircraft B4-19 New Types of Turbine Propellers with Special Characteristics as Constant Power at Various Air Speeds. Curtiss Engineering Corporation, Garden City, L. I.

Aircraft B5-19 Resistance of Flags. Address Curtiss Engineering Corporation, Garden City, L. I.

Apparatus and Instruments B10-19 Design of Aerodynamical Balance of New Type. Address Curtiss Engineering Corporation, Garden City, L. I.

Apparatus and Instruments B11-19 Experimental Determination of Influence of Air Conditions at High Altitudes on Indication of Air Speed Meters of Venturi and Pitot Types. Wind tunnel used under reduced air pressure. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Apparatus and Instruments B12-19 Orifice Gas Meters. An investigation of orifice meters to correlate and verify the work of previous investigators. Coefficients to be determined are of fundamental importance in establishing accuracy of measurements of steam, natural gas and other gases. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Apparatus and Instruments B13-19 Weather Tests of Building Stone. The Bureau of Standards is endeavoring to perfect an automatic freezing apparatus which will give a disintegrating effect comparable with weather conditions and at the same time facilitate the process in the laboratory. The indications are that it will be possible to produce as much disintegration in a few weeks in the laboratory as would occur in several years' exposure to the weather. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Cement and Other Building Materials A9-19 Expansion and Growth of Marble and Limestone. The thermal expansion of marble has been examined at the Bureau of Standards and the tendency to increase its dimensions permanently following successive heatings has been shown to be true. Experiments are being carried out to determine the amount of this growth for different types of marble and also to determine if it is appreciable for the ordinary diurnal temperature changes. Some slabs of marble 6 ft. long are exposed to the weather and measured each month. Tests are also being conducted on Indiana limestone. An examination was made on a marble floor which had been cracking. It is believed that this is due to the gradual growth. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Cement and Other Building Materials B10-19 Volume Changes in Cement Mortars. Continuation of work of previous months. Measurements are being made of slabs of cement mortar with the same mix of cement and sand but with 12, 13, 15, 16 and 18 per cent of water. The indications are that with the same mix and the same amount of water the contraction is the same although the slabs are made under different conditions of temperature and atmospheric humidity. Usually the contraction is greater with a larger amount of water. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Cement and Other Building Materials B11-19 Oil Storage in Concrete Tanks. The Bureau of Standards is examining concrete in connection with oil storage. So far lard oil and cocoanut oil are the only oils which have attacked concrete. After one year the surface of the concrete of the tank containing lard oil has disintegrated. After one year specimens of concrete stored in various oils and under normal conditions give the same compressive strengths. A paper presenting the results of these investigations was read before the annual meeting of the American Concrete Institute. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Chemistry, Inorganic B1-19 Spectroscopic Researches. The Bureau of Standards is investigating the spectra of many metals over a wide range of wave lengths and into the infra-red region. About fifty different elements have been investigated throughout the entire range which can be photographed by using special means of treating ordinary photographic plates so that they become sensitive to the light and to the longer wave lengths as well as the ultra-violet light. This work requires careful manipulation and skillful measurement and it is considered to be of fundamental importance. Small samples may be burned in an arc and the spectra photographed. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Electrochemistry B2-19 Tests of Dry Cells and Storage Batteries. The Bureau of Standards has designed and constructed an improved apparatus to connect in the discharge circuit of batteries to be tested a selected group of cells for any period of time. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Electroplating B1-19 Effect of Pickling and Plating on Properties of Steel. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Electroplating B2-19 Lead Plating. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Electroplating B3-19 Study of Bancroft's Axioms as Applied to Electroplating. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Electric Power B3-19 Survey of Electric-Pole-Line Construction.

An investigation of present practice of pole-line construction to increase the requirements for initial strength as proposed by the Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Fuels, Gas, Tar and Coke B1-19 Gas-Appliances Investigation. The Bureau of Standards is coöperating with the Industrial Fuel Committee of the American Gas Association, studying various types of burners used in industrial applications to correct their faults and deficiencies. The proper designs of air shutter, gas orifice, and burner throat are being worked out by the Bureau of Standards. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Internal-Combustion Motors B6-19 Carburetor Investigations. An investigation is being made of the effect of the pulsations in the air flow through carburetors on account of the intermittent intake on the action of the carburetor. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Illumination B1-19 Miniature Lamps. Life tests of miniature lamps are being planned. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Leather and Glue B2-19 Deterioration of Leather. Tests have been instituted to determine the effect of varying amounts of free acids on tensile strength of leather, using aging test at a fairly high temperature and also at room temperature. In the latter test the effect of light on the rate of deterioration will be studied. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Metallurgy and Metallography B3-19 Phosphorus Content of Steel. The effect of varying amounts of phosphorus on the physical properties of steel including the determination of the limits of quantities permissible in various grades. Effect of phosphorus on the microstructure of basic and acid open-hearth carbon steel after various heat treatments. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Metallurgy and Metallography B4-19 Magnetic Analysis of Steel. The study of the possibility of correlating the magnetic and mechanical properties of steel with the ultimate object of developing methods for testing the quality and homogeneity of steel articles without injuring the specimens. Papers discussing the application to ball-bearing races and rifle barrels have been prepared. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Non-Ferrous Metals B1-19 Pure Aluminum. It has been deemed advisable to produce and determine the properties of pure aluminum. A special furnace has been constructed for this purpose and especially to eliminate the active impurities of silicon and iron. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Oils B1-19 Color Grading of Cottonseed Oils. Specific recommendations of color grading of cottonseed oils have been submitted to the Society of Cotton Products Analysts by the Bureau of Standards. Coöperative work is being carried on. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Pumps B1-19 Pump Valves. The Bureau of Standards is coöperating with two rubber companies and an insurance laboratory representing a Committee on Rubber Products of the American Society for Testing Materials in conducting hardness tests on pump valves, using the plastometer and scleroscope to determine a standard specification for hardness so that this property may be suitably related to temperature and pressure. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Railroad Rolling Stock and Accessories B3-19 Braking Stresses in Chilled-Iron Car Wheels. An investigation of stresses occasioned by braking. Results obtained so far show a marked difference in behavior of wheels of different designs and weight. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Sugar B1-19 Sugar Technology. A preliminary study of the problems of clarification of sugar liquors by other means than the sugar-filtration processes now used. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

D—Research Equipment

Aircraft D4-19 Wind Tunnel of the Bureau of Standards. The wind tunnel of the Bureau of Standards has been completed and investigations have shown that in the working section of the flow at 75 miles per hour is the lines parallel to the channel axis. The velocity at any point was not more than 0.5 per cent from the mean. Air speeds of 150 miles per hour have been attained. Power for this speed is 60 hp. Alterations just completed permit speeds of 180 miles per hour. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Apparatus and Instruments D6-19 Charpy Impact Machine at the Watertown Arsenal. The Charpy impact machine consists of a pendulum of known weight swinging freely on an axis of suspension, the pendulum having the following constants:

Weight of breaking mass (pendulum)	96.370 kg.
Height of fall of center of gravity (max.)	3.1558 m.
Radius of center of gravity	1.627 m.
Angle of fall corresponding to H (max.)	160 deg.
Distance of axis of suspension from middle of impact	2.00 m.
Radius of center of percussion	1.8229 m.
Velocity of shock	7.858 m. per sec.
Theoretical work of fall (PH)	304.124 m-kg.

The principle of operation of this machine is that when the kinetic energy of the pendulum is at a maximum, the specimen to be broken is struck by the pendulum. The energy absorbed in breaking a given specimen is determined by substracting from the known kinetic energy of the pendulum at the instant of impact, the kinetic energy remaining in the pendulum after the specimen is broken. The residual energy after the specimen is broken is determined by measuring the angle through which the pendulum swings after striking the specimen.

Two types of test can be carried out on this machine, namely, transverse and tensile tests. A specimen which is to be broken by a transverse shock is supported at each end on an anvil at the lowest point of swing of the pendulum, and is struck midway between the points of support. The specimen is 16 cm. long and 3 cm. square. A slot is cut in the specimen on the opposite side from the point of impact so as to leave a sectional area to be ruptured exactly 3 cm. by 1.5 cm.

A tensile specimen can be made with or without a notch, but in any case the area of rupture is maintained at 0.2 sq. in. so that direct comparisons can be drawn between the static tensile test and the impact tensile test. The "excess angle," or in other words the angle which enables the measuring of the residual energy of the pendulum, is measured by means of a pointer and dial fixed to the axis of suspension.

From the observed readings of the excess angle at the time of rupture, and the above constants of the machine, the total amount of energy absorbed may be calculated, taking into account the energy absorbed by mechanical friction and the resistance to the air.

The large Charpy machine (Fig. 1) differs from the small machine by having a motor fastened directly to the pendulum supports for raising the pendulum, and furthermore it is equipped with a ratchet brake so as to bring the pendulum quickly to rest after a specimen is ruptured. United States Arsenal, Watertown, Mass., Address Commandant.

Apparatus and Instruments D7-19 Standard Cement Sample 46-*e* for checking 200-mesh sieves has been prepared and is ready for distribution. 80.2 per cent passes this sieve.

Obtainable in 160-gram samples at the Bureau of Standards for 25 cents per sample, one sample for three tests. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Apparatus and Instruments D8-19 Picnometer. A new type of picnometer for the determination of density of viscous substances. Viscous liquids such as molasses and oils owing to their high viscosity retain innumerable air bubbles. This fact makes accurate determination difficult. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Apparatus and Instruments D9-19 Lime Investigations. A plasticimeter designed to determine the plasticity or spreading properties of lime has been developed by the Bureau of Standards. This simulates the action of the plasterer in spreading the material on the wall. Means are provided for obtaining the effort which the plasterer must exert and for varying at will the base upon which the plaster is spread, the time required, and the angle which the trowel makes with the surface. The force required to spread the plaster in conjunction with the time during which this force acts gives the measure of the plasticity. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

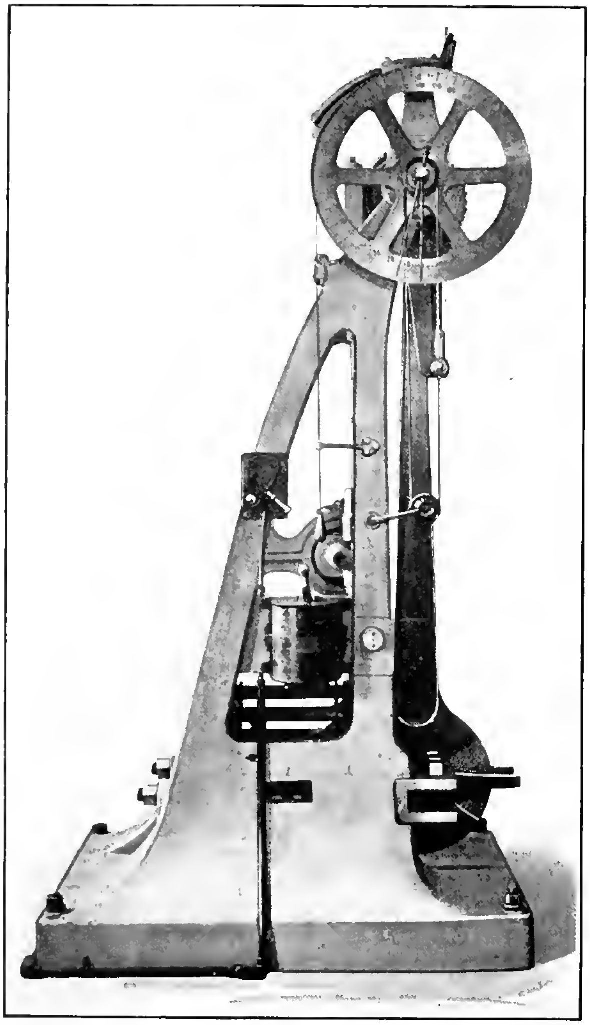


Fig. 1 Charpy Impact-Testing Machine at the Watertown Arsenal

Apparatus and Instruments D10-19 The Micrometer Microscope and Its Use in Gage Inspection. A communication from the Gage Section of the Bureau of Standards. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Calorimetry, Pyrometry, Thermometry D1-19 Naphthalene and Benzoic Acid Samples. The Bureau of Standards has prepared new samples of naphthalene and benzoic acid to be distributed as standard heat samples, and the heats of combustion have been determined. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director of the Bureau.

Metallurgy and Metallography D4-19 New Furnace Equipment. The Bureau of Standards has recently installed a Héroult type of electric smelting furnace of 600 lb. capacity. It has an electrically heated crucible furnace of 70 lb. capacity; also an oil-fired reverberatory furnace for cast iron and brass of 300 lb. capacity. A new type of electrically heated muffle furnace for heat-treatment operation is being installed. A Northrup-Ajax high-frequency electric furnace melting about 10 lb. of iron has been installed. It is used for the preparation of pure metal alloys in vacuo. The Bureau is equipped to roll and forge this metal. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

E—Research Personnel

Calorimetry, Pyrometry, Thermometry E1-19 Naphthalene and Benzoic Acid Samples. The Bureau of Standards has prepared new samples of naphthalene and benzoic acid to be distributed as standard heat samples, and the heats of combustion have been determined. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Properties of Engineering Materials E1-19 Mechanical Properties of Materials. The Bureau of Standards has issued a 51-page circular letter giving the various properties of engineering materials such as iron, steel, non-ferrous metals, rubber, leather, rope and wood from latest information. The properties include density, specific gravity, tensile and compressive strengths, elongation and reduction of area, modulus of elasticity, modulus of rupture, shearing and transverse strength, ductility, Brinell and scleroscope hardness. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

F—Bibliographies

Air F3-19 Pneumatic Conveying of Sand, Gravel, Crushed Coal, etc. A bibliography of 1¼ pages. Search 2647. Address A. S. M. E., 29 West 39th St., New York.

Aircraft F1-19 Standardization in Aeroplanes. A bibliography of 2 pages. Search 2475. Address A. S. M. E., 29 West 39th St., New York.

Economics F3-19 Standardization. A bibliography of 2 pages. Search 2500. Address A. S. M. E., 29 West 39th St., New York.

Properties of Engineering Materials F1-19 Relation Between Hardness and Machinability. A bibliography of 1¼ pages. Search 2629. Address A. S. M. E., 29 West 39th St., New York.

Correction to Paper on Present Condition of Research in the United States

In preparing my Spring Meeting paper on The Present Condition of Research in the United States and in reading the proof I failed to realize that I had made a misstatement in attributing the laboratories at Pittsburgh and Washington to the United States Geological Survey. [See Mechanical Engineering, July 1919, p. 588.] These laboratories should be attributed to the Bureau of Mines. In writing this paper and in reading proof I did not notice this error, although the statement was not due to misinformation or lack of knowledge on my part.

Arthur M. Greene, Jr.

ENGINEERING SURVEY

A Review of Progress and Attainment in Mechanical Engineering and Related Fields, as Gathered from Current Technical Periodicals and Other Sources

AERONAUTICS (See also Internal-Combustion Engineering)

Monoplane vs. Biplane, Grover C. Loening. An argument for the monoplane by the inventor of the first monoplane bought by the United States Government.

There is no question as to the monoplane being the simplest type of machine (having only one set of wings and ailerons) and the lightest type, in that the wing structure itself for any given weight can carry more load than a biplane. The ordinary biplane, however, has two serious defects: (1) lack of strength, particularly against twisting and drift stresses; and (2) a bad range of vision. These objectionable features are claimed to have been eliminated in the Loening biplane, which puts it on a footing of equality with, and perhaps makes it preferable to biplanes for certain purposes.

To maintain the strength against drift and a general rigidity to the wing structure against twisting stresses, the monoplane wing is braced rigidly by large struts at a good angle in much the same way as the overhang section of some biplanes.

As regards the bad range of vision in the Loening monoplane the following structure has been adopted. Instead of raising the wing above the body parasol fashion, the pilot is seated low—so low that his eyes are on a level with the wing—and the side of the fuselage is open on either side of him. In such a position the motor in front shuts off the view forward, but in the Loening monoplane the body is so narrow in front that the pilot by shifting his head a little can see ahead of him on either side.

The author frankly recognizes this as a trick of construction, but states that it had much to do with giving this particular type of monoplane the range of vision which it has been found to have.

Aerodynamically, it is claimed that the centers of thrust, weight, head resistance, etc., have actually by test been found to be every bit as good in the monoplane as in the biplane. The only distinction is that the center of thrust on the monoplane is but a small distance below the wing, and the action of the spiral slip stream of the propeller in washing itself out against the wing results in neutralizing the torque of the motor. Thus no correction whatsoever is made in the wing alignment for the torque and the motor can be thrown on and off without affecting to any noticeable degree the balance and stability of the machine.

Further, on the monoplane a very large and definite area of the wing rides in the slip stream of the propeller under a most efficient condition. The proportional increase in lift so derived is considerable. Actual test has shown that the monoplane with a load of 11 or 12 lb. per sq. ft. will be as buoyant and land as well as the biplane with a load of about 7½ lb.

In fact, the author looks forward to the possibility of having large monoplanes with a 20- or 25-ft. chord carrying 18 or 19 lb. per sq. ft. at a low speed. (*U. S. Air Service*, vol. 2, no. 1, August 1919, pp. 25-27, *tc*)

CORROSION (See Engineering Materials)

ENGINEERING MATERIALS

Corrosion Phenomena in Non-Ferrous Materials

Effect of Corrosion on Wrought Manganese Bronze Under Tensile Stress, P. D. Merica and R. W. Woodward. An investigation to determine what service stresses may with safety be applied to physically normal wrought brass and bronze, and the types ordinarily used for structural purposes.

In the course of a previous investigation by the authors of a series of failures of brass and bronze bolts by fracturing, it was suspected that many cases of such failures were not due to defective material but to the fact that the bolts had been overstressed in service.

An investigation has shown that brass rods exposed to the action of concentrated ammonium hydroxide and subjected at the same time to the very gradual application of tensile stress would break with little elongation at any values of the stress greater than the yield point of the material. From this it appears that the effect of combined tensile stress and surface corrosion is to decrease the stress at which fracture will occur.

This matter is of considerable importance. Brass and bronze usually take the place of steel only because of their supposed superior resistance to corrosion, and if it were proven that such superior resistance is not as great as hitherto assumed, the usefulness of brass and bronze for structural purposes would be very largely limited.

The paper describes in some detail the method of carrying out the tests and making the measurements. The period of exposure was two years, which is relatively short in comparison with the periods for which such materials may actually be used in service. Furthermore, the test bars used were given a low-temperature anneal in order to relieve the initial stresses and consequently their behavior may differ during test from that of brass in which the stresses still remain. Therefore, as pointed out by the authors themselves, any conclusions to be derived from the results given in the paper must be regarded as quite restricted in their definite application and as more or less tentative in their more general aspects.

The general conclusion seems to be that brass or bronze might not be subjected to corrosion (in ammonium hydroxide) while under a tensile stress greater than 20,000 lb. per sq. in. or greater than 5000 lb. per sq. in. above the yield point without danger of failure.

The authors' tests indicate that the proportional limit is to be regarded as the maximum safe stress for manganese bronze of harder tempers, but that it is not certain that this limit may not be slightly exceeded in materials which are soft, that is, free from work hardness. (Paper presented at the Annual Meeting of the American Society for Testing Materials, June 24-27, 1919. Com-

pare *American Machinist,* vol. 51, no. 5, July 31, 1919, pp. 217-220, *ep*)

Mechanical Properties and Resistance to Corrosion of Rolled Light Alloys of Aluminum and Magnesium with Copper, Nickel and Manganese, P. D. Merica, R. G. Waltenberg and J. R. Freeman. The paper is summarized by the authors as follows:

Light aluminum alloys of several compositions belonging to each of the three ternary series, aluminum-magnesium-copper, aluminum - magnesium - manganese, and aluminum - magnesium-nickel, were rolled out into sheets and tested in tension as cold-rolled, after annealing, and after heat treatment consisting of quenching from about 500 deg. cent. and aging at ordinary temperature.

The tensile properties of the alloys of the aluminum-magnesium-copper series were superior in all conditions to those of the other series. They may be much improved by an appropriate heat treatment. The alloys of the aluminum-magnesium-nickel series are also improved by heat treatment, but not in the same degree as the former series. The alloys of the aluminum-magnesium-manganese series are not improved by heat treatment.

Samples of representative compositions of each series were exposed to corrosion in the salt-spray test, and the appearance of the samples observed after exposure to the action of the salt spray for one and for two months. The alloys of the aluminum-magnesium-manganese series resisted corrosion, in general, better than those of the other series, and this observation agrees with other experience in the corrosion of such alloys. The heat-treated specimens of the aluminum-magnesium-copper series, however, were but little inferior to those of the manganese series in their resistance to corrosion; the annealed and the cold-rolled samples of that series were the least resistant to corrosion of any of the alloys tested. Hard-rolled commercial aluminum corroded much more than any of the alloys. Annealed aluminum was more resistant to corrosion than the hard-rolled aluminum, but did not compare favorably with most of the alloys. (*Bulletin of the American Institute of Mining and Metallurgical Engineers,* no. 151, July 1919, pp. 1051-1062, *e*)

Variation of Physical Properties of Test Pieces with Age After Machining

Effect of Time and Low Temperature on Physical Properties of Medium-Carbon Steel, G. A. Reinhardt and H. L. Cutler. Data based on the experience of the Youngstown Sheet and Tube Company in making acceptance tests of medium-carbon steel.

This company produced a large tonnage of 0.35 to 0.45 carbon forging steel, the acceptance of which was based on the physical properties of test specimens obtained by forging the original 5.75-in. square bloom to 0.75-in. round. No difficulty was experienced in meeting the specifications called for.

Soon after, production of slightly higher-carbon forging steel was started. The method of testing this material required that test blooms be either normalized or annealed. The normalizing consisted in heating to 850 to 900 deg. cent. and cooling in still air; the annealing in heating to the same temperatures and cooling in the furnace or mica. From the treated bloom the test pieces were taken either by core drilling or by sawing from joints midway between the edges and the intersection of the diagonals. The cores or blocks were turned to a standard 2-in. test piece with a diameter of 0.564 in. and tested without further treatment.

Difficulty was encountered as soon as work on this material was started. Many precautions and refinements were instituted, but it was found very difficult to secure the required elongation. Still a very good chemical analysis was produced. Great care was taken during the heating and rolling as well as in heat-treating and machining the test pieces, but none of these precautions helped in producing uniform results, although occasionally the results were very good.

A careful examination disclosed the fact that invariably these good results were obtained from test pieces that had been machined the day before they were tested. The experience of several other men in and out of the company showed the similar behavior of rail-steel test pieces. As a result, it was decided to rest all pieces over night and test them the following day. As soon as this practice was adopted the difficulty in heating the elongation requirement of the specification disappeared.

Since it was at times undesirable to hold a shipment long enough to afford a 24-hr. rest for the test pieces, experiments were made, and it was found that a rest of a few hours at about 120 deg. cent. was equal to a 24-hr. rest at room temperature.

A series of tests were also made to determine the cause for the great difference in elongation and reduction of area shown by test pieces which had or had not periods of rest. The cause of this was not found, but some interesting data were collected.

This series of tests showed that a slight increase in temperature during the rest period resulted in a great improvement of elongation and reduction of area. The increase in tensile strength was considerable and greater in the case of a two-day rest than in the case of a four-day rest.

Tests were also made to determine the effect of speed of machining on the physical properties of a test piece and it was found that the rate of machining has practically no influence.

A further series of tests on 16 cores showed that the elongation increased with increased length of rest at the temperature of the top of the furnace. A rest of 16 days at room temperature increased the elongation and reduction of area to about the same extent as a rest of 25 hours on the electric furnace. On the other hand, test pieces heated to 500 and 600 deg. cent. after rests of four and 16 days, respectively, tested immediately after making it, gave lower elongation and reduction-of-area values than pieces that had been rested at lower temperatures. No explanation for this is offered. On the whole, the writers come to the conclusion that the ductility of steel expressed by elongation is greatly improved by some equilibrium adjustment which takes place slowly at room temperature and much more rapidly at slightly increased temperature. It seems possible that the difference in the results obtained on tests taken from blooms and on tests taken from small billets may be due to a combination of solidificatione and rolling strains. (*Bulletin of the American Institute of Mining and Metallurgical Engineers,* No. 151, July 1919, pp. 1091-1098.)

Graphitization Ranges of Temperature in White Cast Iron

Graphitization of White Cast Iron upon Annealing, P. D. Merica and L. J. Gurevich. This investigation was mainly undertaken in connection with other investigations on the properties and characteristics of chilled-iron car wheels, in particular to determine the best range of annealing temperatures.

Chilled-iron wheels are cast with a chill against the thread and the inside of the flange, the remainder being in sand. The composition of the metal is so chosen that under these conditions the tread and inside of the flange will show white iron to a depth of from ⅝ to ⅞ in. (15 to 22 mm.), the remainder of the wheel becoming graphitized or gray. In order to relieve the stresses set up during cooling under such drastic conditions, the wheels are stripped from the mold, while still red hot, piled in a soaking pit, and allowed to cool very slowly from their temperature at stripping.

Obviously, the most suitable temperature for this annealing is the highest at which no formation of graphite occurs within the white tread and at which the wheels can be stripped from the molds. Inasmuch as no direct determinations have been made of the temperature at which the formation of graphite takes place in white iron of compositions used in car wheels upon annealing, it was considered worth while to determine these temperatures as a means of establishing the maximum temperatures at which the annealing of the wheels may be carried out. In the course of this work some incidental observations were made which are of interest in connection with the theory of graphitization in white iron.

The paper is summarized by the authors as follows:

The annealing or graphitization ranges of temperatures were determined for three different compositions used for car wheels.

The temperature of initial precipitation of temper carbon for six hours of annealing was not noticeably affected by variation of sulphur content from 0.10 to 0.20 per cent or by variation of total carbon content from 3.60 to 3.90 per cent, although the effect of greater carbon content is to narrow the temperature range within which graphitization is complete.

The temperature of beginning precipitation of temper carbon was about 830 deg. for the 6-hr period of annealing, and about 730 deg. cent. for the 48-hr. period. The maximum allowable temperature, therefore, for the annealing, or "pitting," of car wheels is about 730 deg. cent.

After complete decomposition of all free cementite by annealing at from 1000 deg. to 1100 deg. cent. and cooling at equal rates in a laboratory electric furnace, less graphite is found in a specimen cooled from 1100 deg. than in one of the same composition cooled from 1000 deg. cent. This indicates that graphite separates directly from solid solution upon cooling, when its nuclei are already present.

The fact that only 0.20 per cent of combined carbon was found in some specimens after annealing at high temperatures and cooling slowly in the furnace, would indicate either that the graphite eutectoid lies at much lower values of carbon content than has been previously supposed, that there is at those rates of cooling a direct precipitation of graphite eutectoid, or that there is a formation of graphite from pearlite at temperatures directly below that of its formation. (*Bulletin of the American Institute of Mining and Metallurgical Engineers,* no. 151, July 1919, pp. 1063-1072, *e*)

HYDRAULIC ENGINEERING

HEXAGONAL CHART FOR FINDING VELOCITY OF WATER IN PIPES, C. Warington Anthony. Reprint of a brief but highly suggestive article and accompanying illustrations.

Exponential formulæ are very much used nowadays in hydraulic problems dealing with the flow of water in pipes and sewers. Many charts or diagrams have been drawn to represent each formula, some taking a variable coefficient into account, which depends on the nature of the inner surface of the conduit, but the writer has never seen one made that does equally well for all the exponential formulæ. For this reason I have designed a hexagonal chart (Fig. 1) that takes care of six variable quantities—the velocity of flow, coefficient of roughness, hydraulic mean radius and slope, together with the powers to which these last two quantities are raised—and yet in spite of all this apparent complexity this chart is as easy to handle as a chart made for working out only one kind of exponential formula. Evidently a chart of his description will prove of great value, since it may be used for rapidly computing and comparing results obtained for a given case by applying different formulæ. It may also be used to deduce the best equation to fit in with the results of experiments that have actually been carried out.

The exponential formula is usually written: $V = C\ (D/4)^p S^q$, or $V = CR^p S^q$, since the hydraulic mean radius of a pipe flowing full is the fourth part of its diameter. There will be seen to be three binary scales in the chart, arranged in the form of an equilateral triangle. The coefficient and velocity go together on

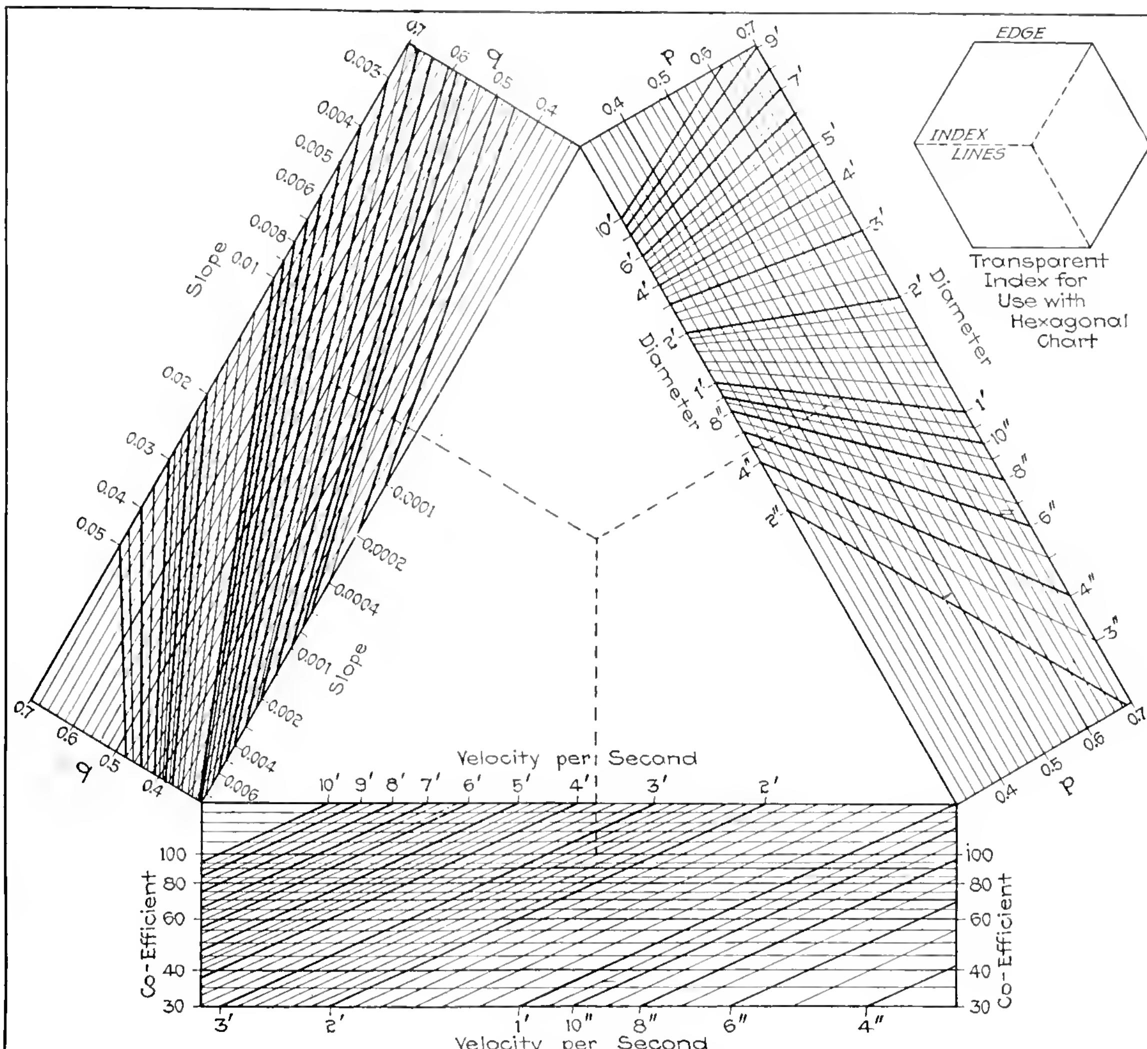


FIG. 1 HEXAGONAL DIAGRAM FOR FINDING VELOCITY OF WATER IN PIPES

one scale, and the diameter and slope, together with their respective powers, on the other two scales. The way the diagram is used is illustrated with dotted lines for the following case:

Diameter, 1 ft.; slope, 0.0025; coefficient, 100, $p = q = \frac{1}{2}$. The velocity is seen to be 2½ ft. per sec.

When using the chart it is convenient to have a hexagonal transparent index, as shown in the upper right-hand corner of the illustration, with its sides parallel to the three index lines. By placing a straight edge against one side, the index lines may be moved without changing their orientation or displacing the one parallel to the straight edge.

The great beauty of the chart lies in the fact that it does not contain a single curve, which makes it much easier to draw and at the same time a high degree of accuracy is insured. This is attained by employing logarithmic instead of equally spaced coordinates. (*Engineering News-Record*, vol. 83, no. 4, July 24, 1919, p. 169, *tpA*)

INTERNAL COMBUSTION ENGINEERING (See also Machine Elements)

Novel Features in Oil-Engine Design

THE DOXFORD OIL ENGINE. Description of an internal-combustion engine of British construction. The engine was first built as a Diesel but has now been changed to a hot-surface type with solid injection of fuel.

As regards the latter the present arrangement is that three rams are used, the fuel pump being driven through small cranks on the camshaft set at 120 deg. so that the work may be divided over the revolution and eliminate the very heavy shock which would occur if but one ram were used. These rams force the oil into two small air vessels initially charged with air at a pressure of 1000 lb. per sq. in., the ram pressure being 8000 lb. per sq. in.

The pumps are said to be a very beautiful piece of work; so good, indeed, is the fit that no packing is required even at this enormous pressure, the leakage representing little more than an overflow of lubricant. This end has been reached by a departure from the ordinary method of driving the fuel pump. In the Doxford machine there is used a slotted crosshead with the sliding block for the driving pin to work in, the crosshead being carried in very closely fitting guides at each side. The plunger is connected to the crosshead with an ordinary union nut, so that provided the center lines are parallel, which of course can be insured, any want of exact concentricity may be allowed for, and the thrust of the ram must be absolutely axial.

The fuel valves present a new feature in that they have only a light spring to keep them on their faces when the engine is not running. The size of a spring strong enough to keep them closed against an oil pressure of 8000 lb. per sq. in. when working would be on the heavy side, but if 8000 lb. will blow the valves off their faces it will equally well keep them on, if applied to a larger diameter and that is, in fact, the plan adopted again with unpacked plungers.

The elimination of the blast air forced the use of a different arrangement of valves. Formerly the fuel was blown in by air tangentially on opposite sides of the cylinder so as to create a turbulence. With the solid jet of fuel no turbulence can be obtained, so that the fuel must be diffused as much as possible, and the valves are now arranged opposite to each other, but one above the other so as to cover as large a volume of air as possible.

One of the peculiar features of the engine is the fact that instead of attempting to keep the piston as cool as possible in this case every effort is made to allow the crown to reach a temperature of not less than 1000 deg. fahr., and it is the piston crown which forms the hot surface which really fires the charge with heavy oils. Such a high temperature is rendered possible by the special design of the piston, Fig. 2. Here *C* is the heatable cap which keeps the fire off *D*, the piston proper. *C* is a steel forging, of which the crown is some 4 in. thick and is water-jacketed on the under side. Thermocouples attached to a point a few millimeters inside the top surface showed a temperature reading of about 950 deg. fahr. at the load on which the engine was running on the occasion of the writer's visit, and a temperature of only 350 deg. fahr. at a corresponding point on the bottom surface. It will be noticed that the cap *C* only comes into contact with the actual piston *B* at the bottom where everything is well cooled, and that there is a good clearance at the sides and top and also between the cylinder liner and the edge of the forging, so that it can expand or distort to a very considerable extent without doing any harm. The water passages *D* are ribbed at close intervals, the alternate ribs having holes at the top and bottom so that the water has to take a very devious course and keeps the cast iron cool, the final outlet being from the passage *E*, which, as a matter of fact, is carried up by a tube to just under the crown and not cut off short as shown in the figure.

The engine has been running for several months and is said to completely consume Mexican oil with its very high percentage of

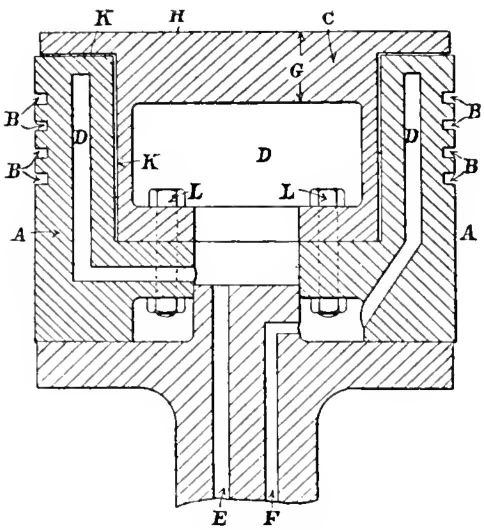


FIG. 2 PISTON OF THE DOXFORD OIL ENGINE

asphaltum, and to give an absolutely clean exhaust. The consumption is said to be 0.42 lb. per b.hp-hr.

The elimination of the high-pressure air compressor for blast injection means, of course, a saving both in fuel and first cost, weight and maintenance. (*The Engineer*, vol. 128, no. 3316, July 18, 1919, pp. 64-65, 2 figs., *d*)

Temperature Relations in an Internal-Combustion Engine Due to Presence of Residual Gases

THE EFFECT OF NEUTRAL GASES ON THE TEMPERATURE OF THE WORKING FLUID IN AN INTERNAL-COMBUSTION ENGINE, Kango Takemura. Discussion of a subject which attracted a considerable amount of attention in the early days of the introduction of the Otto cycle.

The writer believes that the neutral gases left in the cylinder at the end of the previous stroke have a considerable influence on the temperature of the new combustible charge, and gives a mathematical estimate of the rise of temperature which they effect. He uses the following notation:

Let θ_1 = temperature of the neutral gases left in the combustion chamber

c_1 = specific heat of those gases

w_1 = weight of the gases

θ_2 = temperature of a new charge, supposed to be constant and equal to that of the atmosphere

c_2 = specific heat of the charge

w_2 = weight of the charge

θ_3 = temperature of the working fluid or the mixture of the neutral gas and the new charge

c_3 = specific heat of the fluid.

An assumption is made that the new charge is drawn through the neutral or residual gases and that a temperature equilibrium is established instantaneously.

The writer derives the following equation

$$\Theta_3 = \frac{\theta_1 + \theta_2 \dfrac{\theta_1 + 273}{\theta_2 + 273} \times \dfrac{.x}{.l}}{1 + \dfrac{\theta_1 + 273}{\theta_2 + 273} \times \dfrac{.x}{.l}}$$

where Θ_3 is temperature in absolute degrees and the values of θ_1 and θ_2 are in cent. deg; also $.x$ stands for x/L, where x is a portion of the stroke and L is the full length of the stroke; $.l$

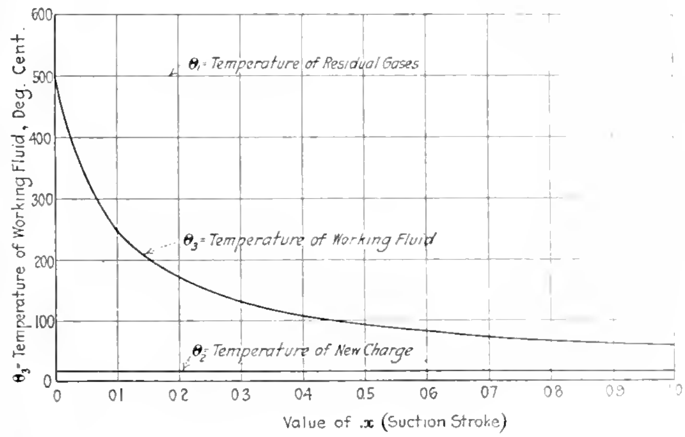


Fig. 3 Relation between the Temperature of Residual Gases and Working Fluid in an Internal-Combustion Engine

stands for l/L, where l is the height of a "equivalent combustion chamber" on a base equal to the area of the piston. The value of $.l$ depends on the ratio of compression and is equal to 0.25, if the latter is taken at 5.

Adopting these figures the writer obtains

$$\frac{D_1}{D_2} = \frac{\theta_1 + 273}{\theta_2 + 273} = \frac{500 + 273}{16 + 273} = 2.67$$

and

$$\theta_3 = \frac{500 + 16 \times 2.67 \times 4 \times (.x)}{1 + 2.67 \times 4 \times (.x)}$$

$$= \frac{500 + 170.9 \times (.x)}{1 + 10.7 \times (.x)}$$

where D_1 = density of the neutral gases at the moment when their mixing with the new charge begins and D_2 is the density of the new charge.

TABLE 1

$.x$	θ_3	$.x$	θ_3	x	θ_3	[illegible]	θ_3
0.1	250	0.4	108	0.7	73	1.0	57
0.2	170	0.5	92	0.8	66		
0.3	130	0.6	82	0.9	62		

The values of θ_3 calculated by means of the foregoing equation are given in Table 1 and shown graphically in Fig. 3. (*Journal of the Society of Mechanical Engineers*, Tokyo, Japan, vol. 22, no. 56, *tm*)

War-Time Research in Aeroplane Feuls

The Investigation of Airplane Fuels. E. W. Dean and Clarence Netzen. Data of recent work carried out chiefly by the United States Bureau of Mines and of considerable importance not only in aviation but in the general design of automotive apparatus.

In the course of this work E. R. Hewitt showed that such fuels as benzol and alcohol did not ignite until heated several hundred degrees fahrenheit hotter than the ignition temperature of paraffin hydrocarbons. These data were of use in indicating the order of ease with which various fuel mixtures could be made to preignite in engine cylinders.

Simultaneously with this the research organization maintained by the Dayton Metal Products Company studied the relation between the nature of the fuel and the maximum compression ratio that could be maintained in an engine without interfering with smooth operations. Data of this investigation have been published quite fully elsewhere. The experiments of the Dayton laboratory have shown, however, that the chemical properties of the fuels were more important than the physical ones, and therefore a large number of fuels were collected and tested. In addition, an extensive research was devoted to the production of cyclohexane.

Attention to this fuel was particularly drawn by the reports that the Germans were using it as an airplane-engine fuel. Actually, though, there does not seem to be any evidence that this was the fact.

The engine fuel actually tested after the first few engine runs was not pure cyclohexane, but a mixture called "heeter," composed of from 70 to 80 per cent cyclohexane and 20 to 30 per cent of benzol.

Through the courtesy of the engineers at McCook Field, the Bureau of Mines obtained the loan of a testing engine made by equipping one cylinder of a standard Liberty engine with a special crankcase, shaft and flywheel (compare Mechanical Engineering, March 1919, p. 249). A set of pistons was obtained which gave compression ratios ranging from 5.3 to 1 to 8.2 to 1. Pressures measured with an Edelman gage, with the engine turned at 400 r. p. m., varied from 113 to 185 lb. per sq. in.

A considerable number of fuels were tested with this equipment, and results obtained showing that gasoline composed of paraffin hydrocarbons had a marked tendency to knock at the 5.3-to-1 compression ratio, whereas heeter-benzol-alcohol and a special alcohol-benzol-gasoline mixture known as Taylor fuel No. 4 showed only a slight tendency to knock under an 8.2-to-1 compression ratio.

Cracked gasoline and California gasolines were intermediate in resistance to knocking, and were notably better in this respect than the paraffin-base products. This superiority is attributed to the presence of unsaturated and cyclic hydrocarbons in the cracked distillates and to cyclic hydrocarbons in the California gasoline. In some of these fuels, however, undesirable properties have been found, and as a last analysis the most promising product was found to be heeter, with California gasoline or gasoline-benzol mixtures as a second choice.

Supplementary tests were carried out on a standard Liberty engine with a full set of 12 special pistons permitting the adjustment to 70 per cent cyclohexane and 30 per cent of benzol in a DeHaviland-4 plane. The results of these tests, however, were unfavorable.

The next series of tests were tried with the same pistons on another Liberty engine, also in a DeHaviland plane. From the figures given in the paper it does not appear quite clear what the composition of the fuel was in this series of tests, the results of which were, however, favorable, the engine operating smoothly and yielding the additional power that was to have been expected on account of its high compression ratio. Similar tests in the altitude chamber of the Bureau of Standards also gave favorable results.

The comparative data obtained with the single-cylinder Liberty engine indicate where by proper selection of fuel it is possible to employ considerably higher compression ratios than the maximum now considered practical for aviation engines.

The establishment of this part is considered of importance, even if it proves that a 7.2-to-1 ratio is too high, and that heeter is not as practicable or desirable as other mixed types of fuels. (Paper before the Society of Automotive Engineers, published by permission of the Director of the United States Bureau of Mines. *Journal of the Society of Automotive Engineers*, vol. 5, no. 2, pp. 126-130, *ea*)

MACHINE ELEMENTS

Tests on Pin-Riveted Joints Made by the Schuch Process (*Zeitschrift des Vereines deutscher Ingenieure*, June 14, 1919). This article describes tests performed on riveted joints made with pin rivets according to a new process (German Patent No. 302,-269). The advantages of the new system of riveting are claimed to be: (1) Cheaper cost of rivets; (2) the rivets are more evenly heated; (3) the hammer scale is removed when the rivets are snapped home. The result is that the rivet heads do not loosen and calking is no longer necessary, thus showing a considerable saving in wages and tools, also time taken on the operation. The new form of rivet is shown in Fig. 4.

The firm of Schuch & Co., who hold the patent rights, have designed a work-controlling apparatus for hydraulic riveting machines for use in connection with the new process. This device records automatically the riveting force and the time taken in snapping a rivet.

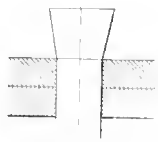


Fig. 4 Schuch Pin Rivet

A riveted joint made as shown in Fig. 5 was sent for test to the Material Test Laboratory of the Stuttgart Technical College, and the following are the conclusions arrived at:

1 The rivet heads were only very slightly warped
2 The plates suffered slight curvature or bulging
3 The plates do not show any appreciable crushing at the margings of the holes.
4 The stresses with which the rivets press the plates together were found to be about the same as with ordinary rivets.

Numerous locomotive boilers have been riveted on the new system and have given satisfaction. (*Technical Supplement to the Review of the Foreign Press*, vol. 4, no. 2, July 22, 1919, p. 45, no. 5643, *d*)

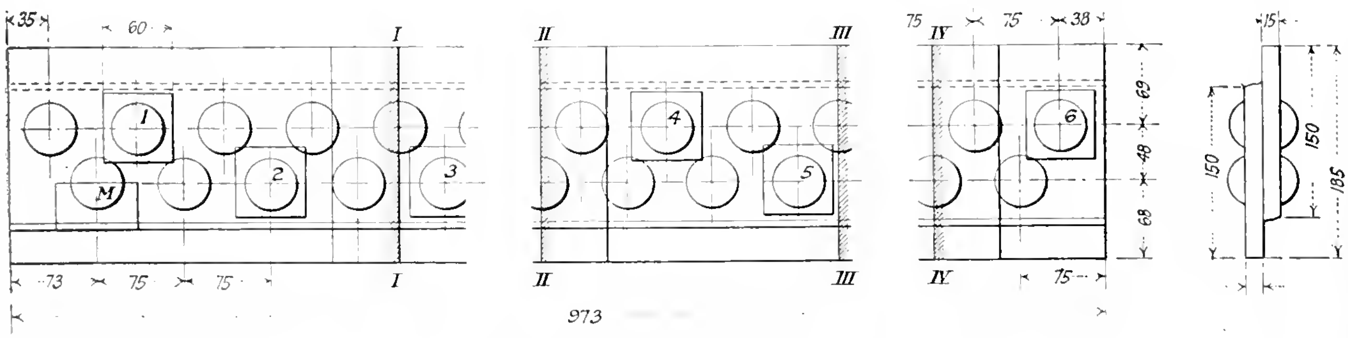


Fig. 5 Schuch Pin-Riveted Joint

Two-Part Piston Ring, Ellsworth Sheldon. Description of a piston ring manufactured by the Yale Piston Ring Company.

The ring as shown in Fig. 6 is made in two parts: the outer part of soft gray iron performing the usual function of piston rings; and an inner ring of tempered steel which furnishes the tension necessary to hold the outer part in contact with the cylinder walls and also serves to keep the ring in contact with the sides of its groove in the piston, thus preventing the leakage of gas past the piston that would occur with the ordinary form of ring as soon as the latter had worn or if it was badly fitted to the groove in the first place. It is also claimed that with this construction worn rings may be reground on their edges, the grooves faced, and the ring still retain its seal.

The outer ring resembles an ordinary gray-iron piston ring, with three differences, however. First, as the ring is not required to exert pressure of itself it may be made of the softest gray iron obtainable; second, for the same reason, the outer diameter is ground to the same size as the cylinder instead of 1/8 to 3/8 in. larger, as in the case of the snap ring; and third, the inside of the ring is not parallel with the outer surface but is bored taper or at an angle of 15 deg., so that the ring has one thick edge and one thin edge.

The inner ring is of tempered steel and is of a section complementary to the outer one, that is, its tapered or beveled surface is on the inside and when the steel ring is pushed into the gray-iron one its tension not only holds the latter against the cylinder walls, but also by reason of the two beveled surfaces coming together the iron ring is pressed against one side of the groove and the steel one against the other side, forming a sort of automatic adjustment for maintaining the width.

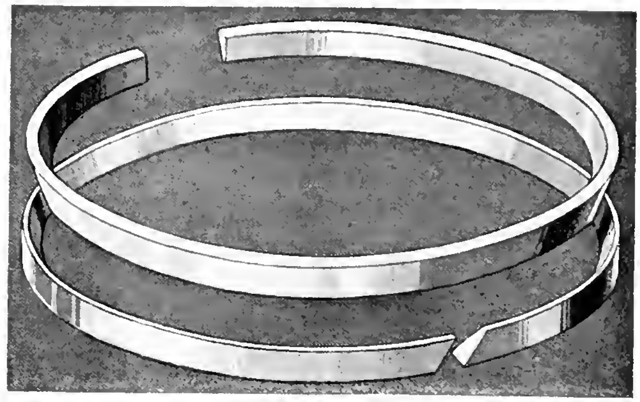


Fig. 6 Two-Part Piston Ring

The article describes in detail the method of manufacture of these rings and the tools used. Of particular interest is a machine especially designed for polishing the outer surface of the ring. As this surface is not parallel to the bore and consequently not square with the ground edges, and further as the ring being sprung open is not round, the job of polishing the outer surface is by no means simple, especially as it is necessary to maintain the bevel at a constant angle to keep the surface flat widthwise and to avoid grinding hollow spots in the contour of the ring.

In this machine a circular table somewhat larger in diameter than the largest ring to be polished is provided for each wheel, the table being supported on the upper end of a rod, which, when the machine is in operation, is given a slowly reciprocating endwise movement in a direction parallel to the axle wheel so that whatever work is held upon the table in contact with the wheel is automatically passed back and forth across the face of the latter. It is stated that by this means the tendency to wear grooves in the surface of the work is obviated.

As the ring is not round, owing to its having been sprung open to give it initial tension, it cannot be rigidly held to the wheel and the operation is therefore somewhat dependent upon the skill of

the operator to avoid grinding hollow spots on the periphery of the ring, but the men soon become experts in this work. (*American Machinist,* vol. 51, no. 5, July 31, 1919, pp. 199-202, 10 figs., *d*)

Design of Ball and Roller Bearings Subject to Centrifugal Loads

Ball and Roller Bearings, Capt. J. B. Swan, R.A.F. Data obtained from the records of the Technical Department, Aircraft Production (British) and dealing with the consideration of the behavior of ball and roller bearings when subjected to centrifugal loads.

When a ball or roller bearing is rotating as a whole about an axis without its own geometric center the condition of loading is quite peculiar, and it has been found that if the rollers or balls are above a certain size and the speed of rotation high the ordinary type of caged and uncaged bearing has a very short life. This particular type of loading is exemplified in practice when ball or roller bearings are used in big ends of connecting rods or in types of reduction gears in which the spider carrying the bearings rotates.

In a 10-cylinder radial engine developed by the Admiralty Air Department in 1916 a ball-bearing type of big end was used and as the engine was a two-throw radial, the big-end loading was necessarily high. When the engine was put into production the bearings were ruined after about five or six hours. At first it

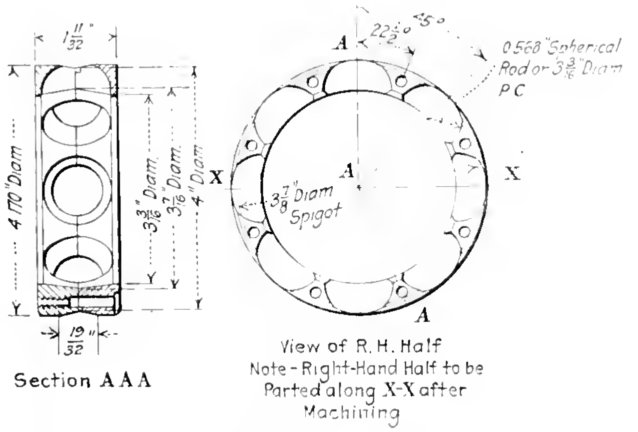


Fig. 7 Located Cage for Ball Bearings

was thought that the cages for the balls were at fault and so cageless races were tried, with the result that the balls were worn with flat belts around them.

As it was also noticed that the balls always showed the first signs of wear, it was deduced that the wear was probably due to the fact that the balls were subject to an undue crowding action which made them abrade each other, and when once the ball surface was roughened the race became speedily destroyed. This appeared to be especially so, as the load if normally applied would have been quite low for a bearing of the size used.

It appeared that as the bearing rotated about the crank center the balls, in the case of a cageless bearing, were crowded away from the center of rotation by a centrifugal force acting on them and rubbed against one another, the balls remote from the crank-pin center being pressed together by the combined centrifugal force of the other balls. As the balls were rotating about their own centers at about 2500 r.p.m. and the points that touched were moving in opposite directions, the abrasive action was very considerable.

When a cage of the steel-plate type was used a similar action took place. The cage was subjected to its own centrifugal force and also to the cumulative centrifugal load of the balls which it carried. This combined load was acting in line with the crank radius but away from the crank center and caused a displacement of the cage in that direction until a point was reached when the bearing load on the balls nearest the crank center due to the cage wedging between them, was equal to the combined load on the cage and this caused a heavy abrasive action between the balls and the cage at the point of application of the mean load on the race, producing a tendency for the balls to skid on the race at this point and causing in a short time serious damage to the balls, races and cage.

The foregoing experience indicated that the function of the cage was to carry independently the rubbing loads on each ball due to the centrifugal force and to prevent abrasive action on the

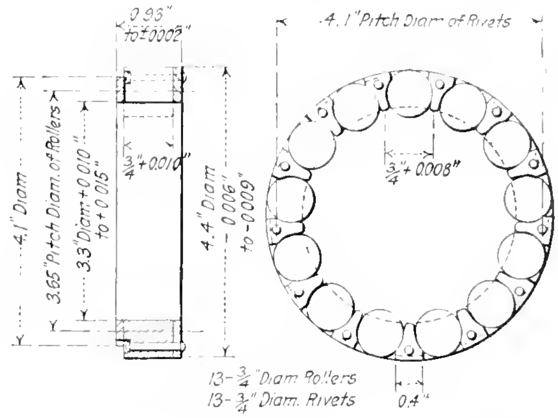


Fig. 8 Located Cage for Roller Bearings

balls. Because of this in designing the cage the following points had to be observed:

1 The cage must be strong enough to take the independent loads from the balls without distortion
2 Sufficient bearing surface must be provided at the surface of location of the cage to carry safely the combined centrifugal load due to the cage itself and the balls
3 Ample bearing surface must be provided between the balls and the cage to prevent wear on the cage
4 The cage must be made of a metal which gives a minimum abrasive action with the steel of the ball and race and at the same time has sufficient strength
5 All surfaces must run with a continuous film of oil over them.

A cage was devised, Fig. 7, which would be definitely located and could not be displaced by more than a few thousandths of an inch by the centrifugal load. It is made in two halves, split in a plane at right angles to the axis of the bearing and spigoted together; eight hemispherical holes were made with 0.010 in. clearance for the balls; the outside circumference was turned down in a flat V to avoid the actual ball path and on either side of the V was a cylindrical surface turned dead true about 5/16 in. wide. The outside diameter of the cage was made to fit in the outer ball race which had two cylindrical surfaces ground on to it on either side of the ball path and a clearance between the cage and the cylindrical part of the outer race was 0.005 in. to 0.007 in. The material of the cage was cast phosphor bronze.

Fig. 8 shows a similar type of cage, except that it was made for a railway bearing. With this cage a radial engine was run at speeds above 1800 r.p.m. for considerable periods and no signs of wear could be detected. In general, it would seem that at speed above 1600 r.p.m. and with a radius of rotation above 2½ in. cageless bearings will not run satisfactorily if the balls or rollers are larger than ⅜ in. in diameter and the inner race larger than ½ in. in diameter.

As regards the design of the located cage, the principal point besides making the cage of ample strength is to avoid any chance of the location of the cage being provided by the balls or rollers themselves, as this would cause the heavy abrasive loads which quickly ruin this type of bearing.

In addition to the above an appendix is attached giving some particulars of the big-end roller and ball bearings which have been found both successful and unsuccessful in practice. Also, a general method is given for finding the abrasive loads on the balls in an uncaged bearing subject to rotation about an external center.

In the case of a caged bearing a method is given whereby the

pressure load on the cage bearing surface may be found for a located cage design. A method is also given by which the total bearing load due to the cage itself and the cumulative loads from the rollers or balls may be estimated when the bearing as a whole rotates about a center without its axis.

In considering the constant comparison for the various bearings, since the wear on the bearing appears to depend almost entirely on the abrasion of the roller, an attempt has been made to find a constant for any bearing which will incorporate the factors controlling the roller abrasion.

The roller abrasion depends, it would appear from observation, on three factors: the pressure between adjacent rollers, the rubbing speed between these rollers, and the length of the line of contact. For this reason the constant K has been chosen equal to the product of the first two items divided by the last—that is: K = inter-roller pressure $\times$ inter-roller rubbing speed length of rollers, the pressure being in lb., the rubbing speed in ft. per sec., and the roller length in inches.

From this it will be at once obvious that the ball bearing, having only point contact between the balls, is at the outset at a very great disadvantage if used without a cage.

Ball bearings should not be used for a bearing rotating about an external center unless an efficient form of located cage is provided.

From the results tabulated in the original article for the uncaged roller bearings it will be seen that for an indefinite endurance the value of K should not be more than 1000.

If the line of the bearing may be limited to about 50 hours before replacement, values of K as high as 1500 may be used; in general this value should not be exceeded.

In regard to the caged bearings, the constant of comparison K_c is equal to the rubbing speed of the cage multiplied by the bearing pressure on the cage. It will be seen that the value of K may for a bearing of indefinite life be safely more than 2500, though this figure should serve as a good guide to designers. (*The Automobile Engineer*, vol. 9, no. 128, July 1919, pp. 200-204, 10 figs., *pt.A*)

MUNITIONS AND MILITARY ENGINEERING

Characteristics of Rifle-Barrel Steel. Abstract of an advance publication of two papers to be presented at the September Chicago meeting of the American Institute of Mining and Metallurgical Engineers.

One of these papers, by G. F. Butterworth, of the U. S. Armory, Springfield, Mass., deals with the Metallography of Rifle Barrel Steel; the other, on Erosion Tests of Rifle Barrels, is by A. E. Bellis, Ordnance Department, U. S. Army.

The first paper points out that the metallographic structures most frequently encountered in rifle barrels fall naturally into two groups distinguished by the method used to produce in the stock a physical condition having the requisite properties. The first group consists of rolled barrels or barrels subjected to hot-working by rolling in or near the critical range. In the second group the stock is upset to form the butt end and then heat-treated by giving it a quench and a draw. These barrels are referred to in the paper as heat-treated barrels.

The structure of the rolled barrels resembles closely that of the same steel after annealing, the grain size being closely related to the rolling temperature. Barrels rolled within the temperature range between 1300 and 1350 deg. fahr. give an exceedingly fine grain, but as the temperature is increased the grains are found to be larger. If the rolling temperature is below the critical range given above, the structure previous to rolling is not obliterated, the only effect of rolling being to elongate the coarse sorbite grains in the direction of rolling.

Heat-treated barrels are quenched in oil from above the critical range, which should give a martensitic structure, but the presence of some troostite in the martensite is frequently noted when the quench has not been sufficiently drastic. The structure brought about by the subsequent draw is sorbitic or sorbito-pearlitic. The structure is substantially the same for all drawing temperatures from 800 to 1300 deg. fahr., but the color of the specimen varies with the drawing temperature, becoming lighter as the temperature increases. Microscopic evidences of defective heat treatment are also discussed.

The paper by Maj. A. E. Bellis on Erosion Tests of Rifle Barrels calls attention to the fact that the extent to which the nature of the steel is a factor in erosion is still a much-discussed question. The paper describes tests made to determine the factor of erosion of gun barrels. The experiments performed appear to indicate that the homogeneous structure of a heat-treated barrel offers the best resistance to erosion. On the other hand, a barrel showing a network of free ferrite apparently offered easily eroded channels to the washing-out action of hot gases and metals. (*Iron Age*, vol. 104, no. 4, July 24, 1919, pp. 225-228, 23 figs., *etA*)

PHYSICS

Langmuir Postulates Regarding Structure of Matter

The Arrangement of Electrons in Atoms and Molecules, Irving Langmuir. Abstract of the first installment of a paper on the structure of matter. Particular attention is called to this paper, as it represents a development of possibly fundamental importance in our knowledge of atomic structure. The main assumption in this theory is that the electrons are stationary and situated in concentrated shells. By means of this theory the writer found that it is possible to explain the periodic properties of the elements and also succeeded in evolving a new view of chemical valency.

In the opinion of the author there is much chemical evidence, especially in the field of stereochemistry, that the primary balance forces between atoms act in directions nearly fixed with respect to each other. This can only be satisfactorily accounted for or explained by electrons arranged in three dimensions. There is conclusive evidence that in substances such as wood carbonized under certain conditions or finely divided WO_3 (tungsten trioxide) reduced in very dry hydrogen the atoms are arranged in branching chains in which most atoms are surrounded by only two or three others. Since the bodies are definitely solid it must follow that the atoms are not able to shift their relative positions except when acted on by strong external forces. Such structures are inconceivable if atoms contain only electrons revolving in orbits about their nuclei.

In attempting to determine the arrangement of electrons in atoms the author was guided by the numbers of electrons which make up the atoms of the inert gases; in other words, by the atomic numbers of these elements, namely, helium 2, neon 10, argon 18, krypton 36, xenon 54 and niton 86. Rydberg has pointed out that these numbers are obtained from the series

$$N = 2\ (1 + 2^2 + 2^2 + 3^2 + 3^2 + 4^2 +)$$

The factor 2 suggests a fundamental twofold symmetry for all stable atoms. By a consideration of this factor and principles of chemistry and from other data the writer has been led to the seven postulates reproduced below.

Postulate 1 The electrons in the atoms of the inert gases are arranged about the nucleus in pairs symmetrically placed with respect to a plane passing through the nucleus which we may call the equatorial plane. The atoms are symmetrical with respect to a polar axis perpendicular to the plane and passing through the nucleus. They have also four secondary planes of symmetry passing through the polar axis and making angles of 45 deg. with each other. The symmetry thus corresponds to that of a tetragonal crystal. Since the electrons must occur in pairs symmetrical to the equational plane there are no electrons in this plane.

Postulate 2 The electrons in the atoms are distributed through a series of concentric spherical shells. All the shells in a given atom are of equal thickness. If the mean of the inner and outer radii be considered to be the effective radius of the shell then the radii of the different shells stand in the ratio 1:2:3:4, and the effective surfaces of the shells are in the ratio $1:2^2:3^2:4^2$.

Postulate 3 Each spherical shell is divided into a number of

cellular spaces each of which may contain one or two electrons. The thickness of these cells measured in a radial direction is equal to the thickness of the shell and is therefore the same (Postulate 2) for all the cells in the atom. In any given atom the cells occupy equal areas in their respective shells. All the cells in an atom have therefore equal volumes. The first postulate, regarding symmetry, applies also to the location of the cells. The first shell therefore contains two cells obtained by dividing the shell into two equal parts by the equatorial plane. The second shell having four times the surface (Postulate 2) must contain eight cells. The third shell thus contains 18 while the fourth contains 32 cells. Or if we consider only one hemisphere the numbers in the successive shells are 1, 4, 9 and 16.

Postulate 4 Each of the two innermost cells can contain only one electron but each of the other cells is capable of holding two. There can be no electrons in the outside shell until all the inner shells contain their maximum numbers of electrons. In the outside shell two electrons can occupy a single cell only when all other cells contain at least one electron. We may assume that two electrons occupying the same cell are at different distances from the nucleus. Each shell, containing its full quota of electrons, thus consists of two "layers." We will find it convenient to refer to these layers of electrons by the symbols I, II*a*, II*b*, III*a*, III*b* and IV*a*, where the Roman numerals denote the shell containing the layer. Helium, neon, argon, krypton or xenon contains respectively the first 1, 2, 3, 4 or 5 of these layers, while niton contains all six.

The two-fold symmetry assumed in Postulate 1 is derived from the factor 2 which occurs in Rydberg's equation. The fourfold symmetry is derived from the remarkable numerical relation brought out in Table 2.

TABLE 2

Shell	Radius	n	Number of cells	
			in axis	in zones
I	1	1	1	0
II	2	4	0	4
III	3	9	1	8
IV	4	16	0	16

Here n represents the number of cells in one of the hemispheres of the shell. If this number is odd one of the cells must lie along the polar axis; all other cells must be distributed in zones about this axis.

We see from this table that the number of cells which must be arranged in zones is always a multiple of four. We can therefore assume tetragonal symmetry for the atoms of the inert gases.

Postulate 5 It is assumed that electrons contained in the same cell are nearly without effect on each other. But the electrons in the outside layer tend to line themselves up (in a radial direction) with those of the underlying shell because of a magnetic field, probably always to be associated with electrons bound in atoms (Parson's magneton theory). This attraction may be more or less counteracted by the electrostatic repulsion between the outside electrons and those in the underlying shell. The electrons in the outside layer also repel each other and thus tend to distribute themselves among the available cells so as to be as far apart as possible. The actual positions of equilibrium depend on a balance between these three sets of forces, together with the attractive force exerted by the nucleus.

Postulate 6 When the number of electrons in the outside layer is small, the magnetic attraction exerted by the electrons of the inner shells tends to predominate over the electrostatic repulsion, but when the atomic number and the number of electrons in the outside layer increase, the electrostatic forces become the controlling factor. As a result, when there are few electrons in the outer layer these arrange themselves in the cells over those of the underlying shell, but where the outside layer begins to approach its full quota of electrons, the cells over the underlying electrons tend to remain empty.

Postulate 7 The properties of the atoms are determined by the number and arrangement of electrons in the outside layer, and the ease with which they are able to revert to more stable forms by giving up or taking up electrons, or by sharing their outside electrons with the atoms with which they combine. The tendencies to revert to the forms represented by the atoms of the inert gases are the strongest, but there are a few other forms of high symmetry such as those corresponding to certain possible forms of Ni, Pd, Er and Pt atoms toward which atoms have a weaker tendency to revert (by giving up electrons only).

These seven postulates are applied by the author to derive the properties of the chemical elements, thus establishing a new basis for the theory of the structure of matter. This part of the paper will be abstracted in an early issue. (*General Electric Review*, vol. 22, no. 7, July 1919, pp. 505-516, 1 fig., to be continued. The paper has also been published in the *Journal of the American Chemical Society*, vol. 41.)

RAILROAD ENGINEERING

Pennsylvania Mallet Compound Locomotives. Description of pusher Mallet locomotives of the 0-8-8-0 type built for the Pennsylvania Lines West by the Baldwin Locomotive Works.

The locomotives are designed for heavy yard service and develop a tractive force of 100,000 lb.

These locomotives embody some features of the Baldwin practice not previously used on the Pennsylvania. They have conical wagon-type boilers with radially stayed fireboxes and three rows of Baldwin expansion stays to support the front end of the crown. The arch is supported on five tubes and firing is done by means of a Duplex stoker. The throttle is equipped with an auxiliary drifting valve.

The equalization of the rear group of wheels is continuous on each side of the locomotive. In the case of the front group the springs of the leading wheels are cross-equalized, while those of the remaining three pairs of wheels are equalized together on each side. The valve gear of the Walschaerts type and the gears are controlled by the Ragonnet type B reverse mechanism. The diameter of the driving wheels is only 51 in., because of which the low-pressure cylinders are placed at an angle of 1 in 35 to provide sufficient clearance above the rails. (*Railway Review*, vol. 65, no. 5, August 2, 1919, pp. 157-159, 5 figs., *d*)

REFRIGERATION

Novel Features in Ice-Plant Design, Including Copper Steam Condensers

Ice Plant of the Colorado Ice and Cold Storage Company in Denver, Victor J. Azbe, Mem.Am.Soc.M.E. Description of a plant having some novel features of design. The plant, the full capacity of which is 350 tons of ice per day, is driven by Corliss engines which exhaust at atmospheric pressure into steam condensers. Contrary to standard practice, however, these condensers are drums 10 ft. long and 37 in. in diameter made of thin-gage copper. When the plant is operated under full capacity there are 14 of these condensers in use, which means that each unit condenses steam for 25 tons of ice each 24 hours.

It is stated that copper condensers not only give better heat conduction than iron, but are also self-cleaning. The writer describes the following demonstration made for his benefit: From a heavy-scale-coated condenser steam was shut off but cooling water allowed to circulate. Immediately the scale began to crack and fall off and expose the clean, smooth copper surface. In this way most of the scale came off and after a few minutes the water was turned off and the steam on. This dried the surface

and by tapping slightly with a wooden mallet the remaining scale was removed. The whole operation of cleaning did not require much over five minutes. Another advantage of this type of condenser is that it is more durable and eventually easily repaired.

The freezing system is of the can type, freezing 800-lb. ice blocks, which it does very successfully. The cans proper are $23\frac{1}{2}$ in. by $12\frac{1}{2}$ in. at the top, $22\frac{1}{2}$ in. by 12 in. at the bottom and 7 ft. 11 in. long. As far as the effort of pulling is concerned, there is stated to be less of it here than is usually encountered with cans of half the size, which is, however, due to the type of electric crane that is employed.

Ammonia refrigeration is used. The ammonia condensing system consists of 29 spans of drip condensers, all being 24 pipes high and 20 ft. long. In addition, the plant is equipped with

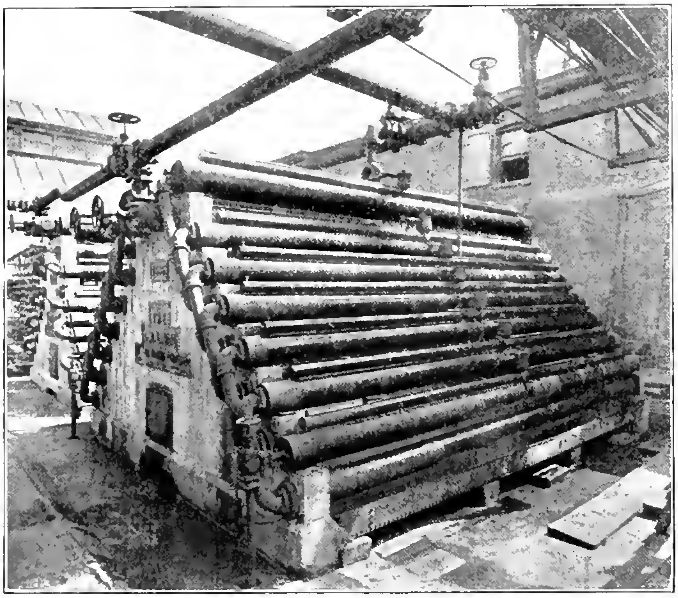


Fig. 9 Vail Ammonia Condenser

condensers designed by George L. Vail, chief engineer of the company, made up of 8-in. standard pipes and arranged as shown in Fig. 9.

Ammonia vapor flows successively through 14 lengths of 8-in. pipe, each having 18 ft. of effective length. The 8-in. pipes are interconnected by 2-in. pipes. While the velocity in this condenser is relatively low, the results obtained are said to be good.

The ice-storage house is 175 ft. long, 60 ft. wide and as much as 60 ft. high, which means that there are 30 layers and 500 tons of ice to the layer. At first objections were offered to building an ice-storage house of such a height as it was thought that the lower layers would not sustain the weight, but tests with an ice block under a hydraulic press showed that such fears were groundless. (*Power*, vol. 50, no. 5, July 29, 1919, pp. 168-170, 6 figs., *d*)

Just How Much Do We Know About Carbon Dioxide?

The Design of CO_2 Machines, John E. Starr, Mem.Am.Soc. M.E. The author points out that while the design of ammonia machines has advanced to a rather fine point and the knowledge of the behavior of ammonia is nearly perfect, the same does not apply to the case of machines employing other fluids, especially carbon dioxide. Machines of this class are often made either too large or too small for their intended duty and tables on the properties of carbon dioxide give results varying to such an extent as to produce at times as much as 50 or 60 per cent variation in the design of the engine.

For example, the curves in Fig. 10 compare the results of the heat content of liquid CO_2 in Siebel's Compendium of Mechanical Refrigeration and Engineering and in Le Doux' Ice-Making Machines with the work credited to Mollier and Amagat.

At first glance the last three sets of the curves do not appear to present discrepancies which would lead to a very great difference in ultimate design of the machines, but in a fluid such as CO_2 where the heat of liquid constitutes so great a proportion of the heat of vaporization, the actual variation greatly affects the results.

The following calculation reproduced from the original article is of considerable interest:

Taking the two principal tabulations and assuming 0 deg. fahr.

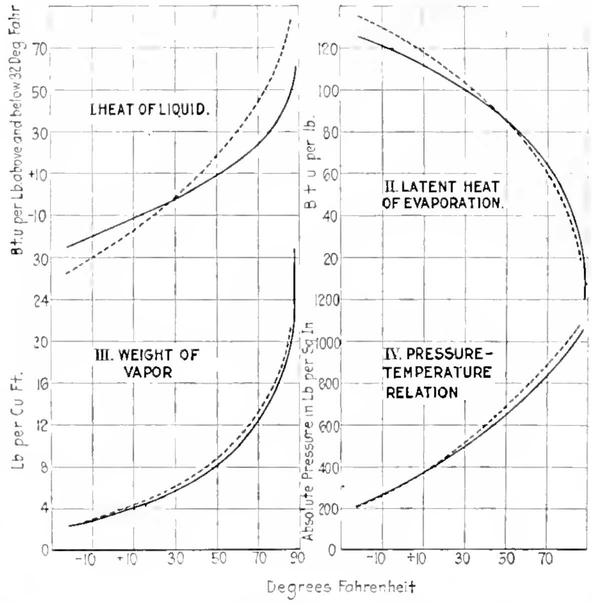


Fig. 10 Properties of Carbon Dioxide as Given by Different Authorities

(Broken Lines—Data given by Professor Schroeter in Le Doux's Book; Full Lines—More recent observations credited to Amagat and Mollier by Macintire.)

for the refrigerating temperature, and 80 deg. fahr. for the average temperature at which heat is rejected in the condenser the designer at once finds himself in a quandary. From the older set of tables (Schroeter, page 174 of Le Doux's book, 1902) he finds the following values:

Heat of vaporization at 0 fahr........125.5 B.t.u.
Heat of liquid at 0 deg.............. —24 B.t.u.
Heat of liquid at 80 deg.............. +63 B.t.u.

Hence, net heat taken up per lb. = 125.5 — (— 24 + 63) = 38.5 B.t.u. Therefore, 200 B.t.u. per min. (= 1 ton of refrigeration) ÷ 38.5 = 5.2 lb. of CO_2 required per ton. He further finds the weight of a cubic foot of gas to be 3.45 lb., or 0.2898 cu. ft. for 1 lb., or total for the necessary 5.2 lb. = 5.2 × 0.2898 = *1.506 cu. ft.* to be compressed per ton from 310 lb. up to 990 lb. absolute pressure.

From the newer tables (prepared by Mollier) he finds:

Heat of vaporization at 0 deg. fahr.... 117 B.t.u.
Heat of liquid at 0 deg. fahr.......... —17 B.t.u.
Heat of liquid at 80 deg. fahr......... +36 B.t.u.

Hence, net heat abstracted per pound = 117 — (— 17 + 36) = 64 B.t.u., and 200/64 = 3.12 lb. CO_2 to be circulated per minute per ton of refrigeration. Weight of vapor per cubic foot = 3.45 lb., and 1/3.45 = 0.2898 cu. ft. per lb. Therefore 3.12 × 0.2898 = *0.9041 cu. ft.* of vapor to be compressed per minute per ton from 310 to 965 lb. absolute pressure.

This is a difference of $66\frac{1}{2}$ per cent in the size of the machine, and as there is very little difference shown in pressures, the economy will also vary about $66\frac{1}{2}$ per cent!

The writer suggests that the Bureau of Standards is the proper authority to settle this matter. (*Refrigerating World*, vol. 54, no. 7, July 1919, pp. 11 to 12 and 20, 1 fig., *t*)

STEAM ENGINEERING

Drop Valves for Steam Engines. Discussion and criticism of the usual Cornish double-beat valve, especially as applied to engines working with superheated steam, and of the Lentz gear.

The author proposes to use instead the valve shown in Fig. 11,

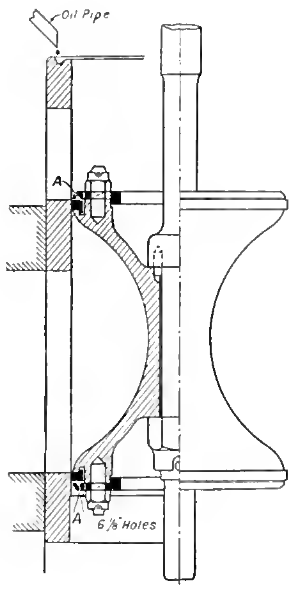


Fig. 11 Piston-Type Drop Valve for Steam Engines

only, however, as a steam-admission valve, and states that such a valve has been used in one instance for seven years and has shown practically no wear.

The valve works in a separate liner forced into the cylinder, the seatings being machined and, if necessary, scraped, so as to be circular when cold. The result of pressing the liner in is that where it touches the cylinder it is contracted. Hence, where the rings seat the bore of the liner becomes less than on either side of that seating. If the ports be cast in, the liner has a tendency to crack, and they are therefore cut from the solid. Now, the rings are restrained by a return flange on the faces. In the steam valve shown they are on the inner faces, but in the exhaust valves they are on the opposite faces. On those faces between the restraining flange and the liner, the rings are a ground fit to the valve, hence steamtight. The ring is not a tight fit in the grooves, but is kept up to its face by a wave spring in the recess *A* shown. Further, the rings are steam-packed, in the case of the inlet valve, by the incoming steam, and of the exhaust valve by the cylinder steam, or from the side on which there is the greatest pressure. The points in the rings are not lapped, but usually just radial, and the joint is pegged opposite one of the grids in the liner. The valve body is clear of the liner, and does not touch in work. It is pegged so that it cannot turn on the spindle, and all is so arranged that once set the valve commences and ends its life without circular movement. But it is necessary that the gland should not prevent the spindle from making slight movements at right angles to the axis of the liner. In work, then, the cylinder will distort the valve liner more in some designs of cylinders than others, but the rings being flexible to the necessary slight amount, follow at the first irregularities and later wear to them. At first sight the restraining flange may appear to prevent this automatic adjustment, and it was at first only used to prevent parts of the rings getting into the ports in case of breakage; but piston rings in work, whether in the piston or valve, expand more than the cylinder or liner—at least, all the writer's experiments have proved this—and, again, the rings are made a fit to the liner before it is forced in. Hence, when the valve is on the seating part of the liner, the rings are off their restraint. With care, then, these valves can be maintained reasonably steamtight. (*The Engineer*, vol. 128, no. 3315, July 11, 1919, pp. 25-26, 4 figs. *d*)

THERMODYNAMICS (See Refrigeration)

VARIA

Absolute Measurement of the Intensity of Sound, Prof. A. G. Webster. Description of a series of acoustical researches dealing, among other things, with the properties of vibrating bodies and the subject of elastic hysteresis.

An instrument has been developed called, the "phone," which is a standard of sound and is capable of reproducing at any time a sound of the simplest character and permits measuring the output of sound in watts of energy.

A second instrument has been developed for measuring the sound in absolute measure. This instrument, called a "phonometer," is now practically as sensitive as the human ear.

By means of these instruments the determination of the space distribution of sound, of the effect of disturbing bodies and measurement of the reflecting coefficient of surfaces have been accomplished.

In the same paper is briefly described an instrument called a "phonotrope," the purpose of which is to find the direction of location of a source of sound—for example, a false signal. Owing to the Doppler effect it cannot yet be used to determine the direction of an aeroplane at night. (*Proceedings of the American Institute of Electrical Engineers*, vol. 38, no. 7, July 1919, pp. 889-900, 7 figs., *dA*)

Dazzle Painting of Ships, Lt.-Comm. Norman Wilkinson, R. N. V. R. Dazzle painting is defined as a method to produce, by paint, an effect in such a way that all accepted forms of a ship are broken up by masses of strangely contrasted colors. The purpose of it is to make it difficult for a submarine to decide on the exact course of the vessel to be attacked.

Invisibility against submarines is not only impossible but said to be dangerous, and marine camouflage is in this respect radically different from sea camouflage. The primary object of the camouflaged vessel was not so much to cause the enemy to miss its shot when actually in firing position (although this has happened in a number of cases) but to mislead him when the ship was first sighted as to the correct position to take up. With a vessel of 10 knots or over a submarine having once failed to obtain a good position has little or no likelihood of regaining that position owing to insufficient underwater speed.

Should the submarine decide to come up the ship attacked, being armed, has every chance of a successful escape, and, in fact, the coming out of the submarine would in itself be a good testimony to the success of the painting.

The striped type of dazzle design which was most successful was arrived at some time before the end of the war. In the initial stages a small wooden model of each ship was made to scale. On this a design was painted in wash colors and the model was carefully studied on a prepared theater through a submarine periscope, various sky backgrounds being placed behind her alternately. A satisfactory design having been evolved giving the maximum distortion, the model was then handed to a trained plan-maker and copied.

The most important parts of a ship on which distortion should be obtained are in the neighborhood of the stem and the fore-bridge, both of these being of great use to a submarine in determining the course. The colors mostly in use were black, white, blue and green, either in their primary condition or mixed to various tones. The speed developed in dazzle painting was such that, for example, the Leviathan was marked out in just over two days. (Paper read before the Northeast Coast Institution of Engineers and Shipbuilders, July 10, 1919. Compare *Engineering*, vol. 108, no. 2797, August 8, 1919, pp. 192-195, 5 figs., *d*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

MECHANICAL ENGINEERING

THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Published Monthly by the Society at 29 West Thirty-ninth Street, New York

M. E. Cooley, *President*

William H. Wiley, *Treasurer* Calvin W. Rice, *Secretary*

PUBLICATION COMMITTEE:

George A. Orrok, *Chairman* J. W. Roe
H. H. Esselstyn George J. Foran
Ralph E. Flanders

PUBLICATION STAFF:

Lester G. French, *Editor and Manager*

Leon Cammen, C. M. Sames, *Associate Editors*

W. E. Bullock, *Assistant Secretary Editor Society Affairs*

Frederick Lask, *Advertising Manager*

Walter B. Snow, *Circulation Manager*

136 Federal St., Boston

Yearly subscription \$3.00, single copies 35 cents. Postage to Canada, 50 cents additional; to foreign countries \$1.00 additional.

Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

Engineering Societies Employment Bureau

The work of the Engineering Societies Employment Bureau has increased rather than decreased during the summer months. Engineers just being released from Government service continue in as great numbers as during last spring to seek employment through the agency of the Bureau. Employers, realizing the good material which may be secured by means of the Bureau, are increasing their demands upon it. In addition to the calls for engineers there are many requests for designers, draftsmen, and minor assistants. Statistics of the work of the Bureau for the eight months ending July 31 last are as follows:

Applications for employment	3763
Positions registered	1334
Positions open at present	350
Applicants placed to date	744
Average number of men visiting Bureau per month	1690
Average number of men sent out for interview per month	675
Average number of letters of application for positions forwarded per month	1457

There is every reason, however, to believe that many more than 744 applicants have been placed who have failed to notify the Bureau.

Recataloging the Engineering Societies Library

Attention is called to the interesting report in another column by Director Harrison W. Craver of the library in the Engineering Societies Building, New York, on the subject of library cataloging and the classification of engineering literature. This great library originally comprised the books of the libraries of the Mining, Mechanical and Electrical Engineers, to which later was added the large and very complete collection of the Civil Engineers. Each originally had its own library catalog, from which, as explained by Mr. Craver, a general authors' catalog was made by interfiling the catalogs of the constituent libraries. There is also an alphabetical classified catalog of the three original collections, a classified subject catalog of the Civil Engineers, and other catalogs and lists.

Work of recataloging is now under way, a very large undertaking which will require from two to three years to complete. There will be an authors' catalog to enable the reader to find a book when the name of an author is known, or what books by any author are in the library; a subject catalog to enable the reader to find a book when the subject is known, and to exhibit the resources of the library on every chief and most subordinate topics; and an alphabetical index which will comprise the names of the various subjects upon which there are important books or pamphlets and which will direct the user to that section of the subject catalog where the books are listed and to the department of the library where they are to be found.

The Dewey system of classification will be used as extended and modified by the Institut International de Bibliographie, usually known as the "Brussels" classification.

The principles underlying this work are explained in the report as well as the details of the system of classification used. The report should prove of value to engineers generally, apart from its direct bearing on the work now in hand for the library of the Engineering Societies.

The Training of Industrial Executives

The successful conduct of manufacturing enterprises demands that type of managerial talent which fully comprehends and effectively coördinates the social, commercial and technical forces which condition the life and prosperity of such institutions. The proper embodiment of physical, chemical and mechanical laws in industrial processes is the first essential in establishing a manufacturing enterprise upon a good technical foundation.

The provision of those conditions which release the creative faculties of the mind, which bring about the coöperative efforts of men and which establish understanding between labor and capital, are the golden fruits of management.

The distribution and marketing of the products of the factory, the financing of the enterprise and control of its activities in the light of market conditions are among the most serious problems dealt with in directing the affairs of an industrial undertaking. Accordingly, therefore, any training for service in manufacturing and industry which has for its object the development of men who shall occupy executive positions should be directed toward the great problems of labor and the human side of engineering, the problems of costs, accounting and finance, as well as the scientific and technical problems arising in industrial processes.

We are beginning to realize that the management of industrial enterprises is a matter of public interest and concern. The late war has demonstrated most forcefully the fact that our ability to combat is in direct proportion to our ability to produce goods; and between nations of equal resources the decision is generally in favor of the one which can produce, handle and use its goods most economically. As we enter the reconstruction period and begin to adjust ourselves to the new economic and social conditions which have arisen as a consequence of the war, we realize as never before that one of our greatest natural problems is the economic production and distribution of goods. And the greatest factor in this problem is that of man power or executive ability. We do not lack devices for production, systems of credit, methods of management—the tools to work with—but our need is men of vision, ability and force, well trained in commerce, finance and technology to direct our industrial organizations and cause them to function properly in all these particulars.

The development of men for such service is important to the public welfare. It is of more than passing interest, therefore, to note that the Engineering Schools of Columbia University have given serious consideration to this question and have developed a plan for training men for this service. Some years past Columbia, appreciating the growing importance of all engineering service to the public welfare and the increasing responsibility of the engineer to the public, raised its requirements for attainment of its engineering degrees to provide a more liberal education in the arts and the humanities. It is provided that this new development shall also stand on the same broad educational foundation. An equivalent of three years' college training will therefore be required of all candidates for instruction in this branch of service.

The instruction under the supervision of the engineering faculty extends over a period of three years, and is about equally divided between technical and commercial subjects. The School of Business of Columbia University is coöperating in the project and will give instruction in commercial practice and finance.

At a recent meeting of business men and educators held in Washington it developed that the Carnegie Institute of Technology and the University of Cincinnati were also working out similar projects and were offering instruction at the present time in those commercial subjects which are most important in matters dealing with the management of factories and the conduct of commercial enterprise.

With our universities and colleges developing men of broad vision and understanding in matters relating to the industrial and commercial development of our country, and with the introduction of these men into our business life, it is felt that the whole plane of commercial operation will be lifted and the problems perplexing labor and capital will be more thoroughly understood and more wisely handled.

Walter Rautenstrauch.

Aeroplane Fuels

About the time when the United States entered into the war the air was full of rumors of wonderful German achievements in the field of heavier-than-air flying. The usefulness of the zeppelin as an engine of warfare was pretty well discredited, but it was said that the Germans had some wonderful invisible aeroplanes, armored aeroplanes, etc. One particularly persistent and disquieting rumor was that the Germans had developed mass production of a new fuel belonging to the class of hydrogenated benzols and known as cyclohexane.

An extensive research undertaken by the Bureau of Mines, together with other governmental and private agencies, had for its purpose (1) to determine the conditions surrounding the combustion of fuels in aeroplane engines of varying ratios of compression, and (2) to develop the production of synthetic fuels of the hydrogenated-benzol type.

Highly gratifying results were secured in both lines of this research, even though neither was developed in time to be of practical use before the signing of the armistice in November of last year.

In the first place, it was found that the various fuels behaved in a definite manner under various degrees of compression. It was found that a fuel could actually be "crushed" under the compression so that it would ignite spontaneously. It appears that of the commercially known fuels kerosene has a comparatively low upper limit of usage in high-compression engines; gasoline comes next; following which come the various compound and synthetic fuels.

It was further determined that under a compression ratio of 8.221, corresponding to a pressure of 185 lb. per sq. in. as measured with an Edelman gage, cyclohexane-benzol alcohol and alcohol-benzol-gasoline mixtures showed only a slight tendency to cause knocking, which, when it occurs, may mean either preignition or excessively rapid combustion.

A mixture composed of 70 to 80 per cent cyclohexane and 20 to 30 per cent benzol, called "hecter," was developed and rapid strides were being made in volume production of cyclohexane when the armistice put an end to this kind of work so far as the Government was concerned.

The immense value of research of this nature is obvious to any engineer and it can only be regretted that the pressure of the terrible war emergency was apparently needed to attract sufficient interest and secure adequate means for work of the character indicated.

Corrosion of Non-Ferrous Metals and Alloys

In the Engineering Survey of this number will be found abstracts of two papers presented before the American Institute of Mining and Metallurgical Engineers on the general subject of corrosion of non-ferrous metals and alloys. These report valuable work done at the U. S. Bureau of Standards and point to a new and promising field of research concerning the behavior of our basic materials of engineering construction.

When the average man speaks of corrosion of metals he has primarily in mind the corrosion of the universal metal, steel, which unfortunately is so subject to the action of the elements. The general assumption is that non-ferrous metals, in particular those with a copper base, are fairly free from corrosion. Because of this, copper, brass and bronze are used in places where the element of construction is particularly subject to corrosion and, as a rule, it is assumed that the yellow metal or alloy will insure practically complete protection from corrosion.

The work done by the Bureau of Standards, however, shows that this is not always the case and that not only aluminum alloys, which it is well known are subject to corrosive action, but under certain conditions brass and bronze suffer from corrosion to an extent sufficient to impair their usefulness as structural materials.

In particular, the paper by P. D. Merica and R. W. Woodward indicates that brass and bronze may be subject to failure when under tensile stress greater than 20,000 lb. per sq. in. and at the same time under corrosive action such as results, for example, from concentrated ammonium hydroxide.

The value of this investigation lies in its contribution toward a clearer knowledge of the life and factors of safety of basic materials of engineering construction and if carried further may indicate the need for more stringent rules for the employment of these factors in places where the metal is subject to hitherto little-suspected destructive agencies.

Ball and Roller Bearings Under Centrifugal Loads

The development of aeronautical engines had made it necessary to use somewhat unusual combinations of machine elements or to employ known elements under new and unusual conditions of operation. One such case was that of a ball and roller bearing rotating as a whole about an axis external to its own geometric center. It was found that if the rollers or balls were above a certain size and the speed of rotation high, bearings with cages of the ordinary type, and bearings without cages, had a very short life.

A series of tests and investigations have been undertaken by the Technical Department, British Aircraft Production, which show that in such cases we have to deal with piling up of the balls or rollers due to the action of centrifugal forces. This in its turn led not only to the development of a new type of bearing, but also to the evolution of the theory of "located" cage design and special uncaged roller bearings. This matter is covered in the abstract of a report of the investigation published in the Engineering Survey section of this number.

The National Budget

A National Budget System is favored by both the republican and democratic parties, and a resolution has been adopted in both Houses, whereby select committees on the budget system have been appointed consisting of 10 members on the Senate Committee and 12 members on House Committee. To these committees will be referred all reports on bills, resolutions and documents for the establishment of a National Budget System, as well as proposed changes in dealing with appropriations, estimates and expenditures.

An outline of the budget plans for our own Government and the budget system used in foreign countries has been submitted, together with an outline of the essentials of the budget system and anticipated results. The Senate Committee, of which Senator McCormick of Illinois is chairman, is now framing and will later present proposed legislation for a Budget System on or before March 1, 1920.

AFTER-WAR EUROPEAN INDUSTRIAL ACTIVITY

EARLY in March 1919 a large delegation of the Cleveland Chamber of Commerce went to Europe to study industrial conditions for the benefit of their community. Mr. E. S. Carman, the former chairman of the Cleveland Section of The American Society of Mechanical Engineers, and the president of the Cleveland Engineering Society, was a member of the delegation and since returning has delivered a number of addresses giving in a general way the results of his observations on after-war European industrial activity. In these he has told his audiences most interestingly his impressions of the trade conditions in the several countries of the Allies and of the destruction wrought in Belgium. In what follows are given excerpts from his remarks that we believe will be equally as interesting to the larger audience comprised by the members of this Society and the other readers of MECHANICAL ENGINEERING. In these addresses Mr. Carman has said in part:

"I have had the great privilege of visiting England, France and Italy and Belgium's industrial plants and of coming in personal contact with their managing directors and engineers and have seen and heard first hand just the condition existing in the various countries from four to six months after the signing of the armistice.

"Arriving in England in early March, I spent two weeks studying the Englishman at home. I heard his complaint, his grumble, his expressed dissatisfaction with his government, with labor, with railroads, with the weather, in fact with everything and everybody—even Americans. His home was cold, exchange value of sterling made the American dollar standard, his food was poor and portions small; he did not have butter, sugar, or cream and he feared that which he did have President Wilson was going to give to the Huns. There was not much activity industrially and labor as a whole threatened to strike on Sunday morning, March 23. The arrogant demands of labor was the paramount talk of the day. The Englishman needed the holiday he had not had for five long years.

"In France the people seemed to be enjoying their new-found and unexpected freedom from the bitter fighting of the past five years. They seemed happy, content and ambitious to take up again the life of peace and happiness. In Paris one is surprised at the gaiety of the throng.

"After visiting the northwest battlefields I left France for a time, entering Belgium. It was here that one asked the question, 'Can Belgium ever regain the industrial position she once held? Can she be a factor in the competition for the export trade of the world?'

"Her industrial plants, stripped by the Hun, are as skeletons, standing upright in all their ghastly nakedness; their hearts have ceased to beat, their flesh, yea, their souls have disappeared, and through their broken windows there shines a light to show the occasional visitor the heartlessness of the Hun.

"We have heard and read of the wilful destruction of the cities and industrial plants of Belgium and Northern France, but neither words nor pen can adequately convey to the mind the real conception of what the eyes can see and the heart can feel—for one must see with his own eyes and hear with his own ears, before he can conceive of the completeness of the devastation that was wrought.

"Then, too, one sees there the human side of after-war, and, if at all sympathetic, his heart is deeply touched.

"I called on a former customer of ours at his office-home in Brussels; a builder of large engines, both steam and gas, also general engineering work. I was shown into the office of the owner (a man of about 55 years of age) and there—after I had convinced him that I was not trying to sell him something but just sympathetically inquiring what I could do to help—he told me the story of his misfortune.

"It developed that his plant was equipped thoroughly with machines of English, Belgian, American and Dutch manufacture. He further stated that of all this large equipment the only thing left was that which was made in Holland as the equipment manufactured in England, Belgium and America had been carried away into Germany.

"It was a sad situation indeed and one that pulled severely at the heart strings to sit in conversation with one who, like the owner of this works, had been well-to-do practically all his life and now, at the age of about 55, did not have a single thing left, and the only people in this large establishment were about six people in the outer office in Brussels.

"In a discussion as to how this vast amount of equipment would be replaced, he admitted he could not see how it could be purchased from America or England, and in answer to the question as to whether or not Belgium could manufacture it, he replied that it could not as they have nothing to manufacture it with. The only course left open for him will be to purchase his machinery and the question is where will he purchase it. Now let us consider this problem from his standpoint. He thinks in terms of francs; they are his standard by which he gages the cost of anything, just as the dollar is ours. The franc is at a discount in dealing both with England and with America. If we quote \$1000 on a piece of machinery, this would normally be approximately 5000 francs, but now with the depreciated value of the franc, he would have to pay 7500 francs for what would still appear to him to be 5000 francs worth of machinery. The same thing is true of English quotations, but on the other hand, consider German quotations. They quote him in marks and a piece of machinery valued at \$1000 will be quoted by a German concern at approximately 4000 marks. Normally 4000 marks would mean practically a price of 8000 francs, but now with the depreciated value of the mark, a quotation of 4000 marks means only 2000 francs, so that if this Belgian manufacturer receives quotations from both America and Germany on a piece of machinery, the normal value of which is \$1000, he will receive a quotation of 7500 francs for the American machinery and only 2000 francs or less than one-third for the German machinery. With money normal, his hatred of the Hun would undoubtedly cause him to purchase the equipment here, but being poverty-stricken, as every Belgian is today, the money consideration becomes one of paramount importance. This is the great question before American manufacturers today. We have the desire to help our Allies, but can we meet conditions in such a way that it will be possible for us to do so?

"The sentiment of the large portion of the Belgian population is very much in favor of America. This was noticeable at every village and city which I visited and I especially call to mind visiting the city of Dinant with its great fortress—the city on which was based the last hopes of Belgium withstanding the German invasion of five years ago; the city that was laid low not by shell fire but by wilful destruction—it was after visiting this city and being entertained by the burgomaster and others, that, in leaving in our automobile and swinging from their main thoroughfare across the River Meuse, a large crowd of school children, waiving their handkerchiefs, cried, 'Vive L' Amerique.'

"Regarding the labor conditions in Belgium, while there was not much being said, nevertheless, upon inquiry, it was found that the workman did not care to work and that where an attempt was made to stir him to industrial activity strike after strike occurred. In many places the demands were immediately granted and then before the workers would accept that which they were striking for, they would immediately ask for more and continue the strike.

"In the city of Alost, the headquarters of the American Food Relief which has now been taken over by the Belgian Government as their headquarters, I found the squares of the city crowded with idle workmen and upon inquiry learned that men out of work were receiving 27 francs per week and with this money, which was paid by the government, they purchased their supplies cheaply from the Belgian Food Relief Stations and lived on this all week. There were at that time about 150,000 Belgians drawing this 'idle' pay.

"In contrast with this idleness it is quite evident that the farms

surrounding the cities required the help of every available man and especially so since all their horses and oxen have been killed or taken away from them by the Huns. One of the most pitiful sights which I saw was two men harnessed together drawing a heavy drag or harrow across the spaded ground.

"Italy has been a consuming nation, importing large quantities of food, clothing materials, and nearly all her iron and steel products of consumption; she has never been known as an industrial or manufacturing nation, but it is my understanding that her after-war aspiration is to become a producer instead of a consumer.

"She feels that the mechanical experience gained in war time should enable her to manufacture and so she has continued and is producing several types of machine tools, hydroelectric power units, motors, etc., as a whole they are crude looking in design and poorly built.

"It was my good fortune to visit many plants in all her large cities, excepting Venice, also a few of the Royal Navy yards and arsenals, including the largest; it was at this plant that I was shown the foundries, machine, pattern, boiler, plate and electric-welding shops. These shops were furnished with only an average equipment and that did not seem to be producing an average output. This being the largest and best navy yard, I was beginning to wonder what the others would look like, when, much to my surprise, upon arriving at the ship yard and entering an enclosure, there lay before me on the ways, a submarine just about ready for launching; it was the last of an order of six; about 20 ft. in diameter and 200 ft. long.

"We give the Italian credit for being an artist and rightly so, but when we think of art we think of painting and sculpture, of palaces and song, but hardly do we expect to see such graceful lines and curves upon a submarine, an engine of destruction. As I looked upon this thing of elegance and beauty, an artistic design with workmanship most skillful in the bending, shaping and riveting of the heavy plates, the American instinct began inquiring within, Was not this built for fighting? Was not this built to win a war, and at a time when labor, capital and skill was in great demand? Why, pray tell me, why the utter waste of labor, capital and skill necessary to fashion these heavy plates in such an artistic manner? Would not a more simple design accomplish the same work?

"What position will Italy hold in the after-war struggle for commercial supremacy? Can she put into articles for general world-wide consumption all the laborious skill that she now puts in her works of art? And can she put into her products that exceptional amount of labor which she puts in the construction of her public works? For I recall that while passing in a train I observed that a winding river in the bottom of a valley was being straightened; the cut being perhaps a mile long and the section which was being excavated was approximately 50 ft. wide by 8 ft. deep; and all this vast amount of earth was being removed by spade and wheelbarrow methods.

"As one travels throughout Italy it becomes at once apparent that the business and home life of the Italians is one of ease and primitive in manner and habits; there are not to be found the many conveniences, and in fact the necessities of the American home and office; mechanical appliances in everyday life are unknown. Labor is plentiful and cheap. Yet when output and cost are compared with ours, their costs will doubtless be much higher.

"Before Italy can export she must consume, and to teach her people to consume requires the changing of customs as old as history itself—a great task indeed.

"In France the conditions are quite different. France has a people whose habits are advanced and her workmen know how to produce a day's work for a day's pay. There seems to be a willingness on the part of the workmen.

"It was my privilege to be the first American civilian to inspect the greatly enlarged works of Schneider & Co., at Le Creusot. I have heard this company spoken of as "The Krupps of France" and so it is, for on every hand was to be seen ordnance of all sizes and description.

"This great plant which was responsible for the furnishing of much of France's war weapons, is now at work building instruments of peace and the preparation is now being made to convert still more of its many shops to the manufacture of useful peace time machinery.

"France is busily at work now, but France has years of work ahead to rebuild, repair and reëstablish her industries and that too with over three million of her best and most skillful workers either dead or disabled. Can France give attention to world-wide trade? Not yet,

"And now, what about England? Yes, England has all that is necessary in the way of equipment to have and to hold the world's trade, but one thing she lacks—a willing labor. England's labor will not work, regardless of the rate of pay; the day's output is restricted and retarded.

"Her plants are not busy. Her labor is unemployed. Her masters are indifferent and I fear in many instances unconscious of the storm that will sooner or later break in great fury. We must look further back than the near past before we can begin to suggest the causes for all this present unrest. Europe's age-old curse—man and master, snobbery and hatred—is at the bottom of all her troubles. She does not and will not recognize that all men have an inalienable right to earn a livelihood and pursue the paths of peaceful, honest and happy living. Many of the masters of industry are autocratic, as are also the masters of labor. They are continually striving one with the other.

"Can England be a factor in the race for world-wide commercial supremacy? The question is a hard one to answer and I believe from observation we shall have plenty of time to wait for a reply. England has troubles of her own."

Business Engineering at Stevens

In another column, Prof. Walter Rautenstrauch of Columbia University comments upon the movement in several colleges, including Columbia, toward courses in administrative work in combination with engineering training to prepare young men for broader activities of engineering and manufacturing. In this connection attention should be called also to the fact that in certain institutions lectures are given in business administration and economics as a part of the regular course of engineering, in distinction from the new courses referred to by Professor Rautenstrauch in which business administration is coördinate with the engineering subjects.

A pioneer in adopting such instruction is Stevens Institute of Technology. Dr. Alex. C. Humphreys, President of the Institute and Past-President of The American Society of Mechanical Engineers, combined with H. de B. Parsons in suggesting that as far as time would permit, instruction should be given at least to members of the senior class on commercial conditions and methods affecting engineering enterprises. The result of these suggestions was that a course of four lectures was delivered to the senior class in the spring of 1897, the first being prepared by Dr. Humphreys and the second by Mr. Parsons. Additional lectures were prepared by George R. Turnbull, vice-president of the Guaranty Trust Company of New York, on Accounts and Accounting, and by William Sherrer, manager of the New York Clearing House, on the Relation of Money and Banking to Engineering Work. During the next college year it was not found practicable to provide regular instruction along the lines suggested, but a brief course in accountancy was offered to the senior class in the spring of 1899.

When Dr. Humphreys assumed the presidency of Stevens Institute, he promptly determined to enlarge the scope of this instruction and, as a result, the Department of Business Engineering was established under his direct supervision; the title of the department being later changed to "Economics of Engineering."

Other lectures have been given from time to time and a selection of these have been gathered together in book form as lecture notes for the use of students. These now comprise a volume of nearly 600 pages upon such subjects as accountancy, depreciation, shop costs, analysis of data, specifications, estimates, law of contracts, patent law, and business methods in general. These probably constitute the most complete volume which has been published on what Dr. Humphreys is pleased to call The Economics of Engineering for the use of engineering students.

FORMULATION OF POWER TEST CODES

Methods of Testing Power-Plant Apparatus now being Standardized by the Largest Committee of Mechanical Engineers

TEN years ago a committee was appointed by The American Society of Mechanical Engineers, known as the Committee on Power Tests, to revise the various testing codes of the Society pertaining to boilers, pumping engines, locomotives, steam engines, internal-combustion engines, etc., and to extend these codes to include other apparatus. The report was presented at the Annual Meeting in 1915 and has since been in extensive use throughout the country.

Appreciation of the Code by the profession led to a proposal for its thorough revision, including the amplification of its several sections where necessary and the formulation of new codes to cover other types of power-plant apparatus. Accordingly, in December 1918 a committee was appointed by the Council to revise and extend the Power Test Code. Nineteen individual committees of specialists in different fields were also appointed, as listed in what follows. The following instructions and directions defining the work of these individual committees in order to facilitate coöperation and avoid conflict have been issued by the committee:

Plan of Organization

The Main Committee has charge of the plan and scope of the work, determines what codes shall be formulated, nominates or suggests those to be appointed by the Council as members of the committees charged with the formulation of the individual codes and suggests revisions if necessary to correlate their work with that of the other committees and with the general plan. When a code submitted by an individual committee is complete and satisfactory, the Main Committee transmits it to the Council with its recommendations, and when approved by the Council it is published as the A. S. M. E. Code upon its particular subject over the signatures of the members of the Individual Committee that formulated it.

The Main Committee holds stated meetings on the first Monday preceding the first Tuesday in March, June, October and December to consider reports from the Individual Committees and such other business as may properly come before it. An Executive Committee of nine of its members, easily accessible to headquarters, functions in the interim. A secretary is assigned to the committee by the Society.

Committees on Individual Codes

The policy of the Main Committee has been to select committees to formulate the individual codes with a view to obtaining the best thought and experience of the profession with regard to the special subjects in hand. The choice of members has not been confined to men belonging to the Society. Special knowledge of the subject is considered more important than society affiliation. A list of the committees, with their personnel as determined to date, is given below.

The committees are favored by the coöperation of other societies. The Committee on Hydraulic Power Plants is composed, for instance, of three representatives each from the American Society of Civil Engineers, the American Institute of Electrical Engineers, the National Electric Light Association, and our own Society. Our Committee on Refrigerating Machines and Plants is identical in its membership with the committees appointed for a similar purpose by the American Society of Refrigerating Engineers. The Mechanical Section of the American Railroad Association has officially designated Mr. A. W. Gibbs to represent that body on our Committee on Locomotives, and our Individual Committees include representatives from the U. S. Bureau of Standards, the U. S. Naval Academy Testing Station, the Machinery Builders' Society, the Hydraulic Society, etc.

The Individual Committees are expected to choose their own officers and perfect their own organization. They are free to seek the coöperation of everybody having information upon or interest in their respective subjects, especially those whose interests will be affected by the Codes. The Committee on Steam Engines, for example, wrote to 119 engine builders, telling them that the Steam Engine Code was to be revised and soliciting their suggestions and interest. Committees may avail themselves of the coöperation of other societies or committees interested in their subjects; but if it is desired to add to their membership or to invite an organization to formal participation in their work by the appointment of representatives upon their committee, recommendations should be made to the Main Committee that the persons desired be appointed or an invitation for such representation be extended by the Council.

Records of the meetings of Individual Committees are to be sent in duplicate to the Secretary of the Main Committee, in whose office one set will be kept intact for reference, the other set being available for circulation among other committees that may ask to see it.

General Instructions

The work of some of the committees is so interrelated that an interchange of records of conclusions reached or important points under consideration will be helpful if not necessary.

The chairman or secretaries of Individual Committees are to indicate to the Secretary of the Main Committee what other committees are likely to be interested in their reports and in the reports of what committees they are likely to be interested. Differences of opinion as between committees will be reconciled if possible by correspondence or joint meetings, but if irreconcilable will be reported to the Main Committee.

Description of instruments, apparatus and methods—such as the salt or color method for measuring the rate of flow of water—and their correction, calibration and use will be treated by a special committee.

Instructions which are not special to their particular codes will be referred by Individual Committees to Committee No. 1 on General Instructions.

Individual Committees will refer the definitions of terms and the fixing of values of physical constants, etc., to Committee No. 2 on Definitions and Values.

The codes formulated by the Individual Committees will treat of special applications of such instruments to their particular code; but refer to the section on Instruments and Apparatus for directions for the calibration, correction and utilization of the instruments themselves. Matter in the codes under revision or suggestions as to points desired to be included in the treatment of instruments, apparatus or methods involved in their work, or already completed upon such instruments applicable to other codes, are to be referred by Individual Committees to Committee No. 19 on Instruments and Apparatus.

The codes will eventually be available in printed form, both in a single volume and separately. Each code when printed as a monograph will be accompanied by the General Instructions, Definitions and Values, and pertinent selections from the section on Instruments and Apparatus and from the Appendices.

Special Instructions

No. 3. Committee on Fuels will formulate a code for the testing of all kinds of fuels, liquid and gaseous as well as solid, and will include the treatment of Flue-Gas Analysis, sampling, the determination of the fusibility of ash, etc.

No. 4. Economizers will be treated by Committee No. 4 on Boilers.

No. 7. Displacement Pumps do not include rotary displacement pumps. (See No. 8.)

No. 8. Centrifugal and Rotary Pumps include displacement pumps of the rotary type as well as those acting by centrifugal force.

No. 9. Displacement Compressors and Blowers include displacement compressors and blowers of all classes, rotary as well as reciprocating.

No. 12. Condenser Units and Feedwater Heaters. The title of this code has been changed to "Condensers, Water Heating and Cooling Equipment." This committee considers cooling towers, spray systems, etc., as well as condensing and heating apparatus proper.

No. 17. Gas and Oil Engines. The title of this code has been changed from the above to "Internal-Combustion Engines."

No. 18. Water Wheel Code. The title of this code has been changed to "Hydraulic Power Plants." This committee will prepare the code for testing turbines and all prime movers actuated by water.

No. 19. Instruments and Apparatus. This committee will prepare directions for the calibration, correction and application of instruments and methods for determining test values and conditions.

The Secretary of the Main Committee will furnish an account of the conclusions arrived at:

By any of the Individual Committees	to all members of the Main Committee
By committees 1 General Instructions 2 Definitions and Values	to all members of all committees
By committee 19 Instruments and Apparatus	to all members of all committees in the work of which the instrument or apparatus reported upon is involved

By committee 3 Fuels { to committees
4 Boilers
11 Complete Power Plants
15 Locomotives
16 Gas Producers

The members of the Individual Committees have been selected with especial reference to their special knowledge of their respective subjects and it is the intention to have the codes when issued embody the best thought and experience of the profession. Advance proofs of each code will be sent to all who are qualified to discuss and constructively criticize them, inviting their comments before the code is issued. The members of the committees are widely distributed geographically and most of their work will have to be done by correspondence; it being impracticable for the Society to reimburse the many who are helping to carry out its purposes for expenses incurred in attending meetings.

Committee on Power Test Codes

Main Committee

*Fred. R. Low, *Chairman*
Edward T. Adams
*George H. Barrus
Oliver D. H. Bentley
*L. P. Breckenridge
William C. Brown
*Nathaniel A. Carle
*Robert H. Fernald
Edwards R. Fish
George J. Foran
*W. F. M. Goss
George R. Henderson
Francis Hodgkinson
Andrew M. Hunt
*David S. Jacobus
Edward F. Miller
Lewis F. Moody
James W. Parker
Richard H. Rice
James A. Seymour
Harry F. Smith
Frederick R. Still
Louis E. Strothman
Edward N. Trump
*William F. Uhl
Arthur West
*Albert C. Wood
C. B. LePage, *Secy.*

Individual Committees

1. *General Instructions*
W. H. Kavanaugh, *Chm.*
J. D. Andrew
G. H. Barrus
W. F. M. Goss
A. M. Greene, Jr.
C. F. Hirshfeld

2 *Definitions and Values*
R. J. S. Pigott, *Chm.*
T. W. Kinkaid
F. R. Low
L. S. Marks
S. W. Stratton
A. C. Wood
P. L. Wormeley
(representing Dr. Stratton)

3. *Fuels*
C. R. Richards, *Chm.*
E. G. Bailey
L. P. Breckenridge
D. M. Myers
S. W. Parr
G. S. Pope
E. N. Trump

4. *Boilers*
E. R. Fish, *Chm.*
A. D. Pratt, *Secy.*
A. D. Bailey
W. N. Best
A. A. Cary
D. S. Jacobus
E. B. Ricketts

5. *Steam Engines*
W. C. Brown, *Chm.*
A. G. Christie, *Secy.*
G. H. Barrus
H. Cooke
H. Diedrichs
J. F. M. Patitz
F. H. Vose

6. *Steam Turbines*
J. W. Parker, *Chm.*
I. E. Moultrop, *Secy.*
F. Hodgkinson
W. J. A. London
S. A. Moss
R. H. Rice
C. C. Thomas

7. *Displacement Pumps*
L. E. Strothman, *Chm.*
C. H. Anderson
E. H. Brown
D. A. Decrow
G. J. Foran

8. *Centrifugal and Rotary Pumps*
L. F. Moody, *Chm.*
M. Spillman, *Secy.*
W. C. Brown
W. B. Gregory
M. B. MacNeille
F. H. Rogers
W. M. White

. *Displacement Compressors and Blowers*
P. Diserens, *Chm.*
H. V. Conrad, *Secy.*
J. F. G. Miller
S. B. Redfield
C. G. Sprado
F. R. Still
C. P. Turner
J. T. Wilkin

10. *Centrifugol and Turbo-Compressors*
†S. A. Moss
J. E. Emswiler
H. F. Hagen
R. H. Rice
S. B. Redfield
C. H. Smoot

. *Complete Steam Power Plants*
N. A. Carle, *Chm.*
B. R. T. Collins
A. R. Dodge
C. F. Hirshfeld
W. S. Monroe
J. W. Parker
A. A. Potter
F. L. Pryor
C. H. Baker
E. W. Christie
R. N. Ehrhart
G. A. Orrok
M. C. Stuart

12. *Condensers, Water-Heating and Cooling Equipment*
G. J. Foran, *Chm.*
P. E. Reynolds, *Secy.*

13. *Refrigerating Machines and Plants*
D. S. Jacobus, *Chm.*
L. Block
N. H. Hiller
F. E. Matthews
E. F. Miller
P. Neff
T. S. Shipley

14. *Evaporating Apparatus*
E. N. Trump, *Chm.*
B. N. Bump
E. A. Newhall
H. L. Parr
L. C. Rogers

15. *Locomotives*
E. C. Schmidt, *Chm.*
G. M. Basford
A. W. Gibbs
W. F. M. Goss
G. R. Henderson
G. E. Rhoads
J. M. Snodgrass
M. Toltz
C. D. Young

16. *Gas Producers*
W. T. Magruder, *Chm.*
W. B. Chapman
R. H. Fernald
G. J. Rathbun
C. D. Smith
H. F. Smith
C. L. Straub

17. *Internal-Combustion Engines*
C. E. Lucke, *Chm.*
E. T. Adams
A. E. Ballin
M. Rotter
J. A. Seymour
A. West

18. *Hydraulic Power Plants*
W. F. Uhl, *Chm.*
A. S. C. E.
N. A. Carle
B. F. Groat
C. Herschel
N. E. L. A.
C. M. Allen
A. C. Clogher
J. A. Walls
A. I. E. E.
H. W. Buck
H. A. Putnam
P. Torchio
A. S. M. E.
J. L. Harper
C. W. Larner
W. F. Uhl

19. *Instruments and Apparatus*
G. H. Barrus, *Chm.*
C. M. Allen
R. E. Dillon
C. F. Hirshfeld
G. A. Orrok
G. B. Upton

* Members of the Executive Committee.
† Temporary Chairman, Committee not yet organized.

TORPEDO-BOAT DESTROYERS IN THE MAKING

(*Continued from page 743*)

From a management standpoint, it is of value to note that the interest and enthusiasm of the working force who accomplished this feat were worked up and maintained by the men themselves. They produced their own cartoonists, banners, graphic daily records, and vaudeville stunts, and jealously guarded the industrious performance on the part of each workman. Not a man or boy was discovered loafing on any part of the work, and it was the usual thing for both mechanics and helpers to move "on the run" while employed on the *Ward*.

Reference has not been made in the above to the introduction of gas and arc welding in destroyer construction, but the progress along these lines has been such as to warrant the prediction that a very considerable amount of riveting work will in the future be performed by welding. At the present time certain bracket stiffeners are arc-welded on many vessels and similar means are being used for securing various deck fittings, such as cleats, bolts, chocks, bitts, trunks, etc. Also, gas welding and cutting are extensively used in the intricate stapling and other furnace work formerly tediously and expensively done by the anglesmith.

The development of the torpedo-boat-destroyer type is still in progress. The British Navy had in service during the war a vessel of the torpedo-boat-destroyer type but of about 50 per cent greater displacement. These boats are known as "flotilla leaders," that is, they are employed as the flagboats of destroyer flotillas or divisions. They carry a heavier armament, more power and the added personnel necessitated by their increased displacement over that of regular destroyers. Consideration has been given to the addition of units of this type for our service but no definite information is available as to the status of this question at the present time.

RECATALOGING THE U. E. S. LIBRARY

A Discussion of Interest and Value to the Profession Generally, Dealing with the Principles of Cataloging and Systems of Classification

TO THE LIBRARY BOARD
OF THE UNITED ENGINEERING SOCIETY.

Gentlemen:

In accordance with your desire to have a brief statement of the principles upon which it is proposed to recatalog the Engineering Societies Library, I beg to present the following account.

In order that the technical terms used may be clearly understood, some general definition of them is desirable. The principal purpose of library catalogs is to enable a reader to find a book of which either (1) the author, (2) the title, or (3) the subject is known; to show what the library has (4) by a given author, or (5) on a given subject; and to assist in the choice of a book, (6) as to its edition, or (7) as to its character.

An Author Catalog fulfills the 1st, 2d, 4th, 6th and 7th of these subjects. The *author* in a narrow sense is the person who writes a book; in a wider sense it is applied to him who is the cause of the book's existence, e.g., editor, translator, compiler, etc. Bodies of men, societies and countries are, from a cataloging point of view, considered the authors of their official publications, memoirs, transactions, journals, proceedings, reports, etc. All names selected as author names are arranged in strict alphabetical order.

A Subject Catalog fulfills the 3rd and 5th of the objects named above by entering or registering each book under the name of that subject or topic of which the book chiefly treats. It may or may not be alphabetical in arrangement. If the arrangement is not alphabetical the catalog is commonly called a Classed Subject Catalog, although this name might with equal propriety be applied to some alphabetical arrangements.

The present catalog of this Library is composed of several parts, as follows:

1 An author catalog, formed by interfiling the catalogs of the four constituent libraries
2 An alphabetical classed catalog covering three of the original collections
3 A classed subject catalog of the Library of the American Society of Civil Engineers
4 An alphabetically classed catalog supplementing No. 3 and acting as an index to it as well
5 A printed index to periodicals, published in 1915, and now vitiated by the changes that have occurred. These periodicals are not represented in Nos. 1 and 2.

It is proposed to substitute for these catalogs an author catalog and a classed subject catalog, the latter to be accompanied by a very full index.

AUTHOR CATALOG

The nature of this catalog is best shown by a statement of the kind of entries that the books will be entered under. These are:

1 Full names of the author or authors, with identifying information when books by different individuals of the same name appear
2 Corporate entries; names of societies, organizations, countries, cities, etc., which are considered the authors of the publications issued in their name or by their authority
3 Titles of periodicals
4 Added entries, comprising the names of joint authors, editors, translators and other persons or bodies other than the one under whom the main entry is made, who had some connection with the making of the book.
5 Analytical author entries for books or articles contained in a collection, e.g., a volume of monographs by various authors, a series, a collection of reports, etc.
6 Cross-reference cards, referring from any form of a name under which a book may be sought, to that form which has been selected for the catalog. These cards take care of alternative, incomplete or foreign forms of names, variations in spelling, translation or transliteration.

The present author catalog, except for the omission of periodicals, is reasonably satisfactorily. Work upon it will be restricted to the addition of these, correction of errors, revision of the location marks, harmonizing of differences of method of entry in the original catalogs composing it and the insertion of additional analytical entries.

SUBJECT CATALOG

For the various alphabetical and classed subject classifications now extant it is proposed to substitute a single classed subject catalog in which the books will be arranged systematically according to their chief contents and to the classification adopted.

Classification has been defined as "the art of placing a book in that part of the library where all similar books on the same subject are placed." In a classed subject catalog it means the entry of a book in that place in the catalog where all similar entries on the subject are collected.

In the classification of books on the library shelves certain difficulties arise to prevent complete attainment of the ideal. The physical book can of course stand in but one place and the business of the classifier is to determine the group to which it belongs and place it there. It is a common thing, however, for a book to treat of more than one important subject. Books on water supply, for example, frequently have long chapters or sections on dams; similarly, books on steel making often give considerable space to rolling mills. These conditious make it impossible to collect the library's resources on the shelves.

It is the business of the catalog to furnish a means by which the reader who desires to see what the library has on dams or rolling mills is made cognizant of the valuable information contained in books treating of water supply or steel making, as well as of the books treating solely of the former subjects. This can be accomplished in the catalog by inserting additioual entries at as many points as seem desirable, so that it will reveal the real resources of the library, insure the efficient use of all the books, and prevent the overlooking of important material germane to the subject under investigation.

The order in which our subject groups follow each other in the catalog will not be alphabetical but a systematic one, in which subjects are divided and subdivided in subordinate groups which succeed each other. As a guide to this arrangement an alphabetical index will be necessary, showing the location of each subject in the catalog. With it, it will be possible to ascertain without delay whether or not the library possesses books on a subject and where these are listed in the catalog.

When these catalogs are completed the catalog equipment of the Engineering Societies Library will be as complete, detailed and satisfactory as it is possible to make it. Our catalogs will be true and helpful guides for all reasonable methods of approach by readers. They will give the information that may properly be expected of them, and a little more. It must, however, be kept clearly in mind that it is not the province of a library catalog to do a reader's work for him or to indicate all possible or probable sources of information on a subject. This is decidedly not the case; but many persous too often approach a great reference collection with the expectation that the information they want and the precise form in which they want it are contained in the catalog or the heads of the assistants. It is common experience for readers to want a book or article treating a subject from exactly the angle or point of view in which they are for the moment interested. They will, for example, ask for a book on Materials Used in Pump Construction. No work exclusively devoted to this topic has, I think, ever been written. Information on these materials may, however, be found scattered through scores of works on the strength of materials, materials of engineering, pumping engines, metallurgy, etc. The work of collecting the scattered data is the duty of the reader and not of the catalog, which should only be expected to reveal the material on which whole books or articles have been written. In other words, the catalog cannot be expected to act as an index to all the books in the library.

The author catalog will enable the reader to find a book when the name of the author is known, to find what books by any author are in the library and also the various editions available; translations as well as their originals will be shown.

The subject catalog will enable the reader to fiud a book when the subject is known, and will exhibit the resources of the Library in orderly form on every chief and most suborbinate topics within its chosen field.

The alphabetical index will comprise the names of the subjects of knowledge upon which we possess important books or pamphlets, and it will at once direct the user to that section of the subject catalog where these books are listed and to the department of the Library where these works are shelved.

These three instruments, properly and patiently used, will give all the assistance that may fairly be expected of them. They will be guides and indicators, not dictionaries, or encyclopedias, but the latter functions should not be demanded of a catalog.

CLASSIFICATION

Two distinct but related problems in classification confront the librarian: the classification of the actual books in order to bring the volumes on each subject together on the shelves, and the classification of the cards representing the works in the library, so that its resources on any subject can be ascertained from the catalog.

It is obviously desirable that the same classification should be adopted for both these purposes; but it is not essential, and as a matter

of fact, some variations between the arrangement of the two classifications are found in most libraries, occasioned by local conditions that seem to warrant a deviation from the logical plan.

We propose to adopt the same classification for all our work, but in doing so it is the intention to keep clearly in mind the basic difference between the classification of the two kinds of material, due to their fundamental physical differences.

Books frequently treat of several subjects or the relations of two subjects to each other. One copy of a book can be shelved in but one place, with the result that only in the broadest sense can it be said that the books in any section of shelves contain the library's resources on a subject. If the books on the metallurgy of iron, copper, etc., are segregated under these specific headings, the alcove for electric furnaces cannot contain all the material on that subject. In the catalog this dispersal of material can be overcome by placing cards under both subjects, or under as many as may be thought desirable.

For many years librarians have been divided into advocates of "broad" classification and "close" classification. Those of the former party base their arguments on the expense of close classification, the impossibility of closely grouping the books on a subject and the cumbersome notation involved in the close classification of a large collection of books, causing frequent mistakes in replacing books on the shelves.

Those who favor close classification point to the saving of the readers' time resulting from it, especially in growing and large libraries.

The point of view adopted seems dependent upon whether classification on the shelves or in the catalog is actually in mind. Close classification in the catalog is undoubtedly desirable; on the shelves it is practically impossible.

In our work we intend to adopt a plan by which the classes on the shelves will be small enough to be conveniently surveyed by a reader, but not so small that extremely long location numbers will be necessary or that every book on a subdivision of a topic is actually touched by another book on the same subdivision; while at the same time the classification in the catalog will be carried to a point where it will be possible to locate a specific subject without examining much related matter.

The scheme of classification that seems best adapted for our needs as indicated above is the Dewey classification as extended and modified by the Institute International de Bibliographie, usually known as the "Brussels" classification, to differentiate it from its progenitor.

This classification follows Dewey's plan in the adoption of a decimal notation and in the arrangement of its main classes. Human knowledge is divided into nine classes and each is given a decimal number as .1, .2, .3, etc. The numbers beginning with .0 are reserved for encyclopedias, newspapers and other material too general in inclusion to be assigned to a specific class.

Each class is divided and subdivided as may be necessary, the location of the classes being indicated by the addition of numbers at the right of the class numbers, as is illustrated by the following example:

.6	Applied Science
.62	Engineering
.622	Mining
.6223	Exploitation of Mines
.62233	Of Coal Mines

This process can be repeated indefinitely.

The Brussels classification differs from the Dewey classification in two important particulars, one of which is a matter of minuteness, the other of form. As regards the first difference, it is probably sufficient to state that the published tables cover 2259 pages, in comparison with the 808 pages of the latest edition of Dewey. This extension of the tables permits a much closer direct classification of material.

The other change is much more important. One of the chief defects of the original Dewey classification is that, owing to the fact that it was planned primarily for the arrangement of books, it lacks certain apparatus needed in classed catalogs. It is not sufficiently minute for the latter purpose and it lacks a method for subdividing existing headings in order to express details, various points of view and the relations between different subjects. For example, it is sometimes convenient to separate the material on some subject into classes by date, language or thoroughness of treatment; or to separate the statistical works on a subject from the technical ones.

The Brussels classification provides for such needs by the addition of certain symbols to express relations and of detailed general tables of usual relations, which can be added to any subject by means of these marks. The symbols adopted are few, their position in the arrangement of items is clearly specified and their use carefully explained. They are outlined below in the adopted sequence.

Accretion Sign: The sign of addition, +, is issued to indicate that a book treats of all the subject number connected by it: e.g., 621.32-621.33, a book on electric lighting and electric traction.

Coupling Sign: The hyphen, —, is used in certain special cases to enable one subdivision within a class to be combined with another in the same class without confusion. The class number for agricultural land drainage is 63.11 and for forestry 63.49; the number 63.49-11 can be composed to indicate works on the drainage of forests.

Relation Sign: The most important of the symbols adopted is the relation sign, the colon, : . When used in the classification to join two numbers it indicates that the subjects represented by them are considered in relation to each other. It enables us to extend the classification to great lengths in order to express relations, without having to provide the apparatus in advance. Taking, for example, the number for rolling mills, 621.77, and the number 310, statistics, we can form the combination 621.77:31 representing the statistics of rolling mills.

Form Sign: Divisions of the literature of a subject by form are made by using a parenthetic number beginning with zero, (0 ——). This is further divided into form divisions which can be used at any place, and divisions restricted to special subjects.

These forms enable the classifier to express such differences in the form of material as are represented by treatises, dictionaries, periodicals, histories, etc. A periodical on metallurgy has the number 669(05), a history of that subject is 669(09).

Examples of the special form division are 621.313(008), Patents on dynamos; 621.325(003), specifications for electric arc lighting; and 622(007) mining law.

Place Sign: Place is indicated by numbers which are written in parentheses and refer to a special geographical table. The table also provides for the differentiation of geologic periods. Examples are: 625(41) railways of Scotland; 621.19(73) steam-power plants in the United States.

Language Sign: Language divisions are indicated by the equality sign, =, followed by a number. We are thus enabled to divide a subject by language if we wish, as 62(05)= 44, French engineering periodicals.

Time Sign: It is sometimes convenient to specify time in our classification. This is done by adding the date in parentheses, as 623(09) "17", the history of military engineering in the eighteenth century.

General Points of View: The sign for these is a double zero, 00. The supplementary tables are:

001 Speculative: idea, plan, purpose, etc.
002 Realization: execution, construction, etc.
003 Economic: industrial production, cost, etc.
004 Service and use: workings, administration
005 Equipment and apparatus
006 Buildings and establishments; organization and service
007 Special personnel

Subdivisions are provided for these numbers.

These supplementary tables are especially useful for the classification of scientific material, such as that in the Engineering Societies Library. They enable us to indicate the point of view of any article when the main division to which it belongs lacks the necessary intention. They provide, for example, for such an analysis of material as

62163.0012 Theory of centrifugal ventilators
62163.0031 Manufacturing costs of centrifugal ventilators
62163.0042 Operation of centrifugal ventilators

As examples of the classification the following arrangements of material by form and by point of view may be interesting:

By Form		
621.13	Locomotives	
621.13(02)	Treatises on the locomotive	
621.13(44)	Locomotives in France	
621.13(5)	Locomotives in Asia	
621.13 "19"	Locomotives in the twentieth century	
621.13 : 622	Locomotives in mining	
621.13 B	Baldwin locomotives	
621.13.0014	Locomotive tests	
621.13.04	Locomotive boilers	
621.13.42	Locomotive valve gears	
By Point of View		
621.12	Marine engine	
621.120012	" "	theory and calculation
621.120014	" "	tests and trials
621.120022	" "	methods of manufacture
621.120023	" "	materials
621.120025	" "	special machinery for making
621.1200272	" "	mounting and assembling
621.120031	" "	cost of manufacture
621.120035	" "	prices
621.120042	" "	management
621.120045	" "	inspection
621.120046	" "	deterioration and accidents
621.12005	" "	fittings
621.12006	" "	factories
621.120072	" "	marine engineers

These examples illustrate the minuteness with which material can be classified if necessary, and the various forms of classification that may be used to meet special needs or the peculiarities of certain kinds of material. It is not necessary, of course, to introduce such great refinement in all cases, nor, in fact, in many, but the possibility of such subdivision, whenever desired, is very valuable.

A frequent objection to the decimal notation is the lengthy numbers that it requires. This objection is sound if the classification of books on library shelves is intended, for it is difficult to mark long numbers clearly on books, or to arrange these rapidly when so marked. The objection loses its force when the numbers are only used for filing cards in catalog trays, for these are not removed after having been once filed and there is also no necessity for copying the numbers.

(Continued on page 789)

ENGINEERING COUNCIL

Engineering Council[1] is an Organization of National Technical Societies of America, Created to Consider Matters of Common Concern to Engineers, as Well as Those of Public Welfare in Which the Profession is Interested

Activities of Council Representatives on Government Boards and Commissions

It is the desire of Engineering Council to be represented in all government bodies and commissions, and to that end the Council recently decided to urge upon President Wilson the appointment of one or more engineers to fill vacancies now existing in the Interstate Commerce Commission. Such representation would unquestionably prove of mutual benefit to the Interstate Commerce Commission and Engineering Council, and it is hoped that the President will approve of and act upon the suggestion offered.

Mr. Rudolph P. Miller, Mem.Am.Soc.C.E. and a consulting engineer of New York has been appointed as the Council's representative on the National Board for Jurisdictional Awards in the Building Industries. This board, whose function it is to settle disputes arising among the various parties engaged in the building industries, held its first meeting on August 11 in Washington, D. C. E. J. Russell of St. Louis, the representative of the American Institute of Architects, was elected chairman, and William L. Hutcheson of the American Federation of Labor vice-chairman. No further action was taken at this first meeting, as the cases on hand were not in the form required. They accordingly will be returned, to be resubmitted in the prescribed manner, and will be considered at the next meeting of the board, which will be held early in November.

Philip N. Moore, a past-president of the American Institute of Mining and Metallurgical Engineers, and the only engineer member of the War Minerals Relief Commission (see MECHANICAL ENGINEERING for May p. 489 and for July p. 634), is now engaged in holding in many of the western cities hearings of claims submitted to the commission. While thus engaged Mr. Moore has been the guest of several of the western engineering societies, and has been offered the opportunity of speaking before the engineers of Portland, Ore., Spokane, Wash., and Butte, Mont.

To the courtesies thus extended Mr. Moore has responded by discussing the activities of the Council and its efforts in behalf of the proposed Department of Public Works to which reference has frequently been made in MECHANICAL ENGINEERING.

Mr. Moore pointed out that the agitation for centralization of engineering work in this country is not new, but has been the hope of the profession for years. In fact, so much so that it has been given definite form many times when the question has been considered. A National Department of Public Works has therefore been proposed, and the profession is now again urging the creation of such a Department in which the engineering activities of the country will be brought together under one head instead of being dissipated as at present among many bureaus.

NATIONAL SERVICE COMMITTEE

Contributed by the Washington Office[2]

A Comment on the Department of Public Works

On October 28, 1884, Mr. Clemens Herschel, Mem.Am.Soc.C.E., published a pamphlet which contained the following statement:

Let those who may shun the proper organization of the States and of the General Government for the systematic construction and maintenance of public works think of one thing: no nation has yet existed that was wholly without them, and this nation, no less than most or all of its states, in spite of all obstacles, has had them, and *is constantly having them*. The question becomes reduced then to this simple proposition: shall our public works be built, and, what is of equal importance, maintained, in a proper, business-like manner, getting year by year a dollar's worth for a dollar's expenditure, or shall the shiftless, hand-to-mouth method of procedure, which looks not forward, and hides its shiftlessness by denying that we have any public works—shall this wastefulness of the public funds be allowed to continue?"

Mr. Herschel is one of the few Public Works Department pioneers who still remain among us, and it will therefore be of interest to read what he has to say thirty-five years subsequent to the date of the foregoing. We accordingly quote from a recent letter to the National Service Committee:

It appears to be no longer necessary, as I can well remember it was in times past, to argue that public works are an essential accompaniment of a civilized state. Formerly such works were, with us, called "Internal Improvements," and schools of political philosophers spent much time in proving, from their view of the Constitution of the United States, that private enterprise was all-sufficient, and consequently should be solely allowed to construct our public works; and again, the reverse of this proposition. That day has gone by. What Henry Clay thought about it, what those opposed to him wanted done on those lines, are both of small importance at the present day. This is a present-day nation of 110 million inhabitants; not a parcel of pioneer colonies, beginning to develop as a modern state. This is the year 1919; not 1819, when the building of the Wheeling turnpike, and of the Erie and other canals first brought the Government at Washington face to face with the need of a governmental executive agency, for the design and construction of public works; not to mention their repair, maintenance and operation, after they had been completed.

In the emergency thus created, midst the clash of resounding rhetoric of the "strict constructionists" who denied the right or power of the United States to undertake any public works; and of the statesmen who argued for the development of the country by the aid of United States governmental agencies, was born the system still in vogue—at the time intended as a temporary measure—of calling upon the military branch of the Government to assume civil-engineering functions. It could not well then have been otherwise. There were no civil engineers in the country, or at least so few, that they formed no material part of the body politic.

The first use of the word engineer, as is well known, came from the exercise of refined military work, and there were none but military engineers, as far as is known, until about 1780, which was some 40 years before the rise of the discussion concerning "Internal Improvements" in the United States.

In 1782, "a Mr. Smeaton," as the law books have it, in the leading case of Folkes vs. Chadd, was called to give his opinion (not testimony) from the witness stand, and thus became the first "expert witness" in English court procedure. This was no other than the celebrated John Smeaton, F.R.S., and of many other titles; the builder of the renowned first built permanent Eddystone Light in the English Channel, and who was the first man to sign his reports as coming from a Civil (not military) Engineer, and thus, also, the first English-speaking "Civil Engineer."

Forty years later, in America, there were, to be sure, surveyors—George Washington had been one of them—but no engineers that were noticeable, except the graduates of West Point, and other military engineers that had been imported for and had survived the Revolutionary War. And so the country turned for its civil engineering, for its turnpikes and canals, to the Department of War, and as an emergency measure designated members of the Corps of Engineers, U. S. Army, were temporarily detailed to supervise the construction of these works.

The wide world over there are today but two systems of providing for the construction and operation of public works: first, either to ignore the necessity for their existence in a civilized state, and thus provide for them by emergency measures; or second, to consider them as forming part of the every-year work of the government of a civilized state, and provide for them in the fundamental law governing such states, in the same way that Departments of War, Navy, Treasury, and even the bodies exercising police powers or the judiciary are provided.

Under the first caption come Great Britain and her dependencies, but even these do not call upon the Royal Engineers (corresponding to our Corps of Engineers, U. S. A.), unless exceptionally to approve the construction of a new railroad, before it is opened for travel.

[1] Officers of Engineering Council: J. Parke Channing, *Chairman*; Alfred D. Flinn, *Secretary*, Engineering Societies Building, 29 West 39th Street, New York.

[2] Washington Office in charge of M. O. Leighton, *Chairman*, National Service Committee, McLachlen Building, 10th and G Streets.

Under the second caption comes each and every European continental country, and, so far as I am informed, the civilized countries of all the rest of the world.

The great exemplar of relying for all public works upon private enterprise, is England. When public works had to be built, harbor works, works of water supply, metropolitan sewerage, and others, the emergency system was followed. For each case a select body of laymen, a so-called commission, would be appointed, and an emergency corps of civil engineers gathered as an executive agency. The commission would studiously, and in some measure, qualify itself for its task, works would be executed, and the whole organization would then dissolve into its original elements. Of course there are exceptions to and variations from this normal state of affairs. And England, it may be said, has grown heartily tired of its want of organization for purposes of constantly recurring and as constantly necessary work, which has been described. The light is beginning to break in upon her, as it must also sooner be apparent to the United States.

The second method for a state to care for its public works a host of our civil engineers and others have no doubt recently seen in operation, even in war times, in France and in other European countries. The Minister of Public Works, an important member of the Cabinet, stands at the head of the organization. In the United States, let me say at once, the Secretary of the Interior could without much disturbance, be converted into such a Secretary of Public Works.

The great change that must come, if public works are to be economically and efficiently designed and constructed, is that of constituting a permanent corps of civil engineers to do the civil-engineering work of the country, under a Secretary for Public Works such as described. It is the only efficient way. Organizations built up as emergency measures must give way to it.

It is its permanence of organization, the holding of like service to the Government, that has always given the Corps of Engineers the respect of the President and Congress. A commissioned corps of U. S. Civil Engineers would equally have the respect of the President and of Congress. It would also and to the same extent have the *esprit du corps*, the trustworthiness and the like desirable attributes that naturally belong to and go with a fixity of tenure of office, and with governmental responsibility.

The Secretary for Public Works and his corps of civil engineers once organized, other and allied work of the Government not already there would naturally come to the same department; for instance, the Geological Survey, Bureau of Mines, Bureau of Standards. Once form a Department whose chief functions are those of civil engineering, and the perfection of its organization and its power to do efficient work for the United States would naturally follow.

The Coast and Geodetic Survey

It is the function of the Coast and Geodetic Survey to chart the coast lines and the waters of the United States and its possessions; make studies and prepare tables and charts of tides and currents; to provide an accurate triangulation control of the interior of the United States; to establish precise level stations; and to make magnetic surveys for the determination of true declination.

The history of the Survey shows that it has been under the Treasury, Navy and Commerce Departments, and that it is now following out a general policy laid down in 1843 while it was subordinate to the Treasury Department. Its early years were marked by many changes of policy and of authority and by little effective work. The survey of the coasts was first authorized by Congress on February 10, 1807. Broad plans for the conduct of the survey were made by F. R. Hessler, a scientist of Swiss birth, and the Treasury Department was made responsible for carrying out these plans. Precision instruments were not available, however, in this country, and had to be secured from abroad, and this, together with the war with Great Britain in 1812, delayed all work on the survey until 1816.

The Survey had barely begun its work when Congress, on April 14, 1818, repealed much of the statute authorizing the employment of other than Army and Navy Officers in the Survey. The War Department made no surveys and the work of the Navy Department was also quite unsatisfactory and so, on the recommendation of the Secretary of the Navy and of others, this Survey was given back to the Treasury Department by Congress in July, 1832, and the law of 1807 with broader powers was reenacted.

The Survey remained under the Treasury Department only two years and in March, 1834, was again transferred to the Navy Department under whose jurisdiction it remained for a similar period, and then was again given back to the Treasury Department, where it remained until July 1, 1903. It was then placed under the Department of Commerce by Act of Congress approved February 14, 1903.

In 1843, while this Department was still under the Treasury Department and the question of retransference back to the Navy Department was being discussed, the President appointed a board to formulate and develop a plan for a permanent organization of the Survey. The report of this board was approved by the President on April 29, 1843, and the work of the Survey has ever since been modeled along the lines then laid down. After the adoption of this report until the war with Spain in 1898, nearly one-half of the vessels of the Survey were manned and officered by the Navy, but since that time the civilian officers and employees of the Survey have officered and manned all vessels.

The results of the Survey's work are made use of by commerce, by the railways, by land owners of every kind and by all enterprises whose primary investigations require the use of maps. The placing of all of these surveys, therefore, whether by land or by sea, under the proposed Department of Public Works would insure a comprehensive mapping plan, the use of consistent scales and legends on all maps, and would bring together a permanent corps of skilled surveyors who would be capable of mapping the interior of the United States with such exactitude as would make their results of unlimited value in time of peace as well as in time of war.

Instead of twelve independent bureaus making surveys, each without liaison with the other eleven bureaus, there would thus be one central department planning and conducting this work, weighing the comparative needs of different sections, and so directing the efforts of the department that the greatest good to the greatest number would result. There is no work that this Survey does that will not fit in with the work planned for the Department of Public Works. It is essentially an engineering work and consequently belongs in the National Department of Public Works together with the other engineering activities of the Government.

The Proposed Department of Aeronautics

Aeronautics is to come in for special governmental attention if the bill providing a Department of Aeronautics is established. The proposed Department will be headed by a Secretary of Aeronautics at $12,000 per annum and an assistant at $5,000 per annum. A commissioned personnel of approximately 5000 and a non-commissioned personnel of approximately 50,000, together with a large number of civilians to carry on the commercial work is also proposed.

The Aviation Section of the Signal Corps; the Division of Military Aeronautics; the Bureau of Aircraft Production; the Air Service of the Army; the Motor Transport Corps; the Naval Flying Corps; the Marine Corps Flying Corps, and the Aerial Mail Service are all to be transferred to this new proposed Department. With each will go their respective clerks and other civilian employees.

It is to be the duty of the new Department to foster, develop and promote all matters pertaining to aeronautics, including purchase, manufacture, maintenance and production of all aircraft for the United States, and to lay down rules and regulations to govern aviators and aeronautics in general. The Department is to establish and supervise aerial landing fields for both military and commercial purposes, and is to care for the coast, border and forest reserve patrol. An aeronautic academy is also to be established.

The Engineering Division under the Secretary of Aeronautics is to select types and designs of all aircraft equipment, including ordnance and communicating equipment, and is to care for the repair and maintenance thereof. The Division is also to operate and maintain aircraft factories, repair shops and experimental stations. Aerial photographic apparatus will likewise be developed by this Division, with which aerial photographic maps of the United States and its territories are to be made and provided for the public good.

NATIONAL RESEARCH COUNCIL

The National Research Council is Devoted to the Advancement of Research in the Mathematical, Physical and Biological Sciences, and in the Application of These to Engineering, Agriculture, Medicine, and Other Useful Arts

DIVISION OF ENGINEERING[1]

Dr. HENRY M. HOWE, who recently returned from Paris, where for three months he served as Scientific Attaché to the American Embassy, has made public, in a recent report to the Division of Engineering, a brief account of his activities during his stay abroad. While in London, on his way to Paris, Dr. Howe states that he was able to interest many in the work of the National Research Council, and in particular to explain its aims and needs to the Council of the Department of Scientific and Technical Research. Dr. Howe also took steps to bring about coöperation between the National Physical Laboratory and the Committee on Fatigue Phenomena of Metals of the Division of Engineering in their work dealing with the heat treatment of carbon steel and with alloy steels.

Dr. Howe was further instrumental in arranging a meeting, under the chairmanship of Dr. Unwin, at the Institution of Civil Engineers, which considered the formation of an International Association for Testing Materials which should carry on the work formerly done by the old society of that name. This meeting was attended by a large and distinguished body of unofficial representatives of many important engineering bodies. It was thought best to call a second meeting of official delegates of these societies, and at this meeting it was decided that the time was not yet ripe for action.

In Paris Dr. Howe consulted several of those best qualified to pass judgment on the question of an international testing society, among them being Professor Le Chatelier and Professor Mesnager, Vice-President of the old International Association for Testing Materials. Their attitude also inclined toward the belief that the decision reached in London was proper.

From May 20 to 23 Dr. Howe took part in the meeting of the Executive Committee of the International Research Council, which formulated more fully the work of that Council and arranged for its first regular meeting, which was held in Brussels during July.

The Division of Engineering now has twenty-one committees engaged in research. Fifteen of these deal with metallurgical subjects, four with civil engineering, one with mining engineering, and one with electrical engineering. Progress reports of all of these committees are now available.

Committee on the Fatigue Phenomena of Metals. The total number of fatigue tests made thus far by the committee is about 90, with the number of repetitions of stress running up to 2,000,000 and 3,000,000. There have been filed with the committee records of fatigue tests of metals made in various governmental and commercial laboratories, and these will be of service in establishing and in checking conclusions. Records of about 100 such tests are now on file.

Because of the change to peace conditions an entirely new and comprehensive program has been adopted, and this should yield results of the first importance. A very valuable report on the present status of our knowledge of fatigue has been prepared by the committee and will be found elsewhere in this issue of Mechanical Engineering.

The Engineering Foundation is to give $15,000 a year for two years to the work of this committee. This will be carried out in large part at the University of Illinois, which contributes for two years the use of its laboratories and the services of Professor Moore. This contribution is estimated conservatively as the equivalent of $6000 a year. The University reserves the right to publish the results in its own bulletin.

Committee on Improvement of Metals at a Blue Heat. It has long been known that working steel at a blue heat and even simple exposure to blue heat under certain conditions, may injure it seriously. This committee investigates this general subject and the influence of exposure and treatment at temperatures below the transformation range on the properties of steel. Three important reports have been issued, and these bring together and analyze a large amount of new information, much of which is as yet unpublished.

The committee has outlined considerable work for the future, and will study among other things the physical properties of boiler-plate steel at high temperatures—reaching approximately 1000 or 1200 deg. fahr. (540 to 650 deg. cent.), the tempering temperatures of high-speed steel, and the quenching of various alloy steels from a blue heat.

Committee on Pyrometry. It is the purpose of this committee to investigate improvements in pyrometry, including the measurement of the temperature of the bath of steel in the open-hearth and electric steel-making processes. Direct experiments have been made at the Midvale Steel Works with an optical pyrometer sighted on the bottom of a closed tube of refractory material immersed in the bath. A suitable material for this tube has not yet been found. For the tip of such a tube Acheson graphite is the best material thus far found.

The committee finds that the Burgess method of taking a series of readings with an optical pyrometer of the temperature of a stream of molten steel, poured from a hand ladle and calculating back to the temperature at the moment of dipping the ladle, gives trustworthy results with an accuracy of 10 to 20 deg. cent. Other methods to be tested are: (1) to determine optically the temperature of a plug of Acheson graphite immediately after immersion in the steel for a fixed time, and (2) to determine optically the temperature of the immersed end of a fused quartz rod or tube immersed in the metal. The transparency of the quartz permits us to see its immersed end, and thus to measure its temperature optically.

The committee has caused sixty-six papers on pyrometry to be written. Of these fifty-seven have been accepted by the American Institute of Mining Engineers, and will be published as a symposium on pyrometry in a separate volume. This symposium is the most important event in pyrometry since the invention of the Le Chatelier thermoelectric pyrometer.

Committee on Substitute Deoxidizers. The original purpose of this committee was to find ways of saving manganese by replacing the iron-manganese alloys now used for deoxidizing steel made by the bessemer, open-hearth and electric processes. It is of the first importance that the oxidized products resulting from the use of such alloys should be readily fusible and fluid, so that they may separate readily from the molten steel. Hence the first work of this committee was to determine systematically the melting points of the oxidized products of the alloys of promise for this purpose. A new method of determining melting points was devised. About one-third of this work has now been done, and steps are to be taken to complete it.

Committee on Welding—Research Committee of the American Bureau of Welding. This committee succeeds the old Welding Research Sub-Committee and the Sub-Committee on Metallurgy of the Welding Committee for the Emergency Fleet Corporation. The purpose of the committee is to carry on the research work inaugurated by the two former committees. They expect to cover the whole field of research in welding, including electric, gas and spot welding. A great deal of useful work was accomplished by the old committees, which derived their financial support from the Emergency Fleet Corporation, whereas the new committee intends to secure support and coöperation from those interested in welding through the medium of the American Bureau of Welding. It is believed that the new committee will continue vigorously the fruitful work of the old.

Committee on Elimination of Sonims (Inclusions) of Steel. It is the purpose of this Committee to study the sources, methods

[1] Dr. H. M. Howe, *Chairman*; G. H. Clevenger, *Vice Chairman*, Engineering Societies Building, 29 West 39th Street, New York.

of occurrence and effects of sonims (solid non-metallic impurities), as well as means for eliminating them from steel. The methods employed are: First, to procure samples of good and bad steels and determine the total sonims; and second, to examine them microscopically to determine their shapes and sizes and ascertain their proximate and ultimate composition. Methods for separating them must also be worked out, solution of the soluble metallic part of the steels being effected by iodine, double chloride of copper and ammonia, dilute acids, electrolysis or other means.

The aid of several of the steel companies has been enlisted, and a number have worked on the scum which gathers on ingot tops of low-carbon effervescing steel. This has been shown to be chiefly formed of sonims which have collected from the molten steel. It is now proposed to form a syndicate of beneficiaries of such an investigation.

PULVERIZED COAL AS A FUEL FOR BOILERS

(*Continued from page 749*)

subordinate to the performance of the boiler; and just as the design of boiler is varied to satisfy the steam requirements, so must the furnace proportions and mode of burning coal vary to supply the necessary gases for the efficient operation of the boiler, and in so doing, secure the greatest fuel economy.

The nature of fuels plays the all-important part in the efficiency and performance of furnaces, regardless of their calorific value. By pulverizing and proper treatment all grades of coals may be dealt with on the basis of their burnable content, thereby rendering their use equally applicable to all heating services.

Design of Pulverized-Fuel Furnace for a 500-Hp. Boiler

To demonstrate the possibilities of pulverized fuel along the lines indicated, a furnace for burning efficiently all grades of coal from the average best bituminous and anthracite qualities to lignite, and of such size as would be applied to a water-tube boiler of about 500-hp. capacity, has been designed, particulars being given in the following paragraphs.

In working out this design for a boiler with a steam pressure of 175 lb. and operating at 100 per cent and 200 per cent rating, consideration has been given to the best features of furnaces successfully burning pulverized coal and fuel oil. The temperatures of the gases as delivered to the boiler have been assumed to be 1800 deg. fahr. and 2750 deg. fahr., respectively, for the two ratings, the boiler efficiency being taken at approximately 80 per cent in both cases.

The purpose of this design is to study the possibilities of meeting as severe demands as are made at the boiler ratings selected, using all grades of powdered fuel. Fig. 4 shows two views of the furnace and Fig. 5 the gas performance of three different fuels.

The distinctive features of this furnace are the delivery of the fuel mixture and of the dilution air to insure perfect combustion, to permit regulation of the fire, and to guard against the slagging and destructive difficulties heretofore encountered. The air is supplied by suitable blowers and is heated before use by the waste flue gases for fuel mixing and by the body of the furnace for dilution purposes.

Regulation is accomplished by control of the fuel and of the air, the fuel-mixture spout outlets being proportioned to deliver, at maximum duty, a mixture containing 75 per cent of the air required for perfect combustion.

The purpose of the air jets *c* (Fig. 4) under the flame is to blow toward the ashpit the ash particles that may fall from the flame as well as the partially consumed particles of fuel. The latter are brought into the deflagration zone with a fresh supply of air and given a new chance to burn completely.

The rows of air jets *d* on top of the flame are for the purpose of directing the flame over a longer path and providing thereby longer time for the complete oxidation of the fuel particles, protecting the furnace from the hottest portion of the flame and aiding in the precipitation of ash toward the ashpit. Aside from supplying additional combustion and dilution air, the joint effect of the two rows of air jets is to carry the flame in *suspension*, away from the furnace walls and the ash deposit, and fulfill thereby one of the chief requirements for burning pulverized coal.

The idea of precipitating the ash by rapidly expanding the flame into a large space is applied, but it is not expected that all the ash can be thus collected. Some of the ash dust will be carried by the gases and deposited on the boiler tubes and surfaces beyond the hearth and must be blown off occasionally by soot blowers to a collecting hopper in the rear chamber of the boiler setting, from which it is discharged in a manner similar to that employed in removing the ash from the furnace.

The furnace design presented in Fig. 4, though possessing good features, is not necessarily typical. In an actual case the conditions of the service would influence largely the most suitable arrangement.

Furnaces for burning pulverized fuel demand careful consideration, not so much on account of the novelty of the fuel, but because, like other fuels, it possesses its peculiarities, which do not obey a general rule and which must be carefully considered to secure the maximum of usefulness for each kind and size of service.

AIRPLANE-WING DESIGN

(*Continued from page 730*)

apply them to conditions where the speed obtained is as great as 600 miles per hour. While the use of scaling rules and empirical factors worked out in practice has enabled us to produce very fair results, the need for accurate data has been pressing.

The high-speed wind tunnel operated by the Technical Section of the Department of Military Aeronautics is of the venturi type and shows an exceptionally uniform flow at all speeds up to about 500 miles per hour. The flow is produced by means of an especially designed 24-blade propeller which produces a suction of about 16 in. of water at the large end of the venturi.

An extensive series of experiments has been started on propeller airfoils in order to determine the effect of speed on the lift and drag coefficients.

It is desired to call attention to the fact that it is not sufficient to understand and be able to calculate the circulation about a horizontal axis perpendicular to the direction of motion; there are also very important vortices about axes parallel to the direction of motion. These are particularly apparent in the form of tip vortices. Their intensity might be estimated similarly to the calculation for fore and aft circulation.

F. E. Cardullo.[1] As I understand the theory which Mr. Durfee is attempting to develop, instead of considering the reactions due to the acceleration produced under the action of the motion through the air of a plate, which may be straight or curved, he considers these reactions from the standpoint of the Bernoulli theory, on the basis that differences in velocity of air relative to the plate will exist on its two sides, and that in consequence to these differences there will be a difference of pressure and a lifting force. As a result, he points out that there are certain vortex motions at the ends and at the trailing edges of the plate. The problem is to reduce these vortex motions to a minimum so that the air comes from the plate in a stream, the filaments of which are as nearly parallel to one another as possible. The best method of attack would seem to me to be that of testing wing sections either by the emission of smoke from a fine orifice or with threads attached to needles. This method gives an opportunity for studying the vortices which represent irregular motion and lost energy. Mr. Durfee prefers to attack the problem from the standpoint of the investigation of these stream lines and velocities rather than the development of the theory of the reaction on the surface produced by acceleration. I do not know that there is much choice in the mathematics of the two methods, but in either case the mathematics is too difficult to offer a practical solution.

[1] Engineer of Tests, Curtiss Aeroplane & Motor Corpn., Buffalo, N. Y. Mem. Am. Soc. M. E.

ANDREW CARNEGIE

ANDREW CARNEGIE, philanthropist and one-time steel master, whose generosity made possible the erection of the Engineering Societies Building and that of the Engineers' Club, died August 11 at his summer home near Lenox, Mass., in his eighty-fourth year.

Mr. Carnegie was born in Dunfermline, Fifeshire, Scotland, on November 25, 1837. When eleven years old his father, a master weaver, suffered such reverses through the introduction of the power loom that he decided to abandon his occupation and emigrate to America with his wife and two sons. Settling in Allegheny City, the father and son found work in a cotton mill, the latter as a bobbin boy at $1.20 a week. A year later Andrew obtained employment in the bobbin factory of a distant relative, John Hay, where he fired the boiler, and ran the engine. At the age of fifteen he became a messenger boy for the Ohio Telegraph Company and a short time later had perfected himself as an operator. When the Pennsylvania Railroad decided to install its own telegraph lines, in 1854, he became clerk under Thomas A. Scott, then superintendent of its Western Division. When the Civil War broke out he was assigned to duty in and around Washington, where he was instrumental in devising a war cipher system that was later adopted. In 1863 he had been promoted to the superintendency of the division, and, largely because of the interest which Mr. Scott took in his fortunes, had been successful in a number of business investments, notably oil and the Woodruff sleeping car.

Mr. Carnegie first became interested in the iron industry in 1864, when he bought a one-sixth interest in the Iron City Forge Company. Foreseeing a great demand for structural iron to be used in railway bridges, he also took part in organizing the Cyclops Iron Co., a rival to the former concern. A year later, however, the two companies were merged as the Union Iron Mills Company with a capital of $500,000. Mr. Carnegie then organized another company, the Keystone Bridge Works, which was prosperous from the first. Into it he drew Colonel Scott, at that time vice-president of the Pennsylvania Railroad, and J. Edgar Thomson, its president.

In 1867 he was sent to England by the Pennsylvania Railroad to sell about $9,000,000 in bonds. While in that country he saw a giant bessemer converter in operation and investigated the process. From that moment his vision was steel. He returned to Pittsburgh and organized the firm of Carnegie, McCandless & Co., the first step being the purchase of a 110-acre tract at Braddock, a dozen miles or so outside of Pittsburgh, where a bessemer plant was promptly erected and named the Edgar Thomson Steel Works.

In 1874 Mr. Carnegie began to realize abundantly on his efforts. The year before the first of the famous Lucy furnaces had been built, to be duplicated two years later, when they forced up the average output of iron from fifty to a hundred tons a day.

As the profits mounted one by one Mr. Carnegie's partners dropped out and by 1881 he owned more than half of the entire business. A reorganization was then undertaken under the name of Carnegie Brothers & Co. The new concern was a $5,000,000 affair, with Carnegie at the head. It operated the Edgar Thomson Steel Works, while a second limited partnership called Carnegie, Phipps & Co., operated the Homestead Mills, the armor-plate mill near the same plant, the Keystone Bridge Works, and other properties. A few years later Phipps and Carnegie alone remained of the original fourteen partners, and in 1888 Mr. Carnegie found himself in control of seven great iron and steel works, whose output was estimated to be in the neighborhood of 190,000 tons of steel rails and 140,000 tons of pig iron a month.

For two years from 1899 the Carnegie Steel Company dominated the industry, but in 1901 it was absorbed by the United States Steel Corporation for $460,000,000. The same year Mr. Carnegie retired from business with a fortune estimated at $250,000,000.

Mr. Carnegie's Donation to the Engineers

Mr. Carnegie was early invited to take an interest in a building for the American Institute of Electrical Engineers, but without success for the reported reason that he felt the building which had been planned to be inadequate. Somewhat later, on account of his interest in libraries, he was approached to contribute to the amount necessary to abstract and catalog the Sir Latimer Clark Collection which had been presented to the Institute and which was mainly in Latin, many volumes being written by hand on parchment. Scarcely any volume was less than one hundred years old and many over three hundred.

It was in connection with a banquet, at which Mr. Carnegie was the guest of honor, given by the Institute under the auspices of its Library Committee, that Mr. Carnegie's interest in a union building was aroused. On the day following the banquet he sent for the chairman of the Institute's Building Committee, Mr. Calvin W. Rice, now secretary of The American Society of Mechanical Engineers. Mr. Rice and Mr. Charles F. Scott, then president of the Institute, called upon Mr. Carnegie, who expressed an interest in the addresses of the previous evening and in the work of the engineering societies.

Anticipating the line of questioning which Mr. Carnegie would be likely to follow, information had been secured upon the number of engineering societies in the city of New York and the amount of rent in the aggregate annually paid by these societies for their respective headquarters. There were then over thirty prominent societies and the gross annual rents amounted to over $75,000.

Mr. Carnegie always gave in the same businesslike manner that he conducted any enterprise. He never gave unless there was every prospect that his gift would make successful and efficient an already promising activity. He consequently wanted assurance that a union engineers' building could and would be maintained and also that the societies would be able to purchase the land, which was another uniform requirement in Mr. Carnegie's gift of buildings.

An estimate of the cost of a union building had been made, so that when Mr. Carnegie inquired the cost Mr. Rice was prompt to say "one million dollars."

Mr. Carnegie replied "that is a lot of money," to which Mr. Rice said, "You would not wish to be identified with anything not creditable to you." Mr. Carnegie immediately assented, adding, "if it should cost $7.50 more, never mind."

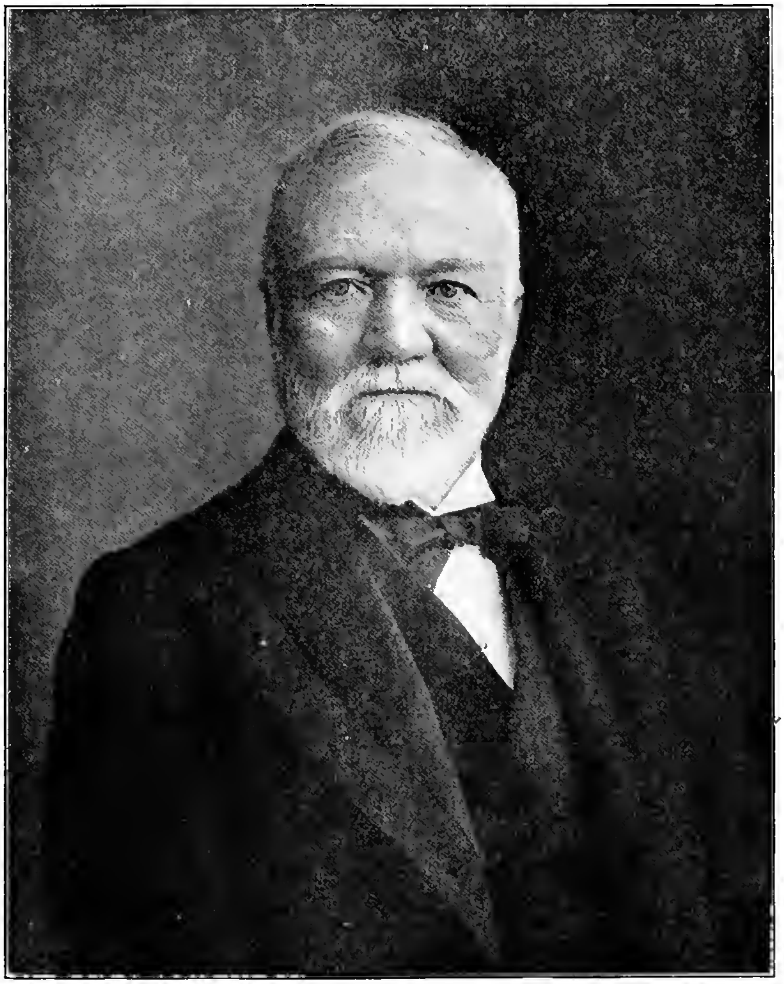
The original plan for a union building placed the Engineers' Club in the upper floors, much like the Transportation Club in the Manhattan Hotel, but it later seemed best to erect two buildings, principally on account of the Club's property being taxable and the Engineering Societies' property non-taxable. It therefore became necessary to ask Mr. Carnegie to increase his gift sufficiently to provide for separate buildings, and Mr. Rice made a trip to Europe, visiting Mr. Carnegie at Skibo, and successfully presented the desire of the Societies and of the Club for an additional $500,000.

One of the interesting incidents in connection with the purchase of the several contiguous lots for the Engineering Societies Building was the demand by an elderly lady of $100,000 cash before noon of the day the negotiations were consummated. Mr. Carnegie saw the humor of the situation and loaned the representatives of the Societies ten ten-thousand-dollar bills.

Mr. Carnegie's motive in this benefaction was both appreciation of the engineer's contribution to his personal success and the desire to promote the solidarity and coöperation of all branches of the engineering profession. "Coöperation," he said, "is America's secret of success."

The cornerstone of the Engineering Societies Building was laid on May 8, 1906, the Council of the Society being present by invitation. The building was brought to completion in the following spring and impressive dedicatory exercises held April 16 and 17, 1907. At the close of these exercises a bronze bust of Mr. Carne-

788[3]



ANDREW CARNEGIE

DIED AUGUST 11, 1919

DONOR OF THE ENGINEERING SOCIETIES BUILDING
AND THE BUILDING OF THE ENGINEER'S CLUB
MEMBER OF THE SOCIETY FROM 1890
HONORARY MEMBER FROM 1907

7 89

gie, presented by the past-presidents of the Founder Societies, was unveiled in the Library.

The inaugural banquet of the Engineers' Club on December 9, 1907, was made the occasion for conferring honorary membership on Mr. Carnegie, John Fritz, honorary member and past-president, making the presentation speech, and T. Commerford Martin, president of the Club, receiving the certificate from the President and Secretary of the Society and tendering it to Mr. Carnegie. The latter in accepting the certificate generously acknowledged his indebtedness to the engineer, and expressed heartfelt appreciation of the honor conferred upon him. Mr. Carnegie had been a member of the Society since 1890. He was also elected a member of the American Institute of Mining Engineers in 1888 and an honorary member in 1905.

Mr. Carnegie's Literary Work, His Honors, and His Benefactions

Despite the demands of business, Mr. Carnegie found time for literary work and wrote several books as well as a number of essays on economic and philosophical subjects for the magazines and reviews. His first work, published in 1883, was An American Four-in-Hand in Great Britain. In 1884 he wrote in Round the World an account of a trip he had made. Among his other writings are: Triumphant Democracy (1886), The Gospel of Wealth (1900), The Empire of Business (1902), The Life of James Watt (1906) and Problems of Today (1909). Triumphant Democracy, his best-known work, passed through eight editions and has been translated into eight languages. In it Mr. Carnegie treated of the progress of the American Republic largely as an advance in material prosperity, which he regarded as the surest test of the validity of the claims of popular government to superiority.

Mr. Carnegie received honors and decorations from rulers and people all over the world. He received as a result of his benefactions abroad the freedom of fifty-four cities in Great Britain and Ireland. He was Lord Rector of St. Andrew's University from 1903 to 1907 and of Aberdeen University from 1912 to 1914, and held the honorary degree of Doctor of Laws from the universities of Glasgow, Edinburgh, Birmingham, Manchester and McGill, as well as from Brown, Pennsylvania, Cornell and other American colleges. In addition to his connection with our Society and with the Mining Engineers, he was a member of numerous philosophical, civic and scientific bodies, among them being the American Institute of Architects, the National Civic Federation, the American Philosophic Society, and the New York Chamber of Commerce. He was commander of the Legion of Honor of France, and had also received the Grand Crosses of the Order of Orange, of Nassau, and of the Order of Daneborg.

Holding as his gospel of wealth that the millionaire should be but a trustee for the poor, "entrusted for a season with a great part of the increased wealth of the community, but administering it for the community far better than it could or would have done for itself," Mr. Carnegie established six great institutions for the furthering of those philanthropic causes which most appealed to his interest. The Pittsburgh Institute, the oldest of the six, was founded in 1896, the Research Institution at Washington in 1902, the Hero Fund in 1904, the Foundation for the Advancement of Teaching in 1905, the Peace Endowment in 1910, and the Carnegie Corporation of New York, with an endowment of $125,000,000, in 1912.

The Carnegie Foundation for the Advancement of Teaching was the outcome of Mr. Carnegie's sympathy with the cause of education and his desire to be of service to the teachers of America. The act of incorporation obtained by Congress enabled the foundation to receive and maintain funds for paying pensions to college teachers in the United States, Canada and Newfoundland, and "in general to do and perform all things necessary to encourage, uphold and dignify the profession of the teacher and the cause of higher education." Seventy-four institutions of higher learning, seventy-one in the United States and three in Canada, have been admitted to the list of associated institutions. In these colleges, universities and technical schools there were on April 1, 1917, 6593 teachers, including professors, associate or assistant professors and instructors. Of these 715 were women.

The largest of Mr. Carnegie's single gifts was that creating the Carnegie Institute of Pittsburgh. This gift to the city of his prosperity called for a total outlay for building equipment and endowment of over $25,000,000.

Mr. Carnegie's benefactions amounted in all to more than $350,000,000, among the more important ones being the following: Library buildings (over 3000), $64,000,000; church organs (over 7500), $6,200,000; Carnegie Corporation, $125,000,000; Carnegie Foundation, $29,500,000; Carnegie Institute, $26,700,000; Carnegie Institution of Washington, $22,300,000; hero funds, $10,500,000; Scottish universities, $10,000,000.

One of Mr. Carnegie's greatest ideals was the abolition of war, a hope that he cherished in the face of international conflicts. He gave $10,000,000 toward an International Peace Fund, and at a cost of $1,500,000 built the peace palace at The Hague, which was dedicated in 1913. He also gave $750,000 for the Bureau of American Republics at Washington.

Resolutions by the Trustees of the U. E. S.

On August 14, 1919, the following resolutions relating to Andrew Carnegie were passed by the Trustees of the United Engineering Societies:

Andrew Carnegie's death August 11, 1919, at Lenox, Massachusetts, brought to its close a career which greatly advanced all the engineering arts and sciences. By the introduction into the United States of the bessemer process for the production of steel and by the establishment and development of steel plants, which became the greatest in the world, he made available for engineers the most useful modern material for engineering construction. In the successful conduct of many industrial enterprises he amassed great wealth, the possession of which he came to regard with deep seriousness as a public trusteeship. He devoted himself to the distribution of large portions of his fortune to projects for the benefit of mankind. He distributed his wealth not only in many directions, but also with the exercise of great wisdom based on careful investigation. His munificence provided large funds for the building of a home for the great national engineering societies and many associate societies. He was an honorary member of the American Institute of Mining and Metallurgical Engineers and American Society of Mechanical Engineers. He was personally known and loved by many engineers. In view of these facts, be it

Resolved, That the American Societies of Civil, Mining, Metallurgical, Mechanical and Electrical Engineers, the United Engineering Society and the Engineers' Club, herein express to the family of Mr. Carnegie and record their sincere appreciation of the great contributions of Andrew Carnegie to the advancement of engineering, and of his friendly assistance in making possible beautiful homes for the Engineering Societies and the Engineers' Club, thus fostering the spirit of unity in the profession.

Recataloging the U. E. S. Library

(Continued from page 783)

An incidental advantage of this classification, but one which is not to be despised, is its wide use. The Dewey classification is used more generally by libraries than any other classification, and the Brussels classification has found greater favor than any other for indexing and cataloging. The latter is now used by a number of Belgian and French magazines to classify the abstracts which they publish and was in use by several other organizations that suspended during the war. It has more international acceptance than any other system and its principles and notation are quite generally understood. The fact that many users of the catalog will have some previous familiarity with its system will enable them to use it more readily and with less assistance.

This outline of the proposed plans is incomplete; many points having been omitted in the desire for brevity upon a subject of considerable magnitude. It is hoped, however, that it will demonstrate to you that the system is sufficiently comprehensive and elastic to meet successfully any demand that this library may have to place upon it. It is also hoped that it will show that the preparation of an efficient catalog is not an easy task, but one requiring professional skill, good judgment and the expenditure of a considerable sum of money. Many library catalogs are unsatisfactory because this has not been realized, and efficiency has been sacrificed in an attempt to do the work too cheaply. The catalog is part of the permanent equipment of a library and is a vitally important part; economy in its construction may easily be carried to excess.

Respectfully submitted,

Harrison W. Craver.

NECROLOGY

FREDERICK SARGENT

Frederick Sargent, senior member of the firm of Sargent & Lundy, of Chicago, and probably the most prominent consulting engineer in the United States specializing in the design of electrical generating sections, died at his home, in Glencoe, Ill., July 26, having been taken ill while abroad. An Englishman by birth, Mr. Sargent had made numerous trips to his native country, the last of which was made in April and May of this year in company with his close friend, Samuel Insull.

Frederick Sargent was born in Liskeard, Cornwall, England, on Nov. 11, 1859, which is also the exact date of the birth of Samuel Insull, another Englishman and Chicagoan, with whom Mr. Sargent was destined to be intimately associated during practically all of his engineering activities. His people were of the farming class, but young Sargent developed a decided mechanical bent, and eight years of his boyhood and youth were spent in acquiring practical mechanical knowledge and experience in the works of John Elder & Co., the great shipbuilders on the River Clyde, near Glasgow. During this time he gained an extensive and practical knowledge of mechanical engineering, paying particular attention to heavy machinery. He also improved his education by going to night school at Glasgow University. Coming to the United States about 1880, he found employment in Eastern shipbuilding yards as a designer of steam engines. He then went West as a designer for the Sioux City (Iowa) Engine Co. A year or so later he accepted a position with E. P. Allis & Co., of Milwaukee, predecessors of the present Allis-Chalmers Manufacturing Co. Here he attracted the attention of the officers of the Western Edison Light Co., organized in Chicago in 1882 to exploit the electric-lighting inventions of Thomas A. Edison in the West, and in the fall of 1884 he moved to Chicago and began his career as an electrical engineer in that city.

Succeeding the Western Edison Light Co., the Chicago Edison Co. was formed in 1887. This was the first distinctively Edison central-station company in Chicago. Mr. Sargent became its consulting engineer, and he has been consulting engineer of that company and its successor, the present Commonwealth Edison Co., ever since.

About 1889 he went to New York under contract with the Edison United Manufacturing Co. In this position he had general charge of all the work done by that company in the United States and Canada. Shortly after this the company in New York was reorganized as the Edison General Electric Co. Mr. Sargent was made assistant chief engineer of the new corporation, of which Samuel Insull was vice-president in charge of manufacturing. But Mr. Sargent had determined to open an office of his own, and, in August 1890 he returned to Chicago and established himself as an independent electrical and mechanical engineer. The firm of Sargent & Lundy was formed in 1891.

In 1891 and 1892 Mr. Sargent was consulting electrical engineer for the World's Columbian Exposition, and he designed the power plant and had much to do with the other mechanical and electrical features of the great World's Fair of 1893.

The original Edison central station in Chicago was built about 1889. Mr. Sargent made the plans for the machinery layout of that station. In 1892 Samuel Insull came to Chicago as president of the Chicago Edison Co., and that company at once took on a new lease of life. Under Mr. Insull's direction the old Harrison Street station, recently torn down to make way for the Union Station railroad improvements, was built. Mr. Sargent was the designer of that station, also the Fisk Street Station, the Quarry Street Station and the Northwest generating stations of the Commonwealth Edison Company.

He was one of the first mechanical engineers who recognized the great part that the steam turbine was destined to play in the development of electric generating stations. The Fisk Street Station was the pioneer of all the large turbine central stations of the world, and it became deservedly famous for its many original features of design and for its simplicity and economy of operation. After this station had been in operation for a short time, Mr. Sargent, at the request of Mr. Insull, President of the Commonwealth Edison Co., went to London to follow the inquiry of the Parliamentary Committee in charge of the London Power-Supply Bill. This hearing crystallized in Mr. Sargent's mind some ideas he had been developing about the importance of unified power supply for great industrial centers so as to reduce the cost of production, and on his return he submitted his ideas to Mr. Insull, and they were worked out in the power-station development of the Commonwealth Edison Company.

Mr. Sargent's engineering work was not confined to Chicago. He was consulting engineer for many of the important electric-light and power companies throughout the country, including the Edison Electric Illuminating Co., Boston; American Gas and Electric Co., New York; Electric Bond and Share Co., New York; the Union Gas and Electric Co., Cincinnati, and many other smaller organizations.

He designed the great combined central power station of the American Gas and Electric Co., and the West Penn Power Co., located on the Ohio River, north of Wheeling, W. Va., which was the first large electric station to be built in a favorable locality near a coal mine for the distribution of power to industrial centers at long distances.

He designed the great new station of the Union Gas and Electric Co., at Cincinnati, which was recently completed. He also designed the new station for the Kansas City Light and Power Co., which is soon to be put into operation. He went to Chile in 1916 as consulting engineer for the Guggenheim mining interests on the development of a power supply for their mine at Chuquicamata.

During the war Mr. Sargent was consulting engineer for the power station of the Edgewood Arsenal, at Edgewood, Md., and also consulting engineer for the United States Government in other wartime projects demanding the application of power on a large scale.

In his profession Mr. Sargent was noteworthy for the clear vision and strong common sense with which he grappled with the essentials of an engineering problem. He was simple, clear, direct and practical. He was a man of broad outlook, tolerant, modest, seeking to achieve results rather than to uphold theories. And he was eminently successful in obtaining results, for his electrical generating stations were milestones of achievement in the economical production of electrical energy.

FREDERICK SARGENT

An idea of the esteem with which Mr. Sargent was held by his business associates was shown in an interview with Wm. S. Monroe, his friend and partner in the firm of Sargent & Lundy for many years, who said:

"Mr. Sargent had an exceptionally keen and active intellect and a vigorous and forceful personality. He was a man of absolute integrity and fearless independence and high idealism in his work. He had an infallible intuition regarding engineering and scientific matters, and the responsible men in the companies for which he was doing his engineering learned to place the utmost confidence in his judgment. He had a remarkable combination of extreme daring and careful conservatism. With a broad and ambitious view of important and fundamental principles of his engineering work, Mr. Sargent combined an accurate knowledge of all the underlying details, and no detail was too small for his personal attention.

"He kept in close touch with everything that was new in the engineering profession. He was a great traveler and made repeated trips to Europe as well as through this country in order to post himself on the important developments not only in the direct line of his own work but in all departments of the engineering field.

"His idealism was at times almost prophetic and he was very ambitious for the highest achievements in his work, but his idealism was held in restraint by a practical common-sense judgment, which combined to give a distinct originality to every new power station which he designed, and made it systematic and harmonious, economical and a perfect working machine."

Mr. Sargent was awarded a medal by the World's Columbian Ex-

position in 1893. He was a member of the jury of awards in power engineering at the St. Louis Exposition of 1904. He was a member of several societies and clubs, including the Western Society of Engineers' University Club, Chicago Yacht Club, and the Engineers' Club, New York. He became a member of our Society in 1901.

He is survived by a widow, one daughter and two sons.

WILLIAM A. BOLE

William A. Bole, Assistant to Vice-President H. T. Herr of the Westinghouse Electric & Manufacturing Co., Machine Works, died at his home in Pittsburgh on June 16. Mr. Bole was born on July 12, 1859, in Pittsburgh, Pa. He received his early education in the schools of Allegheny, later attending the University of Western Pennsylvania, now the University of Pittsburgh.

In 1878 he left school and was employed by his father who at that time was a manufacturer of steam engines in Pittsburgh. Here he gained considerable information regarding the manufacture of the mechanical parts of steam engines. After serving his father for three years he entered the employ of the Westinghouse Machine Co. in 1882 in the capacity of cost and time clerk. In 1883 he became foreman of the company and the following year was appointed Superintendent of Works and Purchasing Agent and in 1900 Manager of Works. In 1906 he was advanced to the position of Consulting Engineer and in 1908 became General Manager. In 1914 he was appointed Vice-President in Charge of Manufacture for the Machine Works and Trafford City Foundry. He was a veteran of thirty-seven years with the company.

Mr. Bole was a member of the Engineers' Society of Western Pennsylvania, of which he was president for one year, and of the American Foundrymen's Association. He became a member of our Society in 1887.

ALLEN EUGENE NICHOLS

Allen E. Nichols, of the firm of E. M. Nichols & Sons, Philadelphia and Chicago, died at his home in the latter city of pneumonia on May 8, 1919. Mr. Nichols was born on September 30, 1888, in Madison, Wis. He was graduated from Purdue University in 1910 with the degree of B. S. and in 1913 received his C. E. degree. He was formerly employed by the Baltimore & Ohio Railroad, R. L. Sackett, consulting engineer for the State of Indiana, the Chicago & Western Indiana Railroad and the firm of Alvord & Burdick, consulting engineers. From 1915 to 1918 he was engineer in direct charge of design, specifications and contracts for the Bureau of Waste Disposal for the City of Chicago. Owing to a permanent injury, Mr. Nichols was not accepted by the military authorities for enlistment in the Army, whereupon he entered the employ of the DuPont Engineering Co. as engineer of construction for a seventy-million-gallon water-filtration plant for the Government powder factory at Old Hickory Works, Nashville, Tenn., which position he retained until construction was completed. Early in the present year he entered into the general engineering and contracting business in conjunction with his father and brother.

Mr. Nichols was an associate member of the American Society of Civil Engineers and was a member of the Franklin Institute, the American Water Works Association and the Sons of the American Revolution. He became an associate-member of the Society in 1917.

PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by September 15 in order to appear in the October issue.

CHANGES OF POSITION

MAURICE L. BULLARD, formerly associated with L. H. Shattuck, Inc., Manchester, N. H., has become affiliated with the Atlantic Corporation, of Portsmouth, N. H., as superintendent of the marine department.

FREDERICK R. PRATT has resigned as mechanical superintendent with D. Goff and Sons, Pawtucket, R. I., and has accepted the position of engineer with B. B. and R. Knight, of Providence, R. I.

WILLIAM H. CHURCHMAN has severed his connection with the East Bay Water Company, Oakland, Cal., as superintendent of pumping stations, and has assumed the duties of constructing and erecting engineer of steam, electrical and hydraulic machinery with the California Hydraulic Engineering and Supply Company, of San Francisco, Cal.

LEWIS S. MAXFIELD, until recently assistant to the secretary of the Heating and Piping Contractors National Association, has resigned to accept a position in the office of the mechanical engineer, New York Central Railroad.

CHARLES C. TRUMP, formerly with the Humphrey Gas Pump Company and Stumpf Una-Flow Engine Company, Inc., Syracuse, N. Y., is now employed by the Fuller-Lehigh Company, of Fullerton, Pa., and the Fuller Engineering Company, of Allentown, Pa., as sales engineer in the New York office.

CHARLES O'C. SLOANE has resigned his connection with the Allied Machinery Company of America, New York, and has joined the sales organization of the Betts Machine Company, of Rochester, N. Y.

WILFORD L. STORK, formerly metallurgist of the Michigan Motor Casting Company, Division of Buick, Flint, Mich., has resigned and is now associated with the Detroit Valve and Fitting Company, of Wyandotte, Mich., in the capacity of foundry superintendent.

LAWRENCE T. CUMMINGS, one of the senior engineers of Miller, Franklin, Basset and Company, consulting industrial and production engineers of New York City, has resigned his position in order to assume the duties of vice-president with the firm of Drefs, Cummings and Drefs, Inc., business consultants, Detroit, Mich.

CHARLES H. SCHMALZ has assumed the position of assistant factory manager with the Holt Manufacturing Company, of Peoria, Ill. He was, until recently, associated with the Hanna Engineering Works, Chicago, Ill., in the capacity of superintendent.

JOSEPH B. LINCOLN, formerly mechanical engineer, Naval Engineering Experiment Station, Annapolis, Md., has become affiliated with the New Departure Manufacturing Company, Bristol, Conn.

WILLIAM H. HAZARD has resigned his position as designing mechanical engineer for the Hercules Powder Company and has accepted the position of industrial engineer for the General Motors Corporation, assigned to work at the Janesville Machine Company and Samson Tractor Company plants.

CECIL R. HUBBARD has resigned his position of designing engineer with the National Metal Molding Company, Ambridge, Pa., and has taken up industrial engineering work with the Revere Rubber Company, Providence, R. I.

FRANCIS J. MCGRAIL, formerly of the Henry R. Worthington Pump Company, Harrison, N. J., and for eight years employed as foundry superintendent of the Struthers-Wells Company, Warren, Pa., has resigned his position to take charge of the iron and brass foundries operated by the Honolulu Iron Works Company, of Honolulu, Hawaii. Mr. McGrail assumed his new duties May 1.

A. L. VALENTINE, who for 19 years was connected with the small tool department of the Pratt and Whitney Company, Hartford, Conn., the last 15 as superintendent, has resigned. He sailed for France recently to become works manager of the Société des Usines Curial, Paris, France, manufacturer of small tools.

ELLWOOD A. METZ, formerly with the De Laval Steam Turbine Company of Trenton, N. J., has become associated with F. X. Hooper Company, Inc., Glanarm, Md., in the capacity of superintendent.

WILLIAM T. CLARK has left the employ of the Moline Plow Company, Moline, Ill., and has assumed the duties of factory manager with The Fuller and Sons Manufacturing Company, Kalamazoo, Mich.

P. J. BRYANT, formerly chief engineer, U. S. Military Academy, West Point, N. Y., has become affiliated with the Wabash Ice and Fuel Company, Wabash, Ind.

ALFRED L. FITCH has become associated with the Ashton Valve Company, Cambridge, Mass., in the capacity of mechanical engineer. He was until recently designer with the Blanchard Machine Company, Cambridge, Mass.

F. G. HECHLER has resigned his position as mechanical engineer at the U. S. Naval Engineering Experiment Station, Annapolis, Md., and has become associated with the Vibration Specialty Company, Philadelphia, Pa., as engineer and superintendent.

ANNOUNCEMENTS

J. J. BROWN, formerly vice-president and general manager of the Wheeler Condenser and Engineering Company, Carteret, N. J., was elected president of the company succeeding Charles W. Wheeler, recently deceased.

F. B. WILLIAMS has been discharged as Captain in the Ordnance Department, U. S. A., after two years' service and has accepted a position as assistant superintendent of the Watertown, Mass., plant of the Walker and Pratt Manufacturing Company.

John B. Price has been transferred from the managership of the Cincinnati office of the Refinite Company and now has charge of the New York office of the company.

Otto R. Kihm, formerly associated with the American Can Company, Edgewater, N. J., in the capacity of chief mechanical engineer, has started in business for himself under the firm name of the Kihm-Bowen Machine Company, Irvington, N. J., specializing in sheet metal working machinery, shear blades and re-grinding shear blades.

R. Sanford Riley, of Worcester, Mass., has gone to England and the Continent in the interest of the Sanford Riley Stoker Company and the Norton Company. Mr. Riley was appointed honorary vice-president to represent the A. S. M. E. at the James Watt Centenary, held at Birmingham, England, the latter part of August.

Thayer P. Gates, consulting engineer and textile specialist, announces the opening of offices in Providence, R. I. He will handle mill and power plant engineering, appraisal and special reports, operation and management, production engineering and textile engineering.

Webster Tallmadge has been transferred to the service department, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. He was, until recently, connected with the Boston office of the company, as superintendent of the steam division.

E. H. Bull, associated with the Green Engineering Company, East Chicago, Ind., for seven years as engineer, is a member of the firm of Bull and Liversparger which has been appointed sales representative of the Green Engineering Company in Chicago and northern Illinois territory.

I. D. Everitt, recently discharged from the U. S. Army, is the New England manager for the Blackmer Rotary Pump Company. He is located in Boston, Mass.

Harry I. Lewis has been discharged from military service as first lieutenant in the Ordnance Department and has become connected with the firm of Bishop and Babcock Company, Cleveland, Ohio, in the capacity of chief engineer in the refrigeration division.

George H. Piman, formerly with the American Woolen Company's mills of Lawrence, Mass., has retired from active duty with this company after 32 years of continuous service. He is still retained by them as a member of the general advisory board.

Fred V. Larkin, assistant general superintendent of the Harrisburg Pipe and Pipe Bending Company, Harrisburg, Pa., formerly assistant professor of mechanical engineering in Lehigh University, will return to Lehigh as professor of mechanical engineering on September 1, to fill the chair vacated by the death of Prof. J. F. Klein, head of that department for many years.

Parry Keller has received his discharge as a first lieutenant, Ordnance Department, U. S. A., and has accepted a position with the Goodyear Tire and Rubber Company, Akron, Ohio, in connection with the development and manufacture of tires and tubes.

Walter W. Tangeman, Major, Ordnance Department, has recently returned from service in France, and has become re-associated with the Cincinnati Milling Machine Company, Cincinnati, Ohio, in the capacity of sales engineer.

L. F. Graff has become affiliated with the Compania Minera del Mirasol, S. A., Cusihuiriachic, Chihuahua, Mexico.

R. R. Shafter has returned to the sales organization of Traylor Engineering and Manufacturing Company, mining, milling, crushing and smelting equipment, Allentown, Pa., after an absence of two years as general superintendent of the Traylor Shipbuilding Corporation. Mr. Shafter as district manager will have charge of the New York office.

M. M. Shuster has become production engineer with the Clip-Bar Manufacturing Company, Philadelphia, Pa., manufacturers of the Shuster Speed Wrench. Mr. Shuster was recently discharged from the Naval Air Service.

Howard Coonley, president of the Walworth Manufacturing Company, Boston, Mass., has been elected a vice-president of the Massachusetts Credit Union Association.

Captain Edward Van Winkle, recently regimental engineer officer of the 24th Engineers, American Expeditionary Forces, desires to announce that he has resumed his practice as consulting engineer and has formed an association with Frederick A. Waldron, consulting engineer, New York, for the general practice of engineering with special reference to the problems relating to the construction, development and operation of industrials.

David S. Wegg, Jr., has left the Army Ordnance, where he was chief examiner, Chicago District Claims Board, and has become testing engineer for the Isko Company, Chicago, Ill., manufacturers of electric refrigerating machinery.

Robert P. Lay has accepted a position with the H. H. Franklin Manufacturing Company, Syracuse, N. Y., in the capacity of special engineer in the engineering department.

Prof. Arthur M. Greene, Jr., was elected president of the Society of the Promotion of Engineering Education at the 27th annual meeting of the Society held in Baltimore, Md., during the last week of June.

L. E. Strothman, who for several years has been manager of the Steam Turbine and Pumping Department of the Allis-Chalmers Manufacturing Co., has left the firm and has become vice-president and general manager of the Richardson-Phenix Co., in which firm he has acquired a financial interest. J. W. Peterson, formerly vice-president and general manager of the Richardson-Phenix Co., has assumed the duties of president and treasurer of the company.

THE HORSE-POWER OF RESISTANCE IN AEROPLANE DESIGN

(Continued from page 727)

estimate on a four-motored machine, for which the fuel must now be computed at $10{,}150 \times 4/2 = 20{,}000$ lb. approx. The new machine weight can now be estimated as follows:

Fuel	20,000 lb.
Four motors and equipment	3600 lb.
Crew (3 men)	450 lb.
Dead load (machine)	8000 lb.
Total weight	32,050 lb.

The total weight would therefore be about 32,000 lb. The approximate wing area (R. A. F. No. 15) is given by the formula $32{,}000 = 0.002958 \times 3025 \times A$ (for 14 deg. angle of incidence) $= 3570$ sq. ft. The ratio of linear dimensions N is 1.77:1, and the ratio of weights m is 3.14:1.

Investigating the problem, we have

$N = 1.77$; $m = 3.14$, hence

$$V_a = \frac{\sqrt{3.14}}{1.77} V_b = V_b$$

i.e., the velocities correspond. Also,

$$\text{Thrust}_a = 3.14 \times \text{Thrust}_b$$

and

$$\text{HP}_a = \frac{3.14\sqrt{3.14}}{1.77}\text{HP}_b = 3.14\text{HP}_b$$

The original type had 800 hp. in two motors. If the new machine were to fly at 100 m.p.h., the effective L/D would be 5.50, which would considerably lower the radius of flight. However, at 80 m.p.h. a value of 6.90 may be realized for the L/D factor. Further, the horsepower requirement at this speed is 320, as compared to 600 for the basic machine. If the new machine be equipped with four motors of the high-compression type, the available horsepower $= 0.82 \times 4 \times 430 = 1410$. This is equivalent to the $1410/3.14 = 450$ hp. flying requirement in the basic machine—about 97 m.p.h. Hence a flying speed of 95 m.p.h. may be counted on, with an effective L/D of 6.0. If the course as laid out were 2000 miles and 300 were allowed for variation, the trip would require 24 hours. With the four motors running continuously the total weight of gasoline necessary would be $33 \times 4 \times 24 \times 6.15 = 19{,}500$ lb., whereas the contemplated quantity was 20,000 lb.

The flight could be successfully accomplished, then, with a flying boat, similar to existing types, of about 32,000 lb. in weight, equipped with four motors, and having a gasoline supply of about 3250 gal., assuming flight at continued full speed and at maximum r.p.m. of the four motors. At economical speed the gasoline supply necessary would be approximately 85 per cent, or 2760 gal.[1]

[1] The NC-4 (total weight, 28,000 lb.) flew 1390 miles in 15 hours 18 minutes and carried a gasoline load of 1650 gal.

LIBRARY NOTES AND BOOK REVIEWS

Abrasives and Abrasive Wheels. Their Nature, Manufacture and Use. A Complete Treatise on the Manufacture and Practical Use of Abrasives, Abrasive Wheels and Grinding Operations. By Fred B. Jacobs. The Norman W. Henley Publishing Co., New York, 1919. Cloth, 5 x 8 in., 338 pp., 174 illus., 1 por., $3.

This work opens with descriptions of the various natural and artificial abrasives, the manufacture of grinding wheels and artificial sharpening stones, the grades established in commerce and the methods of testing grinding wheels, dust-collecting systems and safeguards, abrasive papers and cloths, methods of surface, cylindrical and internal grinding, special grinding operations, and cutter and saw sharpening. The author writes from experience as a machinist and as a salesman of grinding wheels.

Airplane Design and Construction. By Ottorino Pomilo. First edition. McGraw-Hill Book Co., Inc., New York, 1919. Cloth, 6 x 9 in., 403 pp., 248 illus., 58 tables, $5.

A book on the structure and design of airplanes, in which the results of European experimental research in aerodynamics are presented in considerable detail. The problems relating to airplane design and operation are analyzed, working formulæ are derived and the data needed by designers are presented.

The Applications of Electrolysis in Chemical Industry. By Arthur J. Hale. Longmans, Green & Co., New York, 1918. Cloth, 6 x 9 in., 148 pp., 56 illus., $2.50. (Monograms on Industrial Chemistry.)

The author describes briefly the electrolytic refining and winning of metals; the production of hydrogen and oxygen, chlorin, caustic soda, hypochlorites, chlorates and perchlorates; and of various other organic and inorganic compounds. References to the literature and patents are included.

A Century of Science in America. With Special Reference to the American Journal of Science, 1818-1918. By Edward Salisbury Dana and Others. Yale University Press, New Haven, 1918. Cloth, 6 x 9 in., 458 pp., 22 por., $4.

The present book commemorates the one-hundreth anniversary of the founding of the *American Journal of Science* by Benjamin Silliman in July, 1818. The opening chapter gives a somewhat detailed account of the early days of the *Journal*, with a sketch of its subsequent history. The remaining chapters are devoted to the principal branches of science which have been prominent in the pages of the *Journal;* geology, paleontology, mineralogy, chemistry, physics, zoology and botany. They have been written with a view to showing in each case the position of the science in 1818 and the general progress made during the century. Special prominence is given to American science and particularly to the contributions to it to be found in the *Journal's* pages.

Electrical Aids to Greater Production. Plans, Methods and Appliances by Which Industrial Electrical Engineers are Meeting Increased Demands for Power. Compiled and edited by Allen M. Perry. First edition. Published by *Electrical World*, McGraw-Hill Book Co., Inc., New York, 1919. Cloth, 6 x 9 in., 332 pp., illus., chart, tables, $2.

Contents: General Power Problems of Industrial Plants; Distribution, Transformation, Switching and Protection; Motors, Control, Specific Applications, Troubles and Remedies; Illumination—Selection of Equipment, Economics, and Specific Applications; Electric Furnaces, Welding, etc.; Meters and Measurements as Applied to Industries; Handling Material in Industrial Plants with Electric Tractors; Outdoor Substations.

The engineering editor of the *Electrical World* has prepared this volume from the articles on the application of electricity to plants which have appeared in that periodical during the last few years. It summarizes the methods that have arisen from the necessity for increased factory output and reduced cost of production caused by the war in many classes of industries.

Induction Coils in Theory and Practice. By F. E. Austin. (Hanover, N. H., copyright 1919.) Cloth, 6 x 9 in., 64 pp., 45 illus., $1.

A presentation of the fundamental principles of the induction coil, for use as a textbook. Intended to enable the student to construct induction coils to meet a variety of demands as well as to construct coils to fulfill specific requirements.

An Introduction to the Physics and Chemistry of Colloids. By Emil Hatschek. Third edition. P. Blakiston's Son & Co., Philadelphia, 1919. Cloth 5 x 7 in., 116 pp., 17 illus., $1.50.

This small volume is intended to introduce readers with a reasonable knowledge of physics and chemistry to the fundamental facts and methods of this important branch of physical chemistry. Small additions and corrections have been made to this edition, to include such recent advances as fall within the scope of a brief introductory work.

James Woodhouse, A Pioneer in Chemistry, 1770-1809. By Edgar F. Smith. The John C. Winston Co., Philadelphia, 1918. Cloth, 5 x 8 in., 299 pp., 1 pl., 1 por., $1.50.

Dr. Smith's account of the life and labors of James Woodhouse is a valuable contribution to the early history of chemistry in America. Woodhouse was elected professor of chemistry at the University of Pennsylvania in 1795 and retained this connection until his death in 1809. He was an industrious and ingenious chemist, who by his work and writings did much to establish the teaching of chemistry on a sound basis and to arouse interest in the industrial applications of the science.

Laboratory Experiments with Direct Currents. By F. E. Austin. (Hanover, N. H., copyright 1917). Flexible cloth, 5 x 7 in., 152 pp., illus.

A laboratory course, covering about forty hours, for students in technical and industrial high schools, etc., based on the author's experience as a teacher. The chief aim is to make evident some of the engineering applications of direct currents.

MacRae's Blue Book. MacRae's Blue Book Co., New York, 1919. Cloth, 9 x 12 in., 1846 pp., $10.

This record of manufacturers is intended for use by purchasing agents interested in iron and steel products, building materials, railway supplies, etc. It includes an alphabetical address list of the principal manufacturers in the United States, a classified index of the makers of 10,000 products, an index of trade names, a collection of miscellaneous data useful to purchasers and users of the articles considered, and the standard list prices of building materials, iron and steel products, etc.

Military Geology and Topography. A Presentation of Certain Phases of Geology, Geography and Topography for Military Purposes. Herbert E. Gregory, Editor. Prepared and issued under the auspices of the Division of Geology and Geography, National Research Council. Yale University Press, New Haven, 1918. Cloth, 6 x 9 in., 281 pp., illus., pl., maps, $1.25.

This book is the result of a preliminary effort to meet the need which the Great War has demonstrated for a more widely diffused knowledge of geology as an aid in conducting military operations and in the solution of economic problems relating to raw materials. Attention is given mainly to those facts and principles that have proven to be applicable to military problems. Bibliographies for supplementary reference study are included.

ACCESSIONS TO THE LIBRARY

American Book Trade Manual. 1919. Purchase.

American Bureau of Shipping. Extract from the Rules for Building and Classing Vessels. Sections 39-42, inclusive, and Sec. 49. 1917. Revised June 1918. Gift of Bureau.

America's Munitions. 1917-1918. Report of Benedict Crowell, Asst. Sec'y of War, Director of Munitions. Gift of U. S. War Dept.

Bibliography of the Occurrence, Geology and Mining of Manganese with Some References on its Metallurgy and Uses. Compiled by Harold L. Wheeler. Reprint. Gift of author.

Managing for Maximum Production. By L. V. Estes. Pts. I, II and III. Reprints. Gift of author.

Marine and Dock Labor—Work, Wages, and Industrial Relations During the Period of the War. Report of the Director of the Marine and Dock Industrial Relations Division, U. S. Shipping Board. 1918. Gift of Board.

Mechanics' and Engineers' Pocket-Book. By Chas. H. Haswell. 60th edit. *1895*. Gift of Prof. F. R. Hutton.

Missouri Bureau of Geology and Mines. Biennial Report of the State Geologist. *1919*. Purchase.

Monograph on the Constitution of Coal. Dept. of Scientific and Industrial Research. *London, 1918*. Purchase.

Moody's Manual of Railroads & Corporation Securities. 20th Annual Number. Public Utility Section, *New York, 1919*. Purchase.

National Association of Owners of Railroad Securities. Resolutions adopted. By S. Davies Warfield, President. *1919*. Gift of author.

New York Central Railroad Company. Annual Report. 1918. Gift of N. Y. Central R. R. Co.

New York State Department of Labor. 26th Annual Report of the Bureau of Labor Statistics. 1908. Pt. I. Industrial Training. Gift of Prof. F. R. Hutton.

Preliminary Report of the Mineral Production of Canada. 1918. By John McLeish. Gift of Canada Dept. of Mines.

Report of an Investigation of The Akron Industrial Salvage Company. Dept. of Commerce Waste-Reclamation Service. 1919. Gift of Dept.

Report of the Tests of Metals. 1917. Gift of Prof. F. R. Hutton.

Report on the "Hawk's Nest" Group of Copper Claims Located on Talumkwan Island, Queen Charlotte Islands, B. C. By Ronald C. Campbell-Johnston. *1909*. Gift of Kirby Thomas.

The Return and Regulation of the Railroads. By S. Davies Warfield. Gift of author.

The Rockefeller Foundation. Review for 1918. By Geo. E. Vincent.

Safeguards. For the Prevention of Industrial Accidents. Edit. by David van Schaack.

The Salinity of the Waters in the Harbor of New York, One Year's Record of Temperatures, Specific Gravities, and Percentages of Land Water. By H. deB. Parsons. Gift of author.

Silver and Gold. Review of the Bullion Market for 1918. By Srinivas R. Wagel. Gift of author.

Some Economic Considerations in Coke-Oven Practice. By W. Colquhoun. *1918*. Excerpt. Gift of author.

State of New York. Second Report of the Factory Investigating Commission. Vols. I & II. *1913*. Gift of Prof. F. R. Hutton.

The Steam Engine. By Daniel K. Clark. Half-Vols. I, II, III, IV. Gift of Prof. F. R. Hutton.

TRADE CATALOGS

Allen Machine Co., Erie, Penna. Rubber Working Machinery.

The Baldwin Locomotive Works, Record No. 93—War Industries. Philadelphia, Pa.

F. R. Blair & Co., Inc., New York, N. Y. Flexite. Universal Joints and Propeller Shafts. Bulletin No. 7.

H. Channon Company, Chicago, Ill. Discount Sheet for Catalog No. 50 and Supplement of Supplies and Machinery.

The Dayton Engineering Laboratories Co., Dayton, Ohio. Aviation Ignition. A description of the Delco Generator Battery Ignition as Applied to Modern Aviation Engines.

General Electric Company, Schenectady, N. Y. CR 4015 Enclosed Automatic Starters for Small Direct-Current Motors. A "Safety" Installation.
Index to Descriptive Bulletins and Sheets.
Index to Supply Part Bulletins.
Type FK-20 Oil Circuit Breakers for Industrial Service up to 300 Amperes and 2500 Volts. June 1919.

Gifford-Wood Company, Hudson, N. Y. Field & Basin Saws, Bulletin 42.

The Green Fuel Economizer Company, Beacon, N. Y. Bulletin No. 151. Green's Economizer—a Summary of the Facts Regarding Green's Improved Patent Fuel Economizer.

Guaranty Trust Company of New York, 140 Broadway, New York, N. Y. American Goods and Foreign Markets.
Financial and Business Conditions in the United States.
The South American Market for Certain Electrical Material.
The Open Doors to Opportunity.
Swedish Developments in the Use of Electric Power.

Raymond S. Hart, New York, N. Y. Fountain Electrical Conduit Fittings and Boxes.

Hendrick Manufacturing Co., Carbondale, Pa. Perforated Metals. Sheet and light structural iron work.

Wm. Hiergesell & Son, New York.
Long Stem Thermometers and Hydrometers.

Hilles & Jones Co., Wilmington, Del. Machine tools for working plates, bars and structural shapes. Catalog No. 8.

The Home Insurance Co., New York, N. Y. The Fire Hazards of Soft Coal.

The Hoover Suction Sweeper Co., North Canton, Ohio. The Road to Cleanliness.

The Jeffrey Manufacturing Co., Columbus, Ohio. The Jeffrey Pivoted Bucket Carrier, Catalog No. 210
The Jeffrey Type—A Shredder, Catalog No. 245; Jeffrey Bucket Elevators.
Jeffrey Standard Apron Conveyors for Every Service. Catalog No. 258.

Jointless Fire Brick Co., Chicago, Ill. Jointless Fire Brick. (Commonly called Devil's Putty).

Henry C. Kelley Co., New York, N. Y. The House of Kelley.

Kilby Manufacturing Co., Cleveland, Ohio. Building Trim of Permanent Asbestos Protected Metal.

Standard Spiral Pipe Works, Chicago, Ill. Standard Reinforced Spiral Pipe.

The Steam Motors Co., Springfield, Mass. The Steam Motor, Bulletin, No. 5.

Steere Engineering Company, Detroit, Mich.
Bulletin No. 37. Gas Purification.
Bulletin No. 34. Gas Valves and Welded Steel Pipe.
Bulletin No. 35. Tar Cameras for Colorimetric Tar Determination.
Bulletin No. 36. Plant Models.
Table of Producer Gas Costs.

Supplee-Biddle Hardware Co., 513 Commerce Street, Philadelphia, Pa. Bulletin. Monel Metal. vol. 6, no. 2.

Supplee-Biddle Hardware Co., Philadelphia, Pa. Supplee-Biddle Bulletin Monel Metal, vol. 6, no. 4, June, 1919.

The Texas Company, Houston and New York. Texaco at Home and Abroad.

Ulrich Planfiling Equipment Co., Jamestown, N. Y., Ulrich's Guide to Better Filing for Engineers, Architects, Manufacturers and Builders.

The Underfeed Stoker Company of America, Book Building, Detroit, Mich. The Combustion Chamber. April, 1919.

United Shoe Machinery Company, Beverly, Mass. The Ball—The Universal Symbol of Play.
The Story of Three Partners.

Vacuum Oil Company, Rochester, N. Y. Stationary Steam Engines.
Lubrication of the Automobile. No. 1. The Engine.
Lubrication of the Automobile. No. 2. The Chasis.
Horizontal Gas Engines (Small and Medium).
Horizontal Gas Engines (Large Size).
Vertical Gas Engines.

The Vulcan Soot Cleaner Co., Du Bois, Pa. Vulcan Soot Cleaners.

The Watt Mining Car Wheel Company, Barnesville, Ohio. Watt Cars, Mining and Industrial. General Catalog.

Westinghouse Electric & Manufacturing Co., 110 West 42nd Street, New York. Westinghouse Automotive Electric Equipment for Automobiles, Airplanes, Trucks, Motor Boats, Tractors, Locomotives. Publication 1532-E.

Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Railway Engineering Data. Vol. 1, No. 6, February, 1919.
Railway Engineering Data. Vol. 1, No. 7. March, 1919.
Railway Department. Reprint No. 72 from The Electric Journal, October, 1918.
Railway Department. Reprint No. 78. As to the Light Weight Car. January, 1919.
Diagram of Type F-2 Oil Circuit-Breaker.
Dipping and Baking as a Financial Asset.
Seeking the Best Railway Motor.
Westinghouse Electrical Euipment in the Woodworking Industry. Motor application circular 7133.
Electrical Precipitation. The recovery of valuable material from smoke and gases.
Westinghouse Railway Engineering Data, vol. 1, no. 1, June, 1917.
Westinghouse Railway Engineering Data, vol. 1, no. 2, Oct., 1917.
Westinghouse Railway Engineering Data, vol. 1, no. 3, Nov., 1917.
Westinghouse Railway Engineering Data, vol. 1, no. 4, Aug., 1918.
Westinghouse Railway Engineering Data, vol. 1, no. 5, Sept., 1918.
Westinghouse Railway Engineering Data, vol. 1, no. 6, Feb., 1919.
Westinghouse Railway Engineering Data, vol. 1, no. 7, March, 1919.
Electrical Equipment of the Largest Hotel in the World (Hotel Pennsylvania, New York City). Reprint.
Type AK Electrolytic Lightning Arresters.
Selection of Direct-Current Mill Motors (Types MCA, MCB, MCOA and MCOB).
Electrical Equipment for Oil Wells.
Type CS Squirrel-Cage Induction Motors.
Westinghouse No. 567-A-1 Railway Motor.
Westinghouse Graphic Instruments (Motor-Operated). Instruction Book 5190.

Westinghouse Railway Operating Data. Maintenance of Controller Fingers and Contacts.
How to Babbitt Motor Bearings.
Hand-Operated Circuit Breakers.
Oil, Grease and Waste for Railway Motors and Gears.

Williams, White & Co., Moline, Ill. Machinery, Catalog No. 10.

Sept. 1920.

THE ENGINEERING INDEX

Published Monthly by The American Society of Mechanical Engineers

The Engineering Index was Founded in 1884 by the Association of Engineering Societies; Published from 1895 to 1919 by The Engineering Magazine Company; and Acquired January 1919 by The American Society of Mechanical Engineers

THE following pages form a descriptive Index to articles on engineering and related subjects in current periodicals. In its preparation the Society's engineering staff regularly examines all of the technical journals and society publications received by the Engineering Societies Library, which form one of the greatest and most complete collections of scientific periodicals in the world, comprising upward of 1100 distinct publications in some ten languages. Cross-references are freely introduced in the Index, and in all cases where the titles of articles are not sufficiently descriptive, explanatory sentences are appended. The main abbreviations used in the items are given at the bottom of this page.

PHOTOSTATIC COPIES OF ARTICLES LISTED

THE Society is prepared to supply photostatic copies (white printing on black background) of any of the articles listed. Copies of the periodicals themselves, or clippings of articles, cannot be supplied.

Price of each print (up to 11 x 14 in. in size), 25 cents plus postage. A separate print is required for each page of the larger-size periodicals, but where possible two pages will be photographed together on the same print. Bill will be mailed with the prints.

Those holding coupon books for clippings formerly issued by The Engineering Magazine Company may use the coupons in payment for photostatic prints. In ordering, state plainly

(1) Page number of Index on which item appears
(2) Title of article
(3) Name of periodical.

Orders should be sent to

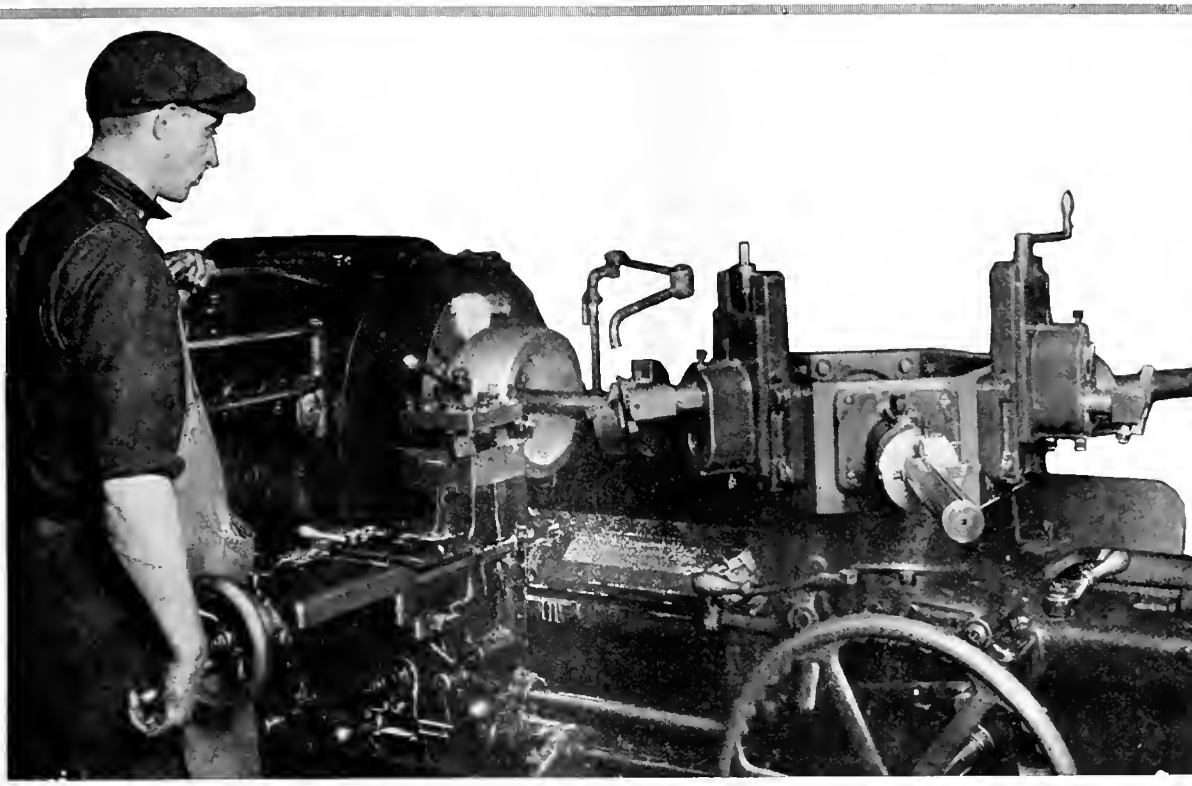
Harrison W. Craver, *Director*,
Engineering Societies Library,
29 West 39th Street, New York City.

DIVISIONS OF THE ENGINEERING INDEX

Note.—The abbreviations used in indexing are as follows:

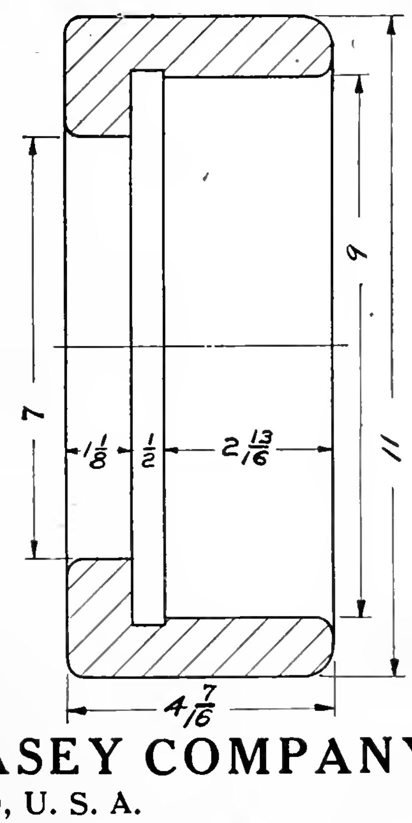
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
New York (N. Y.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
Ventilating (Vent.)
Western (West.)

LIST OF TOPICS IN THE ENGINEERING INDEX SEPTEMBER, 1919



Breaks Another Time Record

The Hahn Manufacturing Company, a jobbing machine shop in Cleveland, reduced production time one-half on this drop forged Clutch Ring when the work was transferred from an engine lathe to a



No. 3-A Universal Hollow Hexagon Turret Lathe

Because of the flexibility of the tool equipment of the No. 3-A, the jobbing shop finds it adaptable for finishing small lots of different pieces as well as long runs of the same piece. Then the time saved by operating both square and hexagon turrets simultaneously, and the wide range of feeds and speeds for all classes of work makes the Universal Hollow Hex the machine for the jobber.

No. 4 Universal, 1½" x 10",	**16" Swing**
No. 2-A Universal, 2½" or 3¼" x 29",	**16½" Swing**
No. 3-A Universal, 3½" or 4½" x 44",	**21½" Swing**

THE WARNER & SWASEY COMPANY

CLEVELAND, OHIO, U. S. A.

TURRET LATHES—TURRET SCREW MACHINES—BRASS WORKING MACHINE TOOLS

NEW YORK Office—Singer Bldg. **Boston Office**—Oliver Bldg. **Buffalo Office**—Iroquois Bldg.
Detroit Office—Ford Bldg. **Chicago Office and Show Room**—618-622 Washington Blvd.

FOREIGN AGENTS: Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. Allied Machinery Company, Paris, Turin, Barcelona, Zurich and Brussels. Stokvis & Zonen, Rotterdam. Wilhelm Sonesson Company, Malmo, Copenhagen, Gotenburg and Stockholm. Yamatake & Co., Tokio. Benson Brothers, Sydney and Melbourne. A. Asher Smith, Sydney. A. R. Williams Machinery Co., Ltd., Toronto, St. John, Winnipeg and Vancouver. Williams & Wilson, Ltd., Montreal.

Mechanical Engineering

AIR MACHINERY

Air Leakage

Determination of Amount of Air Leakage for a System of Pipes and Receivers the Volume of Which Cannot Easily Be Measured. P. H. Trout, Jr. Compressed Air Magazine, vol. 24, no. 7, July 1919, pp. 9216-9218, 1 fig. By cutting off compressors after filling system to convenient pressure and taking readings of pressure gage and times, readings are plotted in two curves from which amount of leakage is calculated.

Psychrometric Chart

The Psychrometric Chart Explained. L. A. Wilson. Sibley Jl., vol. 33, no. 5, June 1919, pp. 68-70, 1 fig. How it can be constructed for any given pressure.

Receivers

The Air Receiver—II. Frank Richards. Engr., vol. 127, no. 3311, June 13, 1919, pp. 573-574. Features of two-stage compressor arrangement.

CORROSION

Calcium Chloride

Corrosion Tests on Commercial Calcium Chloride Used in Automobile "Anti-Freeze Solutions." Paul Rudnick. Jl. Indus. & Eng Chem., vol. 11, no. 7, July 1, 1919, pp. 668-670, 3 figs. Reported that aluminum was attacked most severely, iron next, and copper least; rate of corrosion increased sharply on eighteenth to twentieth day of immersion. Composition of solutions varied from 28 to 30 per cent of calcium chloride and from 0.5 to 3.0 per cent magnesium chloride. Paper read before Div. of Indus. Chemists & Chem. Engrs., at meeting of Am. Chem. Soc.

Conduits

Apparatus for the Prevention of Corrosion in Conduits, Flue-Gas Feed Heaters, Superheaters, Boilers and Steam Turbines (Ueber Apparate zur Verhütung von Anfressungen in Rohrleitungen, Rauchgasvorwärmern, Ueberhitzern, Dampfkesseln und Dampfturbinen). M. R. Schulz. Zeitschrift für Dampfkessel u. Maschinenbetrieb, vol. 42, no. 8, Feb. 21, 1919, pp. 49-51, 4 figs. Types described are the Steinmüller, Hülsmeyer and Balcke apparatus and those made by the Deutsche Sanitätswerke at Frankfort, Germany.

Copper

Corrosion of Copper—VI. Metal Industry, vol. 15, no. 1, July 4, 1919, pp. 8-10, 2 figs. Experiment with sea water, one electrode aerated. From 4th report of Corrosion Committee of Inst. of Metals.

Manganese Bronze

Effect of Corrosion on Wrought Manganese Bronze Under Tensile Stress. P. D. Merica and R. W. Woodward. Am. Mach., vol. 51, no. 5, July 31, 1919, pp. 217-220, 3 figs. Tests claimed to have indicated that proportional limit is to be regarded as maximum safe stress for bronzes of harder tempers, but that it is not certain that this limit may not be slightly exceeded in materials which are soft, i. e., free from work hardness.

Paints

Efficient Protection of Iron and Steel Structures Obtained by Properly Selected Paints. John Grieve. Contract Rec., vol. 33, no. 26, June 25, 1919, pp. 617-619. Functions of various coats and factors governing their efficient application.

Rust Prevention

Rust Prevention. Edward T. Birdsall. Jl. Soc. Automotive Engrs., vol. 5, no. 1, July 1919, pp. 55-57. Classification of rust-proofing processes and enumeration of principal requirements of a rust-prevention process as applied to automobiles, aircraft and other machined and hardened parts.

FORGING

Drop-Stamping

Drop-Stamping, Drop Forgings, Etc. IV & V. Joseph Horner. Mech. World, vol. 65 & 66, no. 1694 & 1697, June 20 & July 11, 1919, p. 295 & 18, 14 figs. Method of fastening stamps into anvil and top of steam hammer. Manufacturing operations. (Continuation of serial.)

Forge Shops

An Example of Forge Shop Construction. Iron Age, vol. 104, no. 4, July 24, 1919, pp. 219-223, 7 figs. Arrangement providing for high and economical production.

Forging Plants

Equips Plant to Make Forgings. Mar. Rev., vol. 49, no. 8, August 1919, pp. 384-385, 4 figs. Addition to Camden Forge Co.'s plant to enable it to handle marine forgings besides the railroad work in which plant formerly specialized.

Welding

Fusion Welding Applied to Drop Forgings. S. W. Miller. Iron Age, vol. 104, no. 5, July 31, 1919, pp. 287-293. Oxyacetylene and electric welds and their applicability to defective forgings. Paper read before Am. Drop Forge Assn.

FOUNDRIES

Automobile Cylinders

Making Automobile Cylinders Without Flasks. Pat Dwyer. Foundry, vol. 47, no. 326, July 1, 1919, pp. 421-425, 9 figs. Cylinders are cast in vertical cores at plant of Buda Co., Harvey, Ill.

Brass Foundries

Materials and Chemicals Used in Brass Foundry Practice, Phosphorus—VII, Charles Vickers. Brass World, vol. 15, no. 7, July 1919, pp. 231-233, 2 figs. Series of articles dealing with history, properties, appearance, physiological action and commercial use of substances commonly employed in brass founding.

Bronze Castings

Cupola Metal for Bronze Castings. Charles Vickers. Foundry, vol. 47, no. 327, July 15, 1919, pp. 479-481, 3 figs. Methods used in large Canadian plant.

Bronze Statuary. Foundry Trade Jl., vol. 21, no. 210, June 1919, pp. 383-385, 7 figs. Historical account of industry with reference to composition of bronzes used by ancient craftsmen as determined by recent analytical analysis, and standard compositions adopted in various nations. From Stahl und Eisen.

Cupola Practice

Notes on Cupola Practice. J. Bagley. Foundry Trade Jl., vol. 21, no. 210, June 1919, pp. 391-395. Based on operating practice and results obtained at various plants. Paper read before Lancashire Branch of British Foundrymen's Assn.

Die Casting

Modern Developments in Die Casting. Adolph Bregman. Metal Indus., vol. 17, no. 7, July 1919, pp. 327-330, 7 figs. Description of plant of Doehler Die-Casting Co.

Use Die Casting and Eliminate Machining. Can. Machy., vol. 22, no. 3, July 17, 1919, pp. 46-47, 4 figs. Viewpoint of Franklin Co. as to why die castings should be used in design of machinery to greater extent than they are at present.

Electric Furnace

Employment of Electric Furnace in Foundry Work (Utilisation du four électrique en fonderie). Fonderie Moderne, no. 2, Feb. 1919, pp. 266-267. Result of experiences had with a 6-ton Héroult furnace. Advantage of electric furnace considered to lie chiefly in reducing cost of production.

French Foundry

Modern French Foundry in Suburbs of Paris. H. Cole Estep. Foundry, vol. 47, no. 326, July 1, 1919, pp. 429-434, and p. 437, 17 figs. Equipped with hydraulic molding machines. Special machine mentioned is one which fills both cope and drag flasks with sand simultaneously and rams two parts of mold at one stroke.

Layout

Steel Foundry Opened in Wilkes-Barre, Pa. Iron Trade Rev., vol. 64, no. 26, June 26, 1919, pp. 1677-1678, 3 figs. Plan showing location of furnace with reference to molding and pouring-off floors.

Semi-Steel

Semi-Steel and General Foundry Practice. David McLain. Can. Foundryman, vol. 10, no. 7, July 1919, pp. 180-183. Suggestions in regard to various foundry processes. Address delivered at annual Convention of Southern Metal Trades Assn.

Ship Castings

Eastern Plant Makes Ship Castings. E. C. Kreutzberg. Foundry, vol. 47, no. 327, July 15, 1919, pp. 468-471, 9 figs. Castings for stern frames, anchors, rudders and stems.

Making Castings Used in Ship Construction—V. Ben Shaw and James Edgar. Foundry, vol. 47, no. 326, July 1, 1919, pp. 417-420, 22 figs. Solid and skeleton construction contrasted.

Stem-Piece Casting

Castings for Ship Construction—VI. Ben Shaw and James Edgar. Foundry, vol. 47, no. 327, July 15, 1919, pp. 474-478, 17 figs. Difficulties attendant upon molding and casting three common types of stem pieces are described.

Valve Castings

Producing Sound Nonferrous Castings for Valves. R. R. Clarke. Foundry, vol. 47, no. 326, July 1, 1919, pp. 441-447, 4 figs. With reference to practice of Eagle Brass Foundry Co., Seattle.

Zinc Castings

The Production of Zinc Castings. E. H. Schulz and R. Fielder. Metal Industry, vol. 14, no. 23, June 6, 1919, pp. 461-462, 3 figs. Copper and aluminum, preferably together, are believed to form most suitable metals for alloying with zinc for production of castings. From Giesserei Zeitung.

FUELS AND FIRING

Anthracite Burning

Burning Steam Sizes of Anthracite With or Without Admixture of Soft Coal. Bur. of Mines, technical paper no. 220, reprint of eng. bul. no. 5, prepared by U. S. Fuel Administration, 1919, 8 pp., 1 fig. Emphasizes that greatest loss in burning fine anthracite is on account of excess air of fire and advises that best way to keep this down to proper minimum is by using uptake damper, throttled as much as possible so as to produce highest CO_2 without formation of unburnt gases.

Coal Combustion

The Economic Use of Coal for Steam-Raising and House Heating. John Blizard. Can. Dept. of Mines, bul. 28, no. 502, Jan. 30, 1919, 21 pp. General principles of combustion of coal and generation and uses of steam.

Gas Fired Furnaces

The Utilization of Gaseous Fuel in Commercial Practice. With Consideration of the Types of Gas-Fired Furnaces and Methods for Their Control. F. W. Epworth. Gas Jl., vol. 146, no. 2927-2928, June 17 & 24, 1919, pp. 755-759 & 804-806, 9 figs. Gas-fired furnaces are grouped under three main headings—(1) natural-draft furnaces, (2) forced-draft furnaces, and (3) compressed gas and air furnaces. A scheme for placing any furnace in its correct group is developed from this classification. (Concluded.)

Gas Fuel

Some Considerations with Regard to Fuel Gas. Fred Crabtree. Proc. Engrs. Soc. Western Pa., vol. 35, no. 3, April 1919, pp. 117-125 and (discussion) pp. 126-139, 1 fig. Based on survey of various works. Remarks refer to stages in manufacturing processes, methods of cleaning and costs.

Holbeck System Pulverized Coal

The Combustion of Powdered Fuel. J. S. Atkinson. Elecn., vol. 82, no. 26, June 27, 1919, pp. 730-732, 2 figs. Details of Holbeck system described and importance of proper design of burner emphasized.

Illinois Coal

Characteristics of Illinois Coal and How to Burn It. T. A. Marsh. Power, vol. 50, no. 3, July 15, 1919, pp. 93-95. Relative values of steaming coals, their characteristics and analysis.

Lignite

Methods for More Efficiently Utilizing Our Fuel Resources. Arthur V. White. General Elec. Rev., vol. 22, no. 6, June 1919, pp. 465-474. Steps being taken in Canada toward development of vast deposits of lignite in Saskatchewan and Alberta.

Low-Grade Fuels

Problems in the Utilisation of Fuels. Raymond F. Bacon and William A. Hamor. Jl. Soc. Chem. Indus., vol. 38, no. 12, June 30, 1919, pp. 161T-168T. Problems to be found in developing methods for utilizing various low-grade fuels, with notes on work done in this direction both in Europe and America.

Oil Fuel

The Utilization of Oil as Fuel (Neues über Oelfeuerung). Petroleum, vol. 14, no. 14, Apr. 15, 1919, pp. 658-661, 6 figs. Koerting


"No, sir! there's no depreciation on '85% Magnesia.'"

Photo by permission of Ordnance Dept., U. S. A.

That's what the chief engineer told his president—

They were figuring on Depreciation of Equipment. The engineer was saying, "Some fellow the other day was knocking our '85% Magnesia' pipe-coverings. So I wrote to W. A. Macan, Chairman of the Magnesia Association. He has been in the pipe-covering business for over 30 years and I wanted his straight experience. He says *there's no such thing as '85% Magnesia' depreciation.* Here's part of his letter":

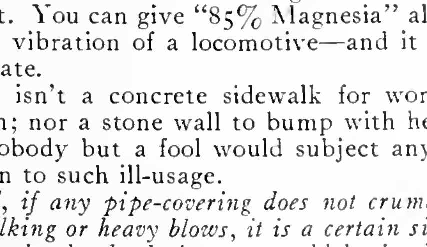
Time-proof—Usage-proof—Not Fool-proof

You can soak "85% Magnesia"—and it dries out as good as ever. You can hold "85% Magnesia" on a shovel over a fire till the shovel gets red-hot—and it isn't hurt. You can give "85% Magnesia" all the tremendous vibration of a locomotive—and it does not disintegrate.

But it isn't a concrete sidewalk for workmen to tramp on; nor a stone wall to bump with heavy ladders. Nobody but a fool would subject any cellular insulation to such ill-usage.

Indeed, if any pipe-covering does not crumble under heavy walking or heavy blows, it is a certain sign that it is lacking in the dead-air spaces which give it its real insulation value.

We invite specific questions on the durability as well as the efficiency of "85% Magnesia." The Engineers of the members of this Association, as well as the experts of the Mellon Institute who have been specially investigating pipe-coverings for three years, are at your service through our Committee. Send for our literature. Also for Specifications for the proper application of "85% Magnesia" compiled and endorsed by the Mellon Institute of Industrial Research of Pittsburgh University, which are furnished to Engineers and Architects on request.



MAGNESIA ASSOCIATION OF AMERICA
721 Bulletin Building, Philadelphia, Penna.

EXECUTIVE COMMITTEE, W. A. Macan, *Chairman*
George D. Crabbs . The Philip Carey Co. . . Cincinnati, Ohio
Alvin M. Ehret . Ehret Magnesia Mfg. Co. . Valley Forge, Penna.
J. R. Swift . . . The Franklin Mfg. Co. . . . Franklin, Penna.
R. V. Mattison, Jr. . Keasbey & Mattison Co. . . . Ambler, Penna

From a Veteran's Experience in "85% Magnesia"

"While it is a common practice to charge up each year a percentage of the cost of a plant for depreciation, in the case of '85% Magnesia' this is not necessary.

"Thus in the Niagara Power Station, '85% Magnesia' covering has been in service nearly twenty years; when recently a section and block of this '85% Magnesia' were analyzed and tested, it showed a depreciation after all those years of approximately 3%—so small that it could hardly be figured.

"Again, the Mellon Institute of Industrial Research of Pittsburgh University has on file many letters from Operating Engineers who have had '85% Magnesia' in service for ten years to twenty-five years stating that those coverings are as efficient today as when first placed in service.

"As long ago as 1888 Mr. J. J. DeKinder was a Consulting Engineer in Philadelphia, having the Pennsylvania Railroad among his numerous clients. A short time ago he wrote me:—

"'I have specified '85% Magnesia' covering for a great many years, in fact, during all my active practice. I have used it under all procurable temperatures, and under all conditions that stationary and locomotive service furnish, and can recall *no time* in which it failed to render efficient service.'

"It may become soaking wet through steam-leaks, floods, sinking of a vessel, or any similar cause, not only once but several times, and when steam is turned on the boilers again, it dries out without shrinking or warping, and continues saving heat units just the same as it did before.

"I challenge anyone to give good evidence of any case where '85% Magnesia' properly applied and properly treated has failed to give maximum and satisfactory service through any inherent defect."

W. A. MACAN
Chairman Magnesia Association of America

steam jet sprayer, centrifugal atomizers; oil-fired crucible furnace for melting tungsten; air atomizers.

Powdered Coal

See Pulverized Coal.

Pulverized Coal

Firing Boilers with Powdered Coal, L. C. Harvey. Blast Furnace & Steel Plant, vol. 7, no. 7, July 1919, pp. 352-353, 2 figs. Also Elecn., vol. 82, no. 26, June 27, 1919, pp. 740-741, 1 fig. Points out that it is essential to provide sufficient combustion area per pound of coal burned per unit time; otherwise ash is not deposited in slag chamber. "Fuller" powdered coal equipment.

Pulverized Coal as a Fuel, N. C. Harrison. Mech. Eng., vol. 41, no. 8, August 1919, pp. 645-649. Review of uses in industries. Report of tests of 468-hp. Edge Moor boiler with pulverized-coal equipment is included.

Pulverized Coal for Stationary Boilers, Fred'k A. Scheffler and H. G. Barnhurst. Mech. Eng., vol. 41, no. 8, August 1919, pp. 650-652. Comparison of stoker and pulverized-fuel plants with particular reference to reliability, cost, adaptability and efficiency.

See also Holbeck System.

Smoke Prevention

Fuel Economy and Smoke Prevention. Can. Ry. & Mar. World, no. 257, July 1919, pp. 357-361, 3 figs. Report of Mech. Section Committee of Am. RR. Assn.

Spontaneous Combustion

"Spontaneous Combustion," Especially with Reference to Ships' Cargoes. Coal, Charcoal, Cotton, and Textile Fibres Generally; Hay, Tobacco, and Certain Chemicals; Dyestuffs and Pigments, etc., Watson Smith. Jl. Roy. Soc. Arts, vol. 67, no. 3474, June 20, 1919, pp. 500-507. Study of causes producing it based on records of accidents as reported in various publications.

FURNACES

Brickwork, Coke-Oven

Patching of Jamb Leaks on Coke-Oven Brickwork, R. L. Fletcher. Gas Age, vol. 44, no. 1, July 1, 1919, pp. 15-17, 5 figs. Blowing material into crack in just sufficient quantity to insure getting inner part of joint filled while outer part will be covered by hand work.

Gas Burners

The Development of Gas Burners for Industrial Purposes (Zur Entwicklungsgeschichte der Gasbrenner für industrielle Feuerungsanlagen), Dr. Gwosdz. Feuerungstechnik, vol. 7, nos. 9 & 10, Feb. 1 & 15, 1919, pp. 69-71 and 78-80, 9 figs. Description of burners developed by Gesellschaft Westfälische Maschinenbau-Industrie Gustav Moll & Co. Type described is principally used for heating steam boilers.

Heat-Treating Furnaces

Heating Furnaces and Annealing Furnaces —VII, W. Trinks. Blast Furnace and Steel Plant, vol. 7, no. 7, July 1919, pp. 321-324, 7 figs. Curves are given for finding recuperator surface for any recuperative furnace.

Anchor Chain Heat Treating Furnaces, T. F. Baily. Blast Furnace & Steel Plant, vol. 7, no. 7, July 1919, pp. 329-330. Heat-treating rails in electric furnaces suggested.

Continuous Furnaces for Heating Forgings. Blast Furnace & Steel Plant, vol. 7, no. 7, July 1919, pp. 346-348, 2 figs. "Oilgas" type. Advantages claimed are uniform heating, maximum economy and constant production.

Kilns

What to Consider in the Design and Layout of Periodic Kilns, T. W. Garve. Brick & Clay Rec., vol. 55, no. 1, July 1, 1919, pp. 29-35, 19 figs. Comparison of various arrangements.

GAGES

Gage Making

Various Examples in the Art of Gauge Making, H. G. Robson. Can. Machy., vol. 22, no. 1, July 3, 1919, pp. 9-12, 33 figs. Illustrating particularly modus operandi rather than extent of calculations required.

Hoke Gages

A Millionth of an Inch. How the Wave Length of Light is Used to Detect Errors of This Infinitesimal Amount. Sci. Am., vol. 121, no. 3, July 19, 1919, pp. 62-63, 8 figs. Light-interference method of measuring gages developed by Bur. of Standards. Apparatus for throwing beam of monochromatic light and photograph of interference fringes thus obtained are illustrated.

Thread Gages

Improved Design of "Not Go" Thread Gage, H. L. Van Keuren and I. H. Fullmer. Machinery, vol. 25, no. 11, July 1919, pp. 1076-1077, 2 figs. Thread form.

GAS ENGINEERING

Carbonizing Plants

Carbonizing Plants of the Future, Having Regard to the Scarcity of Labor, and the Gas Best Fitted to the Consumer, H. D. Madden. Gas Jl., vol. 146, no. 2928, June 24, 1919, pp. 809-810, and (discussion) pp. 810-811. Gas best suited to consumer is believed to be one having for its basis a heating standard. Paper read before Wales and Monmouthshire District Instn. of Gas Engrs.

Gas Investigating Committee Report

Second Report of the Gas Investigating Committee. Gas World, vol. 70, no. 1819, May 31, 1919, pp. 429-440, 16 figs., and Gas Jl., vol. 146, no. 2925, June 3, 1919, pp. 607-619, 16 figs. Data with regard to performance of gases of relatively low calorific value. Tests were made with ring and incandescent burners of various types. Account of tests on relative efficiencies in use of different grades of gas continued from first report.

Governors

A New Governor for Close Pressure Regulation of Gas Exhausters and Boosters. Chem. & Metallurgical Eng., vol. 21, no. 2, July 15, 1919, pp. 99-100, 2 figs. Two-fold type, provided with compensating return.

Providence Gas Company

Manufacturing Plant of the Providence Gas Co.—I & II, Walter M. Russell. Chem. & Metallurgical Eng., vol. 21, no. 1 & 2, July 1 & 15, 1919, pp. 34-39 & 88-95, 19 figs. Water and producer-gas machinery and apparatus. Measuring and recording instruments. Review of gas industry in Providence. Paper read before Am. Inst. of Chem. Engrs.

Water Gas

Exhaust Steam in Water Gas Machines, Raymond L. Greene. Gas Age, vol. 44, no. 1, July 1, 1919, pp. 1-5, 7 figs. Results obtained in actual experience.

HANDLING OF MATERIALS

Bunkering

See Coal Handling.

Coal Handling

Coal-Handling Plant at Pembrey. Engineering, vol. 108, no. 2793, July 11, 1919, pp. 38-41 and 50, 29 figs. partly on supp plate. Equipment designed to permit delivery to be made (1) direct from coal wagon to boiler-house overhead coal bunker, (2) from coal wagon to reserve coal store, or (3) from reserve coal store to overhead coal bunker, leaving clear way for (4) trucking on portable railway or wheeling coal into boiler-house at stoking-floor level, for providing machinery in case of breakdown of mechanical plant.

A British Plant for Handling Domestic Coal, H Hubert. Coal Trade Jl., vol. 50, no. 28, July 9, 1919, pp. 835-837, 3 figs. Description of tidewater coal plant for handling domestic grades and notes on difference between American and British systems of handling.

Bunkering Big Ships, J. F. Springer. Sci. Am., vol. 108, no. 2, July 12, 1919, pp. 34-35, 3 figs. Conveyor apparatus for moving coal from barge to bunker and distributing it evenly in bunker.

Mechanical Coaling Stage at Hull, North Eastern Railway. Ry. Gaz., vol. 30, no. 26, June 27, 1919, pp. 1027-1029, 5 figs. Coal is emptied from wagons into underground hopper, from which it is mechanically elevated to overhead storage bunkers which are provided with chutes for delivering it to various locomotives as required.

The Atlas Coal Co.'s Plant at Louisville, Ky. Coal Trade Jl., vol. 50, no. 27, July 2, 1919, pp. 806-808. Installation of two 50-ton hoppers.

Grain Loading

Mechanical Grain Loading Devices on the Roumanian Danube. Eng. & Indus. Management, vol. 2, no. 1, July 3, 1919, pp. 28-31, 6 figs. Floating grain elevators and pneumatic unloading plant. (Continuation of serial.)

Oil, Vegetable, Handling

Handling Vegetable Oils at Pacific Coast Port Terminals. Eng. News-Rec., vol. 83, no. 5, July 31, 1919, pp. 204-207, 5 figs. Layout of Philippine Vegetable Company's terminal at San Francisco.

Ore, Unloading

Unloading Ore Quickly And Cheaply. Elec. Rev., vol. 75, no. 2, July 12, 1919, pp. 56-59, 3 figs. How iron ore is unloaded from lake steamers by means of electrically operated automatic ore unloaders.

See also Unloading Machines.

Shell Parts, Handling

Making Three Million Trench Mortar Shells, E. C. DeWolfe. Iron Age, vol. 104, no. 1, July 3, 1919, pp. 1-7, 12 figs. System of conveyors, belt, roller, gravity and slat, used in transfer of parts from operation to operation, until delivery of completed and boxed shells to freight cars.

Unloading Machine

A Rapid Unloading Machine. Coal Age, vol. 16, no. 5, July 31, 1919, pp. 188-190, 2 figs. Wellman-Seaver-Morgan Co. Machine consists of main framework mounted on trucks which travel along runway rails. Design is heavy.

Description of Automatic Ore Unloader. Blast Furnace and Steel Plant, vol. 7, no. 7, July 1919, pp. 317-320, 4 figs. Unloader consists of main framework mounted on trucks which travel along railway rails; hoisting mechanism is located in enclosed house at rear end of walking beam.

HEAT-TREATING

Case-Hardening

Improved Case-Hardening Process. Iron Age, vol. 104, no. 3, July 17, 1919, pp. 163-165, 5 figs. Slow cooling of nickel-steel gears for automobile and airplane engines prevents flaking and chipping. Paper read before Iron & Steel Inst.

Modern Practice in Case-Hardening, A Best. Machy. (Lond.), vol. 14, no. 354, July 10, 1919, pp. 436-439, 5 figs. Material suitable for carburizing and notes on selection of carburizing furnace.

Cast Iron, Graphitization of

Graphitization of White Cast Iron Upon Annealing, Paul D. Merica and Louis J. Gurevich. Bul. Am. Inst. Min. & Metallurgical Engrs. no. 151, July 1919, pp. 1063-1072, 7 figs. Annealing ranges of temperatures determined for three different compositions used for car wheels.

See also Metallurgy, Iron and Steel (Graphitization.)

Cast Iron, Gray

The Heat Treatment of Grey Cast Iron at Low Temperatures, J. E. Hurst. Eng., vol. 108, no. 2792, July 4, 1919, pp. 1-3, 2 figs. Results of experiments of heat treatment at temperatures of 575 to 600 deg. cent. of a series of commercial cast-iron bars.

Chrome-Nickel Steel

Heat Treating Chrome Nickel Steel, with Special Reference to Impact Testing, Mr. Loudenbeck. Proc. Steel Treating Research, vol. 2, no. 5, 1919, pp. 18-24 & 54, and 58, 7 figs. Photomicrographs of pieces tested under both high and low impact.

Electrical Heat Treatment of Steel

Electrical Heat Treatment of Steel, H. P. MacDonald. J. Soc. Automotive Engrs., vol. 5, no. 1, July 1919, pp. 69-74, 10 figs. Processes developed at plant of Snead & Co. Iron Works, Jersey City.

Hardening Steel

Modern View of the Hardening of Steel, Haakon Styri. Jl. Am. Steel Treaters Soc., vol. 1, no. 9, June 1919, pp. 286-298, 14 figs. Review of facts occurring when steel is heated and cooled, with reference to what takes place when steel is hardened.

Heat Treating Plants

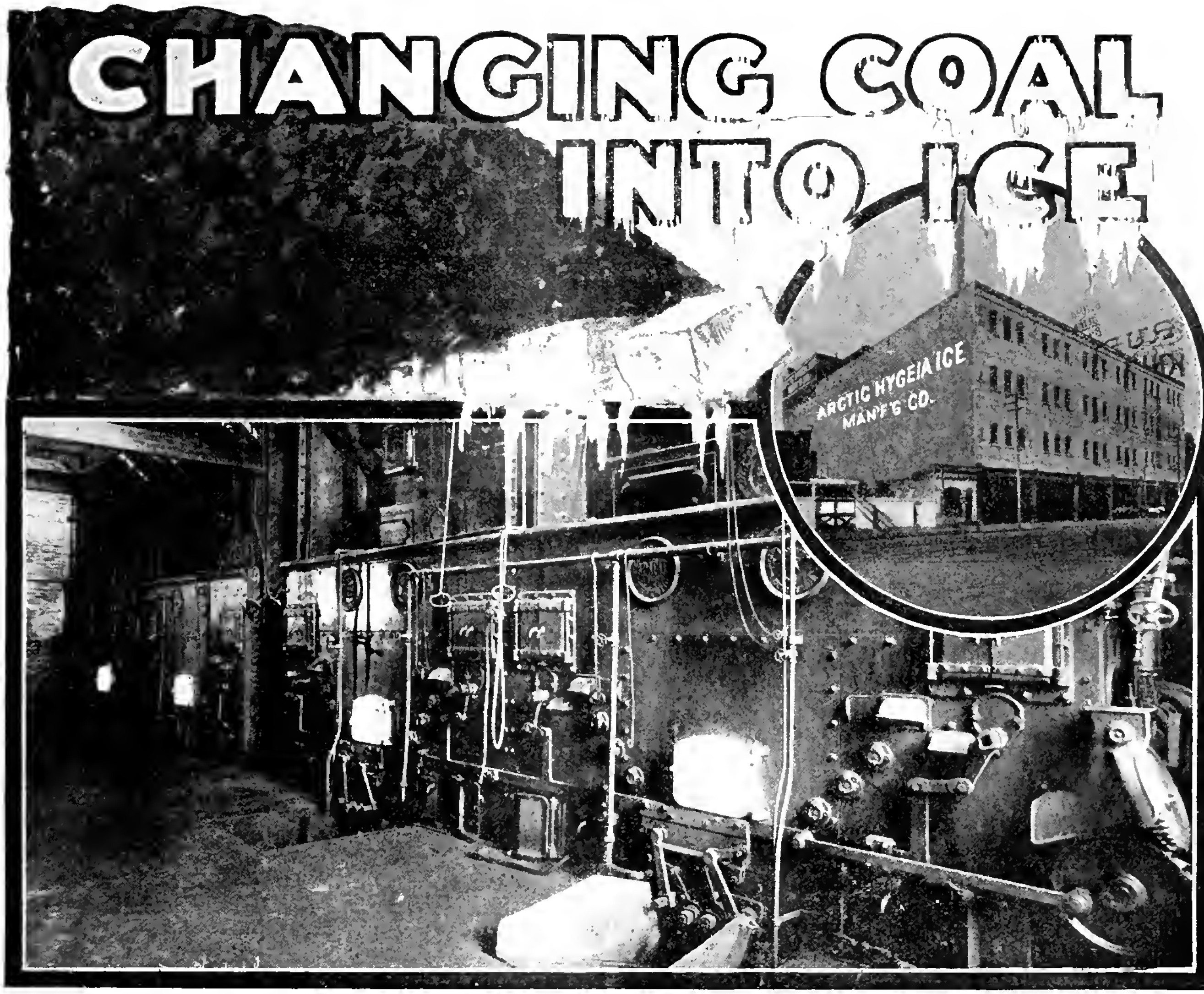
A Complete and Modern Heat-Treating Plant, L. A. Danse. Am. Mach., vol. 51, no. 4, July 24, 1919, pp. 149-160, 24 figs. Structural features of building and details of equipment of Lincoln Motor Co. plant.

High-Speed Steel

The Heat Treatment of High Speed Steel, C. U. Scott. Jl. Am. Steel Treaters Soc., vol. 1, no. 9, June 1919, pp. 299-301. Recommendations in regard to various operations in process of heat-treating.

Malleable Iron

Experiments in Annealing Malleable Iron, H. E. Diller. Can. Foundryman, vol. 10, no. 7, July 1919, pp. 184-186, 4 figs. While manner in which annealing process is proceeded with is considered of vital importance, it is further observed that proper analysis of raw material must not be neglected.



While sweltering New Yorkers are perfectly willing to see heat wasted, one of the largest ice-making companies in the city strives not to waste a heat unit—as heat units saved make more ice.

The Arctic Hygeia Ice Manufacturing Company depends on

MURPHY AUTOMATIC FURNACES

to utilize every heat unit in the coal. While, of course, Murphy Furnaces can't put heat units into coal, they can, however, get them all out.

Do these Murphy Furnaces do it? The entire satisfaction expressed by the management is the answer. They know that Murphy Furnaces will burn *any fuel that has heat in it,* for most every quality of coal has been used during the last 20 years—the service period of the first Murphy Furnace in this plant.

If your boilers are 50 H. P. or larger send for Catalog A-9.

MURPHY IRON WORKS, Detroit, Michigan

BURN ANY FUEL THAT HAS HEAT IN IT

Railroad Materials

Heat Treatment of Railroad Materials, C. B. Bronson. Ry. Rev., vol. 65, no. 2, July 12, 1919, pp. 71-73. Also Iron Age, vol. 104, no. 1, July 3, 1919, p. 25-27. Practice of New York Central RR., particularly in use and treatment of manganese-steel rails, carbon and alloy steel axles, tires and cast-steel wheels. Paper presented before N. Y. Chap. Am. Steel Treaters' Soc.

Size in Heat Treatment

Relative Size in Heat Treatment, T. G. Straub. Iron Age, vol. 104, no. 3, July 17, 1919, pp. 167-168. Conclusion is drawn from experiments that in actual practice large forgings require considerable judgment regarding heat treatment in order to bring desired results.

Steel, Medium-Carbon

Effect of Time and Low Temperature on Physical Properties of Medium-Carbon Steel, G. A. Heinhardt and H. L. Cutler. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 151, July 1919, pp. 1091-1098. Test to determine cause of difference in elongation and reduction of area shown by core tests made directly after drilling and machining and of core tests that had rested after these operations.

HEATING AND VENTILATION

Gas and Electric Heating Compared

Comparative Cost of Electric and Gas Heating (Prix de revient comparés du chauffage électrique et du chauffage au gaz), Ach. Delamarre. Revue Générale de l'Electricité, vol. 6, no. 2, July 12, 1919, pp. 45-47, 1 fig. Graph based on assumption that kilowatt-hour and cubic meter of gas are sold at the same price.

Schools

New Heating and Ventilating System for Chicago Schools, John Howatt. Power, vol. 50, no. 3, July 15, 1919, pp. 109-110, 1 fig. Piping layout designed by Bureau of School Engineering, Chicago.

Workshops

The Heating and Ventilation of Workshops —II. Engr., vol. 127, no. 3312, June 30, 1919, pp. 599-602 and 608, 12 figs. System employed in works of Austin Motor Co. Ltd.

Heating of Large Industrial Plants (Chauffage des Grands Locaux Industriels. Utilisation du chauffage comme régulateur de charge des centrales électriques), M. A. Beaurrienne, Mémoires et Compte rendu des Travaux de la Société des Ingénieurs Civils de France, Bulletin, vol. 8, no. 1, 2 & 3, Jan-Mar. 1919, pp. 49-77, 10 figs. Technical study of comparative economy of various systems of heating.

HOISTING AND CONVEYING

Belt Conveyor, Steel

The Steel Belt Conveyor, or How the Rubber Shortage Can be Met by Employing Flexible Steel Bands. Eng. & Indus. Management, vol. 1, no. 19, June 19, 1919, pp. 605-609, 12 figs. Concerning flexible Swedish steel bands known under the name "Sandvik."

Barnard's Automatic Grab

"Barnard's Automatic Grab," G. F. Zimmer. Eng. & Indus. Management, vol. 2, no. 1, July 3, 1919, pp. 25-27, 6 figs. It works on block-and-tackle principle. Light self-weight for given capacity claimed as important feature.

Cable Transportation

Aerial Cable Transportation (Transporte aereo por cable), Walter C. Kretz. Ingeniería Internacional, vol. 2, no. 1, July 1919, pp. 13-17, 7 figs. As auxiliary service in railway and steamship traffic. Application in mines.

Cranes, Ladle, Main Hoists for

Main Hoists for Open Hearth Ladle Cranes, W. W. Garrett, Jr. Jl. Engrs. Club of Philadelphia, vol. 36, no. 177, August 1919, pp. 319-321. Tests made on main hoists of two overhead electric traveling open-hearth ladle cranes.

Cranes, Pontoon

Designs Massive Pontoon Cranes. Mar Rev., vol. 49, no. 8, August 1919, pp. 372-373, 2 figs. Revolving crane of 150-ton capacity recently installed at Navy Yard, Norfolk, Va.

Hoisting Bucket

Handling Materials in Construction of New York Hotels. Eng. News-Rec., vol. 83, no. 5, July 31, 1919, pp. 222-223, 3 figs. Type of hoisting bucket designed, it is said, to prevent excessive vibration of steel frame. Cost figures.

Hoisting Equipment, Electric

Electric Hoisting Equipment at the Butte & Superior Mine, Oliver E. Jager. Min. & Sci. Press, vol. 119, no. 1, July 5, 1919, pp. 18-21, 3 figs. Historical account of its installation.

Swing-Span Bridges

Protecting Platforms and Fenders for Swing Span Bridge. Commonwealth Engr., vol. 6, no. 8, Mar. 1, 1919, pp. 242-244 2 figs. Particulars of piers.

HYDRAULIC MACHINERY

Governors, Hydraulic Turbine

The Seewer Universal Governor for High-Pressure-Pelton Turbines (Universal Regulierung System Seewer für Hochdruck-Pelton-Turbinen), Franz Prasil. Schweizerische Bauzeitung, vol. 73, no. 22, May 31, 1919, pp. 251-254, 8 figs. Details of method of regulating by changing cylindrical jet to one of hollow conical type.

Ground-Water Movement

Ground Water Movement Between Canals with a Different Water Level (Grondwaterbeweging tusschen kanalen met verchillende waterstanden), J. Versluys. Ingenieur, vol. 34, no. 24, June 14, 1919, pp. 454-456. Questions to be considered when planning irrigation or drainage canals.

Pipe, Wood-Stave

Extension to the Ontario Power Co.'s Plant. Contract Rec., vol. 33, no. 29, July 16, 1919, pp. 685-693, 15 figs. Features particularly remarked are wood-stave pipe 13½ in. in diameter and 6,700 ft. long, dimensions of differential surge tank, and power house with walls designed to withstand 40 ft. rise in tail water.

Pipes

Diagrams for Excess Loss of Head in Pipe Lines, Frank S. Bailey. Eng. News-Rec., vol. 83, no. 4, July 24, 1919, pp. 162-163, 2 figs. For determining losses due to 90 deg. bends, increasers, gate valves, reducers and branches.

Pipes, Velocity of Water in

Hexagonal Chart for Finding Velocity of Water in Pipes, C. Warrington Anthony. Eng. News-Rec., vol. 83, no. 4, July 24, 1919, p. 169. Diagram embraces six variable quantities without using a single curve.

Spain

Hydro-Electric Central Station at Seros (Spain) Le station centrale de Seros (Espagne). Génie Civil, vol. 74, no. 26, June 28, 1919, pp. 517-521, 8 figs. Illustrating Escher Wyss 14,500-hp. vertical turbines used in installation.

Turbines, Hydraulic

New Kern River Development, G. E. Armstrong. Elec. World, vol. 74, no. 3, July 19, 1919, pp. 116-118, 3 figs. Francis turbines to operate under head of 800-ft. at Southern California Edison plant. Two turbines, each with two runners and distributers, furnish 32,000-kw. energy of either 50 cycles or 60 cycles at maximum efficiency.

Break in No. 2 Hydraulic Turbine at Wachusett Power Station, Clinton, Mass., William E. Foss. N. E. Water Works Assn., vol. 33, no. 2, June 1919, pp. 143-152, 5 figs. Section of scroll case blew out immediately after pulling out governor clutch to change from automatic to hand control. Accident attributed to sudden closing of gates causing sufficient water ram to break casting.

See also Governors.

Water Hammer

Water Hammer in Conduits Under Pressure (Note sur le calcul du coup de bélier dans les conduites sous pression), Ed. Carey. Bulletin Technique de la Suisse Romande, vol. 45, nos. 11 & 13, May 31 & June 28, 1919, pp. 102-104, and 122-127, 8 figs. Distribution of force along conduits. In two cases when distributor is open and when sluice is opened suddenly. (Continuation of serial.)

INTERNAL-COMBUSTION ENGINES

Acetylene

Acetylene as a Motor Fuel (Das Azetylen als Motorenbetriebsstoff), A. Wimplinger. Dinglers Polytechnisches Journal, vol. 334, no. 5, Mar. 8, 1919, pp. 50-51, 1 fig. Changes necessary in gasoline motor if acetylene is to be used as fuel; automobile using acetylene. Developments along this line in Switzerland.

Alcohol

Alcohol as Motor Fuel. Autocar, vol 43, no. 1237, July 5, 1919, pp. 10-11. Summary of report of Government's Alcohol Committee. Report does not specifically advocate modification of engines so as to use alcohol but favors rather employment of alcohol mixtures in existing engines.

Bolinder Marine Engine

The Bolinder Crude Oil Marine Engine. Mar. Eng. & Can. Merchant Service Guild Rev., vol. 9, no. 7, July 1919, pp. 236-238, 5 figs. Fuel is mixed with compressed air before injecting it in cylinder, special nozzle being used for this purpose. Engine is manufactured by Bolinder Co. of Stockholm, Sweden.

Carburetor Performance Standard

Standards of Carburetor Performance, O. C. Berry. Mech. Eng., vol. 41, no. 8, August 1919, pp. 674-678, 12 figs. List of essential factors to proper carburetion and record of experimental data.

Cycles, Future

Working Processes of Future Internal Combustion Engines, C. A. Norman. Jl. Soc. Automotive Engrs., vol. 5, no. 1, July 1919, pp. 3-12, 10 figs. Theoretical and practically attainable energy utilization of engines and turbines of the compression, explosion and evaporation types are given.

Design

An Unconventional British Engine. Automotive Industries, vol. 41, no. 1, July 3, 1919, pp. 27-28, 5 figs. Aluminum jackets with cast-iron cylinder sleeves inserted.

Diesel-Engine Regulation

Kinematics of Diesel Motor Regulation (Studio cinematico della regolazione nei motori Diesel), Guglielmo Piperno. Industria, vol. 33, no. 10, May 31, 1919, pp. 292-297, 12 figs. Calculations and diagrams for studying operation of valves.

Diesel Engines

A British 400 H.P. Highspeed Diesel Engine. Motorship, vol. 4, no. 8, August 1919, pp. 46-47, 2 figs. Details and trial results of Armstrong-Whitworth type used in British submarines.

Piston and Valve Cooling in Diesel Engines. Motorship, vol. 4, no. 8, August 1919, pp. 36-37, 9 figs. Examples of designs in use. (Concluded.)

Diesel Engines with Supercompressed Air Injection

Super-Compressed-Air Applied to Solid-Injection Diesel Engines, Chas. G. Barrett. Motorship, vol. 4, no. 8, August 1919, pp. 43-44, 1 fig. Recommends compressing small portion of air in cylinder walls to pressure considerably in excess of prevailing compression pressure of engine and describes arrangement for effecting this compression.

Exhaust Utilization

Plan to Use Exhaust Heat in Vaporization of Low Grade Fuels, F. C. Mock. Automotive Indus., vol. 41, no. 3, July 17, 1919, pp. 110-114, 4 figs. Curve claimed to simplify computation of air velocity.

Gas Engines

Operation of Large Gas Engines, Frank Foster. Power, vol. 50, no. 3, July 15, 1919, pp. 100-102. Considerations in regard to valve timing, ignition timing, overrating of power and blower engines.

Kerosene Engine Rating

Suggested Formula for Rating Kerosene Engines, D. L. Arnold. Mech. Eng., vol. 41, no. 8, August 1919, pp. 672-673. Suggests that piston displacement of 13,000 cu. in. per min. be taken as one brake horsepower.

Lubrication

See Oiling.

Motorship Engines

Internal Combustion Engine on the Pacific Coast, George Dow. Jl. Electricity, vol. 43, no. 1, July 1, 1919, pp. 27-29, 3 figs. With particular reference to motorship installation.

Oiling

Accessible Oiling System Features New Allen Engine. Automotive Indus., vol. 41, no. 3, July 17, 1919, pp. 106-107, 4 figs. New engine has bore of 3½-in. and stroke of 5-in., its four cylinders being cast in block.

Still Engine

A New Prime Mover of High Efficiency, Frank E. D. Acland. Motorship, vol. 4, no. 7, July 1919, pp. 25-27, 6 figs. Still-Acland com-

Chips from cold cutting saw

Chips from hack saw

Starrett Hack Saws
make less waste

Economy of material is almost as important as economy of time—or power.

The Starrett idea is to always use the particular blade that does the work in hand most economically—to save material, time and power.

That's why the Starrett Hack Saw Chart recommends blades of different thicknesses as well as different numbers of teeth to the inch for certain classes of work. And it's the reason why you find Starrett Hack Saw blades and charts in the tool rooms of so many shops—it pays to use them.

CHART LD AND CATALOG NO. 21 "LD"
SENT FREE UPON REQUEST

THE L. S. STARRETT CO., ATHOL, MASS.

THE WORLD'S GREATEST TOOLMAKERS
Manufacturers of Hack Saws Unexcelled

42-955

STARRETT HACK SAWS

sination type steam and Diesel engine. Consumption of 0.302 lb. of fuel oil per shaft hp. said to be obtained. From paper read before Roy. Soc. Arts.

Tank Motors

Motors Used in British Tanks (Moteurs Thermiques), Genie Civil, vol. 75, no. 1, July 5, 1919, pp. 14-16, 1 fig. Motors are six-cylinder, of 158 hp. Construction of piston, which is provided with inner structure for gliding in cylinder guide and acting as crosshead, noted as special feature.

Torque Recoil

Torque Recoil and Car Weight, L. H. Pomeroy. Jl. Soc. Automotive Engrs., vol. 5, no. 1, July 1919, pp 45-47 Factors governing torque recoil, particularly in multi-cylinder engines.

Tractor Engines

The Rayol Agricultural Show—1. Engr., vol. 127, no. 3315, June 27, 1919, pp. 627-630, 10 figs. Notes on oil engines and tractors driven by gasoline exhibited at annual show at Cardiff.

Trego Company Engines

Valve-in-Head and "L" Engines Built of Common Parts, P. M. Heldt. Can. Machy., vol. 22, no. 4, July 24, 1919, pp. 157-161, 10 figs. Twin six-cylinder models being built by Trego Motors Corp. Oil distributing pipes cast in crankcase and arrangement for hot spots in manifold quoted as notable features.

Valve Setting

Valve Setting. Automobile Engr., vol. 9, no. 128, July 1919, pp. 231-232, 4 figs. Systems for defining timing.

LUBRICATION

Carbonization

Carbonizing in Valve Chambers and Cylinders, F. P. Roesch. Ry. Rev., vol. 65, no. 1, July 5, 1919, pp. 30-33, 4 figs. With respect to use of relief and drifting valves for overcoming carbonizing troubles in lubrication. Paper read before Am. R.R. Assn.

Friction, Static

Note on Static Friction and on the Lubricating Properties of Certain Chemical Substances, W. B. Hardy and J. K. Hardy. Lond., Edinburgh and Dublin Phil. Mag., vol. 38, no. 223, July 1919, pp. 32-48. Examining further Lord Rayleigh's experimental research into the reason why "a few drops of water wetting the parts in contact will prevent a cup of tea from slipping about in a saucer." (Phil. Mag., Febr. 1918.)

Michell Thrust Block

See Pressure-Film Lubrication.

Oil Grooves

Arrangement of Oil Grooves (Die Anordnung der Schmiernuten). W. Kucharski. Dinglers Polytechnisches Journal, vol. 334, nos. 1 & 2, Jan. 11 & 25, 1919, pp. 2-4 and 14-16, 7 figs. Critical discussion of Reynolds' theory of lubrication friction. Experiments made by writer especially with reference to temperature changes and thickness of layer of lubricant.

Pressure-Film Lubrication

The Michell Thrust Block, J. Hamilton Gibson. Eng., vol. 107, no. 2789, June 13, 1919, pp. 765-768, 19 figs. Application of pressure-film lubrication principle to thrust bearing. Paper read before Instn. Naval Architects.

Viscosity

Lubrication in the Power Plant, J. D. Roberts. Power, vol. 50, no. 4, July 22, 1919, pp. 134-135. Tests suggested to determine viscosity of lubricants.

See also Internal-Combustion Engineering (Oiling).

MACHINE ELEMENTS AND DESIGN

Bearings

Ball and Roller Bearings, J. H. Swan. Automobile Engr., vol 9, no. 128, July 1919, pp. 200-204, 5 figs. Consideration of their behavior when subjected to centrifugal loads. From data compiled in records of Technical Dept., Aircraft Production, Min. of Munitions.

Load-Carrying Possibilities of Angular-Contact Ball Bearings, F. C. Goldsmith. Jl. Soc. Automotive Engrs., vol. 5, no. 1, July 1919, pp. 49-53, 8 figs. Writer analyzes possibilities of angular-contact type of bearing, and tries to determine the load-carrying powers of such bearings, both for axial (thrust) loads as well as for radial loads and to determine the law of variation of load-carrying capacity in such a bearing.

Cams

Analytical Method of Investigating Motion produced by Cams, B. C. Carter. Automobile Engr., vol. 9, no. 128, July 1919, pp. 209-210, 3 figs. Direct-attack cams and flat tappets.

A New Design for a High-Speed Inlet Cam, H. S. Burdett. Automobile Engr., vol. 9, no. 128, July 1919, pp. 224-230, 8 figs. Exemplifying manner of proceeding in actual case. Paper presented to Instn. Automobile Engrs.

Crankshafts, Power-Press

The Strength of Power-Press Crankshafts, W. J. Smith. Machinery (Lond.), vol. 14, no. 351, June 19, 1919, pp. 337-340, 5 figs. Method of determining approximately safe working loads. Following types of crankshafts are dealt with: overhanging, single-throw, double-throw, double-throw with central support, and double-throw with two supports. Stresses considered are those caused by actual blow or load on shaft.

Gear Design

Involute Gear Tooth Contact, A. Fisher. Machy. (Lond.), vol. 14, no. 354, July 10, 1919, pp. 456-460, 3 figs. Technical study of relation of gear diameters, number of teeth and line of action. Derivation of interference formulæ and contact formulæ.

Gears, Bevel

The Correction of Spiral and Straight Bevel Gears. Machinery (Lond.), vol. 14, no. 352, June 26, 1919, pp. 368-369. Table intended to be used in conjunction with a pressure angle of $14\frac{1}{2}$ deg.

Michell Thrust Bearing

Development of the "Michell" Marine Thrust Shaft Bearing, J. Hamilton Gibson. Shipping, vol. 8, no. 1, July 5, 1919, pp. 17-19, 13 figs. Said to be built on principle of application "pressure oil film lubrication" to thrust bearing. Paper read before Instn. of Naval Architects.

See also Lubrication (Pressure-Film Lubrication).

Piston Rings

A Novel Two-Part Piston Ring, Ellsworth Sheldon. Am. Mach., vol 51, no. 5, July 31, 1919, pp. 199-202, 10 figs. Consists of outer part of soft gray iron performing usual function of piston rings, and an inner ring of tempered steel which furnishes tension necessary to hold outer part in contact with cylinder walls.

Snap Valve Rings

Use of Bronze for Snap Valve Rings and Piston Surfaces, C. E. Fuller. Ry. Rev., vol. 64, no. 26, June 28, 1919, pp. 992-994, 1 fig. Experience of Union Pacific Ry. in reducing piston and valve ring wear by introducing bronze as material for those parts. Bronze-faced pistons when worn are built up by autogenous welding processes. Paper read before Am. R.R. Assn.

Williams-Janney Speed Gear

Applications of the Williams-Janney variable Speed Gear. Eng., vol. 107, no. 2790, June 20, 1919, pp. 794-796. Examples of application to traction purposes. (Concluded.)

MACHINE SHOP

Broach

A Special Tension Broach. Machy. (Lond.), vol. 14, no. 354, July 10, 1919, pp. 434-435, 3 figs. Claims that method of slotting may be greatly cheapened by roughly slotting to within 0.02 in. of finished size; then by pulling a series of broaches through the work a fine finish may readily be obtained and of correct size.

Chucking

Chucking Methods. Machy. (Lond.), vol. 14, no. 353, July 3, 1919, pp. 424-427, 14 figs. Uses to which Coventry's chuck is put.

Connecting Rods, Machining

Machining Connecting Rods, A Thomas. Automobile Engr., vol. 9, no. 128, July 1919, pp. 222-223, 9 figs. Operations in making connecting rod for 4-cylinder motor lorry engine from nickel-steel drop forging.

Grinding

Latest Practice in Cutter Grinding—I & II. Am. Mach., vol. 51, no. 3 & 4, July 17 & 24, 1919, pp. 135-138 & 185-188, 20 figs. Grinding of modern shank and shell end mills, large face mills, side milling cutters and staggered-tooth slotting cutters, as recommended by Cincinnati Milling Machine Co.

Grinding at the C. L. Best Plant. Metal Trades, vol 10, no. 7, July 1919, pp. 291-294, 10 figs. Arrangement of machines which is said to permit minimum amount of handling.

Cylinder Grinding. Machy. (Lond.), vol. 14, no. 354, July 10, 1919, pp. 440-443, 11 figs. Advantages claimed for finishing cylinder bores by grinding; practice in plants making automobile and airplane engines. (Second article.)

Lathes

Inspection and Adjustment of Lathes. Machy. (Lond.), vol. 14, no. 354, July 10, 1919, pp. 429-433, 7 figs. Alignment tests between different parts and calculations for determining amount of metal to remove for a given adjustment when fitting carriage or headstock to bed.

Inspection and Adjustment of Lathes, James Forrest. Machy. (N. Y.), vol. 25, no. 11, July, 1919, pp. 1039-1043. 7 figs. Alignment tests between different parts and calculations ofr determining amoutn of metal to remove for a given adjustment when fitting carriage or headstock to bed.

Microscope in the Tool-Room

The Microscope in the Tool-Room, John Scott. Machy. (Lond.), vol. 14, no. 352, June 26, 1919, pp. 370-373, 6 figs. Application of simple and micrometer type microscopes to precision work on master plates and for cutting screw threads.

Milling, Rotary

Continuous Rotary Milling—II. Machy. (Lond.), vol. 14, no. 350, June 12, 1919, pp. 305-309, 10 figs. Work-holding fixtures and methods of setting up parts to be milled.

Motor Drive

New Plant for Manufacturing Radio Apparatus, W. A. Scott. Elec. Rev., vol. 75, no. 3, July 19, 1919, pp. 103-104, 3 figs. Motor drive throughout a feature of plant.

Operations

A Plea for Better Harmony Between Theory and Practice. Machy. (Lond.), vol. 14, no. 353, July 3, 1919, pp. 397-402, 35 figs. In casting and machining operations with illustrations of actual cases.

Planer Milling

Planer Milling Practice in Automobile Plants, Edward K. Hammond. Machy. (N. Y.), vol. 25, no. 11, July 1919, pp. 1044-1049, 9 figs. Also Machy. (Lond.), vol. 14, no. 352, June 26, 1919, pp. 374-379, 8 figs. Milling operations on cylinder blocks and cylinder heads. Second and last article.

Standardized Part Production

Jigs, Tools and Special Machines. Model Engr. & Elecn., vol. 40, no 944, May 29, 1919, pp. 422-426, 4 figs. With relation to production of standardized parts. Investigating possibilities of continuous cutting with special machine tools. (Concluded.)

MACHINERY, METAL-WORKING

Broach-Making, Materials for

Materials for Broach Making. Machinery (Lond.), vol. 14, no. 351, June 10, 1919, pp. 341-343. Former analysis of bar which is said to have been used in making a successful set of 6 broaches, and note on maintenance of broaches.

Chucks, Magnetic

Relative Characteristics of Magnetic Chucks, Otis Allen Kenyon. Elec. World, vol. 74, no. 1, July 5, 1919, pp. 11-14, 12 figs. Three general types, neutral-pole, single-pole, and multiple-pole, intended for holding work on surface grinders, milling machines, planers, etc.

Gorton Planing Machines

See Planing Machines.

Lathes

Notes on Capstan and Turret Lathes—I, Joseph Horner. Mech. World, vol. 65, no. 1695, June 27, 1919, pp. 302-303, 3 figs. Features of construction.

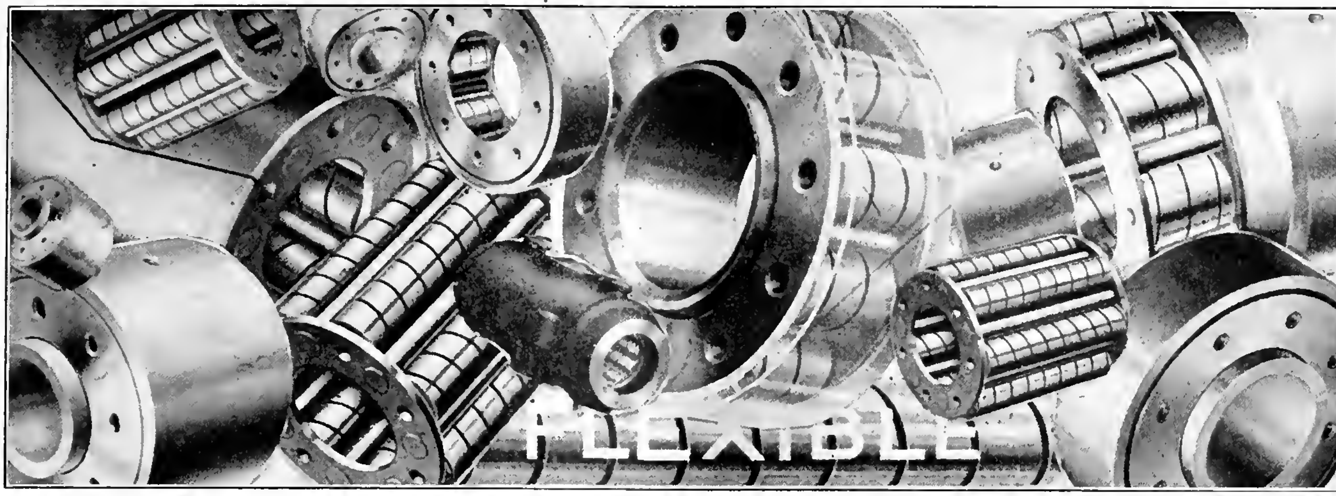
Lathe for Cutting Screw Threads on Gauges. Eng., vol. 107, no. 2790, June 20, 1919, pp. 799-801, 10 figs. Lathe consists of rigid cast-iron cylindrical bed, with a portion cut away to allow work to be placed between centers in the head and tailstocks and for the operator to view the work.

Machine-Tool Developments

Recent Machine Tool Developments—I, Joseph Horner. Engineering, vol. 108, no. 2793, July 11, 1919, pp. 36-38. First article of a series. Classifies and divides subject.

Milling Cutters

Inserted-Tooth Milling Cutters, Joseph Horner. Machinery (Lond.), vol. 14, no. 351, June 19, 1919, pp. 344-347, 28 figs. Illustrat-



ARE BEARINGS IMPORTANT?

It has been an unfortunate practice in machine design in the past to consider bearings as a detail—worthy of only minor consideration. The fallacy of this view has been demonstrated every time an otherwise carefully designed machine developed bearing trouble, necessitating a shut down for repairs or replacements with the consequent loss in production.

All Engineers recognize the merits of Hyatt Bearings, but many feel that the increased initial cost will be prohibitive. This is a mistaken view. The additional expense is very nominal and is soon earned many times over through reduced power, oil and maintenance costs. Both Good Engineering and Economical Operation call for a machine designed UP to a Standard rather than DOWN to a Selling Price.

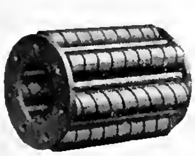
Remember, whatever conditions of load, speed, or size of shaft you may have, it is probable that there is a Hyatt Roller Bearing which will exactly meet your requirements. Our Engineers will be glad to consult with you at any time on the proper application of Hyatt Roller Bearings to your new design.

Send for our complete engineering data on Hyatt Roller Bearings for whatever class of machinery you are interested in.

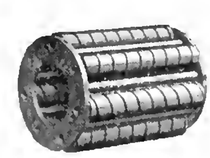
MOTOR BEARINGS DIVISION
DETROIT, MICHIGAN

**HYATT ROLLER BEARING COMPANY
INDUSTRIAL BEARINGS DIVISION
METROPOLITAN TOWER, NEW YORK**

TRACTOR BEARINGS DIVISION
CHICAGO, ILL.



Manufacturers of Bearings for Mine Cars, Ore Cars, Steel Mill Cars, Roller Tables, Trolleys, Cranes, Hoists, Machine Tools, Line Shafts, Countershafts, Concrete Machinery, Textile Machinery, Conveyors, Lift Trucks, Industrial Trucks, Railway Service Cars, Storage Battery Locomotives, etc.



ing methods of tool fastening and designs of face mills.

Drop-Forging High-Speed Milling Cutters, J. V. Hunter. Am. Mach., vol. 51, no. 4, July 24, 1919, pp. 165-168, 8 figs. Tests made by Ford Motor Co. on high-speed-steel milling cutters.

Piston-Ring Tooling Equipment

Tooling Equipment for an Automobile Piston-ring, Thomas Orchard. Machy. (N. Y.), vol. 25, no. 11, July, 1919, pp. 1058-1060, 7 figs. Fixture for holding ring and special multiple-spindle milling head having capacity for holding two cutters.

Planers

Bement Horizontal and Vertical Wall Planer. Machy. (N. Y.), vol. 25, no. 11, July 1919, pp. 1087-1088, 1 fig. Consists of wall plate on which vertical rail is mounted and is so arranged as to permit horizontal and vertical planing.

Planing Machines

The Gorton Planing Machines, J. V. Hunter. Am. Mach., vol. 51, no. 1, July 3, 1919, pp. 1-4, 8 figs. Heavy design intended for use without foundation excepting when placed on soil that is soft and yielding.

Thread-Milling Machine

Continuous Thread Milling Machine of Unusual Design. Machy. (Lond.), vol. 14, no. 350, June 12, 1919, pp. 317-319, 2 figs. Machine is furnished with means for turning bar down to required diameter ready to start thread-milling operation, thus bringing actual center of bar into accurate alignment with milled threads.

Threading Tools

Description of a New Automatic Threading Tool. Can. Machy., vol. 22, no. 2, July 10, 1919, pp. 26-27, 6 figs. In its assembled state it is in two parts: a tool box and an abutment or stop piece.

MACHINERY, SPECIAL

Breaking Machine

Breaking Machine for Handling Frozen Coal, J. P. Considine. Coal Trade Jl., vol. 50, no. 28, July 9, 1919, pp. 838-839, 3 figs. Said to be capable of breaking up in a few minutes a car of frozen coal.

Crusher, Gyratory

Largest Gyratory Crusher in the World, William B. Eastwood. Cement, Mill & Quarry, vol. 15, no. 1, July 5, 1919, pp. 13-17, 5 figs. Bulldog crusher said to be capable of producing 2500 tons of material per hr.

Drilling Machine

A Small Sensitive Drilling Machine, C. H. Copeland. Model Engr. & Elecn., vol. 40, no. 947, June 19, 1919, pp. 498-500, 3 figs. Designed to be made for greater part from ½-in. standard pipe fittings, only castings being table and driving and jockey pulleys.

Molten-Metal Discharger

Device for the Uninterrupted Discharge of Molten Metals (Eine Vorrichtung zur ununterbrochenen Ausstossung geschmolzener Metalle). Metall-Technik, vol. 45, no. 11-12, Mar. 22, 1919, p. 42, 1 fig. It is claimed that this device does not require complicated pumping apparatus nor special liquids nor any interruption while recharging.

Periodograph

The Periodograph, a Decimal Time-Keeping Machine—II, J. V. Hunter. Am. Mach., vol. 51, no. 4, July 24, 1919, pp. 161-164, 17 figs. Milling, drilling and inspecting operations.

Sand Blast

Application of the Sand Blast, H. D. Gates. Compressed Air Magazine, vol. 24, no. 7, July 1919, pp. 9229-9232, 3 figs. Effect of air pressure on abrasive action. From address before Newark Foundrymen's Assn.

Tinning Machine

The Thomas & Davies Tinning Machine, Melingriffith Works, Cardiff. Iron & Coal Trades Rev., vol. 99, no. 2679, July 4, 1919, pp. 4-5, 2 figs. Diagrammatic details of tinning machine.

Typewriters

Typewriter Mechanism — Typewheel Machines, Nathan Sharpe. Model Engr. & Elecn., vol. 40, nos. 944 and 945, May 29, and June 5, 1919, pp. 426-429, and 444-447, 12 figs. Features of Block machine. Shift mechanism of Blick. Third article.

Evaporators, Vacuum

Industrial Vacuum Evaporators—IX, Frank Coxon. Mech. World, vol. 66, no. 1696, July 4, 1919, p. 6, 8 figs. Instrument reliability. (Continuation of serial.)

MATERIALS OF CONSTRUCTION AND TESTING OF MATERIALS

Abrasive Wheels, Testing

Testing Machines for Grading Abrasive Wheels, J. H. Vincent. Am. Mach., vol. 51, no. 4, July 24, 1919, pp. 177-179, 7 figs. Machines for testing the cutting or abrasive factor and for abrasive wheels and their degree of hardness.

Ball Bearings, Magnetic Analysis of

Application of Magnetic Analysis to the Testing of Ball Bearing Races, R. L. Sanford and M. F. Fischer. Preprint, Am. Soc. for Testing Materials, University of Pa. Topical Discussion on Magnetic Analysis, 1919, pp. 65-75, 4 figs. It is concluded that magnetic properties and in particular coercive force and rotary hysteresis measurements constitute good criteria of degree of hardness of a ball-bearing race.

Coir

The Mechanical Properties of Philippine Coir and Coir Cordage Compared with Abacá (Manila Hemp), Albert E. W. King. Philippine Jl. Sci., vol. 13, Sec. A, no. 6, November 1918, pp. 285-338, 4 figs. Cocoanut fiber in Philippines is extracted in small quantities entirely by retting and beating process. Retted filaments average 228 mm., and machine-cleaned filaments 245 mm. in length. Tensile tests conducted on single filaments averaged, it is said, 832 kg. per sq. cm. for retting, and 1208 kg. per sq. cm. for machine-cleaned fiber.

Columns, Concrete

Hooped Concrete Columns with Cast Iron Cores, L. J. Mensch. Am. Architect, vol. 116, no. 2275, July 30, 1919, pp. 155-162, 4 figs. Testing machine of U. S. Bureau of Standards at Pittsburgh, Pa. and results obtained with it.

Gas Tubing

Flexible Gas Tubing Tests, R. S. McBride and W. M. Berry. Gas Rec., vol. 15, no. 12, June 25, 1919, pp. 393-400, 2 figs. Scope of investigations made by U. S. Bur. of Standards and tentative specifications proposed for criticism before adoption.

Machinability Tests

Machinability Tests on Copper Alloys, Alex. E. Tucker. Metal Industry, vol. 14, no. 25, June 20, 1919, pp. 501-502, 3 figs. Machine for making tests. Its action consists in measuring comparative depth of holes cut in piece under test and standard piece by same number of revolutions of ¼-in. drill under constant load.

Magnetic Analysis

Magnetic Analysis as a Criterion of the Quality of Steel and Steel Products, Chas. W. Burrows and Frank P. Fahy. Preprint, Am. Soc. for Testing Materials, University of Pa., Topical Discussion on Magnetic Analysis, 1919, pp. 1-46, 25 figs. Based upon experimental work conducted by writers at U. S. Bur. of Standards. Among objects examined were steel rails, knife blades, drills, etc. Conclusion is reached that there is a very close relationship between magnetic and mechanical characteristics of steel and that the commercial application of this to shop routine is practicable.

Certain Aspects of Magnetic Analysis, C. Nusbaum. Preprint, Am. Soc. for Testing Materials, University of Pa., Topical Discussion on Magnetic Analysis, 1919, pp. 92-112, 8 figs. Methods based on following propositions which are termed experimental facts: (1) that magnetic properties of steel are indicative of transformations which it undergoes with heat treatment; (2) that definite relationship exists between magnetic and mechanical properties of a steel product.

See also Steel, Rails, Ball Bearings.

Malleable Iron

What and Why is Malleable Iron, H. A. Schwartz. Proc. Car Foremen's Assn. of Chicago, no. 163, May 1919, pp. 20-42 and (discussion) pp. 42-62. Processes of manufacture followed by National Malleable Castings Co., Indianapolis.

Physical Constants for Malleable, H. A. Schwartz. Foundry, vol. 47, no. 327, July 15, 1919, pp. 462-466, 12 figs. Based upon tests made on material described as complying with present specifications. Curves indicate tensile strength in relation to chemical composition and effect of heat on dimensions and tensile strength.

Monel Metal Sheets

Monel Metal Sheets and Their Characteristics. Metal Worker, vol. 92, no. 4, July 25, 1919, pp. 93-95. Some of physical properties mentioned are: Melting point 2480 deg. fahr.; specific gravity, 8.87; modulus of elasticity, 22,000,000 to 23,000,000 lb. per sq. in.

Nickel Steel

Some Fatigue Tests of Nickel Steel and Chrome-Nickel Steel, H. F. Moore and Arthur G. Gehrig. Am. Soc. for Testing Materials, University of Pa. Annual Meeting, June 24-27, 1919, 13 pp., 5 figs. Results interpreted as indicating that neither static tension tests nor high-stress short-time fatigue tests are a reliable index of fatigue strength of a material under oft-repeated low stresses.

Plates, Flat Steel, Stress Determination in

Further Experiments on Stress Determination in Flat Steel Plates, J. Montgomerie. Eng., vol. 107, no. 2789, June 13, 1919, pp. 786-790, 13 figs. Investigation to determine condition of walls below elastic limit.

Rails, Magnetic Analysis

Magnetic Surveys on New and Failed Rails, P. H. Dudley. Preprint, Am. Soc. for Testing Materials, University of Pa., Topical Discussion on Magnetic Analysis, 1919, pp. 47-63, 9 figs. Possibility is visualized of developing magnetic apparatus for testing railroad axles, crankpins, connecting, parallel and piston rods, etc., without destruction.

Rubber

The Tensile Strength of Rubber-Sulphur Mixtures, O. de Vries and H. J. Hellendoorn. India-Rubber Jl., vol. 57, no. 26, June 28, 1919, pp. 17-19, 4 figs. Stress-strain curves obtained on Schopper testing machine.

Steel, Electric

Electrically-Melted Steel Castings, John A. Holden. Iron & Coal Trades Rev., vol. 98, no. 2677, June 20, 1919, p. 851, 2 figs. Tests obtained from castings made from Héroult steel.

Steel, Magnetic and Mechanical Properties of

A Systematic Investigation of the Correlation of the Magnetic and Mechanical Properties of Steel, N. J. Gebert. Jl. Am. Steel Treaters Soc., vol. 1, no. 9, June 1919, pp. 302-311, 10 figs. Tests with nickel steel, chrome-nickel steel, straight carbon tool steel, and Swedish chrome file steel.

Steel, Time Factor in Tests

Time is Factor in Tests on Steel, G. A. Reinhardt and H. L. Cutler. Iron Trade Rev., vol. 65, no. 3, July 17, 1919, pp. 164-166. Experiments carried on in laboratories of Youngstown Sheet & Tube Co. said to have indicated that specimens of medium-carbon steel show widely varying tensile strengths, influenced by temperature and time elapsing between moment metal is tested and time it is machined.

Torsion Testing Machine

A Simple Apparatus for Repeated Torsion Test, F. Yamanouchi. (In Japanese.) Jl. Soc. Mech. Engrs., Tokyo, Japan, vol. 22, no. 56, Feb. 1919.

MEASUREMENTS AND MEASURING APPARATUS

Brinell Hardness-Testing Machine

A New Brinell Hardness Testing Machine. Automobile Engr., vol. 9, no. 128, July 1919, pp. 211-212, 2 figs. "Avery" machine designed on dead-weight lever system.

Dynamometers

Commercial Dynamometers—XII, P. Field Foster. Mech. World, vol. 65, no. 1695, June 27, 1919, pp. 307-309, 3 figs. Torsion meter type. (Continuation of serial.)

Manometer, Glass

Glass Manometer with Elastic Walls (Sur un manomètre en verre, à parois élastiques), Georges Baume and Marius Robert. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 24, June 16, 1919, pp. 1199-1201, 3 figs. For measuring pressure of fluids which attack mercury. Fluid does not come in contact with mercury but acts on bulb of thin glass which, by its change in size, forces mercury along vertical tube.

Meters, Gas-Flow

Gas-Flow Meters for Small Rates of Flow, A. F. Benton. Jl. Indus. & Eng. Chem., vol. 11, no 7, July 1, 1919, pp. 623-629, 6 figs. Resistance-tube flow meter, developed in Bur. of Mines, and specifications for construction, calibration and operation are included, and influence of temperature and pressure changes discussed.

Meters, Steam and Water

The Measurement of Steam and Water in Power Stations, W. M. Selvey. Elecn., vol. 82, no. 26, June 27, 1919, pp. 721-729, 26 figs. After briefly indicating application of Bernoulli's theorem to meters of steam and water, writer discusses various types which he classifies under headings (1) direct weighing, (2) automatic weighing, (3) automatic volume measurements, (4) flow meters, and (5) motor meters.

Steam Meters. Engr., vol. 127, no. 3311, June 13, 1919, pp. 580-582, 8 figs. Kent meters; they depend for their action on law governing volume of a gas which will pass through an orifice in a plate when impelled by a known difference in pressures on opposite sides of plate.

Minimeter

The National Physical Laboratory. Engineering, vol. 108, no. 2793, July 11, 1919, pp. 33-36, 11 figs. Minimeter for slip gages and electric graphite ring furnace. (Continuation of serial).

Pine, Yellow, Shear Tests

Concentrated Load Tests of Yellow-Pine Beams for Shear, L. R. Manville and C. R. Hill. Eng. News-Rec., vol. 83, no. 2, July 10, 1919, pp. 69-71, 4 figs. Results considered as showing previous horizontal shear values used in design too low, and 50 per cent increase is recommended.

Pyrometers

Thermo-Electric Pyrometers for Plant Use, A. O. Aseman. Chem. & Metallurgical Eng., vol. 21, no. 2, July 15, 1919, pp. 85-87, 3 figs. Illustrating temperature millivolt relation for principal types of couples.

Refractometry

Refractometry and Its Applications in Technical Analysis, James C. Philip. Chem. Indus., vol. 38, no. 11, June 16, 1919, pp. 139T-146T and (discussion) pp. 146T-150T, 5 figs. Plan of Pulfrich's refractometer, which is used in examination of liquids and in commercial testing of optical glass; accuracy control in manufacture of Abbe and Pulfrich's refractometer; use of refractometer in determination of protein content of sera, and in examination of chlorhydrin.

Temperature Indicators

Electric Temperature Indicator, Victor H. Todd. Power, vol. 50, no. 5, July 29, 1919, pp. 180-181, 7 figs. Illustrates various methods of applying temperature indicator.

Temperature Indicating and Controlling Systems, Franklin D. Jones. Machy. (N. Y.), vol. 25, no. 11, July 1919, pp. 1015-1023, 16 figs. Types of thermoelectric apparatus for indicating and recording temperatures in heat-treating furnaces and for controlling temperatures by signals and by automatic regulation. First of three articles.

Volumeter

Direct Volume-Determination in a Volumeter of the Pycnometer Type, J. B. Shaw. Jl. Am. Ceramic Soc., vol. 2, no. 6, June 1919, pp. 481-483, and (discussion) pp. 483-487, 2 figs. Experimental error obtained in manipulating writer's pycnometer which is described as similar to type developed by H. G. Schurecht. (See Jl. Am. Ceramic Soc., 1, 556, 1918.)

MECHANICS

Beam Committee Report

Report of the Beam Committee (Berich des Trägertypen-Ausschusses). Zeitschrift des österr. Ingenieur-und Architekten-Vereins, vol. 70, nos. 51 & 52, Dec. 20 & 27, 1918, pp. 539-542, and 549-555, 11 figs. Tables and equations for angles with equal and unequal legs, Z-bars, Phoenix column sections, etc. (Concluded.)

Columns

Résumé of Study on the Resistance of columns (Résumé d'une étude sur la resistance des colonnes. H. Lefebvre. Mémoires et Compte rendu des Travaux de la Société des Ingénieurs Civils de France, Bulletin, vol. 8, no. 1, 2 & 3, Jan-Mar. 1919, pp. 78-82. Formula for computing dimensions in case of non-homogeneous reinforced-concrete columns and also in case of homogeneous columns.

Girders, Elastic Curve of

The Elastic Curve of Girders with Double Bend (Die elastische Linie des doppelt gekrümmten Trägers), H. Marcus. Zeitschrift für Bauwesen, vol. 69, nos. 1-3, 1919, pp. 163-179, 15 figs. Regarding deformation, stresses, center of pressure, etc.

Shafting

Shafting Calculations Simplified, H. N. Trumbull. Belting, vol. 15, no. 2, July 20, 1919, pp. 34-37, 3 figs. Charts giving relations between power, shaft diameter, torsional stress and speed.

Stresses, Combined

Combined Stresses, Victor M. Summa, Machinery, vol. 25, no. 11, July 1919, pp. 1061-1062, 2 figs. Application to square and rectangular bars of Rankine's general equations for composition of tensile or compressive stress and of shearing stress acting simultaneously and normally to each other on the same particle of a strained body.

Vibration, Struts

Vibration and Strength of Struts and Continuous Beams under End Thrusts, W. L. Cowley. Proc. Roy. Soc., Series A, vol. 95, no. A 672, June 4, 1919, pp. 440-457, 1 fig. Method of analysis outlined in Proc. Roy. Soc., A, vol. 94, 1918, p. 405, extended to include general problem of vibration of continuous beam simply supported at any number of non-collinear points, external loading being constant longitudinal end thrust, varying from bay to bay and periodic lateral loading. In addition, supports are assumed in state of periodic vibration. Generalized form of equation of three moments is derived and conditions for resonance and crippling are expressed in determinantal form.

MECHANICAL PROCESSES

Boxes, Packing

Balanced Packing-Box Construction. India Rubber World, vol. 60, no. 6, August 1, 1919, pp. 626-628, 4 figs. Investigations and tests to determine box design conducted during war by Forest Products Laboratory.

Crushing, Stone

Plant of Temescal Rock Company, W. A. Scott. Cement, Mill & Quarry, vol. 15, no. 1, July 5, 1919, pp. 19-21, 4 figs. Equipment which is said to permit attainment of high capacity and speed in handling crushed stone and riprap simultaneously.

Drill Chucks, Ettco

Manufacturing the Ettco Drill Chuck. Am. Mach., vol. 51, no. 5, July 31, 1919, pp. 209-212, 10 figs. Chuck consists of five components—body, cone screw, jaws, cap and ball thrust bearing. Operations on each of these are explained.

Files

Some Points in the Manufacture of Files—III. Machy. (Lond.), vol. 14, no. 350, June 12, 1919, pp. 322-324, 4 figs. Influence of overcut and upcut to axle of file on efficiency of tool.

Grinding Wood Pulp

Groundwood Pulpstones. Paper, vol. 24, no. 20, July 23, 1919, pp. 15-20, 4 figs. Experimentation with Canadian sandstone in connection with mechanical grinding of wood pulp.

Lens Manufacture

Making Lenses for Optical Apparatus—I & II (Die Herstellung von Linsen für optisches Gerät), Reishaus. Deutsche Optische Wochenschrift, nos. 11-12 and 13-14, Mar. 17, and 31, 1919, pp. 67-69, and 83-84, 12 figs. Describes manufacture of lenses, especially of very large lenses used in astronomic instruments.

Liberty Motor

Assembling Liberty Motor Cylinders, H. A. Carhart. Am. Mach., vol. 51, no. 1, July 3, 1919, pp. 27-30, 4 figs. Final minor operations before assembling.

Marine-Engine Building

Building Marine Engines on a Quantity Basis, F. B. Jacobs. Mar. Rev., vol. 49, no. 8, August 1919, pp. 388-392 & 397, 5 figs. Assembly operations at works of Hooven, Owens, Rentschler Co., Hamilton, O.

Motor-Car Manufacture

Manufacturing the Chevrolet Motor Car. J. H. Moore. Can. Machy., vol. 22, no. 1, July 3, 1919, pp. 1-7, 10 figs. Steps in production from framework to finished car, ready for shipment.

Pebbles for Tube Mills

Man's Onyx Pebbles for Tube Mills, William B. Eastwood. Cement, Mill and Quarry, vol. 15, no. 2, July 20, 1919, pp. 11-14, 6 figs. Claimed as results of tests that artificial balls from immense onyx deposit in Nevada prove equal to foreign flint product for efficient grinding service in ore and cement plants.

Rolling Mills

Rolling Equipment of the Inland Steel Co. Iron Age, vol. 104, no. 3, July 17, 1919, pp. 155-161, 11 figs. Details of 28-in. 32-in. and 40-in rolling mills, motor room and turbine station.

The New Steel Works and Rolling Mills of the Witkowitz Iron Works (Die neue Stahl- und Walzwerksanlage des Eisenwerkes Witkowitz). Montanistische Rundschau, vol. 11, nos. 7 & 8, Apr. 1-16, 1919, pp. 198-202 and 228-232, 14 figs. Describes rolling mill running at 160 r.p.m. and used for manufacture of channels, beams, rails; tank-plate rolling mill and preheating furnace; yards for storing rails and beams; employees' cafeteria; kitchen for same. (Concluded.)

The Morgan Continuous Wire-rod Rolling Mill. Engr., vol. 127, no. 3312, June 20, 1919, pp. 597-599, 16 figs., partly on supp. plates. Plant at Sheffield built in accordance with system developed by Morgan Construction Co. of Worcester, Mass.

Builds Steel Plant in Far East. Iron Trade Rev., vol. 65, no. 4, July 24, 1919, pp. 230-231, 3 figs. General plans of plate and structural mill for Kiushu Steel Works, Japan, which is expected to cost about $3,000,000.

Sheet Iron

Manufacture of Sheet Iron in Southern Russia (La fabrication des toles minces dans la Russie meridionale), F. Couleru. Génie Civil, vol. 75, no. 1, July 5, 1919, pp. 10-14, 8 figs. Details of processes in manufacture of sheet iron for use in roofs at various works, particularly at plant of Russian Tube Mfg. Co. (To be continued.) From Stahl und Eisen.

MOTOR-CAR ENGINEERING

Autovac Gasoline Feed System

The Autovac Petrol Feed System. Autocar, vol. 43, no. 1237, July 5, 1919, pp. 8-9, 4 figs. Mounted in position above level of carburetor is small cylindrical tank divided into two chambers, and so arranged and connected that it utilizes partial vacuum created in induction pipe of engine for supplying continuous stream of gasoline to carburetor from main storage tank regardless of position of latter.

Bianchi

The New 12 hp. Bianchi. Autocar, vol. 42, no. 1235, June 21, 1919, pp. 971-972, 7 figs. Four cylinders, 65 x 110 mm.; thermo-siphon cooling; single-disk dry clutch.

Carburetors

Tests on the Homa Carburetor (Versuchsergebnisse mit dem Homa-Vergaser), Ing. Praetorius. Motorwagen, vol. 22, no. 7, Mar. 10, 1919, pp. 114-115, 4 figs. Results of tests made. Lowest consumption at various loads and constant speed. Tests made on motor of passenger automobile.

Design

The Relation of Motor Truck Ability to the Trend of Design, Lewis P. Kalb. Jl. Soc. Automotive Engrs., vol. 5, no. 1, July 1919, pp. 18-22, 1 fig. An ability formula is developed, the purpose of which is said to be to determine a factor of experience from which the proper engine size and gear radius can be calculated.

Differentials

Is the Differential Indispensable? (Ist das Differential unentbehrlich?), W. Rödiger. Automobil-Rundschau, vol. 18, nos. 5-6, Mar. 1919, pp. 54-56. Discusses various attempts to replace the differential, as for instance the belt transmission. Special reference is made to the free wheel mechanism.

Enfield-Allday

The 10 hp. Enfield-Allday. Autocar, vol. 42, no. 1234, June 14, 1919, pp. 913-916, 9 figs. Chassis fitted with 5-cylinder air-cooled radial power units.

Fuel Problem

The Engine Fuel Problem, Joseph E. Pogue. Jl. Soc. Automotive Engrs., vol. 5, no. 1, July 1919, pp. 14-17. As situation now stands, writer considers that "most effective means for expanding supply of gasoline is through rapid development of cracking methods of refining whereby gasoline is made from fuel oil and kerosene."

Liberty Engine Applications

Application of Liberty Engine Materials to the Automotive Industry, Harold F. Wood. Jl. Soc. Automotive Engrs., vol. 5, no. 1, July 1919, pp. 23-30. Various materials are considered and it is particularly noted that one of the most important developments during the Liberty engine program was the fact that it is not necessary to use a high-analysis alloy steel

to secure a finished part which will give proper service.

Locks

Foiling the Car Thief. Autocar, vol. 43, no. 1237, July 5, 1919, pp. 12-14, 6 figs. Locking mechanisms, notably Cowey's patent arrangement which, when actuated, short-circuits to earth high-tension leads from magneto to sparking plugs.

Maudslay

Maudslay Industrial Chassis. Motor Traction, vol. 28, no. 747, June 25, 1919, pp. 550-552, 5 figs. Three- four- five-ton chassis, the three-ton having engine of 32 hp. and other engines of 40 hp.

Spyker

The 13-30 hp. Spyker. Autocar, vol. 43, no. 1238, July 12, 1919, pp. 43-44, 6 figs. Dutch car with engine-operated-type pump.

Tires

Important and Neglected Features of Tire Maintenance, A. F. Masury. Eng. News-Rec., vol. 82, no. 26, June 26, 1919, pp. 1262-1264, 5 figs. Effects of overloading, overspeeding, running in car tracks, neglecting cuts and tears, spinning, skidding and sliding, and wheel misalignment.

Tractors

Agricultural Tractors (La Motoculture), M. Paul Lecler. Mémoires et Compte rendu des Travaux de la Société des Ingénieurs Civils de France, Bulletin, vol. 8, no. 1, 2 & 3, Jan.-Mar. 1919, pp. 97-124, 14 figs. Classification and description of various types.

Tractor Rating Chart

Tractor Rating Chart Prepared by the S. A. E. Automotive Industries, vol. 40, no. 26, June 26, 1919, p. 1436, 1 fig. Based on formula: Horsepower = $0.7854\ D^2\ LRN$/13,000.

Tractor Tests

Class B Rules for Tractor Tests. Jl. Soc. Automotive Engrs., vol. 5, no. 1, July 1919, pp. 58-60. Compiled and copyrighted by Am. Soc. of Agricultural Engrs. and designed to govern state or national demonstrations conducted by manufacturers, distributors, dealers, etc.

Truck, Ideal

British Idea of a Truck That Will Meet the Widest Demand. Automotive Indns., vol. 41, no. 4, July 24, 1919, pp. 164-166, 6 figs. Truck is of two-ton capacity, has four-speed gear box, medium-speed engine with first speed of 26.5:1, overhead worm drive, three-plate type of clutch, and cast-steel wheels with hollow spokes.

Visualizing the Future Truck. Automotive Industries, vol. 40, no. 26, June 26, 1919, pp. 1432-1435, and (discussion) pp. 1435 and 1451. Develops ability formula. Paper read before Soc. Automotive Engrs.

PIPE

Cast-Iron Pipe

Flanges for Light Cast Iron Pipe, John Knickerbocker. Fire & Water Eng., vol. 66, no. 3, July 16, 1919, pp. 122-123, 1 fig. Analysis of proposed standard suggested by Am. Soc. Mech. Engrs.' Committee, and proposal that Am. Water Works Assn. take matter up with other societies. Paper read before Am. Water Works Assn.

Cement Joints

Successful Use of Cement Joints for Cast Iron Water and Gas Mains, Stephen E. Kieffer. Mun. & County Eng., vol. 57, no. 1, July 1919, p. 42. Results in construction of U. S. Housing Corporation project at Vallejo, Cal.

Cement Pipe

Friction Tests and Capacity Table for Cement Pipe, G. E. P. Smith. Eng. & Contracting, vol. 52, no. 2, July 9, 1919, pp. 37-38. Conducted at University of Arizona. Paper read before Am. Water Works Assn.

Concrete Pipe

Concrete Pipe Fails From Unequal Expansion of Shell, G. E. P. Smith. Eng. News-Rec., vol. 83, no. 3, July 17, 1919, pp. 113-115, 3 figs. Longitudinal cracks in non-reinforced pipe conduit believed to be due to differential movement because of partial wetness.

Discharge Pipes

Machinery and Pipe Arrangement—XVIII, C. C. Pounder. Mech. World, vol. 66, no. 1696, July 4, 1919, p. 7, 2 figs. Arrangement of discharge pipes. (Continuation of serial.)

Metalium Joints

Experience with Metalium Joints in Water Pipe Lines in Davenport, Iowa, Thomas Healy. Mun. & County Eng., vol. 57, no. 1, July 1919, pp. 47-48. Among advantages claimed is that material is cheaper per joint than lead.

See also Hydraulic Machinery (Pipe, Wood-Stave) and CIVIL ENGINEERING, Cement and Concrete (Concrete Pipe Manufacture.)

POWER GENERATION

France

New Project for Establishing a Law Governing Utilization of Hydraulic Forces (Le nouveau projet de loi sur les forces hydrauliques). Houille Blanche, vol. 18, nos. 29 & 30, May-June 1919, pp. 81-108. Including review of world situation and legislation existing in various countries.

Hydroelectric Power Station at Barberine (Valais) France (Construction de l'usine électrique de la Barberine (Valais)). Bulletin Technique de la Suisse Romande, vol. 45, no. 12, June 14, 1919, pp. 109-112, 3 figs. Concerning union of two waterfalls which is expected will furnish an aggregate of 38,500 hp.

Harnessing the French Rhone (L'aménagement hydraulique du Rhône Français), Auguste Pawlowski. Génie Civil, vol. 74, no. 24, June 14, 1919, pp. 481-487, 3 figs. Projects to make it navigable, of irrigation and of power utilization. Presented to the Congrès de la Houille Blanche (Grenoble, June 1919.)

Hydroelectric Energy in France, C. W. A. Vedits. Elec. World, vol. 74, no. 4, July 26, 1919, pp. 182-183. France possesses about 5,857,000 available hydroelectric horsepower. Writer explains that coöperation of American engineers and American financiers would be welcomed in developing natural resources of republic and in reorganizing her war-stricken industries.

Government Ownership

Government Ownership of Water Power in Relation to Electrochemical Industry, F. A. J. FitzGerald. Chem. & Metallurgical Eng., vol. 21, no. 2, July 15, 1919, pp. 95-98. Claims that arguments advanced by advocates of Government ownership are generally a priori and not based on actual experiences, and presents examples of Government activities in various fields which can be undertaken by private enterprise as offering evidence against public ownership in such cases.

Spain

Spain Plans National Transmission Network, George F. Paul. Elec. World, vol. 74, no. 3, July 19, 1919, pp. 122-123, 1 fig. To connect all industrial centers with power plants at larger waterfalls and coal mines. Contemplated development will harness 2,000,000 hp.

Stand-by Operation

Converting a Steam Plant to Stand-by Operation, L. M. Klauber. Nat. Elec. Light Assn. Bul., vol. 6, no. 6, June 1919, pp. 343-347, 3 figs. Problems met in actual case following tie-in with transmission service.

Water Power

Some Features of Hydroelectric Engineering Practice and Possibilities, H. de B. Parsons. Mun. & County Eng., vol. 57, no. 1, July 1919, pp. 13-16. Advocates nation-wide plan and policy to encourage use of water power to the fullest extent and conserve mineral fuels.

Hydraulic Energy (Creacion de la fuerza hidráulica). Boletin Minero de la Sociedad Nacional de Mineria, vol. 31, no. 241, March 1919, pp. 236-254. Notes on legislation relative to utilization of water power in France, England, United States and other nations.

Water Works, Engines for

Engines for Small Water Works, Henry A. Symonds. N. E. Water Works Assn., vol. 33, no. 2, June 1919, pp. 153-169 and (discussion) pp. 169-185, 3 figs. Economical selection.

POWER PLANTS

Boiler Auxiliaries

Boilers and Auxiliaries. Power Plant Eng., vol. 23, no. 14, July 15, 1919, pp. 624-627. From report of Committee on Prime Movers read at Convention of Nat. Elec. Light Assn.

Boiler-House Equipment

Steam-Electric Plant of the Dominion Power and Transmission Company, Hamilton. Elec. News, vol. 28, no. 10, May 15, 1919, pp. 26-29, 6 figs. Coal-handling and boiler-house equipment. (First article.)

Condensers

Particulars of a 56,000 Sq. Ft. Surface Condenser. Power, vol. 50, no. 3, July 15, 1919, pp. 90-92, 5 figs. Condenser is of Worthington type.

Draft, Induced

Artificial Induced Draft in Steam Boilers (Künstlicher Saugzug bei Dampfkesselanlagen), Mr. Nerger. Zeitschrift für Dampfkessel u. Maschinenbetrieb, vol. 42, nos. 5 & 6, Jan. 31 & Feb. 7, 1919, pp. 25-27 and 33-37, 9 figs. Draft blower with casing governor for Burkhardt boiler. Writer points out close connection between proper draft and fuel economy and discusses various types of blowers.

Economizers

Economizers and Economizer Practice, Robert June. Power House, vol. 12, no. 10, July 5, 1919, pp. 270-272, 4 figs. Illustrating its usefulness as aid to boiler-room economy.

Power Plant Management, Robert June. Refrigerating World, vol. 54, no. 7, July 1919, pp. 24-26, 4 figs. Claimed advantages and disadvantages of economizers.

Equipment, Moving

New Power Plant for St. Mary's Training School. Power, vol. 50, no. 1, July 1, 1919, pp. 2-6, 8 figs. Difficulty encountered while moving equipment from old to new plant without interrupting service.

Fuel Consumption

Steam and Coal Consumption in Power Stations, R. H. Parsons. Eng., vol. 108, no. 2792, July 4, 1919, pp. 3-4, 1 fig. Record of station having rated capacity of about 6000 kw. presented with view to indicating general possibilities of improvement in economy.

Furnace Patents

New Patents Regarding Steam Boiler Furnaces (Neue Patente auf dem Gebiete der Dampfkesselfeuerung), Pradel. Zeitschrift für Dampfkessel u. Maschinenbetrieb, vol. 42, nos. 1 and 3, Jan. 3 and 17, 1919, pp. 3-5 and 11-15, 19 figs. Stopping device for Babcock-Wilcox traveling grate; regulator for fuel layer on Kropelin traveling grates; safety pressure regulation, Gentrup type; exhaust suction and cleaning apparatus, Simon type.

Soot Blowers

What the Mechanical Soot Blower Accomplishes, Robert June. Power House, vol. 12, no. 11, July 19, 1919, pp. 310-315, 6 figs. Results of tests in power station. Importance of keeping tubes free from soot is emphasized.

Steam-Consumption Charts

Finding the Efficiency Ratio, H. L. Doolittle. Power, vol. 50, no. 4, July 22, 1919, pp. 140-141, 1 fig. Chart, consisting of portion of total-heat-entropy chart with curves superimposed thereon indicating steam consumption per kilowatt-hour.

Stokers

Sudden Peak Loads on Chain-Grate Stokers, H. F. Gauss. Power, vol. 50, no. 1, July 1, 1919, pp. 20-22, 1 fig. Chart for finding air-space area for a given boiler output.

Testing, Boiler and Furnace

Boiler and Furnace Testing, Rufus Strohm. Steam, vol. 23, no. 1, July 1919, pp. 11-15, 2 figs. How to make tests and interpret their results.

U. S. Nitrate Plant No. 2

U. S. Nitrate Plant No. 2, Edward R. Welles and W. A. Shoudy. Power Plant, Eng., vol. 23, no. 14 & 15, July 15, & Aug. 1, 1919, pp. 617-622, & 671-675, 12 figs. Power received from 10,000-kw. steam-generating station. Article deals particularly with efficiency features of steam plant. Turbines and condensing equipment.

Waste Wood, Steam Generation

Electrical Equipment of Clear Lake Lumber Mills, W. A. Scott. Elec. Rev., vol. 74, no. 26, June 28, 1919, pp. 1065-1068, 6 figs. Refuse furnishes steam for dry kilns and turbo-generators.

Water Softening

Water Softening and Purifying Processes, C. E. Stromeyer. Power House, vol. 12, no. 11, July 19, 1919, pp. 300-302, 2 figs. Description of purifying processes used.

POWER TRANSMISSION

Belting

Scientific Methods to Prolong Life of Belting, vs. Careless Methods That Destroy, Edward E. Marbaker. Belting, vol. 15, no. 2, July 20, 1919, pp. 17-20. Tallow-cod oil recommended as best belt lubricant.

Steel-Mill Auxiliaries, Drives for

Hydraulic vs. Electric Drive for Steel Mill Auxiliaries, R. B. Gerhardt. Jl. Engrs. Club of Philadelphia, vol. 36, no. 177, August 1919,

pp. 303-308, 5 figs. Also Blast Furnace & Steel Plant, vol. 7, no. 7, July 1919, pp. 330-334. Comparison between hydraulic and electric drive for door hoists, furnace covers, elevators, manipulators, lifting tables, middle roll balance, shears and intensifiers. Paper read before Assn. Iron & Steel Elec. Engrs.

PRODUCER GAS

Tar Disposal

Tar Disposal in Ford Producer-Gas Plants. Power, vol. 50, no. 2, July 8, 1919, pp. 66-67, 1 fig. Method for returning tar to, and vaporizing it in producer.

PUMPS

Air-Lift Pumping

Air-Lift Pumping. John Oliphant. Can Engr., vol. 37, no. 2, July 10, 1919, pp. 121-124, 8 figs. Compressor handling single well pumping at rate of 400 gal. per min. with lift of over 300 ft. Details of operation.

Centrifugal Pumps

Rees Roturbo Centrifugal Pumps. Can Manufacturer, vol. 39, no. 7, July 1919, pp. 33-38, 10 figs. Single- and multiple stage-types illustrated. Venturi principle embodied in shaped contraction in water pipe having abrupt nozzle where water enters contraction, and gradually expanding taper piece after water has passed contraction.

Costs

Calculating Oil Conduits. Zentralblatt der Bauverwaltung, vol. 39, no. 19, Mar. 1, 1919, pp. 101-102, 1 fig. Cost of pumping plant, maintenance, fuel.

Pumping Engine Tests

Pumping Engine Tests. Fire and Water Eng., vol. 66, no. 2, July 9, 1919, pp. 66-69, 7 figs. Record of tests at Electric Park, Kansas City, Mo., during convention of International Assn. of Fire Engrs.

REFRACTORIES

Cements

Patching Oven Jamb Leaks. R. L. Fletcher. Gas Rec., vol. 15, no. 12, June 25, 1919, pp. 401-402, 4 figs. Closing cracks between fire-clay jamb bricks and silica shapes by means of Hytempite dissolved in warm water.

Firebrick

Constitution and Microstructure of Silica Brick and Changes Involved Through Repeated Burnings at High Temperatures. Herbert Insley and A. A. Klein. Techn. Papers Bur. Stand., no. 124, July 11, 1919, 31 pp., 20 figs. Petrographic microscopic examinations of commercial silica brick and those which have received repeated burnings by use in kilns, alleged to show three main constituents—quartz, cristobalite, and tridymite. In addition, small amounts of pseudowollastonite and glass are said to be present.

See also Refractory Material Committee Report.

Refractory Material Committee Report

Report of the Refractory Material Committee on the Crushing Strength of Firebricks. W. Emery and J. W. Mellor. Gas Jl., vol. 146, no. 2925, June 3, 1919, pp. 619-620, 3 figs. Results interpreted as having indicated that present strength is reduced by increasing grain size of grog when proportion of grog is constant; and also by increasing proportion of grog when grain size is constant. Presented before Instn. of Gas Engrs.

REFRIGERATION

Ammonia Receivers

Watch the Ammonia Receiver. John E. Starr. Power, vol. 50, no. 4, July 22, 1919, pp. 142-143, 2 figs. Advises feeding only liquid to expansion coils, and warns against estimating conditions of feeding by sound made in expansion valve.

Brewery

Remodeling Suction Gas Mains Anheuser Busch Brewery. Robert H. Karl. Power, vol. 50, no. 2, July 8, 1919; pp. 48-54, 13 figs. Refrigerating system of brewery occupies 70 city blocks. During growth multiplicity of ammonia-compressor piping demanded remodeling so as to provide means to facilitate operation and to effect greater economy especially by better insulating the piping. Arti-

Carbon-Dioxide Machines

The design of CO_2 machines. John E. Starr. Refrigerating World, vol. 54, no. 7, July 1919, pp. 11-12 & 20, 1 fig. Plate illustrating what writer terms disagreement on data of chief properties of carbonic acid gas as given by different authorities.

Code

Code for the Regulation of Refrigerating Machines and Refrigerants. Ice & Refrigeration, vol. 57, no. 1, July 1919, pp. 6-8, 2 figs. Prepared by Commission on Municipal and State Regulations of Am. Soc. of Refrigerating Engrs.

Ice Plants

Re-Modeled Ice Plant, Columbus, Ohio. Ice & Refrigeration, vol. 57, no. 1, July 1919, pp. 10-15, 11 figs. Rated capacity is 250 tons daily, all distilled-water ice. In the transformation effected, about 20 steam-driven pumps and small steam engines have been replaced by electric-motor-driven apparatus.

Largest Ice Plant in the West. Victor J. Azbe. Power, vol. 50, no. 5, July 29, 1919, pp. 168-170, 5 figs. Plant of 350 ton capacity. Features are drum-type copper steam condensers, ammonia condensers made up of 8-in pipe and ice-making system employing 800-lb. cans.

Shipboard Installations

Refrigerating Installations on Board Large Steamships (Les installations frigorifiques à bords des grands paquebots). Génie Civil, vol. 74, no. 26, June 28, 1919, pp. 521-525, 1 fig. Assembly plan of installations as laid out in French steamer of 15,000 tons.

Storage, Cold

Cold Storage Accommodation. Surveyor, vol. 55, no. 1432, June 27, 1919, pp. 479-480, 6 figs. Design for building of 120-ton capacity.

RESEARCH

Forest Products Laboratory

Production in Industrial Research. Samuel Morell. Indus. Management, vol. 58, no. 2, Aug. 1919, pp. 95-99, 5 figs. Management methods applied to Forest Products Laboratory to increase output of results.

Industrial Laboratories

The Organization of an Industrial Laboratory. A. D. Little and H. E. Howe. Mech. Eng., vol. 41, no. 8, August 1919, pp. 663-666, 3 figs. Divisions of laboratory are enumerated and discussed, laboratories of A. D. Little being taken as type. Methods of management, rating or reports and commercial organization are also discussed.

Industrial Research Laboratory Organization. K. C. Mees. Mech. Eng., vol. 41, no. 8, August 1919, pp. 667-668, 4 figs. Diagrams illustrating functions of industrial research laboratory.

The Scope of the Works Laboratory. Eng. & Indus. Management, vol. 1, no. 19, June 19, 1919, pp. 581-582. Success of a laboratory said to depend on (1) possession of proper equipment which includes ample number of properly trained scientific workers, (2) mutual existence of right attitude of mind between works and the laboratory, (3) complete confidence and sympathetic assistance of management.

Industrial Research

Industrial Research and National Progress. Frank D. Adams. Min. & Eng. Rec., vol. 24, no. 10 & 11, June 1919, pp. 142-146. With notes on the work being done by governments of United States and Great Britain.

Lausanne University Laboratory

Mechanical, Physical and Chemical Laboratory of the Engineering School of Lausanne University (Le laboratoire d'essais mécaniques, physiques et chimiques de l'école d'ingénieurs de l'Université à Lausanne). Bulletin Technique de la Suisse Romande, vol. 45, nos. 11, 12 & 13, May 31, June 14, and June 28, 1919, pp. 99-102, 114-116, and 127-129, 13 figs. Martens apparatus for measuring small elastic deformations; machine used to measure tensile and compressive strength of wires, sheets, springs, etc. Charpy apparatus for measuring resilience.

Lynite Laboratories

Evolution of the Lynite Laboratories. Iron Age, vol. 104, no. 3, July 17, 1919, pp. 149-154, 9 figs. General organization of laboratories is laid out to include research along purely scientific lines in the arts of alloying and fabricating non-ferrous metals, the adaptation of this scientific knowledge by means of experiments and development methods and scientific control of foundry practice to secure

National Physical Laboratory

The National Physical Laboratory. Engineering, vol. 107, no. 2791, June 27, 1919, pp. 846-848, 2 figs. Worm-gear testing machine. (To be continued).

Research Outlook

The Outlook for Research. Nevil Monroe Hopkins. Jl. Engrs. Club of Philadelphia, vol. 36, no. 177, August 1919, pp. 309-316. Present status and economic possibilities of research in America and in European countries.

The Condition of Research in the United States. Arthur H. Green. Mech. Eng., vol. 41, no. 7, July 1919, pp. 587-592, 13 figs. Writer discusses research in its relation to technical schools and engineering experiment stations, its value when comparatively conducted and as undertaken by various government activities.

Works Laboratory

See Industrial Laboratories.

SPECIFICATIONS

Malleable Castings

Technical Specification for the Delivery of Malleable Castings (Spécification technique pour la fourniture des pièces en fonte malléable). Fonderie Moderne, no. 2, Feb. 1919, pp. 43-45. Concerning malleable castings as adopted by railroad companies.

Motor Trucks

Motor Truck Specifications. Power Wagon, no. 176, July 1919, pp. 49-64. List of major specifications of internal-combustion and electric trucks, grouped according to load rating and arranged alphabetically by brand name.

STANDARDS AND STANDARDIZATION

Enamels

See Lacquers.

Engineering Standards Committee

American Engineering Standards Committee. C. B. LePage. Jl. Engrs. Club of Philadelphia, vol. 36, no. 177, August 1919, pp. 321-322. Statement of reorganization activities during period January 1 to June 1, 1919.

Holland

Standardization in Holland (Ontwerp-Standaardvormen der Hoofdcommissie voor de Normalisatie in Nederland). Ingenieur, vol. 34, no. 25, June 21, 1919, pp. 476-479. New standardization rules of Standardization Committee of the Netherlands.

Japans

See Lacquers.

Lacquers

Lacquers, Shellacs, Enamels and Japans. Safety Eng., vol. 38, no. 1, July 1919, pp. 15-22, 2 figs. Tentative safety standards prepared by the State of New Jersey.

Pumps, Liquid Measuring

Specifications and Tolerances for Liquid Measuring Pumps, Tentatively Adopted by the Twelfth Annual Conference of Weights and Measures, May, 1919. Scale Jl., vol. 5, no. 10, July 10, 1919, pp. 11-12. Covering definition of liquid-measuring pump, permanence, constancy of delivery, position of stop mechanism, etc.

Shellacs

See Lacquers.

Wood Screws

New Standards for Wood Screws (Neue Einheitsmasse für Holzschrauben). Metall-Technik, vol. 45, no. 7/8, Feb. 22, 1919, p. 29. New uniform measures for wood screws issued by the Standardization Committee of German Industries.

STEAM ENGINEERING

Boilers

Standard Boilers, Gt. Western Railway. Ry. Engr., vol. 40, no. 474, July 1919, pp. 138-141, 4 figs. Leading particulars of four standard sizes having lengths of 14-ft. 10-in., 11-ft., 10-ft. 3-in., and 11-ft. Details of joints are particularly dealt with.

Design and Construction of Marine Boilers. A. E. Seaton. Mar. Engr. & Naval Architect, vol. 41, no. 502, July 1919, pp. 307-309. Work done by British Marine Eng. Design and Construction Committee. (Concluded). Paper read before Instn. Naval Architects.

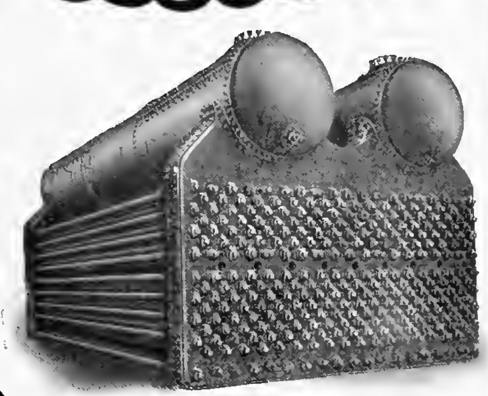
Water Power Can Not Take the Place of Coal

It is interesting to note that the maximum possible hydraulic energy of 230 million kilowatts is little more than the total energy which we can now produce from coal, and is about equal to the present total energy consumption of the country including *all* forms of energy.

This is rather startling. It means that the hope that when coal once begins to fail we may use the water powers of the country as source of energy is and must remain a dream; for if today all the potential water power of the country were developed and every rain drop used it would not supply our present energy demand.

Thus hydraulic power may and should supplement coal as a source of power, but can never replace it.—*Charles P. Steinmetz.*

WHEN STEINMETZ SAYS—"IT CAN'T"



you can be sure **"IT CAN'T"**

It behooves all users of coal, therefore, to burn coal ECONOMICALLY. Use the most efficient boiler you can get.

HEINE BOILERS

Heine Boilers are most efficient. They are famous for their quality, for their strength and for their excellent durability.

Visitors to St. Louis are invited to our Plant No. 1 to see the first Heine Boiler ever built. It was in continuous service for about 35 years. It is still serviceable. A very good record.

WRITE FOR "BOILER LOGIC"

HEINE SAFETY BOILER CO.

5321 MARCUS AVE. HELIOS ST. LOUIS, MO.

3

Tests of High Efficiency Pre-heater Type Boilers, Josiah H. Rohrer. Universal Engr., vol. 29, no. 7, July 1919, pp. 39-45, 2 figs. Experiences at Ford Motor Company.

Newcomen Engines

Two Newcomen Engines. Engr., vol. 127, no. 3313, June 27, 1919, pp. 621-623, and 632, 22 figs. Particulars regarding two engines, one dating back to 1787 and another to 1823, both of which are said to be still working satisfactorily.

Turbines, Blade Fastenings

Turbine Blade Fastenings—III. Mechanical World, vol. 65, no. 1694, June 20, 1919, p. 294, 8 figs. Methods used on running wheels of Westinghouse Rateau turbine. (Continuation of serial.)

Turbines, Bucket Efficiency

Bucket Efficiency of Impulse and Reaction Steam Turbines (Om Skövelverkningsgrader vid Aktions- och Reaktions-angturbiner), Tore G. E. Lindmark. Teknisk Tidskrift, Mekanik, vol. 49, no. 24/3, Mar. 12, 1919, pp. 37-41, 3 figs. Claims that it is frequently stated that the bucket efficiency in a reaction steam turbine must necessarily be lower than the corresponding efficiency in an impulse steam turbine, as long as the ratio between the peripheral velocity and heat drop for the reaction steam turbine does not exceed the most favorable values for the impulse steam turbine.

Turbines for Mechanical Drives

Turbines for Mechanical Drives, R. R. Lewis. General Elec. Rev., vol. 22, no. 6, June 1919, pp. 438-442, 12 figs. Illustrates selection of standard parts to produce turbine best adapted to conditions of particular application.

Turbo-Generator, 45,000-Kw.

The 45,000-Kw. Turbine-Generator set at Providence. Elec. Rev., vol. 75, no. 3, July 19, 1919, pp. 91-93. Cross-compound unit of Narragansett Electric Light Co. consisting of high- and low-pressure turbines, each connected with through flexible coupling to its own generator.

Turbo-Generator, 70,000-Kw.

Interborough Rapid Transit Company's 70,000-Kw. Turbo-generator. Elec. Rev., vol. 75, no. 1, July 5, 1919, pp. 4-6, 4 figs. Methods of operating three elements of triple cross-compound turbine.

Turbine Governing

Turbine Governing for Present Types of Steam Turbines (Zur Regelung der Steuerung der gegenwärtigen Bauarten von Dampfturbinen), Ernst Blau. Zeitschrift des österr. Ingenieur- und Architekten-Vereins, vol. 70, nos. 43 & 45, Oct. 25, and Nov. 8, 1918, pp. 465-466, and 484-487, 10 figs. Throttle governors of the Bergmann steam turbine, oil-pressure valve gears of the Brown Boveri & Co. turbines: Allgemeine Elektrizitäts-Gesellschaft system of automatic governing by cutting out nozzles. (To be concluded.)

THERMODYNAMICS

Equation of State for Fluids

Direct Determination of the Temperature Exponent in the Equation of State of Fluids (Détermination directe de l'exposant de la température dans l'équation d'état des fluides), E. Ariès. Comptes Rendus des Séances de l'Académie des Sciences, vol. 168, no. 19, May 12, 1919, pp. 930-933. Equation solved for exponent of temperature and substitution of values of quantities in second side of equation effected for seven substances.

Heat Conductivity

Heat Conductivity, C. Edwards, A. Rigby and J. W. Mellor. Gas World, vol. 70, no. 1819, May 31, 1919, pp. 448-450, 3 figs., and Gas Jl., vol. 146, no. 2925, June 3, 1919, pp. 620-622, 3 figs. Theoretical. In computation conductivity of air is neglected, and it is assumed that conductivity of solid does not vary with temperature and that no heat is conveyed across space by convection. Problem is taken up with reference to pore gap. Paper before Instn. of Gas Engrs.

Joule-Thomson Effect for Air

The Joule-Thomson Effect for Air at Moderate Temperatures and Pressures, L. G. Hoxton. Physical Rev., vol. 13, no. 6, June 1919, pp. 438-439, 8 figs. Joule-Thomson coefficient was found in experiments to have a decreasing linear variation with increasing line pressures.

VARIA

Astronomical Instruments

An Evening's Journey among the Stars, Frank C. Jordan. Jl. Engrs. Club of Philadelphia, vol. 36, no. 176, July 1919, pp. 253-258, 7 figs. Development of astronomical instruments together with some of records obtained through their use.

Chemical Associations

Part of Chemical Associations in International Documentation (L'organisation de la Documentation internationale et le rôle des associations de chimie), Paul Otlet. Chimie & Industrie, vol. 2, no. 5, May 1919, pp. 547-554. Proposes that an international federation of chemical societies should be entrusted with documentation of all chemical literature. Discourse pronounced before Interallied Conference.

Engineering Profession, Organization of

A National Organization of the Engineering Profession, F. R. Ewart. Elec. News, vol. 28, no. 10, May 15, 1919, pp. 23-26, 1 fig. Referring to example of Great Britain where with development of various engineering sciences a single society of engineers formerly existing separated in spite of strenuous opposition into present organizations, it appears to writer that best realization of single-society idea would be in developing systematic scheme of coöperation which would leave most complete autonomy for technical purposes to all existing organizations. A system of coördinating councils for this purpose is presented.

Engineers

The Engineer—His Opportunities and Responsibilities, John B. Fisken. Jl. of Electricity, vol. 43, no. 2, July 15, 1919, pp. 69-71. Calls attention to the fact that engineer is becoming a more and more important factor in modern world. Still, writer observes, in spite of vast opportunities for service which lie before him, his unnecessarily retiring temperament prevents him from taking the high place which is rightfully his.

Patent System

Proposed Changes in the American Patent System, Wesley G. Carr. Elec. Jl., vol. 16, no. 7, July 1919, pp. 299-300. Recommendations proposed by special committee appointed by Nat. Research Council.

Percentages

Checking Percentages by a Chart, William Wyer. Eng. & Contracting, vol. 52, no. 3, July 16, 1919, pp. 80-81, 1 fig. Methods of U. S. Railroad Administration.

WELDING

Acetylene Generating Plant

Acetylene Generating Plant for Large Welding Shops. Welding Engr., vol. 4, no. 7, July 1919, pp. 27-29, 3 figs. It consists of 7 generators, gas collector, moisture separator, 2 condensers, a gas-meter capable of storing 350 cu. ft. of gas, and 4 large purifiers provided with bypasses for working in pairs.

Acetylene Welding

Oxy-Acetylene Welding of Large Cylinders, L. M. Malcher. Min. & Sci. Press, vol. 119, no. 20, July 12, 1919, pp. 53 and 61-62. Repairing fractured left-hand low pressure steam-cylinder, 70 in. in inside diameter, of Allis-Chalmers twin-tandem compound-reversing engine.

Arc Welding

Electric Arc Welding in Mines, John G. Kjellgren. Coal Age, vol. 16, no. 2, July 10, 1919, pp. 52-53, 2 figs. Illustrating weld on cast iron hoisting sheave.

Blowpipes

Improvements in Blowpipes. Acetylene & Welding Jl., vol. 16, no. 189, June 1919, pp. 121-122, 1 fig. Invention relating to blowpipes in which extension piece can be readily attached between nozzle and handle. Extension piece arranged so as to establish communication between oxygen nozzle and injector, and also between passage for combustible gas and annular space between injector and rear portion of tip.

Concrete Construction

Autogenous Welding in Reinforced-Concrete Construction (Die Flammenverschmelzung im Eisenbetonbau). Autogene Metallbearbeitung, vol. 12, no. 3, Mar. 1919, pp. 38-40, 10 figs. Describes concrete tanks and pipes as made by the Metallindustrie G.m.b.H. at Buhl, Baden. (Concluded.)

Electric Welding

Development of Electric Welding, Howard C. Forbes. Elec. Eng., vol. 53, no. 5, May 1919, pp. 222-223. Emphasized by quoting its application in preparation of depth and gas bombs, construction of Liberty motor, attachment of Otto gear to hulls of ships to protect them from mines, etc.

See also Arc Welding, Spot Welding.

Electric Welding: Its Theory, Practice, Application and Economics, H. S. Marquand. Elecn., vol. 82 & 83, nos. 2144, 2146, and 2147, June 20, July 4 & 11, 1919, pp. 705-707, 17-18, and 40-41, 7 figs. Deals with preparation of welds and then passes on to certain properties of iron and mild steels which have a marked bearing on methods adopted. Examples of various types of welding. (Continuation of serial.)

Firebox Welding

Fire Box Welding, E. K. Smith. Welding Engr., vol. 4, no. 7, July 1919, pp. 42-44, 5 figs. Work done by U. S. Welding Co.

Gas Torch

Modern Welding and Cutting—XVI, Ethan Viall. Am. Mach., vol. 51, no. 3, July 17, 1919, pp. 117-122, 13 figs. Rules for welding with gas torch.

Modern Welding and Cutting—XV, Ethan Viall. Am. Mach., vol. 51, no. 2, July 10, 1919, pp. 61-65, 13 figs. Gas-torch welding and cutting outfits.

Jigs

Welding Jigs and Methods of Overcoming Distortion, C. S. Milne. Welding Engr., vol. 4, no. 7, July 1919, pp. 21-27, 23 figs. Illustrating repair work.

Welding and Cutting, B. S. Milne. Can. Machy., vol. 22, no. 3, July 17, 1919, pp. 48-51, 18 figs. Examples of welding and methods of overcoming distortion. Paper presented before British Acetylene and Welding Assn. (Continued.)

Various Jigs as Applied to the Welding Trade, B. S. Milne. Can. Machy., vol. 22, no. 1, July 3, 1919, pp. 13-15, 17 figs. Illustrating methods for overcoming distortion.

Repair Work

Rolling Mill Engine Repaired by Oxywelding, L. M. Malcher. Blast Furnace & Steel Plant, vol. 7, no. 7, July 1919, pp. 327-328, 5 figs. Repairing low-pressure steam-cylinder fracture on twin-tandem compound reversing engine at Farrell Works of Carnegie Steel Co.

Some Recent Striking Examples of Crankshaft Repairs. Reactions, 1919, vol. 12, no. 2, Second Quarter, pp. 31-36, 13 figs. Such as weld made on extension to 20-in. blooming mill crankshaft.

See also Jigs.

Seam Stress

How the Seam is Stressed in Autogenous Welding (Wie wird heim Autogenschweissen die Schweissnaht beansprucht). Autogene Metallbearbeitung, vol. 12, no. 3, Mar. 1919, pp. 31-36, 18 figs. Heat expansion and upsetting in autogenous welding of mild-steel plates; suggestions for preventing stresses; welding circular seams on cylindrical bodies. (To be continued.)

Spot Welding

A Large Spot-Welding Machine. Engr., vol. 127, no. 3311, June 13, 1919, pp. 588-589, 5 figs. Design for spot welding of tubes 5 ft. long made of ¼-in. steel plates and having an internal diameter of 8 in.

Tank Welding

Tank Welding by the Oxy-Acetylene Process, Charles C. Phelps. Machy. (N. Y.), vol. 25, no. 11, July 1919, pp. 1071-1072, 2 figs. Illustrating application of oxy-acetylene method of welding to duplicate work required in large quantities.

Thermit

Correct and Incorrect Methods of Lining up Broken Crankshafts for Thermit Welding, J. H. Deppeler. Reactions, vol. 12, no. 2, Second Quarter, 1919, pp. 37-38, 2 figs. Placing riser between slabs to prevent shrinkage of thin ribs between heavier parallel members.

Recent Thermit Technique at the Rocky Mount Shops of the Atlantic Coast Line Railroad, D. C. Lewis. Reactions, vol. 12, no. 2, Second Quarter, 1919, pp. 39-40, 5 figs. Welding of guide yoke, cast-iron driving wheel, and the like.

Truck Side Frames

Welding Truck Side Frames, Bolsters and Arch Bars. Welding Engr., vol. 4, no. 7, July 1919, pp. 48-50, and (discussion) pp. 50-52. Autogenous welding, limits and regulations recommended by Welding Committee of Am. R. R. Assn.

WOOD

Drying Wood

The Phenomena of Drying Wood, Harry D. Tiemann. Jl. Franklin Inst., vol. 188, no. 1, July 1919, pp. 27-50, 8 figs. Analysis of inter-

nal stresses which occur in wood during progress of drying, with discussion of physical properties which affect these stresses.

Kilndrying of Wood in the Airplane Industry, Myron A. Lee. Sibley Jl., vol. 33, no. 5, June 1919, pp. 66-67, 3 figs. Results obtained with kiln of hot-air-blast, bake-oven type.

Plywood

The General Properties and Uses of Plywood, B. C. Boulton. Aerial Age, vol. 9, no. 17, July 7, 1919, pp. 813-815, 2 figs. Plywood strength tables. (Continuation of serial.)

See also AERONAUTICS, Materials of Construction (Plywood).

Shrinkage

Shrinkage of Interior Trim: Its Cause and Prevention, Lawrence V. Teesdale. Am. Architect, vol. 116, no. 2275, July 30, 1919, pp. 143-145, 5 figs. Examples of shrinkage which occurs when insufficiently kiln-dried material is used. Writer advises obtaining material that has been kiln-dried to proper moisture content.

The Relation of the Shrinkage and Strength Properties of Wood to Its Specific Gravity, J. A. Newlin and T. R. Wilson. U. S. Dept. of Agriculture bul. no. 676, July 16, 1919, 35 pp., 9 figs, partly on supp. plates. Results of over 200,000 tests expressed in form to utilize them for estimating properties of any particular timber and for selecting timber for any given purpose.

Woodworking Industry

Installing Management Methods in the Wood working Industry, Carle M. Bigelow. Indus. Management, vol. 58, no. 2, Aug. 1919, pp. 124-133, 29 figs. Information in regard to handling lumber, drying lumber, construction and operation of kilns, purchasing and storing; also time study leading up to payment of bonus

Organization and Management

ACCOUNTING, FINANCE AND COSTS

Building Factors in Costs

Fixing Building Factors in Costs, M. H. Potter. Iron Trade Rev., vol. 65, no. 2, July 10, 1919, pp. 97-98. How building and associated factors are apportioned in fixing indirect costs. Fourth article.

Chemical Manufactures

Cost Analysis in Chemical Manufacture—II. Jl. Soc. Chem. Indust., vol. 38, no. 12, June 30, 1919, pp. 224R-226R. Costs and efficiencies of nitric and sulphuric acid production. Based on official reports of English foundries.

Coal-Production Costs

The Cost of Coal Production as Influenced by the Balancing of the Working Organization, F. W. Gray. Iron & Steel of Can., vol. 2, no. 7, July 1919, pp. 159-160. Cost increase since 1913. Unbalanced condition of working forces at collieries due to requirements of military service is quoted as prominent among reasons for increased expenditure required to produce coal.

Manufacturing Costs

A Graphical Analysis of Manufacturing Costs, E. L. Ackerman and L. F. Merritt. Am. Industries, vol. 19, no. 12, July 1919, pp. 20-21, 1 fig. Illustrates with hypothetical case graphical analysis of manufacturing costs of a given contract cancelled prior to completion.

Finding Costs of Manufacture, Clifford E. Lynn. Iron Trade Rev., vol. 65, no. 1, July 3, 1919, pp. 23-25, 5 figs. Recommended forms for keeping records. Fifth article.

Public Utilities

Organization and Methods of Public Utilities Accounting, C. P. Staal. Nat. Elec. Light Assn. bul., vol. 6, no. 7, July 1919, pp. 392-397, 2 figs. Diagrams showing accounting department organization of Southern California Edison Co.

EDUCATION

Accident Prevention

How to Give Illustrated Lectures on Accident Prevention to Workmen, Roy S. Bonsib. U. S. Dept. Labor, Working Conditions Service, 1919, 13 pp. Believes that most effective way to prevent accidents is through lectures with slides and moving pictures, showing results of accidents rather than how to avoid them.

Arc Welders

Training Operators for Arc Welding, E. Wanamaker and H. R. Pennington. Ry. Elec. Engr., vol. 10, no. 7, July 1919, pp. 226-231, 14 figs. Outlines methods said to have been used successfully.

See also Disabled Soldiers.

Colleges

See Engineering Students.

Disabled Soldiers

Electrical Occupations for Disabled Soldiers. Universal Engr., vol. 29, no. 6, June 1919, pp. 41-45. In construction, repair, and maintenance work.

Teaching Autogenous Welding to Disabled Soldiers (Lehrwerkstätte des Verbandes für autogene Metallbearbeitung an der staatlichen Maschinenbauschule zu Cöln). Acetylen in Wissenschaft und Industrie, vol. 22, nos. 3-4, Feb. 1919, pp. 15-18, 7 figs. Showing appliances used for various forms of disability.

Engineering Students

Broader Education for Engineers, George B. Pegram. Jl. Engrs. Club of Philadelphia, vol. 36, no. 176, July 1919, pp. 274-277. Preparing students to come into professional engineering course with fair general education on ordinary subjects and definite amount of preparation in fundamental sciences.

"Case System" Changes in Engineering Curricula, and Business Training for Engineers. Eng. News-Rec., vol. 83, no. 4, July 24, 1919, pp. 183-187. Results at Army Engineer School at Camp A. A. Humphreys in applying definite problem method. Radical reorganization in methods of instruction effected at Tufts College and Yale University.

Hawthorne Training Schools

Training Men and Women at Hawthorne, F. W. Willard. Western Elec. News, vol. 8, no. 5, July 1919, pp. 2-6. Theoretical as well as practical instruction.

Higher Positions

Choosing and Training the Man for the High Position, Julian McGill. Jl. Electricity, vol. 43, no. 1, July 1, 1919, pp. 11-12. Suggests rules governing training of men.

Miners

Educational Methods at the Copper Queen, Chas. F. Willis. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 151, July 1919, pp. 1099-1106, 1 fig. Course designed for education of miners to shift-boss position.

Upgrading in Training Department

Upgrading in the Training Department, M. R. Lott. Indus. Management, vol. 58, no. 2, Aug. 1919, pp. 100-104, 4 figs. Method of Sperry Gyroscope Co.

Tin-Plate Mills

Education a Plant Efficiency Factor, J. K. Lamoree. Iron Age, vol. 104, no. 5, July 31, 1919, pp. 296-297. Application in tin-plate mill.

Training

Preparing Industry for Reconstruction Demands, C. T. Clayton. Am. Mach., vol. 51, no. 1, July 3, 1919, pp. 19-22, 2 figs. Points out advantages of training men in manufacturing industry.

Vocational Education

Vocational Education Under the Smith-Hughes Act. Metal Trades, vol. 10, no. 7, July 1919, pp. 297-300. Provisions of the Act as far as industrial education is concerned.

FACTORY MANAGEMENT

Bonus Systems

Bonus System Reduces Coal Consumption at Denver, W. E. Casey and E. Weber. Power, vol. 50, no. 5, July 29, 1919, pp. 174-179, 7 figs. By installation of new turbine and introduction of bonus system, Denver tramway system claims to have reduced coal consumption to less than 2.5 lb. per kw-hr., with saving in operating expenses of about $150,000 per year.

Construction Records

Mastering Service Problems with a Master Sheet—II. Motor Age, vol. 36, no. 3, July 17, 1919, pp. 22-25, 7 figs. Service records for indicating repair jobs through shop proves a time saver.

Progressive Cards for Shipyards. Shipbuilding and Shipping Record, vol. 14, no. 2, July 10, 1919, pp. 41-42, 1 fig. Suggests system of checking progress of construction.

Drawing Office

The Principles of Drawing Office Organization, N. Gerard Smith. Eng. & Indus. Management, vol. 2, no. 1, July 3, 1919, pp. 13-15, 1 fig. Functions of office are believed to be (1) to design product and manufacturing plant and processes, (2) to collect ideas wherever they may be found, and to utilize them to best advantage, (3) to experiment with and demonstrate all new product and processes, (4) to deal with time study, (5) to record all data.

Employment Management

Employment Management, A. Rowland Entwistle. Eng. & Indus. Management, vol. 1, no. 19, vol. 2, nos. 1 and 2, June 19, July 3, and 10, 1919, pp. 590-593, 6-10, 38-41, 1 fig. June 19: Object, scope and functions of the employment manager. July 3: Constructional details of employment department. July 10: Qualifications of employment manager.

Physical Examination Previous to Employment, Chas. F. Willis. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 151, July 1919, pp. 1013-1020. Advocated not for the purpose of eliminating the unfit, but for measuring physical fitness and placing men where they can do the best for themselves, for their fellow-workers and the company.

Gage Making

See Management Methods.

Garment Trades

See Management Methods.

Industrial Cooperation

Anti-Social, Militant Methods Condemned, Walter Gordon Merritt. Iron Age, vol. 104, no. 1, July 3, 1919, pp. 9-12. Coöperation of different companies through representatives chosen by employer and employees suggested.

Industrial Democracy—The Leitch Plan. Min & Oil Bul., vol 5, no. 7, June 1919, pp. 395-396 and p. 411. Coöperation between executive and operating individuals by means of an industrial democracy house of representatives.

Successful Industrial Democracy, Dale Wolf. Indus. Management, vol. 58, no. 1, July 1919, pp. 67-71, 2 figs. Participation board plan of Miller Lock Company.

Industrial Co-operation, W. R. Ingalls. Min. & Sci. Press, vol. 118, no. 26, June 28, 1919, pp. 877-884. Economical aspect. Paper read before Can. Min. Inst.

Industrial Democracy in Operation, B. C. Forbes. Iron Age, vol. 104, no. 4, July 24, 1919, pp. 239-240. Representative plan which has been adopted by a number of companies.

Industrial Personnel Relations, Arthur H. Young. Mech. Eng., vol. 41, no. 7, July 1919, pp. 581-586. Human factor in organization systems intended to promote safety; also account of International Harvester Co.'s plan of employees' representation.

Interchangeable Manufacture

Principles of Interchangeable Manufacturing, Earl Buckingham. Machinery, vol. 25, no. 11, July 1919, pp. 1024-1029. Factors which make possible, or permanent, interchangeable manufacture of mechanical products.

Labor Labels

Organizing an Industrial Republic, A. J. Hain. Iron Trade Rev., vol. 65, no. 4, July 24, 1919, pp. 21-26. Commercial possibilities of label or trade-mark bearing words "Made in an Industrial Democracy," or similar phrase to denote that product originated in factory where labor is given voice in management.

Management Methods

Installing Management Methods in the Woodworking Industry, Carle M. Bigelow. Indus. Managament, vol. 58, no. 1, July 1919, pp. 1-8, 6 figs. Necessity of establishing engineering department in woodworking industry emphasized by reference to writer's experience in several of these plants where lack of this department permitted conditions which encouraged waste and inefficiency. Basis for organizing such department is suggested.

How We Increased Output 1000 Per Cent in an Already Crowded Plant. Factory, vol. 23, no. 1, July 1919, pp. 40-42. Improvements performed in various departments such as giving better tempering to cutting tool in screw machine that was found to dull quickly. From experiences of Gillette Safety Razor Co.

Efficiency in the Gage-Making Department, C. B. Cole. Machinery, vol. 25, no. 11, July 1919, pp. 1056-1057. Operation and management of gage-making department on time- and money-saving basis.

Scientific Management in Road Construction, A. W. Campbell. Contract Rec., vol. 33, no. 26, June 25, 1919, pp. 634-635. System of cost-keeping for securing greatest possible performance for given outlay.

Modern Management Methods, Applied to Construction, Mean Higher Efficiency, Daniel

J. Hauer. Contract Rec. vol. 33, no. 26, June 25, 1919, pp. 585-589. How scientific scheme of planning and organization opens way to greater and more certain profits.

Factory Management in Garment Trades, Mack Gordon. Indus. Management, vol. 58, no. 1 and 2, July and August 1919, pp. 12-16 and 140-145, 10 figs. July: Functions and methods of planning department. August: Time studies and instructions.

Managing for Maximum Production, L. V. Estes. Indus. Management, vol. 58, no. 1 and 2, July and August 1919, pp. 54-61 and 134-138, 10 figs. July: V—Use of standards and instructions. August: VI—Emphasis is laid upon needed fostering spirit of coöperation, training some one to perpetuate and carry forward betterment work and making an occasional management audit.

Organizing for Work, H. L. Gantt. Indus. Management, vol. 58, no. 2, Aug. 1919, pp. 89-93, 3 figs. Machine-record charts, progress charts and man-record charts.

Organization and Management of a Machine-Tool Plant—II. Machy. (Lond.), vol. 14, no. 353, July 3, 1919, pp. 408-411, 10 figs. Work of planning department in relation to time study and rate setting in medium-sized plant making single line of machines.

System in the Small Works. Eng. Rev., vol. 32, no. 12, June 16, 1919, pp. 340-341. Points out that general shops need have very little fear of total extinction.

Orders

The Production Planning System of Heald Machine Company, W. S. Pratt. Am. Mach., vol. 51, no. 5, July 31, 1919, pp. 203-208, 9 figs. General system and writing of orders. (First article.)

Payroll Computing

The Periodograph. A Decimal Time-Keeping Machine, J. Y. Hunter. Am. Mach., vol. 51, no. 2, July 10, 1919, pp. 49-54, 20 figs. Division of hour into ten parts for purpose of simplifying work of payroll computer. Manufacturing operations at Periodograph shop.

Periodograph

See Payroll Computing.

Planning Department

The Planning Department in Scientific Management—II, James F. Whiteford. Eng. & Indus. Management, vol. 1 & 2, no. 26 & 1, June 26 and July 3, 1919, pp. 632-636 and 23-24. Discussion following reading of paper of that title read before Indus. Reconstruction Council.

Plant Construction

Planning the Industrial Plant—II, Hugh M. Wharton. Indus. Management, vol. 58, no. 1, July 1919, pp. 47-50, 11 figs. Application for standard types of construction. (To be continued.)

Plant Layout

Doubles Steelmaking Capacity, G. H. Manlove. Iron Trade Rev., vol. 65, no. 2, July 10, 1919, pp. 87-95, 13 figs. Works of Inland Steel Co., with reference especially to mill equipment and layout for routing of material.

Planning a Progress Department.—III, W. J. Hiscox. Eng. & Indus. Management, vol. 1, no. 20, June 26, 1919, pp. 621-622, 3 figs. Suggestions in regard to selecting location so as to permit efficient handling of materials and to prevent confusion and overlapping.

Production

Increase Production to Reduce Prices. Contract Record, vol. 33, no. 30, July 23, 1919, pp. 713-715. Greater physical production considered as only solution of present industrial difficulties.

Rate Setting

Time Study and Rate Setting in a Machine Tool Plant, Erik Oberg. Machinery, vol. 25, no. 11, July 1919, pp. 1051-1055, 8 figs. System consists of determining, by actual experiments or performance of work in shop, accurate estimate of time in which it can be done. Bonus time is a certain amount less than "standard" time so determined.

Rating Workers

Dangers in Rating Employes, Roy Willmarth Kelly. Indus. Management, vol. 58, no. 1, July 1919, pp. 35-42, 13 figs. Methods used by representative American firms in rating workers for salary advances and promotions. It is recommended that rating divisions be few and questions to be answered precise.

Scientific Management

Scientific Management (Wissenschaftliche Betriebführung), Victor Frey. Schweizerische Bauzeitung, vol. 73, no. 21, May 24, 1919, pp. 237-240. With reference to systems of Taylor, Gilbreth-Ross and Gantt.

Shop Committees

Shop Committees as Lubricants in Management, William Leavitt Stoddard. Factory, vol. 23, no. 1, July 1919, pp. 37-40, 2 figs. System of representation ordered by War Labor Board at Lynn works of General Electric Co. following strike of workers during June-July 1918.

Representative Shop Committees, Willard G. Aborn and William L. Shafer. Indus. Management, vol. 58, no. 1, July 1919, pp. 29-32. Discusses basis of representation, method of election, election procedure, eligibility requirements, committee procedure, relations with labor unions and personnel of shop committees.

How Far Should Shop Committees Go? William Leavitt Stoddard. Indus. Management, vol. 58, no. 2, Aug. 1919, pp. 121-123. Observes that spirit of compromise must prevail else no good can be accomplished.

Small Shop

See Management Methods.

Symbolization, Mnemonic

Factory "Nicknames" That Save Time, Henry H. Farquhar. Factory, vol. 23, no. 1, July 1919, pp. 50-53. Basis of mnemonic symbolization.

Taylor System

An Object Lesson in Efficiency, Wilfred Lewis. Eng. & Indus. Management, vol. 1, no. 19, June 19, 1919, pp. 594-596. Illustration of what has been accomplished along lines laid down by F. W. Taylor by the Tabor Mfg. Co.

Tool Stores

The Model Tool Stores—II & III, Herbert C. Armitage. Eng. & Indus. Management, vol. 1 & 2, no. 20 & 2, June 26 & July 10, 1919, pp. 615-617 and 35-37, 8 figs. Their functions as independent stores investigated chiefly in regard to maintenance of effective stocks of all wearing tools. Arrangement, organization, construction and equipment. (Continuation of serial.)

Wage Systems

My Objection to the Piece Rate Method of Wage Payment—II, Harrington Emerson. Indus. Management, vol. 58, no. 1, July 1919, pp. 17-20. Lays down physiological laws of work, and discusses manner of estimating task and preparing standard schedule.

See also Bonus Systems, Rate Setting.

Welfare Buildings

Design and Construction of Factories—17, Arthur F. Wickenden. Eng. & Indus. Management, vol. 1, no. 20, June 26, 1919, pp. 618-619. Welfare buildings.

Welfare Work

Coöperation Between Management and Employes, E. O. Davis. Textile World Jl., vol. 56, no. 3, July 19, 1919, pp. 49-51, 5 figs. Emphasizes need of welfare and educational work as means of increasing production and improving quality of manufactured products.

Woodworking Industry

See Management Methods.

Work Records

Machine Repair Records, John A. Davenport. Machy., (Lond.), vol. 14, no. 352, June 26, 1919, pp. 365-367, 6 figs. Forms for keeping record of all repair work completed and in progress.

LABOR

Foremen

Who Make the Best Foremen? Factory, vol. 23, no. 1, July 1919, pp. 63-67, 5 figs. Personnel record forms of Service Motor Truck Co.

Great Britain

What I Found the British Employer Thinking About, Samuel Crowther. Factory, vol. 23, no. 1, July 1919, pp. 57-61. Position trade unions held at the beginning of the war; how women workers were affected by close of war.

Royal Commission on Industrial Relations Reports Its Findings on Labor Situation. Contract Rec., vol. 33, no. 28, July 9, 1919, pp. 667-668. Recommends, among other things, establishment by legislation of eight-hour day and recognition of greater rights of workers in control of industry.

Intelligence Tests

Intelligence Tests in Industry, J. P. Lamb. Indus. Management, vol. 58, no. 1, July 1919, pp. 21-23, 1 fig. Experience in industrial plant where such tests have been used for three years believed to indicate advisability of conducting them.

International Labor Standards

Enforcement in U. S. of International Labor Standards, George W. Wickersham. Am. Industries, vol. 19, no. 12, July 1919, pp. 11-16 and p. 42. Conclusion derived by writer from analysis of labor program as outlined in recent conferences in Europe and the U. S. A.

Labor Unrest

Prepare for Labor Unrest While Labor is Content, Harry Tipper. Automotive Indus., vol. 41, no. 2, July 10, 1919, pp. 77-79. Points out that even during prosperity and industrial peace and contentment radicals never let their printing presses or propaganda machine lie idle.

Living Conditions

Making the Workman's Dollar Bigger, Emerson P. Harris. Indus. Management, vol. 58, no. 2, Aug. 1919, pp. 111-112. By insuring economy and real competition in the purveying of household supplies.

Profit Sharing

Fallacy of the Employees' Profit-Sharing as a Reward for Labor, P. L. Burkhard. Indus. Management, vol. 58, no. 1, July 1919, pp. 42-45. It is emphasized as fundamental fact that no profit-sharing scheme can be substituted for a proper wage-payment system whereby adequate wages are paid to workers. It is pointed out that profit sharing must always be secondary to a fair, suitable reward for labor.

Women

Women's Work in Engineering and Shipbuilding During the War, Lady Parsons. Engineering, vol. 108, no. 2793, July 11, 1919, p. 62. Statistical data obtained from report of War Cabinet Committee on Women in Industry. Paper read before North-East Coast Inst. of Engrs. and Shipbuilders.

Women in Industry (Die weibliche Hilfskraft im Fabrikbetriebe), Karl Beneke. Dinglers polytechnisches Journal, vol. 334, no. 1, Jan. 11, 1919, pp. 4-6, 3 figs. Writer believes that when properly selected, the number of women suitable for ordinary factory work will be found larger than generally supposed. He also considers training course, as introduced by many large plants in Germany, as best method for selection.

LEGAL

Accident Legislation

Legislation and the Coal Trade, E. T. Good. Eng. & Indus. Management, vol. 2, no. 2, July 10, 1919, pp. 56-57. How accidents have been reduced.

Dependency

The Riddle of Dependency—II & III, Chesla C. Sherlock. Am. Mach., vol. 51, no. 1 & 2, July 3 & 10, 1919, pp. 10-12 and 70-72. Effects of desertion, bigamy, divorce and common-law marriages on the making of compensation awards. Question of disposing of compensation in case of death of workman's widow.

Disease and Accident Liability

Disease and Accident Liability, Chesla C Sherlock. Iron Trade Rev., vol. 65, no. 3, July 17, 1919, pp. 168-169. It is noted that courts hold employer must pay damages when disease results from injury and when injury hastens fatal consequence of disease.

Explosion of Chemicals

The Explosion of Chemicals—I, Common Law Liability, Chesla C. Sherlock. Chem. & Metallurgical Eng., vol. 21, no. 2, July 15, 1919, pp. 83-84. With reference to court decisions bearing on the subject.

RECONSTRUCTION

Reconstruction Problems, F. R. Todd. Gas Engine, vol. 21, no. 7, July 1919, pp. 213-216. Expresses optimism in viewing readjustment during period of reconstruction.

The Industrial Situation, E. Garcke. Eng. Rev., vol. 32, no. 12, June 16, 1919, pp. 337-339. Pleads for readjustment of economic system in order to repair ravages of war, to inaugurate industrial peace and to prevent famine of capital a few years hence.

Foreign Countries

Readjustment and Reconstruction Activities in Foreign Countries, Grosvenor B. Clarkson. U. S. Council of Nat. Defense, Reconstruction Research Division, Washington, D. C., May 1, 1919, 188 pp. Extracts from and digests of articles concerning readjustment and reconstruction activities in foreign countries, which have appeared in recent publications. Material selected consists of accounts of governmental activities in organization and administration of readjustment and reconstruction work, and

of similar activities of important national industrial, commercial, and welfare organizations.

Great Britain

British Engineers' Reconstruction Problems. E. J. Elford. Good Roads, vol. 56, no. 3, July 16, 1919, pp. 23-35. Development of labor-saving machinery and methods of dealing with labor situation considered as chief problem of municipal engineers. Paper prepared for meeting of Instn. of Mun. & County Engrs.

International Competition

Applying Industrial Efficiency to Readjustment, Charles E. Bedaux. Am. Contractor, vol. 40, no. 29, July 19, 1919, pp. 21-22. Forecasts that future competition will require at least 33 per cent reduction in production costs to meet foreign labor costs.

Machine-Tool Reappraisal

How War Department Will Revalue Used Machine Tools. Automotive Indus., vol. 41, no. 2, July 10, 1919, p. 67, 2 figs. Chart for use in appraisal of standard machine tools to determine service value.

Markets

Principle for Stabilizing Prosperity, G. Sumner Small. Indus. Management, vol. 58, no. 1, July 1919, pp. 24-28. Suggests utilization of reserve purchasing power of Government to sustain market, providing employment for idle labor on government work, and equalizing rate of purchase of materials with rate of consumption through governmental regulations.

SAFETY ENGINEERING

Acetylene Apparatus Explosions

Explosions in Acetylene Apparatus (Explosionen von Acetylen-Apparaten). Acetylen in Wissenschaft und Industrie, vol. 22, nos. 1-2, Jan. 1919, pp. 4-5. New regulations for cleaning and handling apparatus.

Apparatus Failure

Accidents Due to Structural Defects of Apparatus or Injury to Apparatus, D. Dale Logan. Iron & Coal Trades Rev., vol. 98, no. 2677, June 20, 1919, pp. 850-851. Details of two fatal accidents which happened during rescue operations in France. Paper read before Instn. of Mining Engrs.

Breathing Apparatus

Development and Improvement of Breathing Apparatus, H. H. Sanderson. Can. Min. Inst. Bul., no. 87, July 1919, pp. 730-736. Particularly Gibbs and Paul apparatus.

Electrical Apparatus

Safety Rules for Men Handling Electrical Circuits or Apparatus. General Elec. Rev., vol. 22, no. 6, June 1919, pp. 484-486. Based on experience acquired in electrical field by General Electric Co.

Gas Poisoning

Protection Afforded by Army Gas Masks Against Various Industrial Gases, A. C. Fieldner, M. C. Teague and J. H. Yoe. Jl. Indus. & Eng. Chem., vol. 11, no. 7, July 1, 1919, pp. 622-623. Results of tests against various gases.

Kerosene-Lamp Explosions

Kerosene Lamp Explosions, C. E. Worthington. Safety Eng., vol. 38, no. 1, July 1919, pp. 1-13, 9 figs. Lamp explosions are believed to be more properly termed flares. Conclusions are derived in regard to causes producing such explosions and remedies are suggested.

National Electric Safety Code

Is the National Electric Safety Code Suitable for California? Edward B. Rosa. Jl. of Electricity, vol. 43, no. 2, July 15, 1919, pp. 57-59. Standpoint of Bur. of Standards in regard to safety code and institution of code of ethics.

The National Electrical Safety Code, Geo. E. Quinan. Jl. of Electricity, vol. 43, no. 2, July 15, 1919, pp. 54-57. Discussion of problems, aims and the building up of present national code. Paper read before joint meeting of Am. Inst. Elec. Engrs. and Nat. Elec. Light Assn.

Safeguards

Industrial Safety—I, R. J. Young. Power Plant Eng., vol. 23, no. 15, August 1, 1919, pp. 689-690, 1 fig. Design and construction of safeguards. Lecture delivered before Schools for Safety Engr. conducted by Nat. Safety Council.

Safety-First Instructions

Safety First Instruction Through Moving Pictures, Ernest A. Dench. Jl. Electricity, vol. 43, no. 1, July 1, 1919, pp. 15-16. Pictures available and how to obtain them.

Sprinkler Protection

Automatic Sprinkler Protection a Necessity, C. G. Sherman. Contract Rec., vol. 33, no. 27, July 2, 1919, pp. 644-646. Claims that sprinklers have been proved 95 per cent efficient and that consequently they give a guarantee against fire loss that is needed when wastage is so high.

SALVAGE

Warring on Waste—XIII, Johnson Heywood. Factory, vol. 23, no. 1, July 1919, pp. 44-47, 2 figs. Instances showing how material has been saved in factories.

TRANSPORTATION

Industrial Electric Trucks

Use of Industrial Electric Trucks and Tractors by Railroads, Bernard J. Dillon. Elec. Rev., vol. 74, no. 26, June 28, 1919, pp. 1069-1073, 5 figs. Methods of application in handling of freight and baggage.

Motor Transportation

Motor Transportation, J. M. Ritchie. Jl. Engrs. Club of Philadelphia, vol. 36, no. 176, July 1919, pp. 281-282. Its relation to national highway development.

Hauling Over the Highways with Motor Trucks. Good Roads, vol. 18, no. 4, July 23, 1919, pp. 46-49, 14 figs. Examples of services performed by motor vehicles in rural motor express and intercity hauling. Cost data.

Rail and Truck Transportation Compared

The Relative Economy of Freight Transport by Railway and by Motor Truck, Charles Whiting Baker. Eng. News-Rec., vol. 83, no. 2, July 10, 1919, pp. 52-67. Based on figures compiled by Motor Truck Assn. of America and statistical data of railway companies having freight traffic less than 20,000 ton-miles per annum per mile of line.

Refuse Collection

Cost of Motor Truck Operation for Refuse Collection. Eng. & Contracting, vol. 52, no. 1, July 2, 1919, pp. 11-13. Data given by Rochester Bur. of Municipal Research.

Trailers

Trailers and Trucks for Highway Hauling, Harry Wilkin Perry. Good Roads, vol. 18, no. 4, July 23, 1919, pp. 41-44, 7 figs. How trailer solves special hauling problems, reduces road repair and maintenance costs and cuts down cost of highway transportation.

EXPORT

China

International Engineering Interests in China. Eng., vol. 108, no. 2792, July 4, 1919, pp. 827-829. Advocates reconstruction scheme which should include international supervision of all new loan expenditures and loan allotment and creation of an international railway service, which should control all railway policy.

See also Machine Tools in China.

Electrical Products

Export Conditions for Electrical Products. Elec. World, vol. 74, no. 2, July 12, 1919, pp. 64-65. Summary of information on South American countries emphasizes element of financing sales of manufactured materials for public-utility use and water-power possibilities.

Home Markets

The Future of Industry, F. J. Whiting. Stone & Webster Jl., vol. 24, no. 6, June 1919, pp. 474-484. Considerations on saturation of home markets in the face of present prospects of enlarging our foreign trade.

Internal-Combustion Engines

Where is the Foreign Market for Internal Combustion Engines, Lynn W. Meekins. Gas Engine, vol. 21, no. 8, August 1919, pp. 249-252. Possibilities of exporting internal-combustion engines. Paper read before Nat. Gas Engine Assn.

Latin America, Rolling Stock

Entering the Latin American Markets, Percy F. Martin. Eng. & Indus. Management, vol. 1 (New Series), no. 20, June 26, 1919, pp. 628 and 630. Opportunities for manufacture of rolling stock.

Machine Tools in China

The Machine Shops of China, Frank A. Foster. Am. Mach., vol. 51, no. 3, July 17, 1919, pp. 99-103, 12 figs. Opportunities of American machine-tool builder.

Electrical Engineering

ELECTROCHEMISTRY

Bleaching, Electrolytic

Electrolytic Bleach, Anson G. Betts. Paper, vol. 24, no. 18, July 9, 1919, pp. 15-16. Technical details of operation in electrolytic bleach plants.

ELECTRODEPOSITION

Electrochemical Industry

Utilization of Electrical Energy in Electrochemical and Electrometallurgical Industry (Consommation d'énergie électrique dans la fabrication de divers produits de l'électrochimie et de l'électrométallurgie), Revue Générale de l'Electricité, vol. 5, no. 26, June 28, 1919, pp. 913-923. Figures indicating kilowatts consumed in electrolytical processes.

ELECTROPHYSICS

Alternating-Current Circuits

Calculation of Alternating Current Circuits, Terrell Croft. Nat. Engr., vol. 23, no. 7, July 1919, pp. 338-342, 10 figs. Graphic method of computing wire sizes with Mershon diagram for two- and three-phase circuits. (Continuation of serial.)

Audion

See Vacuum Valve.

Cables, Heating of

Heating of Underground Cables, A. L. Freret. Jl. Engrs., Club of Philadelphia, vol. 36, no. 177, August 1919, pp. 301-303, 4 figs. Experiments to determine safe operating intermittent loads on underground cables.

Circuit Breakers

Calculation of Current Intensity Required to Operate a Circuit Breaker and Study of the Effects of a Short-Circuit (Calcul de l'intensité de déclanchement d'un disjoncteur et recherche d'un court-circuit), B. Guerschinovitch. Industrie Electrique, vol. 28, no. 648, June 25, 1919, pp. 224-227, 3 figs. Application of previously derived formula to various examples. (Concluded.)

Electromagnetic Waves

Electromagnetic Waves, T. J. I. Bromwich. Lond., Edinburgh, and Dublin Phil. Mag., vol. 38, no. 223, July 1919, pp. 143-164. General solution of electromagnetic equations of wave propagation.

The Production and Measurement of Short Continuous Electromagnetic Waves, Balth. van der Pol. Lond., Edinburgh, and Dublin Phil. Mag., vol. 38, no. 223, July 1919, pp. 90-97, 4 figs. By means of three-electrode thermionic tube with suitable circuits.

Gyro Compass

The Electrical Gyro Compass, O. B. Whittaker. Elec. Rev., vol. 74, no. 26, June 28, 1919, pp. 1078-1081, 7 figs. Principle upon which it operates is said to be a combination of laws of gravity and of rotation of the earth and the two characteristics of the gyroscope. Lecture delivered before Am. Soc. Mech. Inspectors.

Inductances

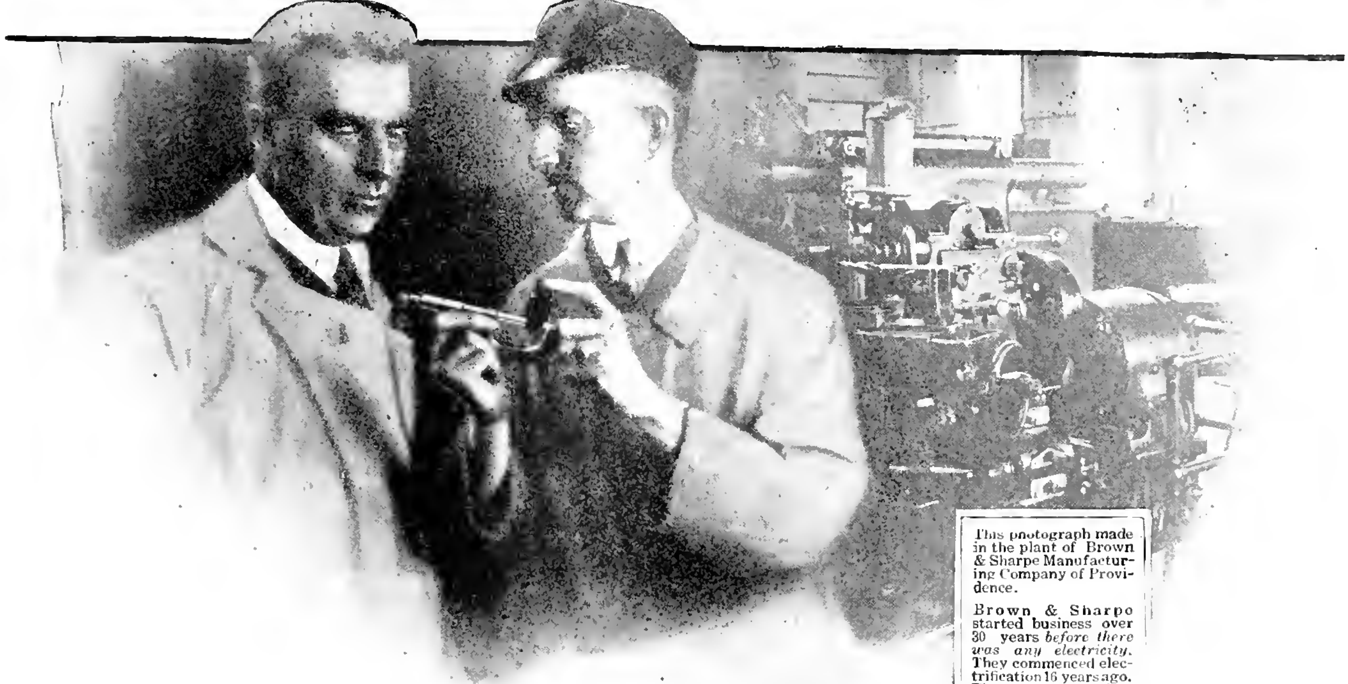
Calculating Growth of Current in an Inductance, Carl Hering. Elec. World, vol. 74, no. 4, July 26, 1919, p. 75. Method offered for simplifying computations when plotting curves showing rise in current in induction coils.

Simplified Inductance Calculations, with Special Reference to Thick Coils, Philip R. Coursey. Phys. Soc. of London, vol. 31, no. 4, June 15, 1919, pp. 155-167, 8 figs. Method based on extension of Nagaoka's formula for single-layer coils, to include as well all ordinary forms of thick coils. Rosa's formula for thick coils is put into the same form as Nagaoka's and by it a series of correction factors is calculated for various coil thicknesses.

Kenotron

Thermoelectric Emission and Its Applications: The Kenotron (L'émission thermo-électrique et ses applications: Le kénotron), G. Johannès. Revue Génerale de l'Electricité, vol. 5, no. 24, June 14, 1919, pp. 857-864, 5 figs. Technical study of rectifiers operating by electronic discharges. (To be continued.)

The wide use of General Electric Motors—precision instruments themselves—has helped make "American standardization" an example of efficiency for the whole world.



This photograph made in the plant of Brown & Sharpe Manufacturing Company of Providence.

Brown & Sharpe started business over 30 years *before there was any electricity.* They commenced electrification 16 years ago. Three years ago electrification was completed—with 90% of all the power applied *through G-E motors.* G-E Motor Equipment is also standard on the machine tools Brown & Sharpe manufacture.

Accuracy—
an American characteristic

ACCURACY finds its highest expression in what the world calls *American Standardization.*

It is attained by the accuracy of the men and tools which produce it.

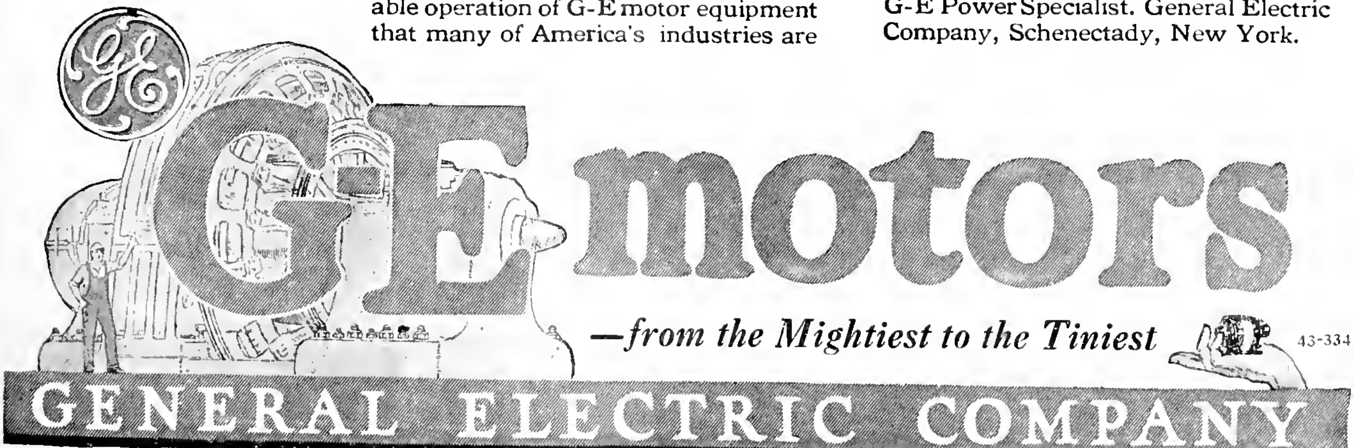
The highest accuracy in men and tools depends a good deal on the way power is applied and *controlled.*

And it is much because of the dependable operation of G-E motor equipment that many of America's industries are achieving fame for accuracy, efficiency and quality.

Accuracy is the element that makes watches "keep time"; makes automobiles save "gas"; makes cooking a science. Accuracy determines efficiency. Accuracy, plus speed, does America's work

To get accuracy and its by-products—dependability and efficiency—call in a G-E Power Specialist. General Electric Company, Schenectady, New York.

*Look for it—
the mark of leadership in electrical development and manufacture*



Nitrogen Electrode

The Potential of a Nitrogen Electrode, Francis Lawry Usher and Ramavenkatasubbier Venkateswaran. Jl. Chem. Soc., vol. 115 & 116, no. 680, June 1919, pp. 613-618, 1 fig. Evidence in support of assertion that during electrolysis of acid solution substance set free at anode is active form of ordinary nitrogen.

Power Flow

The Flow of Power in Electrical Machines, J. Slepian. Elec. Jl., vol. 16, no. 7, July 1919, pp. 303-311, 23 figs. Definitions and properties of Poynting vector and illustration of its application for picturing power flow in reactor, transformer, direct-current generator, alternator, synchronous condenser and induction motor.

Spark Potential

Influence of a Transverse Magnetic Field on the Spark Potential (Ueber die Beeinflussung des Funkenpotentials durch ein transversales Magnetfeld), Edgar Meyer. Annalen der Physik, vol. 58, no. 4, 1919, pp. 297-332, 10 figs. Theory of influence of magnetic field. Dependence from cross-section of spark gap.

Thermionic and Photo-Electric Phenomena at the Lowest Obtainable Pressure, C. F Hagenow. Physical Rev., vol. 13, no. 6, June 1919, pp. 415-433, 5 figs. Studied specially after illuminated plate had been denuded of occluded gases by continued electric bombardment.

Thermoelectric Equations

The Thermoelectric Equation $P = TdV/dT$ Once More, Edwin H. Hall. Proc. Nat. Acad. Sciences, vol. 5, no. 6, June 15, 1919, pp. 197-198. Questions validity of equation as commonly understood, P being taken as ordinary Peltier effect, and V the Volta effect between any two metals.

Three-Electrode Lamp

Maintenance of Mechanical Oscillations by Means of Three-Electrode Lamp (Sur l'entretien des oscillations mécaniques au moyen des lampes à trois électrodes), Henri Abraham and Eugéne Bloch. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 24, June 16, 1919, pp. 1197-1198. Based on property of audions which permits introducing in electrical circuit an inductive resistance.

Vacuum Valves

Maintaining Electrical Oscillations by Means of a Three-electrode Valve (Entretien des oscillations électriques par une lampe-valve à trois électrodes), G. Gutton. Revue Générale de l'Electricité, vol. 6, no. 1, July 5, 1919, pp. 14-24, 10 figs. Scheme developed by the division of military radiotelegraphy of the French army for the purpose of maintaining oscillations of antennæ. A suggested theory of phenomenon involved is presented. (Properties of valves were treated in R.G.E., April 26, 1919, p. 629.)

The Audion as a Circuit Element, H. W. Nichols. Physical Rev., vol. 13, no. 6, June 1919, pp. 404-414, 5 figs. Functional equations for three-element audion used to deduce actions taking place in any circuit containing the audion.

The Theory of Valve Rectification, W. S. Barrell. Wireless World, vol. 7, no. 76, July 1919, pp. 181-186, 6 figs. Outlines elementary theory of thermionic valve in its application to (1) two-electrode or Fleming valve, and (2) three-electrode valve. (To be continued.)

FURNACES

Bailey Furnace

Electric Furnace Progress, L. F. Bailey. Metal Indus., vol. 17, no. 7, July 1919, pp. 316-317, 2 figs. Bailey furnace.

Booth-Hall

The Booth-Hall Electric Furnace, W. K. Booth. Foundry Trade Jl., vol. 21, no. 209, May 1919, pp. 301-302, 4 figs. Vertical-arc type with conducting hearth.

Brass Furnace

Utilization of Electric Brass Furnaces, H. W. Gillett. Jl. Indus. & Eng. Chem., vol. 11, no. 7, July 1, 1919, pp. 664-668. Development and growth of electric brass furnace applications, and table giving performance of various types of electric brass furnaces.

Design

See Requirements.

Great Britain

Electric Furnaces in the United Kingdom, 1918, R. G. Mercer. Foundry Trade Jl., vol. 21, no. 209, May 1919, pp. 295-301. Elecn. vol. 82, no. 25, June 20, 1919, pp. 694-695. Figures quoted indicate that there are installed or being installed 142 electric furnaces with a total capacity of 112,000 kva. Of these, 117 are electric steel furnaces.

Metal-Melting Furnaces

Application of Electrical Energy to the Melting of Metals, H. A. Greaves. Engineering, vol. 108, no. 2793, July 11, 1919, pp. 42-43, 8 figs. Suggested connections to enable three-phase or two-phase current to be applied to furnace with an unequal resistance in one of the phases and still maintain balance load as regards both power and power factor on primary phases. Paper read at joint meeting of Instn. of Elec. Engrs. and Iron and Steel Inst.

Moffat Steel Furnace

The New Moffat Electric Steel Furnace, W. F. Sutherland. Can. Machy., vol. 22, no. 4, July 24, 1919, pp. 69-70, 3 figs. Designed, it is said, to overcome troubles frequently encountered by reason of crescent-shaped masses of partially fused raw material found clinging to walls between electrodes. This is claimed to have been accomplished by shaping body to conform to lines of current flow in bath of molten metal.

Morgan Crucibles

Electric Furnace Developments for Non-Ferrous Metals. Metal Industry, vol. 14, no. 22, May 30, 1919, pp. 444-447, 6 figs. Morgan crucibles. New feature said to be that crucible is container and also conductor to be heated.

Records

Operating Records of Electric Steel Furnaces. Elec. World, vol. 74, no. 3, July 19, 1919, pp. 125-127, 2 figs. Characteristics, 1918 energy consumption, maximum demand and steel output of eighteen arc-type furnaces in Milwaukee district, with experience of some users in operating them.

Requirements

Large Electric Steel-Melting Furnaces, Victor Stobie. Foundry Trade Jl., vol. 21, no. 209, May 1919, pp. 304-311, 8 figs. Technical requirements formulated from experiments and observations.

Developments in Electric Iron and Steel Furnaces, J. Birby. Foundry Trade Jl., vol. 21, no. 209, May 1919, pp. 311-323, 24 figs. Urges that engineers designing electric furnaces for use in manufacture of iron and steel fully grasp requirements of metallurgists and be fully acquainted with working conditions of blast furnaces and with steel foundries.

Sahlin Furnace

A New Type of Electric Furnace, Axel Sahlin. Foundry Trade Jl., vol. 21, no. 209, May 1919, pp. 302-304, 2 figs. Sahlin Furnace. Said to have been designed with a view to embodying advantages of both the direct-arc and the free-burning arc furnaces, at the same time avoiding as far as possible the disadvantages of both. Built as circular ladle with contracted top and dished bottom.

Steel Making

Electric Furnaces in Steel Making, Victor Stobie. Jl. of West of Scotland Iron & Steel Inst., vol. 26, no. 7, Mar. 1919, pp. 90-94 and (discussion) pp. 94-103, 9 figs. on 4 supp. plates. Claims following improvements for thorough sealing up of furnace roof: (1) no cold air is drawn into furnace; (2) no flames or highly heated air burn away the electrodes above roof; (3) electrodes can be of smaller diameter for a given current supply. Also other economic advantages and conveniences in manufacture of various alloys.

Temperature Regulation

A Furnace Temperature Regulator, Walter P. White and Leason H. Adams. Physical Rev., vol. 14, no. 1, July 1919, pp. 44-48, 1 fig. By making heating coil of an electric furnace one arm of a wheatstone bridge and combining this with galvanometer regulator, thus keeping resistance of coil constant, writers assert it is possible, regardless of variations in current supply, and with no attention, to maintain constant temperature of furnace not too directly influenced by temperature of room.

Automatic Temperature Control. Automotive Indus., vol. 41, no. 3, July 17, 1919, pp. 118-119, 2 figs. Thermo-couple of nickel-chromium alloy installed in electric furnace actuates high tension millivoltmeter; arm depressor depresses pointer at regular time intervals and in doing so pointer forces two contact pieces carried by table.

GENERATING STATIONS

Buenos Aires

New Generating and Distributing Electrical Installations of Buenos Aires (Les nouvelles installations de production et de distribution d'électricité de Buenos Aires), Bulletin Technique de la Suisse Romande, vol. 45, no. 11, May 31, 1919, pp. 97-99, 3 figs. Sub-stations where alternating current is transformed into direct current. (Concluded.)

Busbar, Emergency

New Emergency Bus Feature in Brantford Hydro-Electric Station. Elec. News, vol. 28, no. 9, May 1, 1919, pp. 29-30, 3 figs. Scheme contemplates use of double-throw single-pole disconnecting switches, three disconnecting switches being used to each circuit.

Lima

Notes on the Installations of the Associated Electric Enterprises of Lima (Algunas informaciones sobre las instalaciones de las Empresas Electricas Asociadas de Lima), Boletin de Minas, vol. 11, nos. 1-3, March 31, 1919, pp. 32-45. Characteristics of turbine alternators and transformers.

Load Dispatching

Central Station Load Dispatching, P. B. Juhnke. Power Plant Eng., vol. 23, no. 15, August 1, 1919, pp. 661-666, 6 figs. Methods employed to carry load most efficiently and precautions adopted to safeguard workmen.

Load Distribution

Station Load and Economy, Ths. Norberg Schulz. Elecn., vol. 82, no. 25, June 20, 1919, pp. 700-701, 4 figs. Results obtained by studying distribution of load when several machines or stations are working in parallel.

Operation, Combined

Advantages of Combined Operation of Water and Electric Utilities and Selling Electric Current for Private Use in Springfield, Ill., Willis J. Spaulding. Mun & County Eng., vol. 56, no. 6, June 1919, pp. 229-230. Net earnings said to have been over $92,000 for fiscal year ending Feb. 28, 1919.

Overload Protection

Overload Protection for Electric Motors, O. C. Callow. Power, vol. 50, no. 2, July 8, 1919, pp. 60-62, 3 figs. Discusses various types of overload protection for motors, and suggests arrangements to suit special conditions.

Oxygen and Hydrogen Manufacture

Oxygen and Hydrogen—A New Source of Revenue for the Central Station, F. G. Clark. Elec. News, vol. 28, no. 14, July 15, 1919, pp. 30-32, 1 fig. Electrolytic cell suggested as means of smoothing out rough curve of variable load.

Rates

Central Station Rates in Theory and Practice—I, II & III, H. E. Eisenmenger. Elec. Rev., vol. 75, nos. 2, 3 & 4, July 12, 19, and 26, 1919, pp. 47-51, 94-97, and 138-143, 7 figs. General principles by which service costs can be determined. Cost analysis; energy cost and demand cost; load curve and load factor. Capital charges of central stations and how they affect the demand cost.

Rotherham

The New Power Station at Rotherham. Elecn., vol. 82, no. 26, June 27, 1919, pp. 750-760 and vol. 83, no. 1, July 4, 1919, pp. 6-11, 20 figs. June 27: Total generating capacity has increased from 4500 kw. in 1914 to 70,500 at present time. July 4: Switch-gear and accessories; diagram of connection of synchronizing arrangement.

Selection of Electric System

Selection of an Electric System, Terrell Croft. Coal Age, vol. 16, no. 5, July 31, 1919, pp. 178-184, 5 figs. Formulæ and examples of application as applied to electrical problems incident to mine installations are given.

Shanghai

Shanghai Municipal Electricity Undertaking. Elec. Times, vol. 56, no. 1446, July 3, 1919, pp. 3-4, 2 figs. With reference to economical aspect.

Electricity Supply at Shanghai. Electrical Rev., vol. 84, no. 2170, June 27, 1919, pp. 747-749, 5 figs. Turbo-generator installation.

Switzerland

The Massaboden Electric Power Plant (near Brig) of the Swiss State Railroads (Das Elektrizitätswerk Massaboden bei Brig der Schweiz. Bundesbahnen). H. Eggenberger and J. Dänzer. Schweizerische Bauzeitung, vol. 73, no. 24, June 14, pp. 275-278 and vol. 74, no. 1, July 5, 1919, pp. 301-307, 24 figs. June 14: Reservoir holds 8000 cu. m., thus allowing for considerable height of peak loads. Power is transmitted partly by aerial line and partly by underground cable. July 5: Plant has three 3500 hp. double turbines of Francis

Announcement

We are prepared to demonstrate that the Fay Automatic Lathe offers the best known means for performing certain operations on the following automobile, truck, tractor and internal combustion engine parts:

Tractor belt pulleys
Cam shafts
Steering knuckles
Ring bevel gears
Pistons
Transmission Gears
Hubs
Stem pinions, both spur and bevel.

Our practice in machining these parts has been developed by specialized study, experiment and actual experience in the shops of our customers.

The advantages gained relate to labor cost, initial investment, ease of set up and cost of maintenance.

In each case the reasons for superiority are simple and definite, and will be immediately appreciated by the experienced mechanic.

If you are preparing to increase your output of any of the above parts you will find it to your advantage to consult with us.

JONES & LAMSON MACHINE COMPANY

SPRINGFIELD, VERMONT, U. S. A.

109 Queen Victoria Street, London, E. C.

France, Spain and Belgium: F. Auberty & Co., 91 Rue de Maubeuge, Paris
Holland: Spliethoff, Beeuwkes & Co., Rotterdam

SEE OUR DATA IN 1919 A.S.M.E. CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT

type; two of the turbines are coupled with 3300-volt alternator generators; the two sets of transformers consist each of a synchronous motor of 240 hp. and 4000-volt generator.

GENERATORS AND MOTORS

Alternator Characteristics

Experimental Determination of Alternator Characteristics (Méthode d'analyse expérimentale des propriétés des alternateurs), A. Blondel and F. Carbenay. Revue Générale de l'Electricité, vol. 5, no. 24, June 14, 1919, pp. 843-855, 12 figs. Illustrating applications to special cases of methods of analyses described in preceding article. (Concluded.)

Armature Conductors, Current Distribution in

Current Distribution in Armature Conductors, Waldo V. Lyon. Elec. World, vol. 74, no. 2, July 12, 1919, pp. 66-68, 3 figs. Equations are derived showing how alternating current resistance depends upon depth of slot.

Commutator Motors

Graphs of Single-Phase Commutator Motors (Constructions graphiques élémentaires relatives aux moteurs à Collecteur monophasés) Osc. Colard. Société Belge des Électriciens, vol. 33, April-June 1919, pp. 133-145, 5 figs. Based on writer's analytical theory developed in Soc. Belge des Elec., issue Aug. 1906, p. 357.

Mill Motors

A 3000 HP. Mill Motor by the G. E. C. Elecn., vol. 82, no. 25, June 20, 1919, pp. 696-698, 6 figs. Motor is for driving a three-high, non-reversing plate mill and is believed to be the largest non-reversing motor driving a rolling mill in England.

IGNITION APPARATUS

Spark Discharge

Some Characteristics of the Spark Discharge and Its Effect in Igniting Explosive Mixtures, Clifford C. Paterson and Norman Campbell. Phys. Soc. of London, vol. 31, no. 4, June 15, 1919, pp. 168-228, 12 figs. Research to determine relation between electric characteristics of a spark discharge and its power of igniting explosive mixture. Main experiments of ignition of mixtures of petrol and air are described.

LIGHTING AND LAMP MANUFACTURE

Churches

Lighting Installation for a Church Auditorium, H. O. Stewart. Elec. Rev., vol. 75, no. 1, July 5, 1919, pp. 1-3, 5 figs. Indirect lighting with luminous bowl and urn fixtures.

Gases, Residual

Residual Gases and Vapors in Highly Exhausted Glass Bulbs, J. E. Sharder. Physical Rev., vol. 13, no. 6, June 1919, pp. 434-437, 2 figs. Investigation reported to show that vacuum in sealed vessels deteriorates with time, rapidly at first and then more slowly and that subsequent heating even at temperatures lower than the heat treating temperature results in increase of pressure due to further liberation of gases and vapors from glass.

Industrial Lighting

Industrial Lighting, C. E. Clewell. Jl. Franklin Inst., vol. 188, no. 1, July 1919, pp. 51-90, 18 figs. Engineering details of factory lighting and economical advantages derived from efficient illumination of industrial establishments.

Design of Industrial Lighting System, Ward Harrison and H. H. Magdsick. Elec. World, vol. 74, no. 1 and 4, July 5 and 26, 1919, pp. 7-11 and 184-187, 13 figs. July 5: Analysis of deflecting and diffusing units for lighting industrial plants, giving advantages and limitations of each. Data concerning distribution curves, efficiency and mounting heights. July 26: Table giving present intensity standards in industrial lighting and coefficient of utilization.

Inverted Burners

The Regenerative Effect as Influencing Lighting Efficiency of the Inverted Incandescence Burner, J. S. G. Thomas. Jl. Soc. Chem. Indus., vol. 38, no. 12, June 30, 1919, pp. 168T-171T, 3 figs. Concluded from experimental research that efficiency is increased when gaseous mixture of coal gas and primary air is preheated.

Lenses

Luminous Power of Lighthouse Lenses (Studio sulla potenza luminosa delle ottiche dei fari), A. Coacci. Rivista Marittima, vol. 52, no. 5, May 1919, pp. 195-208, 7 figs. Lambert law considered as giving close approximation. Analytical formula offered for what is be-

Motion-Picture Projection

Mazda Lamps for Motion Picture Projection, L. C. Porter. Gen. Elec. Rev., vol. 22, no. 7, July 1919, pp. 556-559, 11 figs. It is reported that lamp wattage has been increased to 900 and a tubular bulb used in place of spherical bulb, for the purpose of adapting Mazda lamps for motion picture projection.

Searchlights

The Development of Anti-Aircraft Searchlights, James B. Cross. Prof. Memoirs, Corps Engrs. U. S. Army & Engr. Dep., vol. 11, no. 56, Mar.-Apr. 1919, pp. 139-149, 6 figs. Types used (1) for seacoast defense, and (2) battlefield illumination.

Street Lighting

Street-Lighting Reconstruction Problems, L. Gaster. Gas Jl., vol. 147, no. 2929, July 1, pp. 29-30. Experiences in London during war.

Wartime

Lighting in Wartime, Preston S. Millar. Jl. Engrs. Club of Philadelphia, vol. 36, no. 176, July 1919, pp. 259-265, 2 figs. Work done by Illuminating Society and Lighting Industry in coöperating with government in promoting industrial production, preventing accidents and saving fuel. Paper presented at joint meeting of Phila. section of Am. Inst. Elec. Engrs. and Illuminating Eng. Soc.

MEASUREMENTS, ELECTRICAL

Asynchronous Machines

New Method for Indirect Testing of Asynchronous Machines (Sur une nouvelle méthode d'essai indirecte des machines asynchrones), J. Le Monnier. Revue Générale de l'Electricité, vol. 6, no. 2, July 12, 1919, pp. 35-40, 6 figs. Method of commuting coefficients necessary for constructing diagram.

Electrodynamometer

An Electrodynamometer Using the Vibration Telescope, Carl Barus. Proc. Nat. Acad. Sciences, vol. 5, no. 6, June 15, 1919, pp. 211-217, 2 figs. Its possible use for finding magnetic field within helix of unknown constants pointed out.

Magnetic Materials, Testing

Rapid Testing of Magnetic Materials, Thomas Spooner. Elec. World, vol. 74, no. 1, July 5, 1919, pp. 4-6, 5 figs. Use of small ring samples and ballistic method of testing.

Meters

Service Tests of Small Capacity Meters, Arthur Horace Bryant. Elec. Rev., vol. 75, no. 4, July 26, 1919, pp. 155-157. Recommends that thorough inspection be made in place of usual 36 months' test and that where inspection raises no question as to accuracy of any given meter, its test be set at 60 months (24 months after inspection.)

Potentiometers

A Rectangular-Component Two-Dimensional Alternating-Current Potentiometer, A. E. Kennelly. Jl. Franklin Inst., vol. 188, no. 1, July 1919, pp. 1-26, 20 figs. Form adapted for telephonic-frequency measurements. Readings are given in two rectangular components of the voltage measured.

Transformers, Instrument

Field Testing of Instrument Transformers — H. H. M. Crothers. Elec. World, vol. 74, no. 3, July 19, 1919, pp. 119-121, 5 figs. Experience with differential methods as applied to voltage and current transformers and to acceptance testing of series transformers for street lighting circuits. Possible simplifications are suggested.

Voltameters

A Note on the Accuracy of Copper Voltameter, J. Obata (in Japanese.) Denki Gakkwai Zasshi, no. 371, June 10, 1919.

POWER APPLICATIONS

Conference Grounds

Electricity at Summer Conference Grounds. Jl. Electricity, vol. 43, no. 1, July 1, 1919, pp. 6-8, 5 figs. Electrical equipment at Y. W. C. A. Conference Grounds.

Heating

High Frequency Induction Heating Today, E. F. Northrup. Chem. Engr., vol. 27, no. 7, July 1919, pp. 167-168 & 171. Recent developments. Paper read before Convention of Am. Inst. of Chem. Engrs.

High Power Factor Induction Heaters, C. Edward Magnusson. Jl. Electricity, vol. 43, no. 1, July 1, 1919, pp. 17-18, 5 figs. Design

Hotels

Electricity in the World's Largest Hotel, Wm. H. Easton. Elec. Jl., vol. 16, no. 7, July 1919, pp. 288-294, 18 figs. Pennsylvania Hotel, New York City. Distributing system divided into two separate parts; (1) direct current system for motors driving elevators, ventilating fans, and other machinery requiring speed control, and (2) alternating current for lighting, cooking and miscellaneous applications.

Sugar (Beet) Factories

Electricity in Beet Sugar Factories, Joseph P. Collopy. Elec. World, vol. 74, no. 4, July 26, 1919, pp. 178-181, 3 figs. Consideration of manufacturing process in its relation to load characteristics and some suggestions on the choice of electrical equipment.

Textile Mills

Canadian Textile Mill Operated by Central-Station Service, V. K. Stafford. Elec. Rev., vol. 75, no. 4, July 26, 1919, pp. 135-137, 7 figs. Remote control and other features of motor service.

STANDARDS

Generators for Electrotyping

Standardization of Generators for Electrotyping, Floyd T. Taylor. Metal Indus., vol. 17, no. 7, July 1919, pp. 323-325, 4 figs. Suggestion in regard to selecting standard.

Polyphase Currents

Two Suggestions to the International Electric Committee (Deux propositions au comité électrotechnique international), E. Pierard. Société Belge des Électriciens, vol. 33, April-June, 1919, pp. 146-151, 3 figs. With reference to a general formula for determining polyphase currents and a symbol for weakening of transmission in long lines.

Transformers

Standardization of Transformers in Germany (Erläuterungen zu den Normen für Einheitstransformatoren), G. Stern. Elektrotechnische Zeitschrift, vol. 40, no. 3, Jan. 16, 1919, pp. 33-34. Rules for constructing transformers with aluminum windings, issued by German Standardization Committee. Capacities, voltages, percentage of short-circuit voltages, temperature rise, overload capacity, and structural data are laid down.

STORAGE BATTERIES

Efficiency

On the Efficiency of Storage Batteries, K. Kimura. (In Japanese.) Denki Gakkwai Zasshi, no. 371, June 10, 1919.

TELEGRAPHY AND TELEPHONY

Antenna

Radio Transmission Formulas for Antenna and Coil Aerials, J. H. Dellinger. Jl. Franklin Inst., vol. 188, no. 1, July 1919, pp. 95-96. Derived from electromagnetic theory.

Baudot Quadruplex

Italian Submarine Cables Operated by Quadruplex Baudot (Le baudot quadruple sur les cables sous-marins Italiens), M. Cesare Albanese. Annales des Postes, Télégraphes et Téléphones, vol. 8, no. 2, June 1919, pp. 228-238, 6 figs. Scheme of arrangement and account of tests performed.

Direction Finders

Aircraft Radio Direction Finding Equipment Developed by the Navy Department, Edgar H. Felix. Aerial Age, vol. 9, no. 13, July 14, 1919, pp. 852-855, 4 figs. Designed by Bur. of Steam Eng., Navy Dept.

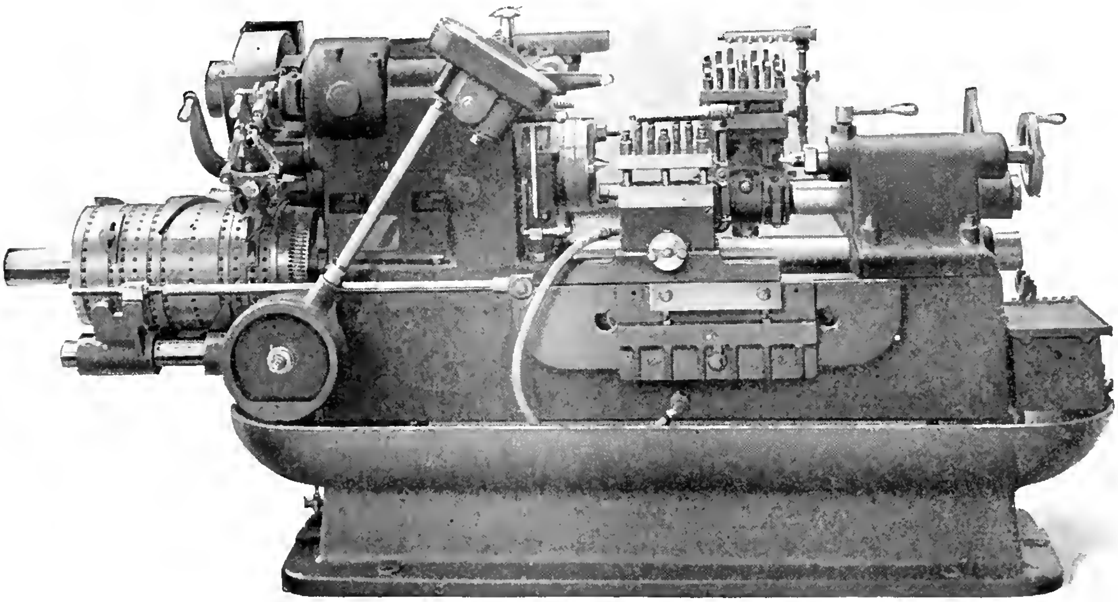
Multiplex Operation

High Frequency Currents on Wires, J. O. Mauborgne. Jl. Franklin Inst., vol. 188, no. 1, July 1919, pp. 91-93. Experiments undertaken to examine possibility of adapting existing types of radio-telephone and telegraphic apparatus to multiplex operation.

Perforators, Keyboard

The Story of the Keyboard Perforator, H. H. Harrison. Instn. Post Office Elec. Engrs., no. 71, January 8, 1917, 40 pp., 18 figs. Varieties in design occurring in respect to (1) selection from a gang assembly of punches corresponding to character key operated, (2) propulsion of punches through paper and their retraction to normal, and (3) feed forward of paper by amount in accordance with length of letter plus space element, these three conditions being quoted as essential in constructing an au-

The Fay Automatic Lathe



An automatic machine for simultaneous turning, facing and shouldering cuts on bar stock and centered forgings, such as pinion shafts, steering knuckles, cam shafts, etc.

An automatie machine for second operations on work held on centered arbors, such as spur and bevel gear blanks, hubs, pulleys, etc.

Designed with strength and driving power to carry all the tools, speed, and feed the work will stand under balanced cuts.

Jones & Lamson Machine Company

SPRINGFIELD, VERMONT, U. S. A.

109 Queen Victoria Street, London, E. C.

France, Spain and Belgium: F. Auberty & Co., 91 Rue de Maubeuge, Paris
Holland: Spliethoff, Beeuwkes & Co., Rotterdam

SEE OUR DATA IN 1918 A.S.M.E. CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT

Photographs

The Electrical Transmission of Photographs. Marcus J. Martin. Model Engr. & Elecn., vol. 41, no. 949, July 3, 1919, pp. 13-17, 5 figs. Historical account of work done by various experimenters. (To be continued.)

Pupinization

Effect of Pupinization of Short Telephone Lines (Wirksamkeit der Pupinisierung kurzer Fernsprechleitungen), Ludwig Schultheiss Telegraphen-u. Fernsprech-Technik, vol. 7, no. 21-22, Feb. 15, 1919, pp. 81-83, 1 fig. Tables showing results of tests. (Concluded.)

Relays

The Oscillatory Valve Relay: A Thermionic Trigger Device, L. B. Turner. Elecn., vol. 83, no. 2147 and 2148, July 4 and 11, 1919, pp. 4-5 and 34-35, and (discussion) pp. 35-36, 9 figs. July 4: Distinguishes between relays and amplifiers and explains operation of triode. July 11: Analysis is made of sensitivity and selectivity of the tuned high-frequency valve relay and general limitations on sensitivity and speed of working are discussed.

Static Interference

See Weagant Static Prevention.

Telephones, Automatic

The Western Electric Company's Automatic Telephone System, B. O. Anson. Instn. Post Office Elec. Engrs., no. 72, Dec. 4, 1916, 62 pp., 22 figs., partly on supp. plate. Including enumeration of requirements writer considers as essential to a mechanical switching system.

Telephone, Wireless

Wireless Telephone Transmitter for Seaplanes. Telegraph & Telephone Age, no. 14, July 16, 1919, pp. 342-346, 4 figs. Marconi type S. E. 1100 set.

Field Wireless Telephony and Direction-Finding. Wireless World, vol. 7, no. 76, July 1919, pp. 199-205, 7 figs. Account of demonstration.

Wireless Telephony and Directional Wireless. Aeronautics, vol. 16, no. 294, June 5, 1919, pp. 586-588, 2 figs. Features for military and commercial purposes. (Continued.)

Radio Transmitting Sets on the NC Type Seaplanes. Telegraph and Telephone Age, no. 13, July 1, 1919, pp. 330-331, 2 figs. Diagram showing connections and arrangement.

Telephony, Secret

Secret Telephony (Procédé de téléphone secrete), M. Poirson. Annales des Postes, Télégraphes et Téléphones, vol. 8, no. 2, June 1919, pp. 239-248, 5 figs. Periodic inversion of currents (without superposition of external current) at starting point and their rectification at receiving point. Scheme evolved by Service d'Etudes des Postes et Télégraphes of France.

Weagant Static Prevention

The Weagant "X-Stopper." Wireless World, vol. 7, no. 76, July 1919, pp. 209-211, 5 figs. Diagrammatic exposition of necessity for spacing two loop aerials comprising this type of receiver. (Concluded.)

TRANSFORMERS, CONVERTERS, FREQUENCY CHANGERS

Converters, Rotary

Pulsation of the D.C. Terminal Voltage in Rotary Converters, J. K. Kostko. Elecn., vol. 83, no. 2147, July 11, 1919, pp. 37-39. Diagrams and formulæ. (To be continued.)

Design

On the Most Economical Design of Transformers, T. Hayakawa. (In Japanese.) Denki Gakkwai Zasshi, no. 371, June 10, 1919.

Dessauer Transformer

Dessauer's High-Tension Transformer, E. Walter. Elecn., vol. 83, no. 2146, July 4, 1919, pp. 12-13, 2 figs. Scheme by which high-tension stresses are so controlled that they are removed to position where they can be safely dealt with.

Frequency Amplifier

Theory of Stationary Frequency Doublers (Beitrag zur Theorie und Wirkungsweise des stationären Frequenzverdopplers), M. Osnos. Elektrotechnik u. Maschinenbau, vol. 37, no. 5, Feb. 2, 1919, pp. 45-48, 7 figs. Argument to demonstrate Epstein frequency doubler is equivalent to two transformers with their primary windings in series and their secondary windings in opposition.

Rectifiers

The Tungar Rectifier—Its Theory, Characteristics and Application—II, F. Keith d'Alton. Elec. News, vol. 28, no. 10, May 15, 1919, pp. 30-35, 26 figs. Performance of simple single-phase rectifier is outlined and claimed advantages of different possible combinations of two or more single-phase rectifiers are presented and discussed.

The Use of Mercury Rectifiers at Hirschberg, Silesia, J. Obach. Elecn., vol. 82, no. 25, June 20, 1919, pp. 698-699. Three rectifying cylinders mounted side by side on wrought-iron frame work; together with the vaccum pump they occupy as much floor space as a rotary converter, giving 100 kw., whereas they themselves have a capacity of 750 kw. From Elektrotechnische Zeitschrift, no. 42, 1918.

Transformer Practice

Essentials of Transformer Practice—XXIV. E. G. Reed. Elec. Jl., vol. 16, no. 7, July 1919, pp. 301-303, 8 figs. Polarity.

Operation at Holtwood, Charles H. Bromley. Power, vol. 50, no. 1, July 1, 1919, pp. 8-9, 4 figs. How transformers are cleaned and inspected.

Transformers, Power

Power Transformers, A. F. Berry. Elecn., vol. 82, no. 26, June 27, 1919, pp. 736-739, 8 figs. Variety in requirements that must be met in transformer design. Points in design of building of sub-stations, such as desirability of being able to run a crocodile truck into building and the need for ample head room.

TRANSMISSION, DISTRIBUTION, CONTROL

Aluminum Conductors

Aluminum Conductors for Overhead Power Transmission Lines, Arthur Jacob. Elecn., vol. 82, no. 26, June 27, 1919, pp. 743-748, 7 figs. Conductivity of aluminum and copper, their relative densities, tensile strength and other qualities are discussed.

Cables

Varnished Cambric Cable for Underground Service, W. E. Hazeltine. General Elec. Rev., vol. 22, no. 6, June 1919, pp. 442-444. Describes structure of varnished cambric cable and points out features wherein this cable is superior to those of paper or rubber insulated type.

Grounding

Grounding (Erdung), Karl Michalke. Dinglers Polytechnisches Journal, vol. 6, no. 334, Mar. 22, 1919, pp. 57-60, 2 figs. Discusses various points which have to be considered in grounding.

High Potential Systems

Distribution of Current Intensity and Potential in line of High Tension System (Etude de la répartition de l'intensité et du potential le long d'une ligne de distribution à très haute tension), Léon Drin. Revue Générale de l'Electricité, vol. 6, no. 1, July 5, 1919, pp. 3-12, 14 figs. Graphical study by means of characteristics which are defined as geometrical loci of points corresponding to extremities of vectors of tensions and intensities of each element of network.

The Practicability of Transmission Lines at Highest Voltages in This Country, G. V. Twiss. Elecn., vol. 82, no. 26, June 27, 1919, pp. 732-736, 4 figs. Considerations alleged to have militated against use of overhead lines in England found exaggerated.

Insulators

Notes on Suspension Insulator Design, H. L. Garbutt. Jl. Electricity, vol. 43, no. 1, July 1, 1919, pp. 19-21, 4 figs. Theories accounting for deterioration of cap-and-pin type suspension insulator.

Overhead Lines

Overhead Net Works (Canalisations aériennes), Ch. Vallet. Industrie Eléctrique, vol. 28, no. 648, June 25, 1919, pp. 232-236. Formula for determining maximum safe distance between consecutive poles. (Continuation of serial.)

Power Factor Correction

Power Factor Correction. Power Plant Eng., vol. 23, no. 14, July 15, 1919, pp. 635-639, 8 figs. From report of sub-committee on power factor correction presented at Convention of Nat. Elec. Light Assn.

Power Transmission

On the Limits of Power Transmission by Alternating Currents (Ueber die Grenzen der Kraftübertragung durch Wechselströme), M. Dolivo-Dobrowolsky. Elektrotechnische Zeitschrift, vol. 40, no. 1, Jan. 2, 1919, pp. 1-4, 1 fig. Discusses question whether system of high-tension a.c. will be given preference, as now, for future power transmissions; writer comes to the conclusion that, since the underground cable will be the future means of transmission, high-tension d.c. will be used for future power transmission.

Relay Protection

Transmission Line Relay Protection, D. W. Roper, H. R. Woodrow, O. C. Traver and P. Mac Gahan. Elec. Rev., vol. 75, no. 1, July 5, 1919, pp. 13-18, 15 figs. Typical application of current and directional relays.

Relays, Reverse-Current

Reverse-Current Relays-Principles of Operation, Victor H. Todd. Power, vol. 50, no. 3, July 15, 1919, pp. 96-99, 15 figs. Schematic diagrams. Construction of features of various types.

Substations

Railway Converter Substations—I, C. F. Lloyd. Power House, vol. 12, no. 11, July 19, 1919, pp. 303-307, 10 figs. Concerning class of equipment to be used and its arrangement in substation buildings.

Canal Substation at Columbus, E. W. Clark Elec. Eng., vol. 53, no. 5, May 1919, pp. 204-205, 3 figs. Transformers, lightning arresters and other high tension equipment located out-of-doors; oil switches, buses, switchboard and auxiliary equipment placed in small building.

Substations for Y-connected Systems, A. V. Taylor. Elec. World, vol. 74, no. 4, July 26, 1919, pp. 172-175, 7 figs. As standardized by company operating in Northwest States, where light loads and long distances prevail.

Switchboards

Developments in Switchboard Apparatus. Gen. Elec. Rev., vol. 22, no. 7, July 1919, pp. 535-537, 8 figs. Plunger type for overload protection.

Three-Phase Current Transmission

Comparative Technical and Economical Study of an Overhead Line and an Underground Line to transmit Three-phase Current at 50,000 volt and 50 Cycles (Etude comparative, technique et économique, d'une ligne aérienne et d'une ligne souterraine à courant triphasé 50,000 volts 50), P. Yersin. Bulletin Association Suisse des Electriciens, vol. 10, no. 5, May 1919, pp. 141-149, 10 figs. Although in various respects underground lines are found more advantageous, the cost of aerial line is estimated to be less than one-half of that of underground.

Transmission at 220 Kilovolts

Problems of Power Transmission at 220 Kilovolts, A. E. Silver. Elec. Rev., vol. 75, no. 2, July 12, 1919, pp. 52-55, 4 figs. Design features of line and apparatus. Paper read before A. I. E. E.

Transmission Circuits

Electrical Characteristics of Transmission Circuits—I, Wm. Nesbit. Elec. Jl., vol. 16, no. 7, July 1919, pp. 279-287, 6 figs. Approximate methods including Mershon and Dwight charts. Resistance of conductors.

Transmission Costs

Transmitting Electric Power at Mines—II S. W. Farnham. Coal Industry, vol. 2, no. 7, July 1919, pp. 275-279. Computing and comparing cost of a. c. and d. c. and efficiency of locomotives. Paper presented before Ill. Coal Min. Inst.

Transmission-Line Computation

An Extension of the Step-by-Step Method of Transmission Line Computation, Frederick Eugene Pernot. University of Cal. Pub. in Eng., vol. 2, no. 4, pp. 131-138, 2 figs. Based on assuming one-sixth of total line admittance at each end of line and the remaining two-thirds in the middle.

Transmission Routes

Selection of Economical Transmission Route, P. O. Reyneau. Elec. World, vol. 74, no. 4, July 26, 1919, pp. 176-178, 1 fig. Equations and curves which are said to simplify choice between several available routes.

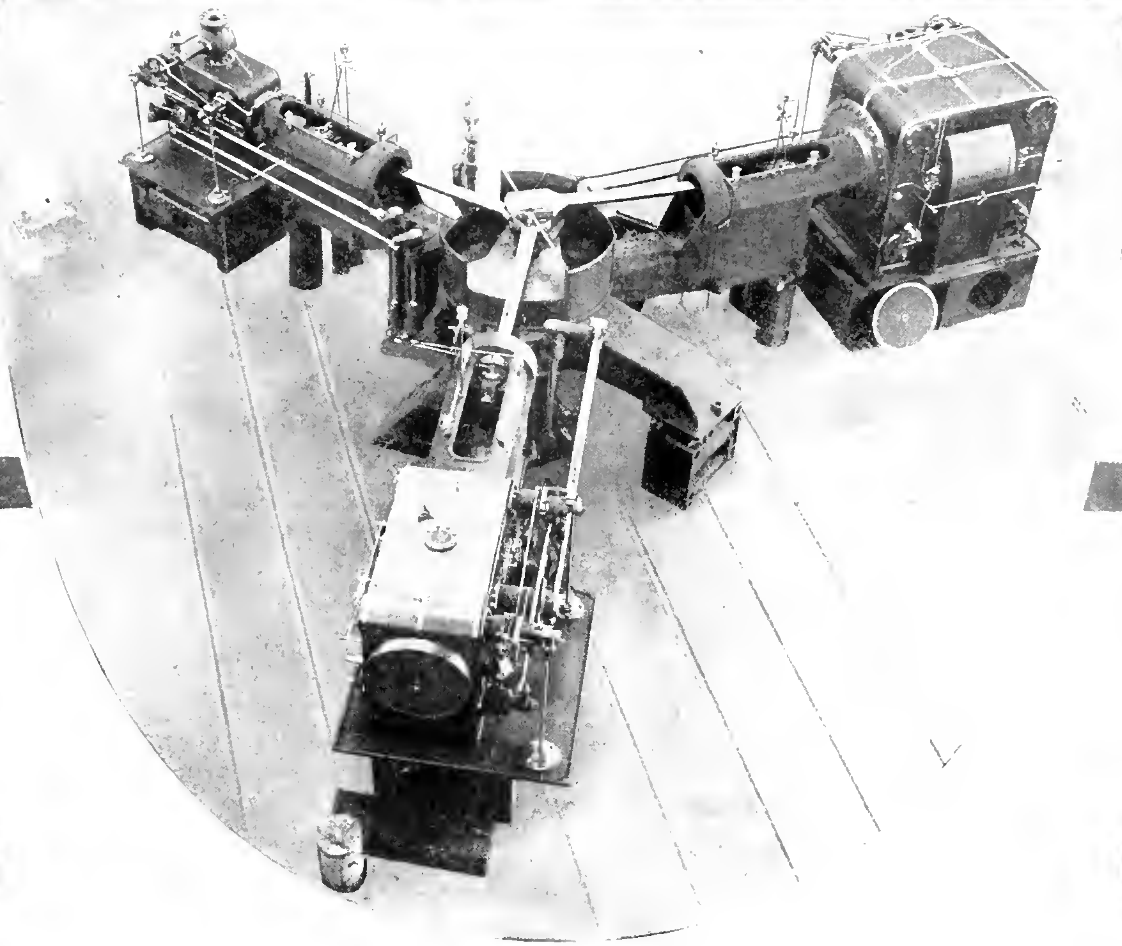
Voltage Regulation of Feeders

Voltage Regulation of Distributing Feeders as a Means of Improving Central Station Efficiency, Frank Hershey. Gen. Elec. Rev., vol. 22, no. 7, July 1919, pp. 544-551, 6 figs. With notes on control of distributing feeders. Paper read before Ohio Elec. Light Assn.

VARIA

Holland

Some Particulars Regarding Inventors in the Electrical Field and Holland's Part in the Development of Electrotechnics (Eenige bijzon-



Solving Power Problems

The illustration herewith tells a very definite, concrete story of the resources of this organization to solve power problems. A "HAMILTON" triple expansion horizontal engine, with vertical shaft extending downward to a centrifugal pump, is used with the elements set at angles of 120 degrees—to secure a continuous flow of power and the highest economy.

This is an extraordinary arrangement—and highly successful—the direct outgrowth of our 74 years of engine-building experience—and our contact with every manufacturing center and industry the world over.

These same resources—the resources which built four complete 2800 horsepower, triple expansion MARINE ENGINES per week for the U. S. Shipping Board—is available and keen to solve your power problem.

Whatever it is—we are building the exactly right unit for the purpose—in its highest and best expression—in its most scientific form, as applied to steam.

Let us demonstrate our solution of your problem. Offices in all large cities

The Hooven, Owens, Rentschler Company

Producers of Prime-Movers for All Industries

Hamilton, Ohio

H.O.R.CO.
HAMILTON
POWER EQUIPMENT

derheden over uitvinders op het gebied der electriciteit en het aandeel dat Nederlanders in de ontwikkeling van de electrotechniek hebben gehad). E. J. F. Thierens. Ingenieur, vol. 34, no. 24, June 14, 1919, pp. 446-453, 4 figs. Historical account.

Lightning Arresters

Records and Maintenance of Aluminum-Cell Lightning Arresters. F. S. Piper. General Elec. Rev., vol. 22, no. 6, June 1919, pp. 475-478, 8 figs. Method followed by Manchester Traction, Light & Power Co.

Soda (Caustic)-Chlorine Cells

Electrolytic Caustic Soda-Chlorine Cells. Karl Horine. Chem. & Metallurgical Eng., vol. 21, no. 2, July 15, 1919, pp. 69-72, 1 fig. Four classes of cells defined after reviewing patent situation—Diaphragm, mercury, Bell and fused electrolyte. An electrolytic caustic of soda-chlorine cell chart is presented.

Wire Pulling

Pulling in Conductors with a Crane. Terrell Croft. Power, vol. 50, no. 4, July 22, 1919, pp. 136-137, 7 figs. Suggestions on how to use traveling crane to pull large electrical conductors into conduits.

Civil Engineering

BRIDGES

Chicago

Problems Encountered in the Design of 12th Street Bridge. Hugh E. Young. Eng. World, vol. 15, no. 1, July 1, 1919, pp. 17-26, 15 figs. Plans for bridge improvement, both involving straightening of Chicago river. Completion will give west side of city a 118-ft. thoroughfare to Lake Michigan.

Concrete Bridge

Calculation of Arched Reinforced-Concrete Bridge of 30 Meters Span (Berekening van een vlakke gewelfbrug van gewapend beton van 30 M. spanning). W. J. Wisselink. Ingenieur, vol. 34, no. 27, July 5, 1919, pp. 496-503, 6 figs. Vertical section of bridge; determination of total constant load per meter; distribution of load.

Foundations

Test of Sandy Foundations at Arch Bridge Pier. Arthur Richards. Eng. News-Rec., vol. 83, no. 5, July 31, 1919, pp. 208-209, 2 figs. Settlement measured by gage at top of timber mast passing through completed concrete base. Stone blocks for load.

Inspection

Points Requiring Special Observation and Investigation in Bridge Inspection. Herbert C. Keith. Can. Engr., vol. 37, no. 3, July 17, 1919, pp. 145-147. Concerning reduction of vibration, investigation of compressing members, preventing decay of timber stringers and similar points. From paper presented before Brooklyn Engrs. Club.

Kansas City

Central Avenue Bridge and Viaduct in Kansas City. Elec. Traction, vol. 15, no. 7, July 1919, pp. 411-416, 14 figs. Design to accommodate both street railway and roadway traffic between Kansas City, Missouri and Kansas City, Kansas.

Pontoon Bridges

The Coblenz Pontoon Bridge. J. W. Skelly. Prof. Memoirs, Corps Engrs. U. S. Army & Engr. Dept., vol. 11, no. 56, March-April 1919, pp. 217-228, 13 figs. Bridge is about 1,050 ft long and is composed of 14 sections—two draw sections, 98 ft and 81 ft. in length, eight fixed sections 81 ft. long and at each end two short ramp sections about 50 ft. long. Other sections are held in reserve for use as required.

Railway Bridge Specifications

Comparison of Five Railway Bridge Specifications. Eng. News-Rec., vol. 83, no. 1, July 3, 1919, pp. 33-36. Proposed revised A.R.E.A. specifications compared with Southern Pacific, Pennsylvania, and New York Central accepted practice.

Reinforcement

Historic Shropshire Bridges Strengthened with Ferro-Concrete. A. T. Davis. Ferro-Concrete, vol. 10, no. 9, March 1919, pp. 249-262, 21 figs. Bridges in question were constructed with cast-iron arches on masonry abutments about a century ago.

How an Old Masonry Arch Bridge Was Rebuilt. Ry. Maintenance Engr., vol. 15, no. 7, July 1919, pp. 228-230, 5 figs. Bridge consisted of five semi-circular arches of 40 ft. span, having a total length of 260 ft. and total height above bottom of footings of 60 ft.

Sectional Bridges

Types of Truss Bridges (Neue Bauarten zerlegbarer Brücken). Rudolf Bernhard. Zentralblatt der Bauverwaltung, vol. 39, no. 15, Feb. 15, 1919, pp. 80-83, 24 figs. Reconstruction of bridges destroyed during war and types developed.

Substructure

Substructure of Michigan Avenue Bascule Bridge, Chicago. Hugh E. Young and William A. Mulcahey. Eng. News-Rec., vol. 83, no. 5, July 31, 1919, pp. 210-213, 4 figs. Cylinder piers sunk to rock and hardpan carry concrete tailpits for double-deck bridge. Steel columns embedded in walls support girders for trunnions and uplift anchorage.

Suspension Bridges

Special Design Features and Erection Methods for 540-Foot Suspension Bridge. William G. Grove. Eng. News-Rec., vol. 83, no. 1, July 3, 1919, pp. 4-8, 8 figs. Designed with varying cable inclinations at towers.

Suspension Bridge and Suspension Ferry in Rio de Janeiro (Hängebrucke und Schwebefähre in Rio de Janeiro). Zentralblatt der Bauverwaltung, vol. 39, no. 28, April 2, 1919, pp. 145-146, 4 figs. Bridge spans branch of the sea 150 meters wide.

Suspension Bridge of Gotteron, Fribourg (Le pont suspendu du Gotteron, à Fribourg). Bulletin Technique de la Suisse Romande, vol. 45, no. 12, June 14, 1919, pp. 112-114, 5 figs. Placing additional cable units so as to reduce maximum working stress to 18 kg per sq. mm.

Widening

Widening Existing Bridges. Ferro-Concrete, vol. 10, no. 9, March 1919, pp. 268-271, 7 figs. By means of reinforced concrete. Reference is made to actual work.

BUILDING AND CONSTRUCTION

Apartment Houses

Million Dollar Apartment House in Montreal. Contract Rec., vol. 33, no. 27, July 2, 1919, pp. 650-653, 6 figs. Eight-story building on site 253 ft. x 75 ft.; to contain eighty apartments.

Army Supply Base

Building the New Orleans Army Supply Base. Eng. News-Rec., vol. 83, no. 3, July 17, 1919, pp. 122-125, 4 figs. Concentration of equipment, use of 7 miles of temporary railway track, and rapid construction of project, mentioned as notable features.

Concrete-Block Construction

Houses for Halifax Reconstruction Built of Granite-Face Concrete Blocks. Contract Rec., vol. 33, no. 26, June 25, 1919, pp. 603-606, 6 figs. Building hollow walls with hydro-stone units presenting natural stone appearance.

Concrete Floor Surfaces

Concrete Floor Surfaces. W. P. Anderson. Ferro-Concrete, vol. 10, no. 11, May 1919, pp. 322-324. It is stated that in putting down concrete floors satisfactory results can be obtained either by using a top dressing or by finishing the structural concrete itself.

Concrete Substructure

The Construction of a Pumping Station for the Schenectady Works, General Electric Company. Keith O. Guthrie. Gen. Elec. Rev., vol. 22, no. 7, July 1919, pp. 538-544, 10 figs. Indicating method of pouring concrete substructure and lowering it into position.

Constructional Elements

Planning the Industrial Plant—III. Hugh M. Wharton. Indus. Management, vol. 58, no. 2, Aug. 1919, pp. 113-117, 12 figs. Practice in roofs, floors, stairways, windows. (To be continued.)

Cribbing

Sectional Concrete Cribbing Displaces Retaining Walls at Embankments. Coal Age, vol. 16, no. 4, July 24, 1919, pp. 141-143, 4 figs. Details of pillow blocks and fillers used in sectional concrete retaining wall.

Concrete Buildings

Concrete Building Addition Made at Reasonable Cost. Eng. News-Rec., vol. 83, no. 2, July 10, 1919, pp. 75-76, 3 figs. Cost per cu. ft., 15.4 cents. Work done in Boston district during war.

Designs

Cutting Down the Cost of Engineering in Building Design and Construction. E. H. Darling. Contract Rec., vol. 33, no. 26, June 25, 1919, pp. 597-599. Fallacy of free engineering and free designs.

Flagpole Erection

Seventy-Foot Concrete Flagpole Poured Erect in Place. R. C. Hardman. Eng. News-Rec., vol. 83, no. 4, July 24, 1919, p. 173. Construction effected by means of a light tower, similar to a hoisting tower.

Framing

Steel and Concrete Framing Combined for Economy. Eng. News-Rec., vol. 83, no. 4, July 24, 1919, pp. 178-182, 5 figs. Cost and space both saved in Chicago 12-story office building carried over theater auditorium. Design includes special heavy trusses, girders and cantilevers.

Garages

Curved Drive for Automobiles in Six-Story Garage. Eng. News-Rec., vol. 83, no. 4, July 24, 1919, pp. 188-189, 2 figs. Incline between floors claimed to give better facilities than elevators.

Hotels

Palmers' New Hotel and Canteen. Eng. & Indus. Management, vol. 1 (New Series), no. 20, June 26, 1919, pp. 619-620, 2 figs. Hotel composed of three large, three-story buildings. Canteen consists of large dining hall, kitchen, stores, offices and staff quarters.

Housing

A Solution of the Housing Problem in the United States. Robert Anderson Pope. Jl. Am. Inst. Architects, vol. 7, no. 7, July 1919, pp. 305-314, 2 figs. Proposal is made that each head of family and individual worker be provided with enough garden space immediately contiguous to his dwelling to enable him to produce, with intelligent direction and co-operation of an agricultural corps of community workers, the larger part of vegetables and small fruits which he and his family consume within the course of a year.

The Plumbing Standards for the Housing Projects of the Emergency Fleet Corporation. William G. Tucker. Architectural Rec., vol. 46, no. 1, July 1919, pp. 47-56, 6 figs. As adopted for various types of housing projects, which are divided into three general classes—(1) bungalows, (2) two-story dwellings, detached, semi-detached or in groups, apartments, and (3) dormitories, hotels, mess halls, kitchens and cafeterias.

The Engineering Aspect of the Housing Problem. Eng. Rev., vol. 32, no. 12, June 16, 1919, pp. 342-344, 2 figs. Alternative method of utilizing bricks with economy of materials in walls to the brick on edge construction. (Second article.)

A Model Housing Plan for Reclaiming a St. Louis District. Am. Architect, vol. 116, no. 2271, July 2, 1919, pp. 8-13, 6 figs. Removing existing buildings in slum sections to make way for more attractive and equitable government housing project.

Inspection

Testing and Inspection as a Means of Safeguarding Construction. R. Robertson Deans. Contract Rec., vol. 33, no. 26, June 25, 1919, pp. 624-626. Duty of testing engineer in detecting faulty materials. Concrete and steel.

Purifiers

The Application of Reinforced Concrete to Purifier Construction. A. E. Broadberry. Gas World, vol. 70, no. 1819, May 31, 1919, pp. 459-462, and (discussion) pp. 462-463, 14 figs., and Gas Jl., vol. 146, no. 2925, June 3, 1919, pp. 601-603, and (discussion) pp. 604-605, 14 figs. Plan and details of construction. Maximum pressure was assumed to be 48 in.

Reservoirs

Storage and Service Reservoirs in British Waterworks Engineering. Ferro-Concrete, vol. 10, no. 10, April 1919, pp. 297-301, 5 figs. Illustrating construction of reinforced-concrete reservoirs.

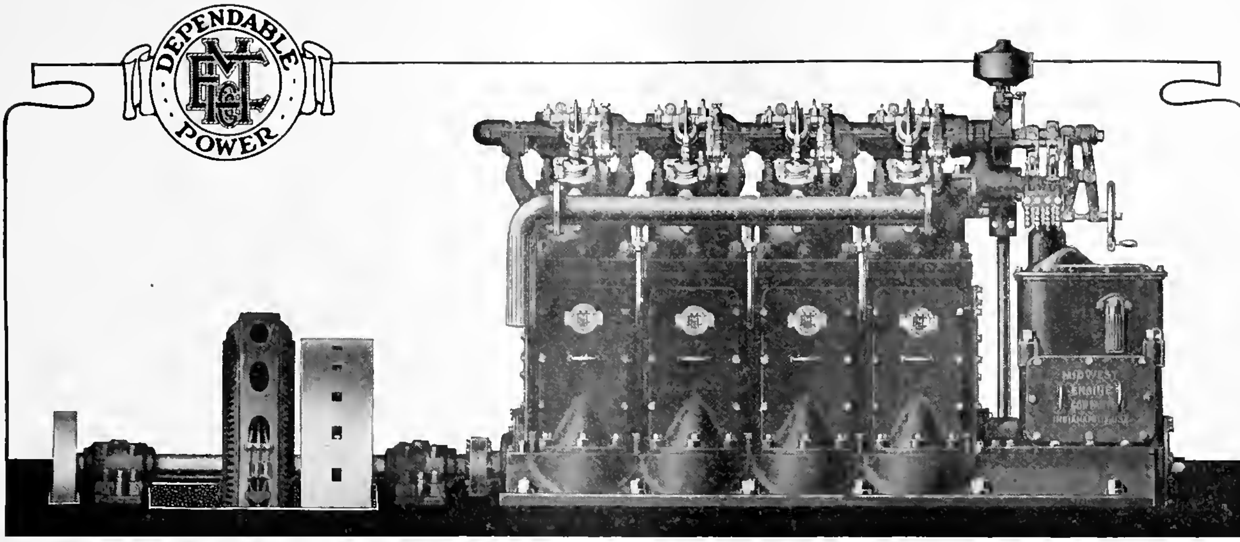
Retaining Walls

The Stability of Reinforced Concrete Retaining Walls. F. Zimmerman. Eng. & Contracting, vol. 52, no. 4, July 23, 1919, pp. 94-96, 4 figs. Diagram for solving design equations graphically.

See also Cribbing.

Silos

Grain Silos of Reinforced Concrete (Getreidesilos in Eisenbeton). G. Escher. Beton & Eisen, vol. 18, nos. 2-3, Feb. 5, 1919, pp. 17-20, 10 figs. Type built on Bank system, which aims at cooling grain by propelling air currents through silo walls into it. (To be concluded.)



MIDWEST
Dependable Power

HERE is power equipment that answers completely and adequately the modern need for more power at lower cost.

It converts the cheapest of crude and fuel oils into the highest known efficiency—does it without break or interruption.

This particular Midwest-Diesel Oil Engine is arranged for direct-connected electrical service. It comes in four standard sizes: 75 B. H. P.—100 B.H.P.—190 B.H.P.—250 B.H.P. Fuel consumption less than 1/10 gallon per K.W. Hour.

You are interested in creating power for your industry at a low cost. Ask for further information—based upon your conditions and requirements.

Midwest Standard Products

For Stationary Service—Midwest-Hvid Oil Engines, Horizontal—20, 25, 30 and 35 B. H. P.; Vertical—50 B. H. P.; Midwest-Diesel Oil Engines, Vertical—75, 100, 190, 250, 333, 500 and 666 B.H.P. units. Midwest-Wait Steam Turbines in units from 25 to 1500 K.W. capacity.

Also centrifugal and reciprocating pumps in a wide range of sizes.

New York Office
111 Broadway

New Orleans Office
617 Maison-Blanche Building

El Paso, Texas
303 Caples Building

Jacksonville, Florida
231 East Bay St.

MIDWEST ENGINE COMPANY
INDIANAPOLIS, U. S. A.

Stacks

Solving a Stack-Raising Problem, Martin Fishback. Eng. & Min. Jl., vol. 108, no. 3, July 19, 1919, pp. 95-96, 5 figs. Work done in replacing stack 6 ft. in diameter and 75 ft. long.

Steel Mill Buildings

An Investigation of the Stresses in the Transverse Bent for Steel Mill Buildings, C. S. Sperry. Proc. Colorado Sci. Soc., vol. 11, June 1919, pp. 253-268, 5 figs., partly on supp. plates. Accuracy of stresses obtained by various approximate solutions.

Tanks

Tank Construction—XXIX, Ernest G. Beck. Mech. World, vol. 65, no. 1695, June 27, 1919, pp. 306-307, 7 figs. Side walls of rectangular tanks. (Continuation of serial.)

Theaters

Engineering Features of the Modern Theater—I & II. Am. Architect, vol. 116, no. 2273 and 2274, July 16 and 23, 1919, pp. 91-98 and 123-129, 26 figs. partly on supp. plate. Study of Sam Shubert Theater at Philadelphia, notable feature of which is entire absence of obstructing columns, and of State-Lake Theater in Chicago.

See also Framing.

CEMENT AND CONCRETE

Calcium Chloride in Concrete Mixtures

Construction Work in New York Last Year. Good Roads, vol. 18 (new series), no. 2, July 9, 1919, pp. 14-15 and 22, 1 fig. From report of First Deputy Commissioner on work of Construction Department of State Commission of Highways during 1918. A graphical description of results of tests with calcium chloride in concrete mixtures is presented.

Cement Gun

Lining a Reservoir with Concrete by the Cement Gun, E. Court Eaton. Eng. News-Rec., vol. 83, no. 4, July 24, 1919, pp. 167-168, 2 figs. Costs and progress made. Given for operations in irrigation district during current high-price period.

Compressing Concrete

Compressing Concrete Increases Its Strength, Frank P. McKibben. Cement & Eng. News, vol. 31, no. 7, July 1919, pp. 22-23, 2 figs. Plain columns of successive layers pressed down said to have averaged half again as strong as these poured for full length.

Concrete

Concrete in Roads, Bridges and Culverts, H. Eltinge Breed. Mun. & County Eng., vol. 56, no. 6, June 1919, pp. 222-225, 1 fig. Concluded from tests that crushed-stone concrete resists impact better than gravel concrete, and that large-sized material is more durable than the small sizes.

Concrete Blocks

Making Concrete Blocks for Toronto Breakwater, Frederick Phillips. Can. Engr., vol. 37, no. 2, July 10, 1919, pp. 119-120, 3 figs. Collapsible wooden forms for making concrete blocks weighing 10 and 18 tons.

Plant Lay-Out for Making Concrete Blocks. Contract Rec., vol. 33, no. 28, July 9, 1919, pp. 665-666, 2 figs. Large units for breakwater construction cast at plant arranged to facilitate handling of raw materials and product.

Concrete Pipe Manufacture

Speeding up the Manufacture of Concrete Pipe with Compressed Air, F. A. McLean. Contract Rec., vol. 33, no. 29, July 16, 1919, pp. 694-695, 3 figs. Results obtained by installation of compressors and pneumatic rammers.

Cracking in Reinforced Concrete

Crack and Rust Formation in Reinforced-Concrete Constructions (Riss- und Rostbildungen an Tragwerken aus Eisenbeton). Zeitschrift des österr. Ingenieur-und-Architekten-Vereins, vol. 71, no. 1, Jan. 3, 1919, pp. 8-9, 1 fig. Caused by faulty design and construction. (To be concluded.)

Curing Concrete

Curing Concrete. Mun. Jl. & Public Works, vol. 47, no. 3, July 19, 1919, pp. 34-35, 2 figs. Results of tests made to determine effect of curing conditions on strength of concrete and wear from abrasion.

Gravel, Grading of

Proportioning of Pit-Run Gravel for Concrete, R. W. Crum. Can. Engr., vol. 37, no. 4, July 24, 1919, pp. 165-170, 8 figs. Also Concrete, vol. 15, no. 1, July 1919, pp. 3-8, 8 figs. Conclusion resulting from investigation is that grading of pit-run gravel may be measured by percentage of fine aggregate to total aggregate and by weight per cu. ft. measured loose.

Gunite

New Concrete Terminals at Norfolk. Cement & Eng. News, vol. 31, no. 7, July 1919, pp. 28-33, 5 figs. With reference to method of attaching wire and method of forming gunite wall.

See also Cement Gun.

India

Ferro-Concrete in India. Ry. Engr., vol. 40, no. 474, July 1919, pp. 154-156. Practice follows British Standard Specification. From technical paper no. 191 of Public Works Dept., Government of India.

Mixing Methods, Concrete

Bettering Concrete by a New Mixing Method, Nathan C. Johnson. Eng. News-Rec., vol. 82, no. 26, June 26, 1919, pp. 1266-1270, 7 figs. Using as basis motion-picture studies of concrete in mixing. Mixer has been developed in which, it is claimed, cement gets necessary thorough contact with aggregate.

See also Mix Water Removal.

Concrete Mixtures for Ferro-Concrete Work. With Special Reference to the Influence of Voids in the Aggregate, T. J. Gueritte. Ferro-Concrete, vol. 10, no. 2, August 1919, pp. 42-52, 6 figs. Comparison of specifications issued by Joint Committee on Reinforced Concrete of Roy. Inst. of British Architects, the regulations drawn up by London County Council, and the Mouchel-Hennebique standards.

Studies in Surface Area Proportionate Method, R. B. Young. Can. Engr., vol. 36, no. 26, June 26, 1919, pp. 563-566, 6 figs. Surface-area method of proportioning materials of mortars and concretes tested and approved by Ont. Hydroelectric Power Commission.

Tests Do Not Bear Out Surface Area Method, Duff A. Abrams. Can. Engr., vol. 36, no. 26, June 26, 1919, pp. 566-569. Comparison of surface area and fineness-modulus methods. Writer prefers latter method.

The "Sand" Method of Proportioning Pit Run Gravel for Concrete. Eng. & Contracting, vol. 52, no. 1, July 2, 1919, pp. 18-20, 5 figs. Investigation to establish engineering methods for proper use of such material, conducted by Engineering Experiment Station of Iowa State College. Paper read before Am. Soc. for Testing Materials.

Mix-Water Removal

Pressing Out Mix Water Adds to Cement Mortar Strength, C. T. Wiskocil. Eng. News-Rec., vol. 83, no. 3, July 17, 1919, pp. 130-132, 3 figs. Tests at University of California with apparatus which permitted pressures up to 30,000-lb. per sq. in. reported as giving very high compressive values.

Quick-Hardening Concrete

Cements Producing Quick-Hardening Concrete, P. H. Bates. Can. Engr., vol. 37, no. 1, July 3, 1919, pp. 113-115, and 117. Data obtained with "Sorel cement" in course of investigations conducted by Pittsburgh Branch of Bureau of Standards and dealing with various problems relating to portland cement.

Proportioning Concrete

See Mixing Methods.

Reinforced-Concrete Tests

Some Tests on the Properties of Reinforced Concrete, W. A. Slater. Eng. News-Rec., vol. 83, no. 5, July 31, 1919, pp. 217-220, 6 figs. Effect of protecting metal, lapping reinforcing bars and of reversing stress in beams as well as action of diagonally placed rods in slab spans studied for concrete ship. Research of Emergency Fleet Corporation.

Reinforcing Elements

High Tensile v. Mild Steel for Reinforcing Concrete, Arthur W. C. Shelf. Surveyor, vol. 55, no. 1432, June 27, 1919, pp. 495-496, 5 figs. Tests interpreted as proving that ordinary plain mild-steel bars of 28 to 32 tons breaking strain are best to employ for reinforced concrete.

EARTHWORK, ROCK EXCAVATION, ETC.

Canals

Enlargement of the Yakima-Tieton Main Canal, G. C. Finley. Eng. News-Rec., vol. 82, no. 26, June 26, 1919, pp. 1255-1258, 7 figs. Half circular section of reinforced concrete increased in height. Bonus system said to have proved successful in overcoming great scarcity of labor at favorable cost.

Chippewa Power Development in all Phases is a Higher Efficiency Enterprise. Contract Rec., vol. 33, no. 26, June 25, 1919, pp. 590-596, 18 figs. Building 12¾-mile canal.

Dams

Dam Foundation Placed by Suspended Pneumatic Caissons. Eng. News-Rec., vol. 83, no. 3, July 17, 1919, pp. 108-110, 8 figs. Difficulties encountered in getting footing in deep and swift water in narrow gorge of Spanish River at High Falls in northern Ontario.

Dam Supported by Bascule Bridge Closes Canal Lock. Eng. News-Rec., vol. 83, no. 3, July 17, 1919, pp. 116-118, 4 figs. Steel beams and panels placed from bridge form temporary dam permitting repair work in Trolhättan Canal.

Forms and Dimensions of Large Masonry Dams (Formes et dimensions des grands barrages en maçonnerie), M. Résal. Annales des Ponts et Chaussées, vol. 2, Mar-Apr. 1919, pp. 165-221, 34 figs. Mechanical discussion of stresses and illustration of method of computing them in various practical cases.

The Tata Hydro-Electric Power Plant, Bombay. Indian & Eastern Engr., vol. 44, no. 5, May 1919, pp. 151-154, 6 figs. Dams are 1200, 1500 and 2700 yards long. They were built with lime mortar. (To be continued.)

Drydocks

Carron Dry Docks at Grangemouth. Eng., vol. 107, no. 2789, June 13, 1919, pp. 762-763 & 774, 15 figs. Utilization of disused junction lock for wet dock.

Excavation Methods

Excavation Methods on the Miami Conservancy Project, G. L. Teeple. Eng. & Contracting, vol. 52, no. 3, July 16, 1919, pp. 61-63, 4 figs. Flood-prevention project which involves construction of five large earth dams.

Grading

How to Get Clean-Cut Grading Jobs, F. F. Mengel. Good Roads, vol. 18, no. 5, July 30, 1919, pp. 68-69. Suggestions in regard to methods in light and heavy work.

Percussion Drilling

Percussion Plant for Oil-Well Drilling. Engineering, vol. 107, no. 2791, June 27, 1919, pp. 830-833, 15 figs. Points out differences of rigs in three systems: American, Standard or Californian, and Canadian.

Sewers

Sewer-Construction Records Used at Scarsdale, New York, Perry Thompson. Eng. News-Rec., vol. 83, no. 3, July 17, 1919, pp. 111-112, 3 figs. Daily record blank, rock book and sample headings from final estimate book used on 2½ miles of sewers.

Shaft Sinking

Sinking and Concreting Mine Shaft 936 Feet Deep, Richard L. Russell. Eng. News-Rec., vol. 82, no. 26, June 26, 1919, pp. 1259-1262, 5 figs. Simultaneous concreting and excavating operations.

Tunnels

Backfilling Tunnel Through Holes Bored from Surface, J. Armstrong. Eng. News-Rec., vol. 93, no. 4, July 24, 1919, pp 174-175, 2 figs. Concrete poured around 60-in. cast-iron pipe in 10 by 10 ft. rock bore by dropping it 70 ft. from trestle across river.

Pittsburgh South Hills Tunnel and Earlier Projects. Eng. News-Rec., vol. 83, no. 4, July 24, 1919, pp. 166-167, 1 fig. Project for 5500-ft. tunnel.

Conduit Construction Work in Tunnels. Bell Telephone News, vol. 8, no. 12, July 1919, pp. 18-19, 7 figs. Formation of conduit under Chicago River consisting of single-duct tile laid three wide and 8 to 10 ft. high with complete encasement of concrete.

Construction Details on the Marin Water and Power Project, H. M. Bowers. Jl. Electricity, vol. 43, no. 1, July 1, 1919, pp. 22-23. Cost and construction data and description of 8700-ft. tunnel.

Tunnel Construction under Water (Tunnelbau unter Wasser), A. Haag. Zentralblatt der Bauverwaltung, vol. 39, no. 11, Feb. 1, 1919, pp. 57-59, 10 figs. With special reference to tunnels under the rivers Spree and Elbe and under the Kiel canal.

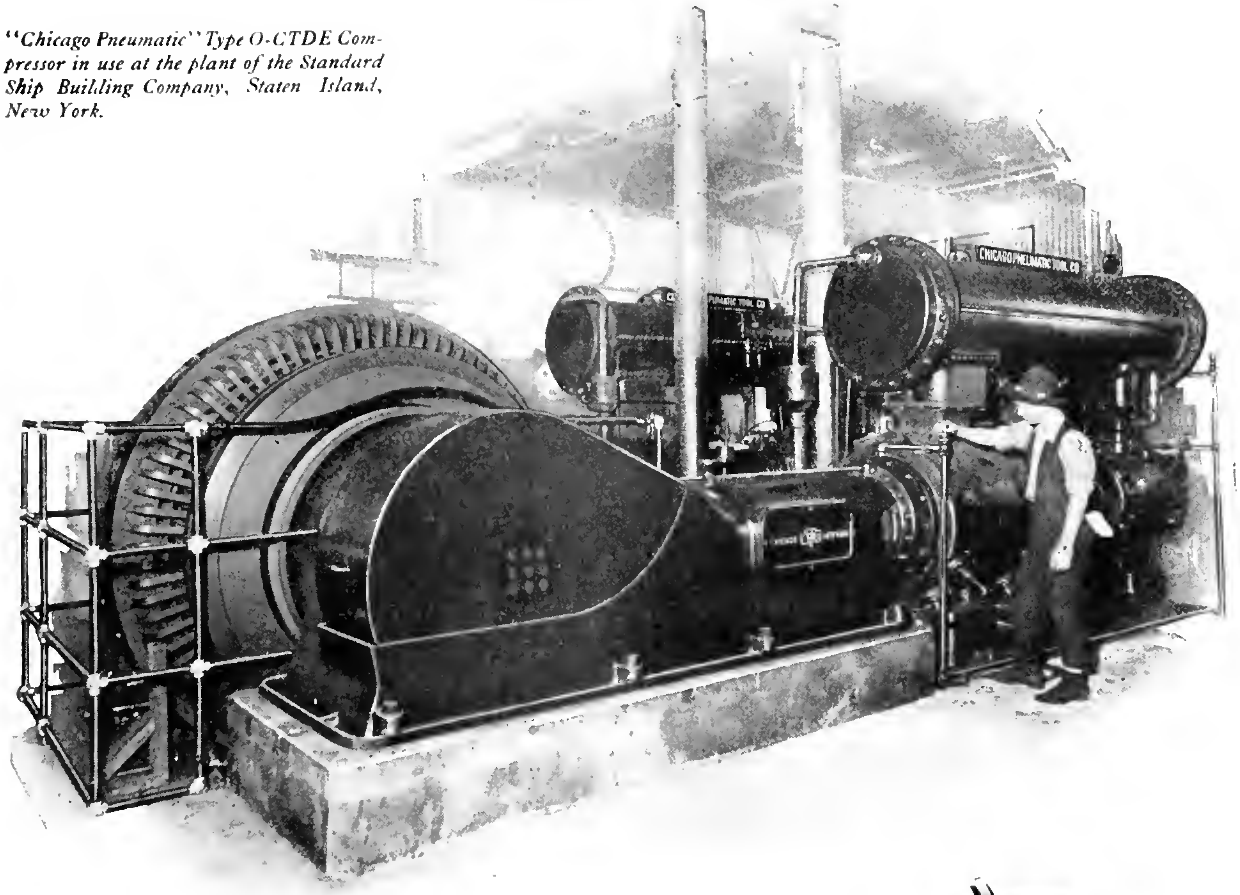
The Catskill Tunnels—IV. Ry. Engr., vol. 40, no. 474, July 1919, pp. 143-147, 4 figs. Alteration of heading during construction of Hunter's Brook Tunnel. (Continuation of serial.)

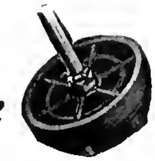
HARBORS

Docks

Reinforced-Concrete Dock (Travaux-Publics), A. Goupil. Génie Civil, vol. 75, no. 1, July 5, 1919, pp. 7-10, 8 figs. Work done at Dutch Indies, notably extension of ports of Soerabaja and Semarang. From De Ingenieur, Feb. 22, 1919.

"Chicago Pneumatic" Type O-CTDE Compressor in use at the plant of the Standard Ship Building Company, Staten Island, New York.



The Compressor with the "Simplate  *Valve"*

Every "Chicago Pneumatic" Air Compressor is equipped with the patented "Simplate" Flat Disc Valves. These valves require no lubrication and are practically indestructible. Operating silently and efficiently, they automatically adjust themselves to all load demands, increase mechanical and volumetric efficiencies, and simplify the whole problem of compressor operation and maintenance.

The "Chicago Pneumatic" line of air compressors comprises over 300 distinct sizes and types. Any compressor need is met by at least one. All are characterized by exceptionally large bearing surfaces, automatic lubrication, simple, sturdy construction and automatic regulation, which insures operating economy under variable load conditions. "Chicago Pneumatic" Air Compressors are, in every detail, thoroughly modern machines, the result of over 20 years' experience in building compressors for every conceivable need

Write for Bulletins

Chicago Pneumatic Tool Company

1006 Fisher Building, Chicago

BIRMINGHAM BOSTON BUFFALO CINCINNATI CLEVELAND DETROIT ELDORADO EL PASO ERIE JOPLIN LOS ANGELES MILWAUKEE MINNEAPOLIS NEW YORK PHILADELPHIA PITTSBURGH PORTLAND RICHMOND SALT LAKE CITY SAN FRANCISCO SEATTLE ST. LOUIS TUCSON TULSA BOMBAY BRUSSELS FRASERBURGH HAVANA HONOLULU JOHANNESBURG CHRISTIANIA LONDON MILAN MONTREAL OSAKA PARIS SEOUL SYDNEY TOKYO TORONTO VANCOUVER WINNIPEG

BOYER PNEUMATIC HAMMERS · ROCK DRILLS COAL DRILLS — LITTLE GIANT PNEUMATIC TOOLS · LITTLE GIANT ELECTRIC TOOLS

CHICAGO — CHICAGO PNEUMATIC — PNEUMATIC

Depend Upon That Name

C-24

CHICAGO PNEUMATIC AIR COMPRESSORS AND VACUUM PUMPS — GIANT FUEL OIL, GAS, GASOLINE AND STEAM ENGINES

Houston, Tex.

Harbor Facilities and Development at Houston, Texas. Eng. News-Rec., vol. 83, no. 4, July 24, 1919, pp. 156-159, 7 figs. Wharves, freight sheds, warehouses, railway connections and freight-handling machinery.

Singapore

Singapore Harbour Works. Ferro-Concrete, vol. 10, no. 8, Feb. 1919, pp. 220-28, 11 figs. Refers especially to reinforced-concrete construction.

Suez

Extensions of the Port at Suez (Les travaux d'extension du port de Suez). Génie Civil, vol. 74, no. 26, June 28, 1919, pp. 525-529, 2 figs. Involving extension of docks.

MATERIALS OF CONSTRUCTION

Asphalt

Melting Point of Asphalts, Leland M. Proctor. Chem. & Metallurgical Eng., vol. 21, no. 2, July 15, 1919, pp. 81-83, 1 fig. Comparison of data obtained by various processes for determining melting point.

Road Materials

Proposed Tests and Specifications for Road Building Materials. Good Roads, vol. 18, no. 1 & 2, July 2 & 9, 1919, pp. 3-4 and 13 & 18-19, 3 figs. Recommendations of Committee D-4 on road materials of Am. Soc. for Testing Materials.

Instructions for Field Inspection of Road Materials. Eng. & Contracting, vol. 52, no. 1, July 2, 1919, pp. 16-18. Issued by New Jersey State Highway Dept. for guidance of inspectors.

Stone, Crushed

Commercial Sizes of Crushed Stone. Eng. & Contracting, vol. 52, no. 3, July 16, 1919, pp. 72-73. Results of survey of Ohio, Kentucky, Tennessee, North Carolina and Georgia, undertaken by Bureau of Public Roads, for securing data to be used in developing of system of standard sizes and uniform nomenclature for crushed-stone products. From Public Roads.

ROADS AND PAVEMENTS

American Society of Civil Engineers

Highways and Their Construction (Carreteras y su construcción). Ingeniería Internacional, vol. 1, no. 3, June, 1919, pp. 131-140, 8 figs. Final report of special committee on materials for road construction and standards for their test and use, of Am. Soc. Civil Engrs.

Asphalt Pavement

Asphalt-Covered Napped-Block Pavement. Mun. Jl. & Public Works, vol. 47, no. 3, July 19, 1919, pp. 32-34. Pavement is constructed of old granite block napped and reclipped and laid with a filler of sand and asphalt mixed, novel feature consisting in addition of covering of same sand-asphalt mixture over entire pavement to depth of about ½ in.

Association of Dominion Land Surveyors

Roads, A. H. Hawkins. Annual Report of Assn. of Dominion Land Surveyors, Jan. 29, 30 and 31, 1919, pp. 91-97. Building of permanent roads is advocated.

Bituminous Mats

Bituminous Mat Protects Texas Roads, James P. Nash. Am. City, Town & County Ed., vol. 21, no. 1, July 1919, pp. 1-5, 2 figs. Process claimed to work satisfactorily in dry climate.

Bituminous Roads

Bituminous Roads in Great Britain and the United States (Les chaussées bitumineuses en Grande-Brétagne et aux Etats-Unis), R. Feret. Annales des Ponts de Chaussées, vol. 2, Mar-Apr. 1919, pp. 222-244. Gives particulars regarding work done and practices adopted in these countries.

The Design and Construction of Bituminous Macadam Roads and Pavements, A. W. Dean. Mun. & County Eng., vol. 56, no. 6, June 1919, pp. 206-208. Best and most lasting results believed to be obtained with sizes of stone in second course varying from ¾ in. to 2½ in., with larger sizes predominating.

Brick Pavements

A Review of Recent Progress in Brick Pavement Design and Construction, Clark R. Mandigo. Mun. & County Eng., vol. 57, no. 1, July 1919, pp. 9-11, 2 figs. Includes notes on advantages claimed for asphalt filler.

Concrete-Road Specifications

Chartered Summary of State Concrete Road Specifications, A. N. Johnson. Eng. News-Rec., vol. 83, no. 4, July 24, 1919, pp. 160-162, 1 fig. Arrangement in chart form.

Constructing Concrete Pavements. Mun. Jl. & Public Works, vol. 47, no. 2, July 12, 1919, pp. 22-23. Standard practice as recommended by Mississippi Valley Assn. of State Highway Departments.

Concrete-Road Stresses

Stresses in Concrete Roads. Mun. Jl. & Public Works, vol. 46, no. 26, June 28, 1919, pp. 466-467. Experiments made by Bur. of Public Roads believed to have shown that concrete road under action of traffic or perhaps under influence of frost and different percentages of moisture in subgrades is continually bending so that reaction pressures between subgrade and slab are neither constant nor uniform in intensity.

Costs

The Cost of a Mile of Road, George A. Duren. Can. Engr., vol. 37, no. 4, July 24, 1919, pp. 161-163, 3 figs. Tabulation of figures compiled by State Highway Engineer of Texas. From paper presented at Eng. & Road Builders' Congress.

Character and Cost of Highways for Motor Truck Use, S. Whinery. Eng. News-Rec., vol. 83, no. 2, July 10, 1919, pp. 77-78. Estimates they will have concrete foundations, will be not less than 20-ft. wide and will cost from $35,000 to $40,000 per mile.

Drainage

See Subsoil.

Granite-Block Pavements

The Design and Construction of Granite Block Pavements in Cincinnati, H. F. Shipley. Mun. & County Eng., vol. 57, no. 1, July 1919, pp. 19-21, 6 figs. Presents specifications.

The Design and Construction of Modern Granite Block Pavements with Special Reference to Practice in Borough of Manhattan, C. M. Pinckney. Mun. & County Eng., vol. 56, no. 6, June 1919, pp. 199-202, 11 figs. Specifications and requirements.

Iowa State Road Law

The New State Road Law of Iowa. Good Roads, vol. 56, no. 3, July 16, 1919, pp. 25-26. Measure provides for improvement of 6000-mile system of primary highways.

Labor

Convict Labor on Highways Good Business. Good Roads, vol. 18, no. 5, July 30, 1919, pp. 65-67, 4 figs. Experiences of highway officials in various states claimed to demonstrate efficiency and economy of prison labor on roads, and physical, mental and moral benefits accruing to convicts.

Maintenance

Macadam and Gravel Road Maintenance, R. C. Heath. Good Roads, vol. 18, no. 2, July 9, 1919, pp. 16 and 22. Practice followed by Kentucky Dept. Public Works.

Night Work

Road Building Twenty-four Hours a Day, William Ord. Contract Rec., vol. 33, no. 30, July 23, 1919, pp. 709-711, 2 figs. Examples quoted where it is said to have been found that night work effected economies and required less labor.

Pipe Lines, Subsurface

Location of Subsurface Pipe Lines to Conserve Street Pavements, Harry M. Adams. Mun. & County Eng., vol. 56, no. 6, June 1919, pp. 225-226. Policies suggested from conditions in New York City.

Road Design for Motor Traffic

Influence of Motor Traffic on Road Design, Arthur H. Blanchard. Good Roads, vol. 18, no. 4, July 23, 1919, pp. 50-52. Transportation surveys, laws and regulations, widths, grades, curves, bridges, drainage and foundations, wearing surfaces, detours and other considerations.

Highways and the Duty of Their Builders, S. M. Williams. Good Roads, vol. 18, no. 4, July 23, 1919, pp. 35-37, 5 figs. Observes that modern motor-truck transportation demands durable all-year roads that will make profits.

Highway Requirements for Twentieth Century Transportation, with Special Reference to New Jersey Practice, Wm. G. Thompson. Mun. & County Eng., vol. 56, no. 6, June 1919, pp. 208-210. Address delivered to Nat. Highway Traffic Assn.

Rubber Pavements

Rubber Pavements: A Historical Résumé. India Rubber World, vol. 60, no. 4, July 1, 1919, pp. 548-550. Although cost of rubber pavement is estimated at about $25 per sq. yd. it is alleged that experience has shown that it will last much longer than any other and will be less expensive in the long run. Pioneer work in England is quoted.

Sidewalk Specifications

Some Suggested Changes in Concrete Sidewalk Specifications, Chas. E. de Leuw. Mun. & County Eng., vol. 57, no. 1, July 1919, pp. 16-17. Recommends elimination of cinder foundation unless soil is impervious.

Subsoil

Comparison of Road Subgrade and Air Temperatures, C. C. Wiley. Eng. News-Rec., vol. 83, no. 3, July 17, 1919, pp. 128-129, 2 figs. Experiments at University of Illinois claimed to have shown that changes in air temperatures are slow to affect subsoil.

Notes on Road Foundations, Drainage and Culverts, U. W. Christie. Mun. & County Eng., vol. 57, no. 1, July 1919, pp. 17-18. Including table showing height to which capillary water rises in certain soils in 24 hours.

Cleveland Underdrains All New Pavements, Fred R. Williams. Am. City, City Ed., vol. 21, no. 1, July 1919, pp. 9-11, 3 figs. Methods and advantages of artificially draining subsoil.

SANITARY ENGINEERING

Air Diffusers for Activated Sludge Process

Test of Air Diffusers for Activated Sludge Process. Eng. & Contracting, vol. 52, no. 2, July 9, 1919, pp. 41-42. "Filtros" plates said to have proved more effective under test than perforated pipe and basswood blocks.

Factory Sanitation

Design and Construction of Factories—VI. Eng. & Indus. Management, vol. 1, no. 19, June 19, 1919, pp. 588-589. Sanitation.

Garbage Disposal

Garbage Disposal by Feeding Successfully Practiced at Lansing, Mich. Mun. & County Eng., vol. 57, no. 1, July 1919, pp. 23-25. Comparison of garbage-fed with grain-fed hogs.

Industrial Wastes

The Disposal of Industrial Wastes, Jacob L. Crane, Jr. Am. Industries, vol. 19, no. 12, July 1919, pp. 22-24. Fundamentals in solution of problem and remarks on attitude of law and recent developments in this direction.

Refuse Collection

Organization for Refuse Collection. Mun. Jl. & Public Works, vol. 47, no. 2 & 3, July 12 & 19, 1919, pp. 16-19 & 35-37, 4 figs. Study of operation and efficiency of existing plant at Rochester and recommended organization of Bureau of Sanitation. (Continued.)

Refuse Collection in Rochester. Mun. Jl. & Public Works, vol. 46, no. 26, June 28, 1919, pp. 464-466, 2 figs. Report of Bureau of Municipal Research. (To be continued.)

Sanitation and Mortality Rates

Reducing the Mortality Rate by Sanitation (Diminución de la mortalidad por el saneamiento), George A. Soper. Ingeniería Internacional, vol. 2, no. 1, July 1919, pp. 29-32, 4 figs. Illustrating sanitary measures conducted in representative European cities.

Sewage

Indianapolis Sewage Purification Plant, Edwin C. Hurd. Fire & Water Eng., vol. 66, no. 5, July 30, 1919, pp. 250-251, 1 fig. Inverted siphon used to convey sewage under river.

The Utilization of Sewage Sludge, John D. Watson. Surveyor, vol. 56, no. 1433, July 4, 1919, pp. 5-8, 1 fig. Diagram illustrating method of purifying sewage at Birmingham. Paper presented at annual meeting of Instn. of Municipal and County Engrs.

Some Unusual Sewerage Problems and How They Were Solved at Ocean Beach, New York, Andrew J. Provost, Jr. Mun. & County Eng., vol. 56, no. 6, June 1919, pp. 203-205, 7 figs. Precautions taken to prevent excessive infiltration of ground water into sewers through joints and at manholes.

SURVEYING

Classification of Lands

Classification of Lands, L. Brenot. Annual Report of Assn. of Dominion Land Surveyors, January 29, 30 and 31, 1919, pp. 51-56. Methods of classifying land for soldiers' settlement.

Highway Surveying

Surveying for Highway Improvement, F. G. Phillips. Good Roads, vol. 18 (new series), no. 2, July 9, 1919, pp. 11-12, 1 fig. Advises making thorough survey of road that is to be rebuilt and resurfaced.

Maps, Military

The Military Mapping Problem in the United States, R. C. Kuldell. Prof. Memoirs, Corps Engrs. U. S. Army & Engr. Dept., vol. 11, no. 56, Mar-Apr. 1919, pp. 229-244, 2 figs. Advocates making all military maps of the U. S. as complete as A. E. F. found available in France. System of scales for both metric and English systems is suggested.

Photographic Surveying

New Method in Photogrammetry, Robert Heindl. Sci. Am. Supp., vol. 88, no. 2272, July 19, 1919, pp. 44-47, 21 figs. Offered as accurate and convenient method for photographic surveying with any camera. Translated from Archive für Kriminal-Antropol. u. Kriminalistik, 1916.

Rod for Triangular Work

Topographical Surveying on Atacama Desert in Chile, B. L. G. Rees. Eng. News-Rec., vol. 83, no. 5, July 31, 1919, pp. 224-226, 2 figs. Special rod designed for triangulation work.

WATER SUPPLY

Artesian Wells

Artesian Well Supply at Baton Rouge, La., L. R. Howson. Eng. & Contracting, vol. 52, no. 2, July 9, 1919, pp. 40-41, 2 figs. Consists of 915 ft. of 12-in., 934 ft. of 10-in., 44 ft. of 8-in. casing, and a 70-ft. strainer. Paper read before Am Water Works Assn.

Chlorination

Chlorination in West Virginia. Mun. Jl. & Public Works, vol. 47, no. 2, July 12, 1919, pp. 20-22. Reported results of disinfection in lowering typhoid rates.

See also Filtration Plants.

Contamination

Contamination of Bello Springs of Matanzas Aqueduct (La contaminación de los manantiales de Bello del Acueducto de Matanzas), Jose M. Cadenas. Revista de la Sociedad Cubana de Ingenieros, vol. 11, no. 6, June 1919, pp. 259-270. Survey undertaken to determine cause of contamination.

Corrosion, Elimination of

The Chemical Treatment of Corrosive Cooling Water. W. O. Andrews. Jl. of South African Instn. of Engrs, vol. 17, no. 11, June 1919, pp. 239-244 and (discussion) pp. 244-246, 5 figs. Forms of rapid corrosion observed by Victoria Falls and Transvaal Power Co. and causes to which they attribute them.

Covering Water Basins

The Need and Cost of Covering the Clear Water Basins of the St. Louis, Missouri Water Works, Cornelius M. Daily. Mun. & County Eng., vol. 57, no. 1, July 1919, pp. 42-44, 1 fig. Typical sections of proposed cover.

Filtration Plants

The Design and Operation of the Water Filtration Plant at Camp Meade, Maryland, C. R. Potteiger. Mun. & County Eng., vol. 57, no. 1, July 1919, pp. 33-38. Design of rapid sand-filter plant.

Point St. Charles Filtration Works, Montreal. Can. Engr., vol. 37, no. 4, July 24, 1919, pp. 155-160, 8 figs. Efficiencies during last nine months claimed to be from 96.2 per cent to 99.1 per cent without chlorination and from 98.1 per cent to 99.8 per cent with chlorination.

Army Water Purification Units, William J. Orchard. Fire & Water Eng., vol. 66. no. 4, July 23, 1919, pp. 185-187, 4 figs. Motor-driven water trucks for chlorinating and filtering supply for A. E. F.

Gallery Collection System

The Gallery Collecting System of the Des Moines (Ia.) Water Co. Eng. & Contracting, vol. 52, no. 2, July 9, 1919, pp. 32-34, 7 figs. Water is obtained primarily from Raccoon River. Drainage area 3677 sq. miles above city.

Madison Water Works

The New Madison Water Works. Power, vol. 50, no. 4, July 22, 1919, pp. 128-133, 8 figs. Building new plant over old one while maintaining service. Choice of artesian or lake water and comparative costs.

Metering

Water Waste Control by House Inspections with District Metering, E. D. Case. Can. Engr., vol. 37, no. 4, July 24, 1919, pp. 163-165. Results obtained by pitometer at various cities. Paper read before Southwestern Water Works Assn.

Pitometer Surveys

Reduction of Water Consumption by Means of Pitometer Survey and Constant Inspection at Buffalo, N. Y., George C. Andrews. Mun. & County Eng., vol. 56, no. 6, June 1919, pp. 236-240.

See also Metering.

Purification of Water

See Filtration Plants.

Water Softeners

English and American Water Softeners. Power House, vol. 12, no. 10, July 5, 1919, pp. 278-280, 5 figs. Description of various types.

Water Testing

Water Testing Stations, W. T. McClenahan and R. S. Rankin. Fire and Water Eng., vol. 66, no. 2, July 9, 1919, pp. 63-65, 1 fig. Result of tests at Whiting Testing Station. Paper read before Am. Water Works Assn.

HYDRAULIC ENGINEERING

Spillways

Spillway Capacities Required for Reservoirs in Western United States, John T. Whistler. Eng. News-Rec., vol. 83, no. 1, July 3, 1919, pp. 28-32, 1 fig. Said to be based on a study of the flood discharges of 402 North American and 60 European and Indian records, with curves of probable flood discharges for far-western streams.

Thunderstorms and Storm Sewers

Some Broader Aspects of Rain Intensities in Relation to Storm Sewer Design, Robert E. Horton. Mun. & County Eng., vol. 56 & 57, no. 6 & 1, June and July 1919, pp. 218-222 & 3-9, 16 figs. Comparative study of rain-intensity formulæ with a view to determining what, if any, general relations exist between rain intensity and the various meteorological factors to which it is related. Simpson's theory of thunderstorm.

MUNICIPAL ENGINEERING

City Planning

Actual Accomplishments in City Planning in America, Andrew Wright Crawford. Jl. Engrs. Club of Philadelphia, vol. 36, no. 177, August 1919, pp. 291-299, 11 figs. Examples of improvements at various cities.

Town-Planning and Tramways. Tramway & Railway World, vol. 45, no. 30, June 19, 1919, pp. 309-311, 3 figs. Tramways on special track in parkway free from obstruction, as proposed at Dundee.

Bolton's Housing Problems—Past, Present and Future, E. Morgan. Surveyor, vol. 55, no. 1431, June 20, 1919, pp. 462-464, 4 figs. Bolton Corporation Act gives powers to insist upon intersecting street at every 200 ft. and forbids construction of blocks of buildings exceeding this length.

VARIA

Architects, Registration of

Model Form of Law for the Registration of Architects. Jl. Am. Inst. Architects, vol. 7, no. 7, July 1919, pp. 335-338. Regulation by State legislation of practice of architecture is proposed at annual convention of Am. Inst. of Architects.

Contract Work, Methods of Letting

Advantages and Disadvantages of Various Methods of Letting Contract Work, J. A. L. Waddell. Eng. & Contracting, vol. 52, no. 4, July 23, 1919, pp. 89-90, 1 fig. Diagram Indicating basis for division of profits between contractor and client.

Storage Tanks, Moving

Moving 60-Ft. Oil Storage Tanks 150 Miles by Water, A. J. J. Taylor. Can. Engr., vol. 37, no. 1, July 3, 1919, pp. 107-108, 7 figs. Each tank was moved in one piece.

Mining Engineering

BASE MATERIALS

Sands

The Texture of Sands. Nature vol. 103, no. 2590, June 19, 1919, pp. 315-317, 3 figs. Diameter obtained by plotting great sizes horizontally at distances proportional to their logarithms.

COAL AND COKE

Alaska

Methods for more efficiently utilizing our Fuel Resources—XXIX. The Coal Resources and Transportation Facilities in Alaska, F. P. Coffin. Gen. Elec. Rev., vol. 22, no. 7, July 1919, pp. 517-535, 7 figs. Alaskan coal fields contain the only accessible deposits of high-grade semi-bituminous coal on the shores of Pacific Ocean, as well as extensive deposits of lignite.

Bituminous Coal

A Chemical Investigation of Banded Bituminous Coal, Studies in the Composition of Coal, Frederick Vincent Tideswell and Richard Vernon Wheeler. Jl. Chem. Soc., vol. 115 and 116, no. 680, June 1919, pp. 619-636, 2 figs. In banded Hamstead coal investigated, it is claimed that ingredients show differences which grade them in fusain, durain, clarain and vitrain.

Preparation of Bituminous Coal—VII, Ernst Prochaska. Coal Age, vol. 16, no. 3, July 17, 1919, pp. 96-103, 7 figs. Considers advantageous to drive machines of washery in groups with larger units driven individually. It is noted that buildings should preferably be of steel, although wood and reinforced concrete are often employed.

Bunker Coal

A British System of Unloading, Stocking and Reclaiming Bunker Coal, H. Hubert. Coal Trade Jl., vol. 50, no. 29, July 16, 1919, pp. 865-866, 2 figs. System of bunkering with steam cranes described as being capable of handling 74 tons per hr.

Coal, Geology of

Résumé of Theories of the Origin of Coal, C. W. Hippard. Coal Age, vol. 16, no. 3, July 17, 1919, pp. 104-104. As some theories hold that beds now rest where vegetable matter from which they were formed originally grew, while others believe that beds are result of drift, writer, who finds arguments advanced in support of either hypothesis of value, concludes that it is quite probable that all coals were not formed by identical process.

Research on the Constitution and Origin of Coal, A. C. Fieldner. Gas Age, vol. 44, no. 2, July 15, 1919, pp. 45-49, 18 figs. Microphotographs taken at Pittsburgh Bur. of Mines Research Laboratory, with notes on practical investigation of microscopical examination.

The Formation of Coal, J. D. Kendall. Can. Min. Inst. Bul., no. 87, July 1919, pp. 761-778, 13 figs. Geology of English coal fields. (Continuation of serial.)

Coal Industry Commission

The Coal Industry Commission. Reports on Nationalism. Colliery Guardian, vol. 117, no. 3052, June 27, 1919, pp. 1541-1546. Quoting reasons for State ownership of coal royalties, suggested method of purchase and carrying account of coal mines, and proposed scheme for local administration.

Coal Mining and Rock Structure

The Effect of Coal Mining on the Overlying Rocks and on the Surface, W. D. Lloyd. Tran. Instn. Min Engrs., vol. 57, part 2, May 1919, pp. 74-95, and (discussion) pp. 95-100. Summary of theories which have been put forward and of opinions which have been expressed by various investigators.

Coke from Illinois Coal

Metallurgical Coke from Illinois Coal, R. S. McBride and W. A. Selvig. Iron Age, vol. 104, no. 5, July 31, 1919, pp. 283-286, 4 figs. Operating test at St. Paul plant of Minnesota By-Product Coke Co. conducted by Bureaus of Standards and Mines.

Coke Ovens

Coke Ovens (Koksöfen), E. Locoq and J. Pieters. Feuerungstechnik, vol. 7, no. 12-13, Mar. 15, April 1, 1919, pp. 95-96 & 101-104, 2 figs. Heat required for distillation; by-product yield; calculation of distribution of gases on walls of coke oven. The development of the coke oven. (Concluded.)

Coke-Plant Equipment

Clairton By-Product Coke Plant Equipment—II Frank F. Marquard. Blast Furnace & Steel Plant, vol. 7, no. 7, July 1919, pp. 340-342 & 358, 1 fig. Coal Industry, vol. 2, no. 7, July 1919, pp. 284-287, 1 fig, also chart showing operating organization of coke works.

Coking Capacity

The Coking Capacity of Coals, A. Meurice. Colliery Guardian, vol. 117, no. 3052, June 27, 1919, pp. 1559-1560, 1 fig. Practical commercial tests said to have proven that value of coking coals is directly proportional to their index limit of agglutination. From Annales des Mines de Belgique.

Depreciation

Depletion and Depreciation of Coal-Mining Properties. D. C. Burdick. Coal Age, vol. 16, no. 5, July 31, 1919, pp. 185-187. Writer's opinion is that charges should be graduated and of such amount that total investment may be extinguished when property is worked out.

France

The French Coke Problem, N. C. Berethelot. Colliery Guardian, vol. 117, no. 3050, June 13, 1919, pp. 1415-1416. Suggests as model specification for coking plant attached to works comprising blast furnaces, that surplus gas from the latter be used to heat the coke ovens, while coke-oven gas of 4000 calories be utilized in matallurgical furnaces. Translated from Chimie et Industrie.

Gas Exhausters

Gas Exhauster in Coke-Oven Plants (Gassauger in Koksofenanlagen). B. Schapira. Fenarungstechnik, vol. 7, no. 12, Mar. 15, 1919, pp. 93-94. Special reference is made to the Brown-Boveri and C. H. Jaeger types turbo-gas exhauster and also to the fan gas exhauster of the Berlin-Anhaltische Maschinenbau Gesellschaft.

Gas from Broken Coal

Effect of Breaking of Coal on the Emission of Gas, Robert Dunn. Coal Age, vol. 16, no. 1, July 3, 1919, p. 20. Daily sampling and analysis of mine air at Crow's Nest Pass Mine said to have shown that amount of gas in mine air changes but little and seems to bear no relation whatever to mining operations.

Impurities

Impurities in Raw Coal and Their Removal. Coal Age, vol. 16, no. 4, July 24, 1919, pp. 150-151. Limitations of three methods for removing impurities—hand-picking, mechanical shale pickers and coal washers.

Preparation

Preparation of Bituminous Coal—VI. Ernst Prochaska. Coal Age, vol. 16, no. 1, July 3, 1919, pp. 9-15, 5 figs. How, after coal has been washed, it must be freed from adhering moisture before it can be shipped. Draining bins, elevators, conveyors and centrifugal dryers as means for this purpose.

Pyrites

Valuable Pyrite in Illinois Coal Beds, G. H. Cady. Coal Age, vol. 16, no. 4, July 24, 1919, pp. 136-140, 9 figs. Defines various types of pyrite and their modes of occurrence, and shows in what beds and sections these types may be most generally found

Saar Basin

Problem of the Great Saar Coal Basin, Wilbur Greely Burroughs. Coal Industry, vol. 2, no. 7, July 1919, pp. 268-274, 1 fig. With reference to its political, economical and geological value.

Shaft Mine

Modern Shaft Mine at Amsterdam, Ohio. Jack L. Ball. Coal Age, vol. 10, no. 2, July 10, 1919, pp. 46-47, 2 figs. Coal mine. Capacity of mine is 800 tons a day.

Splitting of Coal Seams

On the Splitting of Coal-Seams by Partings of Dirt I, Percy Fry Kendall. Proc. Midland Inst., Min., Civil & Mech. Engrs., vol. 24, no. 4, 1918, pp. 104-119, and (discussion) pp. 119-123, 10 figs, partly on supp. plate. Evidence in support of theory that linear splits in coal-seams that rejoin are erosion phenomena and not, as Bowman supposed, tectonic in origin.

Stripping

Operating a Coal-Stripping Plant in Ohio. S. B. Creamer. Coal Age, vol. 16, no. 4, July 24, 1919, pp. 134-135, 3 figs. Overburden handled by shovel entirely. Suggestions are made for stripping by this method.

Thickener, Dorr

Use of the Dorr Thickener and Classifier in Coal Preparation, John Griffen. Coal Age, vol. 16, no. 4, July 24, 1919, pp. 146-148, 2 figs. Principles of construction and operation. Dorr continuous thickener is used for collection and dewatering of fine solids mixed or suspended in liquid.

Washing

The Examination of Coal in Relation to Coal Washing. M. Wynter Blyth and L. T. O'Shea. Iron & Coal Trades Rev., vol. 98, no. 2677, June 20, 1919, pp. 852-853. Suggests that purity of washed coal to be used for coking should be judged by its ash content as determined by incineration.

Washington (State)

The Coal Fields of Southwestern Washington, Harold E. Culver. Wash. Geol. Survey, bul. no. 19, Jan. 2, 1919, 155 pp., 36 figs., partly on supp. plates. General geological features; details of various areas and remarks on utilization of coals.

COPPER

Milling, Lake Superior

Developments in Lake Superior Milling, C. H. Benedict. Eng. & Min. Jl., vol. 108, no. 1, July 5, 1919, pp. 5-10, 8 figs. Two types of copper ore are mined in region—conglomeratic ore which is hard, close-grained rhyolite, characteristically composed of pebbles with copper as cementing material, and amygdaloidal ore, in which copper occurs in more massive form. Methods of dressing and leaching as required by these two types are described.

EXPLOSIVES

Blasting Equipment

Electric Blasting Equipment, L. D. Rowen. Eng. & Min. Jl., vol. 108, no. 2, July 12, 1919, pp. 45-46, 1 fig. Dependability and conditions under which electric detonating cap can be used.

Electric Priming in Mines (Note sur le tir électrique). MM. Taffanel, Dautriche, Durr and Perrin. Annales des Mines, vol. 7, no. 11, Apr. 1919, pp. 6-124, 13 figs. Composition and properties of powders used for inflammation and electrical features of inflammator. (To be continued.)

Permissible Explosives

Tests and Comparisons of Various Types of Permissible Explosives, Joseph C. Thompson. Coal Age, vol. 16, no. 3, July 17, 1919, pp. 94-95. Notes tests used by Bureau of Mines to establish permissible explosives. Comparison is made of black powder and some permissible explosives and several classes of permissibles are discussed.

Priming

See Blasting Equipment.

Storage

Regulations Governing Storage of Explosives. (Réglementation des dépots de substances explosives). Comité Central des Houillères de France et Chambre Syndicale Française des Mines Métalliques. Notes Techniques, no. 384, June 1, 1919, pp. 19-63. With provisions in regard to sales and importation of dynamite and other nitroglycerine explosives.

Storing and Handling High Explosives During the War, G. C. Munoz. Eng. News-Rec., vol. 82, no. 26, June 26, 1919, pp. 1242-1246, 9 figs. Methods developed by Ordnance Department.

TNT

TNT as a Blasting Explosive, Charles E. Munroe and Spencer P. Howell. Can. Engr., vol. 37, no. 4, July 24, 1919, pp. 170-172 and 174. Industrial use, general characteristics, solubility and hygroscopicity grade of determination, precaution in packing, and remarks on practical field demonstrations.

GEOLOGY AND MINES

Amber

Amber and Its Origin, George F. Black. Am. Mineralogist, vol. 4, no. 7, July 1919, pp. 83-85. Geology of Samland peninsula, East Prussia. (To be continued.)

Barite, Stalactitic

Stalactitic Barite from Madoc, Ontario, T. L. Walker. Am. Mineralogist, vol. 4, no. 7, July 1919, pp. 79-80, 1 fig. on supp. plate. Outer surface formed by projecting ends of small crystals arranged in radial fashion with macro-axis of tiny crystals approximately parallel to axis of aggregate.

Colorado Rockies

The Building of the Colorado Rockies—II. Rollin T. Chamberlin. Jl. Geology, vol. 27, no. 4, May-June 1919, pp. 225-251, 10 figs. System is characterized by open, gentle folding, moderate crystal shortening affecting a zone several scores of miles in depth in its deeper portions by strong uplifting and by extrusion of much lava.

Earthquakes

Surface Reflexion of Earthquake Waves, George W. Walker. Phil. Tran. Roy. Soc. Lond., Series A 567, vol. 218, June 12, 1919, pp. 373-393, 8 figs. partly on two supp. plates. Investigation undertaken to study sharp impulses noted on seismograms, which in Wichert's opinion represent arrival of waves that have undergone one or more reflexions at earth's surface.

Florida

Geology in Florida, E. H. Sellards. Jl. Geology, vol. 27, no. 4, May-June 1919, pp. 286-302, 3 figs. partly on supp. plate. General structural conditions.

Foliation and Metamorphism

Foliation and Metamorphism in Rocks, T. G. Bonney. Geological Mag., vol. 6, no. 6, June 1919, pp. 246-250. Pressure-modified gneisses and schists. (Concluded.)

Manganotantalite

Manganotantalite from Amelia, Virginia, O. Ivann Lee and Edgar T. Wherry. Am. Mineralogist, vol. 4, no. 7, July 1919, pp. 80-83, 1 fig. Physical properties of deep red columbite containing manganese in excess over iron and tantalum slightly in excess over columbium.

Metamorphism

See Foliation and Metamorphism.

Mud Volcanoes

Mud Volcanoes in Colombia, South America, Stanley C. Herold. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 151, July 1919, pp. 1025-1027, 2 figs. Their occurrence in faulted localities used as basis of explanation of their origin.

Pre-Cambrian

Some Stratigraphic and Structural Features of the Pre-Cambrian of Northern Quebec—III, H. C. Cooke. Jl. Geology, vol. 27, no. 4, May-June, 1919, pp. 263-275. Petrographical similarities, geological successions, deformations and relation to older and younger formations as criterion for correlation.

Some Problems of the Adirondack Precambrian, Harold L. Alling. Am. Jl. Sci., vol. 48, no. 283, July 1919, pp. 47-68, 3 figs. Following are some of points brought out as consequence of investigation: That Greuville strata have been extensively isoclinally folded; that individual phases of Saranac series may be some one or other of well recognized rock units, and establishment of metagabbro closely following intrusion of Laurentian granite.

Rock Composition Determination

A Planimeter Method for the Determination of the Percentage Compositions of Rocks, Albert Johannsen. Jl. Geology, vol. 27, no. 4, May-June 1919, pp. 276-285, 6 figs. Based on claimed proportionality of surface measurements to volumes in any uniform, non-banded rock, irrespective of shape of individual components.

IRON

Great Britain

Recent Iron-Ore Deevlopments in the United Kingdom, F. H. Hatch. Iron & Coal Trades Rev., vol. 98, no. 2676, June 13, 1919, pp. 795-796, 2 figs. Working of low-grade iron-ore deposits as influencing industrial recuperation. From lecture delivered at Roy. School of Mines.

Nova Scotia

The Iron and Coal Industry in Nova Scotia, F. W. Gray. Iron & Steel of Can., vol. 2, no. 7, July 1919, pp. 152-153. Economical conditions. Paper read before Montreal Metallurgical Assn.

LEAD, ZINC, TIN

Lead and Vanadium

Treatment of Vanadinite for the Recovery of Lead and Vanadium Metallurgically, J. E. Conley. Metal Industry, vol. 14, no. 26, June 27, 1919, pp. 521-524, 2 figs. Results of methods which are said to have proven successful in recovering lead from vanadinite and fusion with caustic soda and soda ash; recovery by solution.

Spelter

The Spelter Industry in Australia and Britain, F. A. Govett. Steel & Metal Digest, vol. 9, no. 7, July 1919, pp. 344-346. Statistics and account of projected increases of various plants.

Vanadium

See Lead and Vanadium.

Zinc

War's Influence on the Zinc Industry, Pope Yeatman. Eng. & Min. Jl., vol. 108, no. 1, July 5, 1919, pp. 19-21. Development of new uses of zinc; coöperation between miner and smelter. See also Spelter.

MAJOR INDUSTRIAL MATERIALS

Manganese

Manganese Deposits of the West Foot of the Blue Ridge, Virginia, G. W. Stone, H. D. Miser, F. J. Katz and D. F. Hewett. Virginia Geological Survey, Univ. of Va., Bul. no. 17, 1919, 166 pp., 38 figs. Based on examination of mines and prospects and studies of physiographic and stratigraphic conditions under which manganese deposits of region were formed, and of application of hypothesis proposed by D. F. Hewett for discovery of new ore deposits.

Preparation of Manganese Ore, W. R. Crane. Dept. Interior, Bur. of Mines, Minerals Investigations Series, no. 17, May 1919, 16 pp. Including summary of conditions affecting concentration.

Nickel

Treatment of Low-Grade Nickel Ores, C. W. Davis. Jl. Indus. & Eng. Chem., vol. 11, no. 7, July 1, 1919, pp. 644-648. No satisfactory concentration of ores was obtained by sizing tests, panning, tabling, magnetic concentration, or flotation. Magnetic treatment of reduced North Carolina ore brought concentration of nickel from 0.97 per cent to 3.6 per cent, recovery being 45 per cent.

MINES AND MINING

Apex Law

A Phase of the Apex Law, Chas. E. Dutton. Eng. & Min. Jl., vol. 108, no. 4, July 26, 1919, pp. 146-147. Examples quoted in support of contention that its application has operated to thwart development.

Concentration, Magnetic

Treatment of Low-Grade Iron Minerals by Magnetic Concentration (Le traitement des minérais de fer pauvres par concentration magnétique), Henry Louis. Chimie & Industrie, vol. 2, no. 5, May 1919, pp. 511-524, 20 figs. Description of process with illustration of machines employed and diagrammatic sketch indicating order of procedure in successive operations. Paper read before Interallied Conference of Chemistry.

Costs, Mining

Excerpts from Reports of Mineral Investigations of the Bureau of Mines for June, 1919. Dept. of Interior, Bur. of Mines, 1919, 50 pp., 1 fig. Covering production and cost data and mining situation in regard to labor and mining methods in various industries.

Diamond Drill Exploration

Progress in Methods of Exploration, Hugh M. Roberts. Min. & Sci. Press, vol. 119, no. 20, July 12, 1919, pp. 55-57. Tracing particular claim in increasing effectiveness of diamond-drill as exploring instrument.

France, Mining Law

New French Mining Law. Colliery Guardian, vol. 98, no. 3053, July 4, 1919, pp. 29. Provides profit-sharing scheme.

Hydraulic Mining

Hydraulic Mining in California With Special Reference to the You Bet Mine, F. A. Goodale. Colo. School Mines Mag., vol. 9, no. 7, July 1919, pp. 167-173, 2 figs. Including example of calculations involved in determining size and grade of sluice.

Mill, Ball and Tube Drives

Ball and Tube-Mill Drives at the Rochester Combined Mill, K. Freitag. Min. & Sci. Press, vol. 119, no. 1, July 5, 1919, pp. 7-8, 1 fig. Arrangement in two units, each composed of one 6 ft. by 4 ft. 6 in. ball mill and one 7 by 12 ft. tube mill.

Mine Examination

Proper and Lawful Examination of a Mine by the Mine Examiner, Steve Gosnell. Coal Age, vol. 16, no. 1, July 3, 1919, pp. 18-19. Calls attention to the fact that an inspection may be entirely legal but not adequate and recommends that examiner, while making his daily inspection, should not confine his activities to a perfunctory accomplishment of legal prescriptions.

Nevada Packard

Description of Nevada Packard Mine and Mill, Herbert C. Thomson. Salt Lake Min. Rev., vol. 21, no. 6, June 30, 1919, pp. 21-24, 4 figs. Said to consist of series of rhyolite flows, with several intercalated beds of rhyolite stuff, the latter deposited in water, and grading imperceptibly into true shales: they are probably of Jurassic age.

Power Transmission

Electrical Transmission of Power in and About Coal Mines, S. W. Farnham. Coal Age, vol. 16, no. 2, July 10, 1919, pp. 48-51. Types of mine loads to be considered and survey of practice in regard to methods of transmission. Paper read before Ill. Min. Inst.

Rock Drills

Pneumatic-Electric Rock Drill and Some of the Tools Used in Its Construction—I, Frank A. Stanley. Am. Mach., vol. 51, no. 3, July 17, 1919, pp. 107-110, 10 figs. Machine which is claimed to provide for air cushion for minimizing shock on electrical apparatus.

Sealing Up

Sealing Up Old or Abandoned Workings, Joseph C. Thompson. Coal Industry, vol. 2, no. 7, July 1919, pp. 259-260. Suggests method of procedure. Paper presented before annual meeting of Ill. Min. Inst.

Shaft Sinking

Sinking and Concreting Deep Mine Shaft. Contract Rec., vol. 33, no. 28, July 9, 1919, pp. 674-677, 4 figs. Lining and walls of four compartment shaft, 936 ft. deep, concreted simultaneously with excavation operations.

MINOR INDUSTRIAL MATERIALS

Graphite

The Graphite Situation, Hugh S. Spence. Can. Chem. Jl., vol. 3, no. 7, July 1919, pp. 213-216. Summary of situation as faced by Canadian producers with review of development of present process of recovery and discussion of market conditions.

Graphite Mining and Milling in Alabama, H. P. H. Brumell. Eng. & Min. Jl., vol. 108, no. 1, July 5, 1919, pp. 17-18. Flotation methods reported as successful.

Magnesium and Sodium Salts

Natural Deposits of Salts of Magnesium and Sodium Near Clinton, British Columbia, L. Reinecke. Can. Chem. Jl., vol. 3, no. 7, July 1919, pp. 209-213, 5 figs. Descriptive and historical. (Continued.)

Sodium

See Magnesium and Sodium.

OIL AND GAS

Appalachian

Depletion of Natural Gas in the Applachian Field, J. A. Bownocker. Gas Age, vol. 44, no. 2, July 15, 1919, pp. 57-60, 8 figs. Situation is seen fairly satisfactory for present but is considered as uncertain for future.

Conducting

Irvine Oil District, Kentucky, Stuart St. Clair. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 151, July 1919, pp. 1079-1089, 1 fig. Calls attention to probability that area of production from Irvine sand in eastern Kentucky is a function of the distance from the outcrop of the oil formation and from the major faults.

Drilling

Percussion Plant for Oil Well Drilling. Eng., vol. 108, no. 2792, July 4, 1919, pp. 830-833, 15 figs. Differences in various systems—American, standard or Californian and Canadian. Paper presented to Inst. of Petroleum Technologists.

Great Britain

The Search for Subterranean "Oil-pools" in the British Isles, V. C. Illing. Geological Mag., vol. 6, no. 7, July 1919, pp. 290-301, 1 fig on supplement plate. Evidence brought forward in favor of possible occurrence of oil pools in Great Britain studied in its geological aspect. Conclusions are generalized in regard to possibility of ascertaining existence of oil in a locality from knowledge of geological formation.

Sections of English Oil Wells. Petroleum World, vol. 16, no. 226, July 1919, pp. 293, 2 figs. Hardstoff where oil is flowing and Brimington where next strike for oil is expected.

Oil Accumulation

Notes on Principles of Oil Accumulation, Alex. W. McCoy. Jl. Geology, vol. 27, no. 4, May-June 1919, pp. 252-262, 6 figs. Experiments are offered to substantiate conclusion that bituminous shales are in close relationship with producing sand of oil field. It is asserted that this bituminous material is in solid form and is only changed to petroleum in local areas of differential movement, accumulation of oil in commercial pools being accomplished by capillary water after such a change is made.

Petroleum Refining

Petroleum Refining, R. W. Cunningham. Jl. Soc. Automotive Engrs., vol. 5, no. 1, July 1919, pp. 78-82 and (discussion) pp. 82-84, 4 figs. Charts showing products obtained in running distillation of oil for petroleum coke and for cylinder stock with notes on oil testing instruments.

Water Sealing

Sealing Water in California Oil Fields, Seth S. Langley. Eng. & Min. Jl., vol. 108, no. 1, July 5, 1919, pp. 11-16, 4 figs. Formation and cement shut-off methods.

Water Separation

Separating Water from Petrol. Petroleum World, vol. 16, no. 226, July 1919, pp. 304-305, 2 figs. Device which is said to be more particularly applicable to (1) buried gasoline storage tanks, and (2) portable tanks.

PRECIOUS MINERALS

Cariboo

Cariboo Placers and Lodes, J. A. Macpherson. Min. & Eng. Rec., vol. 24, nos. 8 & 9, May 1919, pp. 125-129, 9 figs. Concerning conditions, ore treatment and transportation costs.

Gold

Operations of Round Mountain Mining Company, Charles F. Spilman. Salt Lake Min. Rev., vol. 21, no. 7, July 15, 1919, pp. 23-26, 5 figs. Gold deposits.

Oregon

Placer Mining in Oregon, A. E. Kellogg. Eng. & Min. Jl., vol. 108, no. 3, July 19, 1919, pp. 90-91, 1 fig. Geology of Waldo district.

Platinum

The Platinum Situation, James M. Hill. Eng. & Min. Jl., vol. 108, no. 4, July 26, 1919, pp. 131-137, 4 figs. Uses of platinum and possibilities for maintaining supplies. Shortage in platinum and platinum group of metals attributed to disturbances of normal production created by war.

Silver

Silver Spur Mine, Lionel C. Ball. Queensland Dept. of Mines, Geological Snvey. No. 264, 1918, 36 pp., 13 figs. Recent developments and future prospecting.

Silver Volatilization in Smelting, Frederic P. Dewey. Eng. & Min. Jl., vol. 108, no. 3, July 19, 1919, pp. 87-89. Distinguishes between volatilization and dusting and points out that mechanical loss due to ebullition has nothing to do with the vapor pressure, or true volatilization.

SAFETY ENGINEERING

Fires

Use of Inert Gas to Extinguish Mine Fire, Joseph J. Walsh. Coal Industry, vol. 2, no. 7, July 1919, pp. 266-267, 1 fig. Applicability in extinguishing crop fires or those at inaccessible points.

TRANSPORTATION

Belgium

Underground Transportation (Les transports souterrains), F. Defize. Revue Universelle des Mines & de la Métallurgie, vol. 1, no. 1, Jan. 1919, pp. 70-117, 6 figs. Comparative examination of various systems referring to conditions prevailing in Belgium mines.

Quarries

Transportation in Quarries, Daniel J. Hauer. Cement, Mill and Quarry, vol. 15, no. 2, July 20, 1919, pp. 19-20, 3 figs. Illustrating track layouts for inclines in pit quarries that are worked in two or more lifts.

Rails, Mine, Bonding of

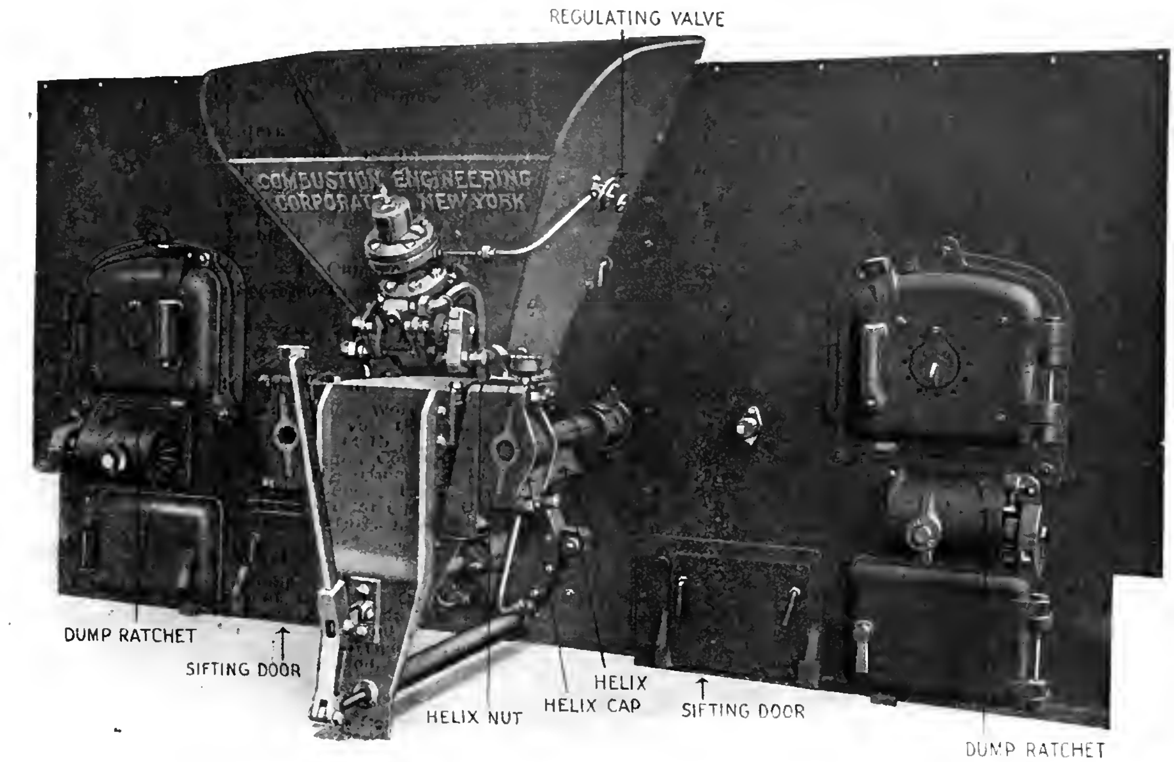
Importance of Proper Bonding of Mine Rails, C. C. Beck. Coal Age, vol. 16, no. 3, July 17, 1919, pp. 90-93, 22 figs. Type of bond employing terminals welded to rail ends recommended.

VARIA

Germany

Economical Situation of the Basic Steel Works in Germany, Belgium and France (Situation économiques des aciéries au conver-

STANDARD



TYPE "E" STOKERS

UNDERFEED **SELF CLEANING**

EQUIPPED WITH STRONG SIDE DUMPS FIX THE STANDARD FOR SIMPLICITY IN FIRING BIG BOILERS

Get the facts from us

Combustion Engineering Corporation

11 Broadway, New York City

Owners and manufacturers of

Type "E" Stokers—for Bituminous Coal **The Grieve Grate—Hand-Firing**
Coxe Stokers—Anthracite Coal and Coke Breeze

PHILADELPHIA, PA. PITTSBURGH, PA. MINNEAPOLIS, MINN.
BIRMINGHAM, ALA. HAZLETON, PA. BOSTON, MASS. CHICAGO, ILL.
SEATTLE, WASH. SALT LAKE CITY, UTAH ALBANY, N. Y.
OMAHA, NEB. TAYLOR ENGINEERING CO., VANCOUVER, B. C.

tisseur basique en Allemagne, en Belgique et en France), Fernand Tordeur. Revue Universelle des Mines & de la Métallurgie, vol. 1, no. 1, Jan. 1919, pp. 1-69. Discusses application of modern methods as economical factor for developing industry.

Public Control

State Versus Private Control of Mines and Minerals. Can. Min. Inst. Bul., no. 87, July 1919, pp. 697-701. Based on evidence before British Coal Industry Commission.

Metallurgy

ALUMINUM

Aluminum-Copper-Magnesium Alloys

Constitution and Metallography of Aluminum and Its Light Alloys with Copper and with Magnesium, P. D. Merica, R. G. Waltenberg and J. R. Freeman. Bul. Am. Inst. Min & Metallurgical Engrs., no. 151, July 1919, pp. 1031-1049, 28 figs. Temperature solubility curves of $CuAl_2$ and of Mg_4Al_3 in aluminum obtained by method of annealing and microscopic examination.

Lynite

Aluminum Alloy Combines Strength with Toughness. Automotive Indus., vol. 41, no. 3, July 17, 1919, pp. 108-109, 4 figs. Tests on lynite alloy said to have indicated that this material may be applied in parts subjected to shock, such as axle housings and differential carriers.

Mechanical Properties

Mechanical Properties and Resistance to Corrosion of Rolled Light Alloys of Aluminum and Magnesium with Copper, Nickel, and Manganese, P. D. Merica, R. G. Waltenberg and A. N. Finn. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 151, July 1919, pp. 1051-1062, 3 figs. Light aluminum alloys of several compositions belonging to each of three series—aluminum-magnesium-copper, aluminum-magnesium-manganese, and aluminum-magnesium-nickel—were rolled out into sheets and tested on tension as cold-rolled, after annealing and after heat treatment.

BEARING METALS

Researches on Bearing Metals. Antimony, Lead, Tin Alloys, E. Heyn and O. Bayer. Metal Industry, vol. 15, no. 1, July 4, 1919, pp. 1-7, 17 figs. Investigation covered (1) chemical analysis of raw materials for preparation of alloys, (2) behavior during solidification and fusion, (3) influence of rate of cooling and subsequent heat treatment on microstructure and ball hardness, (4) mechanical properties, (5) experiments on effect of additions of copper on microstructure and melting point.

BLAST FURNACES

Design

The Principal Changes in Blast Furnace Lines. Iron & Coal Trades Rev., vol. 99, no. 2679, July 4, 1919, pp. 6-7, 6 figs. Review of developments during past twelve years, especially in regard to capacity leads to conclusion that 1,000-ton furnace will be attained, either along present lines or completely revolutionizing useful designs.

Explosions

Blast-Furnace Explosions, B. B. Hood. Eng. & Min. Jl., vol. 108, no. 2, July 12, 1919, pp. 47-49, 2 figs. Disastrous accident occurred when blowing engine was shut down, believed to have been due to leaky jacket permitting contact of water and hot coke, and consequent generation of water gas.

Pulverized Coal

Application of Pulverized Coal in Blast Furnaces, E. P. Mathewson and W. L. Wotherspoon. Can. Min. Inst. Bul., no. 87, July 1919, pp. 737-760, 11 figs. Experiments by various plants, notably Tennessee Copper Co., and International Nickel Co. smelters.

Steel Turnings in Blast Furnace

On the Utilization of Steel Turnings in the Blast Furnace. Engineering, vol. 108, no. 2793, July 11, 1919, p. 58. Practice at iron works in North of France. Translated from Comptes rendus de la Société de l'Industrie Minérale.

COPPER AND NICKEL

Electric-Furnace Smelting of Speiss

Smelting Copper Speiss in the Electric Furnace, P. Papencordt. Metal Industry, vol. 14, no. 25, June 20, 1919, pp. 502-504, 2 figs. Experiments said to have yielded copper matte containing merely traces of arsenic, speiss high in antimony but free from arsenic, slag and sublimate. (From Metall und Erz.)

Monel Metal

Some Facts About Monel Metal, Hugh R. Williams. Power, vol. 50, no. 1, July 1, 1919, pp. 14-16, 3 figs. Charts comparing behavior of monel metal and nickel steel; also of monel and other metals of high temperature.

FLOTATION

Concentrate Treatment

Considerations on the Treatment of Flotation Concentrate, Oliver E. Jager. Min. & Sci. Press, vol. 119, no. 20, July 12, 1919, pp. 43-44. States what changes, if any, must be made in smelting process and equipment, and what differences are to be expected in results, when considerable proportion of material to be treated consists of flotation concentrate. The question is taken up by assuming the case of a smelting plant having a concentrator, the whole being in operation, and that the latter is about to install flotation.

Copper Ores

Flotation Concentration of Copper Ores. Chem. Eng. & Min. Rev., vol. 11, no. 123, Dec. 5, 1918, pp. 68-72, 5 figs. Device installed at Wallaroo, Australia, mines concentrating plant to deal with overflow from mine.

Physics of Concentration

Concentration by Flotation (Concentración por flotación), Federico C. Fuchs. Boletin Minero de la Sociedad Nacional Mineria, vol. 31, no. 239, Jan. 1919, pp. 37-49. Experiments said to have established that phenomena taking place in concentration by flotation are principally those of capillarity, surface tension and molecular cohesion.

Recent Progress

Recent Metallurgical Progress, Hugh K. Picard. Eng. & Min. Jl., vol. 108, no. 2, July 12, 1919, pp. 65-69. Following progress emphasized: That flotation has revolutionized concentration; that zinc metallurgy has slightly advanced in smelting: that in copper, reverberatory practice and ammonia leaching are chiefly to be noted.

FURNACES

Booth Electric Brass Furnace

The Booth Electric Rotating Brass Furnace, Carl H. Booth. Metal Indus., vol. 17, no. 7, July 1919, pp. 317-319, 2 figs. Modified by placing door in one end of furnace and having tapping hole in other end, in order to overcome difficulties that have been experienced in maintaining lining around former combination spout and door.

Crucible Furnace

Crucible Furnace with Blower and Detachable Preheater (Gebläse-Tiegel-Schmelzofen mit aufgesetztem und wegnehmbarem Vorschmelzer). Metall-Technik, vol. 45, no. 7-8, Feb. 22, 1919, p. 28, 4 figs. Special feature claimed is arrangement for exhaust gases to escape from side of preheater instead of from center.

Design

Metallurgical Furnaces, A. Bregman. Metal Industry, vol. 14, no. 25, June 20, 1919, pp. 507-509, 5 figs. Conditions that govern size, shape and type of metal-melting furnace. (Concluded.)

Detroit Rocking Furnace

The Detroit Rocking Furnace for Melting Brass and Bronze, H. M. St. John. Metal Indus., vol. 17, no. 7, July 1919, pp. 320-322, 3 figs. Consists essentially of cylindrical steel shell with refractories, and mounted on rollers and ring gears which permit it to be rocked through any desired arc of revolution up to maximum of 200 deg.

Furnace Selection

Melting Process Chosen Depends on Requirements, H. E. Diller. Foundry, vol. 47, no. 326, July 1, 1919, pp. 411-415, 9 figs. Acid open hearth and converter both operated by Detroit Steel Casting Co. Illustration of application.

Pulverized Coal

The Use of Pulverized Coal, L. C. Harvey. Engineering, vol. 108, no. 2793, July 11, 1919, pp. 62-67, 5 figs. With special reference to its application in metallurgy. (To be continued.)

Reveberatory Furnaces

Continuous Overflow and Its Effect on the Slag Loss of Reverberatory Furnaces, Oliver E. Jager. Min. & Sci. Press, vol. 118, no. 26, June 28, 1919, pp. 875-876. Continuous flow considered as most important factor in reduction of slag-loss (particularly when using pulverized coal as fuel), because, it is argued, there is a better opportunity for any entrained metal to settle out of slag blanket.

Prolonging the Life of the Roofs of Reverberatory Furnaces at Anaconda, Oliver E. Jager. Min. & Sci. Press, vol. 119, no. 3, July 19, 1919, pp. 85-86, 3 figs. Ribs are built on roof; when this is burnt in, space between ribs is filled with brickwork, thus forming new roof on top of old one.

Slag in Electric Furnace

How Slag Influences Electric Steel, J. L. Dixon. Foundry, vol. 47, no. 327, July 15, 1919, pp. 483-484. Removal of first slag and making of second not considered necessary. Superiority of acid steel questioned.

IRON AND STEEL

Differential Crystallization

Differential Crystalliation in a Cast-Steel Runner, Francis B. Foley. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 151, July 1919, pp. 1117-1121, 4 figs. Photomicrographs of open-hearth runner metal, 2 in. in diameter, that had been fractured, presented as sample of cast-steel structure.

German Industry

Light on the German Iron and Steel Industry. Iron Age, vol. 104, no. 4, July 24, 1919, pp. 246-247. German views of stipulations of peace terms; study of wartime conditions of iron and steel industry; labor an obstacle to quick resumption of peace-time operations. Discussed in report of May meeting of the Verein Deutscher Eisenhüttenleute.

Graphitization

Graphitization in Iron-Carbon Alloys, Kunlchi Tawara and Genshichi Asahara. Foundry Trade Jl., vol. 22, no. 210, June 1919, pp. 398-401, 2 figs. Report of experiments made at Tokio University.

Magnet Steel

Steel for Magnets—III. Carbon. Mech. World, vol. 65, no. 1694, June 20, 1919, pp. 292-293, 1 fig. Magnetic materials and their composition. (Continuation of serial.)

Malleable Iron

Research Work on Malleable Iron, Enrique Touceda. Mech. Eng., vol. 41, no. 7, July 1919, pp. 593-600, 17 figs. Account of work undertaken during four years for American Malleable Castings Assn.

Oxygen in Cast Iron

Oxygen in Cast-Iron and Its Applications, Wilford L. Stork. Metal Trades, vol. 10, no. 7, July 1919, pp. 295-296. Offers evidence in support of theory developed by J. E. Johnson in regard to good effect of oxygen on cast iron. To be presented at September meeting of Am. Inst. Min. & Metallurgical Engrs.

Slag

The Acid Hearth and Slag, J. H. Whiteley and A. F. Hallimond. Eng., vol. 108, no. 2792, July 4, 1919, pp. 852-860, 26 figs. Records of observations and experiments dealing with microstructure of slag, structure of hearth and reaction occurring in molten slag. Paper presented before Iron & Steel Inst.

Tool Steel

Making High-Grade Tool Steel, John D. Knox. Iron Trade Rev., vol. 65, no. 3, July 17, 1919, pp. 153-157, 7 figs. Care exercised in cooling ingots after they are stripped. Importance of annealing and hardening processes.

Vanadium

Manufacture of Modern High Speed Steel, John A. Mathews. Iron Age, vol. 104, no. 1, July 3, 1919, pp. 17-20. Use of vanadium found as most notable change in recent years. Paper read before Am. Soc. for Testing Materials.

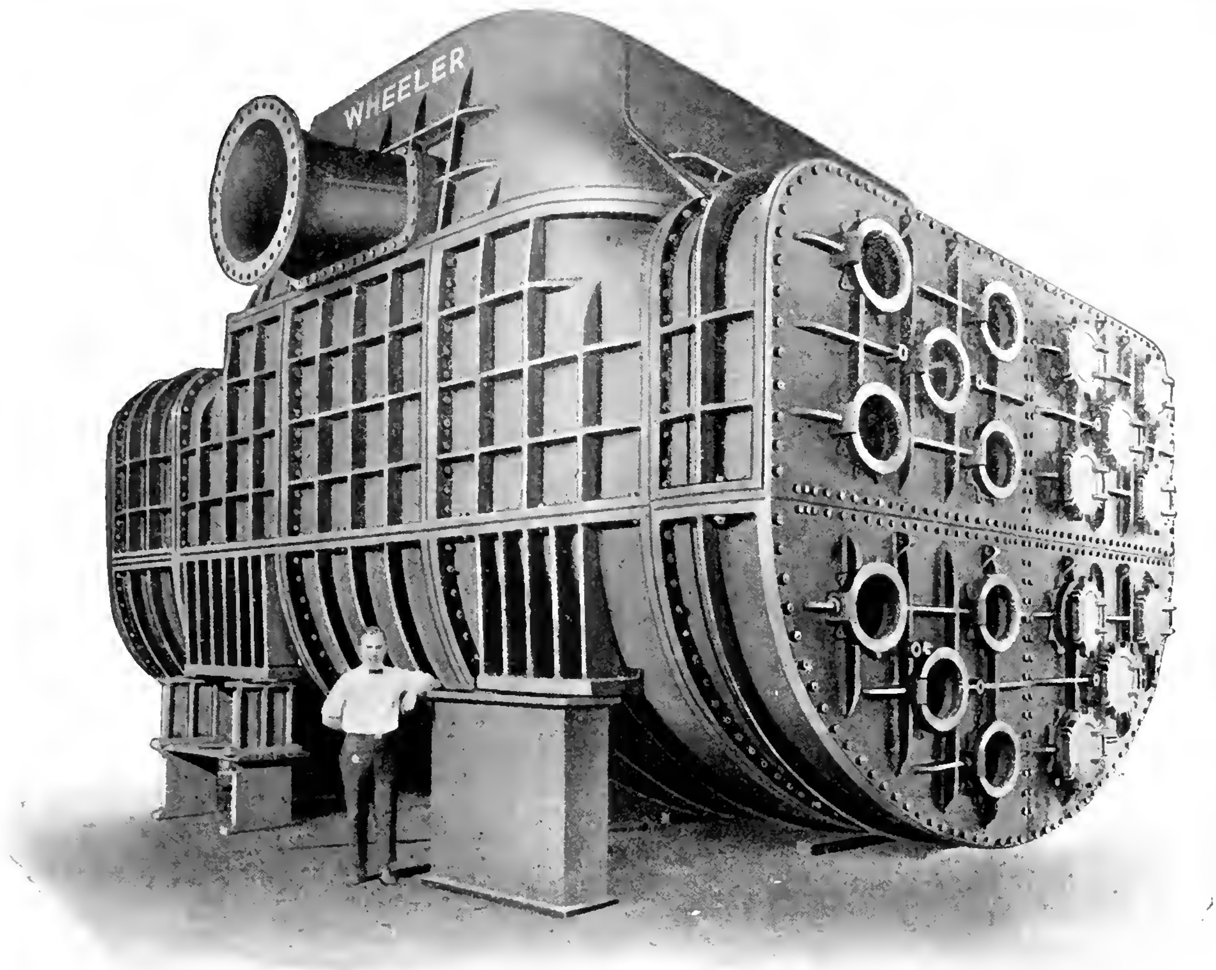
METALLOGRAPHY

Etching, Deep

Deep Etching and Rail and Forging Defects, F. M. Waring and K. E. Hofammann. Iron Age, vol. 104, no. 1, July 3, 1919, pp. 13-14 and (discussion) pp. 14-16, 7 figs. and Ry. Rev., vol. 65, no. 1, July 5, 1919, pp. 11-15, 10 figs. Investigation by means of deep etching with hot acid at Pa. R. R. laboratories said to have disclosed that interior defects appear to be more frequent in rails that had developed a number of transverse fissures than in others which had only a few or no such fissures. Paper read before Am. Soc. for Testing Materials.

Non-Ferrous Metals

Metallography Applied to Nonferrous Metals —VII, Ernest J. Davis. Foundry, vol. 47, no. 326, July 1, 1919, pp. 438-439, 3 figs. On deoxidation of metals and alloys by use of elements having strong affinity for oxygen.



We Are Now Building 16 Wheeler Condensers Like This

EACH CONDENSER CONTAINS APPROXIMATELY 50,000 Sq. Ft. OF SURFACE AND WEIGHS OVER 400,000 POUNDS

No condenser manufacturer has heretofore produced more than three or four units of this size in one year.

1000 MILES OF CONDENSER TUBING

For these 16 condensers 1000 miles or 1,700,000 lb. of Wheeler Crescent Brand tubing is required, an amount the large Wheeler tube mill easily produces in two months.

WHEELER CONDENSER & ENGINEERING CO.

CARTERET, N. J.

Aeronautics

AIRCRAFT (LIGHTER THAN AIR)

Airship Requirements

Lighter-than-Air Craft, T. R. Cave-Brown-Cave. Aviation, vol. 6, no. 11, July 1, 1919, pp. 585 & 588-591, 3 figs. Fabrics, engine requirements, useful carrying capacity, water recovery and use of hydrogen as fuel, mooring, towing and anchors. (Concluded.) Paper read before Roy. Aeronautical Soc.

R-9

The Evolution of the Airship—I. Aeronautics, vol. 16, no. 297, June 26, 1919, pp. 664-665, 3 figs. Construction of R-9.

R-34

British Airship R-34 Described. Aviation, vol. 6, no. 12, July 15, 1919, pp. 629-632, 6 figs.

Rigid Airship

The Tension in the Radial Wires of a Rigid Airship, E. H. Leavitt. Aeronautics, vol. 16, no. 295 and 297, June 12 and 26, 1919, pp. 617-618 and 675, 2 figs. Derivation of formulæ.

Vickers

The Evolution of the Airship—II. Aeronautics, vol. 17, no. 298, July 3, 1919, pp. 15-18, 8 figs. Vickers, Ltd. and their war productions.

APPLICATIONS

Commercial Applications

American Commercial, Tourist and Pleasure Aeroplanes. Aerial Age, vol. 9, no. 20, July 28, 1919, pp. 930-931, and p. 943, 10 figs. Aerial mapping and photopgraphy, express and mail delivery, passenger-carrying, fire and police patrol, advertising, exploring, reconnaissance, news distribution, and exhibitions. Details of ten types are briefly reported.

Mail Service

Aerial Mail Service (L'aviation et la poste), M. Delfieu. Annales des Postes, Télégraphes et Téléphones, vol. 8, no. 2, June 1919, pp. 216-227. Sees it handicapped at present by three essential deficiencies of aviation—irregularity, insecurity and excessive expense.

AUXILIARY SERVICES

Landing Fields

Municipal Landing Fields for Air Service. Am. City, City Ed., vol. 21, no. 1, July 1919, pp. 20-23, 2 figs. War Department's specifications.

Parachutes

The Sperry Parachute, H. E. Goodman. Aerial Age, vol. 9, no. 17, July 7, 1919, p. 812, 2 figs. Advantage said to be that aeronaut is able to get out of machine when it is in abnormal position.

The "Guardian Angel" Parachute. Indian Eng., vol. 65, no. 20, May 17, 1919, pp. 276-277, 2 figs. on supp. plate. Automatic and instantaneous opening said to be effected by enclosure in parachute body as it emerges from its case of cylindrical column of air, which under compression of fall is immediately converted into a cushion of air, extending in every direction to periphery. It can be used from height of 200 ft.

Wireless

Wireless Telegraphy Applied to Aviation, W. Knight. Aviation, vol. 6, no. 11, July 1, 1919, pp. 572-575, 7 figs. Principles of transmission and application of invention to air navigation, particularly with reference to its use for communication between airplanes and radio stations on the ground.

Development of Radio Equipment for Naval Aircraft, Edgar H. Felix. Flying, vol. 8, no. 6, July 1919, pp. 536-540, 11 figs. Installation on NC-3.

Wireless Telephone Transmitter for Seaplanes. Rudder, vol. 35, no. 7, July 1919, pp. 332-334, 4 figs. As designed for flying boats of H 16 class of U. S. navy.

DESIGN

Altitudes, Flight at Various

Theory of Airplane Flight at Various Altitudes. Predetermination of the Ceiling (Théorie du vol des aéroplanes aux diverses altitudes. Prédétermination de la hauteur du plafond), A. Rateau. Comptes Rendus des séances de l'Académie des Sciences, vol. 168, no. 23, June 10, 1919, pp. 1142-1147. Equations expressing angle of wings, speed of airplane, revolution per second of propeller, and slip of propeller with reference to "effective pitch."

Flying Boats

The Design and Construction of Flying Boats, David Nicolson. Aeronautics, vol. 16, no. 293 (New Series), May 29, 1919, pp. 562-565, 11 figs. For types known officially as F.2A, F.3, F.5, P.5, and N.4. Paper presented before Instn. Engrs. and Shipbuilders in Scotland. (To be continued.)

Loads and Stresses

The Loads and Stresses on Aeroplanes, John Case. Aeronautics, vol. 16, no. 293, 294, 295, 296 and 297, May 29, June 5, 12, 19 and 26, 1919, pp. 556-559, 589-592, 619-622, 644-647 and 671-673, 32 figs. May 29: Equations of equilibrium when flying and when alighting with engine shut off; approximate method of calculating loads when turning in horizontal position and when flattening out from vertical dive and looping. June 5: How flattening out of flight path is brought about. June 12: Loads caused by gusts, spiral glides and spinning. June 19: Distribution of load over the planes. June 26: Pressure distribution in spiral guide.

Metal Construction

Metal Construction of Aircraft, A. P. Thurston. Aeronautics, vol. 16, no. 293 (New Series), May 29, 1919, pp. 570-571. Methods of design and calculation of guide spars. Paper read before Royal Aeronautical Soc. (Concluded.)

Rigging

The Rigging of Aeroplanes, R. J. Goodman Crouch. Aeronautical Jl., vol. 23, no. 100, April 1919, pp. 143-178, 21 figs. Based on diagrams published by Roy. Air Force. Application of methods illustrated by various examples.

Struts

Strength of Two Combined Struts, K. Aichi. (In Japanese.) Jl. Soc. Mech. Engrs., Tokyo, Japan, vol. 22, no. 56, Feb. 1919.

Formula Giving the Ultimate Load for a Long Strut of Varying Cross-Section, K. Aichi. (In Japanese.) Jl. Soc. Mech. Engrs., Tokyo, Japan, vol. 22, no. 56, Feb. 1919.

Struts of Conical Taper, H. A. Webb and E. D. Lang. Aeronautical Journal, vol. 23, no. 100, April 1919, pp. 179-186, 3 figs. Strength of wooden struts consisting of parallel center portion with ends of conical taper is considered mathematically. Best results are obtained when parallel portion is half total length of strut, and when taper of ends is such that end of diameter is half of center diameter. Formula for design is offered.

War Developments

Some developments in Aircraft Design and Application During the War, Lord Weir. Engineering, vol. 108, no. 2793, July 11, 1919, pp. 59-61, 7 figs. Aerodynamical aspect of design and progress. Applicational aspect taken up in second part of paper. (To be continued.) Read before North-East Coast Instn. of Engrs. and Shipbuilders.

ENGINES

Altitudes, High

Operation of Airplane Motors at High Altitudes (Höhenregelung für Flugmotoren), R. Krüger. Motorwagen, vol. 22, no. 6, Feb. 28, 1919, pp. 103-104, 5 figs. Discusses French, American, Swiss and German inventions for insuring proper working conditions for motor even in thin air of high altitudes.

Cosmos

Cosmos "Jupiter" Aero Engine. Aeronautics, vol. 16, no. 297, June 26, 1919, pp. 666-668, 4 figs. Specifications and performance at demonstration flight at Filton.

The Cosmos Aero Engines. Flight, vol. 11, no. 27, July 3, 1919, pp. 869-871, 7 figs. Radial types constructed by Cosmos Engineering Co., Ltd.

Curtiss

The Curtiss Model K-6 Aero Engine. Aeronautics, vol. 16, no. 295, June 12, 1919, pp. 608-609, 1 fig. Six cylinders en bloc, 4-stroke cycle, rated horsepower 150 at 1700 r.p.m.

Design

The Design of Aeroplane Engines, pts. 22, 23 and 24, John Wallace. Aeronautics, vol. 16, no. 296 and 297, June 19 and 26, 1919, pp. 638-641 and 660-662 and vol. 17, no. 298, July 3, 1919, pp. 22-24, 9 figs. June 19: Stresses in crankshaft and crankpins; crankshaft bearings; ventilators; oil, water and air pumps. June 26: Requirements of satisfactory carburetor; venturi tube; principle of Zenith carburetor. July 3: Sources of poor efficiency; starting installations.

Hispano-Suiza

The Hispano-Suiza Airplane Engine—II. H. O. C. Isenberg. Am. Mach., vol. 51, no. 2, July 10, 1919, pp. 55-58, 13 figs. Foundry methods used for aluminum and bronze castings at works of Wright-Martin Aircraft Corporation.

Liberty

The Liberty 12A Aircraft Engine. Automobile Engr., vol. 9, no. 128, July 1919, pp. 213-221, 12 figs. Analysis of internal stresses, forces, and pressures on main members.

R-34 Motor Plant

A Technical Study of the R-34 Motor Plant. Automotive Indus., vol. 41, no. 2, July 10, 1919, pp. 81-83, 2 figs. With reference to operation of engines.

Salmson

France's Liberty Engine. The Amazing Salmson, W. F. Bradley. Automotive Indus., vol. 41, no. 2, July 10, 1919, pp. 59-66, 16 figs., partly on supp. plate. Engine is intermediate between rotary air-cooled aviation engine and fixed cylinder water-cooled star type. Outstanding features are nine steel cylinders mounted around circular crankcase, crankcase and cylinders being fixed and single-throw crankshaft revolving.

Supercharging

The Value of Supercharging. Aviation, vol. 6, no. 11, July 1, 1919, pp. 577-579, 5 figs. and Aerial Age, vol. 9, no. 19, July 21, 1919, pp. 892-893, 4 figs. Tests conducted at altitude laboratory of Bureau of Standards, said to indicate that net gain in hp. will result even if considerable power is needed to drive blower.

MATERIALS OF CONSTRUCTION

Balloon Fabrics

Notes on Balloon Fabrics, Junius David Edwards. Aviation, vol. 6, no. 12, July 15, 1919, pp. 626-627, 2 figs. Characteristics of fabrics in use and discussion of means along which future development may be expected to take place.

Duralumin

Duralumin in Aviation (Le duralumin en aviation). Aérophile, vol. 27, nos. 9-10, May 1 and 15, 1919, pp. 129-130, 1 fig. Advantages claimed over wood by reason of less sensitiveness to atmospheric changes.

Plywood

The General Properties and Uses of Plywood—III, B. C. Boulton. Aerial Age, vol. 9, no. 19, July 21, 1919, pp. 895-897, 4 figs. Monocoque type of fuselage. (Concluded.)

METEOROLOGY

Aerial Currents, Errors in Determination

Errors Arising from Insufficiency of Knowledge of Meteorological Variations of Aerial Navigation (Sur les erreurs d'estime que peut entrainer la connaissance incomplète du régime aérologique), L. Dunoyer. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 22, June 2, 1919, pp. 1102-1105. Probable errors in estimating effect of crossing on aerial current.

Anticyclones and Depressions

The Origin of Anticyclones and Depressions, John Logie. Proc. Roy. Soc. of Edinburgh, vol. 39, part 1, Session 1918-19, pp. 56-77, 8 figs. Theory based on two postulates—(1) when two portions of air differing slightly in density are adjacent and in the same level, they tend to mingle and so destroy the difference of density; (2) when changes of pressure occur at any level in an extensive layer of air, the surrounding air does not "immediately rush in," but only slowly intrudes into the region of diminished pressure.

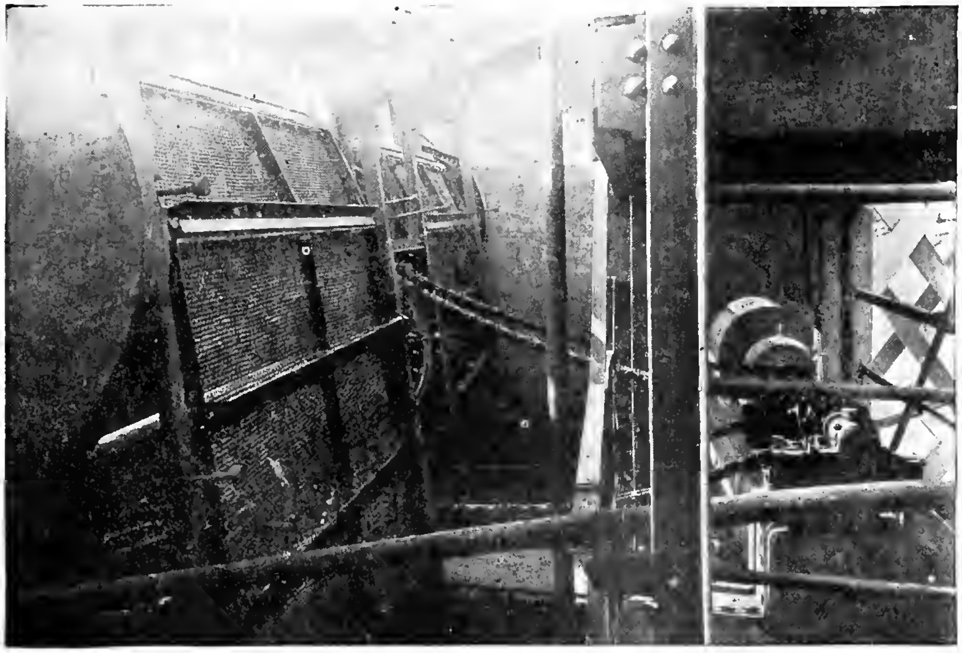
Storms

Storm Types and Peculiarities, George S. Bliss. Jl. Engrs. Club of Philadelphia, vol. 36, no. 176, July 1919, pp. 272-274, 8 figs. Bowie and Weightman map studies and summary of their conclusions. Paper read before Am. Soc. Heating & Ventilating Engrs.

See also Anticyclones.

Wind Velocities

Influence of the Vertical Distribution of the Temperature on the Wind Velocity Measured in the Vicinity of the Ground (Influence de la distribution verticale des temperatures sur les vitesses du vent mesurées au voisinage du sol), C. E. Brazier. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 23, June 10, 1919, pp. 1160-1161. Observations extending over period of ten years alleged to establish that considerable influence is exerted by temperature distribution on ratio of wind velocity



A close-up of the Rex Traveling Water Screens guarding the intake shown opposite

Operating Costs too Small to Figure

A steel company in Ohio uses two Rex Traveling Water Screens to protect the water supply.

When intake conditions are very good, they throw in the motor switch and turn the spray valve several times a day, letting the screens run for a few minutes each time.

Generally, however, they keep the screens running most of the time because the running costs, according to their estimates, are too small to take into account.

The water has a 4-foot minimum depth in the screen chamber and they pump 8,500 gallons per minute. With the Rex Traveling Water Screens there is practically no loss of head, so that they are always sure of adequate quantities of water.

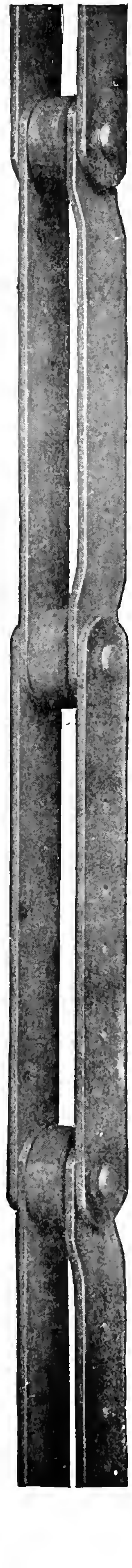
Send for Catalog No. 85 describing in detail the construction, operation and installation of Rex Traveling Water Screens.

REX TRAVELING WATER SCREENS

Rex Chains, Rex Concrete Mixers and Pavers,
Rex Sprockets, Rex Elevators and Conveyors

CHAIN BELT COMPANY, MILWAUKEE

Branch Offices and Representatives in Principal Cities in United States and Abroad



Rex Steel Roller Chain of the Chabelco type used for carrying the baskets of Rex Traveling Water Screens.

You can secure Standard Rex Sprocket Chain of any size or type, either through distributors or direct, for every transmission and conveyor need.

to gradient at altitudes at which anemometers are usually placed.

The Pilot Balloon Method of Determining the Direction and Speed of the Upper Winds, Ivan R. Tannehill. Jl. U. S. Artillery, vol. 51, no. 1, July 1919, pp. 1-16, 4 figs. One-theodolite method for sighting balloon compared with two-theodolite and other methods. Rapidity of calculations in one-theodolite method admitted to lead to small errors, but it is observed that atmospheric changes taking place during longer observations required by other methods lead also to errors.

Influence of Seasons and the Periodic Changes in Atmosphere on the Corresponding Variations in Atmospheric Pressure and Wind Intensity (Influence des saisons et des régimes aérologiques sur les variations corrélatives de la pression atmosphérique et de l'intensité du vent), G. Reboul and L. Dunoyer. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 19, May 12, 1919, pp. 947-950. As factor for determining coefficient of certitude of rules for forecasting weather conditions.

Various Cases of Diminution of Wind Velocity with Altitude (Sur certains cas de diminution de la vitesse du vent avec l'altitude), Albert Baldit. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 24, June 16, 1919, pp. 1211-1214. Instances are quoted to prove that established rule of increasing wind velocity with altitude represents merely average of a great number of cases, but not absolutely constant law.

PRODUCTION

Fittings

Making Aircraft Fittings with Temporary Tools, S. A. Hand. Am. Mach., vol. 51, no. 5, July 31, 1919, pp. 221-225, 22 figs. Tools developed to facilitate production in large quantities.

NC Boats

How the NC Boats were Built Under Pressure of War Need—II, J. C. Hunsaker. Automotive Indus., vol. 41, no. 3, July 17, 1919, pp. 120-123, 2 figs. Guarding against corrosion; glue for laminated construction; building of testing hangar.

MILITARY AIRCRAFT

Blackburd

See Torpedo-Carrying Aeroplanes.

British Airships

The Evolution of the British Naval Airship. Eng., vol. 107, no. 2789 and 2790, June 13 and 20, 1919, pp. 757-759 and 797-799, 46 figs., partly on supp. plates. Account of airship work of Vickers concern. Particulars of construction of R-80. (Concluded.)

Torpedo-Carrying Aeroplane

The "Blackburd" Torpedo-Carrying Aeroplane. Engineering, vol. 108, no. 2793, July 11, 1919, pp. 46-48, 5 figs. Weight with torpedo and full tanks, 5,800-lb.; engine, 350-hp. Rolls-Royce Eagle.

Naval Aircraft

Progress in Naval Aircraft, J. C. Hunsaker. Jl. Soc. Automotive Engrs., vol. 5, no. 1, July 1919, pp. 31-44, 10 figs. Notes on development of NC boats, notably manner of guarding against corrosion, protecting wooden and fabric parts and special equipment for transatlantic flight.

MODELS

Electrically Driven Models

Elementary Aeronautics and Model Notes, John F. McMahon. Aerial Age, vol. 9, no. 20, July 28, 1919, p. 941. On models driven by electricity.

Spar Forms

Model Aeroplanes—XXVII (New Series), F. J. Camm. Aeronautics, vol. 16, no. 295, June 12, 1919, pp. 623-624, 27 figs. Spar forms.

PLANES

Ansaldo

The Ansaldo 1 Biplane. Aerial Age, vol. 9, no. 19, July 21, 1919, pp. 890-891, 4 figs. General specifications are: Span, upper plane 25 ft., lower plane 21 ft. 8 in.; overall height 10 ft. 6 in.; engine, S. P. A. Ansaldo 220 hp.

Avro

The Avro "Baby" Sporting Biplane. Flight, vol. 11, no. 26, June 26, 1919, pp. 831-836, 12 figs. Fuselage is of rectangular section and conventional girder type. Machine is a single seater. Span 25 ft.; length overall 18 ft. 6 in.; height 7 ft. 6 in.; weight, loaded, 857 lb.

B. A. T.

B. A. T. 340 H.P. A. B. C. (Type F. K. 25—"Basilisk"). Aeronautics, vol. 16, no. 296 (New Series), June 19, 1919, p. 637, 1 fig. Fuselage follows system adopted in Bantam, but machine is somewhat larger.

See also Wasp.

Bristol

The Bristol Passenger Triplane. Aerial Age, vol. 9, no. 20, July 28, 1919, p. 932, 2 figs. Graph of performances of Bristol triplane cargo machine.

The Bristol Triplane Braemar. Aviation, vol. 6, no. 12, July 15, 1919, p. 639, 1 fig. Intended to be used for bombing of Berlin and other interior German towns. Driving power supplied by 400-hp. Liberty engines, fitted tandem, in pairs, on either side of fuselage.

Curtiss

The Curtiss Model 18-B Biplane. Flight, vol. 11, no. 28, July 10, 1919, pp. 902-904, 5 figs. Machine is built around same fuselage and power plant as the triplane, but has lesser over-all height.

Flying Boats

Design and Construction of Flying Boats, David Nicolson. Flight, vol. 11, no. 28, July 10, 1919, pp. 915-919, 7 figs. Hull construction of F. and N. types. (Concluded.)

Lawson

Lawson Aerial Transport. Aerial Age, vol. 9, no. 17, July 7, 1919, pp. 810-811, 3 figs. Fuselage built to accommodate 26 passengers. Designed from commercial point of view for transcontinental service between New York and San Francisco.

Navy Specifications

The New Navy General Specifications for Airplanes, Archibald Black. Aviation, vol. 6, no. 11, July 1, 1919, pp. 592-594, 1 fig. Comments on subject matter which has been added to or changed from that in previous issue. Addition referred to as new is no. 100-A.

Wasp

B. A. T.—170 H.P. Wasp (Type F.K. 23—"Bantam"). Aeronautics, vol. 16, no. 296 (New series), June 19, 1919, p. 636, 1 fig. Fuselage consists entirely of large sheets of three-ply birch, fixed on oval section formers which are supported on four ash longitudinals.

See also B. A. T.

PROPELLERS

Moisture-Proofing

Moisture Proofing Airplane Propellers with Aluminum Leaf, M. E. Dunlap. Aviation, vol. 6, no. 12, July 15, 1919, pp. 636-638, 9 figs. Method of applying aluminum leaf. A diagram is presented showing comparative effectiveness of different coatings in moisture-proofing wood as determined by tests.

Wood Propellers

Wood Propeller Construction, Porter E. Stone. Aerial Age, vol. 9, no. 20, July 28, 1919, pp. 934-938, 12 figs. Suggestions in regard to their manufacture in quantity.

TRANSATLANTIC FLIGHT

NC Flight

Precautions That Spelled Success, James L. Breese, Jr. Sci. Am., vol. 121, no. 3, July 19, 1919, p. 55, 2 figs. Engineering features of flight of NC planes across ocean, notably arrangement for maintaining water in radiators and method of hooking up batteries.

R-34 Flight

Transatlantic Voyage of R-34. Aeronautics, vol. 17, no. 298, July 3, 1919, pp. 7-9, 1 fig. Plans considered by Admiralty and details of equipment.

VARIA

Altitude Errors

Altitude Errors in Aerial Navigation, J. G. Coffin. Aviation, vol. 6, no. 12, July 15, 1919, pp. 624-626, 5 figs. Form of pressure indicating device suggested for avoiding errors consists in placing instrument inside container, for instance, a sphere, with an opening to outside air and rotating or oscillating container so as to periodically cover the entire 360 deg.

British Regulations for Air Navigation

The British Regulations for Aerial Navigation, Henry Woodhouse. Flying, vol. 8, no. 6, July 1919, pp. 525-533. Governing civilian aeronautics.

Log Books

The New Air Navigation Directions. Aeronautics, vol. 16, no. 293 (New Series), May 29, 1919, pp. 567-569. Instructions for use of log books. (Continued.)

Physiology of High-Altitude Flight

Physiological Aspect of Travel at High Altitudes (Transports à haute altitude des voyageurs en cabine aérienne. Communication faite par le docteur Guglielminetti à la Commission scientifique de l'Aéro-Club de France, Séance du 30 avril 1919). Aérophile, vol. 27, nos. 9-10, May 1 and 15, 1919, pp. 132-135, 2 figs. Based on experiments and writer's experience during sojourn on top of Mont Blanc.

Wilbur Wright Lecture, 1919

The Wilbur Wright Lecture, 1919, Leonard Bairstow. Aeronautics, vol. 17, no. 298, July 3, 1919, pp. 12-14. Progress of aviation during period of war. (Concluded.) Paper read before Roy. Aeronautical Soc.

Marine Engineering

AUXILIARY MACHINERY

Compass

The Navigational Magnetic Compass Considered as an Instrument of Precision, M. B. Field. Jl. Instn. Elec. Engrs., vol. 57, no. 282, May 1919, pp. 349-386, 45 figs. Physico-mathematical study of forces entering in operation of various types, with reference to British Admiralty practice in regard to effecting corrections and recording measurements.

Electric Auxiliaries

First American Full-Powered Motorship Equipped with Electric Auxiliaries, H. W. C. Smith. Motorship, vol. 4, no. 8, August 1919, pp. 31-35, 16 figs. Machinery details of the "Benowa."

Hawthorne-Cockburn Valves

The Supply of Superheated Steam to Astern Turbines. Shipbuilding & Shipping Rec., vol. 13, no. 25, June 19, 1919, p. 775, 2 figs. Hawthorne-Cockburn patent valves for mixing of saturated and superheated steam.

Marine Two-Cylinder Engine Sets

Novel Features in a Two-Cylinder Marine Set. Automotive Industries, vol. 40, no. 26, June 26, 1919, pp. 1449-1451, 3 figs. Engine combined with reverse gear in single unit.

Turbine Drive for Auxiliaries

Turbine-driven Marine Auxiliaries. Eng., vol. 127, no. 3313, June 27, 1919, pp. 636-638, and 640, 10 figs. Equipments for merchant steamers, built by Franco Tosi Company of Legnano, Italy.

SHIPS

Concrete Ships

Auxiliary Motor Sailing Ship of Reinforced Concrete (Motosegler aus Beton). Beton & Eisen, vol. 18, nos. 2-3, Feb. 3, 1919, p. 32, 2 figs. Danish vessel 112 ft. long provided with screw propeller driven by 80-hp. oil engine.

Advantages, Progress and Permanence of Concrete Ships, Robert W. Lesley. Concrete Craft, vol. 1, no. 5, June 1919, pp. 119-122 and 126 and 132, 1 fig. Sees concrete ship, both large and small craft, better, cheaper and of lower upkeep and for many uses essentially superior to any other type of hull.

Barge Building in Scotland. Ferro-Concrete, vol. 10, no. 2, August 1919, pp. 35-38, 4 figs. Construction of 1,000-ton reinforced-concrete barges.

Concrete Coaling Barges. Colliery Guardian, vol. 117, no. 3050, June 13, 1919, p. 1413, 3 figs. Length, 185 ft.; beam, 35 ft.; depth, 18 ft.; hull is of straight-line type.

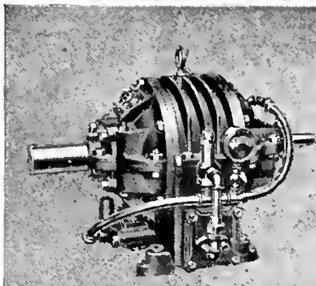
Concrete Merchant Ships. Concrete Craft, vol. 1, no. 5, June 1919, pp. 123-126, 5 figs. Their chance of development in time of peace.

Design

Suggestions for Increasing Revenue from Cargo Carriers, M. F. Carr. Shipping, vol. 8, no. 2, July 12, 1919, pp. 15-16, 2 figs. Concerning modifications in design of 8,800-deadweight-ton cargo carrier.

Diesel

The Diesel Engine in Great Lakes Freighters, R. D. Karr. Motorship, vol. 4, no. 8, August 1919, pp. 28-29, 2 figs. Recommends operating freighters with internal-combustion engine as economical measure and necessity because, "low price of coal hertofore prevailing in the Great Lakes trade will never be reached again."



The IDEAL DRIVE

TURBOGEAR

FAST PATENTS

The Modern Way to connect Driving and Driven Units

A Better Drive *for* Refrigerating and Ice Making Plants

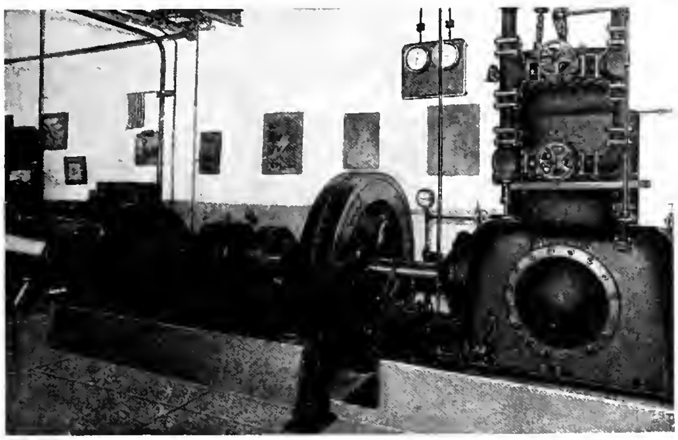
There are many advantages and economies of the Turbo-Gear for refrigerating drives.

Some of the advantages are:

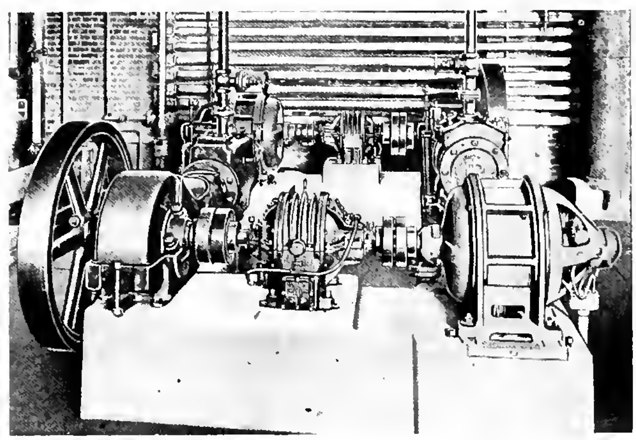
- Small floor space required.
- Higher speed; less expensive motors can be used.
- High and low speed shafts in the same straight line.
- Positive transmission of power—no slip.
- Continuous operation.

Some of the economies are:

- Low first cost.
- Low erection cost.
- Lower overhead.
- Practically no upkeep expense—simplicity of construction of Turbo-Gear economically abolishes the big item of repairing and replacing power transmission equipment.



75 HP. Turbo-Gear 1200 to 150 RPM.
Motor Ammonia Compressor Drive



One 25 HP. and one 50 HP. Turbo-Gear 1150 to 232 RPM.
Motor Air Compressor Drive

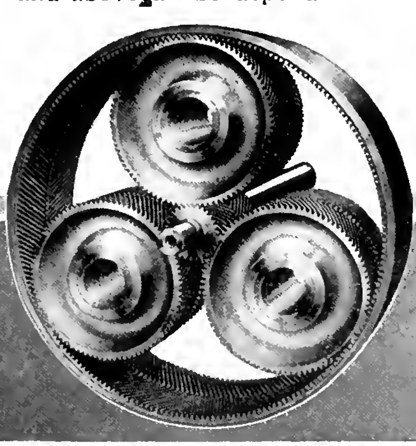
Economy and Sureness of Operation are of Primary Importance in all Drives.

Unless the drive is satisfactory, all else goes for naught. The merit of the driving unit is only proved by the performance of the drive. The drive must deliver uniform power at the right speed, and above all be dependable.

That is why the leading industries are installing Tubor-Gear, the modern drive—safe—certain—reliable.

Let us tell you about some of these installations—Let us solve your driving problems.

Write today for our Bulletin 101



POOLE ENGINEERING and MACHINE COMPANY

Manufacturers of Gears and Power Transmission Machinery since 1843

BALTIMORE, MD., U.S.A.

General Sales Office: 50 Church St., New York, N.Y.

Electric Propulsion of Submarines

Electrical Equipment Used on Submarines, H. C. Coleman. Elec. Jl., vol. 16, no. 7, July 1919, pp. 295-299, 9 figs. General arrangement of propelling machinery. There are two main motors, each having its own shaft which is connected by heavy clutches to engine shaft at one end and to propeller shaft at the other.

Ljungstrom System

The Ljungstrom System Steam Turbo-electric Marine Propulsion. Pac. Mar. Rev., vol. 16, no. 7, July 1919, pp. 71-80, 10 figs. Plant consists of two turbo-generators of equal power, delivering their power electrically to two motors.

Motor Ships

Motor Ship Glenapp. Engr., vol. 127, no. 3312, June 20, 1919, pp. 612-613, 1 fig. Alteration as compared with "Selandia" referred to are cooling of piston with water instead of oil, and substitution of a battery of eight fuel pumps for the eight cylinders in each engine instead of a single pump for each set of four cylinders.

Propelling Machinery Type

Crude-Oil Motors vs. Steam Engines in Marine Practice, J. W. Morton. Mech. Eng., vol. 41, no. 7, July 1919, pp. 609-612, 1 fig. Discussion of various factors to be considered, also exposition of advantages and disadvantages, as compared to steam engines, of crude oil motors of constant pressure, constant-volume four-stroke cycle and two-stroke cycle types.

Specifications for Machinery

Specifications for Machinery for 8,100 Ton d.w. Steamships for Canadian Government Merchant Marine Ltd. Can. Ry. & Mar. World, no. 257, July 1919, pp. 394-399, 4 figs. Propelling machinery is to consist of one set of inverted, vertical, direct acting, triple expansion, surface condensing engines, having 3 cylinders working on separate cranks placed at angles of 120 deg. with each other, supplied with steam from 3 multitubular boilers at a working pressure of 180 lb. per sq. in.

YARDS

Concrete Shipbuilding

British Concrete Shipbuilding: Unit System Construction, W. Noble Twelvetrees. Eng., vol. 107, no. 2791, June 27, 1919, pp. 825-826, 17 figs., partly on supp. plates. Developed, it is said, with a view to reduce the absolute minimum amount of timber supports and shuttering required on building berth and arranging and spacing frame members in a manner similar to that generally specified for steel ships.

A New Irish Industry. Concrete Shipbuilding at Warrenpoint. Ferro-Concrete, vol. 10, no. 8, January 1919, pp. 177-187, 12 figs. Yard suitable for construction of concrete ships up to 10,000 tons capacity.

Costs

Shipyard Costs and Ship Wages—a Comparison, Winthrop L. Marvin. Pac. Mar. Rev., vol. 16, no. 7, July 1919, pp. 81-86. Comparison of American and British ship wages.

Fabricated Ships

The Fabricated Ship, Henry R. Sutphen. Universal Engr., vol. 29, no. 6, June 1919, pp. 21-27, 6 figs. Operations at Newark Bay shipyard.

Fabricated-Ship Plant Planned for Later General Use, M. E. Allen. Eng. News-Rec., vol. 83, no. 2, July 10, 1919, pp. 79-83, 5 figs. Mobile Shipbuilding Co. forced to revise steel design to make use of timber at Birmingham shop for fabricating ship material.

Ford Methods

Ford Methods in Ship Manufacture—VII, Fred E. Rogers. Indus. Management, vol. 58, no. 1, July 1919, pp. 8-11, 10 figs. Outfitting operations and power plant.

Fore River Yards

Shipbuilding Equipment and Methods at Fore River—I, Hull Construction Plant. Eng. News-Rec., vol. 83, no. 1, July 3, 1919, pp. 19-22, 5 figs. Single type of berth for various kinds of ships. Concrete substructure and bridge crane equipment.

Reconditioning War Service Vessels

Refitting War Fleet is Big Job, V. G. Iden. Mar. Rev., vol. 49, no. 8, August 1919, pp. 375-378, 5 figs. Reconditioning vessels used for war service is taxing capacity of repair yards.

Repairs

Repair of the "Curaca" a Triumph of Skill and Ingenuity. Shipping, vol. 8, no. 1, July 5, 1919, pp. 15-16, 4 figs. Straightening out bottom of ship sunk during explosion in Halifax Harbor.

See also Welding.

Welding

Some Experiences with Electric Welding in Warships, W. H. Gard. Eng., vol. 108, no. 2792, July 4, 1919, pp. 25-30, 12 figs. Sketches illustrating such repair work as required by broken cast steel stem of "P" boat, shaft bracket of a large 36-knot destroyer broken through, and lower portion of stern post of a Castle liner broken off, etc. Paper read before Instn. Naval Architects.

Repairing the Broken Stern-Post of the "Northern Pacific"—the Biggest Marine Weld in the World. Reactions, Vol. 12, no. 2, Second Quarter, 1919, pp. 23-31, 13 figs. Cast-steel stern post was cracked through just above uppermost gudgeon, cross-section of break forming roughly a triangle, each side of which was about two feet in length.

VARIA

Great-Circle Sailing

Great Circle Sailing—A Few "Wrinkles" to Save Time, H. G. S. Wallace. U. S. Naval Inst. Proc., vol. 45, no. 7, July 1919, pp. 1197-1199, 2 figs. Marcq Saint-Hilaire method.

Soundings

Sea Sounding on Board a Moving Vessel, Based on Propagation of Sound in Water (Sur un procédé de soudage en mer, à bord d'un bateau en marche, basé sur la propagation du son dans l'eau), M. Marti. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 22, June 2, 1919, pp. 1100-1102. Microphone fixed to vessel and immersed at convenient depth registers explosion on surface of water and its reflection from sea bottom.

Surveys

The Safeguarding of Our Seafarers, Robert G. Skerrett. Rudder, vol. 35, no. 7, July 1919, pp. 305-311, 19 figs. Work done by U. S. Coast and Geodetic Survey, including illustrations of corrections that have been made during a single year in chart of New York harbor.

Industrial Technology

Alcohol

Ethyl Alcohol from Waste Sulphite Liquor, E. C. Sherrard and Galo W. Blanco. Paper, vol. 24, no. 17, July 2, 1919, pp. 15-21, and 26. Experiments conducted both commercially and experimentally said to have shown production ranging from 0.70 to 1.15 per cent on a laboratory scale and from 0.53 to 0.79 per cent on a large scale production.

Ammonia

Manufacture of Ammonia by Means of Electric Arc. Study of the Influence of a Partial Vacuum (Formation de l'ammoniaque au moyen de l'arc électrique. Etude spéciale de l'influence de la dépression), E. Briner and A. Baerfuss. Jl. Chimie Physique, vol. 17, no. 1, March 31, 1919, pp. 71-140, 3 figs. Experiments at chemical laboratory of Geneva University. The best results obtained were mixture of one to three parts of nitrogen and hydrogen respectively.

The Manufacture of Ammonia and Ammonium Compounds, M. Rindl. South African Jl. of Industries, vol. 2, no. 5, May 1919, pp. 463-466. Sources of production and uses.

Benzene

Chlorination of Benzene. Analysis of Mixtures of Benzene, Chlorobenzene and Dichlorobenzene, etc., Percy F. Frankland, S. Raymond Carter and Dorothy Webster. Jl. Soc. Chem. Indus., vol. 38, no. 12, June 30, 1919, pp. 153T-155T, 1 fig. Three fractions obtained by interrupting distillation from Engler flask under uniform conditions at 122 deg. cent. and again at 142 deg. cent. Percentages of benzene and chlorobenzene obtained from graph constructed from experiments with mixtures of known composition.

Carbon, Artificial

The Manufacture of Artificial Carbon in Norway (Herstellung künstlicher Kohle in Norwegen), Sander. Dinglers Polytechnisches Journal, vol. 6, no. 334, Mar. 22, 1919, p. 63. The raw material used for this purpose is the lye drained off in the manufacture of cellulose, this lye being rich in organic matter. The product obtained can be used either wet or dried.

Caustic Soda

See Chlorine.

Chlorine-Caustic Soda

The United States Government Chlorine-Caustic Soda Plant at Edgewood Arsenal, Edgewood, Maryland, Samuel M. Green. Chem. & Metallurgical Eng., vol. 21, no. 1, July 1, 1919, pp. 17-24, 9 figs. Historical and descriptive account.

Clays

Some Properties of Bond Clays for Graphite Crucibles, M. C. Booze. Jl. Am. Ceramic Soc., vol. 2, no. 6, June 1919, pp. 461-476, 6 figs. Result of tests with nineteen domestic clays, one English, and one German clay.

Crucibles

The Effect of Electrolytes on the Properties of Graphite Crucible Bodies, H. G. Schurecht. Jl. Am. Ceramic Soc., vol. 2, no. 6, June 1919, pp. 443-450, 5 figs. Addition of NaOH to graphite-crucible bodies containing Dorset bond clay spoiled working properties of bodies, while effect of same electrolyte on bodies containing Mississippi bond clay was observed to be improvement of their moldability. HCl claimed to have opposite effect.

See also Clays.

Cyanamid

Warrior Extension Station for U. S. Nitrate Plant No. 2. Southern Engr., vol. 31, no. 5, July 1919, pp. 36-40, 7 figs. Plant uses cyanamid process.

Notes and Data on Fixed Nitrogen Plants. Chem. & Metallurgical Eng., vol. 21, no. 2, July 15, 1919, pp. 66-67. Cost figures obtained at Government's cyanamide process nitrate plant at Muscle Shoals as presented before Committee on Military Affairs of House of Representatives.

Dust Precipitation

Electrical Cleaning of Blast Furnace Gas, W. H. Gellert. Blast Furnace & Steel Plant, vol. 7, no. 7, July 1919, pp. 334-339, 2 figs. Data concerning electrical precipitation.

Dyes

Gas in the Dye Industry, Gilbert Colville Shadwell. Gas Rec., vol. 16, no. 2, July 23, 1919, pp. 17-21, 10 figs. Points out possible utilization. (To be concluded.)

Fertilizers

The World's Supply of Nitrogeneous Fertilizers, George W. Anderson. Gas Jl., vol. 146, no. 2926, June 10, 1919, pp. 695-696. As production of nitrogeneous products in Germany has been greatly promoted during the war, writer believes that a strong competition may be expected now that demand for munitions having ceased Germany will not be able to absorb total production herself.

Glass

Glass-Making Before and During the War, Harry J. Powell. Jl. Roy. Soc. Arts, vol. 67, no. 3473, June 13, 1919, pp. 485-493, and (discussion) pp. 493-495. Descriptive account of progress made by glass industry in England during the war.

Use of Optical Pyrometers for Control of Optical Glass Furnaces, Clarence N. Fenner. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 151, July 1919, pp. 1001-1011, 2 figs. Investigations at the Geophysical Laboratory, Carnegie Instn. of Washington, and account of results obtained in actual practice.

Glass, with Special Reference to Its Production in South Africa, Percy A. Wagner. South African Jl. of Industries, vol. 2, no. 5, May 1919, pp. 436-449, 2 figs. On selection of sands. (To be concluded.)

Procedures in the Manufacture of Optical Glass, W. S. Williams and C. C. Rand. Jl. Am. Ceramic Soc., vol. 2, no. 6, June 1919, pp. 422-442, 6 figs. Account of investigations made by Bur. of Standards.

Grease Extraction

Extraction of Grease from Sewage Sludge at Morley, F. Turner. Surveyor, vol. 55, no. 1428, May 30, 1919, pp. 401-403. Including cost of operation. Paper read before Instn. Mun. and County Engrs.

Helium

Bibliography of Helium Literature, E. R. Weaver. Jl. Indus. & Eng. Chem., vol. 11, no. 7, July 1, 1919, pp. 682-688. Articles published in scientific magazines up to January 1, 1919.

Hydrogen

See Oxygen.

Lime

Lime Calcination (Calcinacion de cal), W. D. Mount. Ingenieria Internacional, vol. 1, no. 3, June 1919, pp. 154-155, 1 fig. Sugges-

tions in regard to securing economy in production.

Oil, Linseed

Effect of Exposure on Raw Linseed Oil, E. J. Sheppard. Jl. Indus. & Eng. Chem., vol. 11, no. 7, July 1, 1919, pp. 637-639, 3 figs. Thickness of exposed layer thought to affect only rate of change in constants. For any gain in weight over range covered by experiments described, changes occurring in constants were found to be independent of rate of gain in weight.

Opacifiers

Note on the Use of Magnesia as an Opacifier, V. S. Schory. Jl. Am. Ceramic Soc., vol. 2, no. 6, June 1919, pp. 477-480. Experiments to determine whether additions of small amounts of barium and zinc would result in increased transparency of glaze.

Oxygen

Automatic Electrolytic-Oxy-Hydrogen Plant, Fred H. Woodhull. Jl. Engrs. Club of Philadelphia, vol. 36, no. 176, July 1919, pp. 271-274, 1 fig. Features in connection with electrical operation and control of compressor set. Paper read before Assn. Iron & Steel Elec. Engrs.

Paints

Paint Pigments Their History and Development, S. J. Cook Chem. Indus., vol. 38, no. 11, June 16, 1919, pp 137T-139T. With reference to Church's and Toch's methods of classification.

Paper

Waste Paper for Papermaking, Henry Aldous Bromley. Paper, vol. 24, no. 18, July 9, 1919, pp. 18-21. Researches on printing ink in relation to its destructibility.

Porcelain

An American Porcelain Containing no Free Silica, Arthur S. Watts. Jl. Am. Ceramic Soc., vol. 2, no. 6, June 1919, pp. 488-489. It is claimed that by calcining or semi-fusing fluxes and flint prior to incorporation in porcelain body maturing point can be lowered approximately two cones, color vastly improved, and resistance to sudden temperature changes improved approximately 200 per cent.

Potash

Non-German Sources of Potash, Arthur Holmes. Geological Mag., vol. 6, no. 6, June 1919, pp. 251-254, 1 fig. Deposits in Alsace, Spain, and Abyssinia, where beds of potassium are associated in workable quantities with saline formations. (To be continued.)

Rubber

Prices of Rubber Products, Isador Lubin. India Rubber World, vol. 60, no. 5, August 1, 1919, pp. 614-620, 7 figs. From War Industries Board, Press Bulletin no. 30.

Recent Improvements in Rubber Compounds for Solid and Pneumatic Tires. India-Rubber Jl., vol. 58, no. 1, July 5, 1919, pp. 1-2 & 5. Advantages claimed for using carbon gas black in rubber compounds

Soap

Colloid Chemical Studies of Soap I, Martin H. Fischer Chem. Engr., vol. 27, no. 7, July 1919, pp. 155-162, 8 figs Hydration capacity of some pure soaps.

Sugar

Better Results by Better Management, L. W. Alwyn Schmidt Sugar, vol 21, no. 7, July 1919, pp 350-353 Quotes instance in which it is said installation of suitable equipment in sugar factory increased amount of sugar obtained from same quantity of raw material.

The Color of Sugar Cane Products and Decolorization in Factory Practice, F. W. Zerban and E. C. Freeland. Sugar, vol. 21, no. 7, July 1919, pp. 354-359b, 2 figs. Results obtained in experiments at laboratory of Louisiana State University said to show that combination of ferric iron and polyphenols plays a very important part in the color of sugarhouse products.

Tellurium

A Study of the Preparation of Certain Organic Salts of Tellurium, Aaron M. Hageman. Jl. Am. Chem. Soc., vol. 41, no. 3, March, 1919, pp. 342-346. Method for the preparation of tellurium acid tartrate. Writer asserts that, contrary to the findings of Becker, this salt can not be separated from tartaric acid by crystalization.

A Contribution to the Chemistry of Tellurium Sulfide, Aaron M. Hageman. Jl. Am. Chem. Soc., vol. 41, no. 3, March, 1919, pp 329-341, 1 fig. Investigation concerning production and stability of a sulfide of tellurium.

Railroad Engineering

CONSTRUCTION

Gradient, Economical

Technical Study Preliminary to Projecting a Railway (El control técnico en los proyectos y obras ferroviarias), César A. Cipriani. Informaciones y Memorias de la Sociedad de Ingenieros del Perú, vol. 21, no. 5, May 1919, pp. 227-232. Formula for determining economical gradient.

Station Rebuilding

Union Station is Rebuilt Without Interrupting Traffic. Eng. News-Rec., vol. 83, no. 2, July 10, 1919, pp. 84-87, 6 figs. Erecting elevated trainshed and rearranging tracks while carrying 165 trains daily.

Track Construction

Constructing a Track Layout in Close Quarters, W. F. Rench. Ry. Maintenance Engr., vol. 15, no. 7, July 1919, pp. 232-234, 1 fig. Difficulties encountered especially because rail was of heaviest section and had to be unloaded and placed by hand.

ELECTRIC RAILROADS

Italy

Electric Traction in Italy (La grande trazione elettrica in Italia). Industria, vol. 33, no. 11, June 15, 1919, pp. 325-329, 3 figs. Features of installation in line of 50 miles.

ELECTRIFICATION

France and Belgium

Railway Electrification in France and Belgium, Robert E. Thayer. Ry. Age, vol. 67, no. 3, July 18, 1919, pp. 93-94. Plan under consideration involves electrification of 5,220 miles in France, and 147 miles in Belgium.

Main-Line Railroads

Electrification of Main-line Railroads, W. B. Potter. Street Ry. Bul. vol. 19, no. 7, July 1919, pp. 252-258, 7 figs. Statistical data on power demands for electrical operation of steam railroads in United States. Remarks on design of electric locomotives. Also abstracted in General Elec. Rev., June 1919, pp. 430-437.

Possibilities

Possibilities of Steam Railroad Electrification, Calvert Townley. Power Plant Eng., vol. 23, no. 14, July 15, 1919, pp. 639-642, 2 figs. Survey of electrified sections of railways, pointing out what are considered as advantages which had been realized in both freight and passenger service.

Single-Phase High-Tension Current

The Shortage of Coal and the Electrification of Railroads (Die Kohlennot und die Elektrisierung der Bahnen), Richard Baecker. Zeitschrift des österr. Ingenieur-und Architekten-Vereins, vol. 71, no. 1, Jan. 3, 1919, pp. 6-8. Writer considers high-tension single-phase alternating current as best suited for standard gage systems of European railroads.

Sweden

Extensive Electrification Proposed for Sweden. Ry. Age, vol. 67, no. 2, July 11, 1919, pp. 61-63, 5 figs. Findings of commission appointed to study question. Of estimated total of 5,000,000 water h.p. available, 1,000,000 has been developed

Switzerland

Electrification of Federal Railways (Electrification des chemins de fer fédéraux), Bulletin Technique de la Suisse Romande, vol. 45, no. 13, June 28, 1919, pp. 121-122, 2 figs. Hoeter reinforced-concrete piles. (To be continued.)

EQUIPMENT

Standardization

Standardization of Railway Equipment, Frank McManamy Ry. Rev., vol. 65, no. 1, July 5, 1919, pp. 7-9. What Railroad Administration planned and expected to accomplish.

FOREIGN

South America

Railways in the Americas (Ferrocarriles en las Américas), Percival Farquhar. Ingeniería Internacional, vol. 2, no. 1, July 1919, pp. 1-5, 1 fig. Points out advantages of building trunk lines with easy slopes in diminishing cost of freight and for developing uncultivated and slightly populated sections.

Necessity of Railways for the Development of South America (Ferrocarriles necesarios para la animación y desarrollo de la América del Sur), F. B. Morris. Ingeniería Internacional, vol. 2, no. 1, July 1919, pp. 7-8, 1 fig. Indicates three lines which writer believes are necessary for rapid development of South American continent.

Train Speeds

European Train Speeds. Ry. Gaz., vol. 30, no. 24, June 13, 1919, pp. 958-961, 1 fig. Germany and Scandinavia. Survey of highest, longest, and fastest non-stop runs, speed of trains between two places and geographical distribution of important services. (Continuation of serial.)

LABOR

Suitability Tests

Suitability Tests for Railway Men. Eng. & Indus. Management, vol. 2, no. 1, July 3, 1919, pp. 3-5, 5 figs. Illustrating what are believed to be imperfections in processes devised to test mechanically man's psychological conditions and activities.

LOCOMOTIVES

Design

Problems in the Construction and Operation of Locomotives (Probleme in Lokomotivbau und -betrieb), R. Sanzin. Zeitschrift des Osterr. Ingenieur-und Architekten-Vereins, vol. 70, no. 1, Jan. 4, 1918, pp. 1-5, 3 figs. Compares various types and discusses complete utilization of their power.

Engine Calibration

Engine Calibration as Adjunct to Efficient Operation, B. B. Milner. Ry. Rev., vol. 64, no. 26, June 28, 1919, pp. 1000-1004, 8 figs. Tests performed to determine maximum drawbar pull developed at various speeds and similar characteristics, for the purpose of gaining knowledge as to manner in which behavior of locomotives was effected through manipulation of reverse lever.

Fuel Economy

Locomotive Fuel Economy. Ry. Rev., vol. 65, no. 1, July 5, 1919, pp. 27-20, 2 figs. From report of committee on Fuel Economy and Smoke Prevention read at annual convention of Am. R. R. Assn.

Gasoline Locomotive

A New Petrol Shunting Locomotive. Ry. Gaz., vol. 31, no. 1, July 4, 1919, pp. 25-26, 1 fig. Engine is a 40-h. hp. internal-combustion motor having four water-jacketed cylinders working on 4-stroke principle.

Grand Trunk

Grand Trunk 0-3-0 Type Switching Locomotives. Ry. Age, vol. 67, no. 1, July 4, 1919, pp. 7-8. 1 fig. Tractive effort 36,700 lb; weight in working order 166,000 lb.

Mallet

Simple Mallet Locomotive Pennsylvania R. R. Ry. Rev., vol. 65, no. 3, July 19, 1919, pp. 81-89, 14 figs. Among special features to which particular attention is called are design of firebox and combustion chamber, superheater, float system for water-level indication and multiple stack and exhaust nozzle arrangement. Also in Ry. & Locomotive Eng., vol. 32, no. 7, July 1919, pp. 193-194, 2 figs.

Standard

Standard Light Mountain Type. Ry. Mech. Engr., vol. 93, no. 7, July 1919, pp. 431-437, 9 figs. Total weight, 327,000 lb.; tractive effort, 53,900 lb.

Standardization of Parts

The Standarization of Parts for Half-Inch Scale Model Locomotives, Henry Greenly. Model Engr. & Elecn., vol. 40, nos. 945, 946 and 948, June 5, 12 and 26, 1919, pp. 448-453, 470-473 and 519-522, 18 figs. June 5 and 12: Schemes for types writer classifies into outside-cylinder and inside-cylinder machines. June 26: Method of building up a machine.

Front Ends, Grates and Ash Pans. Ry. Jl., vol. 25, no. 7, July 1919, pp. 19-21. Committee report before International Ry. Fuel Assn.

Stoking, Mechanical

Mechanical Stoking of Locomotives an Economy, W. S. Bartholomew. Ry. Age, vol. 67, no. 4, July 25, 1919, pp. 163-167, 7 figs. Factors determining necessity of applying stokers; operating results secured by stoker firing. Paper presented before Western Ry. Club.

Switching

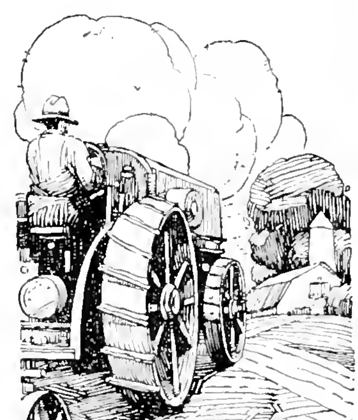
C.C.C. & St. L. 0-8-0 Switchers, R. W. Retterer. Ry. Mech. Engr., vol. 93, no. 7, July 1919, pp. 411-414, 5 figs. Consolidation type converted with special features to adapt engines for switching service.

The Carburizing Room

The Ten-Acre Plant of the New Process Gear Corporation

New Process Quality Counts

An automobile, truck or tractor is as good as its gears. New Process Differentials and Gears are designed and made by gear-specialists in a factory that is equipped to produce gears in quantity as well as quality. The product is uniformly good because of exceptional facilities and right inspection.



New Process Gear Corporation

Syracuse Member of the AGMA New York

New Process Gears

MAINTENANCE

Permanent Way

Maintenance of Permanent Way—I. Ry. Engr., vol. 40, no. 474, July 1919, pp. 141-143. Comparison of British and American methods of management. (To be continued.)

OPERATION AND MANAGEMENT

Accounting

Calculating Machine in Railroad Accounting, C. O. Price. Ry. Rev., vol. 64, no. 26, June 28, 1919, pp. 972-976, 5 figs. Contrasting present methods with those of ten years ago.

Allocation of Cars

Rolling Stock Distribution on the Midland Railway. Ry. Gaz., vol. 31, no. 1, July 4, 1919, pp. 9-16, 9 figs., partly on two supp. plates. Method of allocating vehicles which forms an essential part of the company's train control system.

France

Brief Survey of the Road Organization in France, A. Forbes. Surveyor, vol. 55, no. 1430, June 13, 1919, pp. 439-441, 4 figs. Work done by British army in order to fit French roads for war traffic. Paper road before Instn. Mun. & County Engrs.

Fuel Efficiency in Stationary Plants

Fuel Efficiency in Railroad Stationary Plants. Ry. Rev., vol. 65, no. 1, July 5, 1919, pp. 24-25, 1 fig. From report of committee on Fuel Economy and Smoke Prevention, read at annual convention of Am. R. R. Assn.

Interstate Commerce Law

A Comprehensive Revised Interstate Commerce Law. Ry. Age, vol. 67, no. 3, July 18, 1919, pp. 105-108. Suggestion for law which shall correlate laws passed since and including that of 1887.

Transfer Roads

How Operating Capacity Can Be Increased, E. H. Lee. Ry. Age, vol. 67, no. 1, July 4, 1919, pp. 34-36. Suggestions for improving intermediate transfer roads. From an appendix to preliminary report of Yards and Terminals Committee of Am. Ry. Eng. Assn.

PERMANENT WAY AND BUILDINGS

Grade-Separation Work

Extensive Grade Separation Work at Indianapolis. Ry. Age, vol. 67, no. 3, July 18, 1919, pp. 95-101, 16 figs. Improvements embrace a four-track high-level line and additional station facilities.

Track Support, Concrete

Concrete Railway Track Support. Eng. & Contracting, vol. 52, no. 3, July 16, 1919, pp. 65-67, 9 figs. Illustrating types constructed on various American railways. Paper read before Am. Concrete Inst. Also in Ry. Rev., vol. 65, no. 3, July 19, 1919, pp. 92-99, 20 figs.

Water Troughs

New Water Troughs at Langley, Great Northern Railway. Ry. Gaz., vol. 30, no. 25, June 20, 1919, pp. 997-999, 5 figs. Total length is 1,800 ft., of which 1,500 ft. is on level, the ramps at each end being 150 ft. long, graded to correspond with rails.

PUBLIC REGULATION

Government Operation

A New Advocate of Government Operation, Joseph B. Eastman. Ry. Age, vol. 67, no. 2, July 11, 1919, pp. 57-58. Letter to Congress suggesting that modifications proposed in the Cummins bill be continued "for an appropriate period of time," in order that uncertainty as to immediate future may be ended and sufficient time gained for deliberate and constructive consideration of entire problem.

RAILS

Electric-Railway Rails

Notes on the History and Development of Electric Railway Rails, R. C. Cram. Elec. Ry. Jl., vol. 54, no. 3, July 19, pp. 106-112, 11 figs. Takes up practical and theoretical considerations which are gradually leading to rail standardization and simplification.

ROLLING STOCK

Box Cars

Box Cars for Chilean Railway. Ry. Mech. Engr., vol. 93, no. 7, July 1919, pp. 417-420, 5 figs. Steel construction of American type for meter-gage line, including M.C.B. couplers and trucks.

See also Express Cars.

Express Cars

Utility Express Car of the Pennsylvania Railroad. Ry. Rev., vol. 65, no. 1, July 5, 1919, pp. 1-5, 6 figs. Box car fitted with heating and axle lighting equipment, and "semi-passenger" design of trucks to permit of its being run in fast trains.

Hopper and Gondola Cars

High Capacity Hopper and Gondola Cars, Pennsylvania Railroad. Ry. Rev., vol. 65, no. 2, July 12, 1919, pp. 45-50, 11 figs. Bodies are fabricated from plates and pressed-steel shapes. Underframe is composed of center sills, consisting of two 10-in. channels, weighing 30 lb. per ft. and two side sills, for which 4 x 6 x 3/4-in. angles are used.

Lighting

Report on Train Lighting and Equipment, Ry. Elec. Engr., vol. 10, no. 7, July 1919, pp. 233-240, 9 figs. Relating particularly work done by committee to develop standard ratings for axle generators. Paper presented at Ann. Conv. of Am. RR. Assn.

Vibration

On the Vibration of Railway Cars, N. Fukushima. (In Japanese.) Jl. Soc. Mech. Engrs., Tokyo, Japan, vol. 22, no. 56, Feb. 1919.

SAFETY AND SIGNALING SYSTEMS

Explosives, Transportation of

The Baltimore Tunnel Disaster, Frank H. Kneeland. Coal Age, vol. 16, no. 2, July 10, 1919, pp. 55-58, 3 figs. Judicial inquiry into causes which led to explosion of blasting powder which was being carried in same mined car with workmen.

Fire Prevention

Fire Prevention on Railroads, W. H. Hoyt. Bul. Affiliated Eng. Societies of Minnesota, vol. 4, no. 5, May 1919, pp. 89-94. Methods of reducing fire loss grouped under three heads—(1) fireproof construction, (2) fire-prevention and fire-fighting equipment, and (3) inspection and education. Applicability and value of each of these to fire prevention on railroads is discussed.

Locomotive Failures

Personal Injuries Due to Locomotive Failures, John L. Mohun. Ry. Age, vol. 67, no. 3, July 18, 1919, pp. 113-118, 2 figs. Suggestions for their reduction based on review of Interstate Commerce Commission locomotive inspection reports.

Safety-Signal Repetition

Safety in Operation of Railroads (La sécuritité de la circulation des trains de chemin de fer), J. Carlier. Société elge des Electriciens, vol. 33, April-June 1919, pp. 99-132, 3 figs. "Cesar" apparatus installed in locomotives for repeating safety signals.

Switch Machines

The Use of Low Voltage Switch Machines, A. R. Whitehorn. Ry. Signal Engr., vol. 12, no. 7, July 1919, pp. 241-242, 2 figs. Describing why such apparatus has been introduced and the main requirements to be met.

SHOPS

Chile

New Shops of the Chilean State Railways, Ernesto Gusman Donoso. Ry. Rev., vol. 64, no. 26, June 28, 1919, pp. 967-972, 8 figs. Reinforced-concrete sanitary repair plant.

Smoke Jack

An Unusual Form of Roundhouse Smoke Jack. Ry. Age, vol. 67, no. 4, July 25, 1919, pp. 155-157, 7 figs. Smoke jacks that cover entire length of stalls, special form of door construction and reinforced-gypsum roof mentioned as features in roundhouse of Pittsburgh & Lake Erie at Haselton, Ohio.

SPECIAL LINES

Light Railways

Light Railways (Ferrocarriles livianos), Charles F. Lang. Ingeniería Internacional, vol. 2, no. 1, July 1919, pp. 9-11, 5 figs. Economic advantages.

Construction and Operation of Light Railways in France, J. H. McKnight. Annual Report of Assn. of Dominion Land Surveyors, January 29, 30 and 31, 1919, pp. 136-139, 1 fig. Types used for military purpose.

A Technical Description of the British Light Railways in France, B. W. Guppy. Prof. Memoirs, Corps Engrs. U. S. Army & Engr. Dept., vol. 11, no. 56, March-April 1919, pp. 185-216. System was designed to connect broad-gage railways with front. Operating rules and signals are given.

STREET RAILWAYS

Cars

New Cars for Liverpool Corporation Tramways. Tramway & Railway World, vol. 45, no. 30, June 19, 1919, pp. 307-308, 4 figs. Single-truck car with reversed stairway and canopy top.

One-Man Car Operation, S. W. Greenland. Elec. Traction vol. 15, no. 7, July 1919, pp. 421-423. Types, service, and data secured from their operation. Paper read before Central Elec. Ry. Assn.

Cleveland

Cleveland Rapid Transit Report, Elec. Ry. Jl., vol. 54, no. 2, July 12, 1919, pp. 71-74, 5 figs. Report of Rapid Transit Commission of the city suggesting means of relief for present congestion and plans for development of rapid transit system.

Japan

Practices and Tendencies in Japanese Electric Railway Transportation, Shiro Sano. Elec. Ry. Jl., vol. 54, no. 1, July 5, 1919, pp. 4-6, 7 figs. Both double and single trolley are used, track gages are far from standard and people seem to lean toward public ownership.

Moving Platforms

Continuous Trains for Forty-Second Street Transit, Henry B. Seaman. Eng. News-Rec., vol. 82, no. 26, June 26, 1919, pp. 1248-1250, 3 figs. Moving platforms recommended. Operation illustrated.

Passenger Traffic, Analysis of

Methods of Observing and Analyzing Passenger Traffic, R. H. Horton. Elec. Ry. Jl., vol. 54, no. 2, July 12, 1919, pp. 75-78, 3 figs. Merits of various methods of obtaining data are pointed out and suggestions are offered in regard to using traffic study data.

Rail Hardening

The Sandberg "in Situ" Rail Hardening Process, Robt. B. Holt. Tramway & Railway World, vol. 45, no. 30, June 19, 1919, pp. 314-315, 1 fig. Experiments carried out by operating a car on an upgradient on a length of track a portion of which had been treated by the "in situ" process, with the front motor cut out and brakes applied to front wheels.

Track Construction

Latest British Street-Railway Track Construction. Eng. News-Rec., vol. 83, no. 2, July 10, 1919, p. 83, 2 figs. Ties generally omitted; bituminous granite chip packing under rails used; standard welding and rail hardening in place.

Bonds for Temporary and Permanent Track Construction, G. H. McKelway. Elec. Ry. Jl., vol. 54, no. 3, July 19, 1919, pp. 114-117, 14 figs. Advantages and disadvantages of various types are discussed from practical standpoint.

Zone Fares

The Zone Fare in Practice, Walter Jackson. Elec. Ry. Jl., vol. 54, nos. 1, 2 and 4, July 5, 12 and 26, 1919, pp. 7-12, 56-61 and 154-157, 27 figs. July 5: Comparative bus and trolley statistics obtained at Leeds, England. July 12: Despite higher fares and cut in service, traffic is said to have fallen off only 3.4 per cent and revenue increased 23.3 per cent. July 26: How British Elec. Traction Co. stimulated riding as close to destination as possible by introducing half-penny stages on top of maximum penny ride.

TERMINALS

Chicago

Proposed New Passenger Terminal in Chicago. Ry. Rev., vol. 65, no. 2, July 12, 1919, pp. 57-61, 6 figs. Plans of Illinois Central which also involve electrification for all types of service and lake-front developments.

Illinois Central Will Build New Chicago Terminal. Ry. Age, vol. 67, no. 2, July 11, 1919, pp. 51-54, 3 figs. Electrification project embracing terminal capable of development to accommodate all railroads at present entering passenger stations east of Chicago River.

Pennsylvania

Engine Terminal Improvements: Pennsylvania Lines West. Eng. News-Rec., vol. 83, no. 1, July 3, 1919, pp. 24-28, 5 figs. Heavy traveling crane, circular crane runway, parking tracks with transfer table and turntable and mechanical ashpits.

Northwest Pennsylvania's Newest Station, J. B. Scott. Elec. World, vol. 74, no. 2, July 12, 1919, pp. 60-63, 5 figs. Power house built on unit principle. It is expected that installation will eventually be rated at 120,000 kw.

Munitions and Military Engineering

Cables

Military Uses of Cables (Etude sur l'emploi des cables aux armées), G. Leinekugel le Cocq. Genie Civil, vol. 74, no. 24 & 25, June 14 & 21, 1919, pp. 477-481 and 497-504, 95 figs. partly on supp. plates. Mechanical details and technical study of semi-permanent Gisclard bridges; aerial transport cable and its use in rapid reconstruction of masonry piles and railroad beds. (Concluded.)

Camouflage

Memoranda on the Camouflage Service of the United States Army, Evarts Tracy. Prof. Memoirs, Corps Engrs. U. S. Army & Engr. Dept., vol. 11, no. 56, Mar-Apr. 1919, pp. 175-184. Including discussion of qualifications of a field camoufleur.

The Principles of Camouflage, M. Luckiesh. Tran. Illum. Eng. Soc., vol. 14, no. 5, July 21, 1919, pp. 234-255. Particularly in reference to marine practice and applicability of art to airplanes.

Camouflage, Harold Van Buskirk. Tran. Illum. Eng. Soc., vol. 14, no. 5, July 21, 1919, pp. 225-233, 8 figs. on six separate plates. Outline of progress made in United States before and after Navy Dept. took over and organized its camouflage section.

Painting Battleships for Low Visibility, Everett L. Warner. Tran. Illum. Eng. Soc., vol. 14, no. 5, July 21, 1919, pp. 220-224, 2 figs. on four supp. plates. Standard navy gray considered as most suitable shade.

The Science of Marine Camouflage Design, Everett L. Warner. Tran. Illum. Eng. Soc., vol. 14, no. 5, July 21, 1919, pp. 215-219, 10 figs. on four supp. plates. Showing various designs with reference to principles involved. Paper presented before N. Y. Section Illum. Eng. Soc.

Camps

Construction of Camp Meade, R. F. Proctor. Cornell Civil Engr., vol. 27, no. 5, June 1919, pp. 159-167. Camp provides housing for 41,500 men.

Construction Division, U. S. A.

Expediting the Engineering Work of the Construction Division of the Army, A. B. McDaniel. Eng. & Contracting, vol. 52, no. 3, July 16, 1919, pp. 77-79, 3 figs. Outlining method for routing work and coördination of various departments.

Destroyers

Notes on Handling Destroyers, C. C. Slayton. U. S. Naval Inst. Proc., vol. 45, no. 7, July 1919, pp. 1201-1219, 6 figs. Suggestions to captains.

Engineering in the Navy

The Importance of Engineering to the Navy, Josephus Daniels. Jl. Engrs. Club of Philadelphia, vol. 36, no. 177, August 1919, pp. 299-300. From address at opening exercises of Post-Graduate School at Annapolis.

German Fleet, Sinking of

The Sinking of the German Fleet at Scapa-Flow (Le coulage de la flotte allemande a Scapa-Flow), A. Poidlouë. Génie Civil, vol. 75, no. 1, July 5, 1919, pp. 1-7, 22 figs. Technical notes on relative values of British and German fleets. Structural features of ships which participated in Jutland battle.

Gun-Mount Construction

Building 5-inch Gun Mounts at Brantford, J. H. Moore. Can. Machy., vol. 22, no. 4, July 24, 1919, pp. 65-68, 9 figs. Dealing practically with machine-tool equipment. (To be concluded.)

Gun Mounts, Naval

Making Naval Gun Mounts. Machinery (Lond.), vol. 14, no. 351, June 19, 1919, pp. 349-353, 11 figs. Tools, gages and fixtures used in operations. (Continued.)

How the Navy Designed and Built the World's Heaviest Field Piece, C. L. McCrea. U. S. Naval Inst. Proc., vol. 45, no. 7, July 1919, pp. 1159-1169, 2 figs. Seven-inch caterpillar mount.

Mounts for Naval Anti-Aircraft Guns, Fred H. Colvin. Am. Mach., vol. 51, no. 2, July 10, 1919, pp. 79-83, 14 figs. Carriage and ball races. First article.

Mines

Bringing in the Sheaves, Clarence Nelson Hinkamp. U. S. Naval Inst. Proc., vol. 45, no. 7, July 1919, pp. 1117-1133, 11 figs. Structural details of German mines. Account of mine sweeping.

Ordnance Base

The Ordnance Base of the American Expeditionary Forces. Stone & Webster Jl., vol. 25, no. 1, July 1919, pp. 10-22, 14 figs., on supp. plates. Describes Mehun plant, which was laid out to serve army of two million men in France.

Ordnance Materials

The Manufacture of Steel for Ordnance Materials in England and in France, F. F. McIntosh. Proc. Engrs. Soc. Western Pa., vol. 35, no. 3, April 1919, pp. 140-163, and (discussion) pp. 164-170. Observation and impression obtained on inspection of steel mills through England and France. The method of etching for macrostructure of steel as developed by Mr. J. C. W. Humphreys, Chief Chemist in charge of Naval Inspector of Steels Laboratory at Sheffield, England, is presented.

Paravanes

Paravanes, George L. Catlin. U. S. Naval Inst. Proc., vol. 45, no. 7, July 1919, pp. 1135-1157, 8 figs. Types used, manner of applying them, and description of operation.

Zeebrugge Attack

Destruction of the Flanders Triangle. Z. W. Wicks. U. S. Naval Inst. Proc., vol. 45, no. 7, July 1919, pp. 1093-1116, 3 figs. Technical consideration involved in planning the Zeebrugge attack.

General Science

CHEMISTRY

Air Analysis

A Simple Form of Apparatus for Estimating the Oxygen Content of Air from the Upper Atmosphere, Francis William Aston. Jl. Chem. Soc., vols. 115-116, no. 679, May 1919, pp. 472-475, 1 fig. Watson apparatus modified by measuring difference only in oxygen content between sample and normal air.

Apparatus for the Rapid Analysis of Confined Air and Unhealthy Atmospheres (Appareil pour l'analyse rapide de l'air confiné et des atmosphères insalubres). Génie Civil, vol. 74, no. 24, June 14, 1919, p. 490, 1 fig. Air drawn in through independent Cloez flasks by running of water out of large zinc cylinder. Apparatus permits simultaneous examination of various atmospheres.

Allotropy

Theory of Allotropy; Allotropes and Allotropoids, Maurice Copisarow. Chem. News, vol. 118, no. 3086, June 6, 1919, pp. 265-266. Regards allotropy as function of valency and defines it as "capacity of an element to exist in forms, differing in the mode of their ultramolecular linkage."

Analysis, Electrochemical

New and Rapid Apparatus for Electrochemical Analyses, J. T. King. Chem. & Metallurgical Eng., vol. 21, no. 1, July 1, 1919, pp. 25-29, 7 figs. Stirring effected by rotating containing beaker. Table showing results of experiments on three different brasses, obtained by this and other methods of stirring and carried out by different operators, is included.

See also under names of materials analyzed.

Analysis, Nickel

Quantitative Analysis of Nickel in Ferro-Nickels and Steels (Dosage du nickel dans les ferro-nickels et les aciers), Paul Nicolardot and Georges Gourmain. Bul. Société Chimique de France, vol. 25-27, no. 6, June 1919, pp. 338-344. Preference is given to eletrolytic method, which is said to be most exact.

Asphalt Precipitation

Quick Method for Determination of Hard Asphalt (Schnellmethode zur Bestimmung von Hartasphalt), J. Tausz and A. Lüttgen. Petroleum, vol. 14, no. 14, Apr. 15, 1919, pp. 653-654, 1 fig. Principal features of method are: Hard asphalt is precipitated with benzine in special small centrifugal containers which may be weighed on the micro scale, and is immediately put into the centrifugal apparatus, where it is said to be completely separated within 10 min.

Calcium Determination

See Zinc and Calcium Determination.

Clay Analysis

A Simplified Apparatus for the Determination of Air in Clay. H. Spurrier. Jl. Am. Ceramic Soc., vol. 2, no. 6, June 1919 pp. 490-493, 2 figs. Disengaging gases occluded in clay by use of air-free and nearly boiling water, introduced as simplification in process given as accurate in connection with apparatus described in Jl. Am. Ceramic Soc., 1, 710-715, 1918.

Cyanide Reactions

The Sensitiveness of Some Cyanide Reactions, John B. Ekeley and Icie C. Macy. Proc. Colorado Sci. Soc., vol. 11, June 1919, pp. 269-274, 1 fig. Experiments lead to recommendation that Schonbein tests should be carried out in closed vessels in dark to get trustworthy results.

Distillation

New Laboratory Alembic and Measure of its Efficiency (Sur une nouvelle colonne à distiller, pour laboratoire, et sur la mesure de son éfficacité), M. H. Robert. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 20, May 19, 1919, pp. 998-1001, 2 figs. For fractional distillation.

Elements

New Periodic Classification of the Chemical Elements (Sur une nouvelle classification périodique des éléments chimiques), Marc Chauvierre. Bul. Société Chimique de France, vol. 25-26, no. 6, June 1919, pp. 297-305, 1 fig. Based on periodicity resulting from atomic weights and presented as applicable to theories of organic evolution and believed to suggest hypotheses explaining origin of radioactive phenomenon.

Explosive Reactions, Temperature

Temperatures Obtained in Explosive Reactions (Sur la détermination des températures atteintes dans les réactions explosives), Henri Muraour. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 20, May 19, 1919, pp. 995-997. Experiments are said to have proved that the greater part of methane contained in the products of combustion of powders is formed during period of cooling.

Gas Analysis

Computation Tables for Flue and Chimney Gas Analyses (Rechentafeln zur Rauchgas- und Auspuffanalyse), Wa. Ostwald. Feuerungstechnik, vol. 7, no. 7, Jan 1, 1919, pp. 53-57, 12 figs., partly on supp. plate. Endeavors to show the state of dependence to each other of the following variations: (1) proportion of mixture or surplus of air or air factor of exhaust mixture, (2) completeness of combustion or percentage of carbon monoxide, (3) percentage of carbonic acid in flue gases, (4) percentage of free oxygen in flue gases.

Lead Sulphide

The Chemical Equilibrium between Sulphide of Lead and Its Roasting Products (Ueber die chemischen Gleichgewichte zwischen Bleisulfid und seinen Röstprodukten), Rudolf Schenk and Agnes Albers. Zeitschrift für anorganische und allgemeine Chemie, vol. 105, no. 4, Apr. 3, 1919, pp. 145-146, 6 figs. Purpose of experiments was to determine nature of tension curves and to deduce from these the condition of existence of the various solid phases.

Petroleum Analysis

Estimation of Benzene and Toluene in Petroleum, F. B. Thole. Chem. Indus., vol. 38, no. 4, Feb. 28, 1919, pp. 39T-43T, 2 figs. Comparative examination of various methods.

Phosphates, Acid

On Various Properties of Acid Phosphates (Sur quelques propriétés des phosphates acides), A. Joannis. Comptes rendus des séances de l'Academie des Sciences, vol. 168, no. 24, June 16, 1919, pp. 1202-1203. Experiments said to confirm Berthelot's conclusions in regard to the different values he obtained for the three acid functions of phosphoric acid.

Rock Analysis

The Determination of Combustible Matter in Silicate and Carbonate Rocks, A. C. Fieldner, W. A. Selvig and G. B. Taylor. Bur. of Mines, technical paper no. 212, April 1919, 22 pp., 1 fig. Lissner's method of determining organic carbon and hydrogen found to give abnormally high results for organic hydrogen in rocks containing small amounts of combustible matter.

Schonbein Test

See Cyanide Reactions.

Soil Analysis

A Simplified Wet Combustion Method for the Determination of Carbon in Soils, D. D. Waynick. Jl. Indus. & Eng. Chem., vol. 11, no. 7, July 1, 1919, pp. 634-637, 1 fig. Said to require about 25 min. total time for determination.

Solubility

Solubility—III. Relative Values of Internal Pressures and their Practical Application, Joel H. Hildebrand. Jl. Am. Chem. Soc., vol. 41, no. 7, July 1919, pp. 1067-1080. Various methods for calculating solubility of liquids are reviewed, and though the values they yield differ considerably, argoments are presented to show that they are closely parallel.

Steel Analysis

The Determination of Vanadium in Steels by Electrometric Titration. The Selective Oxidation of Vanadyl Salts by Nitric Acid in the Presence of Chromic Salts, G. L. Kelley, J. A. Wiley, R. T. Bohn and W. C. Wright. Jl. Indus. & Eng. Chem., vol. 11, no. 7, July 1, 1919, pp. 632-634. With illustration of application of methods to analysis of synthetic steels.

Zinc and Calcium Determination

Determination of Zinc and Calcium in the Presence of Lead, Ernest Nyman. Can. Chem. Jl., vol. 3, no. 7, July 1919, pp. 217-218. Based on solubility of lead ferrocyanide and lead oxalate in amml acetate solution, and titration of zinc in ammoniacal solution by using uranylacetate weakly acidified with hydrochloric acid as outside inicator.

Zirconium Analysis

Analysis of Zirconium Ores and Alloys, A. Travers. Metal Industry, vol. 14, no. 22, May 30, 1919, pp. 441-444. Chancel's method of separating ZrO_2 and Fe_2O_3 by means of sodium hyposulphite considered as best.

MATHEMATICS

Determinants

Notes on the Determinant of the Primary Minors of Special Set of $(n-1)$ — by n Arrays, Thomas Muir. Proc. Roy. Soc. of Edinburgh, vol. 39, part 1, Session 1918-19, pp. 35-40. Cases in which determinant vanishes.

Equations

Two-dimensional Solutions of Poisson's and Laplace's Equations, Leonard Bairstow and Arthur Berry. Proc. Roy. Soc., Series A, vol. 95, no. A 672, June 4, 1919, pp. 457-475, 2 figs. Based on theorem stating that "any irrotational acyclic fluid motion can be reproduced by an appropriate choice of simple sources round the fixed boundaries." Strength of sources corresponding with given boundaries is determined by solution of an integral equation; in case of double boundaries simultaneous integral equations are solved.

Application of Gibbs-Helmholtz Equation to Monovariant Systems (Sur l'application de l'équation de Gibbs-Helmholtz, aux systèmes monovariants), A. Boutaric. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 19, May 12, 1919, pp. 939-942. Suggests modification in form adapted by Nernst for extending above equation to such systems.

Numerical Integration of Differential Equations, F. R. Moulton. Jl. U. S. Artillery, vol. 51, no. 1, July 1919, pp. 40-55, 1 fig. Examples illustrating application of Picard's method.

On the Numerical Integration of Differential Equations, H. T. H. Piaggio. Lond., Edinburgh and Dublin, Phil. Mag., vol. 37, no. 222, June, 1919, pp. 596-600, 1 fig. Formula for computing order of magnitude of error in final result when Runge's formula (Math. Ann., vol. 46, 1895) is used.

Isothermal Surfaces

On Isothermal Surfaces (Sur les surfaces isothermiques), C. Guichard. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 24, June 16, 1919, pp. 1185-1188. Solution of equation of system formed by lines of curvature, which is satisfied by the solutions of Laplace, of an equation having equal invariants such that the sum of their squares equals zero.

Polynomials

Development of Jacobi's Polynomials (Sur les développements de Jacobi), Erwand Kogbetliantz. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 20, May 19, 1919, pp. 992-994. Limiting cases of summation.

Series

Summation of Divergent Series (Sur la sommation des séries divergentes), Erwand Kogbetliantz. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 22, June 2, 1919, pp. 1090-1092. Theorem concerning application of method (R, λ, κ) by Riesz typical mean function.

Trigonometric Series

Trigonometric Series (Sur les séries trigonométriques), Erwand Kogbetliantz. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 24, June 16, 1919, pp. 1193-1194. Problem summation (C, $\delta < o$).

Vector Algebra

Further Contributions to Non-Metrical Vector Algebra, L. Silberstein. Lond., Edinburgh, and Dublin Phil. Mag., vol. 38, no. 223, July 1919, pp. 115-143, 6 figs. Theory of vector multiplication.

PHYSICS

Acoustics

The Resonance Theory of Audition subjected to Experiments, E. H. Barton and H. M. Browning. Lond., Edinburgh, and Dublin Phil. Mag., vol. 38, no. 223, July 1919, pp. 164-173, 1 fig. Reviewing position of resonance theory about audition, writer acknowledges subject to be controversial, but endeavors to throw sidelight upon it by trial of a graduated set of pendulums.

The Function of Phase Difference in the Binaural Location of Pure Tones, R. V. L. Hartley. Physical Rev., vol. 13, no. 6, June 1919, pp. 373-385, 5 figs. In expressing sound images observed when pure tones of same frequency and intensity but of different phase are applied to the two ears, use is made of theoretical curves calculated by Stewart and Fry, giving relation between the position of actual source and the resulting phase difference of sound at the two ears.

The Absolute Measurement of the Intensity of Sound, Arthur Gordon Webster. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 7, July 1919, pp. 889-900, 8 figs. on two supp. plates. Theory of operation of phone (used for measuring output of sound in watts of energy), phonometer (for measuring a sound in absolute units), and phonotrope (designed and used to find direction of a source of sound). A list of various technical papers on sound is appended.

Colors

The Persistence of Vision of Colours of Varying Intensity, Frank Allen. Lond., Edinburgh & Dublin Phil. Mag., vol. 38, no. 223, July 1919, pp. 81-89, 5 figs. Method of critical frequency of flicker applied to investigating phenomena of color vision.

Crystal Formation

A Method of Growing Large Perfect Crystals from Solution, R. W. More. Jl. Am. Chem. Soc., vol. 41, no. 7, July 1919, pp. 1060-1066, 3 figs. It consists of placing small seed crystals or several in nearly saturated solution of salt, cooling solution until it is very slightly supersaturated, and maintaining a state of slight supersaturation by slowly cooling solution, with the temperature regulated within very narrow limits.

Electron Discharges

Determining the Velocity of Electron Discharge (Ueber die Bestimmung von Elektronen-Austrittsgeschwindigkeiten), A. Becker. Annalen der Physik, vol. 58, no. 5, 1919, pp. 393-473. 17 figs. Theories: homogeneous field; cosine law of radiation; practical derivations; special applications.

Fluid Flow

Flow of Gasoline Vapor (Sur l'écoulement de la vapeur de pétrole), Jean Rey. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 22, June 2, 1919, pp. 1092-1095. Further discussion of equations presented in Comptes Rendus, vol. 168, 1919, p. 509.

Fluids

The Spreading of Fluids on Glass—III, W. B. Hardy. Lond., Edinburgh, and Dublin Phil. Mag., vol. 38, no. 223, July 1919, pp. 49-55. Evidence offered in confirmation of Lord Rayleigh's suggestion that complicated secondary changes in secondary composite surface are due to chemical heterogeneity of surface layer.

Heat Measurement

The Measurement of Heat and the Scope of Carnot's Principle, Arthur C. Lunn. Physical Rev., vol. 14, no. 1, July 1919, pp. 1-19. What is termed symmetric form of exposition of principle of thermodynamics is developed through recognizing on a parity from the outset the two kinds of conservation naturally called after Black and Carnot which lead to energy and entropy scales of measurement of heat.

Heat, Mechanical, Equivalent of

Value of the Mechanical Equivalent of Heat (Ueber den Wert des mechanischen Wärmeaquivalents), W. Jaeger and H. von Steinwehr. Annalen der Physik, vol. 58, no. 5, 1919, pp. 487-488. Discussion of value found by Carlton Sutton and table of equivalents obtained in research work of twelve other scientists, during period extending from 1843 to 1915.

Liquids

Vapor Pressure of Thin Liquid Films (Pression de vapeur des liquides en lames minces), Felix Michaud. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 23, June 10, 1919, pp. 1155-57. Concluded analytically that vapor from such films exerts pressure considerably below normal corresponding to conditions of saturation.

The Rotational Oscillation of a Cylinder in a Viscous Liquid, D. Coster. Lond., Edinburgh, and Dublin Phil. Mag., vol. 37, no. 222, June 1919, pp. 587-594, 1 fig. Following method used by Professor Verschaffelt in analogous case of sphere. (Comm. Leiden, p. 22.)

Michelson's Experiment

See Relativity.

Optics

Scattering of Light by Solid Substances, R. J. Strutt. Proc. Roy. Soc., Series A, vol. 95, no. A 672, June 4, 1919, pp. 476-479, 4 figs. on separate plate. Comparison between intensities of vibration, (1) parallel to direction of primary beam and (2) perpendicular to primary beam. Former is given as percentage of latter. Result for Chance's crown glass given as 8 per cent and for ordinary plate glass as 3 per cent.

Osmotic Pressures

On Osmotic Pressures Derived from Vapour-Pressure Measurements: Aqueous Solutions of Cane Sugar and Methyl Glucoside, E. G. J. Hartley and C. V. Burton. Phil. Tran. Roy. Soc., Lond., Series A 565, vol. 218, May 20, 1919, pp. 295-349, 6 figs. Investigations to determine best conditions for making method described in Roy. Soc. Proc., A, vol. 77, 1906, and in Phil. Trans., A, vol. 209, both accurate and of general applicability, and to obtain data for construction of suitable apparatus for determination of absolute vapour density of liquids in air or other gas.

Photographic Rendering of Contrast

The Fundamental Law for the True Photographic Rendering of Contrast, Alfred W. Porter and R. E. Slade. Lond., Edinburgh, and Dublin Phil. Mag., vol. 38, no. 223, July 1919, pp. 187-197, 9 figs. Examination of technical principles assumed in method of treating photographic plates devolved after researches of F. Hurter and V. C. Driffield. (See Jl. Sic. Chem. Industry, May 31, 1890.)

Radioactivity

On the Relation between the K Series and the L Series of X-Rays, William Duane and Takeo Shimizu. Physical Rev., vol. 14, no. 1, July 1919, pp. 67-73, 2 figs. Experiments with tungsten. Graphs are given representing ionization currents as functions of the crystal table angle.

Radioactive Bricks, H. J. Knollman. Jl. Am. Ceramic Soc., vol. 2, no. 6, June 1919, pp. 451-460. Method of manufacturing radioactive clay bricks.

Soap Films

Soap Bubbles and Films, J. Perrin. Sci. Am. Supp., vol. 88, no. 2273, July 26, 1919, pp. 50-51. Examination of black spots which appear just before rupture of bubbles or films of soap. Translated from the French.

Structure of Matter

The Langmuir Postulates, Ellwood Hendrick. Chem. & Metallurgical Eng., vol. 21, no. 2, July 15, 1919, pp. 73-81, 13 figs. Method of determining physical qualities of chemical compounds from their atomic, ionic and molecular struture. Presented as introduction to theory of chemical reactions developed by Dr. Irving Langmuir.

Sulphur Vapor

The Constitution of Sulphur Vapour, James J. Dobbie. Proc. Roy. Soc., Series A, vol. 95, no. A 672, June 4, 1919, pp. 484-492, 5 figs, partly on two separate plates. Experiment performed by enclosing quantity of metal in closed tube from which air was subsequently drawn out and nitrogen introduced. Sources of light employed were Nernst filament, ultra-violet, and cadmium arc.

Vortices

Vortices of a Fluid (Sur les tourbillons d'une veine fluide), L. Lecornu. Comptes Rendus des séances de l'Académie des Sciences, vol. 168, no. 19, May 12, 1919, pp. 923-926. On Beltrami's researches (Rendiconti del reale Istituto lombardo, 1889), as to whether in movement of fluid curves tangent to velocities coincide with lines of vortex.

X-Rays

See Radioactivity.

Centrifugal Compressors[1]

By GUSTAV FLUEGEL, D. ENG.

For a period of more than four years German engineering and scientific periodicals have been received in this country only to a very limited extent, and American engineers have been unable to follow the technical developments in Germany. Meanwhile the same urgent necessity which inspired the development of new ideas on the Allied and American side during the years of the war has existed also on the German side, with the result that many important and interesting inventions, improvements and researches have been carried out. The American Society of Mechanical Engineers has made a vigorous effort to collect copies of the German periodicals, particularly of the Zeitschrift des Verein Deutscher Ingenieure, and hopes within the limits of the available space to bring to the readers of Mechanical Engineering some of the more important of the German developments, either in the Engineering Survey section or as separate articles. The investigation of the characteristic curves of centrifugal compressors by Dr. Gustav Fluegel, printed below, is but the first installment of what is hoped will develop into a series of articles, abstracts, and translations.

I BASIC CHARACTERISTICS

THE characteristic curves of centrifugal pumps and water turbines may be derived in accordance with comparatively simple laws when certain data are available and certain conditions maintained, but the relations are far more complicated in the case of centrifugal machinery for handling elastic fluids. It is due to this fact, in the opinion of the author, that no general formulæ defining the behavior of multi-stage centrifugal compressors are available in technical literature, notwithstanding their great importance.

The characteristic curve of a compressor, that is, the curve which for the same speed of rotation n defines the rise of pressure as a function of the suction volume, can be considered as a result of superposition of the characteristics of all the single stages. If all such single-stage curves for the same speed of rotation and the same initial state be plotted in some system of coördinates, one obtains a group of curves such as shown in Fig. 1; and, as a rule, the nearer the stage is to the compressor end the smaller is the volume of fluid q flowing through it and the delivery head Δp. In a similar manner could be plotted the efficiency curves, which are different for every individual stage. The whole system of curves varies with the speed of the compressor and with the density of the fluid handled, but this variation of curves may be simplified in what the author calls an extraordinary manner, as will be shown later.

The delivery head Δp for a single stage can be expressed by the known formula

$$\Delta p = m \frac{\gamma}{2g} u^2$$

where m is the value of pressure rise which varies with the angle of blades and for the same angle may be considered as constant, though strictly it increases with the speed in revolutions (regarding which more will be said in another place), u is the peripheral velocity of the pumping wheel, γ the specific weight of fluid at entrance to the wheel and g the acceleration due to gravity.

The compressor is always built for a certain normal output at a normal speed in revolutions n_0 at which it should reach its maximum efficiency. In such a case the admissions of the single stages are equal to unity and the amount of fluid passing therethrough per second is Q_0. With the same speed in revolutions n_0 but with a different amount of fluid passing therethrough, the admission is

$$\varepsilon = \frac{Q}{Q_0}$$

When, however, the speed in revolutions varies also, the same magnitude is expressed by

$$\varepsilon = \frac{Q}{Q_0}\,\frac{n_0}{n}$$

With the same admission the entrance and exit triangles for the same stage are similar. Hence one may, instead of representing the delivery head Δp as a function of the amount of fluid flow Q, represent the magnitude of the delivery head m of each individual stage as a function of its admission ε, Fig. 2, in which case the curves $A_1 B_1$, $A_2 B_2$, etc., are obtained, and all of them differ but

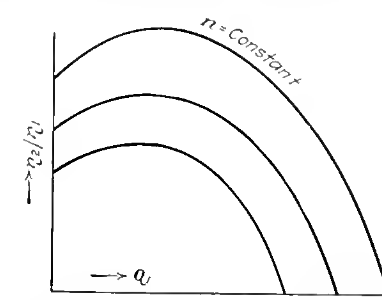


FIG. 1 CHARACTERISTIC CURVES OF A COMPRESSOR (AS A WHOLE)

little from each other because of the fact that all stages in a compressor are usually built very similar to each other. It is therefore natural to plot in their stead an average curve AB, derived from the following point of view. If, at a certain speed in revolutions n of the compressor and peripheral velocity of a wheel u, the value of $S = \Sigma u^2$, then for the stages under consideration can be calculated and for each of the curves A_1B_1, A_2B_2 can be found the corresponding value

$$\gamma_1 = \frac{u_1^2}{S}, \quad \gamma_2 = \frac{u_2^2}{S}$$

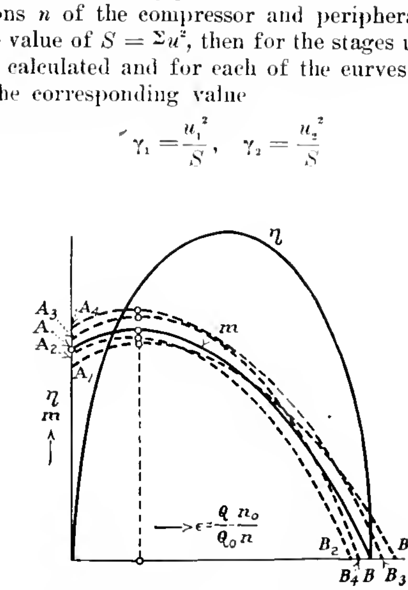


FIG. 2 DELIVERY-HEAD ADMISSION AND DELIVERY-HEAD EFFICIENCY CURVES

If now m_1, m_2, etc., be the numerical values of the pressure head with certain admission ε^1, the average value for the whole group is found to be

$$m = \Sigma \gamma m^1$$

By repeating such determinations as above for a number of admissions, one finds the average curve AB. In a similar manner may be determined as a function of ε the average curve of efficiency η for the single stages.

These two average curves of m and η derived of functions of ε the author calls the *basic characteristic* of a multi-stage compressor group. They are independent of the speed of rotation in revolu-

[1] From *Zeitschrift des Vereines deutscher Ingenieure*, no. 20, vol. 63, May 17, 1919, pp. 455-460.

tions, or the amount of fluid flowing per unit of time, of the density of the medium handled and of the location of each individual stage, and therefore may be used as a starting point for determining the general behavior of turbo-compressors. Since the individual stages of all centrifugal compressors are built in a manner very similar to each other and since in practice the variation in the speed of rotation, velocity of flow, and delivery head of a compressor is comparatively small, a single basic characteristic ought to be sufficient as a foundation for all calculations, at least when applying to machines of similar design.

II COMPRESSOR WITH UNCOOLED CASING

(a) Compression in a Single Multi-Stage Group

When a considerable rise of pressure is desired, compressors without external cooling are always divided into several groups of stages with intercooling of air between the groups. It is therefore only necessary to investigate the behavior of a single group of stages due to variation of the speed of rotation in revolutions, the amount of fluid flowing through and the initial state of the air. With normal load the admission in all stages is $\varepsilon = 1$, and without impairing materially the precision of results one may consider the magnitude of the pressure head m and the efficiency η_i of all stages of the group as constant. Under different conditions of operation, however, the values of ε, m and η_i may vary from stage to stage. From

$$\Delta p = m \frac{\gamma}{2g} u^2$$

we find with sufficient precision for our purposes the following expression for the work consumed in compressing the air in each stage.

$$\Delta E = A \frac{V \Delta p}{\eta_i} = \frac{A G}{2g} \frac{m}{\eta_i} u^2$$

where A is the mechanical equivalent of heat; V the amount of air flowing per second and $G = V\gamma$ the weight of air flowing per second. Since, further,

$$\Delta E = G c_p \Delta T$$

when ΔT is the rise of temperature in the stage and c_p the specific heat of the gas, it follows that

$$\Delta T = \frac{A}{2g\, c_p} \frac{m}{\eta_i} \Delta s$$

where $\Delta s = u^2$. Further, it has been shown (*Zeitschrift des Vereines deutscher Ingenieure* 1918, p. 662), that

$$\Delta T = \frac{k-1}{k\eta_i} \frac{\Delta p}{p} T$$

when p is the absolute pressure, T the absolute temperature at the entrance to the stage and k the exponent in the adiabatic equation. This equation was derived by considering the compression as if it were occurring not in a finite number of stages but in an infinite number of very small stages. Because of this the above two relations may be expressed in the form of differential equations

$$\frac{d\,T}{T} = \frac{k-1}{k\,\eta_i} \frac{d\,p}{p}$$

$$d\,T = \frac{A}{2\,g\,c_p} \frac{m}{\eta_i} ds$$

If great precision in calculation is desired it is necessary in the integration of these equations to consider only the variation of m and η_i under normal load by assuming that

$$\eta_i = \eta_{i1} = k_1 T$$

$$\frac{m}{\eta_i} = \left(\frac{m}{\eta_i}\right)_1 - k_2 s$$

where k_1 and k_2 are constants and $s = \Sigma u^2$ from the first stage to the stage under consideration. The integration gives then the following solutions for the entire group of stages

$$\frac{T_2}{T_1} = \frac{(1+a)\left(\frac{p_2}{p_1}\right)^c}{1 + a\left(\frac{p_2}{p_1}\right)^c}$$

$$T_2 - T_1 = \frac{A\,S}{4\,g\,c_p}\left[\left(\frac{m}{\eta_i}\right)_1 + \left(\frac{m}{\eta_i}\right)_2\right]$$

provided the following substitutions are made

$$a = \frac{\eta_{i2} - \eta_{i1}}{2} \frac{T_1}{T_2}$$

$$c = \frac{k-1}{k\,\eta_{i1}}$$

and $S = \Sigma u^2$ for all stages of the group. The subscript 1 denotes the values for the entrance to the group and the subscript 2, exit from the group.

Since, however, no especially great precision is necessary for purposes of general calculation in practice, approximations may be sufficient and it is permissible to substitute in the integration for m and η_i constant average values m_m and η_{im}. This gives

$$\frac{T_2}{T_1} = \left(\frac{p_2}{p_1}\right)^c \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad [1]$$

where

$$c = \frac{k-1}{k\,\eta_{im}}$$

and

$$\frac{A\,S}{2\,g\,c_p\,T_1}\left(\frac{m}{\eta_i}\right)_m = \frac{T_2}{T_1} - 1 \ldots\ldots\ldots\ldots\ldots [2]$$

The value of S is to the value of S_0 at the normal speed in revolutions n_0 in the ratio of $\frac{S}{S_0} = \left(\frac{n}{n_0}\right)^2$. With the aid of Equation [2] may be found for various values of m_m and η_{im} the corresponding temperature ratios T_2/T_1 for constant value of S and hence, in accordance with Equation [1], the ratios of compression p_1/p_2, or, inversely, with the constant compression ratio the respective values of S, that is, speeds in revolutions. The average values of m_m and η_{im} can be derived from the fundamental characteristic curves, Fig. 3, in accordance with the following procedure. If ε_1 denotes the admission of the first and ε_2 of the last stage, then the average admission of the group is

$$\varepsilon_m = \frac{\varepsilon_1 + \varepsilon_2}{2}$$

The values corresponding to m_m and η_{im} corresponding to ε_m are next inserted in Equation [2]. Attention is called here to the fact that the actual average values of m and η_i lying between ε_1, and ε_2 differ somewhat from m_m and η_{im} because of the curvature of the curves, the more so the more there is difference between ε_1 and ε_2. This circumstance may, however, be taken into consideration in inserting these values into Equation [2], and estimated variations in the values made.

Let subscript o denote the relations existing at normal load, subscript 1 the entrance to the compressor group and subscript 2 the exit therefrom. Further, let G be the weight of air flowing through the unit per second. Then the following values obtain for ε_1 and ε_2

$$\varepsilon_1 = \left(\frac{Q}{Q_0}\right)_1 \frac{n_0}{n} = \frac{G}{G_0}\left(\frac{p_0}{p} \frac{T}{T_0}\right) \frac{n_0}{n},$$

$$\varepsilon_2 = \left(\frac{Q}{Q_1}\right)_2 \frac{n_0}{n} = \frac{G}{G_0}\left(\frac{p_0}{p} \frac{T}{T_0}\right)_0 \frac{n_0}{n}.$$

Hence

$$2\varepsilon_m = \varepsilon_1 + \varepsilon_2 = \varepsilon_1\left[1 + \left(\frac{p_2}{p_1} \frac{T_1}{T_2}\right)\frac{p_1}{p_2} \frac{T_2}{T_1}\right],$$

$$\varepsilon_1 = \frac{2\varepsilon_m}{1 + \left(\frac{p_2}{p_1} \frac{T_1}{T_2}\right)_0 \frac{p_1}{p_2} \frac{T_2}{T_1}}.$$

The volume of air taken in by suction is then

$$Q_1 = \varepsilon_1 Q_{01} \frac{n}{n_0}$$

or

$$Q_1 = Q_{01}\,\frac{2\varepsilon_m \dfrac{n}{n_0}}{1+\left(\dfrac{p_2}{p_1}\dfrac{T_1}{T_2}\right)\dfrac{p_1}{p_2}\dfrac{T_2}{T_1}}\ \ldots\ldots\ldots\ldots\ [3]$$

The work of compression consumed by the group is

$$E = G\,c_p\,(T_2 - T_1)\ \ldots\ldots\ldots\ldots\ [4a]$$

and it has been shown in a previous paragraph that

$$\Delta E = \frac{A\,G}{2g}\,\frac{m}{\eta}\,u^2.$$

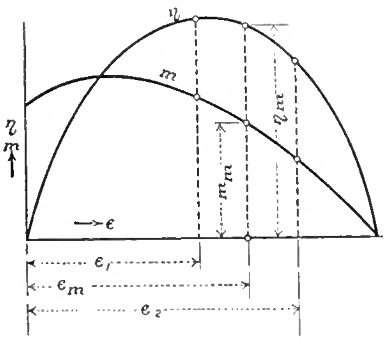


FIG. 3 BASIC CHARACTERISTIC CURVES, COMPRESSOR WITH UNCOOLED CASING

From these the following further equation is obtained, namely,

$$E = \frac{A\,G\,S}{2g}\left(\frac{m}{\eta}\right)_m\ \ldots\ldots\ldots\ldots\ [4b]$$

which must give for E the same value as Equation [4a]. In order to evaluate the main equations more uniformly the temperature relation

$$\frac{T_1}{T_2} = \left(\frac{p_2}{p_1}\right)^{\varepsilon} = \frac{E}{G\,c_p\,T_1} + 1$$

can be expressed as a function of the pressure ratio p_2/p_1 for the various values of ε, that is, of η_m = constant. In this way Equation [1] will be graphically reproduced. The characteristic curve of the group is then determined in a simple manner, as follows:

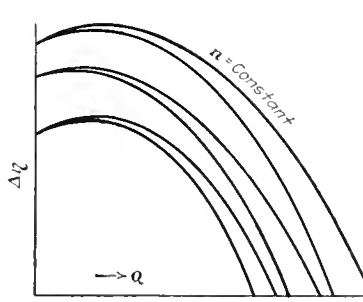


FIG. 4 CHARACTERISTIC CURVES FOR THE FIRST GROUP OF STAGES OF A COMPRESSOR

In Equation [2] are inserted the values of $\left(\frac{m}{\eta}\right)_m$ corresponding to the various values of Σ_m for the same value of n, (that is, for S = constant). Thereby may be determined the corresponding values of T_2/T_1 and hence the values of p_2/p_1. In this manner all the magnitudes on the right side of equation 3 are determined and the volume of the air taken in by suction Q_1 may be calculated. When this is done the compression ratios p_2/p_1 may be plotted as a function of Q_1, as in Fig. 4, which determines the first group characteristic curves. In a similar manner the other group characteristic curves may be computed for other speeds in revolutions n.

The problem may be therefore considered as solved for multistage compressors without intercoolers.

(b) TOTAL COMPRESSION OF COMPRESSOR

If a group of stages is followed by an intercooler, the amount of heat taken away from the flowing air can be in the first approximation expressed by

$$W = Gc_p(t_2 - t_1) \cong kF\frac{t_2 - t_k}{2}$$

where t_2 is the entrance temperature and t_1 the temperature at the exit from the cooler and t_k the average temperature of the cooling water, k the coefficient of heat transmission and F the area of the cooler. Since, in intercoolers, by far the greatest resistance to heat flow from air occurs at the tube wall and since practically all factors except the velocity of flow c and the density γ are constant, k can be expressed as follows:

$$k = k^1(c\gamma)^q$$

where k^1 and q are constants. Because of the constant magnitude of the cross-section of flow of air, $c\gamma$ is proportional to the weight of the flowing air G and therefore

$$k = k_0\left(\frac{G}{G_0}\right)^q$$

where k_0 is the coefficient of heat transmission at normal load.

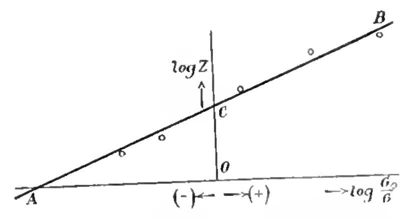


FIG. 5 GRAPHIC REFERRING TO EQUATION [18]

If K be used to denote all the constants, the above heat equation can be written as follows:

$$G_0(t_2 - t_1)_0 = KG_0{}^q(t_2 - t_k)_0 \text{ at normal load}$$
$$G(t_2 - t_1) = KG^q(t_2 - t_k) \text{ at any load}$$

From these two equations it is found that

$$t_1 = t_2 - \left(\frac{G_0}{G}\right)^q\left(\frac{t_2 - t_1}{t_2 - t_k}\right)_0 (t_2 - t_k)\ \ldots\ldots\ldots\ [5]$$

This determines the absolute temperature $T_1 = 273 + t_1$ at the entrance to the next group of stages. As regards q, in well-designed coolers one can use with fair approximation the value 0.78, which has been found by Nusselt to be good under different circumstances. The fall of pressure Δp in the intercooler varies in proportion to the average density γ and also in proportion to the square of the amount of air flowing per second Q

$$\frac{\Delta p}{\Delta p_0} = \left(\frac{Q}{Q_0}\right)^2\frac{\gamma}{\gamma_0}\ \ldots\ldots\ldots\ldots\ [6]$$

This establishes all the factors necessary for the calculation of the characteristics of compressors which may be determined in the following manner:

(1) It is necessary to determine for each group of stages a set of group characteristic curves in accordance with Fig. 4.

(2) For a given speed of rotation and volume of flow the state of the air at the exit from the first group of stages can be determined from the corresponding group characteristic curve which permits to determine the state of air at the entrance to the second group by the application of Equations [5] and [6]. In this manner Q_1 for the second group becomes known.

(3) Next, the same process as in (2) is applied to the second group with the intercooler following it and so on until the last group, which permits the determination of the final state of air for a given speed of rotation and amount of flow of air.

(4) The final state of air may be determined in the same manner for the same speed of rotation and different amounts of air flowing, which gives the first characteristic curve of the compressor. In a similar manner other characteristic curves for different speeds

of rotation may be determined. The total work of compression is then

$$E_s = Gc\,\Sigma(T_2 - T_1) = \frac{AG}{2g}\,\Sigma\left[S\left(\frac{m}{\eta}\right)_m\right] \ldots\ldots\ldots [7]$$

Instead of this rather complicated process there is a simpler way to secure the same results with sufficient approximation. Since it is desirable to have the same work of compression in all groups of stages of a compressor, and in practice an effort is always made to secure it, it may be assumed that this actually takes place and that further all the groups have the same air temperature at the entrance and the same conditions of compression. If then,

T_1 = average absolute air temperature at the entrance (arithmetic average of the actual temperatures at the entrance to each individual group of stages), which, with constant cooling-water temperature, varies only very little with the load, and may be estimated

T_2 = absolute average temperature at exit from the groups of stages

T = average absolute temperature at the entrance to the first group of stages

T_{II} = average absolute temperature at the exit from the last group of stages

$\frac{p_2}{p_1}$ = average compression ratio of a single group

p_I = absolute pressure ahead of the first group of stages

p_{II} = absolute pressure behind the last group of stages

i = number of groups of stages

Then the total compression ratio is in the usual manner found to be

$$\frac{p_{II}}{p_I} = \left(\frac{p_2}{p_1}\right)^i$$

The actual end temperature is found from

$$\frac{T_{II} - T_I}{T_2 - T_1} \cong \left(\frac{T_{II} - T_I}{T_2 - T_1}\right)_0$$

and proves to be

$$T_{II} = T_I + (T_2 - T_1)\left(\frac{T_{II} - T}{T_2 - T_1}\right)_0$$

According to the above assumption all the groups of stages are to be considered as equivalent. Because of this, Equation [2] may be applied to the case of one group in the following manner

$$\frac{AS_s}{2igc_pT_1}\left(\frac{m}{\eta}\right)_m = \frac{T_2}{T_1} - 1 \ldots\ldots\ldots\ldots\ldots\ldots [8]$$

but in this case $S_s = \Sigma u^2$ applies to the entire compressor. If we assume various values for the average admission, this equation by means of Equation [1] may be evaluated in exactly the same manner as Equation [2]. It must be observed in this connection that here the average admission ε_m is the average of the admissions ε_I of the first stage of the first group and ε_I of the last stage of the last group, these two magnitudes being determined from the following equations:

$$\varepsilon_I = \left(\frac{Q}{Q_0}\right)_I \frac{n_0}{n} = \frac{G}{G_0}\left(\frac{p_0}{p}\frac{T}{T_0}\right)_I \frac{n_0}{n}$$

$$\varepsilon_{II} = \left(\frac{Q}{Q_0}\right)_{II} \frac{n_0}{n} = \frac{G}{G_0}\left(\frac{p_0}{p}\frac{T}{T_0}\right)_{II} \frac{n_0}{n}$$

where the subscript 0 corresponds again to the conditions existing with normal loading.

From these equations is derived the following equation, which takes the place of Equation [3]

$$Q_1 = Q_{0I}\,\frac{2\varepsilon_m\dfrac{n}{n_0}}{1 + \left(\dfrac{p_{II}}{p_I}\dfrac{T_I}{T_{II}}\right)_0 \dfrac{p_I}{p_{II}}\dfrac{T_{II}}{T_I}} \ldots\ldots\ldots [9]$$

Just as in the preceding case, from Equations [8] and [9] may be derived the compressor characteristics instead of the group characteristics. Equation [5] may be used to check the assumed value of T_1 since $t_2 - t_1 = T_2 - T_1$.

The total work of compression is

$$E_s = G\,c_p\,i\,(T_2 - T_1) = \frac{AGS_s}{2g}\left(\frac{m}{\eta}\right)_m \ldots\ldots [10]$$

To this should be added two small amounts to cover the losses through rotor friction and those due to leaks on the pressure side; these losses vary in accordance with laws of their own. Practice indicates that the work consumed in rotor friction of a stage is proportional to $\gamma\, n^3 D^5$, where D is the diameter of the rotor, while the loss due to leaks depends on the final state of the gas in accordance with well-known laws.

(c) Determination of the Basic Characteristic from a Given Compressor Characteristic

According to the reasoning given in Section I the basic characteristic can be determined when the characteristics of all single stages have been found. Since, however, this is never the case, another method may be resorted to, viz., reversing the problem solved in Section II(b), and determining the compressor characteristic from the basic characteristic. Since, for a given load, the entrance and exit temperatures for each group, and, as a rule, also the total work of compression E_s, may be measured with sufficient approximation, it is possible to calculate the average entrance temperature T_1, as well as the sum of all the raises in temperature $\tau = \Sigma\,(T_2 - T_1)$, and, hence, the average raise of temperature per group

$$T_2 - T_1 = \frac{\tau}{i} = \frac{E_s}{i\,G\,c_p}$$

The average compression ratio of a group is

$$\frac{p_2}{p_1} = \left(\frac{p_{II}}{p_I}\right)^{\frac{1}{i}}$$

And, hence, when the ratios T_2/T_1 and p_2/p_1 are known, the average efficiency η_m of a single stage may be determined from the relation

$$\frac{T_2}{T_1} = \left(\frac{p_2}{p_1}\right)^c$$

Equation [8] makes it possible to determine the magnitude of the pressure head m_m if S_s is given. If, further, a certain load be taken as a normal load so that with it the admission in all the stages is $\varepsilon = 1$ and all the corresponding magnitudes are indicated by a subscript 0, then the corresponding average admission ε_m may be calculated from Equation [9]. By this are determined the exact locations of the points ε_m, m_m and η_m of the basic characteristic. Similarly the corresponding basic characteristic can be determined from a group characteristic.

III COMPRESSOR WITH COOLED HOUSING

(a) Compression in One Group of Stages

As in the case of compression with uncooled housing, the writer uses an equation derived by him elsewhere (*Zeit. Ver. deut. Ing.*, 1918, p. 662) under the assumption of the presence of an infinite number of stages and in this way derives the following relation for the temperatures

$$T_2 = \frac{M}{1 + \dfrac{a}{b}\dfrac{T_1}{T_K}(M - 1)} \ldots\ldots\ldots\ldots [11]$$

wherein for the sake of simplicity is substituted

$$M = \left(\frac{p_2}{p_1}\right)^{bc}$$

and further, the following expressions are used in which minor members are neglected

$$a = \frac{kFT_k}{E}$$

$$b = 1 + a$$

$$c = \frac{\kappa - 1}{\kappa\,\eta_m}$$

Here $k = k_0\left(\dfrac{G}{G_0}\right)^q$, the average coefficient of heat trans-

mission k_0 having the value which it has at normal load; because of the greater resistance to heat flow q is here smaller than in the case of intercoolers with smooth thin brass tubes. Also F = cooling area of the group and T_k = average temperature of the cooling water.

In accordance with the previous derivation by the same author referred to at the beginning of this section, the work of compression of the group is

$$E = \frac{Gc_pT_K}{a}\log\left[1+\frac{a}{b}\frac{T_1}{T_K}(M-1)\right] \ldots\ldots\ldots [12]$$

Further, as in the case of compression in an uncooled cooler

$$E = \frac{AGS}{2g}\left(\frac{m}{\tau_1}\right)_m \ldots\ldots\ldots\ldots\ldots\ldots [4b]$$

By combining these two equations we get

$$V = \log\left[1+\frac{a}{b}\frac{T}{T_K}(M-1)\right]$$

where for simplicity sake is substituted

$$V = \frac{aAS}{2gc_pT_K}\left(\frac{m}{\tau_m}\right)$$

The equation can also be written in the form

$$\frac{b}{a}\frac{T_K}{T_1}\left[e^V-1\right] = M-1 \ldots\ldots\ldots\ldots\ldots [13]$$

If now in the expression $a = \frac{kFT_K}{E}$ be inserted the expression for the coefficient for heat transmission k as given by Equation [4b], we obtain

$$a = \frac{2gk_0FT_K}{AG_0S\left(\frac{m}{\tau_1}\right)_m}\left(\frac{G_0}{G}\right)^{1-q} \ldots\ldots\ldots\ldots [14]$$

Further, Equation [3] applies here without alterations, only instead of the volume of flow of air, the author uses in this case the weight of the flowing air which gives that equation the form

$$\frac{G}{G_0} = \frac{2\varepsilon_m\frac{n}{n_0}\left(\frac{p}{p_0}\ \frac{T_0}{T}\right)_1}{\left(\frac{p_2}{p_1}\frac{T_1}{T_2}\right)_0\ \frac{p_1}{p_2}\frac{T_2}{T_1}} \ldots\ldots\ldots\ldots\ldots [15]$$

These equations are sufficient for determining the usual characteristic from a given basic characteristic. Since, however, some of these equations appear in a transcendent form, the problem cannot be solved directly and to assist in this the author derives a very useful additional formula in the following manner:

The expression

$$\Delta p = m - \frac{\gamma}{2g}u^2$$

may be written in the form of a differential, as follows:

$$dp = \frac{m}{2g}\ \frac{p}{RT}ds,$$

when R is a gas constant and $ds = d(u^2)$. Its integration gives

$$\log\frac{p_2}{p_1} = \frac{m_mS}{2gRT_m} \ldots\ldots\ldots\ldots\ldots\ldots [16]$$

where $m = m_m$ = constant and likewise $T = T_m$ =constant. This simple relation applies, of course, to the case of compression in an uncooled casing also, but there is no need for making use of it there.

Given two of the values $\frac{p_2}{p_1}$, ε_m (that is, m_m) and H (that is, n), the third value can be easily plotted. With constant average admission ε_m of the group, the average temperature T_m increases somewhat with the speed of rotation and falls off with the decrease of the speed of rotation. Since, however, T_m may be calculated from a given characteristic corresponding to the speed of rotation in revolutions n_0 in accordance with an equation for the admission ε_m, T_m can be estimated with fairly close approximation for any other speed in revolutions.

Hence, from Equation [16] we may compute, for various values of the average admission ε_m, either the corresponding compression ratios p_2/p_1 for a constant speed of rotation in revolutions, or the corresponding speeds of rotation in revolutions for a constant compression ratio.

Equation [15] enables us to determine the relation G/G_p by using an estimated value of the end temperature T_2. The same rule applies to it as to T_m, namely, that for a constant admission ε_m it varies in the same sense as the speed of rotation in revolutions (with an uncooled casing $T_2 - T_1$ is proportional to S, that is, the square of the speed of rotation in revolutions; with the cooled casing $T_2 - T_1$ varies somewhat less). Since a given characteristic for n_0 and ε_m gives the end value T_2 it may be equally well estimated for any other speed of rotation in revolutions, and with this the value of a can be determined from Equation [14]. The values thus obtained must satisfy Equation [13] and it is well to compute from ε_m, S and a, also first M and then the compression ratio $\frac{p_2}{p_1}$, which should agree with that derived from Equation [16]. Finally, from Equation [11] can be computed the temperature relation T_2/T_1 which should agree within fairly close limits with that obtained by estimation from Equation [15]. Likewise one may plot, as has been done in the compression with an uncooled vessel, the function

$$M = \left(\frac{p_2}{p_1}\right)^{bc}$$

for various sufficiently closely located values of bc = Constant as a function of $\frac{p_2}{p_1}$. This gives for the case of a compressor with the cooled housing a solution of the problem of deriving the group characteristics of Fig. 4 from a given basic characteristic.

(b) TOTAL COMPRESSION IN A COMPRESSOR

If the compressor is divided into two or more groups of stages separated by intercoolers, then the computation may be carried on from group to group in the above described manner by determining the back cooling and the fall of pressure in the intercooler following each group of stages (by using Equations [5] and [6]; it must be noted however that the exponent q in the case of an intercooler is different than when used for housing of the condenser. There is, however, a shorter method for the computation of the characteristic curves of a compressor based on the assumption that all the groups of stages are equivalent to each other. The corresponding relations set forth in Section II (b) are applied in this also. Hence, here also the total ratio of compression is

$$\frac{p_{\mathrm{II}}}{p_{\mathrm{I}}} = \frac{p_2}{p_1}$$

and the end temperature

$$T_{\mathrm{II}} \cong T_{\mathrm{I}} + (T_2 - T_1)\left(\frac{T_{\mathrm{II}} - T_{\mathrm{I}}}{T_2 - T_1}\right)_0$$

Equations [11] to [16] apply here also, but the values

$$S = \frac{S_s}{i}$$

$$E = \frac{E_s}{i}$$

$$F = \frac{F_s}{i}$$

must be used, if $S_s = \Sigma u^2$ applies to the entire compressor and E_s represents the total work of compression while F_s represents the total cooling area of the compressor. Further, instead of the coefficient of heat transmission k_c there should be used here its average value for the entire compressor. Equation [15] is to be used here in the form

$$\frac{G}{G_0} = \frac{2\varepsilon_m\frac{n}{n_0}\left(\frac{p}{p_0}\ \frac{T_0}{T}\right)_{\mathrm{I}}}{1+\left(\frac{p_{\mathrm{II}}}{p_{\mathrm{I}}}\ \frac{T_{\mathrm{I}}}{T_{\mathrm{II}}}\right)_0\ \frac{p_{\mathrm{I}}}{p_{\mathrm{II}}}\ \frac{T_{\mathrm{II}}}{T_{\mathrm{I}}}} \ldots\ldots\ldots\ldots [17]$$

which corresponds to Equation [9] if the weight of the flowing air be used instead of the volume of said air. The method of computation is the same as in III-a.

(Concluded on page 858)

Certification of Gages at Bureau of Standards

By H. L. VAN KEUREN,[1] WASHINGTON, D. C.

During the early stages of the preparation for war in this country the need of a central bureau for the test and certification of munitions gages was apparent. Action was taken by the Committee on Standardization of Gages of The American Society of Mechanical Engineers in recommending to various branches of the War and Navy Departments that there be a central place for the inspection of munitions gages and that inasmuch as the Bureau of Standards was already prepared for this work, it be the recognized institution for the inspection of all gages required by the Government in securing munitions. Since the signing of the armistice the Bureau has been continuing its work of gage certification for manufacturers in the production of their regular products and it has already become an important element in this country.[2] In the following contribution Mr. Van Keuren, Chief of Gage Section, Bureau of Standards, gives an account of the work and methods of this department.

THE war has changed in a radical way many of our ideas, habits, words and expressions, as well as many of our commercial and industrial methods. Today we speak of the certification of gages rather than the certification of standards. To the manufacturing public a gage is the usable thing; the standard is for reference. The time is long past when people need be inconvenieneed by carrying and using silver dollars as a measure for the value of their purchases but they use instead, as their working medium, the convenient paper bills or checks, which are directly or indirectly certified by a standard value in silver or gold money in the custody of one of our banks or the United States Treasury. In the same way it is not necessary for manufacturers of interchangeable work to be burdened with an elaborate system of measuring devices and a highly-trained scientific organization for originating and comparing precision length standards; but rather, for convenience and rapidity, they use gages for measuring their product and these gages may be authenticated by being referred directly or indirectly to suitable standards in the custody of the Bureau of Standards.

As a result of the war even our ideas of standards have been radically changed. We now use a standard of length which cannot change with time; one which can be duplicated anywhere in the world; one which cannot be stolen, lost or destroyed; and one which is susceptible to greater accuracy of measurement than the standard meters or yards deposited in goverenment institutions in this country or in foreign countries. I refer to the use of the length of a wave of light which makes length measurements to within a millionth of an inch an easy matter.

Organization and Facilities of the Gage Section, Bureau of Standards

On June 15, 1917, the Bureau of Standards was granted an appropriation by Congress for the purpose of standardizing and certifying gages for the War and Navy Departments and other branches of the Federal government. As early as July 8, 1917, apparatus and equipment was transferred to a special building for the testing of munition gages. The first lot of gages was submitted on June 16, 1917. In addition to the laboratory in Washington, Branch Gage Sections were inaugurated as rapidly as need became apparent. The Branch Gage Section in New York City was opened on April 15, 1918; the Branch Gage Section in Cleveland on July 1, 1918; and the Branch Gage Section in Bridgeport on August 20, 1918.

The gage laboratories at Washington, New York and Cleveland are completely equipped, and the facilities in the branch laboratories for the inspection of gages are practically the same as those available in Washington.

A general view of the Gage Laboratory at Washington, showing the testing of plain and profile gages, is shown in Fig. 1. The equipment includes various types of commercial measuring instruments, such as inside and outside micrometers; a number of sets of working standards of the flat-end type, cylindrical type and spherical-end type; and other devices and instruments designed and constructed at the Bureau for the measuring of complicated profile gages and thread gages.

Routine of Inspection Work

In the inspection of gages at the Bureau, the following procedure has been adopted:

- *a* Unpacking and checking with shipping memorandum
- *b* Marking with a lot number and serial number
- *c* Acknowledgment of receipt
- *d* Routing for test
- *e* Measurement
- *f* Tabulation of results and comparing results with specifications
- *g* Mailing report
- *h* Ship or stock gages.

Particular care is taken in the various operations in checking and measuring the gages and in writing the reports in order to prevent mistakes. During each test measurements are made on a gage by two inspectors who work independently. The results obtained by each inspector are entered on a suitable form and from the records of both inspectors the results of the test are compared with the specifications upon which the gage was purchased, or with which the gage is supposed to correspond. In case of tests for the War Department, gages which meet the specifications, are marked with a seal and date of approval. If rejected, they are returned to the manufacturer with a report stating the reasons for rejection, in order that corrections may be made or new gages submitted.

The importance of two inspections by different people, oftentimes employing different methods, cannot be over-estimated. Not only is it possible to avoid numerous errors of reading but differences in results are sometimes found to be due to actual variations in the apparatus, which results in the development of new and improved methods of measurement and new measuring appliances.

Methods of Test

The apparatus in use and the methods of test have been selected with the object of obtaining the required accuracy of test, and at the same time reducing to a minimum the time required in testing the gages. As an illustration of a simple, effective, accurate and quick device for testing snap gages, the apparatus shown in Fig. 2 has been used with excellent results. In carrying out this test, one or two standardized size blocks are selected to permit the insertion of a pair of accurately-ground and lapped wedges, which, when placed together, have their contact surfaces parallel. With a calibrated micrometer the thickness of the adjustable wedge is determined and then added to the size block selected, which results in the measurement of the gage being inspected.

To describe all of the devices, methods and apparatus in use is quite beyond the scope of the present paper. However, the following outline indicates the more important pieces of apparatus used for gage inspection:

---

[1] Chief of Gage Section, Bureau of Standards, Washington, D. C. Mem. Am.Soc.M.E.

[2] A detailed statement of the work of this committee and its recommendations can be found in THE JOURNAL, January 1918, p. 70. The extent to which the recommendations were carried out, the opportunities afforded and results accomplished by the Bureau of Standards is given in detail in THE JOURNAL for February, 1919, p. 185. This paper was presented at the meeting of the Washington Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, April 30, 1919.

A Plain gages, outside dimensions
1 Calibrated micrometer calipers
2 Special Anderson bench micrometer, accurate to 1/100,000 in.
3 Commercial fluid-gage comparator
4 Pratt & Whitney measuring machine
5 Brown & Sharpe measuring machine

B Plain gages, inside dimensions
1 Calibrated size blocks
2 Micrometer and taper wedges as shown in Fig. 2 for snap gages
3 Calibrated size blocks for snap gages and ring gages
4 Special device, using mechanical indicator, for ring gages

6 Use of thread plug check gages for determining effective diameter of ring thread gages.

Throughout all phases of the measuring work, apparatus and instruments are carefully calibrated against precision standards, which have been verified by the light-wave interference method in the Optical Laboratory of the Bureau of Standards. As far as possible measuring instruments are used as comparators, thus eliminating errors which might arise due to imperfection in measuring instruments.

Descriptions, drawings, and other information with reference to the design and construction of gage apparatus previously listed, may be secured from the Bureau without charge, and demonstrations of different pieces of apparatus and methods of test can best be realized by visiting one of the gage laboratories.

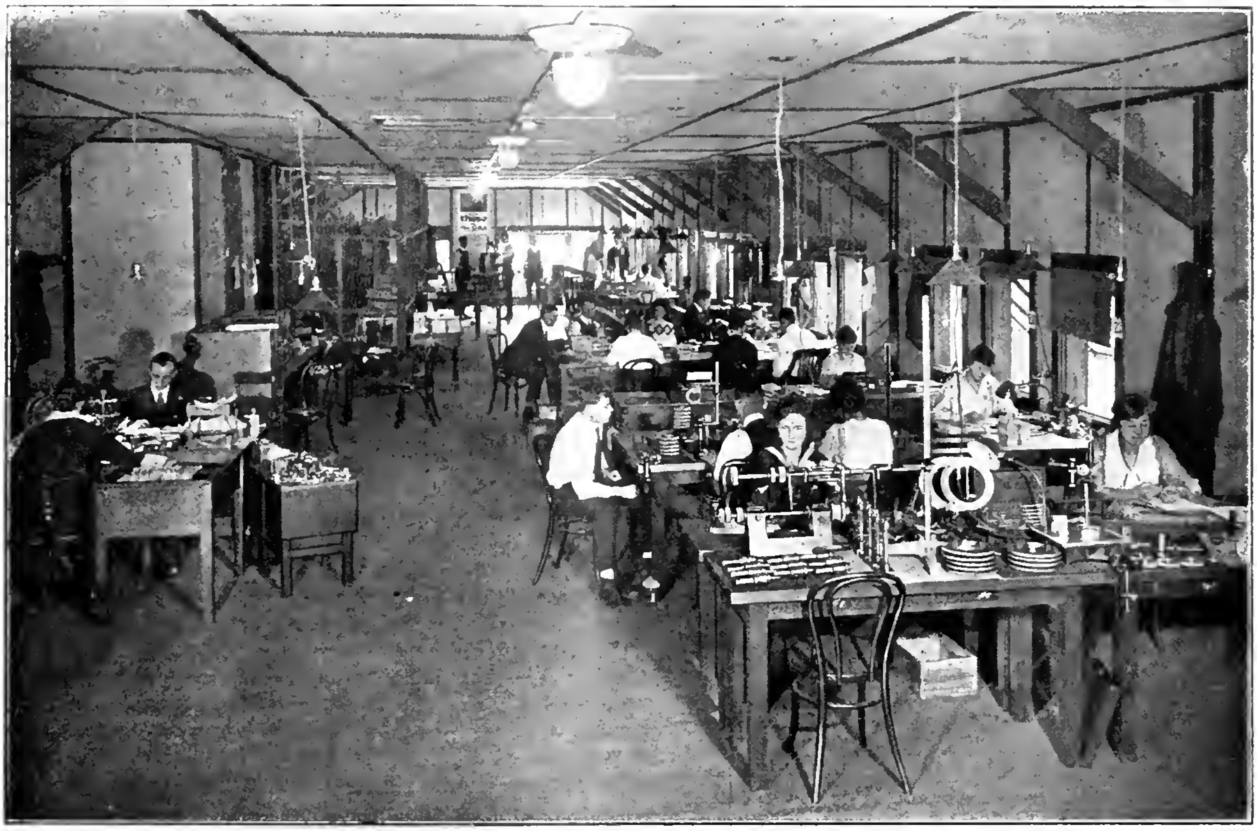


Fig. 1 Gage Laboratory, Bureau of Standards, Washington, D. C.

5 Inside micrometer, used as comparator only
6 Special forms of star gages
7 Use of standardized steel balls, size blocks and taper wedges

C Profile gages
1 Gaertner measuring machine
2 Projection lantern
3 Surface plate set-ups, employing sine bar, size blocks, mechanical indicators, calibrated steel balls, wires, plugs, etc.
4 Special applications for surface plate work of micrometer microscope.

D Thread gages
1 Special lead-testing machine for measuring pitch or lead of plug and ring thread gages
2 Projection lantern for examining form and angle of plug and ring thread gages
3 Calibrated micrometers and wires for measuring effective diameters by 3-wire method
4 Calibrated micrometer calipers and bench micrometers for plain diameters of thread gages
5 Three-ball method for measuring effective diameter of ring thread gages

Research and Experimental Work

Until recently the energy of the Gage Section has been devoted mainly to the test and certification of gages. However, in this work there has been accumulated a vast amount of information and data on the construction, measurement, and use of all kinds of gages, and it is planned to use the technical staff now available for the preparation of pamphlets, publications, and other literature in order to make this information accessible to American manufacturers. In addition, there are a great many problems upon which research and experimental work should result in improvement in the manufacture and use of tools and gages. Among the problems which are under investigation at the present time will be mentioned the following:

1 Experiments to determine the proper thread allowances and tolerances for wrench fits in cast-iron, aluminum and other materials
2 Compilation of formulae and description of methods of test of complicated profile gages and thread gages
3 Compilation of designs of gages found to be most practical for different classes of work
4 Investigation of the cutting properties of taps to determine the amount the tap cuts over-size when new

and when worn under different conditions of lubrication and with different materials

5 Investigation of suitable steels and their heat treatment, to determine the most suitable steel for a given type of gage

6 Life of different types of gages.

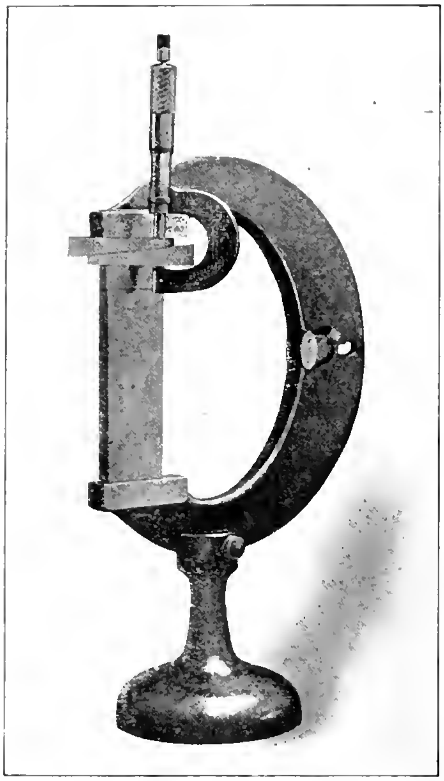


FIG. 2 METHOD USED IN TESTING SNAP GAGES

GAGE SHOP

The Bureau of Standards in Washington has, in addition to the Gage Laboratory, a shop which includes about 75 machine tools. This shop has been of great utility in the salvage of master gages purchased by the Ordnance Department and Motor Transport Corps and for the manufacture of gages needed in cases of exigency to prevent stoppage of production or to facilitate the shipment of munitions over-seas, which was being held up owing to lack of final inspection gages. The equipment of this shop is such as to permit the manufacture of practically any type of gage required for the manufacture of ordnance, aircraft, and motor trucks.

One of the important phases of the shop work was the development of a process of manufacturing precision gage blocks similar to the Swedish or Johansson gage blocks, described in MECHANICAL ENGINEERING for March, page 289, and for May, page 484. The manufacture of these blocks was undertaken about September 1, 1918. These gages are being produced to within an accuracy of five millionths of an inch for flatness and parallelism of faces and of absolute length.

It is not surprising that in some cases there has been a misunderstanding among manufacturers regarding the purpose and utility of the gage work at the Bureau of Standards. There have been instances where a manufacturer, not knowing the facts, has been under the impression that the chief cause of his rejected gages was the extremely close specifications and tolerances originated by the Bureau. There are other cases where manufacturers have imagined that the inspection methods of the Bureau were purely theoretical and, furthermore, that the chief aim of the Bureau was to find errors in gages by a minute examination with apparatus and devices suited only to the needs of precise scientific work.

The function of the Gage Section of the Bureau, during recent military preparations, has been to examine gages purchased by the War and Navy Departments and determine from a disinterested standpoint whether or not these gages corresponded to the specifications and tolerances laid down by the department for which the gages were purchased.

The Bureau of Standards is a government institution organized under the Department of Commerce for the development, construction, maintenance, custody, and use of standards of measurement, performance, and practice. It is by necessity a scientific institution and its relation to various branches of the federal government, to manufacturers and individuals, can be nothing but absolutely impartial. The policy of the Bureau is to extend to manufacturers every opportunity to secure information resulting from experimental and routine activities. In placing at the disposal of manufacturers the designs of apparatus, descriptions of methods of test and by demonstrating to gage manufacturers the advantages of better measuring facilities, many manufacturers have been able to improve their product and have realized the purpose and facilities available at the gage laboratories of the Bureau. During the war, courses of instruction were offered to gage makers and gage inspectors in the employ of the government or manufacturers having government contracts, and in this way further benefit and coöperation was secured.

FUTURE WORK

The results to be accomplished and the service to be rendered to American manufacturers during the reconstruction period will depend largely upon the demands made by manufacturers upon the facilities now available. The inspection laboratories at Washington, Cleveland, and New York can accommodate an appreciable amount of gage testing work and, in addition, can be used to good advantage for the demonstration of measuring apparatus, methods of test and for distributing technical information on gage problems. For routine work of the certification of gages, where the tests are of benefit to but one or two parties, a nominal fee is charged for the work done. However, where investigations and research are carried on, and where the results are of general utility to American manufacturers, no fee or charge is made for the resulting information or service rendered.

In the reconstruction of our industries, if we are to compete with foreign countries and not only share but lead in manufacturing progress, it will be necessary to secure a better quality of product at a minimum of cost, and in this problem the combined results of scientific, engineering, industrial, and commercial endeavor towards standardization is most essential. With this thought in mind, the facilities of the gage laboratories of the Bureau of Standards are available to American manufacturers.

The particulars of the thread-cutting mechanism of an engine lathe now manufactured by Brödrene Sundt, Christiania, Norway, are given in an article in the September issue of *Machinery*. The lathe is equipped with two lead-screws for cutting both inch and metric screw threads, and the gearing is so arranged that coarse threads, or helical grooves with leads up to 12 inches, may be cut, in addition to the usual range of pitches for threads. The headstock is so designed that its gear ratios may be utilized in connection with screw cutting. With this arrangement, the number of pitches ordinarily attained will be multiplied by the number of gear ratios in the headstock. There is one lead-screw for the inch pitches and one for the millimeter pitches. The metric lead-screw is practically a threaded feed-rod. By means of an additional screw on the feed-rod, metric threads can be cut without using translating gears and by employing the same gearing as for the inch pitches. The inch lead-screw is $\frac{1}{4}$ inch pitch, and the feed-rod 4 millimeters pitch; hence, when the lathe is geared for cutting 1/16-inch pitch, it is also geared for cutting a pitch of 1 millimeter with the metric lead-screw. The change-gear box in connection with one set of spur gears and the gear ratios of the headstock provide for cutting 342 different pitches: 167 inch pitches and 175 millimeter pitches. These different pitches are obtained by shifting handles or levers.

Gage Limits in Interchangeable Manufacture

By E. C. Peck,[1] Cleveland, Ohio

As indicated by the title, it is the purpose of the following paper to present modern gage practice as applied to interchangeable manufacture. As an introduction the author first discusses the merits of the English and metric systems, and suggests that a 10-in. meter would be a most desirable unit. Some interesting facts in the development of interchangeable manufacturing methods are next presented. The author also gives an explanation of the terms allowance and tolerance, and the method of using gages in strict interchangeable quantity production are outlined in some detail. The paper concludes with a discussion of the methods of interchangeable screw-thread manufacture.

The word gage is the name which has been given to a large number of instruments and appliances used in determining dimensions, capacities, quantities, forces, etc. Gages have been used since man first began to contrive conveniences for himself. The standards of weight, measure, and volume mentioned in the Bible are simply gages, and the instruments and appliances used in building the pyramids can be likewise so considered. In fact, it has been apparent from the beginning of time that standards for determining dimensions, capacities, quantities, forces, etc., are absolutely necessary in conducting all kinds of commerce and business.

In early times many tribes, states, and countries used gages originating with themselves, and in all probability the tribe or state which did the most trading succeeded in establishing their standards in other countries, and it is these standards that have been handed down to us. It would, however, have been much better for the present generation if there had been more coöperation among the ancients in regard to standardization, for then we would not have had our present heterogeneous collection of gages or units.

At the present time there is a consistent effort towards the establishment of international standards and there is no doubt but that the near future will see rapid strides in that direction. The World War has done more to help this movement than all the propaganda of the last decade, for it has shown in a very practical way the delay, trouble, and cost of production when a number of different standards are in use.

It would seem like a logical statement to say that some one system of standards ought to possess sufficient merits to win over the entire world by its greater utility, but this has not proved to be true. First, we have the natural pride of every country against giving up its own standard for that of another, and second, the objection of the industries themselves because of the cost involved in the necessary purchase of new gages and tools.

English vs. Metric System

The two systems which most concern this country are the English and metric. Both are used extensively, both are legal and both have warm advocates. It is obvious that the outstanding advantages of the metric system have not been sufficient to supplant the English in this country. Doubtless the chief advantage of the metric system is that all subdivisions are multiples of ten, and hence in calculation it is only necessary to move the decimal point in the reduction from unit to unit. Great advantage is also claimed in that the units of weight and volume are derived from the unit of measure, but to the writer this is of little account because for accurate work one does not want to originate his own standards but prefers to obtain them from a recognized bureau of standards.

One advantage claimed for the English system is that most sub-divisions are made by successively halving each unit. If these arguments are adhered to by the advocates of each side they both fail, because their methods result in units whose sizes are impracticable as has been found by experience.

In the English system, beginning with the inch and halving for each subdivision, we finally reach the units 1/64, 1/128, 1/256, 1/512, and 1/1024, all of which are awkward to handle and not readable on the well known micrometer without estimating. To obviate this difficulty, the inch is divided into tenths, hundredths, thousandths, and ten-thousandths, and all of these decimal units are practicable and usable units.

In the metric system the first subdivision of the meter is the decimeter, a unit 3.937 in. long, of no utility and rarely used. The next unit is the centimeter, a unit too large for good work and too small for use in distance measurements.

The next is the millimeter, 0.03937 in., the most widely used unit because of the adaptability of its size value. Many industrial enterprises require no greater accuracy than a millimeter, and, therefore, as this unit is about as fine as can be used on a steel scale it is sufficient for their needs.

For tools and fine accurate mechanisms the millimeter is too large, and so is the next subdivision, 1/10 millimeter, which is 0.0039 in. The great bulk of good work in our machine tool, automobile, and the tool making industries require units between 1/10 and the 1/100 millimeter, as one is too coarse, and the other too fine. Because of such fact there has resulted a halving and quartering of the millimeter and the 1/10 millimeter to obtain usable units approximating 1/100, 1/000 and 2/1000 of an inch. Thus it will be seen that the advocates of both systems use what the other claims as an inherent fundamental of his favorite system, and this, of course, proves the utility of it.

The impracticable size of the units of the metric system is, in the writer's judgment, the greatest stumbling block to its universal adoption, and if when the meter was adopted, all romance and sentiment had been left out of the question, and the meter made 10 English inches long, then the metric system would have been in universal use long ago.

If the meter were 10 English inches long, a decimeter would be the well-known standard inch, and the other decimal subdivisions the familiar decimals of an inch, all of which are thoroughly practical working units. The present 10-foot pole which is extensively used, would be 12 meters long, and 4 meters would easily have been substituted for the yard, as the error is only 1½ per cent. Furthermore 2 dekameters is within 2 inches of the English rod and as a unit would be satisfactory. The mile would be 6336 meters, just as easy to handle as 5280 feet.

The adoption of the 10-inch meter would have simplified at once the adoption of an International Standard Thread System, for the metric threads could have been expressed in whole numbers per decimeter, and this would not only agree with present practice, but would also fit in with the United States system.

Interchangeable Manufacture

The first interchangeable manufacture attempted was in France in the year 1717, and although it failed, another trial was made in 1785. This, however, also failed. In 1798 Eli Whitney of cotton-gin fame took and completed a contract to make ten thousand muskets for the United States Government. The parts of these guns were to be interchangeable.

English and French ordnance officers ridiculed and criticised Whitney's ideas to such an extent that Congress became alarmed and so Whitney went to Washington with ten guns and after distributing the parts on the floor assembled repeatedly from these parts ten guns that operated properly. This remarkable

[1] General Supt., Cleveland Twist Drill Co., formerly Lieut.-Col., Ordnance Dept., U. S. A. Mem.Am.Soc.M.E.

Abstract of a paper presented at a meeting of the Washington Section of The American Society of Mechanical Engineers, April 30, 1919.

achievement astonished everyone and it is believed to be the first successful interchangeable manufacture of accurate work. As nearly as can be determined from records available this occurred in 1800. In 1808 Simeon North accomplished a like feat on pistols for the Government and it is claimed by some that he was the first to introduce interchangeable manufacture.

While it is a matter of record that John George Bodmer began to manufacture guns at St. Blaise in the Black Forest about 1806 by a method which is believed to have been partly interchangeable, such methods of manufacture are conceded to be an American development, and are described by writers on the continent as an American method. In 1853 a British commission visited the United States to investigate the methods in use, and as a result ordered 20,000 Enfield rifles for the British Government, and later 157 machines for the Government arsenals. They also hired James H. Burton to install the machinery and methods.

From this small beginning the practice grew steadily in the armories and arsenals, and later, as the advantages became known, it spread to bicycles, typewriters, and various other articles, until now it is quite common to speak of interchangeable manufacture. There is no doubt, however, but there is some difference between the exact meaning of the term as used then and at present, just as there is also a great difference between manufacture at that time and the present.

There are several degrees of interchangeability, or at least several meanings to the exact interpretation of the term. Strict interchangeability consists in making the different parts of a mechanism so uniform in size and contour that each part will fit and properly function in any one of the whole number of mechanisms, no matter when or where it is made. It will be noted that this definition means that each part of the mechanism of a certain model will fit any of the mechanisms of the same model regardless of the lot to which it belongs or the year in which it was made. Some interchangeability consists in making each part fit any mechanism in a certain series, that is, the interchangeability exists only in the same series.

In the early days, before modern machinery came into use, it was necessary to finish work by hand, and to make it uniform, template filing and finishing was employed. For example, gun and pistol parts would have the holes drilled and reamed in a jig or fixture, and then the contour finishing done by putting these pieces into a template jig provided with pins to fit the holes. The outside of the jigs would be a duplicate of the shape and size of the model piece but hardened. The workman would then file down to the hardened template, which controlled the shape and size of the piece. Many ingenious devices and schemes were used to facilitate the duplication of parts, and great skill was developed by the workmen.

The great improvement in machine tools, especially as to accuracy of output, has been a very large factor in promoting interchangeability, and here again America has led the world. The refinements, accuracy, and efficiency of modern machine tools are strictly American, and are the outcome of the demands placed upon them by interchangeable manufacture at a low cost.

American labor costs so much more than foreign that to compete in the world markets we have been forced to obtain as much product for each dollar of labor as our competitors, and we therefore have been compelled to develop machinery to get more product for less labor. This, in turn, has developed skill in our mechanics and raised the standard of living of the American skilled workmen.

Allowances and Tolerances

It is a fundamental law that interchangeable manufacture is facilitated by the largest allowable freedom in the fit of mating parts without interfering with the proper functioning. This statement leads to the subject of allowances and tolerances, one of the simplest but least understood in the whole system of interchangeability. As these two words will be used repeatedly, it is well to point out the difference between them.

Allowance is a prescribed difference between the dimensions of two mating parts to produce a desired kind of fit. For example: a standard hole exactly 1 in. in diameter, contains a free running shaft, the journal diameter of which is 0.998 in. The difference between this hole and the journal prescribed for the oil film is 0.002 in., and this is the allowance.

Tolerance is the prescribed difference in the dimensions to tolerate the unavoidable errors or variations in manufacturing a large number of pieces. In the example just given, if a thousand running fits were to be made, the holes might be dimensioned $1.000 \text{ in.} {}^{+0.0005}_{-0.0000}$. This half thousandth permissible error is the tolerance. The shaft journal might be dimensioned 0.997 to 0.998 in., and this permissible error of 0.001 in. is the tolerance. Then the minimum allowance is 0.002 in. and the maximum looseness, or the sum of both tolerance and the minimum allowance, is 0.0035 in.

Thus the kind of fit is finally determined by the combination of the allowance and tolerance, and most engineers prefer to use allowance as a minimum value, which is never intentionally encroached upon, the tolerance providing for larger freedom of fits. The reason for this is that the data for minimum allowance are more reliable and has been more clearly demonstrated than the maximum allowance, and as it is vital it must be uneffected by tolerances. This is plainly evident in the case of free moving parts, as it is well understood that a space must be provided for an oil film, and this space must not be so small as to endanger failure by the parts seizing. Again, it has rarely been determined, except in individual cases, how loose moving parts can be before they are unsuitable. It must also be understood that the tendency of the engineer is in the direction of longer wearing life of the parts, hence the tendency to decrease maximum allowance or looseness.

There are many conditions in which maximum looseness determines the strength of the parts or the limits of engagement, and any more freedom of fit would make the parts unsatisfactory. When this is the case, maximum looseness must be the starting-point in the calculations, and must then be uneffected by tolerance. Then if minimum allowance can be determined, the difference between these two (maximum and minimum looseness) is the sum of the tolerances.

The tolerances are then divided between the mating parts according to the manufacturing ability to produce the parts to uniform size. That is, if the manufacturing ability is such that it is much easier to produce one member, to a uniform size, than another, the tolerance on the members is divided in direct proportion to this condition. When the dimensioning is finished, we will have the equation—maximum looseness equals minimum allowance plus the sum of the tolerance of both parts, and this equation will apply whatever the known factors are.

Very often the allowance has zero value, that is, there is no clearance whatever allowed for the fit, and in a single pair of mating parts they fit metal to metal. If a large number of such parts are to be made it must be determined whether this zero allowance is for the tightest or the loosest fit permissible, and then substitute the known values in the equation just mentioned.

The term "negative allowance" is often used to indicate that a certain prescribed amount is allowed so as to make a tight or force fit. This is very confusing because it implies being subtracted, whereas such is not the case. According to present usage, zero allowance indicates that there is no clearance or space allowed between the two mating parts. Positive allowance indicates that there is prescribed a space between the mating parts. Negative allowance indicates that there is less than a space provided for between the mating parts, or an imaginary space displaced by the flow of the metal to make a tight fit. Negative allowance should, therefore, be treated as a negative quantity in the formula above mentioned, and then the quantity resulting used for either greater or less looseness, according to whether the sign of the quantity is positive or negative.

The minimum allowance, or greatest tightness and maximum looseness, must be known when the tolerances have been set, and usually they are known at such time. There are, however, cases in which it is known that certain tolerances are the smallest that can be successfully used in manufacture, and then maximum

looseness and tightness must be adjusted to obtain the best functioning condition in conjunction with these tolerances. This occurs often in very close work.

After determining the maximum and minimum looseness of mating parts and setting the tolerances it becomes necessary to control the dimensions of the parts so that none of the dimensions will be outside of the limits established, and this is best done at this time for strictly interchangeable manufacture by the use of proper "go" and "no-go" gages. First-class gages are expensive and soon wear, so that strict interchangeability is sacrificed to keep down gage cost.

Past Methods of Using Gages

In times past it was common practice to use only "go" gages and limit the looseness of fit by the shake of the piece in the gage, or, where a little more refinement was practiced, a piece of newspaper was used on one side of the "go" gage, and if the piece which passed without the paper was tight with the paper it was accepted. A piece of newspaper used with each of a pair of mating "go" gages usually produced a freedom of fit of from 0.004 to 0.006 in., and with skilled help it produced satisfactory results.

For a strict interchangeable quantity production work of good character, a good gaging system will prove economical. Such a system comprises the minimum number of properly designed gages to control all the factors of the various parts of a mechanism so that they will assemble and function properly. As stated before, this assumes that proper allowances and tolerances have been established.

The designer should always remember that tolerances should be as large as proper functioning will permit, and he should be well informed as to what tolerances successful manufacturers actually work. He should take pains to inform himself how tight and how loose working parts can actually be and give satisfactory results.

Once these tolerances are set as large as the designer will risk, they should be rigidly adhered to, and considered a boundary line. The product should always be kept within these boundary lines, and this is best accomplished by making the component drawing dimensions the master gage dimensions. Then with all the working and inspection gages checked against the master gage, and never allowed to wear beyond master gage dimensions, the work is bound to be within component dimensions.

The procedure just outlined gives us the definition of master gage, namely; they are for reference only, and represent the extreme tolerance limits allowed on the parts being made. They are often the same design as inspection and working gages. In many cases, however, they are in the form of checks or master component parts for the purpose of checking the actual inspection or working gages. In all cases the dimensions are the exact physical standards and represent extremes of the component dimensions.

As exact duplicate master gages cannot be made except at a prohibitive cost, a master gage manufacturing tolerance is allowed. This tolerance is usually in good practice from 4 to 6 per cent of the component tolerance, and is applied in the direction to keep the work within the boundary line defined by component dimensions. This gage tolerance is treated as a wear limit, and robs the working tolerance by this 4 or 5 per cent.

Inspection gages are usually of the same design as the working gages, and often the same as the master gages, but they should have an additional allowance for wear. Inasmuch as the gages will wear, and as they are expensive, the exact amount to allow for wear is an economic point for each manufacturer to decide, keeping in mind that a small wear limit increases the gage cost, and a large wear limit requires closer attention and work at the machines.

Where experience is lacking, it is good practice to allow 10 per cent of the component tolerance for wear on the "go" gages, as the "no-go" gages wear but little, 5 per cent will be sufficient. The inspection gage can only represent extreme tolerance limits when worn to master gage size. The working gages are those used to check the work as it is machined, and should have liberal wear limits to insure the work being passed by the inspection gages.

Thus it will be seen that this system, if followed, will admit of the acceptance of work that will be interchangeable. It also emphasizes the fundamental that tolerance should be as large as will properly function, for if the tolerances are too small the work will be more costly, as better workmen will be required, and this always means higher wages. Better tools and machines to produce the close work, and more frequent adjustment and attention will be necessary also, and this will likewise increase costs.

Screw Thread Work

The examples and descriptions thus far given have applied to all kinds of interchangeable work, with no particular reference to screw thread work; and, while the principles and practice are the same, a great deal more care is required to produce strictly interchangeable screw thread work than plain work. The problem becomes more difficult because a larger number of factors make up a proper screw thread fit, and a large error in any one of them will prevent a proper fit. A comparison of these factors may help to make the solution more comprehensible. A cylindrical fit depends upon the size, rotundity, and parallelism of the mating parts. Rectangular and sliding fits depend upon size, contour, rotundity, and parallelism of the mating parts, and to a considerable extent upon the ability of the metal to flow under stress. Of course, all depend upon size, but in a screw thread fit size is effected by the errors of the lead in the mating parts and the errors in the angle of the thread. Thus the factor contour in a screw thread is made up of the factors of lead and form of thread.

Two mating parts with correct lead require no compensation in size for the lead factor. Two mating parts with an equal lead error in the same direction, either long or short, require no compensation in size for the lead error. Two mating parts with differing lead errors, or the equivalent, require a compensation in size for this lead difference to enable the mating parts to go together.

Two mating parts in which the contour of the thread is effected by having an error in the angle of the flanks of the thread must also have a compensation in the diameter to offset the angle error, or the metal must flow to make the fit. Thus it will be seen that strict interchangeable screw thread product is more difficult to produce than plain work, and if good fits are required close tolerances and good thread producing tools are necessary. There must also be a rigid inspection, and means of controlling all the factors which make a fit.

Where gages are used, as at the present time, they must be periodically checked against the master gages in order that boundary lines are not encroached upon. It is fundamental that the "go" gages should check all the factors simultaneously, and the "no-go" gages should check the factors separately. This must be obvious when it is remembered that lead and form errors are compensated for by increasing the diameter, and hence to be sure of the correct relation of all the factors to each other they must be gaged at once, and with a gage as long as the engagement of the ma g parts. The exception to this is the minor diameter of the nut and the major diameter of the screw. To include these two dimension factors in the "go" gages would make the cost of the gages prohibitive, and as these surfaces in the mating are intended to be cleared when assembled, it is practicable to gage them separately.

There has been considerable said about robbing the tolerances with the gages, especially where the fits are close and the tolerances small. As a matter of fact, if the master gages are exactly to the component dimensions they do not rob the tolerance at all. This can be demonstrated by gaging the mating parts of threaded work with a plug and ring thread gage which are correct form, lead, and diameter. If these gages fit snugly, requiring some hand pressure to screw them together, the work which they gage will go together at least as freely as the gages do, even if the lead is correct, or if there are errors in the opposite direction.

(*Concluded on page 858*)

Refrigeration Requirements of Chemical Warfare

By MAJOR A. M. HERITAGE,[1] U. S. A.

Had the war continued, chemical warfare would have unquestionably assumed greater and greater importance, and even as it was it is common knowledge that the use of gases had no small part in the conduct of the war. The problems associated with the production of gases and gas-filled shells involved the creation of many plants and the undertaking of tremendous tasks. Such duties naturally fell to the lot of the chemist and engineer, and upon the mechanical engineer in particular, devolved the design and operation of the necessary refrigerating systems used in connection with chemical warfare. It is the purpose of this paper, as its title indicates, to discuss such a use of refrigeration, and the author first describes the properties and manufacture of many of the gases which were in general use during the war. He next outlines the method of manufacturing phosgene filled shells, and in conclusion discusses the need and uses of refrigeration and the type of equipment usually employed.

WHEN, on April 17, 1917, the United States Government declared war upon the Imperial German Government it became apparent that it would be necessary to fight the enemy with its own style of weapon. The Huns had been using gas in various forms since April 22, 1915, to fight the British and French, and commercial concerns in our country had engaged somewhat in furnishing the Allies with certain materials used to make toxic gas for filling shells. Up to this time, however, our Government had not engaged in the manufacture of toxic gases, and it, therefore, became necessary not only to immediately investigate and stimulate the manufacture of poison gases but also to devise a process for placing these gases into projectiles.

The initial step was taken by the Government on April 6, 1917, when a sub-committee of the National Research Council met and plans were made for extensive research in all matters pertaining to toxic gases. This sub-committee, under the chairmanship of the Director of The Bureau of Mines, was composed of representatives of the Army and Navy, and civilian chemists, gas experts and physiologists.

This enormous task, to be thus undertaken, was assigned to the Trench Warfare Section, Gun Division, of the Ordnance Department, and out of this small group of men grew a new corps known as the Chemical Warfare Service of the U. S. A. The Chemical Warfare Service, A. E. F. was formed independent of the Chemical Warfare Service, U. S. A.

Since no plan whatever was provided for chemical warfare when that service was organized in France, the Commander-in-Chief wisely permitted a wide latitude in its formation. Thus it was that the Chemical Warfare Service in France, as well as that organization nine months later in the United States, included research, development, production and supply, training in gas defense, chemical warfare intelligence, and the actual training, equipping, and operating of gas troops. These latter, of course, were handled in battle by the Chemical Warfare Service entirely in accord with and under orders of the commanding general of the armies, corps, and divisions with which they were operating.

This was a very fortunate organization. It permitted the widest latitude in using the personnel obtained to the best advantage, and in realizing very early the gas and gas defense needs of all other troops at the front. In fact, with its special knowledge of gases and gas warfare, the Chemical Warfare Service was enabled, in nearly every case, to realize the needs of the man at the front long before he realized them himself. It is believed that this is the soundest kind of organization, for the reason that it binds, into intimate contact, research, supply, experiment, intelligence, development, and actual fighting. The Chemical Warfare Service as organized in France had five subdivisions—Offense, Defense, Technical, Supply, and Intelligence. Experience indicated that Offense and Defense should be merged and that Training should be separate. These changes and other minor ones to adapt the organization to the regular General Staff organization appears to be the ideal, and was what the Chemical Warfare Service was working toward when the war closed.[1]

The gases experimented upon and used, some to a greater extent than others, were chlorpicrin, stannic chloride, phosgene, dichlorethyl sulphide (mustard gas), cyanogen chloride, chlorine, diphosgene, bromacetone, ethyl-iodoacetate, brombenzylcyanide, and diphenylchlorarsine. Of these gases phosgene requires the most refrigeration and the engineering problems solved in its manufacture were by far the greatest. Mustard oil also requires refrigeration in its manufacture but not during the process of the placing of the liquid into the projectiles.

The Properties and Manufacture of the Gases

A few words concerning the manufacture of the gases requiring refrigeration, although somewhat extraneous to the subject at hand, might nevertheless, prove of interest and for that purpose the writer quotes below from two recent articles, one by General A. A. Fries which was published in the *National Service Magazine* for June 1919, and the other by Major D. Domerest which appeared in *The Ohio State Engineer* for May 1919.

Chlorpicrin is a liquid boiling at about 115 deg. cent. and is made by reaction between bleaching powder and the high explosive picric acid. Picric acid is made by mixing phenol and sulphuric acid in sulphonators and allowing the mixture to age. This phenolsulphonic acid is added to nitric acid and water in nitrating pots, thus making picric acid. The spent acid is drawn off and the dry is mixed with water and calcium chloride, or lime, forming calcium picrate, and this is poured into a mechanical mixer together with calcium hypochloride, or bleach which has been creamed with water. The mixture is then pumped into stills where steam is introduced, as the reaction between the acid and bleach distills over into a water cooled condenser and the result is Cl_3NO_2, commonly called chlorpicrin which, being heavy, settles to the bottom and this allows any water carried over with it to be drawn off at the top.

Chlorpicrin was manufactured both at Edgewood Arsenal, Stamford, Conn., from which place there was shipped 111,853 lbs., and at Edgewood Arsenal, Edgewood, Md. This latter plant had an estimated capacity, January 1, 1919, of 3,000,000 lb. per month. This gas is highly lethal with low persistency and of it 3,806,000 lb. were shipped overseas.

Stannic chloride is a chemical made by passing chlorine gas over old tin cans. This gas when liberated in the presence of air produces a dense, white smoke cloud. It is also known as chloride of tin, and when added with chlorpicrin in gas shells, proved to be an excellent marker for the gunner.

Cyanogen-chloride, chlorine, diphosgene, and others of a similar nature are also highly lethal gases with low persistency. Bromacetone, ethyl-iodacetate, brombenzylcyanide, diphenylchlorarsine, or sneezing gas, and several other lachrymators are all highly irritating but not lethal except in extremely high concentrations. Lachrymators are highly economical in forcing the wearing of the gas masks and are used principally for that purpose.

Mustard gas, called yperite by the French, is the king of all gases. It is estimated that more than 80 per cent of all gas casualties among the English and Americans was caused by this gas. Technically it is dichlorethyl sulphide. This gas was discovered by a German chemist, Victor Mayer, in 1886. He pursued his experiments until he saw that the gas was having as serious an effect upon his experimenters as upon the animals experimented with. At that stage he stopped.

It is interesting to note that an English chemist recommended the use of this gas a year before the Germans began using it. But

[1] Chemical Warfare Service, Edgewood Arsenal, Baltimore, Md. Assoc.-Mem. Am. Soc. M. E.

The author desires to give credit to the American Society of Refrigerating Engineers for permission to publish the latter part of this paper, which was presented before the Sixth Western Meeting of that Society at Cincinnati, Ohio, during May 1919, and which appeared in their Journal of the same month.

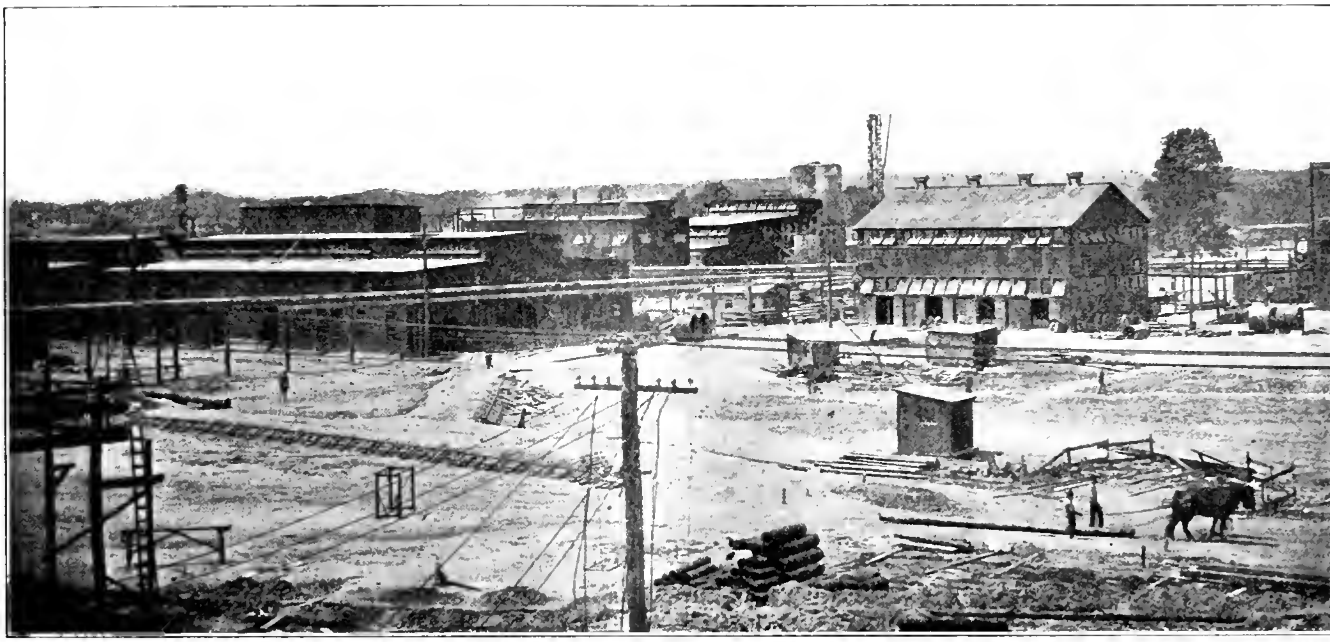
[1] These two paragraphs are quoted from an article by General A. A. Fries which appeared in the *National Service Magazine* for June, 1919.

here, as in the case of many other things, there was either too much fear, or hostility, or perhaps both, to new ideas, and once again the initiative was left to the Germans.

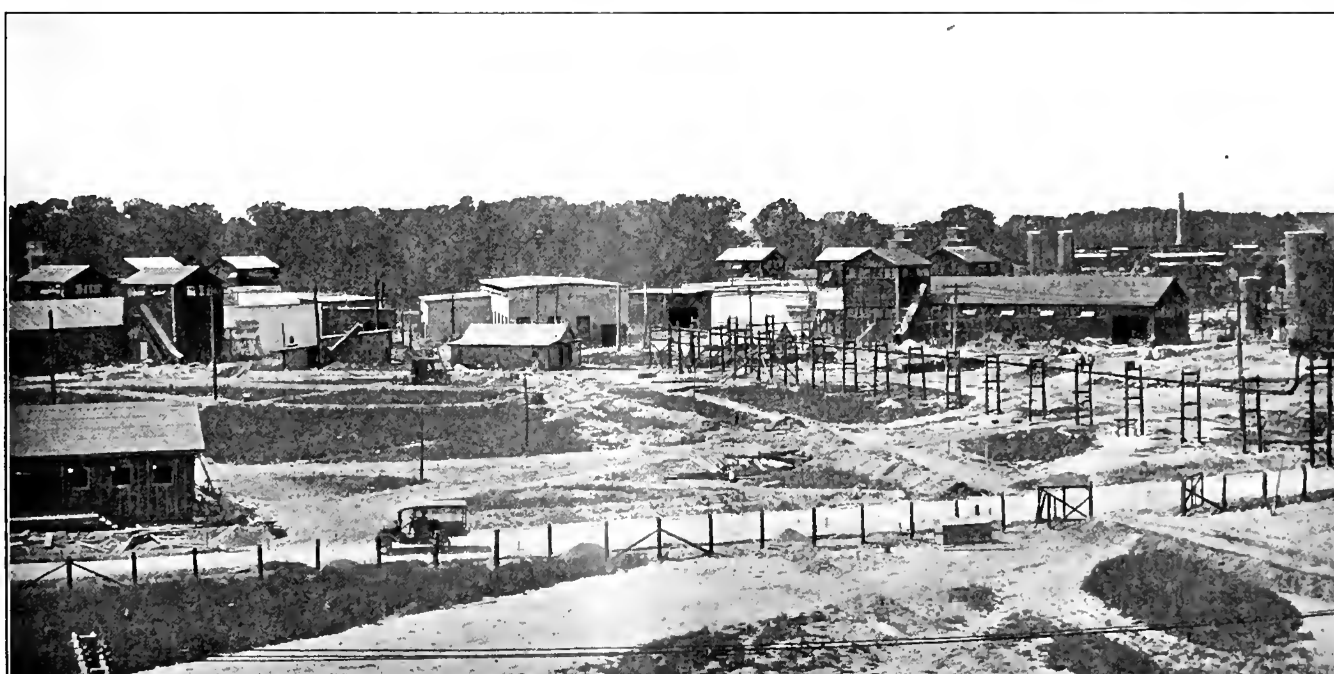
The gas is a yellowish oily fluid, freezing at about 50 deg. fahr. and boiling at about 422 deg. fahr. and its color varies with the impurities and solvents in it. It appears to combine to a certain extent with the iron or steel in shells, because the mustard gas as seen sprayed on vegetation from bursting shells appears to vary from fairly dark brown to almost tar black. The modern method of making it is to agitate sulphur-monochloride vigorously in the presence of ethylene vapor.

The gas is highly persistent—that sprayed on the ground being dangerous from a minimum of about two days in warm dry weather to a week or even longer in damp cold weather. It vaporizes very slowly. The idea will naturally occur that it must be effective in extremely low concentration or else its slow vaporization would make it useless, and that idea is correct. It is claimed that the highest concentration of the gas that can be obtained at 65 deg. fahr., is about one part in 30,000 of air. It has, moreover, the quality of cumulative effect to a very marked degree, being fully 50 per cent even for very low concentrations. For example; one part in 2,000,000, if breathed for 20 hr., will produce as serious a casualty as one part in 100,000 will produce in two hours; that is, if you multiply the time by 10 the concentration can be decreased to one-fifth and yet get the same result.

Mustard gas produces casualties almost wholly by burning. The theory is that the gas in the presence of moisture is broken up so as to liberate hydrochloric acid and that this acid produces the burn. The gas accordingly burns any soft moist tissue it reaches, whether inside or outside the body. Moreover, as it readily penetrates clothing, all soft parts of the skin are burned by the true gas, which is contrary to the original idea that burns were caused only by splashes of the liquid. The mustard gas of the Germans has an odor somewhat like mustard and that of the Allies exactly like garlic. Finally the gas has a pronounced delayed action, as its effects are not felt until 4 to 12 hr. after exposure, during which time the person breathing it experiences no discomfort. It should also be added that after breathing the gas for from thirty minutes to two hours, depending upon the person, one loses his sense of smell and can no longer detect the gas. As may be readily imagined these qualities make it highly valuable, or highly dangerous, depending upon which way you are looking at it. Indeed, as before said, it is the king of gases. It



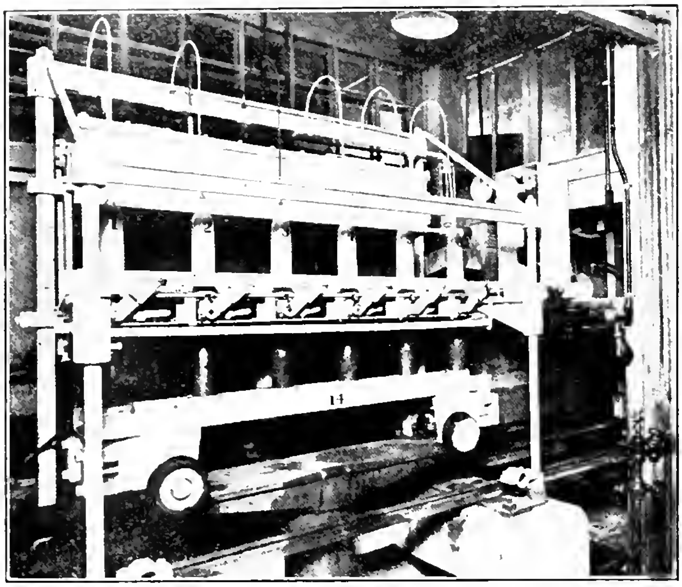
A GENERAL VIEW OF THE PHOSGENE MANUFACTURING PLANT



A GENERAL VIEW OF THE SHELL FILLING PLANT

changed not alone gas warfare, but to a considerable extent all warfare.

Mustard gas shells were picked up and opened after the first attack against the British in July, 1917. The English extracted the gas and within 48 hr. knew its composition. Within a week they had found, in German chemistries, Mayer's account of his discovery and the laboratory methods for making it. Notwithstanding an early realization of the importance of this gas and the determined efforts made to manufacture it on a large scale by the English, French, and Americans, it was almost eleven months after its first use by the Germans before the first Allied mustard gas attack took place. This was made by the French in the vicinity of Compiegne in June 1918. Thus for eleven months the German had a tremendous advantage over the Allies. That he did not make a greater use of it was



Shell Filling Machine

surprising to the Allies until just before the armistice, when it was learned that he had been making it by a cumbersome, slow, and expensive method, and that his total production was only about six tons per day. It is interesting to note that before the armistice was signed the Americans actually made 40 tons in one day and were equipped to make 80 tons but had not the shell in which to put it.

Mustard is a liquid boiling at 219 deg. cent., which gives out vapors highly destructive to the mucous linings of the body, and the liquid itself is terribly destructive to all living flesh that it touches, producing fearful burns. It is made by passing ethylene gas into liquid sulfur chloride reacting according to the following quotations:

$$2C_2H_4 + S_2Cl = (C_2H_4)_2SCl_2 + S$$

This reaction looks very simple but is exceedingly difficult to carry out practically. Sulfur chloride is a liquid easily handled and easily stored and obtainable in large quantities. Ethylene is a gas which had to be made in a plant on the grounds erected for that purpose.

To make ethylene 95 per cent ethyl alcohol is vaporized by steam and the vapors passed through 8-in. tubes filled with kaolin in the form of sphagetti and heated from the outside to a temperature of 550 deg. cent. Under these conditions the alcohol decomposes thus:

$$C_2H_5OH + heat = C_2H_4 + H_2O$$

About 80 per cent of the alcohol is thus decomposed and in the best practice yield 97 per cent ethylene gas, the undecomposed alcohol being condensed and recovered. It was necessary here to calculate the amount of steam necessary to vaporize the alcohol, and the amount of water and condensing surface required to condense the undecomposed alcohol and water vapor, and also to design an alcohol still to distill and recover the alcohol passing through the ethylene furnaces undecomposed. It was likewise necessary to operate a water gas plant for furnishing gas to heat the ethylene furnaces.

The ethylene, after leaving the condenser, was passed through a large scrubbing tower to remove the last traces of alcohol and ether remaining in the gas, then it was passed through especially designed sulphuric acid towers, built of lead and quartz pebbles, by which the ethylene was thoroughly dried, since moisture in the ethylene caused endless troubles in the mustard reaction. The ethylene gas was then compressed in reciprocating compressors, the size and power of which had, of course, to be previously calculated. From the compressors the ethylene was blown in the form of fine bubbles through the sulphur chloride in the reaction vessel.

Several varieties of reaction vessels were used and it was very difficult to secure a design whereby the difficulties resulting from the precipitation of sulphur set free in the reaction might be avoided. It must be remembered that this sulphur was mixed with "mustard" and was fearfully toxic. The reaction between ethylene and sulphur chloride is exothermic and since the temperature in the reactor must not be allowed to go over 38 deg. cent. owing to the precipitation of sulphur and decomposition of "mustard" in contact with iron at a higher temperature it was necessary to design the reactor with a sufficient amount of lead coil inside to keep the temperature of the liquid below 38 deg. cent. This was difficult owing to the tendency of sulphur to settle on the cooling pipes and make the cooling inefficient, notwithstanding that ice-cold brine was used. If the reaction can be carried out sufficiently rapidly below 38 deg. cent., the process is practical and the sulphur does not precipitate but remains in collodial suspension.

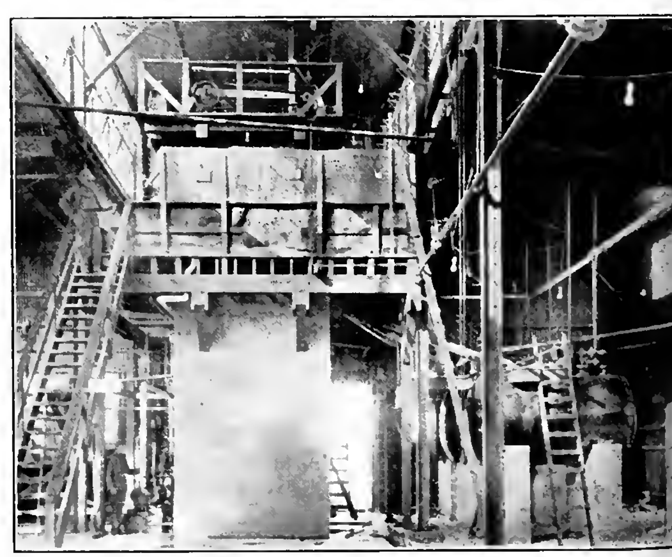
It was necessary to install blow cases for handling sulphur chloride and for pumping the "mustard" from the reaction vessel to storage tanks and from the storage tanks into drums for shipment across the seas or for transfer to the shell-filling plant. The chief difficulty at the "mustard plant," both in design and operation, arose from the necessity for taking care of occasional bad charges in which the sulphur precipitated badly and which resulted in stoppage of pipes. The most successful way to handle this difficulty was to dissolve out the sulphur mixed with "mustard" with an excess of sulphur chloride and pump the solution by means of a special pump built for pumping liquid sulphur through a steam jacketed pipe line into a large cistern in the swamp.

The day of the armistice the chemical plant was regularly and smoothly producing phosgene, chlorpicrin and mustard in quantities larger than shipping facilities could take it across the water and 1500 tons had accumulated stored in steel drums at the Chemical Plant.

Phosgene is a gas condensing at 8 deg. cent., and is made by a catlytic reaction between carbon monoxide and gaseous chlorine, extremely porous carbon being the catalyst. The product is $COCl_2$, and is extremely poisonous, consequently all pipes, valves, and fittings had to be extraordinarily tight. To make this substance it was of course necessary to handle large quantities of liquid chlorine, more in fact than was ever dreamed of before, and to gasify it and to transport the gas in pipes in such a way as to keep the liquid and gaseous chlorine under easy control. It was necessary to design and have built special tanks for the storage of liquid chlorine, vaporizers for vaporizing the chlorine and to install extra heavy pipe and special fittings to handle the liquid and gaseous chlorine. All this involved a good many calculations based on vapor pressure, latent heat of vaporization, and density of chlorine liquid and gas. The results were very satisfactory.

The production of reasonably pure carbon monoxide had never been a commercial process until this plant was built and after a great deal of thought on the subject it was finally decided that it would be necessary to make use of the two following reactions going on simultaneously:

$$2C + O_2 = 2CO + 58{,}000 \text{ calories}$$
$$C + CO_2 = 2CO - 39{,}000 \text{ calories}$$



Installation of a Mustard Oil Reactor

The first reaction could not be conveniently used alone on account of the enormous temperature produced by the reaction endangering the safety of the producer. The second reaction could not be conveniently used alone since it is endothermic and would soon smother the fire, requiring a frequently reversing procedure with resultant low purity of gas. Upon calculation it is found that when making

proper allowance for radiation heat-loss the above reactions when going on simultaneously should produce a state of fairly constant temperature when 30 cu. ft. of oxygen is used with 50 cu. ft. of carbon dioxide. It was expected that when using seventy-hour foundry coke as the source of carbon that a carbon monoxide gas of 98 per cent purity could be obtained.

The Manufacture of Phosgene Filled Shells

The preceding paragraphs give a general knowledge of the gases used and how manufactured and as phosgene is the principal gas requiring refrigeration, on account of its low vaporizing temperature, the writer will discuss at some length the subject of the handling of this gas, as it is placed in the various kinds of projectiles. It should first of all be stated that mustard oil and phosgene both require two tons of refrigeration for each ton of gas manufactured. This is due to the heat of reaction between the sulphur chloride and the ethylene gas.

Phosgene is made by bringing CO and Cl_2 together in equal volume in the presence of a catalytic agent where chemical reaction produces heat. This heat is partly counteracted by passing the mixed gases through a double-pipe water-cooler and the water used in steam boilers for general heating purposes. The mixed gases are then condensed in large spiral lead coils with a cold circulation of brine surrounding them. This phosgene, which condenses to a liquid at 40 deg. fahr. is then stored in either 300 lb. steel containers or in large steel drums of one-ton capacity made of ⅝-in. steel plate, the empty drum weighing approximately 1650 lb. These drums, before introducing the phosgene, are cooled to prevent the first phosgene entering the drum from again vaporizing and causing pressure, thereby preventing other liquid phosgene from running by gravity into the drum.

It might properly here be stated, that about 10 cc. of phosgene liberated in close proximity to a person, or 0.0003 gram taken into the lungs or even one part in 200 of air breathed for ten minutes, is sufficient to cause death. From this, one can easily see that in transferring the cold liquid phosgene from the phosgene condenser, or its supply tank, into the storage drums it is absolutely necessary to allow none to escape and this is best done by precooling the drums and preventing the first phosgene from gasifying upon entering the drum. These drums are tested to a pressure of 5,000 lb. per sq. in.

The next task requiring refrigeration is the transfer of the phosgene from the drums into the system for filling shells and other projectiles. This was accomplished by means of steel mixing bottles made of ¼-in. plate, welded, and containing floats for regulating levels and especially made distributing valves for the admission and eviction of the liquid "gas" in and out of the mixing bottles. Phosgene is sometimes mi ed with either chloropicrin or stannic chloride. The mixed gas, while probably not more toxic or poisonous than phosgene alone, is harder for the gas mask to hold against than the phosgene alone. The latter mixture, phosgene and stannic chloride, is made for the purpose of showing the artillerymen the point of explosion of the gas shell. This is accomplished by the fact that stannic chloride, upon coming in contact with air, produces a white smoke.

The Need and Use of Refrigeration

In order to fill shells or other projectiles with either straight phosgene or a mixture containing phosgene, it is necessary to cool the metal to a temperature below 32 deg. fahr, and as thousands of shells were filled per hour, and each shell weighed according to size from 10 to 90 lb., the amount of refrigeration required can be easily discerned. These shells and other projectiles, such as Stokes mortars and Livens projectors, were cooled by placing them on specially designed conveyors which traversed through rooms held at zero temperature. These rooms were designed with an anti-room at either end through which the conveyor carrying the shell travelled. The space necessitated by carrying three 75 mm. shell abreast on one conveyor, left open so far as cork insulation is concerned, was boxed in and hung full of felt strips which entirely covered and surrounded the shell and conveyor. The rooms were built with bunker lofts which contained, according to the size of the shell cooled, from 4,000 to 20,000 lineal feet of 2-in. direct expansion pipe and No. 5 ventura fans were used for circulating the heat given up by the metal of the shells over the direct expansion coils.

The program for filling gas shells at first being very uncertain on account of the lack of e perience, it was decided not to build a too permanent an installation to start with and accordingly the buildings were designed for wood construction and mill shavings as an insulation. Accordingly, four buildings, 77 ft. long and 8 ft. wide with 15 ft. ceiling, were first built and a 3 ft. mill shaving insulation installed. This type of construction and insulation proved extremely satisfactory and the only change made in it was that a curtain wall of 8-in. hollow tile was set up on account of fire risk.

Recording thermometers were installed with connections leading from every room, which thus made the control very easy. The machines used for filling gas shells with phosgene were designed and worked out, using the siphon principle. These machines were all insulated as were all pipes containing the liquid "gases." The large containers of phosgene were taken from the rooms where they were filled and transported to the filling buildings on industrial railways. Here they were moved into small chapels—each one just large enough to place the container for connection to the shell filling system.

These chapels were kept under negative pressure, being connected to large ventilating scrubbing systems. The chapels were situated eight in a row, each one containing a chlorine pressure gauge and special gas connection. The fronts of the chapels were made with two vertically sliding glass doors and each chapel being

Installation for Production of Chlorpicrin.

under negative pressure, immediately as the door was raised, air was drawn in from around the attendant which prevented him from being gassed.

Each chapel also contained a metal carriage made with ball-bearings and wheels which run on tracks set in the floor. These carriages were made with a revolving metal basket so that the large drum of phosgene could be placed in the basket and easily revolved for the purpose of bringing its outlet connection to the system's inlet connection. After a drum of phosgene was connected to the system, its pressure reading was taken to denote the presence or absence of ferric chloride and if satisfactory, it was allowed to run by gravity into a double pipe brine and gas cooler.

The brine used for circulation through these coolers was held at 15 deg. fahr. and the same brine was used for cooling the filling machines and the pipes carrying the gas from the double pipes of the brine and gas cooler to the filling machines. Experience taught many lessons and it was quickly discerned that it was necessary to have a drop leg in connection with the double pipe brine cooler for the purpose of collecting and removing ferric chloride, which precipitated out at low temperature. This ferric chloride is produced by water resulting from moisture in

the atmosphere coming in contact with the phosgene. It was also quickly learned that a large quantity of cold, dry air was necessary for the transferring of phosgene, for in this manner the liquid "gas" could be "shot" from one part of the system to another with little trouble.

Connections were made from the double pipe gas and brine cooler to the mixing bottles, which held 900 lb. of liquid "gas." Connections were also made whereby the liquid "gas" could be run from the mixing bottles back through the double pipe brine and gas cooler, thereby enabling the operator to mix cold phosgene with warm chlorpicrin and circulate the mixed gases back up through the double pipe brine cooler. The air used for the circulation of the liquid "gas" was produced by large air compressors run through dehumidifying systems. These systems proved very satisfactory although they required constant attention.

Each system was made of two banks of double pipes and a brine tank containing two sets of double pipes. The air coming from the compressors travelled through the double pipe air and brine color in the brine tank, which brine, in tank, was held at a temperature of 33 deg. fahr. From this cooler it traveled up through a double pipe brine and air-cooler above, which contained brine of a temperature of 15 deg. fahr. The brine cooler, located in the tank, had a pipe leading from the lowest air tube to a steam trap for the purpose of removing the humidity or moisture. The double pipe cooler above the brine tank was used for reducing the temperature of the air in the neighborhood which was approximately 32 deg. fahr. to –15 deg. fahr. Between the two sets of coolers, a large receiver was installed for the purpose of catching drops of moisture left in the air after passing through the first double pipe cooler.

Refrigeration Equipment

The machinery used was of the ammonia compression type and comprised various makes. Some were direct-connected engine driven and others were belt driven and used electric motors. The size of the machines varied from 12 tons to 120 tons refrigerating duty. Direct expansion piping was used entirely in the bunker lofts of the shell conveyor coolers and double pipe and shell type brine coolers used for the cooling and condensing of the phosgene.

All lead and steel pipes used for conveying the liquid "gas" were either burned or welded, or connected by means of flanged fittings welded on the pipes. No soldered joints could be used on account of the action of phosgene on tin. The phosgene showed little or no action on lead and on this account the phosgene condensers were made by wrapping 2-in. lead coils in special form around shell type brine coolers set vertically in large cylindrical steel tanks.

Several large installations at Edgewood, Md., due to a desire to keep the gas and ammonia lines short, were made by using a short belt drive with an idler. This short belt drive proved very successful and enabled the use of a narrow building. On either side of these ammonia compressor buildings were located the shell filling and phosgene cooling buildings,—two in number on each side. This lay-out made it possible for any one of four filling buildings or any one of four phosgene manufacturing buildings to be shut down, due to any cause such as bad gas leak, and the remainder left in operation without the operators being hindered in their duty. Inasmuch as each filling building and each phosgene gas manufacturing building required refrigeration which was produced at a central ammonia compression building, it became necessary to run liquid ammonia lines, cold brine lines, and cold dry air lines from the central buildings to each of these buildings. The idea of making the ammonia compressor buildings long and narrow made it possible for theses lines to be shorter than had long belt drives been used.

As stated before, the first unit of four shell filling buildings were insulated with three feet of mill shavings. The second unit of four shell filling buildings were insulated with sheet cork board set in plaster with a plastic cement on the outside for protection against the elements. The third unit of four buildings were insulated with sheet cork board plastered against an 8-in. hollow tile. The phosgene manufacturing unit of four buildings were insulated with sheet cork board and plastered. Various kinds of insulation were used for pipe covering and the kind which could be removed the more easily was the kind which seemed to be the most satisfactory,—especially on the cold phosgene pipes on account of speed being required to remove a pipe which developed a gas leak caused by the presence of ferric chloride. After removing many feet of covered pipe it was decided to build insulated box chambers around the cold pipes where they were located close together in connection with the gas mixing bottles. The double-pipe ammonia and, brine coolers and double-pipe gas and brine coolers were placed in insulated rooms with cold storage doors which made them accessible for changes or quick removal.

In conclusion, one statement should also be made which is that the handling of phosgene gas in a liquid form readily collects moisture from any source, air included, and this causes the formation of ferric chloride. This ferric chloride denotes that iron is being given up from some source and that source, be it a cold pipe, is quickly getting thinner and this deterioration will quickly produce a leak because of the fact not only of the wall of the pipe getting thinner, but also of the fact that ferric chloride denotes the presence of hydrochloric acid vapor which produces great pressure. Tests made on samples of phosgene containing ferric chloride showed a pressure on a standard gauge up to 500 lb. This means that either lead pipe or extra heavy pipe with strong fittings and welded joints must be used. Of the hundreds of tons of phosgene made and filled into containers by the Chemical War Service, at its various plants, only three fatal casualties resulted and two of these were caused by the explosion of a phosgene container in one shell filling wing which caught on fire from some unknown source.

A new design for rigid airships which seems to eliminate most of the drawbacks of the existing types forms the subject of a recent British patent which has been taken out by a well-known firm of English motorboat and yacht builders.

In this design the hull of the airship is formed by a gas-tight shell made of several thin layers of wood veneer with layers of fabric between them, the whole being cemented and stitched together with fine copper wire, and internally stiffened by longitudinal and transverse girders. Such a monocoque hull offers several advantages over the conventional fabric-covered girder type for the following reasons:

First, owing to the fact that the shell acts at the same time as framework, outer cover and gas container, the monocoque design is for the same size or for the same weight lighter than the Zeppelin type.

Second, the veneer shell eliminates the tedious adjustment of the wire stays which brace the girder type athwartship and longitudinally, the transverse bracing being insured by veneer bulkheads which subdivide the gas container into compartments.

Third, head resistance is reduced to a minimum because no external projections beside fins and rudders occur on the hull, the machinery and accommodations being situated inside. The latter are separated from the gas container by a double wall, the space between which is filled with an inert gas, such as nitrogen, to reduce the fire risk when hydrogen is employed as a lifting gas. With the use of helium—which is non-inflammable—this double wall could most likely be done with entirely. The reduction of head resistance effected by such a design, where the airship is a strictly streamlined body, must obviously result in a considerable increase of speed for the same power.

Fourth, the monocoque hull promises to solve the much tangled problem of conserving the lifting gas for continued use, that is, without losing it through leakage or having it deteriorate by air penetrating the gas container owing to the imperfect gas tightness of existing balloon fabrics and their gradual deterioration due to sunlight. It is believed that a veneer hull, suitably lined with gas impervious fabric, will insure an almost perfect gas tightness.—*Aviation*, August 1, 1919.

The Lubrication of Ball-Bearings

By H. R. TROTTER,[1] HARTFORD, CONN.

Ball-bearing lubrication is a subject of which little is known, and this is chiefly due to the fact, that there is no accepted method of determining the lubricating value of an oil or grease. As a step toward the development of a satisfactory method the author has devised an instrument for such a purpose, a brief description of which follows in this paper. The operating characteristics of a ball-bearing as related to the problem of lubrication are also discussed and the specifications for a satisfactory oil are given. The use of grease and graphite as a lubricant is next presented and the paper concludes with a suggested procedure for the analysis of lime-soap greases.

An investigation of existing literature on the subject of ball-bearing lubrication reveals the fact that up to date a comprehensive study of this particular phase of lubrication has not as yet been published. The efficient lubrication of the plain-sleeve type bearing presents, on the other hand, few difficulties, as the engineering world is in possession of an accumulation of data acquired during many years of patient study, experiment, and practice.

In 1885, Beauchamp Tower completed a series of experiments which he had made to obtain data regarding the behavior of a lubricant under various loads and speeds. These experiments were made at the request of the British Institute of Mechanical Engineers, and were later made the subject of a very thorough mathematical analysis by Prof. Osborne Reynolds. The outstanding feature of these experiments was the discovery of the wedge-shaped film of oil. Professor Reynolds later gave the rule for efficient lubrication which is that where two surfaces are in sliding contact a satisfactory film of oil cannot be maintained, unless the surfaces are at a slight inclination to each other.

The formation of such a wedge shaped film of oil can be described as follows: In Fig. 1 is shown a pan or tray (A) containing a small amount of oil. A flat plate (B) is loaded with weights (C). When in a stationary position, the surfaces of the plate and pan are parallel to each other, but if the plate is now pulled along the surface of the pan the leading edge will rise and the plate will float on an oil film with the surfaces at an inclination to each other. The oil film assumes the shape of a wedge as shown in Fig. 2.

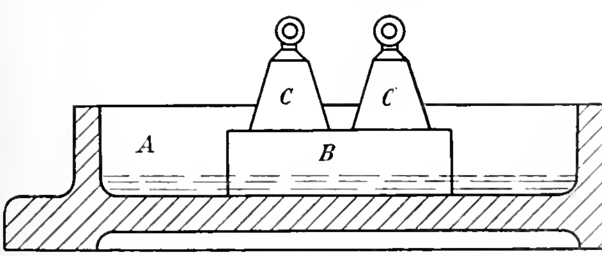


Fig. 1 Formation of Oil Film, Initial Stage

The Mitchell thrust-bearing, which is manufactured in Great Britain, and the Kingsbury thrust-bearing, made in this country, are designed to take advantage of this phenomenon and both have proven very successful.

Successful bearing operations is a problem that should be solved by the designer, and not by the lubrication engineer who acts in an advisory capacity after the bearing is in service. It must be admitted, however, that the average engineer is not in possession of the necessary data which would enable him to select the proper type of lubricant for his particular use. Nor has he the instruments or appliances to analyze a lubricant both physically and chemically.

The final choice of a lubricant is at best the result of a compromise between the engineer and the chemist. This compromise is very often unsatisfactory and due in part to the chemists' inability to thoroughly comprehend the engineer's problem and in part to the engineer's lack of chemical knowledge.

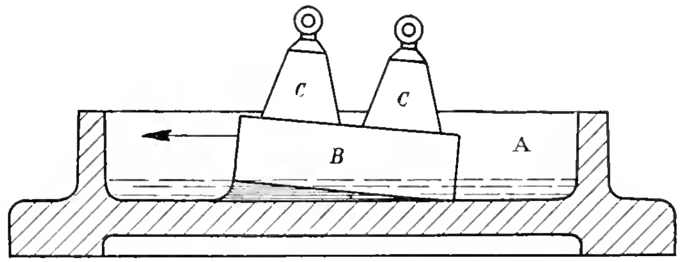


Fig. 2 Formation of Oil Film, Final Stage

The Testing of Lubricants

At the present time there is, unfortunately, no instrument which will accurately indicate the true lubricating value of an oil or grease, and until such an instrument is devised, the selection of a lubricant must be more or less a matter of guess work. A viscosimeter gives a comparative reading of the inertia of a liquid, but it does not indicate the value of a lubricant under working conditions. Furthermore, all authorities are not agreed on the desirable qualities of a lubricant. Many claim that a high surface tension is a requisite, and others lay great stress on adhesive qualities. All are agreed, however, that a lubricant should have the minimum of internal friction. Generally speaking, the requirements of a lubricant for the plain-sleeve type of bearing are a certain amount of adhesive quality to enable it to adhere to both the revolving and stationary surfaces. It should have sufficient body to withstand the pressures. The lubricant film will, therefore, consist of three layers, which in operation approximate the features of a ball-bearing in that one element is stationary, one rotating, and one an intermediate layer consisting of globules similar to the balls in a ball-bearing. From this description, the importance of body in a lubricant will be realized, and as the best and toughest material is required in the balls of a ball-bearing, so is body required in the intermediate layer of a lubricant.

Body in a lubricant cannot very well be defined. It seems certain that its effects are opposite to viscosity. Professor Kingsbury gives the following relations of viscosity and body. (Trans. A. S. M. E., 1903, page 147).

With increase of	Where the viscosity is effective the coefficient of friction	Where the body is effective the coefficient of friction
Pressure	Decreases	Increases
Speed	Increases	Decreases
Temperature	Decreases	Increases

The author has designed an instrument which may possibly be the means of obtaining data of value regarding lubricants. This instrument is shown diagrammatically in Fig. 3. The appliance consists of a revolving element driven by a small

[1] President Trotter-Patterson Corporation, Hartford, Conn. Assoc.-Mem. Am. Soc. M. E.

For presentation at the Annual Meeting, New York, December 2 to 5, 1919, of The American Society of Mechanical Engineers All papers are subject to revision.

motor and a stationary element similar to a block used in a Mitchell or Kingsbury bearing with suitable means of obtaining readings of the inclination angle of the block to the revolving element.

At one time it was considered necessary to support the blocks in a Mitchell or Kingsbury thrust-bearing at a point behind its center of figure in order to secure the wedge of oil between the opposing surfaces. Furthermore, it was assumed that if such a block was centrally supported, it would possess no load carrying capacity. Independent experiments by Professor Kingsbury and Sir Charles Parsons established the fact, however, that a centrally pivoted block could carry considerable load. This was an important discovery, as most of the applications of Mitchell and Kingsbury thrust-bearings have been on marine propeller shafts where reverse rotation is necessary. It was later found that with a centrally supported block, the wedge shaped film of oil was due to the change of viscosity of the lubricant when passing through the block. It will thus be seen that the angle, which the block assumes to the rotating member, gives an indication of the change of viscosity in a lubricating film when in operation.

Referring again to Fig. 3 (*A*) marks a casing consisting of an inner chamber which contains the lubricant to be tested and an outer chamber containing oil which is electrically heated and which transmits its heat to the inner chamber. At (*B*) is shown a small electric motor with a shaft extension on which is placed a flange, the face of which is highly polished. The motor swings on a pivot (*C*) which allows the flange to take various positions with relation to the block thus enabling readings to be taken at various rubbing velocities. By means of the lever (*D*) various pressures can be obtained. The movement of the block is magnified by minimeters and transmitted to the dial indicator. Holes are drilled in the block and can be connected to a monometer to obtain pressure readings, or as there is practically no pressure difference, the holes can be connected to each other in such a manner that there will be practically no velocity through them. Temperature may be obtained at the leading and trailing edges of the block. Readings can be taken at constant speed with varying loads or with constant load at varying speeds. While the author is not certain as to the practical value of such an instrument, it is at least a step in the right direction.

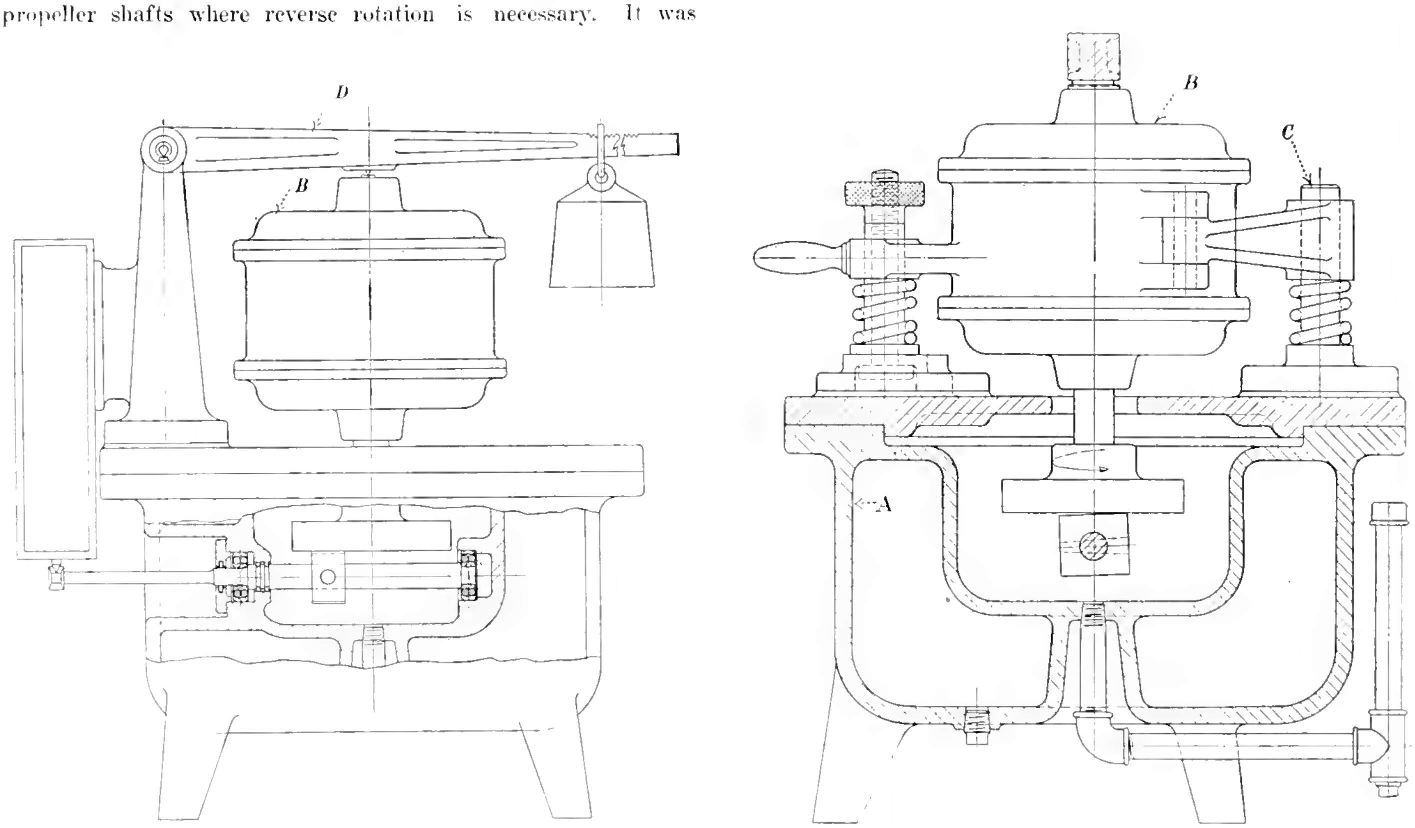


Fig. 3 Diagrammatic Sketch of Author's Device for Obtaining Data Concerning Lubricants

Operating Characteristics of Ball-Bearings

The two cardinal points of successful sleeve-bearing operation are:

1 A design of such a type as will permit of the formation and preservation of an oil film

2 Selection of a lubricant that will provide a film of maximum strength with a minimum of internal friction

With a ball-bearing, however, the problem is not so easily understood, but the important points to be remembered are:

1 The coefficient of friction is practically constant throughout wide ranges of loads and speeds

2 Metal to metal contact (an oil film only possible at very high speeds when slippage may take place)

3 The coefficient of friction is lower in an unlubricated ball-bearing (at light loads and moderate speeds).

The first point is, of course, generally known, but the conclusion to be derived from this point has not been stated before to the author's knowledge, namely, the impossibility of an oil film between balls and races.

In Fig. 4 curve *A* shows the change of friction coefficient of a plain-bearing under constant load and varying speed. This curve is self-explanatory and shows that a satisfactory oil film is not formed till a certain speed is reached. In the same figure curve *B* gives the friction coefficients of a well-made ball-bearing, and shows that the friction loss of a ball-bearing is practically constant throughout wide ranges of speed. If an oil film were formed between balls and races, curve *B* would possess the same general characteristics as curve *A*.

The difference between the friction coefficient of a lubricated and unlubricated ball bearing is shown in Fig. 5. This property of a ball-bearing is not generally known, and should not be used as an argument in favor of operating ball-bearings

without lubrication. From the foregoing statements it should be evident that plain-bearings and ball-bearings possess such radically different characteristics that a true comparison is impossible. It naturally follows, therefore, that practically all the accumulated experience of the lubricating engineer is of little value when analyzing ball-bearing operation.

Requirements of a Ball-Bearing Lubricant

The use of a lubricant with ball-bearings is necessary to protect the highly polished surfaces of the balls and raceways, and to minimize the slight friction between the balls and ball retainer. The small amount of friction between balls and retainer

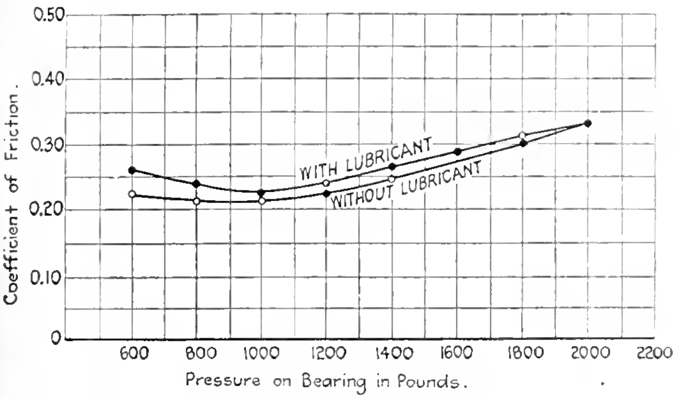


Fig. 4 Fiction Coefficient of a Plain-Bearing

can also be minimized by careful design. The principal requirement of a ball-bearing lubricant is chemical neutrality. The lubricant used must not contain over 0.10 per cent acid or alkali. There are many commercial lubricants on the market which come within this limit, but very few are acceptable because of their tendency to develop acid with age or when operating at high temperatures.

Most of the high grade oils can be used with safety, but many of the lubricating greases, while suitable for general purposes, are a positive menace to successful ball-bearing operation, not because of poor material used in the manufacture of greases, but because of the lack of scientific mixing methods. The manufacturer is in no way to blame for this condition, because he is making grease for general commercial use and not for ball-bearings. There are now on the market a few greases manufactured especially for ball-bearings, but, with one exception, all those tested by the author have proven worthless and clearly indicate the maker's ignorance of the requirements.

Experience shows that the most satisfactory lubricant for ball-bearings is a highly refined mineral oil having the proper viscosity and cold test for the installation. Greases should be used only where operating conditions require viscosities greater than can be obtained with a mineral oil.

Whenever a ball-bearing is operated at high speeds, it is not advisable to run it submerged in a lubricant, and provision should be made to supply the oil from a pressure system. If such a system is not available, good results may be obtained by a large-sight feed-oil cup. A few drops of oil per minute is all that is required.

At moderate speeds a heavy oil will generally give better results than a light oil. The substitution of a heavy oil for a light oil will generally result in a decreased operating temperature. This peculiarity may be explained by the fact that when the bearing is running at the actual operating speed, less opposition is offered to the rotation of the balls by the oil because of the inertia of the oil. In addition, there is less churning and frothing with its resultant air pockets. Air pockets in a lubricant act as insulators and prevent the transmission of the heat generated to the outer casing where it can readily be dissipated.

All mineral oils used on ball-bearings should be highly refined, filtered, and contain a minimum amount of acid, alkali or sulpho compounds, and in order to insure the use of such oils the following specifications are suggested:

Free acid (calc. as oleic acid), maximum, 0.10 per cent
Free alkali, absent
Ash, trace
Heat test (15 minutes at flash point), slight darkening, but no sediment
Flash point (Cleveland open cup), minimum, 300 deg. fahr.
Fire test, minimum, 350 deg. fahr.
Viscosity at 100 deg. fahr., Saybolt Universal

Light oil	100 to 200 sec.
Medium oil	200 to 300 sec.
Heavy oil	300 to 500 sec.
Extra heavy oil	More than 500 sec.

Free Acid Test. The test for free acid should be made in accordance with the method of the American Society for Testing Materials, which is as follows:

Accurately weigh 10 grams of the oil into a flask, add 50 cc. of 95 per cent alcohol which has been neutralized with weak caustic soda, and heat to the boiling point. Agitate the flask thoroughly in order to dissolve the free fatty acids as completely as possible. Titrate while hot with tenth-normal alkali, using phenolphthalein as indicator. Express results as percentage of oleic acid. 1 cc. N/10 alkali = 0.0282 gram of oleic acid.

Emulsion Test. This test gives a very definite indication of the presence of sulpho-compounds in an oil (sulphuric or sulphonic). There are several methods for carrying out this test, but for routine work, the following method for motor oil specified by the War Department in Specification No. 3502 issued April 24, 1918, should be followed:

One ounce of the oil shall be placed in a standard four-ounce bottle with one ounce of distilled water. The mixture shall be heated to a temperature of 180 deg. fahr. and then shaken vigorously for five minutes. After standing for one hour the oil must be clear and of the same color as before the test. All of the water must have settled and appear only slightly cloudy.

This method is simple and gives valuable indications as to degree of refinement of the oil. Highly refined oil shows a thin white line of demarcation between the oil and clear water below, thus indicating the absence of sulphuric acid compounds. Impure oil mixes permanently with water, appearing often as a curdled mass floating on milky water. The curdled portion contains what is frequently called a sulphuric acid soap and the extent to which it is present is an indication of the quantity of the "sulpho" compounds left in the oil, due to improper refinement. Oils containing appreciable amounts of these sulpho compounds are unsuitable for ball-bearings.

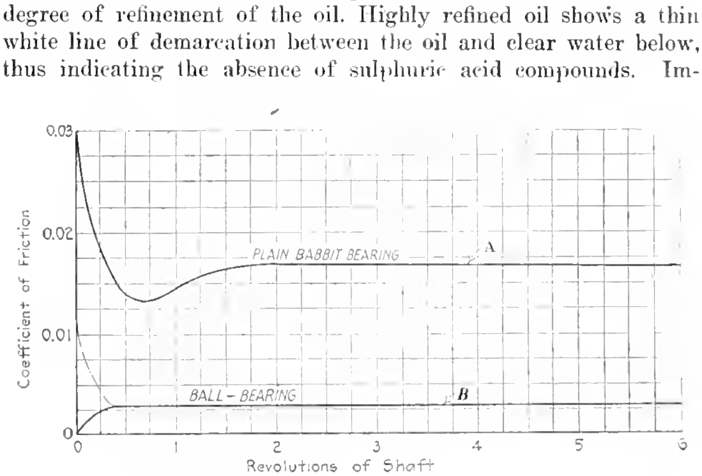


Fig. 5 Friction Coefficients of a Plain and a Ball-bearing

Heat Test. This test is conducted by heating a small portion of the oil in a flask or beaker up to the flash point and holding it at this temperature for fifteen minutes. A comparison is made between the heated and unheated oil. Highly refined oil darkens slightly but does not deposit sediment on standing twenty-four hours. Oils that contain sulphuric acid compounds turn black and deposit carbonlike substances. Such oils are not suitable for ball-bearings.

Inflammability Test. A flash point of 300 deg. fahr. (open cup) is the lowest limit considered safe for ordinary work and, on installations subject to high temperatures, oils having a flash point above 400 deg. fahr. should be used. The fire hazard is the factor to be considered in specifying the flash and fire tests.

Cold Test. For installations running at low temperatures asphaltic base or low pour-test oils are recommended as this type of oil shows pour tests of 5 deg. fahr. or below, while the paraffin base oils do not ordinarily run below 30 or 35 deg. fahr.

Lubricating Greases for Ball-Bearings

Most of the high-grade mineral oils conform quite closely to the above specifications. In connection with lubricating greases, however, the problem is more difficult. Many of the greases now on the market are entirely satisfactory for general purposes, but lack certain characteristics which experience shows to be highly important for successful ball-bearing lubrication. Tables 1, 2, and 3 show the variations to be found in a number of lubricants on the market, and it includes a sufficient number of analyses to show characteristic variations in the different types of greases available.

A large number of greases contain lime-soap as thickeners, a few are of the soda-soap type, while others are a combination of both. The lime greases are valuable in that they can be used without harmful results where moisture is present. Their consistency, however, is more easily changed by heat than greases of the soda type.

Using the tests previously mentioned as a basis, we can very easily arrive at a suitable specification which will ensure the production of lubricants suitable for ball-bearings without putting any undue burden on the lubricant manufacturer. The following specifications are accordingly suggested:

- Free acid (calc. as oleic acid), maximum, 0.10 per cent
- Free alkali (calc. as sodium hydroxide), maximum, 0.10 per cent
- Free lime (calc. as calcium oxide), maximum, 0.5 per cent
- Neutral saponifiable oil, maximum, 1.0 per cent
- Viscosity of mineral oil (minimum 200 sec. Saybolt Universal 100 deg. fahr.)
- Abrasive particles (sand, etc.), absent.

The determination of acidity in a grease containing lime-soap requires special treatment and the following modification of Marcusson's method is strongly recommended:

Ten grams of the grease are carefully weighed into an extraction flask and dissolved in 88 deg. gasoline by shaking cold (it is well to dissolve cold as by heating or boiling some of the free lime may combine with the free acid). Allow the soap to settle, and pour clear gasoline solution on medium large filter, without stirring the soap, treat the insoluble soap, lime, etc., again with gasoline thoroughly shake and allow to settle clear, pour on filter paper and when filtered wash soapy residue into filter paper and wash several times with gasoline until all soluble is washed out. Filtrate and washings are caught in Erlenmeyer flask of sufficient capacity, the gasoline solution is slowly distilled off on electric hot plate, being careful not to carry down too far so as to break up the oils.

The residue is washed into a stoppered bottle with a small amount of gasoline and 50 cc. of 50 per cent neutral alcohol added and titrated with standard N/100 sodium hydroxide solution, shaking the mixture thoroughly after each drop of solution is added, using phenolphthalein as an indicator. By this method, the acid content can be determined within 0.02 per cent, calculated as oleic acid.

Ball-bearing manufacturers are quite agreed that the limit of free acid in a grease should not exceed 0.10 per cent calculated as oleic acid, and from the Tables 1, 2, and 3 it is evident that there are plenty of greases available which meet this requirement.

It is essential that the grease be comparatively free from unsaponified fatty oil, or as expressed in the analyses, "neutral saponifiable oil." This specification is imposed because the unsaponified fatty oil has a tendency to become rancid or develop an acidity with age in service, particularly when operating at high temperatures. We have established a limit of 1.0 per cent, and the above tables show that this can be met in most of the compounds which are suitable in other respects.

One feature of grease lubrication which cannot be too highly emphasized is the importance of using a high-grade mineral oil conforming to the tests for purity as previously outlined. A grease may be perfect in every other respect, yet if a poor grade of mineral oil is used, the life of the bearing will be shortened.

Some manufacturers take advantage of the fact that a grease made with kerosene looks much the same as one containing high-grade oil and cheapen their product by using inferior light oils. It is desirable that a highly refined oil showing about 200 sec. viscosity Saybolt Universal at 100 deg. fahr. be used in the ordinary grease formula.

In view of the high polish necessary on ball-bearings, the elimination of abrasives such as sand particles, etc., is manifestly important.

At the present time, there is no generally accepted method for determining the consistency or melting point of a grease. Grease manufacturers have adopted systems of nomenclature peculiar

TABLE 1 LIME-SOAP GREASES

Mark	Mineral Oil per cent	Neutral Saponifiable Oil per cent	Lime Soap (calc. as calcium oleate) per cent	Free Lime per cent	Free Acid (calc. as oleic acid) per cent	Moisture and Undetermined per cent	Melting Point deg. fahr.
130,849	67.26	0.42	27.18	1.53	0.05	3.56	210
131,859	84.56	0.10	10.72	0.15	0.04	4.43	190
131,860	86.35	0.32	8.76	0.09	0.04	4.44	165
131,574	88.31	1.55	8.15	0.19	0.07	1.73	103
141,537	74.04	0.95	19.13	0.21	0.03	5.64	182
142,543	74.49	2.03	17.94	0.30	0.08	2.16	170
141,544	82.00	4.72	10.72	0.03	0.07	2.46	151
132,255	65.76	5.64	21.29	0.53	0.76	6.02	202
132,254	81.62	0.56	15.85	0.20	0.14	4.65	158
141,533	78.88	1.95	17.82	0.22	1.16	2.94	157
141,535	75.46	1.11	17.82	0.37	0.51	4.73	177
143,098	83.09	1.10	13.21	0.23	0.30	2.07	174

TABLE 2 LIME SODA-SOAP GREASES

Mark	Mineral Oil per cent	Neutral Saponifiable Oil per cent	Lime-Soap (calc. as calcium oleate) per cent	Soda-Soap (calc. as sodium oleate) per cent	Free Acid (calc. as oleic acid) per cent	Free Alkali (calc. as sodium-hydroxide) per cent	Free Lime per cent	Moisture and Undetermined per cent	Melting Point deg. fahr.
134,705	74.28	0.42	19.09	1.78	absent	0.014	0.65	3.76	205
134,710	77.30		0.71	19.76	absent	0.013	0.52	1.697	205
134,711	85.38	0.40	11.02	0.95	absent	0.002	0.13	2.118	192
134,712	90.44	0.53	6.80	0.77	absent	0.006	0.04	1.414	114
134,713	84.26	0.50	2.17	11.04	absent	0.002	0.22	1.808	160
141,536	72.82	1.20	18.42	1.88	0.57	absent	0.05	5.06	186
141,538	84.70	2.15	9.12	1.14	0.42	absent	0.40	2.43	183
141,540	78.00	3.95	14.34	1.52	absent	0.004	0.57	1.606	189

TABLE 3 SODA-SOAP GREASES

Mark	Mineral Oil per cent	Neutral Saponifiable Oil per cent	Soda-Soap (calc. as sodium oleate) per cent	Free Alkali (calc. as sodium oleate) per cent	Free Acid (calc. as oleic acid) per cent	Moisture and Undetermined per cent	Melting Point deg. fahr.
132,736	98.13	0.60	0.70	absent	0.05	0.52	Fluid at r'm.temp
132,738	95.02	0.32	3.69	0.01	absent	0.96	98
134,136	92.60	0.30	6.10	absent	0.06	0.94	110
135,863	53.60	28.88	5.17	absent	0.14	12.21	108

to their product, but not directly comparable to any other manufacturer's product. In the absence of a standard test, the adoption of the method for determining the melting point described by Gillett is urged. (See *Journal Industrial and Engineering Chemistry*, 1909, page 351.)

This method makes use of an open capillary tube 4 mm. inside diameter and about 8 cm. long, graduated at 1 cm. and 5 cm. from one end. The tube is stuck into the grease, and if necessary, suction is used at the same time to draw up a plug of grease 1 cm. into the tube. The tube is then attached, with a rubber band, to a thermometer so that the grease plug is beside the bulb. The thermometer and tube are immersed in a beaker of water so that the bottom of the tube is 5 cm. below the surface of the water, and the water is heated at a rate of 3 to 4 degrees per minute. When the melting point is reached, the plug which is under a pressure of 5 cm. of water, slides upward in the tube.

By itself, this test means very little, but when made in conjunction with a complete analysis of a grease, it enables one to check up the uniformity of the manufacturer's product on various lots of the same grade and gives some idea of the temperature under which the grease will operate. The melting point as determined above is dependent upon the nature and amount of soap, oil, and water in the grease as well as the processes used in combining the various constituents of the grease.

It is also desirable to keep the free lime content of the grease down to a minimum as any excess detracts from the lubricating qualities of the grease. Experience indicates that 0.5 per cent is a desirable limit. In some of the greases that the author has examined, small lumps of free lime were discovered to be distributed throughout the grease.

The highest grade ball-bearing greases are put through a milling process after compounding. This treatment insures very intimate mixing of all constituents and pulverizes any chance impurity to an impalpable powder. It is strongly recommended that all greases for ball-bearings be so treated.

Graphite as a Lubricant

Graphite, despite its unctious qualities, cannot be regarded as a true lubricant. It can, however, be used with success in plain bearings as it fills in the interstices in the bearing surfaces and allows the true lubricant to operate efficiently. A modern well-made ball-bearing with mirror-like finish has, however, practically no interstices in the balls and raceways. A perfectly finished ball shows no scratches when magnified 100 diameters and furthermore, were there irregularities present, graphite would not eliminate them as there is considerable difference between the sliding action of a plain-bearing and the rolling action of a ball-bearing.

Graphite, moreover, has a tendency to pack in the ball retainers and raceways, and a bearing which has been lubricated with graphite grease generally has a distinct wavy appearance in the ball paths. A recent brief test of a grease containing colloidal graphite revealed the fact that while the graphite did not pack in the raceways, and the wavy ball paths were absent, the complete raceway presented a burnished appearace quite different from that obtained by the use of ordinary greases. The graphite packed hard in the ball retainer and could not be removed by dipping in gasoline.

The use of graphite in ball-bearings cannot, therefore, be regarded as beneficial, and its application is purely a question of economics. Its use in ball-bearing automobile transmissions and rear axles is advisable only if the increased efficiency and life of the gears offsets any possible harmful effect on the bearings.

Analysis of Lime-Soap Greases

The procedure for analyzing lime greases is not a simple one and the following suggested form may prove of interest. The ordinary constituents of a lime-soap grease are:

$$\left.\begin{array}{l} a\ \text{Mineral oil} \\ b\ \text{Saponifiable oil} \\ c\ \text{Free lime} \\ d\ \text{Free fatty acid} \\ e\ \text{Moisture} \\ f\ \text{Soap.} \end{array}\right\}\ \text{Original State}$$

Determination of Total Fatty Matter. Weigh 10 grams of the grease into 250 cc. extraction flask, add 50 cc. water and 5 cc. of hydrochloric acid. Boil on hot-plate for one hour or until the soap is completely broken up. Make sulphuric ether extraction, leaving,

$$\left.\begin{array}{l} a\ \text{Mineral oil} \\ b\ \text{Neutral saponifiable oil} \\ d\ \text{Fatty acid.} \end{array}\right\}\ \text{Second stage}$$

Determination of Total Acidity. Add 50 cc. of neutral alcohol, heat under reflex condenser for fifteen minutes to dissolve fatty acids and titrate with standard alkali using phenolphthalein as indicated. The standard alkali used in the titration is calculated to oleic acid which gives a total of fatty acids combined as soap and free fatty acids existing in the grease, leaving

$$\left.\begin{array}{l} a\ \text{Mineral oil} \\ b\ \text{Neutral saponifiable oil} \end{array}\right\}\ \text{Third stage}$$

Determination of Neutral Saponifiable Oil. To the contents of the flask from the above determination, add 25 cc. of standard alcoholic caustic potash solution and boil under reflex condenser for two hours. Titrate the excess of caustic potash with standard hydrochloric acid and calculate the number of milligrams of caustic potash used up by the neutral saponifiable oil. The neutral saponifiable oil is then calculated from the saponification number, leaving

$$a\ \text{Mineral oil}\ \}\ \text{Fourth stage}$$

Determination of Mineral Oil. Add 10 cc. of standard alcoholic caustic potash solution to the contents of the flask used in the previous determination and boil under reflex condenser for one-half hour. Cool and make petrolic ether extraction. Ether extract contains the mineral oil.

Determination of Ash Content. Weigh 10 grams of grease in a platinum dish. Burn to ash over gas burner. Residue may contain lime, lead, sodium, sand, potassium, silicates, iron, aluminum, mica, talc, or mineral filler. Weigh residue and add hydrochloric acid. Heat and filter. Residue contains sand, silicates, mica, talc, etc.

The filtrate contains iron, aluminum, calcium, sodium, potassium, etc., and should be made alkaline with ammonia, then boiled and filtered. Residue is iron and aluminum. Filtrate contains calcium, sodium, and potassium. Add excess of ammonium oxalate to filtrate, and filter. Residue contains lime in form of calcium oxalate, filtrate contains sodium and potassium.

While the bases used in the soap may be determined by the usual chemical methods as indicated above, micro-chemical methods are quicker and more delicate for qualitative tests and in some instances the latter method represents the only practical means of determining very small amounts of the bases used. Chamot, in his book on Elementary Chemical Microscopy, gives a complete and detailed account of the methods to be used in microscopic analysis.

In conclusion, the author would like to point out the need for further investigations to obtain data so that lubricating grease specifications may be standardized. The lubrication problem is essentially a chemical problem and we should welcome the assistance of the chemical societies in this matter.

The railroads have at last shown a net gain to the government. The operating results for the month of July of practically all Class 1 railroads and terminal companies under federal operation indicate that this net gain will run to approximately $2,000,000. The net operating income for the month of July, 1919, was about $77,000,000. The indicated net gain to the government for July is obtained after allowing one-twelfth of the annual rental due the railroads. The net loss to July 31, 1919, was $290,526,307.

Mid-Continent Section Meeting of A. S. M. E.

A Group of Papers Relating Mainly to the Oil Industry, Presented at the First Meeting of the Mid-Continent Section of the Society at Tulsa, Okla.

One of the newest Sections of The American Society of Mechanical Engineers is located in the heart of the famous mid-continent oil fields, with headquarters at Tulsa, Okla. This Section covers the large territory included in Oklahoma, Kansas, Northern Texas, and a portion of Louisiana and Arkansas. While its meetings will be devoted to general engineering subjects, it is expected that many of the papers will relate to the betterment of the mechanical phases of the petroleum industry. On May 23, 1919, an all-day meeting was held, at which the group of papers here abstracted was presented. A feature was made of the inspection of airplanes which had been brought from the Air Service Center, No. 2, Romorantin, France, by Lieut. E. E. Ives, recently of the U. S. Air Service, who gave a brief paper, here included. The Mid-Continent Section is now planning a second meeting to be held the latter part of October, announcement of which is in this number.

THE EDUCATION OF A PETROLEUM ENGINEER

By J. H. FELGAR,[1] NORMAN, OKLA.

IN discussing this topic, the writer desires, first of all, to call attention to Dr. Mann's preliminary report on engineering education in which there was discussed the replies received from a questionnaire sent out to a large number of employers of technical men, and to technical men themselves. The replies indicated the rather startling conclusion that the factors which go to make up technically educated men, able to compete in their professions, are mainly personal qualifications and not technical knowledge as might have been supposed. This report has naturally led to a general consideration of the requisites of a technical education.

There are certain fundamental studies which form the backbone of any engineering course and these are mathematics through calculus, one year of college physics, a full treatment of applied and theoretical mechanics, a full course in strength of materials, and a carefully-given course in statics and dynamics. To these might be added a year in chemistry and a course in English composition and literature.

There should also be included in the curriculum a course in business law and contracts, elementary accounting, and the fundamentals of cost accounting. These three courses make a foundation upon which a knowledge of business administration could very well be built.

No engineering course is complete without a year of mechanical drawing, and in addition to this, a course in descriptive geometry develops constructive thought and imagination. Shop work and elementary surveying are also essential.

There are, of course, the subjects taken just for their educational value and the satisfaction in the knowledge gained, and there are few engineering educators who would not appreciate an opportunity for their students to take a course in history, political science, sociology, literature, and art.

Coming now more particularly to the subject of petroleum engineering from the production standpoint, this should include scientific work in locating new fields, location and drilling of wells, conservation of the product, whether oil or gas, the piping of oil to storage and gas to the consumption point. Following the year of fundamental chemistry, there should be a course in quantitative analysis and organic chemistry with special attention to the specific problems of oil and gas. This course is for the general education of the technical student entering this field and should, therefore, be included whether any application is made of it or not. In the second semester of the freshman year, a course in the elements of surveying should be started, continued through the more advanced subjects and concluded by a practical course in the field. In the sophomore year the student should begin the study of the elements of geology, and sufficient work in higher geology should also be given so as to permit of his entering the field and seeking employment in the geology department of any oil company.

The moment that one approaches the field of petroleum engineering he realizes that there is a demand for training in mechanical engineering, and such a training should comprise the fundamentals of steam machinery, including engines, pumps, compressors, etc., and also the fundamental principles of gas and gasoline engines. A course in the study of transmission of oil and gas through pipe-lines is also worthy of a hearing, and it would not be amiss to acquaint the student with classes, types and methods of drilling.

Electricity and electrical machinery are finding a place in the production of oil, and for this reason a petroleum engineer should be familiar with the fundamental principles of electricity as presented by a course in electricity and magnetism. He should also have a knowledge of the workings and principles of electrical machinery, gained through laboratory experiments. Such a course as this will be found in practically every non-electric course in any technical school throughout the country, and will fulfill the fundamental needs in a course in oil and gas production.

Turning to the refining standpoint, there is no doubt but that from the fundamental outline already discussed, the technical work could be filled in from the departments of chemistry and engineering. In mechanical engineering it would be necessary to begin with the fundamental course in steam engines and boilers, taking along with it some laboratory work in the operation and efficiency of steam machinery, together with the discussion of the transmission, metering and flow of fluids in pipes and a knowledge of the machinery necessary to produce this flow. It would be well to include a careful study of the economy of burning fuels under different types of boilers, including their cost and construction, and to obtain a knowledge of the fundamentals of heat transfer, a thorough course in thermodynamics should be included, which should take up in detail the different engine cycles, compressors, and the specific heat of different substances, taken separately, and a mixture of these substances; also a study of the saturation tables of different fluids at different temperatures and pressures, a study of the specific gravity, etc. This course can be made as comprehensive in the theory of heat as time will allow, and is, without doubt, a fundamental course. There could also be included a course in the principles and operation of oil and gas engines.

The foundation work in chemistry should be continued, including a course in quantitative analysis which follows the first year's work taken by all students. A fundamental course in organic chemistry and another in organic preparation could also be given. Qualitative analysis should likewise be more carefully studied, for no better course exists to develop insight into the scientific spirit than a study of physical chemistry and physical-chemical measurements. Along with all this material, the study of petroleum technology could be begun. The studies dealing more intimately with petroleum engineering could be given in as many subdivisions as there was time to devote to them, and would include lectures on theory and practice of petroleum refining, petroleum products, natural gas and natural-gas products, and the analysis of petroleum products, coal tar, oil shales, and natural gas. The details of petroleum refining could be taken up in a separate course, each followed with laboratory work to emphasize the theory. Research problems might

[1] Dean, College of Engineering, University of Oklahoma. Mem. Am. Soc. M. E.

also be given and inspection trips should be taken to study actual conditions. The laboratory work would also include the carrying out of the refining process in a small but complete refinery of about one to five barrels capacity.

Although such an undergraduate course is intended primarily to give a fundamental training in petroleum technology, nevertheless, the student would not find himself unnecessarily handicapped if an opportunity presented itself in other allied fields.

Even a brief study of this undergraduate course, by anyone interested in petroleum engineering, will immediately disclose the fact that many of the problems, which he had in mind for such a course, could not be considered by undergraduate students, but must be solved by the work of graduates. Each will realize also that any technical course is perfected through development, or through a process of evolution, as a biologist would call it, and if the engineering profession can come to some reasonable agreement as to what fundamental general training and professional work should be included in the undergraduate course, then such agreement will immediately eliminate the more advanced problems for graduate study. The problem of getting this material into the course can be attacked in two ways: first, by requiring a year of general training before entering the technical school, in which considerable of the preliminary work will be carried, leaving room at the end for these more advanced classes in technology; or second, by the addition of a stiff graduate year to the course already outlined, in which the advanced problems could be approached.

In conclusion the writer wishes to present the outlines of three courses, the first giving the essentials of any technical course, as combined with suggested professional work adapted to prepare for the petroleum field, the second, a suggested course in petroleum-production engineering and the third, a suggested course in petroleum-refining engineering.

The Essentials of a Technical Course[1]

First Year

Chemistry	5	Analytical Chemistry	3
Algebra	3	Analytical Geometry	5
English	3	English	3
Drawing	2	Drawing	2
Shop	1	Shop	1
		Surveying	3
Total	14	Total	17

Second Year

Calculus	3	Calculus	3
Physics	4	Physics	4
Descriptive Geometry	2	(Courses especially related to the petroleum industry)	11
(Courses especially related to the petroleum industry)	9		
Total	18	Total	18

Third Year

Mechanics	5	Strength of Materials	4
Graphics	1	Testing Materials	2
Elementary M. E.	3	Hydraulics	3
Economics and Business Administration	3	Elementary Accounting	2
(Petroleum Industry Courses)	8	(Petroleum Industry Courses)	7
Total	**20**	Total	18

Fourth Year

Electrical Machinery	3	Electrical Machinery	3
Electrical Laboratory	1	Electrical Laboratory	1
Adv. English Composition	2	Engineering Contracts	2
Cost Accounting	2	Organization and Management	2
(Petroleum Industry Courses)	10	(Petroleum Industry Courses)	10
Total	18	Total	18

[1] The courses in parenthesis apply only to such as are especially adapted to prepare one for the petroleum field and include chemistry, geology, mechanical engineering, civil engineering, etc. The course in petroleum production requires somewhat different studies than that in petroleum refining.

A Suggested Course in Petroleum-Refining Engineering

First Year Common to All

Second Year

Quantitative Analysis	3	Petroleum Chemistry	5
Organic Chemistry	5	Organic Chemistry	2
Gas and Gasoline Engines	3	Adv. Quantitative Analysis	3
Total	11	Total	10

Third Year

Elementary Geology	5	Elementary Geology	5
Physical Chemistry	3	Physical Chemistry Measurements	3
Petroleum Chemistry	3	Chemical Technology	2
Total	11	Gas Analysis	3
		Total	13

Fourth Year

Steam Machinery	2	Field Work	3
Petroleum Chem. Lab.	3	Petroleum Research Chemistry	5
Petroleum and Gas Transmission and Measurement	3	Total	8
Total	8		

A Suggested Course in Petroleum-Production Engineering

First Year Common to All

Second Year

Advanced Surveying	4	Surveying Field Practice	2
Elementary Geology	5	Elementary Geology	5
		Topographical Drawing	2
Total	9	Oil and Gas Engines	2
		Total	11

Third Year

Quantitative Analysis	3	Organic Chemistry	5
Elementary Mineralogy	5	Geological Map Interpretation	5
Steam Machinery	3	Adv. Mineralogy	3
Total	11	Total	13

Fourth Year

Economy Geology	5	Peroleum and Gas Geology	5
Oil and Gas Transmission, and Measurement	3	Petroleum Chemistry	5
Total	8	Total	10

THE TANK CAR MAINTENANCE PROBLEM

By PAUL BATEMAN,[1] COFFEYVILLE, KAN.

SINCE tank cars constitute a large item of initial expense to almost every producer and marketer of petroleum products, it is of some importance that they be maintained at a point of greatest efficiency with minimum up-keep expense.

As an engineer and designer for several years, in the employ of two of the largest car builders in the country, it was a matter of circumstance that one of the outstanding ideas of car builders was forcibly brought to my notice. That is, in substance, design *something different*. The best engineering practice is sometimes made subservient to the principle of designing something on which a claim for a patent may be made.

This practice has resulted in innumerable types of cars, each type with its own variations, and has greatly complicated the problem of maintenance of equipment. Repair shops have been called into existence by the impossibility of car owners carrying a sufficient variety of parts to repair their cars properly. Although there are some few concerns which employ experienced repair men, the owners of cars must in general trust to inefficient labor to perform work that requires specialized knowledge and experience.

Behind the experience, also, there must be knowledge, not only knowledge of how to make repairs, but of why the part requires repairs and of how to prevent a recurrence of the same trouble.

[1] Superintendent, Peoples Tank-Line Co. Assoc.-Mem. Am. Soc. M. E.

To make this clear we will refer to Fig. 1 showing the end of the underframe of a car. There are innumerable variations in the end structure, but the principle must remain the same in all.

Repair of Friction Draft Gear

The yoke, Fig. 1, is riveted to the butt end of the coupler and contains certain friction parts, which, in buffing, are compressed by the coupler against stops, or lugs, riveted to the longitudinal beams, or sills. In pulling, the yoke is brought into play and performs the same duty in a reverse direction, by compressing the friction parts against the front stops or lugs.

When originally installed the "friction draft gear" is provided with sufficient travel to enable the full capacity of the gear to be utilized. Any shock in excess of the capacity of the gear is absorbed by the horn of the coupler striking against the buffer

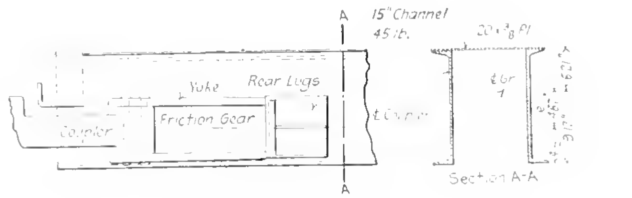


Fig. 1 End of the Underframe of a Car

on the end of the sills, after the gear is compressed to its full capacity.

The gear, as installed, is not at the center of the sills, due to details of construction based on truck clearances and the necessity of keeping the center of gravity of the loaded car as low as possible and there is approximately a 200,000-lb. shock on a 13 in. to 15 in. girder with an eccentricity of about 4 in. to 6 in. Any shock above the absorption capacity of the gear is absorbed by a direct blow against the fully-compressed gear which now

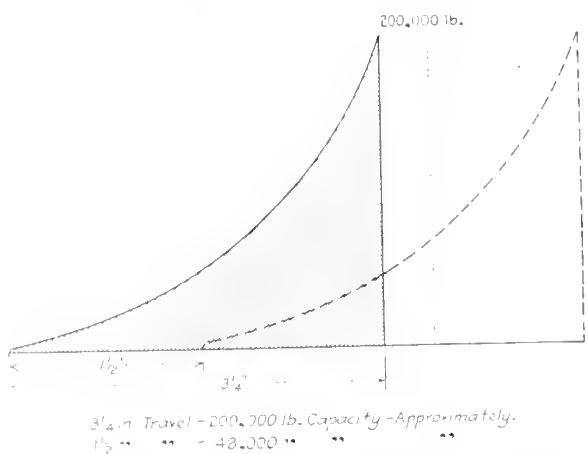


Fig. 2 Composite Compression Diagram of Draft Gears

acts as a rigid block. When wear on the friction elements develops, the end clearance betweene coupler and buffer block is eliminated and the impact load in excess of the gear capacity is received by the buffer. The gear, as originally installed, gives protection to the car, but when the friction parts wear, more and more of the impact load is directly transmitted to the buffer. As the latter has relatively little resiliency, it is only a question of a short time before it is broken, thus bringing the full load on the gear and thence directly to the sills. The obvious result is that the sills spread and buckle, or else the rivets on the rear draft lugs are sheared, sometimes both. The usual procedure has always been to say. "Oh, let it ride, the sills are all right, we'll fix it sometime." When it is finally released for repairs the first and only thing done is to put on a new buffer and let the worn-out gear alone.

If the gear has worn so that the first $1\frac{1}{2}$ in. of travel has become non-effective, there will be left only $1\frac{3}{4}$ in. of useful travel of the original $3\frac{1}{4}$ in., giving a retarding value of only about one-fourth of the capacity of the gear. (Fig. 2.) With the full load of a moving train, having a possible buffing shock up to 1,000,000 ft-lb., it is not hard to imagine the effect on the new buffer casting.

This is not an isolated case but is the usual procedure all over the country, not alone with the refiners, but also with the railroad companies and even some of the private repair shops.

As we are dealing with buffer forces, we have kinetic energy, which does not permit of the same assumption for fiber stresses as in the case of static loads. Under static loads we can figure a column at its full value, with each of the fibers bearing an equal portion of the load. Under our conditions, however, we have two variable forces, one along the center line of the coupler and the other along the center line of buffer impact, the latter after the frictional resistance of the gear has been absorbed. In addition we have the forces compounded by secondary forces which cause torsional stresses. These latter are caused by inequalities of tracks, different heights of couplers, impacts on curved track, couplers being off center, etc. We term them secondary forces,

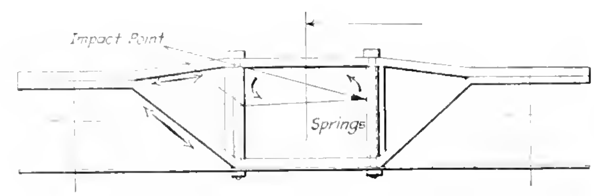


Fig. 3 Arch Bar Truck Construction

but they are really as much a part of the primary forces as are any others.

In tank car design, we do not have to consider the deflection due to loading on account of the loads usually being concentrated at the bolsters and thence transmitted directly to the truck, so all we have is the compound load due to conditions previously mentioned.

The above case, as illustrated, is indicative of the usual methods employed in making repairs. No thought is given to the cause. The best way to make repairs, of course, is to prevent the necessity. However, in conditions as they are, the best procedure is to remove the slack travel of the coupler by renewal of necessary parts and by placing shims between the gear and the lugs. After that, see that the correct position is maintained.

Truck Repairs

Reference to Fig. 3 shows the usual design of arch bar truck construction and the lines of force with their attendant results. We will suppose a loaded car to be in a rapidly-moving train, when an emergency application of the brakes is made.

The braking power is from 70 per cent to 90 per cent of the light weight of the car which, in a 38000-lb. car of 8000 gal. capacity, loaded with gasoline, is 30 per cent to 40 per cent of the total weight of the car. The result is that the trucks receive a direct load at the center plate due to the inertia of the entire loaded body of car at whatever speed it is traveling.

It has always seemed inconsistent that one part of the car—the sills, through the coupler—should be used to start the car, and another and much lighter part—the brakes operating on the trucks—should be used to stop it. The writer sees no way, at the present time, to improve the basic principle of this.

The resultant tendency in brake application is to transmit a load to *one* side of the center plate and generate torsional stresses tending to rotate the bolster. This load very naturally comes on only one side of the truck springs, which are intended always to act as a unit. The result is that the springs compress unequally and throw the bolster against the columns with unequal bearing. This causes failure in the columns by tearing the column bolt

through the wearing surface of the column. A condition of this kind is usually caused by neglect in allowing nuts of column bolts to become loose, thus permitting the arch bars to spread and allowing excess clearance. Quite frequently the cars, as originally built, have entirely too much clearance.

The material wear of columns and of the column guides on the bolster should be taken up by placing shims on one column or else on the column guide on the bolster. This is almost never done as it requires that the truck be practically dismantled.

Another cause of trouble is the rapid rounding of curves at which time the loaded car seeks a tangent and the trucks must follow the rails. That causes the bolsters to exert more pressure on one set of springs than on the other, thus allowing the springs to slip and quite frequently lose out. Improper side bearing spacing and clearance are very usual causes of truck failure and also cause derailment.

The principal instructions would seem to be to keep the truck tight and see that wooden shims, above or below springs, are renewed at sufficient intervals to insure that they are solid. The shims are made of seasoned oak but they decay very rapidly and allow the springs to settle into them, thus increasing clearances to an unsafe margin. Side bearing clearances must be kept at the proper point, 1/8 in. to 1/4 in. between top and bottom.

Repair of Tanks

Of the tanks proper little need be said except that all *indications* of leaks should be immediately looked into as stains on the *outside* usually mean that the caulking edge of the sheets and rivets on the *inside* has deteriorated. The tank should not only be caulked on the outside but more especially on the inside. It might be stated that caulking on the inside is almost never practiced except in the shop where its necessity is understood. The fact that inside caulking is obligatory, under Bureau of Explosives' Rules, seems to be overlooked. Leaks are quite commonly caused by deflection of the sheets of the unsupported end portion of the tank which causes distortion of the sheets at riveted joints.

The safety valves ordered to be used have always been a source of wonder to the writer, particularly as to why it seemed necessary to provide 40 sq.in. to safety valve outlet surface while the largest locomotive using superheated steam and a pressure of up to 250 lb. per sq. in. has only about 10 per cent of this area. The Master Car Builders Association has designed a device using a spring balance to determine the proper point at which to set the valve. Inequalities of bearing surface on the valve seats seem to be overlooked, consequently there is practically no guarantee that the valves will hold any pressure whatever.

All valves should be removed and ground in with emery in oil, then set to the proper point under a test by compressed air. The valve question is not only a maintenance problem but one in design, which we hope will have the attention of qualified engineers.

The advisability of keeping cars well protected by paint is too well known to require more than passing comment. That comment is mostly directed toward the policy of merely making the cars a good advertising sign board instead of seeing that the painting is properly done. Cars, particularly the tanks, should be thoroughly cleaned preparatory to painting as the improperly cleaned car will not hold the best paint made. My company has found it advisable to put the problems of painting up to the paint manufacturers, using their knowledge and experience in connection with our own.

One of the greatest causes of tank cars being neglected is the attitude of certain railroads, particularly at competitive points. When an inspector refuses a "Bad Order Car," a competing road's inspector will take it and so drum up business for his road. If it is impossible to run the car in its condition as accepted, temporary repairs are made. In fact, anything is done that will get it out of the yard at the point of origin. The owner is very grateful to the railroads accepting the car and consequently the accommodating railroad gets the future business.

This policy can have only one result, and that is evident when it is stated that the policy is pursued in endless chain fashion, the original road accepting cars that even the first offending road refused to handle.

INSPECTION OF AIRPLANES AT ROMORANTIN, FRANCE

By Lieut. Earl E. Ives,[1] Tulsa, Okla.

This paper relates to the inspection of airplanes at Air Service Production Center No. 2, Romorantin, France. All of the American-built planes which were used abroad were De Haviland-4s. They were shipped to Romorantin in a semi-assembled condition, there to be uncrated, set up, tested, and flown to the battle line. The plant in which this work was done had a floor capacity of 120 machines with wings on, and 75 to 100 machines without wings. In addition there was ample room for uncrating 50 machines a day and storage capacity for all this material. An airplane repair shop and a motor repair shop, each of the same size as the assembly plant, operated as auxiliaries to the assembly work.

When a machine was first uncrated an inspector was on the job with a handful of red rejection cards and repair shop cards. If defective material was found it was marked and the disposition to be made of it was indicated on the red card; that is, it was labeled "repair" or "salvage," as the case might be. If no trouble was found these first inspectors put a card on the machine which gave it the right to remain on the assembly floor.

Inspection in Fuselage Department

When the assembly work began the inspectors in the Fuselage Department went over every part of the machine. In checking up the machine for alignment the following rule was observed: "With the upper longerons level in the pilot's cock-pit, the motor bed should be level. A line parallel to and 16 7/8 in. below the top of the upper longerons, in the pilot's cock-pit, should bisect the sides of the tail. This line will be referred to as the line of flight of the machine. That is, it is a line parallel to the path of the machine when the machine is flying level and straight ahead at its rated speed. With the two upper longerons level with each other in the pilot's cock-pit, the rudder post in the tail of the machine should be in a vertical position, and the clips to which the main tail plane, or horizontal stabilizer, as it is called, is fastened, should be level. The motor should be level in the machine, and the center line of the crank shaft of the motor should be parallel with and directly under the center line of the machine. The axle in the landing gear should be at right angles to the center line of the machine, and should extend the same distance out on each side of the fuselage. The clips or hinges to which the wings are fastened must be uniformly located on the sides of the fuselage and in such a position that, when the wings are put on, the upper wing will be 12 in. ahead of the lower one. The center of the center section must be exactly above the center line of the machine."

It would be impossible to mention here all of the details watched by the inspectors as they looked over the fuselage, but a few will be interesting. "Make sure that the controls in the floor of the cock-pit are properly fastened. Be sure that the main stay-rods in the under side of the machine have not been cut by some Hun sympathizer. What is in the fire extinguisher, Pyrene or gasoline? Have all the internal brace wires in the fuselage been fastened so that the vibration of the motor will not loosen them? Are the brace wires that hold the motor in place damaged by corrosion?"

The controls to the motor, and instrument leads from the motor, were carefully examined, but in doing so the inspector knew that the man who tested the motor later on would find out whether every part of the power plant was functioning, so he looked the motor over more to help hasten the work than anything else. However, every defective instrument and damaged motor part was tagged as soon as it was found.

Before the machine could leave the assembly floor its propeller had to be properly installed. Before its installation the propeller was checked up by the following specifications: it must be in static balance, 3 in-oz. being the maximum error. The error in

[1] Recently of the U. S. Air Service.

track and length must not exceed 1/8 in., that is, ± 1/16 in. The error in pitch must not exceed 1 deg. at any point along the effective areas of the two blades, and the average error in pitch of the two blades must not exceed 20 min.

Every propeller was carefully watched for defective workmanship, and the writer has seen a great number of excellently finished oak and walnut blades uncrated in France with the hub hole bored through each at such an angle as to give the propeller a track error of half an inch. An Englishman in looking over the propellers said: "I say, why don't you fellows catch the Hun who is boring those holes for you?"

Motor and Propeller Inspection

The motor, of course, received a careful test. It was placed in a concrete stall where a free current of air could be obtained, and a bank of dirt received the bullets from the machine guns when their synchronizing mechanism was tested in connection with the propeller. The following requirements were rigidly demanded of every motor. After being warmed up it must run at 1600 r.p.m. without loading or choking; throttle to at least 300 r.p.m. without stopping; maintain an oil pressure of not over 30 lb. nor under 15 lb. in its range of speed; maintain a speed of 1500 r.p.m. without excessive vibration or over-heating; show that it is getting proper lubrication, that its ignition and throttling mechanisms are in first-class condition; and the sound of its exhaust must indicate that its valve openings are properly adjusted.

After this test a rigid inspection of all water, oil, and gasoline leads must prove that there are no leaks. A second check was made of the propeller alignment and general behavior of all motor control instruments. One instrument which was very carefully watched was the tachometer. It was very necessary to know that the motor actually developed its rated r.p.m., for with a standard propeller the motor speed was a direct check on the horsepower of the motor.

Final Inspection of Machine and Its Instruments

In the final inspection, after the machine was fully rigged and before its flight test, the following alignment specifications were followed. The angle of incidence measured with a straight edge rule and level must be 3 deg. The method of checking this was very simple. A straight edge touching the under side of the rear edge of the rear wing beam and held level must be 1 15/16 in. from the rear edge of the front wing beam when the machine was level in its line of flight. That is, the under side of the wing must cut the air stream at a positive or lifting angle of 3 deg. A simple jig reduced this check to the taking of one measurement, that is, the 1 15/16-in. measurement, with an over- and under-limit of 1/64 in. The dihedral angle of 3 deg. was even more easily checked. A string stretched across the top of the upper wings above the front wing beam must clear the center section 9⅛ in. when it touched the wing at the center strut fittings.

But the details which must be covered on an airplane before it can be OK'd as a perfect machine are an entirely different matter. For instance, to counteract the torque of the 400-hp. motor an extra amount of incidence must be put in the left wing. If this were not done the big bird would fly as though it had lost some of the feathers from its left wing. If the inter-plane struts are not all of proper length, the upper wing will not have the same angle of incidence as the lower one, and the pilot will say that the machine is heavy on one side, that it does not want to climb, or that it has a heavy tail. The angle of incidence is the all important factor in the final alignment of an airplane.

Then new wire, or cable, as it is referred to, will always stretch. The question of just how tight the machine can be set up and not endanger the strength of its own members and at the same time be sure of holding its alignment is one that the inspector must be able to answer without a second thought. With the check-up on equipment, and especially such special equipment as cameras, bomb-dropping sights, and machine guns, comes the necessity for an inspector with a ready mind. If he is not wide awake he will surely pass his machine with some of its vital parts missing.

The compass must be adjusted after all other apparatus has been installed. The residual magnetism of the motor has a tendency to throw the magnetic needle out of its proper course. When the motor is running, the magnetism of its rotating parts produces a still heavier effect on the compass needle. Before that instrument will function, the magnetic effect of the running motor must be counteracted. The inspector must make sure that the compass needle will point straight north when the machine is in the air, and he must, if possible, get all adjusting done before the flight test.

On the field the machine underwent a hasty inspection by the test pilot before flight. In the air it must fly level with a motor speed of 1350 to 1400 r.p.m. It must be easy enough on the controls to permit the pilot to release the stick and maintain his course and altitude with the use of his rudder alone. The motor must meet all the demands before mentioned, and in addition be able to maintain its r.p.m. in a steep climb. That is, a change of the level of gasoline in the float chamber of the carbureter must not affect the motor speed.

The card system mentioned earlier in this paper was a great aid in getting the excellent results obtained by the inspection department. When the assembly work was begun on the machine a card 5 in. by 8 in. was put in a holder on the outside of the machine. As one part of the work was completed or one alignment properly checked out the inspector on the job made record of the fact on the card. At the same time if he found some defect which must be remedied before the final OK he noted it on the back of the card. When the machine was ready to leave the first department all the assembly work assigned to that one floor had been passed on by the inspector and many of the defects remedied, which might have been overlooked later on, or if discovered would have delayed the machine in its schedule. The inspector who passed the machine to the next department removed the card and put on one which, it might be said, gave it the privilege of leaving the first assembly floor. Any defects still unattended to were carried forward to the new card and the old card was filed in the inspector's office as a part of the history of that plane. This process was repeated four different times, the plane receiving at last a final OK from the inspector. This OK was on a linen tag and remained on the machine when it was delivered to the front. If at any time a defect was found that would hold the machine in the department as much as two hours over its schedule, the inspector would remove the regular inspection card and put on a repair shop card which constituted a pass to the repair shop for that machine. When the repair shop card was properly signed, by the inspectors at the repair shop, the machine was placed back into the assembly process again and its old card was attached to it.

Personnel of Organization

A careful selection of the men available for inspection work revealed the fact that young men with some college training or at least high school education made the best inspectors. Men skilled in automobile repair work were the poorest. They wanted to do the job themselves. Jewelers were available for instrument inspection and cabinet makers for wood work. But men who could and would learn how to exercise good judgment along mechanical lines were hard to find. The best inspectors it was found could be more easily and quickly made out of young men who had not had a large amount of practical mechanical experience along any line.

The organization, which in November was capable of passing successfully on 50 complete airplanes a day, consisted of 75 non-commissioned officers and privates, and 10 commissioned officers. Five of the commissioned officers were test pilots. There were five distinct departments, first inspection, fuselage assembly inspection, motor inspection, final assembly inspection, and flight test. The daily and hourly reports came on the regular inspection cards to the inspection office from these different departments. The record of the work of the department is best told by saying that none of the 1400 machines passed by that organization, up to November 11, 1918, failed on the field because of some defect carelessly overlooked by an inspector.

INDUSTRIAL DEVELOPMENT IN THE TRANS-MISSOURI REGION

By P. F. Walker,[1] Lawrence, Kan.

By the Trans-Missouri region is meant the section of country west of the chain of towns on and in prolongation of the Missouri River, the prolongation referring to that part of the river north of Kansas City and extending westward into the intermountain region until the point is reached where Pacific coast shipping conditions are directly felt. This forms one of the zones recognized by the Interstate Commerce Commission in its railway-rate regulation measures. It is not the plan to include the whole of this zone, however, because vital factors other than railway rates tend to limit us in north and south directions, notably the influence of fuel supply. Our region then includes the entire states of Kansas, Oklahoma and Colorado, and parts of Texas, Arkansas, Missouri, Nebraska, and New Mexico. Gulf conditions cut off a considerable portion of Texas, as do Mississippi River conditions portions of Missouri and Arkansas. A strip of southern Nebraska and the northeastern portion of New Mexico come in to round out the circle of influence exercised by the oil field. It is worth noting that the geographical center of the United States lies due north of the center of this region and within the state of Kansas. It is, therefore, a section cut out of the heart of the country.

It is well to consider with care the natural resources of this region other than oil and gas. They are of significance on several bases: first, as raw or auxiliary material consumed in the production of finished goods; second, as indicative of the capacity of the region to support population in the direct matter of foodstuffs; and third, as an index of freight traffic on the railroads, and thus of the importance of the region in the transportation business of the country. The following figures are about ten years old and so are not to be taken to show accurate values for today, but are relative and so indicative of conditions in this group of states when compared with the United States as a whole. The figures are totaled for the states of Nebraska, Kansas, Oklahoma, Texas, Colorado, and New Mexico when available. It is to be borne in mind that the population of these states amounts to about 18.5 per cent of that of the United States and also that the center of population of the country has been moving westward gradually until now it is Indiana. This last point is of significance in the transportation of foodstuffs as well as in the location of the domestic market for manufactured goods.

Agricultural

Only approximate statements are given. In staple foodstuffs, wheat and meat products, the region produces about 40 per cent of the total for the country. This being four times the population ratio, three-fourths of the total product moves outside the region in either raw or manufactured form, representing an immense amount of through freight originating here. Other foodstuffs are more nearly balanced as regards shipment into or out of the region, with a difference in favor of the incoming in many of the more expensive varieties. In cotton and other fiber products the movement is outward, but not in notably large quantity. In general, the producing power of the region is far in excess of its population needs and creates outgoing traffic. It means a balance of credit in its favor, a not inconsiderable portion of the capital thus represented being invested in projects outside the

Mineral Products

The total value of the output of mines and quarries in this region amounted in 1909 to $123,214,000, which is 9.95 per cent of the total for the United States. This figure includes lead and zinc for Missouri because of the fact that in recent years this industry has moved almost wholly into Oklahoma and Kansas, and always has been identified in a distinctive way with these states. These mineral products are of special significance. It is to be noted that the percentage is essentially the same as that of population. Developments of recent years have made it slightly more. Outside of petroleum products, the most distinctive are lead and zinc, occurring and treated as one. The figures of ten years ago show this item as $23,196,000, 81.2 per cent of the total of the country. The figures are altered now, but possibly the older ones are fully as significant as are those resulting from the abnormal conditions of the last two years. The deposits are small in area, but of tremendous significance in the production of those metals on a world basis. Happening to occur at the junction of three states, the really small distribution appears in a large way in the published statistics. In this case concentration is a fortunate circumstance, especially as the field is close to the best coal and petroleum fields of the region.

Coal deposits occur in workable form in each state excepting Nebraska. The total product is about 27,000,000 tons, which is 7.1 per cent of the total of the country. The wide distribution is a fortunate element with reference to the general upbuilding of industrial enterprises, and an increased production would follow with the increasing demand. The western mines have been proven to produce coal yielding fair grades of metallurgical coke, a thing, by the way, which should be followed out and developed with care. Its association with the foundry and machine products business is apparent.

Gypsum is produced in nearly every part of the region, the total output amounting to $1,381,300, which is 23.8 per cent of the total of the country. This output can be readily increased and to advantage.

Limestone is abundant throughout and is produced as desired. The recorded output is 7.5 per cent of the total of the country and valued at $2,237,000. This is independent of that produced directly for cement manufacturing purposes.

Clays, shales, and limestones for the production of many varieties of clay products, including Portland cement, are abundant. Monetary or quantitative values are difficult to secure, and as records, would be of slight significance. There is no limit at all to possible developments in this line dependent upon quantities of material available. Cement manufactures are included in manufacturing statistics to be discussed later.

In the western portion of the region many of the finer metals are plentiful, notably copper, silver, and tungsten. They do not figure appreciably in respect to transportation considerations, however, and their development is dependent on conditions quite special and distinct from other economic relationships.

In general, the outstanding resources of the region which contribute to the enterprises of the country as a whole beyond the needs of the local population are the cereals and meat products in the food group; lead and zinc spelter and gypsum products in the metal group, together with the special rare metals of Colorado; salt in both raw and refined forms; and petroleum and its refined products in the fuel group. In large measure these commodities leave the region in raw or only partially manufactured form. Others of the list of resources are undeveloped because of the fact that their shipment in raw material form is impossible, and manufacturing enterprise has not yet brought the opportunity for full realization of the possibilities.

Accomplishments in Manufacturing

Only a brief summary will be given. Contrary to the popular impression, the number of kinds of manufacturing enterprises which have grown up in the region to an extent which makes them of real significance in supplying the markets is large, and to go into detail is beyond the scope of this paper.

In 1909 the value of the manufactured products in the six states was $988,642,000. This is 4.8 per cent of the total for the United States. Some advance has been made in the past ten years, although the percentage relationship may not be greatly increased because of the tremendous impetus which manufacturing has undergone everywhere. If we eliminate the meat-packing plants of Kansas City and Omaha, in order to get a closer comparison with respect to general diversified manufacturing, the percentage

[1] Dean of the School of Engineering, University of Kansas. Mem. Am. Soc. M. E.

drops to 3.6, or almost exactly one-third the amount which the local market demands on the basis of population. After making due allowance for manufactured goods going to export trade, it appears that our region is producing, in gross, slightly over 40 per cent of the value of articles needed in local markets. Probably the surprise is that the percentage is so high rather than so low, although it is to be borne in mind that the purchasing power of this western region is high compared with many blocks of population of similar size in the congested cities of the east, so that our actual market is not supplied up to this figure.

The lines of manufacturing in which a substantial development has taken place, arranged without reference to magnitude, are as follows:

Meat packing	$310,742,000
Flour and grist-mill products	146,271,000
Canning and preserving	2,793,000
Dairy products	17,902,000
Cotton goods	2,815,000
Men's clothing	3,933,000
Leather goods	8,746,000
Medicines and druggists' preparations	2,636,000
Tobacco goods	2,877,000
Lumber and timber products	48,252,000
Clay products (not including cement)	1,411,000
Portland cement	5,537,000
Glass	2,037,000
Salt, refined	1,513,000
Agricultural implements	521,000
Foundry and machine-shop products	24,807,000
Furniture and refrigerators	2,670,000
Sheet-metal manufactures	4,608,000
Paint and varnish	1,948,000
Wall plaster (gypsum)	884,000
Paper and paper goods	300,000
Railroad shop-repair work	39,706,000
Zinc smelting	13,859,000
Oil refining	......
Beet-sugar industry	......
Total	$646,768,000

Certain industries included in census reports under the heading of manufactures, such as printing and publishing, artificial ice, bakery products, etc., which are in themselves considerable items, are omitted from the list because they bear a somewhat different relationship to industrial development than do the others, which are forced to go to the market on a purely competitive basis. These listed industries, with values subject to great changes during the past ten years, but taken as they stand, involve the operation of equipment calling for 437,623 hp. They represent an invested capital of $310,255,000 and the employment of 135,044 persons.

It is significant that these enterprises are well distributed over the region, and that they embrace the nucleus of a mill population. This does not mean a mill population of the type found in manufacturing cities of the East, but it does mean that there is a group that is becoming skilled in shop and factory work. It is well known that the development of a population with a portion sufficiently large that is trained and acclimated to industrial-plant activities, so as to make the systematic development of manufactures possible, is a long process. Happily the progress made already in this region has carried us through the first difficult stages, and the curve of difficulties grows flatter and cause for concern on this score is rapidly growing less.

Transportation and Freight Adjustments

The one element in industry which must form the basis for gravest consideration in this Trans-Missouri region is that of transportation and freight adjustments. Freight rates make or break enterprises without number. This region has been peculiarly unfortunate during some periods in the past history of railroad manipulations and later adjustments, and anything that is done on a considerable scale very far west of the Missouri River must be prefaced by a very careful study of the rate situation. It is well understood that the river towns are basing points for through shipments and enjoy certain advantages on that account as compared with interior points which have to bear a local-rate addition. It results, therefore, that on commodities to and from the eastern markets the towns away from the river have a handicap that may be considerable, especially if some secondary material like fuel must be transported westward through a river point to the point of manufacture of the article in question.

We have a special interest, however, in the shipping conditions westward, now greater than ever with the striking possibilities before the Pacific coast towns. In the intervening country lies the natural home market for manufactured goods produced in the Trans-Missouri region. With the growth of that section of country should go the growth of industries in this section. The problem has been to reach it with our goods under conditions advantageous with reference to other more distant regions. Previous to the war, before the taking over of the railroads and the confusion resulting from unprecedented demands upon our entire transportation system, two steps had been taken in the adjustment of rates which reacted favorably for this region. The principles laid down in those decisions are practically sure to hold whatever the ultimate destiny of the railroads may be.

By the decision of the Interstate Commerce Commission in 1911, and upheld by decision of the Supreme Court in June, 1914, on traffic originating at the Missouri River and points west thereof, the rates to intermediate points should not be more than the rates through to the Pacific coast terminals. This region is designated as Zone 1. On traffic originating in Zone 2, which is the region east of the Missouri River as far as the Chicago territory, the rates to intermountain points should not exceed by more than 7 per cent the rates through to the coast terminals. Similar provisions with increasing percentages of excess are prescribed for zones in territory still farther east. This decision made the intermountain territory accessible to this Zone 1 region on terms slightly in our favor as compared with shipments made by way of the Pacific coast terminals.

The policy of blanketing the westbound rates over the eastern half of the United States gives another point that is favorable in a slightly more positive sense. By this plan of blanketing, the rate on a shipment westward is the same when starting from any point east of the Missouri River. Traffic originating west of the river for west coast or intermountain points may be given lower rates. This distinctly favors the establishment of enterprises in this district for the intermountain market.

With the opening of the Panama Canal a new condition was created. With the above conditions in force any lowering of rates to coast terminals to meet the new type of competition of the water routes would have carried like reductions to all intermountain points. It was clear that some adjustment was necessary in order to preserve for the railroads an amount of business that would enable them to serve the country. On January 29, 1915, the Interstate Commerce Commission rendered its decision, containing this provision: that from points on the Missouri River and in the territory west thereof carload rates to intermediate points are not to exceed those of Pacific coast terminal points.
points are not to exceed those of Pacific coast terminal points, except for a list of twenty-eight articles or commodity groups which consist, for the most part, of various kinds of iron and steel manufactures. The decision also contains the provision that for these excepted articles the rate to intermediate points east of the Missouri the rates to coast terminals may be less than for intermediate points on a much greater number of articles.

Under transportation conditions of the last two years many changes have taken place in rates but the above comparison as to the relative adjustments will remain as the substantial basis, with little question of doubt. That such adjustment constitutes any marked advantage for this Trans-Missouri region in shipping to western markets over eastern producing territory, is not claimed. It does, however, tend to remove the unfavorable conditions which previously existed, and serves to give a fair and

equal opportunity for manufacturers of this region to reach a market which is bound to be increasingly profitable.

RESULT OF PRESENT-DAY TRANSPORTATION DIFFICULTIES

A condition, more or less temporary, exists now in the transportation business of the country which in a very real way makes for the encouragement of industrial enterprises in the West. This is the fact that shipments of goods from the East are difficult to secure. Because of the need this has produced the Pacific coast business men have actually started manufacturing enterprises of considerable magnitude. A few years more of the present stringency in transportation facilities and the west coast region will have developed a manufacturing business which it would not have done, under more normal conditions, in as many decades. In only a small measure is the situation different in this mid-west region. All that is needed are progressive groups of men, business men and engineers, who are alive to the fact that permanent prosperity and the unchecked increase in the value of their securities depend upon the development of a well-rounded out group of producing industries, and who in their several communities will devote their influence and energies to the encouragement of prospective manufacturers. This transportation tie-up is not a simple matter of diversion of effort to moving war material nor an illustration of inefficient management. Serious as may have been these factors, there is another that is with us to stay. It is the greatly augmented foreign trade that is upon us as a nation and that is bound to be a dominating factor in many phases of our industrial life. All over the country there is being preached the doctrine of promotion of export trade, and it means a change in many of our practices and ideals. An opportunity is at the door of this country greater in its way than anything else that has come to us in history. In a dozen different corners of the globe there are markets waiting for intelligent development by this nation.

The export trade in manufactured commodities may be a matter somewhat remote from this section west of the Missouri River so far as direct participation in it goes, excepting for products in the lines of foodstuffs, petroleum, lead and zinc. Even in those lines, in which production is on such a large scale, it may be that a wiser course to pursue is to look a little less intently for the foreign market as a direct market, and give more attention to the development of the varied lines which will build up our own region and make the home markets a more complete absorbent for these dominating products. And in particular let it be observed that the diversion of so much product from the established manufacturing centers, from home to foreign markets, makes the creation of new industries in these regions more natural. Materials in place of manufactured goods in return for the immense quantities of freight taken out of the region in the form of cereal and meat products only partially manufactured will mean the development of our population in more systematic manner, and the substitution of intensive for extensive method on many wide expanses of the western plains. It will mean a more complete realization of the possibilities which lie in these sections of Texas, Oklahoma, and western Kansas which now yield so little.

REGIONAL FUEL SITUATION

There is one serious condition which remains to be satisfied in the full before such program can be carried out in full confidence. Reference more or less detailed has been made in four of the prime essentials for industrial development; namely, materials, labor, transportation, and markets. A factor of equal import is that of power, which means the regional fuel supply. Coal is well distributed over the region, but the deposits are not large. The Pacific coast states have at their north doors in the remarkable coal deposits of Alaska, a source of energy for industrial enterprises that is unmeasurable. All that is needed is a more enlightened policy on the part of the federal administration to make coal production from that field a sure and determining factor in our national progress. Before we are many years older Alaskan coal will be on its way in American ships through the Panama Canal up the Mississippi River for distribution in the Missouri Valley. But the Pacific coast states will have that coal first, and at low cost.

The fuel situation in this Trans-Missouri region calls for careful survey and analysis. The extent to which the unique petroleum resources will be available for local industry should be worked out by men who have the oil business at their fingers' ends. The full realization of possibilities in the lead and zinc field is waiting on the creation of a source of cheap power, making the electrolytic-zinc process feasible. The full utilization of paper pulp in the arts, with untold tons of the principal raw material going up in smoke on the Kansas wheat fields while the forests of the north are dwindling, is dependent upon the economical production of heat energy in the form of steam. The time is not far distant when fertilization of western soil will be demanded, for which nitrogen secured by the fixation process of electrical means is the direct response. It is the fuel that is to determine the future of the region and this Section of the Society can do no greater service to the people of the country than to produce the sound facts which will show where we stand. This can be done by well considered information which will show material facts regarding both petroleum and coal as the fuel supply on which the local industrial life of the region must depend for indefinite periods of time.

A VOLUMETRIC EFFICIENCY TEST OF A VACUUM PUMP

By GEORGE S. TAYMAN,[1] TULSA, OKLA.

IT was the purpose of this test to determine the volumetric efficiency and indicated horsepower of a Laidlaw-Dunn-Gordon Duplex dry vacuum pump, size 18 in. by 12 in., when operating under different intake and discharge pressures. Tests were made on April 10, 1919, at Station No. 28, Helen Hardridge Lease, for the Gypsy Oil Company, located at Tulsa, Okla.

The vacuum pump was belt-driven by a 2-cycle Bessemer gas engine rated 50 hp. at 180 r.p.m., and a 11 in. by 12 in. Ingersoll-Rand duplex booster was used to obtain a vacuum on the discharge side. The booster was also driven by a 2-cycle Bessemer gas engine, rated 50 hp. at 180 r.p.m.

The general arrangement of piping and connections for gages, orifice prover, and location of thermometer wells were as follows: The intake of the vacuum pump consisted of a 6-in. line with gate-valve near the pump for controlling the vacuum on the intake. Connections for manometer and thermometer wells were located between the gate-valve and vacuum pump.

The discharged air was led to a scrubber tank in order to eliminate the effect of the pulsations from the pump to the manometer, the latter being placed in the discharge line near the vacuum pump. The intake of the booster was connected to the scrubber tank, and the degree of vacuum or pressure on the discharge side of the vacuum pump was controlled by a gate-valve on the intake of the booster. The discharge line from the booster was connected to a second scrubber tank, and the orifice prover was connected to this tank by a 4-in. pipe. The function of this scrubber tank was to maintain a uniform pressure on the orifice prover during each test by reducing the pulsations from the discharge of the booster as far as possible.

Before starting the test the valves were removed from the vacuum and thoroughly cleaned and inspected. The packing glands were tightened on the piston rods of both vacuum pump and booster and tests were made for air leaks on all manometer connections. The intake valve of the vacuum pump was set so as to obtain a vacuum of 28 in. of mercury, and the intake valve on the booster was left wide open (this being the controling valve for discharge vacuum or pressure on vacuum pump) and under such conditions a maximum discharge of 24 in. of mercury was obtained.

It should be noted that the displacement of the booster per revolution was less than that of the vacuum pump, and that it was also driven at a lower speed, therefore, a high vacuum during

[1]Mechanical Engineer, Gypsy Oil Co., Tulsa, Okla., Jun. Am. Soc. M. E.

the discharge period of the vacuum pump could not be expected. When a vacuum of 20 in. of mercury was obtained during the intake of the vacuum pump, the booster had only sufficient capacity to reduces the discharge pressure to atmospheric. The intake vacuum was kept constant for each series of tests and the discharge vacuum varied from the highest value that it was possible to obtain by the use of the booster to the greatest discharge pressures.

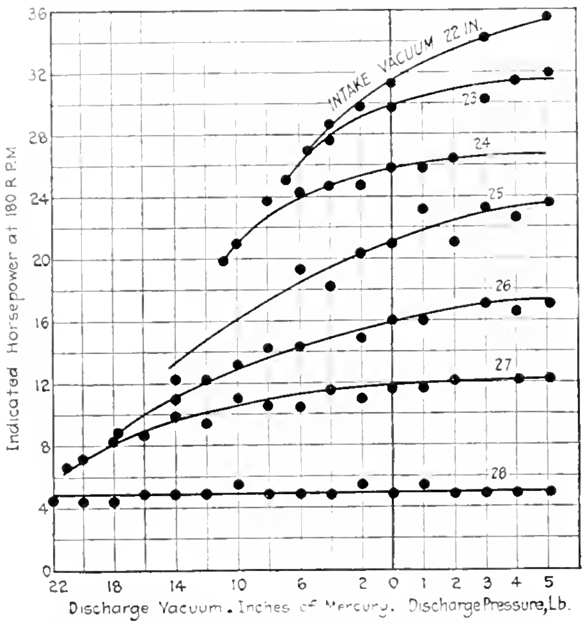


FIG. 1 INDICATED HORSEPOWER CURVES OF AN 18 X 12 IN. LAIDLAW-DUNN-GORDON PUMP

The following observations were taken for each test. Temperature of intake, temperature at orifice prover, vacuum on intake (constant for each series of tests), vacuum or pressure on discharge of vacuum pump, volume of air discharged through orifice prover per hour, barometer reading, and r.p.m. of vacuum pump.

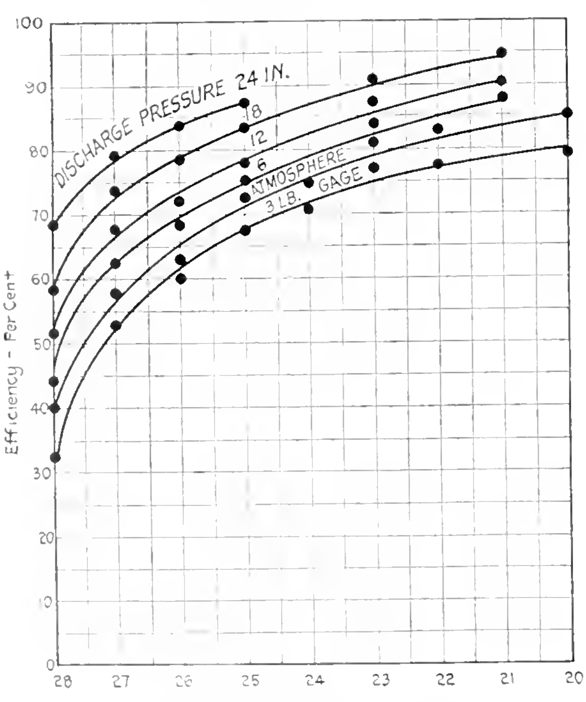


FIG. 2 VOLUMETRIC EFFICIENCY CURVES OF AN 18 X 12 IN. LAIDLAW-DUNN-GORDON PUMP

Three indicator cards were also taken for each test; one from each end of the cylinder and one including both ends. An American-Thompson indicator with 16-lb. spring was used for this purpose. From the cards thus secured the indicated horse-power was calculated, and curves plotted of indicated horse-power as the discharge vacuum or pressure, one curve being plotted for each intake vacuum from 22 to 28 in. inclusive, as shown in Fig. 1.

The primary object of this test, however, as previously stated, was to obtain a set of volumetric efficiency curves for constant discharge pressures with variable intake vacuum. Accordingly from the data secured, curves were plotted of volumetric efficiency vs. intake vacuums, one curve being plotted for each intake vacuum from 20 in. to 28 in. inclusive as shown by Fig. 2. The volumetric efficiency, in each case, was calculated by the following equation:

$$E_v = \frac{AT\sqrt{\frac{P}{P_1}}\left[\left(\frac{P}{13.6}\right)+B\right]}{DT_1\ P_2\ N}$$

When

E_v = volumetric efficiency

A = cu. ft. of air per min. through prover as shown by open holes

P = pressure on prover in inches of water

P_1 = correct pressure of orifice prover from tables

P_2 = absolute pressure on intake of vacuum pump in inches of mercury

B = barometer reading at time of test

T = absolute temperature of intake

T_1 = absolute temperature at orifice prover

D = displacement of vacuum pump, cu. ft. per revolution

N = revolutions per minute of vacuum pump.

Engineers in the Pan-American Financial Conference

Those in charge of the Second Pan-American Financial Conference state that the engineering profession will be well represented at the January conference to be held in Washington. Latin-American engineers are more closely connected with important industrial projects and have a greater command in matters pertaining to the developments on which they are working than is the case in the United States. Our own engineering profession may, therefore, do well to study the Latin-American plan of coöperation between capital and the engineers. The former Assistant Director of the Bureau of Foreign and Domestic Commerce has gone to Central America to obtain definite data on the credit and investment requirements of Latin-America, and these data are for the special use of the conference.

Experimental Work on Oil Shales

Because of the enormous amount of oil tied up in the great shale deposits of the United States it has been the opinion of many engineers that the recovery of the oil can be profitably undertaken. A bill has been introduced in the Senate proposing to provide the Bureau of Mines with $140,000 for experimental work on oil shales. The Secretary of the Interior has advised the Senate Committee on Mines and Mining that the plan for the proposed research work is necessary to ascertain the most profitable way of recovering the oil. The bill has his complete approval.

A large initial outlay of capital will be necessary in any projects organized to get commercial oil in this way because an extensive manufacturing process is involved. The importance of accurate and extensive preliminary research work is, therefore, apparent. This source of petroleum supply will be of added value to the country when the point is reached where oil wells do not produce sufficiently to meet all requirements. One item of great importance which must be looked to in the future is the increasing tendency to use oil in high-power naval craft.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A. S. M. E.

Industrial Research

IN an excellent paper on Industrial Research by Dr. Frank B. Jewett, read before the Royal Canadian Institute at Toronto on September 8, 1918, the great need for the training of research men is again clearly set forth, and the method of obtaining these men for this work is outlined. The concluding remarks of this paper are very significant, and are given here for the consideration of our members:

In conclusion I should like to present for your consideration a few points which I think are fundamental to the successful carrying out of any broad policy of industrial research growth within a nation and a few other points which my experience has taught me to look upon as beacons in the course of building up an effective and smooth-running industrial research organization. The points of the general problem which I would make are:

1 That no extensive and successful industrial research growth can be looked for unless provision is made for a continuous supply of competent men of broad general training and a specific and thorough training in the methods of scientific research.

2 That coincident with the growth of real industrial research there must be a corresponding and equal growth and development in the domain of fundamental scientific research which will broaden the bounds of knowledge and open up new avenues for the industrial research worker.

3 That there must be education to develop a full understanding of the material and economic advantages which will result from the supplanting of the purely cut-and-dry inventive type of growth by the application of scientific research methods and the further knowledge that a vigorous and healthy growth of fundamental scientific research is an integral and absolutely necessary part of the problem. In the one case this education must be directed toward the industrial interests for the purpose of indicating to them the advantages to be gained by an abandonment of methods which are not in accord with the present-day state of world-knowledge and the building up of a demand for the right type of men, and in the other case toward the population at large for the purpose of instilling an appreciation of the advantages which will accrue to the nation and attracting to the field of research, whether fundamental or industrial, a large proportion of qualified men; also for the purpose of having the people at large view with sympathy a reasonable allotment of general funds for the advancement of research activities.

4 That a realization of all of the foregoing can best be obtained by a close coöperation between the industrial and business interests of the country and the higher educational institutions, which are already looked upon with favor by educated and thinking people, and from which must come the men qualified to build up industrial research.

5 That whatever the scheme finally adopted to provide for an expansion in the domain of fundamental research and the development of competent industrial research workers, care must be taken to insure that pressure from the industries will never be so great as to withdraw those men who can render the greatest service by continuing as investigators in the field of pure research and the training of younger men. Such a course would be suicidal if long continued and I mention the point because of the fact that my experience indicates a considerable tendency on the part of industries which have benefited from industrial research to endeavor to attract into their service the best of the university research men. I confess that the temptation to do this is very great and that the monetary inducements which industry can offer to the individual are large and not easily to be withstood by a man whose normal human reaction is for the material welfare of his family.

Finally, as to those specific points which may be of interest to anyone endeavoring to build up an industrial organization:

1 The research department must be so organized, developed, and equipped with men and machinery that the net result, direct or indirect, will be of decided monetary value to the industry. Otherwise, it has no reason to be.

2 The present state of the art is such that a large number of the problems falling within the field of the industrial research laboratory are inherently expensive. For this reason, while enormous returns may be possible from the successful completion of any line of research, lack of success or an attempt to conduct it with inefficient help will mean the waste of much valuable time and money. For these reasons the choice of the staff and the careful consideration of all of the factors in any problem are of the utmost importance.

3 That successful industrial research under modern conditions is essentially one of organization and group working, as distinguished from the essentially individualistic work of fundamental research. For this reason extreme care must be taken to secure competent executives either from the ranks of those whose primary training has been along research lines and who have shown capacity for handling men and complicated problems, or from those of executive capacity and experience who have shown a proper sympathy for the requirements of research.

4 That all industry tends to be conservative and that great care must be taken not to attempt the forced growth of a broad industrial research development where a too rapid growth will engender the active opposition of those who have been educated in a different environment. My experience has indicated that there is never any trouble where the proper method is employed but that there is always trouble if the so-called practical man feels that the proposed new methods are essentially a reflection on his ability and that his point of view is not receiving sufficient consideration. As a matter of fact, the practical man's point of view and his knowledge, gained by long experience, will be found to be one of the chief assets of the successful industrial research worker.

5 That some industries are much more conservative in their attitude toward the adoption of modern research methods than others. In general, I think it will be found that the most conservative are the oldest and are those industries which existed long before the science of their art had been developed. Because of the fact that modern electrical and chemical industries have grown directly from pure scientific developments, I think they will be found to be easier fields for the cultivation of industrial research than older industries, such as those which were well developed in the earlier periods of human affairs.

6 Finally, a most important point, not to be lost sight of in the organization of a successful industrial research department, is the fact that many very capable men trained for industrial research are essentially devoid of certain commercial attributes. Many of them, for instance, fail to realize that on a large number of their problems time is an essential element in the work, while others fail to give due weight to that phase of the work which lies between the completion of the research activity and the introduction of the results into commercial manufacture or employment under modern conditions where the day-by-day control must, of necessity, be largely in the hands of those who are not highly-trained skilled workers. For this reason it is essential that whoever is responsible for the direction and success of the industrial research under-taking should be a man with a broad outlook, a full appreciation of all of the factors of the business problem and a man who can sympathize with and appreciate the varying points of view which he encounters and who can harmonize all of the activities into a smooth-working machine.

In closing, I wish merely to go on record with you by saying that after many years of experience, I now, as an executive in a large technical organization, am more than ever a firm believer in the benefits to be derived from a vigorous stimulation of both fundamental and industrial research, benefits which I believe will accrue not only to individual industries but to the people at large as well. It seems to me that, provided we have proper legislation to safeguard a just distribution of the benefits, we have in industrial research a most valuable means for ameliorating and bettering the conditions of mankind.

United States Bureau of Mines

The Bureau of Mines of the Department of the Interior has been recently reorganized under general order dated August 1, 1919. This general order describes the relation between the various branches of the Bureau and the duties and responsibilities of the various officers and employees of the Bureau. To give a brief statement of the plan of organization, the following statement and table have been taken from this general order:

The work entrusted to the Bureau involves matters both of business and of investigation. This necessitates that there shall be both administrative and technical control. In some matters there is necessity for only the minimum of technical control, since the work is either non-technical in character or follows established routine. In matters primarily investigative, it is desirable that the minimum of non-technical administrative control be exercised. For this reason the investigative work is set off as much as possible from the other work of the Bureau. The Bureau will, therefore, be organized with Investigations and Operations Branches with suitable subordinate divisions and sections, and so far as possible, work and personnel

will be assigned to one or the other. It will be necessary in certain instances that the work be co-operative as between sections, divisions, or branches, or that a member of the Bureau may work for a period or regularly for part time with more than one section or division. In all cases the officers of the Bureau are charged with the duty of marking out a clear line of responsibility in regard both to administration and technical control, subject to the authority and final approval of the Director. Allotments and transfers of funds will be made for the various divisions of the work only on authority of the Director.

The general plan of organization will, therefore, be as follows:

UNITED STATES BUREAU OF MINES
DIRECTOR

INVESTIGATIONS BRANCH ASSISTANT DIRECTOR	OPERATIONS BRANCH ASSISTANT TO THE DIRECTOR
1 Division of Mineral Technology	1 Office Administration
2 Division of Fuels	2 Division of Education and Information
3 Division of Mining	3 Government Fuel Yard
4 Division of Petroleum and Natural Gas	4 Mine Rescue Cars and Stations
5 Division of Experiment Stations:	
Pittsburgh, Urbana, Columbus, Bartlesville, Minneapolis, Fairbanks, Golden, Salt Lake City, Tucson, Seattle, Berkeley	

In connection with this attention should be called to the dedication of the new million dollar laboratories comprising the Bureau of Mines Experiment Station at Pittsburgh, Pa., in which the Pittsburgh Chamber of Commerce coöperates. The exercises will extend through three days, from September 29 to October 1.

ARTHUR M. GREENE, JR.,
Chairman of Research Committee.

A—RESEARCH RESULTS

The purpose of this Section of Engineering Research is to state the source of research information which has been completed, to give a resume of research results with formulae or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigator do not warrant a paper.

Aircraft A1-19 Wind Tunnel Investigations. The wind tunnel at the Bureau of Standards has been used for studies in connection with fall of aircraft bombs in rapidly moving air steams, and the effect on the position of the center pressure by displacement of the stabilizing finns forward and backward. Studies are being made on the manner of damping aircraft bombs which oscillate and of bringing them back to steady flight. Tests have been made on the aerodynamical characteristics of a model flying boat. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Aircraft A2-19 Angle-of-Attack Meter. Calibrations of pressure head used with angle-of-attack meter up to speeds of 120 miles an hour, Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Aircraft A3-19 Beams. Three-piece beams as strong as solid beam. Technical Notes, Feb. 15, 1919. Forest Products Laboratory, Madison, Wis. Address Director.

Automotive Vehicles & Equipment A1-19 Exhaust Gases. Vitiation of Garage Air by Automobile Exhaust Gases, by G. A. Burrell and A. W. Ganger. Technical Paper 216, Bureau of Mines. Address Van H. Manning, Director, Washington, D. C.

Concentration of Ores A1-19 Manganese Ore. Problems Involved in the Concentration and Utilization of Domestic Low-Grade Manganese Ore by Edmund Newton, War Minerals Investigations Series No. 9. Bureau of Mines, Address Van H. Manning, Director, Washington, D. C.

Concentration of Ores A2-19 Sulphur Ores. Concentration of Native Sulphur Ores by Flotation by James M. Hyde. Minerals Investigations Series No. 15, Bureau of Mines, Address Van H. Manning, Director, Washington, D. C.

Fuels, Gas, Tar & Coke A4-19 Coal Analysis. A Method of Least Squares Applied to Estimating Errors in Coal Analysis by J. D. Davis and J. G. Fairchild, Technical Paper, 171, Bureau of Mines, Address Van H. Manning, Director, Washington, D. C.

Fuels, Gas, Tar & Coke A5-19 Lignite. Combustion Experiments with North Dakota Lignite by Henry Kreisinger, C. E. Augustine and W. C. Harpster, Technical Paper 207, Bureau of Mines, Address, Van H. Manning, Director, Washington, D. C.

Heat A2-19 Solder of Intermediate Melting Point. In aircraft research work a solder melting at about 400 deg. cent. was needed. One of the following composition was found to be satisfactory: Silver 40 per cent, Tin 40 per cent, Copper 14 per cent, Zinc 6 per cent. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Leather & Glue A2-19 Comparison of Various Types of Glues. The Forest Products Laboratory of the United States Department of Agriculture at Madison, Wis., has issued a circular on the comparison of various kinds of glues: animal, casein, vegetable, blood and liquid. Animal glue has been used for a long time. It has great strength, a free flowing consistency and does not stain fancy veneers. Its price and the fact that it does not resist water to a high degree are the factors which limit its use.

Casein glue is made from casein obtained from milk. It has been used for a short time commercially and its possibilities and limitations are not well known. It can be spread with a brush when cold and has a good strength. Its special value lies in its high resistance to water. This glue stains through veneers. When hard it is difficult to machine.

Vegetable glues are made from starch and are quite cheap. They are used cold and remain in a good working condition for many days. They are very viscous and are difficult to spread by hand. They lack resistance to water.

Blood albumin glue is made of soluble dried blood and is of high water resistance. The formula for mixing may be changed to produce various properties. The great objection to the use of this glue is the expense of the apparatus required.

Liquid glues are usually made of skin and bones of fish or animals quite similar to animal glue. They are ready for immediate use, have little or no water resistance and the cost is high.

Leather & Glue A3-19 Animal Glues. The Forest Products Laboratory of the United States Agricultural Department at Madison, Wis., has issued a circular on animal glues, their manufacture, preparation and application. The stock of bone and skin is washed and treated to remove dirt and grease and then boiled to extract the glue forming substance. The solution is concentrated by evaporation until jelly forms on cooling. The jelly is cut into various forms and dried. Calcium salts are removed for higher quality of glue. Temperature and time are controlled as overcooking reduces strength. Stock may be boiled several times to obtain glue solution. Mineral matters such as barium sulphate, white lead, zinc oxide or whiting may be added to the concentrated solution before cooling to give color and make the glue opaque.

Nominal grades can be relied upon for high-grade work. It is necessary to specify requirements and then provide means to determine whether or not those requirements are fulfilled. A system of classification based on jelly strength was devised by Peter Cooper. These are designated A Extra, 1 Extra, 1, IX, 1¼, 1⅜, 1½, 1⅝, 1¾, 1⅞, 2. 1 Extra is the strongest glue. There are now glues stronger then 1 Extra and weaker than 2. This is little used today.

In using glues it is important to find the proper proportion of glue and water for the best results with the wood used and the conditions under which it is used. This should be determined by strength tests and then the proportion adhered to. Clean cold water should be used and the mixture thor-

oughly stirred to prevent lumps, allowing it to stand in a cool place until the glue is thoroughly water soaked and softened. This may take from one hour to ten hours. It should then be melted on a water bath of not more than 150 deg. fahr. as high temperature and long heating reduces strength. The pot should be kept covered to prevent the formation of skin or scum. The glue should be applied in a warm room free from drafts, and it is good practice to warm the wood without warping it before applying the glue. Clamps should be applied as quickly as consistent with good workmanship.

Clamping pressure should be evenly distributed over joints. The proper amount of pressure is not definitely known. In gluing veneers pressures as high as 150 lb. per sq. in. are sometimes used. Too much pressure may force glue completely from joint.

Strict cleanliness of pots, apparatus, floors and tables should be observed. Old glue becomes foul and breeds bacteria which decompose glue. Glue pots and brushes should be washed after every day's work. Keep brushes in weak solution of carbolic acid. Mix enough glue for one day's run only.

A strength of animal glue is greater than the wood upon which they are used. Certified glues give a shearing strength of from 2200 to 2400 lb. per sq. in. Address Director, Forest Products Laboratory, Madison, Wis.

Leather & Glue A4-19 Blood Albumin Glues, Their Manufacture, Preparation and Application. The Forest Products Laboratory of the United States Department of Agriculture of Madison, Wis., has prepared a circular on blood albumin glues. The use of blood albumin glue is comparatively new in this country. Previous to the entrance into war some plants had their own secret formulae. The demand for water resistant plywood caused increase in production of all kinds of water proof glue. The Forest Products Laboratory developed several formulae for blood albumin glues, and worked out method of gluing thin veneers with such. Prepared blood albumin glues are not offered on the market. Owing to decrease of solubility of albumin with age they are mixed at time of using. The glue is made from fresh blood of slaughtered animals or from black soluble blood albumin obtained by processing fresh blood. Unless fresh blood is utilized at once it must be treated with preservative or converted into dry soluble form by removing the fibrin and part of the red corpuscles and then evaporating to dryness at a temperature below the coagulating point of albumin which is 160 deg. The glue is prepared by the Forest Products Laboratory method according to the formula for which a patent has been applied for in the name of S. B. Henning. The dried albumin is allowed to soak for some time before stirring. The water added should be at room temperature and the soaking should take two hours. It is then agitated until it is of uniform consistency. If any of the material is insoluble the mixture should be strained through a thirty mesh sieve. This mixture makes a glue of considerable value but it is improved by adding ammonium hydroxide and hydrated lime. The formula for which the patent has been applied for is as follows:

Six parts of black soluble blood albumin, 90 per cent solubility. Eleven parts of water at about 80 deg. fahr. One-fourth part of ammonium hydroxide of specific gravity 0.90. One-eighth part of hydrated lime.

After the blood has been put in solution the ammonia is added while slowly stirring the mixture. Lime is then added in the form of a thick cream while slowly stirring. Care should be exercised in adding the lime as a small excess will cause the mixture to thicken. The glue should be of moderate consistency when mixed and should be suitable for use for several hours. The exact proportions of albumin and water may be varied to produce a glue of greater or less consistency.

The glue is applied with a bristle brush or glue spreader. The spreader should only be operated when actually coating the wood as its operation is apt to cause the glue to foam.

To set the glue a minimum temperature of 160 deg. fahr. is necessary. When thoroughly coagulated the glue cannot again be dissolved in water. Heat is conveniently applied by pressing between hot platens of hydraulic press. High temperatures to speed production are apt to cause steam pockets. A pressure of 50 to 100 lb. per sq. in. is desirable. With temperatures of 212 deg. three minutes are sufficient for three ply panel of 1/16 in. plies.

Blood glue is highly water resistant, retaining 50 to 75 per cent of dry strength after soaking or boiling.

Precautions: Weigh out constituents. Add cold water and do not heat. Do not stir until after soaking. Avoid stirring or agitation. Apply pressure before coagulation takes place. Be careful not to use excessive amount of lime. Do not use excessive temperatures. Address Director, Forest Products Laboratory, Madison, Wis.

Leather & Glue A5-19 Dry Glue Process for Thin Veneer. The Forest Products Laboratory of the United States Department of Agriculture at Madison, Wis., has issued a circular on blood albumin glues in which is described a dry glue process for thin veneers of 1/30 in. to 1/125 in. thickness. The previous troubles with thin veneers have been to prevent warping due to the water. The Forest Products Laboratory coöperating with the Bureau of Aircraft Production has developed a blood albumin glue which when dried was used successfully to glue thin veneers. A standard glue was mixed and then applied to tissue paper or cloth after which it was dried. The paper or cloth thus treated was placed between thicknesses of veneer which if too dry were sprinkled or sponged before placing in press where the pressure was from 150 to 200 lb. per sq. in. Address Director, Forest Products Laboratory, Madison, Wis.

Leather & Glue A6-19 Casein Glues, Their Manufacture, Preparation and Application. The Forest Products Laboratory of the United States Department of Agriculture at Madison, Wis., has issued a circular on this subject. Casein glues have been used in Europe to a limited extent in bookbinding and cabinet work, but their production on a large scale was unknown. In the United States the use of this glue is more recent, but there has been a more rapid development. This development was due to the great demand for water-proof plywood.

There are two types of casein glues, one in which the components are mixed dry, the other in which the components are added separately during preparation. Those on the market are of the first class.

The principal constituent of casein glue is casein, a product obtained from milk. This is the curd which precipitates when milk sours naturally. Hydrochloric and sulphuric acids and rennet are used to precipitate casein. Casein is produced by the removal of the butter fat by means of a separator, precipitation of the casein, washing to remove acid or other impurites, drying, finally grinding to a powder. To make it desirable for glue it should have only a small percentage of acids, moisture, fats or other impurities. It should be free from sour odors, clear and uniform in color, and should be in the form of a powder. The powder should pass through a 50 or 60 mesh sieve.

To produce glue, the casein is mixed with lime and water to increase the working life, the water resisting quality and to improve the glue. Caustic Soda, sodium fluoride and sodium silicate are used in patented formulae. They will lengthen the life of the glue, and sodium fluoride probably gives the glue antiseptic properties. Oils are added to dry mix glues to prevent dusting in handling the glue. Several formulae for mixing have been developed at the Forest Products Laboratory. One of these has been patented. U. S. Patent No. 1,291,396 granted to Samuel Butterman and assigned to the United States Government.

Glue 4-A Formula: 100 parts casein with 130-280 parts of water soaked for 15 minutes is mixed with a mixture of 15-22 parts of hydrated powdered lime and 90 parts water. To these add 70 parts of silicate of soda. After mixing, the mixer being turned at 50-60 r.p.m., add casein. Continue

until the casein passes into the form of a mush. After a period of about 15 minutes the soaking is considered complete and the mixing blade is started again. Then add lime water, and after two or three minutes add liquid silicate of soda. Mix for 20 or 30 minutes.

Casein glue is applied by hand or machine spreader, a wire brush or metal scraper used for hand work or a bristle brush. Enough glue should be spread so that a small amount is squeezed out when pressure is applied.

The working life of the glue is from four or five hours for moderate consistency to many hours for thinner consistency. The time that elapses between the spreading of the glue and the pressing depends on the moisture content of the wood, the consistency of the glue, the kind of wood, the quantity of the glue and the temperature of the wood and glue in general. The pressure should be applied while the glue is yet in a wet condition. The pressure used should be from 75 to 100 lb. per sq. in. Unless the surface is very irregular and the glue thick the pressure should be held for at least one-half hour, although longer periods are advisable.

After removal from press the stock should be allowed to condition before being finished. The time of conditioning depends on the nature of the material. Dry casein and casein glues will keep for a long time if stored under proper conditions. The place should be cool and dry as excessive moisture and high temperature causes deterioration. Casein glues have good strength and water resistant properties. After boiling for eight hours and soaking for ten days in cold water samples glued with this glue show no separation. Address Director, Forest Products Laboratory, Madison, Wis.

Metallurgy & Metallography A10-19 Manganese Alloys in Steel. The Use of Manganese Alloys in Open-Hearth Steel Practice by Samuel L. Hoyt, War Minerals Investigations Series No. 11, Bureau of Mines, Address Van H. Manning, Director, Washington, D. C.

Metallurgy & Metallography A11-19 Aluminum Alloys. Special and Commercial Light Aluminum Alloys by Robert J. Anderson. Minerals Investigations Series No. 14, Bureau of Mines, Address Van. H. Manning, Director, Washington, D. C.

Metallurgy & Metallography A12-19 Manganese. Uses of Manganese Other Than for Steel Making by W. C. Phalen, Minerals Investigations Series No. 16, Bureau of Mines, Address Van. H. Manning, Director, Washington, D. C.

Metallurgy & Metallography A13-19 Flotation Oils. Oils from hard wood tar have been shown to have high flotation values. Crude tar obtained in making of wood alcohol has been shown to be as good as redistilled oils. The presence of pitch from hard wood tar and oils has been shown to be desirable and not detrimental. Forest Products Laboratory, Madison, Wis. Address Director.

Metallurgy & Metallography A16-19 Graphite. Preparation of Crucible Graphite by George D. Dub, War Minerals Investigations Series No. 3, Bureau of Mines, Address Van H. Manning, Director, Washington, D. C.

Metallurgy & Metallography A19-19 Graphite. Refining Alabama Flake Graphite for Crucible Use by Frederick G. Moses, War Minerals Investigations Series No. 8, Bureau of Mines, Address Van H. Manning, Director, Washington, D. C.

Petroleum, Asphalt & Wood Products A1-19 Gasoline from Natural Gas. Recent Developments in the Absorption process for Recovering Gasoline from Natural Gas by W. P. Dykema, Bulletin 176, Bureau of Mines, Address Van. H. Manning, Director, Washington, D. C.

Wood Products A1-19 Hints on Storing Timber to Prevent Decay. Store on well drained ground, remove debris and keep down weeds, use proper foundations, slope timber piles, assist ventilation by avoiding close piling in the open, take care of stickers, keep sheds dry and well aired, check fungus with breaks. Technical Notes, Feb. 15, 1919. The Forest Products Laboratory, Madison, Wis. Address Director. Also Bulletin 510, Department of Agriculture, "Timber Storage Conditions in Eastern and Southern States with Special Reference to Decay Problems." Address Superintendent of Documents, Government Printing Office, Washington, D. C. Price 20c.

Wood Products A2-19 Moisture-Proofing Wood with Aluminum Leaf. Aluminum leaf is very effective for water proofing woods. When exposed for seventeen days in atmosphere of 95 to 100 per cent humidity natural birch absorbed fifty-five grams of moisture per sq. ft. of surface. Wood treated with five coats of linseed oil and two coats of floor wax absorbed coat of spar varnish eight grams; with filler and three coats of spar varnish absorbed fifteen grams per sq. ft. Samples coated with filler and three coats of orange shellac absorbed ten grams per sq. ft., with filler, two coats of enamel and one coat of spar varnish eight grams; with filler and three coats of rubbing varnish, seven grams. With two coats of shellac, one coat of spar varnish, one coat of aluminum leaf, two coats of shellac and one coat of spar varnish about 1½ grams. A little less than this was obtained from one coat of spar varnish, one sizing coat of spar varnish, aluminum leaf and two coats of spar varnish. The leaf is applied from the book without the aid of gilders tips as soon as the size reaches the right condition. It is important to let the size reach the right condition just before the varnish sets dust free. It takes 1½ hr. for this condition to be reached. Forest Products Laboratory, Madison, Wis. Address Director.

Wood Products A4-19 Circulation and Piling in Dry Kilns. The Forest Products Laboratory at Madison, Wis., has shown that the piling of lumber in a kiln must suit the circulation of the kiln in order to make the product uniform and cut down the time required. In a kiln having vertical lateral circulation lumber piled endwise dried quicker and gave more uniform results. Forest Products Laboratory, Madison, Wis. Address Director.

Wood Products A6-19 Scratched and Smooth Joints in Gluing. Tests of hard maple blocks with smooth and tooth planed contact surfaces were sheared after standing one week after gluing with high grade hide glue. Eleven tests gave 1988 lb. per sq. in. for scratched joints with 35 per cent of wood surface in the fracture while eleven smooth pieces gave a shearing strength of 2040 lb. per sq. in. with 47 per cent of wood surface in the failure. Forest Products Laboratory, Madison, Wis. Address Director.

Wood Products A7-19 Kiln Drying. Quarter sawed oak was dried in kiln originally at 105 deg. fahr. with 85 per cent humidity and with final temperatures of 145 deg. fahr., 155 deg. fahr. and 165 deg. fahr. The higher temperature produced a marked difference in the drying rate without causing visible defects. Douglas Fir in 2½-in. planks required twenty hours to reduce the moisture content from 50 per cent to 8 per cent. This was reduced to fourteen hours when starting at 130 deg. fahr. and ending with 150 deg. fahr. Ten tests were required with a temperature ranging from 160 deg. fahr. to 180 deg. fahr. and eight days with temperatures ranging from 220 deg. fahr. to 240 deg. fahr. Higher humidities were used with higher temperatures. Checking, warping, and cupping were very slight, but the higher temperatures seemed to darken the wood. In drying butt log cypress a high humidity in the kiln was used with a high temperature. This increased the rate of drying without producing checking. Forest Products Laboratory, Madison, Wis. Address Director.

B—Research in Progress

The purpose of this section of engineering research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Aircraft B6-19 Air Propellers. A general study of air propellers at Leland Stanford Jr. University undertaken for the National Advisory Committee for Aeronautics, of a general

character and scope as indicated by reports of the above committee and issued as a government publication. Address Prof. W. F. Durand, Leland Stanford Jr. University, Stanford University, Cal.

Bureau of Mines B1-19 The activities of the Bureau of Mines have recently been communicated to the Research Committee of the American Society of Mechanical Engineers, and during the next few months these will be listed in this department. To show the activities, however, the following statement of the work of the Bureau is given:

Number of Problems Under Investigation or Planned by Stations

Station or Office	Number of Problems Under Investigation	Planned or Outlined	Number of Men Employed
Bartlesville, Okla	4	3	7
Berkeley, Cal	6	3	6
Columbus, Ohio	10	..	9
Fairbanks, Alaska	9	3	3
Golden, Colo	8	7	9
Ithaca, N. Y	4	4	3
Minneapolis, Minn	6	1	9
Moscow, Idaho	5	3	3
Pittsburgh, Pa	..	..	.
Chemical Research	9	2	32
Coal Mining	6	..	8*
Electrical	9	3	5
Fuels	7	7	15
Iron and Steel	1	3	1
Mechanical Equipment	1	1	1
Mine Safety	6	1	4*
Non-Ferrous Metals	1	4	1
Petroleum Research	6	2	6
Physical Testing of Explosives	8	4	6
Technical Service	4	..	12
Salt Lake City, Utah	13	13	9
San Francisco, Cal	8	2	10
Sattle, Wash	11	6	6
Tucson, Ariz	4	5	4
Urbana, Ill	8	1	7
Totals	154	78	176

*These numbers do not include various field engineers.

Fuels, Gas, Tar & Coke B2-19 Aero Fuel Development. So far most favorable fuels were (1) Hecter (a synthetic cyclohexane and benzol); (2) Gasolines using large percentage of napthane hydrocarbons; (3) Mixtures of Gasoline and benzol. W. B. Dykema, Bureau of Mines Station, Bartlesville, Okla.

Fuels, Gas, Tar & Coke B3-19 Coal Analysis by A. C. Fieldner and W. A. Selvig, Bureau of Mines Station, Pittsburgh, Pa. Analysis of standard coal samples of the United States collected from July 1, 1916, to July 1, 1919, by the Bureau of Mines. Address Bureau of Mines, Van H. Manning, Director, Washington, D. C.

Fuels, Gas, Tar & Coke B4-19 Ash. Fusibility of Coal Ash by A. C. Fieldner and W. A. Selvig, Bureau of Mines Station, Pittsburgh, Pa. Investigations on the fusibility of coal ash from the well known coals of the United States. Results on coals from West Virginia, Illinois, Indiana, Kentucky, Kansas, Missouri, Oklahoma and Arkansas have been completed and published. Tests on Pennsylvania coals have been completed and results are being compiled. Maryland, Virginia, Eastern Kentucky and Ohio coals have been tested but results are not yet available, one thousand samples are yet to be tested. A final report covering all coals will be published in the form of a Bulletin. Bureau of Mines, Address Van H. Manning, Director, Washington, D. C.

Fuels, Gas, Tar & Coke B5-19 Constitution of Coal by A. C. Fieldner and R. Theissen. An extensive investigation including a large number of photo-micrographs. These show that the bright bands or anthraxylon consist of coalified wood, while the dull bands consist of small layers of bright coal or woody chips embedded in ground mass of dull coal composed of macerated remains of cellulodic degradation products, cultlicles, spore-exines, resinous particles, etc., which are all called attritus. Bureau of Mines Station, Pittsburgh, Pa. Address Van H. Manning, Director, Washington, D. C.

Hydraulics B3-19 Surge Chambers. A research problem in power hydraulics relating to the operation of a surge chamber in connection with an adjacent auxiliary reservoir, or in effect, the operation of two surge chambers, one large and one small, and separated by a conduit about 1400 ft. in length. This combination is one which gives rise to six differential equations in order to represent the hydraulic conditions. It is therefore quite beyond the range of investigation by analytical or other direct mathematical processes. The problem is being investigated by means of a model representing a special application of the law of kinematic similitude, and in accordance with methods developed by Professor Durand as given in Transactions, A. S. M. E., Vol. 34, p. 359. Address Prof. W. F. Durand, Leland Stanford University, Cal.

Metallurgy & Metallography B5-19 Alloy Steels. Simple and Complex Steels using uranium, tungsten, molybdenum, chromium, vanadium, titanium and aluminum. Light Armor Plate Steels containing zirconium. These steels are to be tested physically and in some cases ballistic tests are to be made. Some are to be used in forgings and some in castings. H. W. Gillett, Field Office of the Bureau of Mines at Ithaca, N. Y. Address Van H. Manning, Director, Washington, D. C.

Metallurgy & Metallography B6-19 Aluminum Chips. Melting of Aluminum Chips. This investigation is to be continued although results of investigations by H. W. Gillett and G. E. James were published in Bureau of Mines Bulletin No. 108, (Van H. Manning, Director). H. W. Gillett, Chief Alloy Chemist, Field Office, Bureau of Mines Station, Ithaca, N. Y.

Metallurgy & Metallography B7-19 Aluminum. Metallurgy of Aluminum, Robert J. Anderson, Metallurgist, Bureau of Mines Station, Pittsburgh, Pa. Object of experiment is to prevent waste in metal and fuel and to secure and disseminate information regarding metallurgy of aluminum. Problems being investigated are:

1 Causes for and prevention of defects in aluminum-alloy castings.

2 Blowholes, porosity, and unsoundness in aluminum-alloy castings.

3 Comparison of methods of melting aluminum and aluminum alloys.

4 Comparison of methods of introducing copper into the production of aluminum copper alloys.

5 Electric furnace melting of aluminum and aluminum alloys.

6 Study of quality of aluminum ingot as related to casting practice.

7 Pyrometry for aluminum-alloy foundries.

8 Development of method of analysis for aluminum oxide in ingot and alloy castings.

Worthless alloys are being discussed in a Technical Paper now in the course of publication.

This work is being done with the coöperation of various aluminum alloy foundries.

Coöperative work is being done with The Foundry. Metallographic studies have been made. These show that micrographs to seven diameters are very instructive. Address Van H. Manning, Director, Bureau of Mines, Washington, D. C.

Mining, General B1-19 Dust. Explosibility of Coal Dust by J. W. Paul, Bureau of Mines Station, Pittsburgh, Pa. Work done at experimental mine at Bruceton, Pa. Tests are being conducted on explosibility of coal dust from mines in all coal producing states to determine the explosibility and the treatment to render dust inert to explosion influences. Address Van H. Manning, Washington, D. C.

Mining, General B2-19 Coal. Mechanical Preparation of Coal by E. A. Holbrook, Bureau of Mines Station, University

of Illinois, Urbana, Ill. Work being conducted in laboratory of the university equipped with every type of coal washing and dressing machine. Probably the best equipped coal laboratory in the country. Problems so far worked upon include coal washing tests and the separation of pyrite from coal and especially coals used for cooking purposes. Bureau of Mines. Address Van H. Manning, Washington, D. C.

Wood Products B1-19 Effect of Kiln Drying on Strength. The Forest Products Laboratory is conducting a research on the strength of lumber when dried in the kiln and when air dried. Twenty-six species are to be examined. Forest Products Laboratory, Madison, Wis. Address Director.

Wood Products B2-19 Swelling and Shrinking of Wood as Influenced by Various Treatments and Coatings. The Forest Products Laboratory has 450 test panels coated with varnish, enamel or aluminum leaf. One-half of these will be hung in the laboratory under room conditions and one-half will be exposed to the weather. The effect of exposure will be measured from time to time. Forest Products Laboratory, Madison, Wis. Address Director.

C—Research Problems

The purpose of this section of engineering research is to bring together persons who desire coöperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring coöperation or aid will state problems for publication in this section.

Fuels, Gas, Tar & Coke C1-19 Alcohol. The Commercial Applications of Alcohol Fuels. Work is being done on this problem by a number of engineers and manufacturers, but other applications are needed to increase the demand for this fuel. Address Prof. Charles E. Lucke, 117th Street and Broadway, New York.

D—Research Equipment

The purpose of this section of engineering research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done

Aircraft D5-19 Wind Tunnel. The tunnel of the Bureau of Standards has been altered to permit the attainment of air speed up to 180 miles an hour. Address Bureau of Standards, S. W. Stratton, Director, Washington, D. C.

Stanford University D1-19 Laboratory of the Department of Mechanical Engineering.

1 *General Laboratory:* Miscellaneous instruments and equipment necessary for general problems including dynamometers, measuring instruments for pressure, time, revolutions, electrical quantities, etc.

2 *Laboratory of Steam Prime Movers:* Simple and compound engines of various kinds, including special Nordberg corliss experimental engine; one high pressure B. & W. experimental boiler; one vertical tubular boiler; one horizontal tubular boiler.

3 *Laboratory of Internal Combustion Prime Movers:* Internal combustion engines of industrial, automatic and aeronautic types.

4 *Laboratory of Hydraulic Machines:* Various forms of pumps and water wheels with special facilities for the investigation of problems in power hydraulics.

5 *Laboratory of Aerodynamics:* Special wind tunnel of circular section 7 ft. 6 in. in diameter equipped for wind velocity up to 60 m.p.h. Especially intended for problems relating to air propellers.

6 *Miscellaneous Equipment:* Mechanical refrigerating unit for measuring and testing various quantities in refrigerating problems. One piston air compressor. One turbine air compressor. Apparatus for use in problems of lubrication, bearing friction, etc. Address Prof. W. F. Durand, Leland Stanford Jr. University, Cal.

E—Research Personnel

The purpose of this section of engineering research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

During the absence of Dr. Van H. Manning, Prof. O. P. Hood of the Bureau of Mines has been Acting Director.

F—Bibliographies

The purpose of this section of engineering research is to inform the profession and especially the members of the A. S. M. E. of bibliographies which have been prepared. These bibliographies have been prepared at the request of members, and where the bibliography is not extensive, this is done at the expense of the Society. For bibliographies of a general nature the Society is prepared to make extensive bibliographies at the expense of the Society on the approval of the Research Committee. After these bibliographies are prepared they are loaned to the person requesting them for a period of one month. Additional copies are prepared which are available for periods of two weeks to members of the A. S. M. E. or to others recommended by members of the A. S. M. E. These bibliographies are on file in the offices of the Society and are to be loaned on request. The bibliographies are prepared by the staff of the Library of the United Engineering Society which is probably the largest Engineering Library in this country.

Boilers F2-19 Oil Burning Equipment for Boilers. A bibliography of one page. Search 2609. Address A. S. M. E., 29 West 39th St., New York.

Leather & Glue F1-19 Glues. A bibliography of 2 pages on Glues of Various Kinds. Address A. S. M. E., 29 West 39th St., N. Y. Forest Products Laboratory, Madison, Wis.

Steam Power F1-19 Engines for Steam Cars. A bibliography of 2½ pages. Search 2465. Address A. S. M. E., 29 West 39th St., New York.

Steam Power F2-19 Exhaust Steam from Non-Condensing Compound Engines. (No bibliography.) Search 2522. Address A. S. M. E., 29 West 39th St., New York.

Steam Power F3-19 Uniflow Engines. A bibliography of 4½ pages. Search 2580. Address A. S. M. E., 29 West 39th St., N. Y.

Steam Power F4-19 Testing of Steam Turbines in Europe. A bibliography of 3 pages. Search 2477. Address A. S. M. E., 29 West 39th St., N. Y.

Transmission F1-19 Static Electricity in Belt Drives. Search 2481. Address A. S. M. E., 29 West 39th St., New York.

Transmission F2-19 Ball Bearings in Railway Rolling Stock. A bibliography of 1¼ pages. Search 2591. Address A. S. M. E., 29 West 39th St., New York.

Sugar F1-19 Manufacture of Sugar Syrups; Maltose; and Use of Bone Black in Filters. A bibliography of 3½ pages. Search 2564. Address A. S. M. E., 29 West 39th St., New York.

Water Sewage & Sanitation F1-19 Water Softening for Industrial Purposes. A bibliography of 5 pages. Search 2579. Address A. S. M. E., 29 West 39th St., N. Y.

Water Sewage & Sanitation F2-19 Inquiry of Starr System of Sewage Disposal. Search 2575. Address A. S. M. E., 29 West 39th St., N. Y.

Water Sewage & Sanitation F3-19 Incinerators. A bibliography of 2¼ pages. Search 2596. Address A. S. M. E., 29 West 39th St., N. Y.

Wood Products F1-19 Drying Kilns and Kilns of Lumber. Search 2536. Address A. S. M. E., 29 West 39th St., N. Y.

Welcome-Home Dinner to Herbert Hoover

FEW receptions have expressed the enthusiasm accorded Herbert Hoover during a dinner held at the Waldorf Astoria Hotel on Sept. 16. The grand ball-room was filled to its utmost capacity by some 1200 of his colleagues, members and friends of The American Institute of Mining and Metallurgical Engineers of which Mr. Hoover is a member.

The honor of toastmaster was bestowed upon W. L. Saunders, past president of the society, and in his address of welcome he said, turning to Mr. Hoover: "Here we have the example of an engineer who typifies the modern definition of engineering which is thus written in large letters on the wall of the engineer's library in New York: 'Engineering, the art of organizing and directing men, and controlling forces and materials of nature for the benefit of the human race.'"

In referring to Mr. Hoover's strongest characteristic, capacity to think straight in advance, the toastmaster said: "While Congress was hesitating and amending the Food Act Bill, Hoover was busy organizing every state and territory, even going into counties of each state, so that when the bill was finally passed the machine had been completed and was ready to function. His abiding faith in public opinion is based upon the belief that the people will always support an effort to do that which is right."

Herbert Hoover is a graduate of Stanford University. He first served with the United States Geological Survey, then went to West Australia and China, in mining activities. Shortly after America entered the war Mr. Hoover was summoned to Washington to take charge of the food situation here. The problem was a large one as food demands from Europe were centered upon the United States. His organization in every state and county comprised 8500 men and women, giving their whole time to the Food Administration. In addition to this there were half a million persons registered and ready to be called upon for emergency work. Twelve million families were pledged to support the work. It has been estimated that this administration carried out its functions, 92 per cent by voluntary effort, 7 per cent by persuasion and 1 per cent by legal authority.

"Immediately after the armistice was signed Mr. Hoover was directed to proceed to Europe to investigate the part that America could play in the relief of the civilian population. Though he had but four days before sailing he arranged for the purchase and shipment of 250,000 tons of food. It was not until February of the following year that Congress appropriated one hundred million dollars for European relief. At that time several hundred thousand tons of food-stuffs had been actually distributed. Up to a recent date over three million tons of food-stuffs, valued at over seven hundred and seventy million dollars have been distributed.

Mr. Hoover's speech reviewed his impressions gained since the armistice. He said that as a result of the stupendous social ferment and revolution which has existed, the people of Europe have been attempting to find a solution for their social ills by practical experiments in socialism, resulting in bankrupting the productivity of industrial commodities.

"In the situation which existed in Europe, with its desperation, greed, century-old animosities, its idealistic and proper aspirations, there was only one hope; that hope, expressed by every city and state, was that the American people, being the one disinterested and uncrippled economic and political force, still existing in the world, should again intervene. It was in response to this call that the President, comprehending the real heart of the American people, intervened in Europe a second time and took those steps which resulted in a practical economic organization of Europe pending the consummation of peace and the arrival of the forthcoming harvest.

"I cannot pay enough tribute to all these thousands of Americans, many of them engineers, men taken from the common life of the United States, who were thrust into the face of staggering political economic problems, the solution of which must affect the well-being, not of hundreds, but of millions. The proof of their performance lay in the fact that Europe has come through the most terrible period of its history with no loss of life from economic causes, with a stronger democracy and a glow in its heart for the United States.

"These matters have been brought to a successful close with the arrival of the harvest and the prospect of peace. What the future has a right to demand from us in further economic support is not yet clear, but it is at least certain that if the world cannot quickly secure the settlement of peace and safeguards for the future through the League the whole of our two great interventions in Europe will have gone for nothing, and the menace of reaction will again return against us upon the wings of chaos."

In Russia the majority of their people were comparatively well fed, warmly clothed and housed, but due to their ignorance it was possible to introduce most desperate conditions. "Socialism was brought in overnight at the hands of a small minority of intellectual dilettante and criminals. And this tyranny of minority, more terrible even than the old, has now had nearly two years in which to effect the conversion of the wicked competitive system into the elysium of communism. Two-thirds of the railways and three-fourths of the rolling stock that they control are out of operation. The whole population is without any normal comforts of life and plunged into the most grievous famine of centuries. Her people are dying at the rate of hundreds of thousands monthly from starvation and disease. The capital city has diminished in population from nearly 2,000,000 to less than 600,000. The streets of every city and village have run with the blood of executions. Nor have these executions been confined to the so-called middle and upper classes, for lately the opposition of the workmen and farmers to this regime has brought them also to the firing squad in appalling numbers."

Herbert Hoover

The aims of socialism were thus defeated and in reversing their methods are now trying to summon back the forces of production, for we know that country has ample supplies of food, coal, oil, wood, flax, cottons and metals and the factories with which to work them and that their sole deficiency is human effort.

"My conclusion from all these observations is, therefore, that socialism as a philosophy of possible human application has already bankrupted itself. Bankruptcy of the socialist idea, however, does not relieve us from the necessity of finding a solution to the primary question in the better division of the products of industry and the steady development of higher productivity. The bankruptcy of the socialist idea should, if reaction is to be prevented, return the guardianship of this problem from the radical world to the liberal world of moderate men, working upon the safe foundations of experience."

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Departments of MECHANICAL ENGINEERING by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in this journal, or brief articles of current interest to mechanical engineers.

Theory of Tolerances

To the Editor:

The writer noted with considerable interest an abstract of an article from Le Génie Civil, May 3, 1919, in MECHANICAL ENGINEERING of July 1919, on Theory of Tolerances. This subject has developed in the machine shop and has, up to recently, received comparatively no attention from theoretically-trained men. Mathematicians have played with the theory of probability, but a gap has been left between the mathematicians' results and machine-shop requirements.

Judging from current technical literature, the above-mentioned gap is going to be bridged and great value will result thereby.

The writer disagrees with the methods of analysis on some points used in this article, believing them to be unsound and likely to be very misleading in the initial stages of this subject. The following remarks are, therefore, made for the purpose of correcting these supposed defects and in the hope of encouraging further discussion on this subject.

The probability curve is admittedly the basic starting point. However, it is very necessary that this be applied with a considerable mixture of common sense, for possibly in no branch of mathematics can false steps be so easily made as in the application of probability theory. The psychology of the operator must be kept in mind all the time.

Fig. 14, of the article referred to, shows the result of an asymmetrical system of tolerances but very rarely represents the facts. The physical interpretation is that the operator tried to make all these shafts of diameter a as nearly as possible. Then the inspector chose both a positive and a negative tolerance, but unequal. Surely, if the inspector is going to use unequal positive and negative tolerances, then the operator will be aware of this before he does the work in question. In the interests of economy the operator certainly should be aware of this, and usually always is. This being the case, it is a rational guess that he plays for the mean of the high and low permissible diameters. Briefly, he uses the available tolerance to the best possible advantage. If he does this then Fig. 14 would change so that the axis of symmetry OY will be exactly in the middle of the shaded area, as is the case in Fig. 13. To restate the case, no matter how asymmetric the tolerances might be in respect to the nominal shaft diameter, the operator will interest himself with the limits and this reduces the case to a symmetric one.

In Figs. 18 and 19, it is seen that the controlling factor in stepping from Case 1 to Case 2 is to keep the theoretical play constant. This seems somewhat artificial. From the standpoint of a designer the theoretical play, which is really average play, is not a feature of prime importance. The minimum play is an important feature, as this will measure the risk of seizing; also, the maximum play is an important feature, as this might interfere with accuracy. As to which of these two is the more important depends entirely upon the particular bearing under discussion. It would appear more rational, as a rule, to decide upon a minimum play and then let tolerances be controlled by manufacturing convenience, keeping, of course, the maximum play as small as possible. The writer believes that the complete results of the argument, centering on Figs. 18 and 19, are invalidated due to an artificial hypothesis having been taken.

Figs. 20 and 21, which are used in discussing a comparison between symmetrical and asymmetrical tolerances when the tolerances are suddenly cut in half, are particularly misleading. The following free translation of these diagrams is given in order to bring out the error:

Fig. 20 says that a man is grinding shafts and aiming at a diameter D. Then his results would show variation of diameters represented by the given curve. This is perfectly true provided he made an infinite quantity and it may be taken as true in principle for a small quantity. He makes exactly 50 per cent of these shafts oversize and 50 per cent undersize, as would be expected. The total shaded area, if suitable units be taken, represents the number of shafts ground within tolerance t. Any area under the curve and outside the shaded area represents scrap. The doubly-shaded area, to the same units, represents shafts within tolerance $\frac{1}{2}t$

$$\frac{\text{Shafts within tolerance } \frac{1}{2}t}{\text{Shafts within tolerance } t} = \frac{\text{Doubly-shaded area}}{\text{Total shaded area}}$$

Fig. 21 says that the operator endeavors to make shafts of diameter exactly D but that these are inspected on the basis of a minus tolerance t. Now if this were so, what would be the results? Obviously there would be exactly 50 per cent scrap. Fig. 21 appears to be based on the assumption that the operator does the work in the belief that both plus and minus tolerances are allowable, and then the inspector decides to use only a negative one. The diagram, Fig. 21, is distinctly incorrect. It could be justified only on the assumption of 50 per cent scrap existing, which is clearly an untenable position. Excluding this, then we must assume the operator knew that a negative tolerance only would be permitted. Under these circumstances let us temporarily assume he would endeavor to strike the mean permissible diameter. Then the axis of symmetry OB would be exactly in the middle of the figure where line cC now is. In this case, of course, Figs. 20 and 21 become identical, the results identical, and the whole case that is being pleaded, namely the advantage of the symmetric over the asymmetric system, fades away as the two merge into each other, so far as results are concerned.

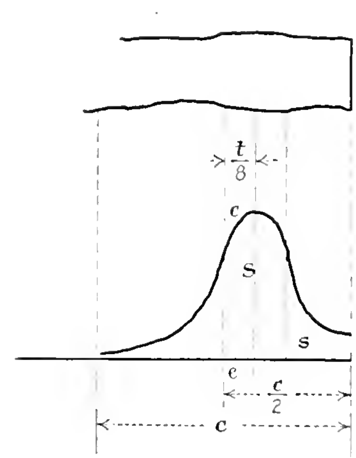


Fig. 1 Average Probability Curve Suggested by the Writer

Actually there are rational arguments for moving the axis of symmetry of the probability curve a little to the right in Fig. 21. An operator who had a perfectly mathematical instinct would attempt to make the diameter exactly the mean of the maximum and minimum permissible diameters. However, there are various psychological traits, which make the operator differ from a perfectly mathematical one. For instance, an operator, who was a high-grade mechanic, might take sufficient pride in his work virtually to reduce the permissible tolerance and try to play more

nearly to the maximum diameter. Probably most of us know from observation that this is usually true, although it is not the soundest business. Furthermore, there is a natural tendency on the part of an operator to play on the big side due to the ever present instinct that he can take off but that he cannot put on. The diagrammatic result of the above two points would be to displace the axis of symmetry of the probability curve somewhat to the right. Just how much depends upon the individual operator. It is probable that an average operator would give a curve similar to the writer's, shown in Fig. 1.

Yours truly,

J. Airey.

East Moline, Ill.

Industrial Relations

To The Editor:

The following quotation is from a paper read before the National Conference of Social Work at Atlantic City on June 2 by Hon. Basil M. Manly who in acting with Hon. Wm. H. Taft as joint chairmen of the National War Labor Board has probably had a better opportunity than anyone else to obtain a correct interpretation of existing conditions with regard to labor conditions and their possible developments.

> We are about to enter a period of the most acute industrial unrest and the most bitter industrial controversy that the American nation has ever known. Unless effective and radical steps are taken to bring about a better understanding between labor and capital and to establish an equitable basis for orderly industrial progress we are certain to see within the next year strikes and mass movements of labor beside which all previous American strikes will pale into insignificance. Those who regard the American industrial situation with complacency ignore both the psychology of the workers and the compelling facts. The workers of the Allied world have been told that they were engaged in a war for democracy; that out of the ruins of war would arise a new and more beautiful world. They are asking now where is that democracy for which they fought. When are we to enter into this new world with its greater regard for the rights of the common man? They see no change for the better but they find themselves in conditions in many respects worse than those against which they protested before they entered the war. The masses of the people are being rapidly disillusioned and when the people lose their illusions there is danger ahead.

Mr. Manly says further that workers now realize more than ever the autocratic control of industry in which the majority of the people of the country are participants and that there can be no real democracy where the people are under autocratic rule during the greater number of their waking hours. So they are fighting for the democracy here that they fought for abroad and they want to have something to say in the control of the management of their affairs. They feel that they are partners in business and they are demanding that they be recognized in that capacity.

Here is a terse and concise statement of facts and a plain warning of what may happen, and what are the members of this Society, many of whom are employers of labor, doing to meet the serious situation thus described as confronting them?

The Committee on Industrial Relations has advised against "establishing a standing committee on relations between employer and employe" and "entering the controversial field of industrial economics as involved in the relationship between employer and employe."

The only constructive suggestion, if it can be so construed, is from a member of the Committee on Aims and Organization who advises the Society that "there should be an awakening that will match and help to head off the stampede of those who are doing things with their hands." And how does he recommend that this shall be done? He says "*if we select the right slogan* the activities of the country will no longer be handicapped by unwise guidance of labor." Now the dictionary says a slogan is "a Scottish war cry" and if we are only to resort to a war cry to bring about the wonderful results prophesied by this committee man, we should have an American one which logically would be an Indian war whoop and "whoop it up" as in the good old pre-war days, and by hiring and firing and lockouts and shut-downs, head off the threatened stampede. Then of course we may expect the workers to come back with their tomahawks raised and we will continue to have each house divided against itself, resulting in the same old inefficiency.

But the way to meet the present discontent is not to assume the right to fire and lockout for that implies the converse right to leave and strike at will and we know now and should have known long ago the cost of labor turnover if we had given the thought we should have to the psychology of the workers and to industrial economics. And we are too apt to forget our responsibility to the community to whom we commit those whom we fire and lockout and which has to bear the expense of our inefficient management.

What is necessary is for employer and employe to get together and drop these strong-arm methods and work for their own and the community's welfare. Democratic methods have been working satisfactorily in so many industrial plants and for so long a time that there can be no excuse for the continuance of autocratic methods by employers. I do not know of any plant in which democratic methods have been properly introduced and maintained where either employer and employe would think of reverting to what existed previously.

The Government through the War Labor Board has recommended employes' representation in management in more than one hundred plants doing work for the Government. The War Department is now introducing these democratic methods in the Arsenals. The employes' representatives in the Rock Island Arsenal have stated in a report to Secretary of War Baker that a condition of antagonism and distrust had developed owing to the autocratic methods long existing but that since the employes have their shop committees "they no longer feel like mere employes, simply bent on holding down a job quite apart from their conception of life, for no other purpose than the earning of wages, the only crude means available to them for securing the necessaries and perhaps a little of the better things of life. They are beginning to see that they are on their way towards becoming partners in a large enterprise." Whereas, before the introduction of democratic methods they not only refused to have the Taylor system of Scientific Management introduced but deliberately restricted production, they now ask for technical experts to help them and say that under the new spirit dominating the men "a spontaneous efficiency is in the making which we sincerely feel will before long produce records of production that will make the most ardent Taylor system advocate envious. And this will all be because the employes want to produce not because they are obliged to do so." There is all the difference in the world between volition and compulsion, the will to do and enforced obedience. The new spirit is cutting cost in half now. What will it do under the willing guidance of technical experts?

Secretary Baker verifies these statements and says that the committees which the employes have formed are coöperative with the management who thereby have lost no control which they cannot yield as they are held responsible by the Government for results.

It has been asked how great a part shall the workers be granted control in industry. They should be granted all the control that they are capable and competent to exercise. They will not want more for they are human beings and are looking out for their own interests which are involved in the success of the enterprise. Already in many of the plants in which democratic methods are installed, including the Government arsenals, the foremen are elected and so become leaders instead of drivers. In some other plants the workers are represented in the Board of Directors. The employes should be considered as partners and so treated. They should be taken into confidence and authority and responsibility apportioned where it properly belongs, a square deal and fair play should be the principles adopted and no slogan can take their place.

When these democratic principles are properly operating the employe works with increased efficiency and the cost of product is thereby reduced. The greater profits which accrue are then divided equitably between the employer in increased dividends, the employe in higher wages and the public in lower costs. Thus the three partners in business coöperate. How many employer

members of the Society are doing their part to lower the cost of living in this manner?

It seems to me that it is high time that the members of this Society who are both engineers and employers and therefore well qualified to analyze the problems inherent in the situation, if we expect to be recognized as taking an active, even if not a leading part, in the large and important questions of the day affecting the public welfare, should do something more than have qualified speakers talk at meetings as the committee recommends. We have had enough talk on the subject and gotten nowhere. Now we should have a standing Committee authorized to do something definite.

H. F. J. Porter.

New York, N. Y.

WORK OF THE BOILER CODE COMMITTEE

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York City.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in Mechanical Engineering, in order that any one interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee in Cases Nos. 240-246, inclusive, as formulated at the meeting of June 27, 1919, and approved by the Council. In this report, as previously, the names of inquirers have been omitted.

Case No. 240

Inquiry: Is it necessary under the rules of the Boiler Code to use an internal feedwater delivery pipe in the boiler of a traction engine, and also if such internal delivery pipe be omitted, is it necessary to use a boiler bushing?

Reply: Neither the boiler bushing nor internal feed pipe is required for boilers of the locomotive type, as will be observed by reference to Par. 315 of the Boiler Code.

Case No. 241

Inquiry: Are we correct in our understanding that under the requirements of Part 1, Section 2, of the Boiler Code:

a There are no restrictions as to the manner of making rivet holes?

b There are no particular requirements as to the method of suspending the boiler?

c A manufacturers' Data Report is not required?

d An inspector's affidavit is not required by Par. 373, if the manufacturer should furnish a data report?

e We have the right to stamp a heating boiler which conforms to the requirements of the Boiler Code with an A.S.M.E. Stamp without having a state inspector present?

Reply: *a* and *b* Your understanding is correct.

c Your understanding is correct as far as the requirements of the A.S.M.E. Boiler Code are concerned, but the actual requirements in any particular locality in regard to this will, of course, depend upon the local laws governing boiler construction there.

d The requirement for the inspector's affidavit on a Data Report, if furnished, will depend on the laws of the localities where Manufacturers' Data Reports are required.

e Under Par. 377 of the Boiler Code, it is permissible to mark all heating boilers built according to the Code Rules with the designation "A.S.M.E. Standard." In regard to the feature of inspection, this will also depend entirely on the laws of the locality in which the boiler is to be installed.

Case No. 242

Inquiry: Is it permissible under the requirements of the Boiler Code to use "marine steel" in lieu of firebox steel for a boiler to be stamped A.S.M.E. Code standard, if the marine steel has chemical and physical properties very similar to those required for Boiler Code material?

Reply: If the "marine steel" will conform in all respects to the specifications for boiler plate steel given in the Boiler Code, and is re-stamped by the manufacturer in the way specified in the Code, it may be employed in the construction of Code boilers

Case No. 243

(In the hands of the Committee)

Case No. 244

(In the hands of the Committee)

Case No. 245

Inquiry: Is it permissible under the requirements of the Boiler Code to close up handhole openings in a boiler by the use of oval plates slightly larger than the handhole openings, placed inside and welded tight against the opening by the electric welding process?

Reply: If the plate which is placed on the inside of the opening is as strong as would be employed in the cap of a handhole fitting, or the like, which would not be welded to the boiler, there is nothing in the Code to prohibit the construction described except where the temperature of the gases striking the surface would limit the allowable thickness of the material. This is in accordance with Par. 186, which specifies that autogenous welding may be used in boilers in cases where the strain is carried by other construction which conforms to the requirements of the Code and where the safety of the structure is not dependent upon the strength of the weld.

Case No. 246

Inquiry: Will low-pressure heating boilers of the double, return-tubular type, with all joints welded instead of riveted, but which are built for heating service only, comply with the Rules of the Boiler Code? It is pointed out that the electric process of welding is used in this construction throughout and advised that all the boilers built in this manner have been operated for low pressure heating service (not exceeding 15 lb.), and that no trouble has ever resulted with them.

Reply: When the heating boiler section of the Code was formulated, welded joints were not considered for heating boilers. In general, the Code Committee does not approve of autogenous welding for any joint subject to tension (see Par. 186). This matter of welding joints for heating boilers is being referred to the Sub-committee on Heating Boilers and to the Sub-committee on Welding of the Boiler Code Committee.

According to the *Scale Journal* of July, 1919, the Pennsylvania Railroad has just completed one of the largest engines, and possibly the heaviest, ever built. The engine alone, without the tender, weighs 610,000 lb. As the engine is longer than the scale at Harrisburg, Pa., upon which it was weighed, its total weight was placed on the scale by means of jacking up the pilot wheels clear of the track and chaining them to the frame, thereby hanging them from the engine frame; thus, the total load of the engine was on the scale.

ENGINEERING SURVEY

A Review of Progress and Attainment in Mechanical Engineering and Related Fields, as Gathered from Current Technical Periodicals and Other Sources

SUBJECTS OF THIS MONTH'S ABSTRACTS

AERONAUTICS

Engine Designed to Operate at High Altitudes

The Napier Lion Aircraft Engine. Description of an engine very unusual in several respects. In the first place, it is unique in being the only example of its type which has been accepted by the Air Ministry as a "program" engine in that it is of the triple-four type, being of three rows of four cylinders each.

Next, it is lighter per horsepower than any water-cooled aero engine yet produced [a statement, which, however, has to be qualified by the fact that it is by no means certain what rating an engine of this type should be given, as will be evident from what follows].

The relation of the three rows of cylinders may be understood from Fig. 1 which gives a section through the timing gears. The engine was originally designed for work at high altitudes. The initial specifications of the Air Ministry required an engine at full throttle at a height of 10,000 ft. only, and to give at that altitude not less than 300 hp. These requirements have been amended to read that the engine would not be expected to run at full throttle at ground level.

The three rows of cylinders are at an angle of 60 deg. between the rows, which gives a short though fairly broad engine. Four overhead valves per cylinder are fitted and are operated by two overhead camshafts per row of cylinder. The cylinder blocks are built up of a single casting, forming the head for the four cylinders into which are secured separate steel barrels with water jackets made up of thin sheet steel. The crankshaft is a simple four-throw type mounted on roller bearings with a reduction gear between it and the propeller hub of simple spur type.

The inlet valves are of phosphor bronze and the outlet and exhaust valves of steel. Separate valve seats are used and the makers state that they have not expressed any trouble with them, while, on the other hand, the flanged valve seats form a convenient method of fastening the cylinder barrels and heads together. The writer criticizes this arrangement claiming that it makes the construction inaccessible and the removal of a valve difficult.

An interesting problem came up in connection with the connecting rod assembly. In this type of engine three connecting rods work on to a common crankpin and the method adopted (Fig. 2) has been to use a central master rod on each side of which is mounted an articulated rod carried on wrist pins fixed in lugs integral with the big end of the master rod.

The most remarkable part about the engine is the arrangement made for permitting it to run at high power at extremely high altitudes.

[The engine is really what might be called an "undercharged" engine (as opposed to the conventional idea of a supercharged engine) in that it has been designed to operate at an air density lower than the atmospheric.

The compression ratio is 5.55 to 1, which is an exceedingly high figure, but the engine is not designed to operate at full throttle at sea level but only at high altitudes. Therefore, notwithstanding the very high compression ratio the actual compression pressures at which the engine operates do not differ materially from those at which engines of conventional design operate at sea level.

This required, of course, great care and skill in design but the result is an engine with which a ceiling of more than 30,000 ft. has been reached.]

Fig. 4 is of interest as it gives the average power curve of the engine based on official tests taken over a number of engines at ground level and corrected for the barometric reading. The weight of the engine complete without water, fuel or oil is approximately 840 lb. and the gross weight of the engine in running order but without fuel and oil is 1132 lb. With fuel and oil for six hours it weighs 2671 lb. The engine is of 5.5-in. bore and $5\frac{1}{8}$-in. stroke, giving a total volume of the engine of 1461 cu. in., and a normal piston speed of 1708 ft. per min. (*The Automobile Engineer*, vol. 9, no. 129, August 1919, pp. 250-258, 29 figs., *d*)

BLAST FURNACES (See Gas Engineering)

ENGINEERING MATERIALS (See Heat Treatment)

FUELS AND FIRING

By-Product Recovery from Coal in Power Plants Practically Paying for Fuel

Low-Temperature Distillation of Coal, C. M. Garland, Mem.Am.Soc.M.E. An article which makes claims deserving the most careful consideration. Among other things, that for power plants with constant load burning over 50 tons of coal per day a combination of the low-temperature process with the by-product gas producer to recover ammonium sulphate improves economy to such an extent that the by-products pay for the coal, the overhead and operating expense, while the gas containing about 70 per cent of the heat in the coal and burning at higher efficiency is available for fuel under the boilers or for direct use in gas engines.

Low-temperature distillation is carried out in closed retorts at temperatures ranging from 700 to 1200 deg. fahr. The coke produced is much softer than in high-temperature distillation, but it has sufficient mechanical strength for all practical purposes, permits the maintenance of a fuel bed under low draft and burns without smoke notwithstanding the fact that it has from 3 to 18 per cent of volatile remaining in it. It is, however, not suitable for metallurgical operations.

As regards by-products, from 20 to 30 gal. of tar are produced per ton of coal. This tar contains a high percentage of pitch and free carbon and also a high percentage of tar acids suitable

for wood preservation, as well as low boiling distillates suitable for motor fuel. Investigations indicate that this tar at the present time has a value close to 10 cents per gal. in the crude state.

The temperatures in the low-temperature process are too low to yield much ammonium sulphate. The volume of gas produced is also low and varies from 1000 to 4000 cu. ft. per ton of coal. The gas has a heat value of from 750 to 1000 B.t.u. per cu. ft.

The author briefly describes the processes of Traer, Bostaph, Smith ("Carbocoal"), and G. & L. The essential differences between the processes are, as follows: In the process of Traer and

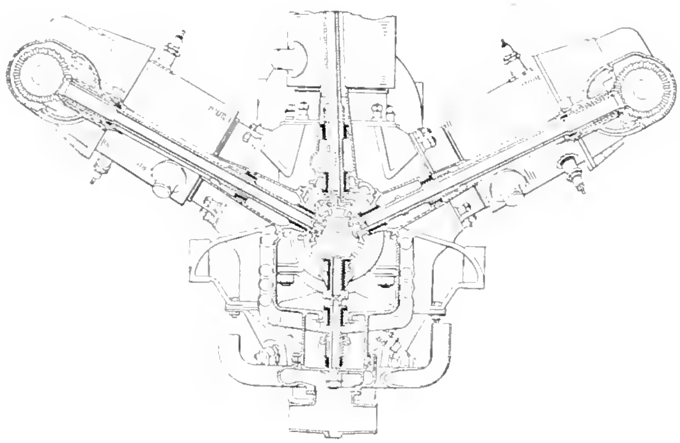


FIG. 1 NAPIER LION AIRCRAFT ENGINE SECTION THROUGH TIMING GEAR

Bostaph the coal is coked in cast iron forms, in the Traed process in a vertical form divided by partitions to produce rectangular slabs of coke about 4 x 12 in. in cross-section by 6 ft. in length. In the Bostaph system the coal is coked in the form of slabs, but these slabs form segments of a cylindrical drum which is provided with a hollow core for drawing off the products of distillation. Furthermore, in the Bostaph process the heat is supplied externally and the products of distillation pass through perforations in the inner wall of the retort to the central core, the idea being that the products of distillation should not come into contact with a higher temperature than from which they are distilled, as such contact may result in the chemical breaking up of the products.

In the carbocoal process the coking is carried out in two stages, the first stage being straight distillation of the coal, which gives a finely divided coke with a high percentage of volatile. This coke is mixed with some pitch and briquetted, the briquets being then subjected to a temperature in the neighborhood of 800 deg. fahr. which cokes the pitch and drives off most of the volatile.

The tar from the low-temperature process yields a large quantity of oil suitable for motor fuel, and it is possible to increase this quantity still further by cracking the tar.

The author believes that ultimately it will be possible to combine this low-temperature process with a by-product recovery gas producer, such as the Mond producer, and recover ammonia in the form of ammonium sulphate.

An important limitation to the application of this system lies in the fact that installations of this character are adapted only to plants using 50 tons or more of coal per 24 hr. and operating continuously 24 hr. per day and preferably every day in the year. On the other hand, it would mean that a plant using as much as 50 tons per day with an ammonium sulphate recovery of 85 lb. per ton of coal would generate power practically at no cost, while a larger plant may even have a small surplus after the disposal of the by-products. (*Power*, vol. 50, no. 7, Aug. 12, 1919, pp. 248-251, 4 figs., *dg*)

FURNACES

USE OF A MODIFIED ROSENHAIN FURNACE FOR THERMAL ANALYSIS, H. Scott and J. R. Freeman, Jr. Rosenhain in 1915 published a description of a furnace for the thermal analysis of metals operating under a new principle. Instead of carrying the temperature of the furnace containing the specimen under investigation, he heated the furnace so as to produce a uniform temperature gradient along its length and moved the specimen through the furnace. The present paper describes in detail some improvements in the design of his furnace and considers certain features of its operation. A simple method of mounting is described which gives highly satisfactory results using specimens of less than 2 grams weight. (*Abstract of Scientific Paper No. 348, U. S. Bureau of Standards, d*)

GAS ENGINEERING

GAS WASHERS, Geo. B. Cramp. The article discusses the general principles of gas-washer construction and operation and suggests a certain design which is claimed to increase the efficiency of gas washers. In order to secure a thorough and efficient wet washing of the blast furnace gas, it is necessary, the author states, to subdivide the gas volume into as small bodies as possible and bring them into intimate and positive contact with as small an amount of water as will clean the gas to the desired limit of dust content without too great a reduction in the temperature of the gas.

Washers having sprays of water directed on baffles between which the gas must pass give a positive contact of gas with water, but their efficiency depends upon a number of conditions, such as uniformity of water, distribution and uniformity of baffle arrangement and area of baffle space. Of these conditions, the first, uniformity of spray, may be considered as satisfied in the modern spray nozzle and it only remains to arrange judiciously the nozzles themselves to secure a uniform distribution of water over any area greater than one nozzle spray can cover. The next point is, therefore, the selection of the baffle shape to be used in the washer. The writer considers several shapes of baffles, such as, straight, angular and wavy (corrugated) and gives preference to this latter type. Corrugated sheet is a commercial shape in general use and can be readily bent without deformation of its corrugations to fit within a cylindrical shell of a gas washer. Furthermore, the corrugations permit the wash water to flow evenly down the entire surfaces of the plates while preventing the gas from travelling in a straight line, and cause it to deviate, eddy, and wind its way between the plates, so as to bring it time after time into contact

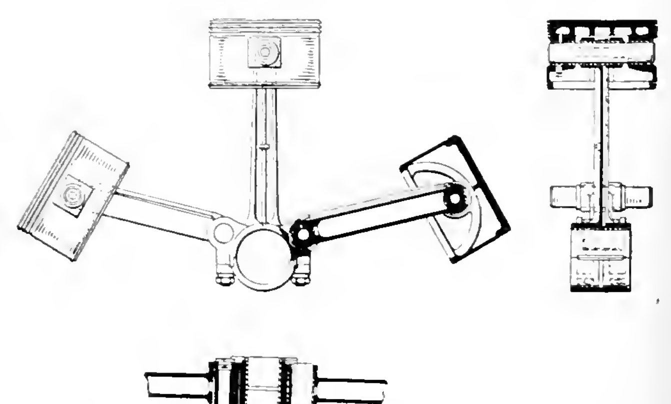


FIG. 2 NAPIER LION AIRCRAFT ENGINE ASSEMBLY OF CONNECTING RODS AND PISTONS

with the perfectly flush surfaces at the baffles and in so doing remove a far greater amount of dust from the gas.

The writer describes in general terms the construction of a washer using corrugated sheets. (*The Blast Furnace and Steel Plant*, vol. 7, no. 9, September 1919, pp. 430-432, 4 figs., *d*)

HEAT TREATMENT

THE HEAT TREATMENT OF DURALUMIN, P. D. Merica, R. G. Waltenberg, and H. Scott. The heat treatment of alloys of the type, duralumin, was investigated and the effect observed of variations in the heat treating conditions, such as quenching

temperature, temperature of quenching bath, and of aging or tempering, and time of aging upon the mechanical properties.

Conclusions were drawn relative to the best conditions for commercial heat-treating practice for this alloy. The temperature of quenching should not be above that of the $CuAl_2$ aluminum eutectic, which is usually about 520 deg. cent., but should be as near to this as possible without danger of eutectic melting. The pieces should be held at this temperature from 10 to 20 min. and quenched preferably in boiling water. The hardening may for most purposes best be produced by aging for about 5 days at 100 deg. cent.

A theory of the mechanism of hardening of duralumin during aging after quenching from higher temperatures was developed which is based upon the decreasing solubility of the compound $CuAl_2$ in solid solution in aluminum with decreasing temperatures from 520 deg. to ordinary temperatures. It is believed that the precipitation of excess $CuAl_2$, which is suppressed by quenching, proceeds during aging, the precipitation taking place in very highly dispersed form. The hardening is due to the formation of this highly dispersed precipitate.

According to this theory the hardening of duralumin during aging or tempering after quenching presents a very close analogy with that of steel, and the evidence in support of the theory is of the same nature and of approximately the same competence as that in support of the prevailing theory of the hardening of steel. (*Abstract of Scientific Paper* No. 347, *U. S. Bureau of Standards*, *t*)

HOISTING MACHINERY

British Standard Crane Developed During War by the Government

A British Crane. Description of the standard crane developed during the war by the Technical Branch of the Directorate of Inland Waterways and Docks. By the end of April 1918 some 200 steam cranes of this type, known as the I. W. D. standard, were completed.

The crane was designed to perform the ordinary work of a traveling crane on the standard British railway gage and to be capabile of easy conversion into a floating, fixed or gantry crane for dock or general purposes. The conversion is effected without alterations to the machinery or ropes by using special jibs and extra balance weights.

The crane is designed to lift loads up to 2½ tons on a single

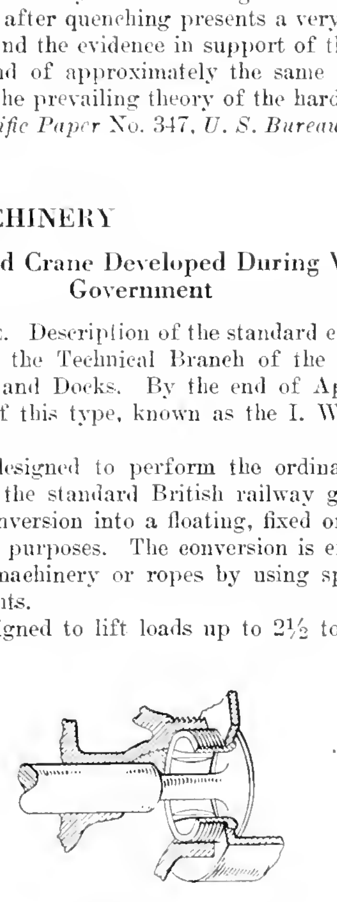


Fig. 3 Napier Lion Aircraft Engine Valve Seating

rope direct off the barrel, greater loads up to 10 tons being dealt with by a block. The lifting barrel accommodates 200 ft. of working rope so that the range of lift is about 200 ft. for the single rope and 2½-ton hook, and 100 ft. and 50 ft. for the 5-ton and 10-ton blocks, respectively.

Figs. 5 and 6 show the general arrangement of the crane and the gear. No rail clips or blocking girders have to be fitted, as the reserve stability is 50 per cent on a level track and the crane is stable backwards with jib removed and coal bunkers and tanks full.

Steam was adopted as the motive power in order to render the crane self-contained and independent of local power. The operating levers are in front of the crane on the left-hand side so that the crane driver has a clear view of his work under all conditions.

The boiler used on these cranes is No. 14 Spencer Hopwood squat pattern water-tube type designed for a working pressure of 100 lb. per sq. in. This type of boiler steams very fast, and as there are only 18 cwt. of water in the boiler, the water level has to be watched very carefully. To avoid fluctuations in the water level the cranes are provided with an independent duplex feed pump, placed on top of the water tank on the right-hand side of the crane. This enables the driver to regulate the speed of the pump to suit the work being performed (the steam valve of the feed pump is fixed to the left-hand side of the boiler). In addition to this an injector is provided as a reserve, the injector

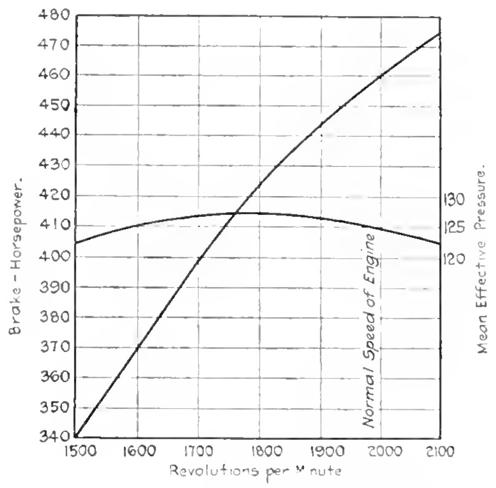


Fig. 4 Napier Lion Aircraft Engine Average Power Curve

steam valve being placed on the right-hand side of the boiler.

A standard design of fire bars was adopted, consisting of four segmental bars around the firebox with single center bars resting on the segmental bars. The use of this design enables the center bars which burn out first to be removed cheaply and easily. (*The Railway Gazette*, vol. 31, no. 7, August 15, 1919, pp. 206-210, 14 figs., *d*)

HYDRAULIC ENGINEERING

New Method for Graphically Representing Water Turbine Performance

Comprehensive Plotting of Water Turbine Characteristics, Karl R. Kennison. The paper presents a chart for the comprehensive plotting of water turbine characteristics intended to enable a manufacturer of waterwheels to show the performance of his turbine under any and all conditions, and also to compare the merits of different turbines and their compliance with specified requirements.

The usual system of representing test performances of a turbine by a series of curves, one for each gate opening used in the test, does not give a sufficiently clear indication of the results that would be obtained at any other gate opening not included in the test, though an engineer who specialized on the subject may be enabled to interpret these curves and fit them to any desired conditions of operation. It is claimed that the method of plotting described here is free from this objection.

Water turbine operation is determined by the following seven variable quantities:

D = rate of diameter in inches
H = head in feet
N = speed in revolutions per minute
P = power output in horsepower
Q = discharge in cubic feet per second
Gate opening
Efficiency

These quantities are interconnected by twelve simultaneous equations which the writer gives. Of these seven variables only six are independent, since power output and discharge are interrelated through efficiency and either of them may be eliminated for the sake of simplicity. Contrary to present practice, the

auth[illegible] eliminates power output and retains discharge capacity.

In deriving his characteristics the writer takes advantage of a fortunate mathematical coincidence, namely, that what he proposes to call specific "r.p.m." or the relation between speed, head and discharge is numerically equal to the "specific speed" currently expressed as the relation between speed, head and power output at the efficiency attained by wheels of good design, namely, 88 per cent.

The characteristics are as follows:

$$\text{Specific Head} = \frac{H \times 10^6}{N^2 D^2}$$

$$\text{Specific discharge} = \frac{Q \times 10^6}{N D^3}$$

$$\text{Specific diameter} = \frac{D H^{1/4}}{Q^{1/2}}$$

$$\text{Specific r.p.m.} = \frac{N Q^{1/2}}{H^{3/4} \times 10^3}$$

INTERNAL COMBUSTION ENGINEERING (See Aeronautics, Gas Engineering)

MACHINE DESIGN (See Power Plants)

MACHINE TOOLS

Huge Tool Doing Thirty Days' Work in Two Days

Crankshaft Lathe, Ethan Viall, Mem.Am.Soc.M.E. The full title of the article here abstracted is "A Record-Smashing Crankshaft Lathe," a title which is justified both by the design and results secured by the new machine.

The machine was the outcome of the shortage of crankshafts for multiple-cylinder oil engines of large horsepower which existed in the summer of 1917 and was designed by T. K. Webster, of Chicago, previously engaged in manufacturing a single-purpose gun-boring and shell-making machines.

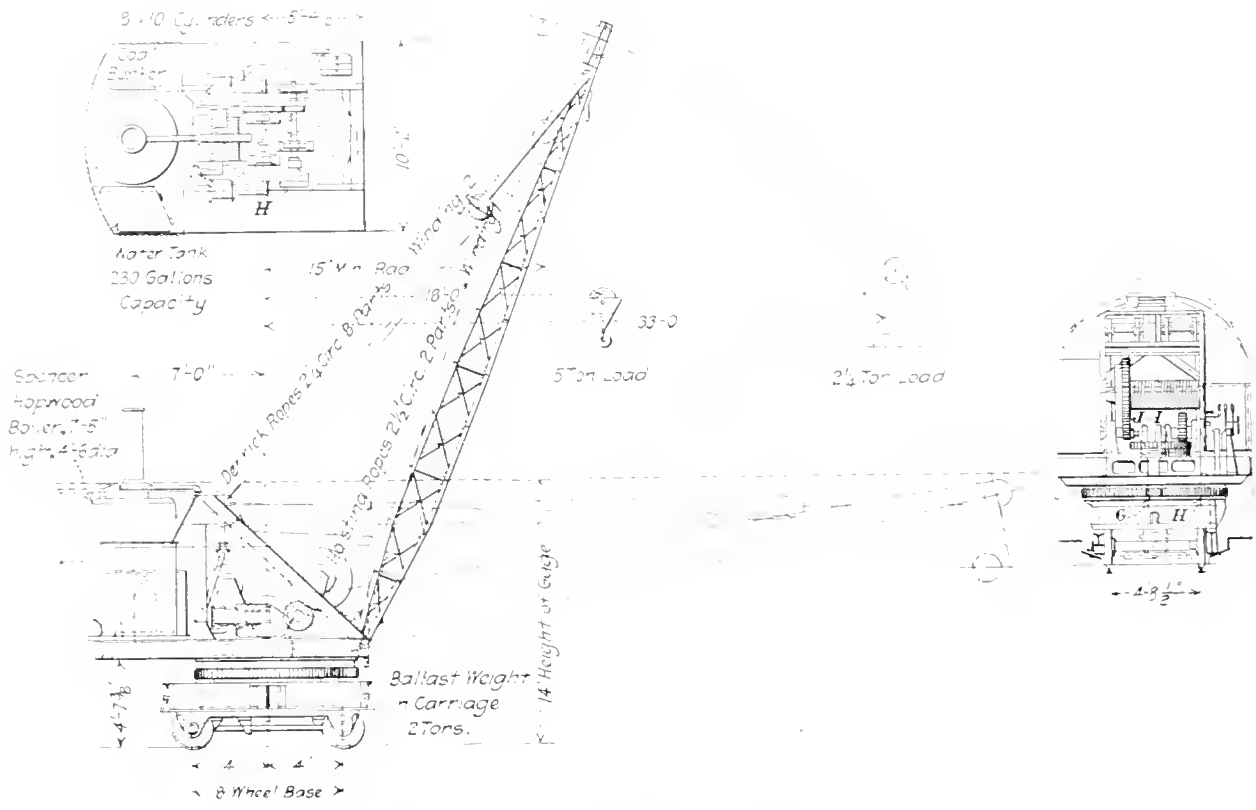


Fig. 5 General Arrangement of British Wartime Standard Steam Crane

The chart is simply a means of plotting efficiency and gate opening in terms of these four fundamental type characteristics.

The vertical and horizontal scales represent the two most important variables, namely, head and discharge, respectively, so that when the characteristic curves are plotted for any type of turbine the available range of head and discharge stand out very clearly.

A logarithmic scale of coordinates is used which permits comparing the range of operation of any two types regardless of their location on the chart. The writer gives several charts for typical water turbines of American manufacturers (inward- and downward-flow type) and describes in detail the method of using the charts. Several charts are given in the original article. (*Proceedings of the American Society of Civil Engineers*, vol. 45, no. 6, August 1919, pp. 475-481 and 3 large charts. *dp*)

HYDRAULIC MACHINERY (See Pumps)

The machine is of very large dimensions and is capable of machining crankshafts of from 7 to 10 in. in diameter and any throw. It machines the sides of the webs and turns the ends of the crankpins on all of the throws at once. Fig. 7 shows that the machine has a main and an auxiliary bed. The main bed is 33 ft. 10 in. long, 50 in. wide and carries two opposing spindles 14 in. in diameter and tool carriages after the manner of a lathe. Each of the opposing spindles is driven through back gears by means of a 20-hp. Triumph variable-speed motor with the range of 400 to 1200 r.p.m., the motors being synchronized by means of a special electrical device so that the drive on each spindle is exactly the same at all times, and no twist is imparted to the crankshaft being machined. Before the crankshaft is placed in the machine it is slabbed out, blanked by drilling and sawing, twisted according to the arrangement of the throws, centered and has the concentric bearings turned in a big lathe. Heavy-flanged driving plates are then shrunk on to each end of the crankshaft and the crankshaft is put into the machine, where it is centered

to run true and the driving plate bolted to the faceplates of the machine at each end.

The turned parts of the crankshaft run in steadyrests *A* (Fig. 8 which shows the machine with the 4-throw crankshaft in place), the bearing of which are babbitted to fit the turned parts. After this is done the crankshaft is ready for the placing of the crank-action tool carriers shown at *D*. These tool carriers have the same stroke and action as the connecting rods of the engine and are made to machine the inside faces of the crank webs and about a quarter of each end and the fillets on the crankpins.

The placing of the tool carriers is an operation requiring expert skill of high order. With the tool carriers all placed and the tools set, the machine is ready for starting. As the crankshaft revolves the two tools *H* and *I* (first tool carrier) in the sliding block are automatically fed forward and machine the inside of the webs and turn down each end of the crankpin. All the other tool carriers act in the same way. At the same time the tools in the carriages at *J* feed straight in and machine the outside faces of the webs.

While in action on the 4-throw crankshaft the machine closely resembles a huge 4-cylinder engine. One of the great advantages claimed for this method of machining is that all the webs and crankpins are machined at once. It would take 30 days to turn a 4-throw crankshaft of the size indicated in the ordinary way and it takes only two days to do the same work on this machine. Furthermore, the tools can be held close up to the cutting point, eliminating the spring, since all the tools are set out the same distance from the tool blocks for a length of throw which improves the final work.

The size of this machine may be well imagined from the fact that it weighs approximately 95 tons. (*American Machinist*, vol. 51, no. 9, August 28, 1919, pp. 395-399, 8 figs., *dA*)

Thread-Cutting Mechanism of a Norwegian Lathe. The following description is given by *Machinery* of an engine now manufactured by Broederne Sundt, Christiania, Norway. The lathe is equipped with two lead-screws for cutting both inch and metric screw threads, and the gearing is so arranged that threads of very coarse pitch, or helical grooves with leads up to 12 in., may be cut, in addition to the usual range of pitches for threads. The headstock, which is the geared type, is so designed that its gear ratios may be utilized in connection with screw cutting, the different gear combinations being used to drive the lead-screw. With this arrangement the total number of pitches obtained in the ordinary way will be multiplied by the number of gear ratios in the headstock. For example, if the lathe is set to cut ½-in. pitch, and the ratio of the gearing between the driving pulley and

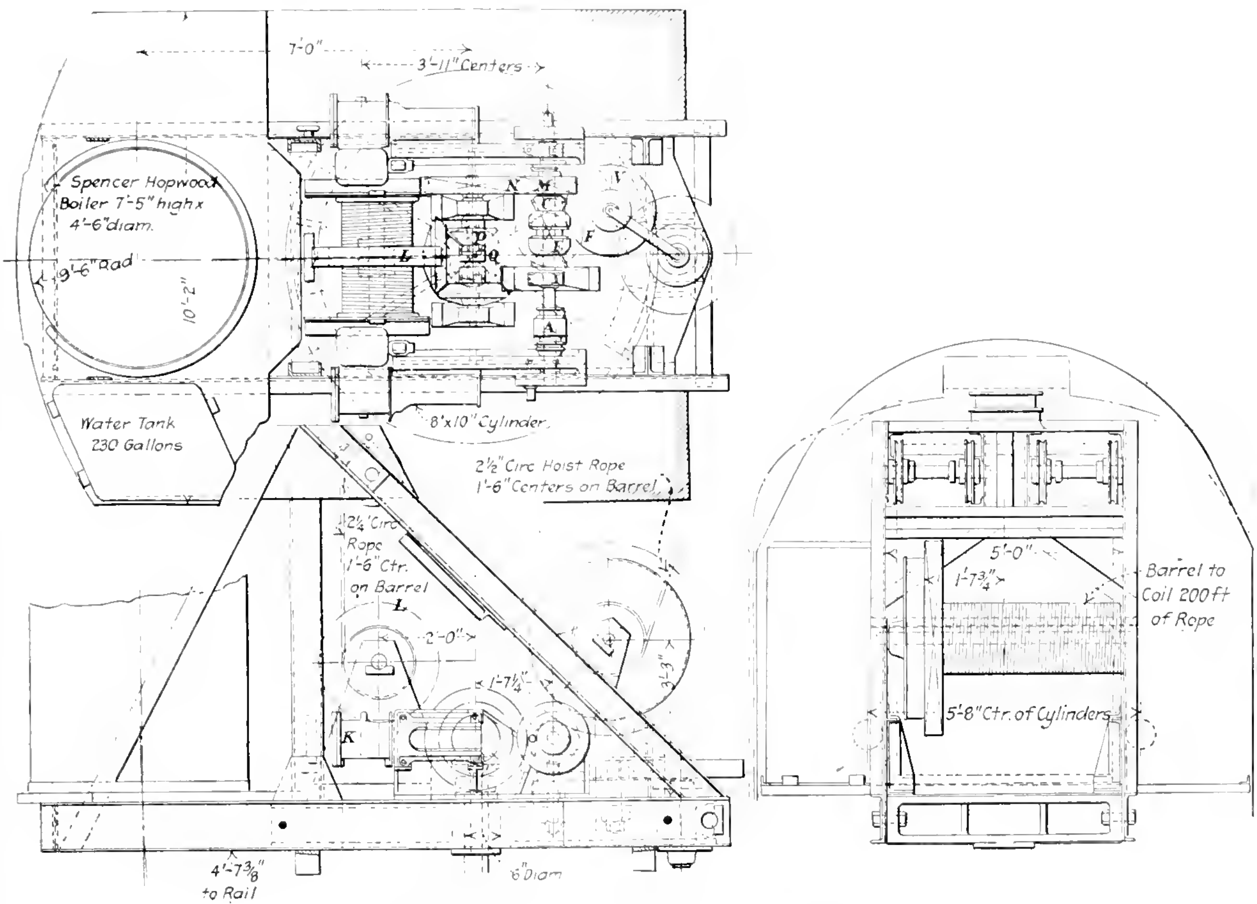


Fig. 6 Arrangement of Gear of the Crane Shown in Fig. 5

spindle at this particular time is 24 to 1, then by turning a handle the pitch may be changed from ½ in. to 12 in.; or if a metric thread of, say, 8-mm. pitch were being cut, the pitch would be changed to 192 mm. ($24 \times 8 = 192$).

The headstock of the lathe has eight different gear ratios, and it is said that the stress on the gearing is not much heavier when cutting the large pitches than when cutting the finer ones. There is one lead-screw for the inch pitches and one for the millimeter pitches. The metric lead-screw also serves as a feed-rod; in fact, it is practically a threaded feed-rod. When used as a feed-rod the threads are not engaged by the nut on the carriage, as there is a keyway which transmits the feed motion worm and spur gearing in the usual manner. The apron has separate nuts for engaging each screw, but they are both operated by the same handle, and only one can be engaged at a time. By means of this additional screw on the feed-rod, metric threads can be cut without using translating gears and by employing the same gearing as for the inch pitches. Both lead-screws run at the same speed, and either one may be disconnected when the other is in use. The inch lead-screw is ¼-in. pitch, and the feed-rod 4-mm pitch; hence, when the lathe is geared for cutting $\frac{1}{16}$-in. pitch, it is also geared for cutting a pitch of 1 mm. with the metric lead-screw.

The change-gear box in connection with one set of spur gears

and the gear ratios of the headstock provide for cutting 342 different pitches, there being 167-in. pitches and 175 millimeter pitches. These different pitches are obtained by shifting the handles or levers and without changing any gear; and if other gears are inserted an entirely different series of 342 pitches may be obtained. The maximum pitch is 12 in. The pitches are divided into a large series and a small series. The latter, which is for general use, is obtained when the lead-screw is driven from the spindle in the usual manner. In the small series there are 37-in. pitches and 37 millimeter pitches. The large series is obtained when the lead-screw is driven from the driving pulley through the headstock gearing.

The lathe may be used for cutting worms intended for worm-wheels based on the module system. (The module of a gear is equal to the pitch diameter in millimeters, divided by the number of gear teeth.) With eleven change-gears, 69 module pitches may be obtained, having a range of from 0.75 to 60.

The cross-feed screw of this lathe is connected to the feed-rod, or metric lead-screw, with gearing, so that spiral grooves may be cut on a plane or flat face; as, for example, when making the scroll of a chuck. There is a fixed ratio between the movement of the cross-slide and that of the carriage. For instance, on one lathe if it is geared for ½-in. pitch with the inch screw, and 8 mm. pitch with the millimeter screw, a spiral of 4 mm. pitch will be obtained, the cross-slide moving half as fast as the carriage when using the metric screw. By means of a special device, the carriage may be moved automatically along the bed while the spindle is stationary. (*Machinery*, vol. 26, no. 1, September 1919, pp. 59, *d*)

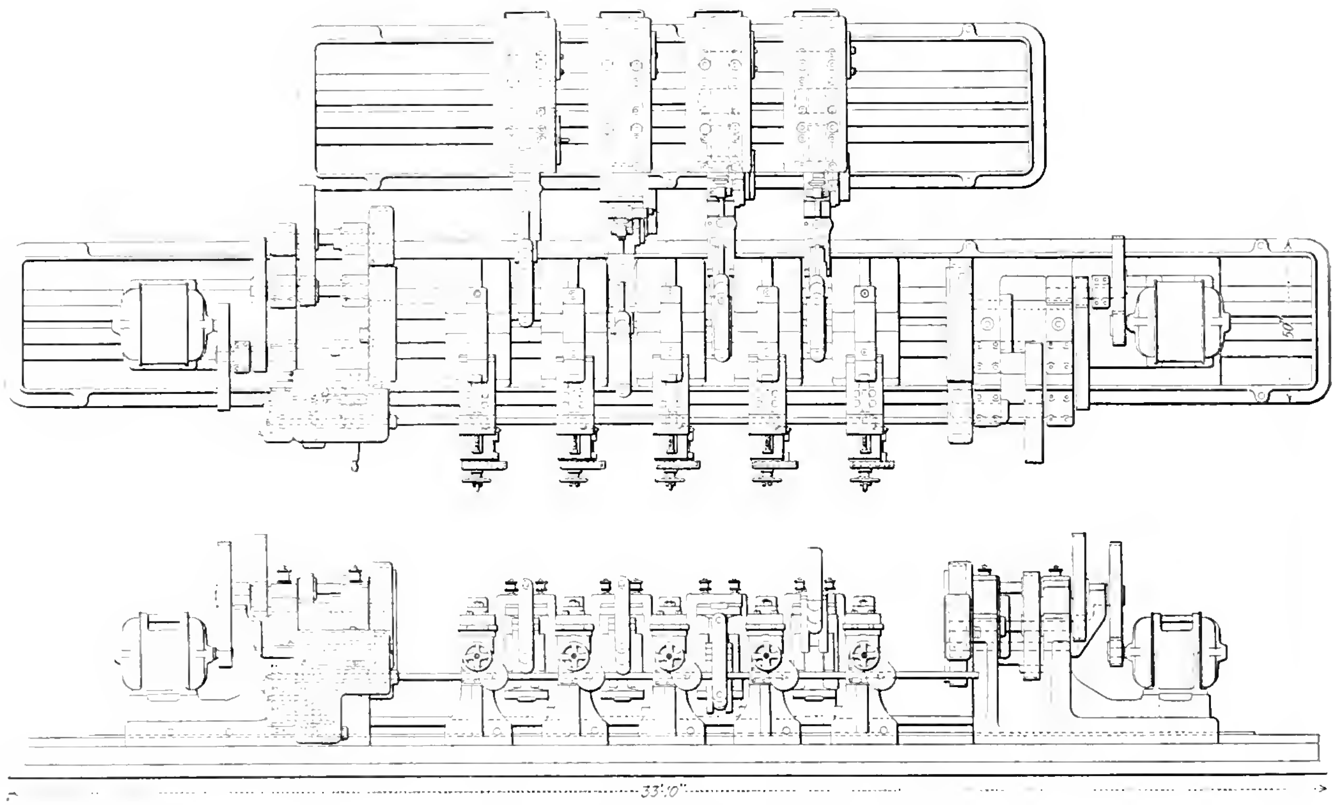


Fig. 7 Details of Crank-Shaft Lathe

MEASUREMENTS AND TESTING

Advance Publication of an Investigation by the U. S. Bureau of Standards

Photoelectric Spectrophotometry by the Null Method, K. S. Gibson. In connection with the color standardization work of the National Bureau of Standards (I. G. Priest, The Work of the National Bureau of Standards on the Establishment of Color Standards and Methods of Color Specifications, Trans. I. E. S. XIII, p. 38, 1918) it is desired to have available a number of independent methods of making spectrophometric determinations, especially in the visible part of the spectrum; for it is generally admitted that the fundamental basis of color specification is spectrophotometry. To supplement the other methods at present in use at the Bureau and especially to overcome the well-known uncertainty of measurements by these other methods in the blue and violet, the author in 1917 was given the problem of developing a method for accurate and convenient photoelectric spectrophotometry suitable for routine determinations. This was especially desirable for the measurement of spectral transmission. The sensitive potassium-hydride photoelectric cells now on the market (made by Kunz) when used with an incandescent lamp and a glassdispersing prism, give a maximum response usually near 460 millimicrons, and are thus very suitable for the purpose. The making and assembling of apparatus was completed in April, 1918; and since that time it has been in continual use, being very satisfactory as to speed of operation, ease of keeping in working condition, and accuracy of measurement.

In the null method as used, two photoelectric cells and the proper batteries are connected in a sort of Wheatstone bridge arrangement (F. H. Richtmyer, Phys. Rev. (2), VI, p. 66, 1915), with the electrometer as the indicator. Radiant energy from a 600-watt Mazda C moving picture lamp, after dispersion through a hilger constant deviation spectrometer, is incident upon one of the photoelectric cells. Radiant energy from a 14-watt Mazda C lamp is incident on the other photoelectric cell. The photoelectric currents generated in the two cells by the radiant energy from the two lamps tend to nullify each other so far as charging the electrometer is concerned; and by proper adjustments, the two currents may be made exactly equal, the zero motions of the spot of light from the electrometer indicating the balanced condition.

Measurements of the spectral transmission of a specimen are made by observing at any desired wave length the distances of the

600-watt lamp from the spectrometer slit necessary to obtain a balance of the electrometer with and without the specimen in position, all other factors such as slit widths, currents, etc., being kept constant. The ratio of the squares of these two distances respectively is the transmission. By this use of the null method all errors are eliminated, as well as the necessity of any kind of calibration, in connection with the relation between photoelectric current and incident radiant power, with the dark currents through the photoelectric cells, and with electrometer deflection methods.

The accuracy has been tested in various ways, chief of which are the measurements of rotating sectors of known transmission and comparisons with values obtained by other methods. It is considered that the uncertainties of values obtained from 410 to 550 millimicrons, inclusive, are not greater than 0.01 for any values of transmission between 0.00 and 1.00 and not greater than 0.003 for transmissions between 0.00 and 0.10. Beyond these wave lengths just given, as far as 390 and 600 millimicrons, inclusive, the uncertainties of measurement are not greatly increased, being at 390 and 600 not more than twice as great as throughout the better range. Measurements can be made from 380 to 650 millimicrons.

The apparatus has also been used for the measurement of spectral diffuse reflection relative to that of a standard such as magnesium carbonate, and is adapted to the measurement of the relative distribution of radiant power of two sources, to the measurement of fluorescence, and to extension into the ultra-violet if quartz parts instead of glass were used. (*Abstract of Scientific Paper* No. 349, *U. S. Bureau of Standards*, *dA*)

MECHANICS

Mathematical Investigation Abstracted from a Japanese Publication

The Stability of Long Struts of Variable Section, Prof. Akimasa Ono. The writer considers the determination of critical loads for long struts of variable section, in particular a long strut fixed at one end and free at the other tapered end. Furthermore, the same calculations may be applied to the case of a strut symmetrically formed about the middle and with tapered ends free to bend, in which case, however, either half of the strut must be taken separately.

The calculation is based on the assumption, as in the deduction of Euler's formula, that the axis of strut is quite straight, the material is homogeneous, the loading takes place without eccentricity and, moreover, the length of the strut is sufficiently long. Next, the cross section is supposed to vary in such a manner that the least moment of inertia is proportional to a certain power of the distance from the free end, where the axial thrust acts on the strut and the corresponding axis of reference lies always in a plane. Then the bending takes place in one plane and the differential equation to the elastic line is of a standard form whose solution can be readily written down. This being done the critical load may be determined with due regard to the end conditions, and the result thus obtained may be applied to find the least volume of struts for the same load and height.

In this connection, the author states that Professor Aichi has also deduced a formula based on the same principle as stated above, but obtained the results expressed in a form different from that obtained by the present writer owing to the difference in the expressions for the root of Bessel's function.

The author obtains the following expression for the critical load on the strut

$$P = \left(1 - \frac{n}{2}\right)^2 z_1^2 \frac{EI_1}{l^2}$$

where P is the end thrust on the strut, E the modulus of elasticity, I_1 is the moment of inertia of cross section, n a numerical constant, l the distance between a plane at which the strut is fixed and the free end, and z_1 is given by

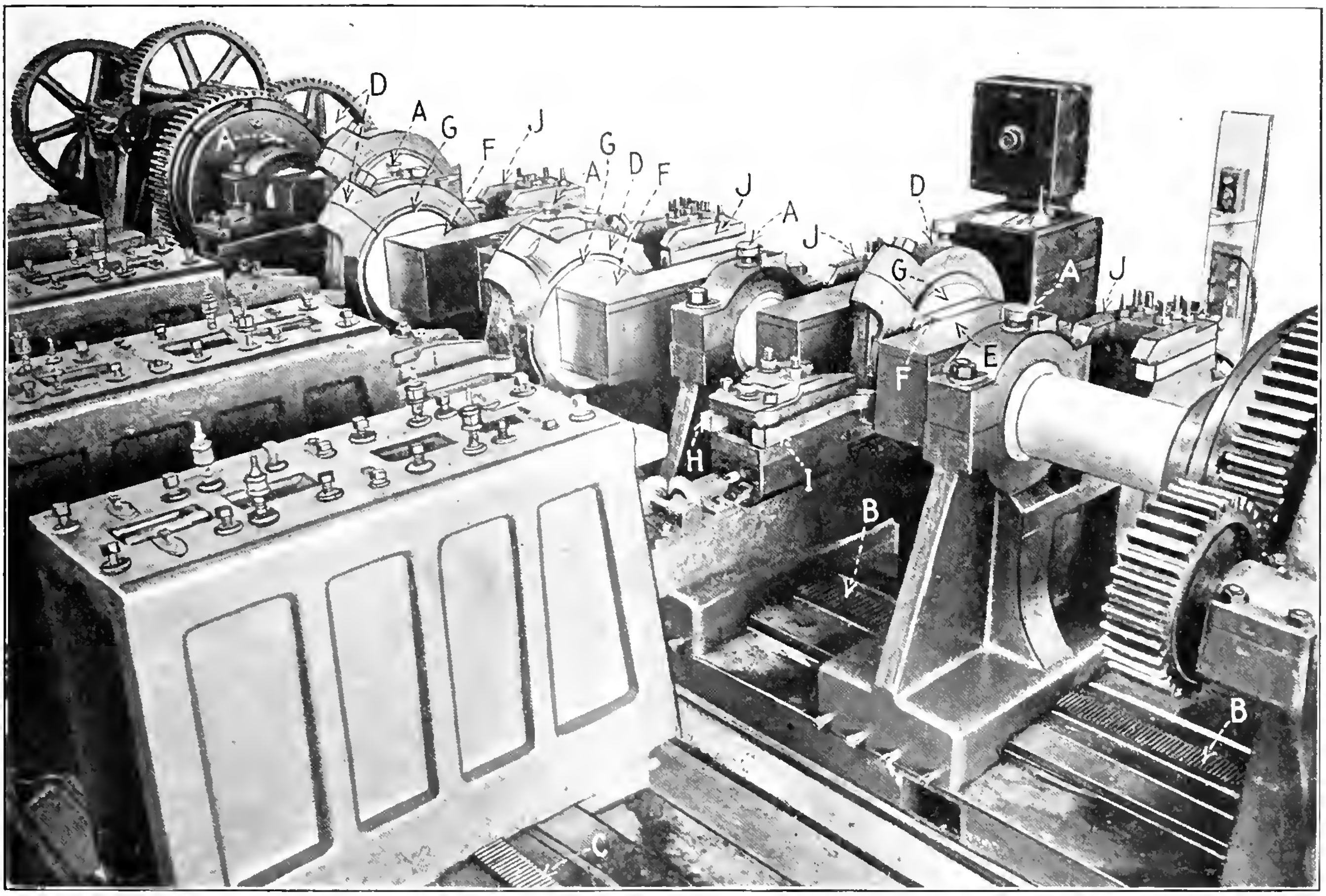


Fig. 8 The Machine with a Large-Crankshaft in Place

$$z = \frac{a^{\frac{1}{2}}}{1-\frac{n}{2}}\, l$$

where a is given by

$$\frac{Pl^n}{EI} = a \text{ (constant)}$$

The author gives a numerical example by means of which he shows the laws of variation of the constants.

He also gives equations expressing the volumes of struts and shows that all other conditions being assumed to be equal, except the form of rods, the volumes of tapered and prismatic struts, V and V_s, respectively, are in the ratio

$$\frac{V}{V_s} = \frac{1}{n+2} \times \frac{\pi}{\sqrt{c}}$$

where both n and c are constants. (In another part of the paper it has been shown that the coefficient c varies in accordance with the certain law with the variation of the coefficient n).

The following summary of the paper is given by the author:

(1) The assumption that the amount of inertia varies as the n-th power of the distance of the section from the free end, leads to the simple formula for the critical load.

(2) For a given rod, whose cross section varies in any assigned manner, the present formula may be used to judge the range, in which the critical load lies.

(3) With proper choice of form, the volume of struts may be reduced to a limit about 13 per cent less than the uniform rod of similar sections for the same load and height.

(4) When $n = 1$, the volume is nearly least, though the tapering is a little over. In this case the stress is a maximum at the distance equal to about one-third of the length of the strut from the tapered end.

(5) An empirical formula may be conveniently used for finding the first root of Bessel's function $J_s(z)$ in a small range of s. (*Memoirs of the College of Engineering, Kyushu Imperial University*, Fukuoka, Japan, vol. 1, no. 5, 1919, pp. 395-406, 4 figs., *mt*)

POWER GENERATION (See Fuels and Firing)

POWER PLANTS

Description of a New Type of Governor for Steam Turbines

PNEUMATIC STEAM TURBINE GOVERNOR. Description of a new type of pneumatic governor designed by the Ridgway Dynamo and Engine Company, of Ridgway, Pa. Air replaces the metal balls or weights as well as the connecting linkage levers, etc., between the centrifugal elements and the valves. It is described in the following manner in an interesting article in *Power*:

Referring to Fig. 9, a small fan impeller A bolted to the end of shaft B is enclosed by the fan housing C and generates an air pressure of about 12 in. of water at 3600 r.p.m. This air pressure acts on the under side of two light aluminum pistons D and E, Fig. 10, forcing them upward. This movement is opposed by the spring F. At the upper end of the piston rod G the lever H operates the pilot valve I, which admits oil to and from the cylinder J, the piston K of which operates the main inlet valves L, M, N, N being an overload valve. The spring O is for the purpose of closing the main valve in case the oil pressure should fail for any reason.

A synchronizing motor P is for adjusting the speed from the switchboard. Q is a worm on the motor shaft and R is a wormwheel which engages with the handwheel S by means of pin T. The speed may, therefore, also be adjusted by hand with the sheel S. An electric contact U is for the purpose of breaking the circuit in case the motor is run too far in either direction.

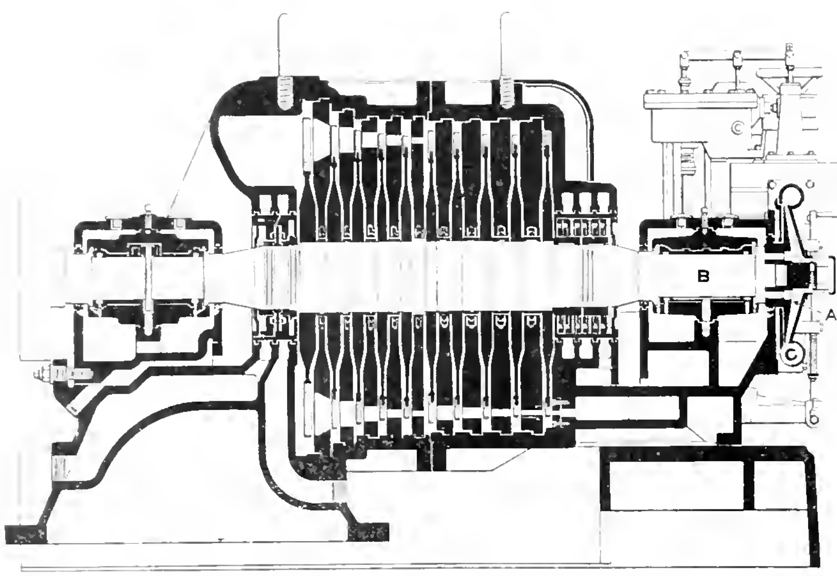


FIG. 9 APPLICATION OF FAN IMPELLER TO THE TURBINE SHAFT

The hub of the fan impeller A has a spring bolt V, for operating the emergency trip. In case of overspeeding this bolt V strikes the hair trigger W, releasing the hammer X, which in turn strikes the main latch Y a blow, releasing the rod Z which, due to the spring A^1 closes the butterfly valve B^1 in the steam line. Handle C^1 is in the form of a loose toggle, the lost motion of which permits some movement of Z before a movement of the bell crank takes place; thus the inertia of Z under movement is used to start the butterfly below the throttle valve.

The pneumatic governor has many advantages. The only running part is a plain disk, with vanes on the side of it, which is bolted to the end of the shaft. Air forms the connecting medium between it and the other moving parts, and these move only on a change of speed due to a change of load. The small pilot valve I and piston K move in oil and should therefore last indefinitely. The governor as a whole is simple and little subject to wear. The only work to be performed by the air pistons is to operate the small $\frac{5}{8}$-in.-diameter pilot valve, which is balanced and floats in oil. The air force on these two pistons is about 150 lb. The pneumatic action is therefore quite powerful and reliable. The air pressure generated by the fan is as the square of the speed, and slight change in speed, therefore, is quick and effective in its action.

Oil is used in the power cylinder J because it acts like an oil dashpot, preventing jumping, overtraveling or hunting of the main valves, and at the same time it insures long life to these parts. Oil for the operation of the governor is supplied from a branch off the oiling system for the bearings. The conditions of atmosphere may slightly change the speed of the turbine, but these are so slight as to be negligible and need not be considered. (*Power*, vol. 50, no. 8, Aug. 19, 1919, pp. 300-301, 2 figs., *d*)

Suggested Standard Form for Reporting Economizer Tests

PERFORMANCE TESTS OF ECONOMIZERS, B. M. Baxter, Mem.Am. Soc.M.E. The author suggests a standard method of making and reporting economizer tests.

The important factors entering into the design of an economizer are the rate of heat transfer from the gases to the water, the draft loss and to some extent the efficiency. The first of these determines the heating surface necessary for the desired results; the second, the arrangement of the heating surface and the amount of free area between the tubes necessary to be provided to avoid undue resistance to the flow of the gases, or expressed in another way, loss of draft; the efficiency affects the performance

in that it determines the percentage of available heat of the gases which can be counted upon to be absorbed by the feedwater. Furthermore, the rate of heat transfer from the gases to the water is materially affected by the velocity of the gases through the economizer. Hence, it is essential that as high velocity of the gases be obtained as the conditions of the installation in question will permit, but the higher the gas velocity the greater the draft loss, and it is in connection with the calculation of draft loss that present knowledge of economizer performance is deficient.

The author suggests the following form for reporting economizer tests:

1 Date of test
2 Type of economizer, parallel flow or staggered tube
3 Length of tubes
4 Number of tubes per section
5 Number of sections
6 Square feet of heating surface, builder's rating
7 Square feet free area between tubes
8 Duration of test in hours
9 Total amount of water passed through economizer
10 Average rate of flow of water through economizer, lb. per hour
11 Average temperature of water entering economizer, deg. fahr.
12 Average temperature of water leaving economizer, deg. fahr.
13 Average temperature rise of water in passing through economizer
14 Average temperature of gases entering economizer, deg. fahr.
15 Average temperature of gases leaving economizer, deg. fahr.
16 Average analysis of gases: carbon dioxide, per cent; carbon monoxide, per cent; excess oxygen, per cent
17 Pounds of flue gas per hour passing through economizer
18 Average velocity of gases through economizer
19 Average draft at entrance to economizer
20 Average draft at exit from economizer
21 Average draft drop through economizer
22 B.t.u. transmitted per hour per sq. ft. of heating surface
23 Mean temperature difference between gases and water
24 B.t.u. transmitted per hour per sq. ft. of heating surface per degree mean-temperature difference (Coefficient of heat transfer)
25 Specific heat of gases (State whether assumed or calculated)
26 Efficiency (Ratio of heat absorbed by water to heat lost by gases)
27 Draft loss per section

(*Power*, vol. 50, no. 8, August 19, 1919, pp. 299-300, *t*)

PUMPS

Water Pumps of the Drainage Station at Codigoro. Part of an article describing the whole installation. The general construction of the pump appears in Fig. 11. The pump is designed for a delivery of 8000 litres (2113 gallons) per sec. and the rotor is so located that even at the lowest level of the water the pump can be started without priming. The water itself is of an exceedingly corrosive nature attacking both wrought iron and steel. Hence, the use of these materials has been carefully avoided and where inevitable the metal parts were protected by bronze bushings or sleeves.

The weights of the rotating parts of the pump are taken up in starting by a roller bearing located under the crankshaft bearing. During the operation of the pump, however, the load on the roller bearing is entirely taken up by a pressure oil bearing, the construction of which appears from Fig. 12.

The suction and pressure chambers are so proportioned that in each group these chambers may be emptied without thereby affecting the operation of the other groups. For this purpose, protective devices have been installed on the suction chambers so that they could be kept empty during repairs or cleaning. A special centrifugal pump is provided to take care of the emptying of these chambers. (Part of serial article in *Schweizerische Bauzeitung*, vol. 74, no. 3, July 19, 1919, the part abstracted here being on pp. 30-31, 7 figs., *d*)

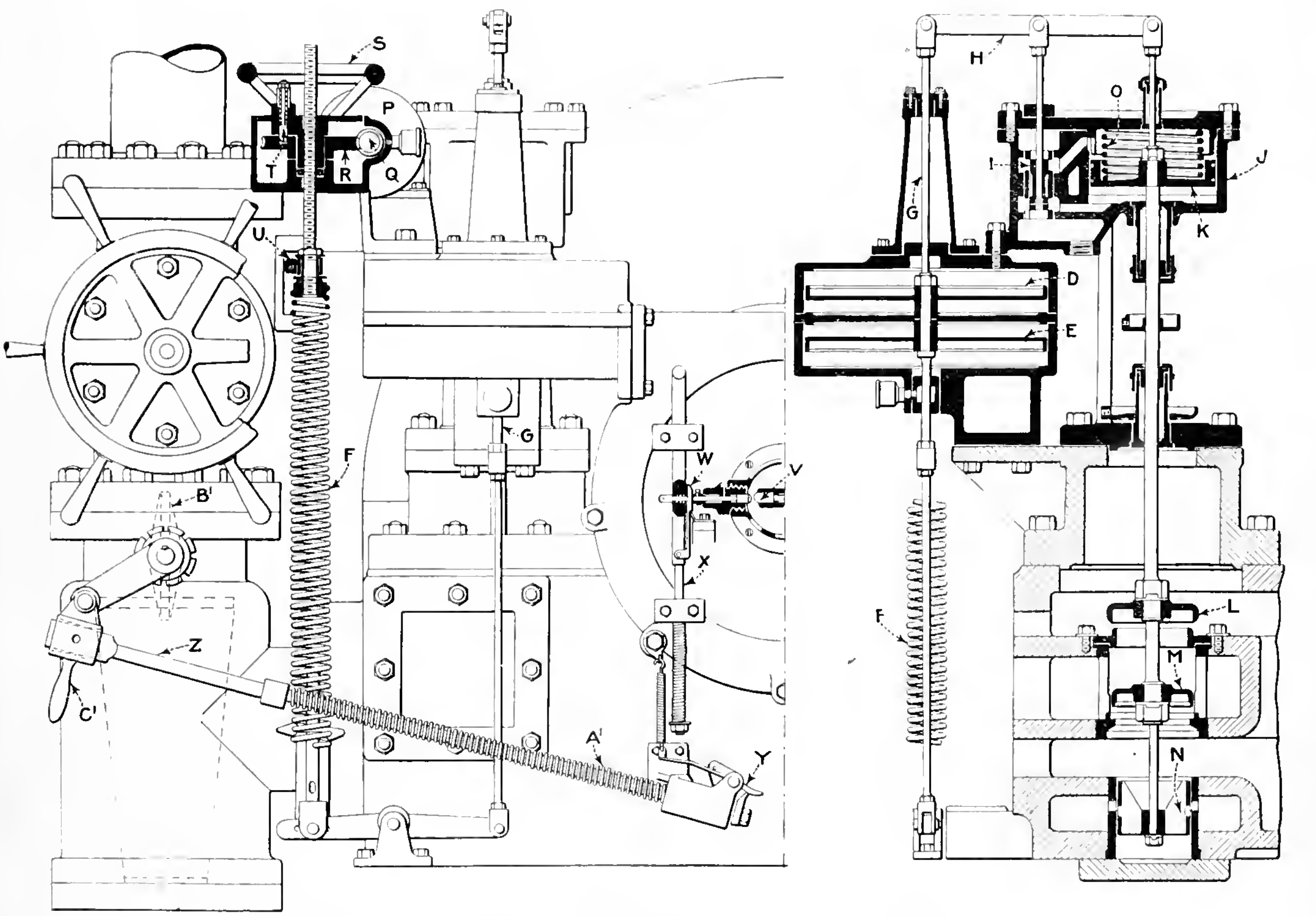


Fig. 10 Details of the Pneumatic Steam-Turbine Governor

RAILROAD ENGINEERING

Production of Corrugations on Rail Surfaces. (F. Märtens, *Organ fur die Fortschritte des Eisenbahnwesens*, April 15, 1919). This well-known and troublesome phenomenon is discussed in detail. Faults in rail material and manufacture have their influence, the composition and structure of the steel can either facilitate or hinder corrugation; but the essential causes

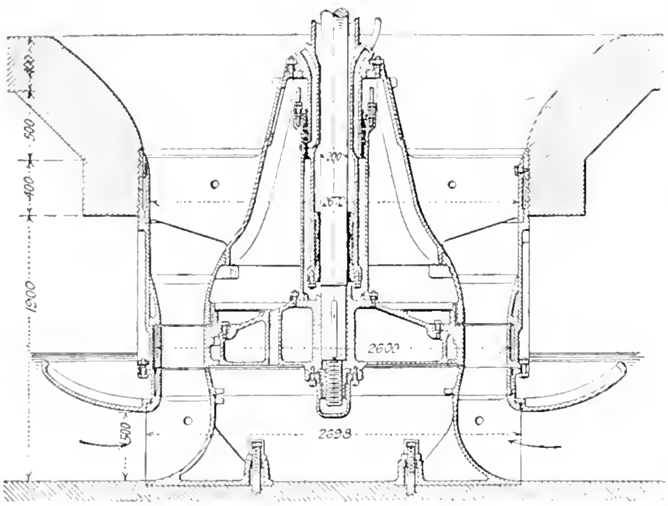


Fig. 11 Cross Section Through the Axial Pump at the Codigoro Drainage Plant

are mechanical, and may be induced by rough surface left on the rail by defective rolling, or on the wheel by excessive lathe vibration during turning.

Especially on hard and non-resilient track, oscillations are set up in running by these causes, which increase with increase of

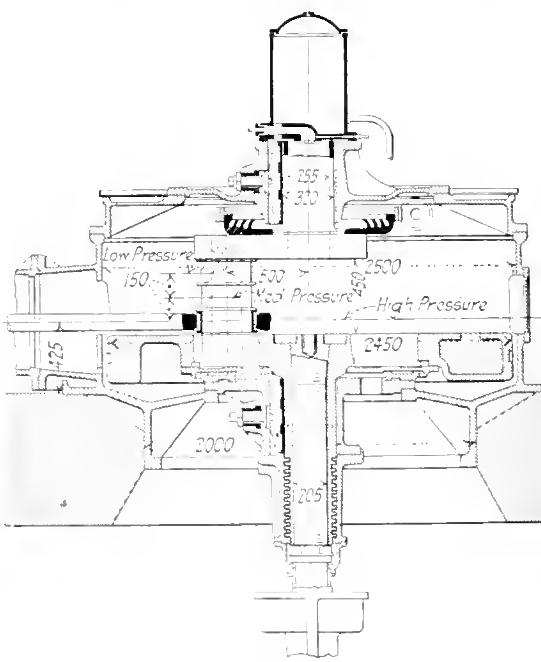


Fig. 12 Section Through the Bearings of the Pump Shown in Fig. 11

speed. Both rail and rolling stock are set in oscillatory motion; the wheel ceases to roll uniformly, and partly slips, partly jumps along the track. The wheel positions constantly alter, transverse axle movement takes place, and friction from side to side as well as in the line of travel takes place upon the rail.

By these forces the original inequalities are hammered flat, and these places become harder than the other parts of the rail, the unequal hardness leading to uneven wear, and the development of further corrugations. Rough-surfaced rails should therefore never be used.

To prevent lateral movement of the wheels on the rails, the causes of which are explained in detail, it is necessary to see that uniform wheel diameter is maintained. It is further recommended to lay the rails with the surrfaces inclined inwards.

The great importance of the condition of the rail joints is insisted upon; the defective joints are fertile initial causes of corrugation.

The influences of braking and speed acceleration are dealt with, and results of the author's observations described.

Corrugation is not so likely to take place at lower speeds and with resilient track.

A number of photographs and a diagram are given, showing the microscopic structure of the steel in the troughs and on the peaks of the corrugations, and the shape and arrangement of the latter.

Remedies are discussed, and the importance is indicated of finding the relation between the rates of pulsation of the rails, trackwork, and rolling stock, so that by alterations of construction these may be made to neutralize each other, when the corrugations will, in time, disappear.

The question of rail joints is dealt with. The vertically interleaved joint would, theoretically, be the ideal one, but in practice such joints have been found to be dangerous through their tendency to open and spread. An improvement in the horizontal type of overlapping joint is suggested as a fruitful line of experiment, though it is admitted that these also have hitherto proved too weak in service.

In spite of the low speeds usual on street tramway lines, corrugation is a frequent and obstinate trouble in these also. The corrugations are usually removed by hand or by special planing machines, but quickly reappear.

Corrugation can only be remedied by an analysis of its causes and the adjustment of these to counteract each other, or by such an improvement in rail material as will defy the action of these causes altogether. (*Technical Supplement to the Review of the Foreign Press*, vol. 4, no. 4, August 19, 1919, p. 122, no. 5857, *t*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

A triple-motored monoplane of the seaplane type, with twin floats, is being constructed at the Los Angeles factory of the George D. White Company. This monoplane is intended for use in a trans-Pacific voyage from Los Angeles to Shanghai, and will stay at San Francisco, Victoria,, Sitka, Unalaska, Petropavlovsk, and Yokohama, making in all a 7000-mile trip.

The dimensions of the machine are as follows: wing spread 82 ft.; length overall 39 ft.; height to top of fuselage, 9 ft.; weight empty, 3700 lb.; weight with crew and fuel for the Pacific flight, 7900 lb.; total horsepower, 660, generated by three Hispano-Suiza engines. Two 180-hp. engines are located, one on each wing, on each side of the body. The third engine, 300 hp., is installed in the nose of the fuselage as in single-motored aeroplanes.

Either the two 180's or the one 300-hp. engine will be used, but all three are not to be used simultaneously. A speed of 110 miles an hour will be given by the 300-hp. engine. By having approximately the same amount of power in reserve as is being used, it is expected that the possibility of failure will be lessened. At the start the two 180's will be used with the 300-hp. engine in reserve. After running a number of hours the central engine will be switched on and the two smaller engines shut off. This method will be followed throughout the entire flight in order to allow the engines to rest and also to allow the engine expert to make an inspection and the necessary minor adjustments. New spark plugs can be installed, carburetor adjustments made, ignition troubles overcome, or other minor requirements which, under ordinary conditions, mean motor failure and an interrupted flight. From *Aerial Age Weekly*, August 11, 1919.

Recent Work of C. E. Johansson

C. E. Johansson, the Swedish gage manufacturer, whose invention and production of the famous Johansson gage blocks has constituted one of the important steps in the development of interchangeable manufacturing, is now in this country and exhibits some exceedingly interesting measuring and gaging devices of almost unbelievable accuracy. Prominent among these is a set of 11 gage blocks, the opposite surfaces of which Mr. Johansson assures are parallel and accurate within 1/1,000,000 in. In other words, he states, and shows his gages as evidence, that he not only is able to measure to this degree of accuracy, as others have done, but actually to produce surfaces having this remarkable accuracy. These blocks start at 1/10 in. in thickness and increase

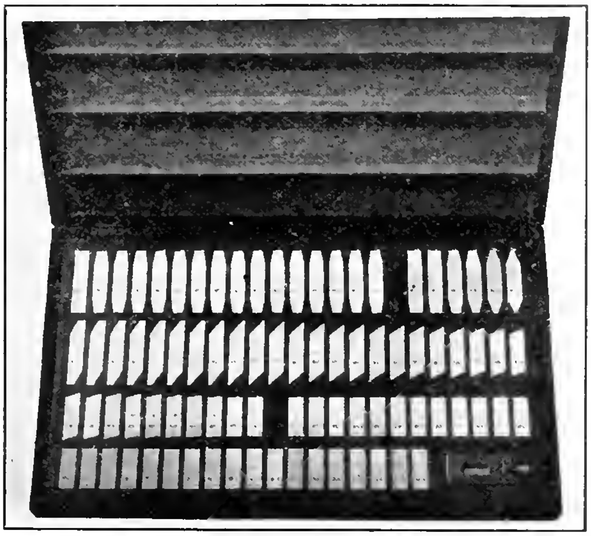


Fig. 1 Set of Angle Gage Blocks

by increments of 0.000001 in. up to a thickness for the last block of 0.00010 in.; that is, the distance between the parallel surfaces of the last block of the series of 11 blocks is only 1/100,000 in. greater than in the first block.

Even more striking is a large set of angle gages shown in Fig. 1. The adjacent edges of the successive gages form angles increasing by increments of one minute until 60 minutes or one degree is reached; after which they increase by increments of one degree up to 90 degrees, thus completing the first quadrant of the circle. A third group then divides the last degree of the quadrant into minutes. By means of these gages any angle can be obtained to a refinement of one minute. By their use, for example, screw threads can be measured on a line parallel with the center line of the screw as well as normal to the screw spiral.

A rigid test of the regular Johansson blocks is made by Mr. Johansson with a new type of micrometer in the screw casing of

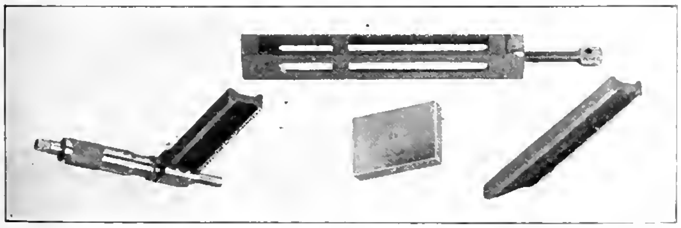


Fig. 2 Parts of Adjustable Micrometer used in Combination with Gage Blocks of Different Sizes

which is a row of standard disks spaced definite distances apart, by means of which the micrometer screw can be set at certain definite distances from the anvil; and when so set the Johansson block corresponding to the reading of the micrometer can easily be slipped between the measuring points and held suspended there by the almost imperceptible friction of the surface. Repeated trials with different blocks and different settings showed not the slightest variation from standard by either blocks or micrometer —truly a remarkable test.

The parts of one of a series of micrometers of another type, in which gage blocks are used to set the instrument for measuring a piece of any desired size, are shown in Fig. 2. There is a holder in which the several parts are clamped and held while measuring. The micrometer head is slipped in at one end and a bar constituting the anvil at the other; while between them is inserted a gage block used as a distance piece against which the two other parts are clamped by the screw at the end of the holder.

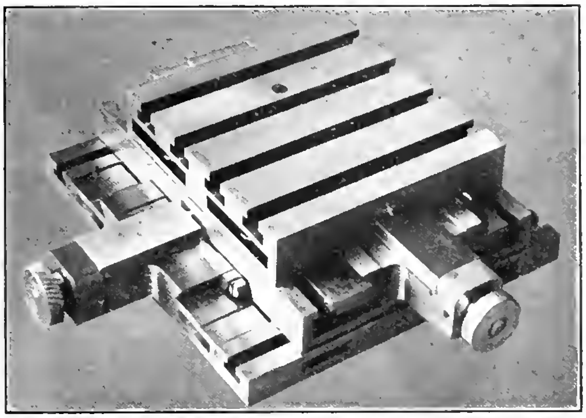


Fig. 3 Compound Dividing Plate used in Combination with Gage Blocks

In Fig. 3 is a compound table or dividing plate for laying out jigs or other work requiring the accurate location of holes or definite points. It will be noted that the table itself is moved either parallel or at right-angles to the slots of the baseplate in the usual way by means of the adjusting screws; but that the location of the plate in either direction is determined by the insertion of gage blocks between fixed surfaces and the edges of the two moving parts of the table. By bringing these edges firmly against the blocks the desired setting is obtained with great precision.

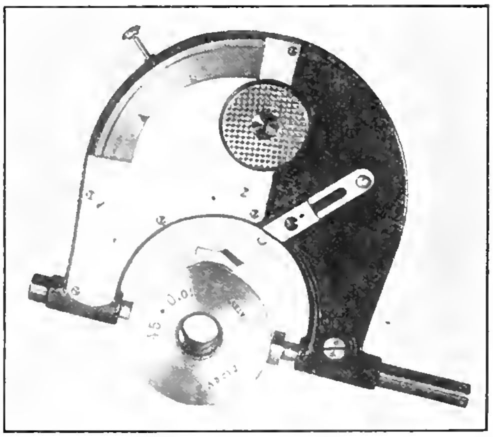


Fig. 4 Rapid-Indicating Snap Gage

In Fig. 4 is a rapid indicating snap gage measuring in minute fractions of a millimeter. The pointer will be seen in the upper left-hand part of the gage, as it appears in the engraving, and after the measurement has been taken and read the pointer is returned to zero, ready for the next reading, by pushing the projecting button seen projecting from the edge of the gage.

Announcement has been made of scholarships in the various universities and colleges in Pennsylvania now available for ex-service men. Special short courses, reduced rates, and loan funds are also being offered, and every effort is being made to assist those who desire a college education.

MECHANICAL ENGINEERING
THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Published Monthly by the Society at
29 West Thirty-ninth Street, New York

M. E. Cooley, *President*
William H. Wiley, *Treasurer* Calvin W. Rice, *Secretary*

PUBLICATION COMMITTEE:
George A. Orrok, *Chairman* J. W. Roe
H. H. Esselstyn George J. Foran
Ralph E. Flanders

PUBLICATION STAFF:
Lester G. French, *Editor and Manager*
Leon Cammen, C. M. Sames, } *Associate Editors*
W. E. Bullock, *Assistant Secretary*
Editor Society Affairs
Frederick Lask, *Advertising Manager*
Walter B. Snow, *Circulation Manager*
136 Federal St., Boston

Yearly subscription \$3.00, single copies 35 cents. Postage to Canada, 50 cents additional; to foreign countries \$1.00 additional.

Contributions of interest to the profession are solicited. Communicotions should be addressed to the Editor.

The printing industry in New York City is threatened with the most serious strike in the history of the industry, to occur October 1. While it is hoped, and by many expected, that matters will be adjusted by the time this number of Mechanical Engineering is issued, the immediate result has been congestion in the printing offices of the city which has caused the omission from this number of certain matter, particularly relating to the work of the Sections for the past year, which otherwise would have appeared. Whether difficulties will be encountered in the publication of the November and subsequent issues yet remains to be seen. This brief announcement, however, is made to our members so that in the event of the strike being called, they will understand that any delays which may occur are unavoidable.

The Annual Meeting

Following the plan of the meetings which have been called during the past few years, there will be a keynote session at the Annual Meeting on the Industrial Situation in Relation to Present Conditions, with papers on several topics, including wage payment, rights of workers, systems for mutual control of industry and profit sharing. This is a continuation in a broader field of the session on Industrial Relations held at the Spring Meeting at Detroit which evoked so great an interest and resulted in a vote by the meeting in favor of continuing the discussion at the time of the Annual Meeting.

There was so great interest at Detroit, also, in the subject of fuels, and particularly pulverized fuel, that the subject will again come up at the Annual Meeting for further discussion. It is proposed, also, to have a session on Appraisal and Valuation Methods.

The Sub-Committees on Machine Shop and Foundry Practice, Textiles and Gas Power are planning sessions. The Foundry Sub-Committee has arranged for papers on castings of various metals and bronzes, and die castings. The Textile Committee will devote its attention this year to education for the textile industries in our technical schools. There will be the usual miscellaneous technical papers.

At this meeting, following as it does the signing of the armistice and the return of our troops from abroad, the tendency will be to deal with subjects which concern the forward movement of the nation and the engineer in the work of building up the industries and putting the nation on a stable basis as regards labor and industrial conditions. At the same time, the past will not be forgotten. There will be the memory of those of the Society who have given their all in the service of the country and the winning of the condition of democracy which all hope may eventually obtain. As a testimony to these, there will be a memorial service with suitable exercises during the period of the meeting.

International Pipe Threads Hearing

The Committee on International Standard for Pipe Threads, of the American Society of Mechanical Engineers, is to hold a public hearing in the Engineering Societies Building, New York, on October 2, 1919, at 10:30 a. m. The Committee is to meet at this time to discuss and prepare resolutions which are to be presented at the next meeting of the Commission for an International Standard Pipe Thread, which is to be held in Paris, November 7th. As it is the desire of this committee and the Society that these resolutions express the opinions and best judgment of the American pipe industries, they will welcome to this meeting representatives of all associations and manufacturers interested in this important branch of engineering.

Final Hearing of National Screw-Thread Commission

The last public hearing in America of the National Screw-Thread Commission on national screw-thread standards will occur on Monday, October 6, 1919, at 10 a. m., in the Engineering Societies Building, New York. The engineering bodies interested and the industries manufacturing and using screws will meet and give full and final consideration to the report. A general invitation is issued to all who are interested to attend, and it is hoped that a large number will be present.

Labor Problem Discussed at New York

Industrial Unrest and the Engineer was the subject discussed at a largely attended meeting of the New York Section of the A. S. M. E., the first to be held this fall, in the Engineering Societies Building on September 17. The speaker of the evening was Dr. William M. Leiserson, formerly Chief, Division of Labor and Administration, Working Conditions Service, U. S. Department of Labor.

The circular of the meeting announced the address as a "straight from the shoulder talk," and the speaker lived up to expectations. He gave an admirable review of labor conditions and difficulties in the very early days in Europe and in this country since the beginning of the last century, showing how these were first allied with religious conditions, second with political conditions and finally, at the present time, with industrial conditions. He made the statement that current labor unrest as evidenced by strikes is not relatively greater than at some other periods in our history, in spite of its present huge proportions and widespread distribution.

He analyzed the various classes of strikes, showing that those which occurred independently of our large organizations are less influential in the labor problem as a whole, even where extreme radicalism is displayed, than well-organized, conservative movements on a large scale, as for example, by the railroad employees of the country. With his historical background as a basis, he discussed causes and possible remedies of our industrial unrest in which he emphasized the need for consideration of the public welfare rather than of class interests.

In referring to unions of municipal and federal employees, he said that undoubtedly the American public was not willing to sanction their affiliation with a central body like the A. F. of L., but that he persoanlly could see no serious objection to such affiliation. This remark gave the cue to the first speaker on the

list to discuss the address, Mr. Richard H. Rice, Acting Manager of the General Electric Company's plant at West Lynn, Mass. Mr. Rice said he had just come from Boston and knew what the conditions were because of the police strike there, and that he was unalterably opposed to any division of allegiance on the part of public employees, to which the audience responded with unqualified cheers of approval.

During the discussion, a report was presented by the New York Committee in charge of this meeting, which contended that the engineer is the only one who speaks the language of both the capitalist and the workman, and that out of his ranks must come the remedy—a remedy which must be nation-wide in its purpose, as have been the solutions of past crises in this country, such as that of taxation without representation during the Revolutionary War, and preservation of the union during the Civil War.

The discussion lasted until well past twelve o'clock, at which time, fortunately, the chairman was obliged to catch his last train for home and closed the meeting; but the interest was so great that it was voted unanimously to continue the subject at a later meeting. As a whole, the discussion failed to focus on any definite policy, because of the tendency to emphasize individual experiences and interests, rather than a constructive policy.

Joint Mid-Section Meeting

Eight Sections to Participate in Two-Day Session at Indianapolis—October 24-25

The Indianapolis Section has invited the Sections at Birmingham, Chicago, Cincinnati, Cleveland, Detroit, Milwaukee, and St. Louis to join with it in conducting a two-day session on Friday and Saturday, October 24 and 25.

The program is being developed along the following outline:

Headquarters—Claypool Hotel

Friday, October 24

9:00 a.m.	Registration Hotel Claypool
10:00 a.m.	Council Meeting
10:00 a.m.	Meeting of Several Committees
10:00 a.m.	Visit to Indianapolis Industries
12:30 p.m.	Luncheon—Claypool Hotel
2:00 p.m.	Professional Session on "Industrial Unrest"
6:30 p.m.	Banquet and Entertainment at Claypool Hotel

Saturday, October 25

9:30 a.m.	Professional Session on "Research"
9:30 a.m.	Visit to Indianapolis Industries
12:00 m.	Automobile Trip to various interesting points about the City
1:00 p.m.	Canoe Club for luncheon, continuing trip thereafter until 4:30 p.m.

Sunday, October 26

For those remaining over Sunday an automobile trip to Turkey Run or Wyandotte Cave has been proposed.

Quarterly Joint Sections Meetings

This meeting is being planned with an aim to secure two such Quarterly meetings to be held alternately with the Annual and Semi-Annual (or Spring) meetings. The Indianapolis meeting will compare favorably with the recent Spring Meetings of the Society and warrants the attendance of a large representation of the membership. The central location of Indianapolis should secure a registration of one thousand members and their friends. Members should advise the Secretary of the Society of the names and addresses of any engineers whom they would like to have formally invited.

Every member of the Society is, of course, expected to attend this meeting, and those who avail themselves of the opportunity are assured a meeting which will be enjoyed by all, and which will be good and lively throughout the entire two days. The many attractions of Indianapolis will add to the interest.

Ninth Volume of Condensed Catalogues

The ninth annual volume of The American Society of Mechanical Engineers' Condensed Catalogues of Mechanical Equipment, with General Classified Directory and Engineering Data Section, is now being printed and will be ready for distribution on October first if conditions in the printing trade remain normal.

It is with much pleasure that the Society records the continued satisfactory development of this volume. Five hundred and five firms are this year represented by publication of catalogue data, as against four hundred and fifteen last year.

There are six hundred and sixty-nine catalogue pages, and the general Mechanical Equipment Directory, in which all eligible manufacturers are entitled to listing of their products free of charge, within reasonable limits, has been further extended this year.

The Engineering Data Section is continued and contains the current data from the Society's publications, the Transactions and Mechanical Engineering, as well as other useful information concerning the standards issued by the Society, and a list of papers published in the Transactions since the beginning of the Society's activities.

To the Members of the American Society of Mechanical Engineers

A committee has been organized to assist in securing employment for blind and other disabled soldiers and sailors who have been specially trained for useful pursuits by the Red Cross Institute for the Blind at Baltimore. The Institute is educating the blind soldiers along certain definite lines, so as to train them in trades and occupations, and thus enable them to become useful and self-supporting members of the industrial community. In time this service will be extended to include blind civilians as well as soldiers and sailors.

Individuals so trained will be competent to take their appropriate places in industry, and will in no sense be subjects for charity. They will only ask that they be given equal opportunities with those not so handicapped.

Now is the time to inaugurate a movement looking toward the teaching and employment, not only of disabled soldiers, but also of crippled civilians. To train and use men and women, who from one cause or another have been partially disabled, will be an economic gain, as well as a social duty, and will add a valuable asset to our national ledger.

The committee appeals to you, as a member of this Society and as employers of labor, to lend your assistance in this important work by studying the problem as it affects your establishment, by finding employment for such disabled workers as may come to you and by endeavoring to develop a sympathetic attitude in your community.

We further hope that you will give suitable publicity to the work being done by the American Red Cross for the blind soldiers, sailors, and marines. News items and editorial comment in your local papers will help in this. The Red Cross Institute will gladly furnish any needful information.

May we not count on you to give this subject earnest consideration and to assist the committee by your coöperation and by such counsel as your experience dictates? The committee will appreciate any response which you may see fit to give.

C. H. Benjamin,
Chairman, Committee on Rehabilitation of the Blind.

That the Blind May See and Work

In the above letter Dean C. H. Benjamin, Chairman of the A. S. M. E. Committee for the Rehabilitation of the Blind, makes an appeal to engineers to provide employment for the blind men of the army who have been trained for useful service at the Red Cross Institute at Baltimore.

It is gratifying to know at the outset that the number of the young men of the A. E. F. who lost their eyesight in the war is no greater than one hundred and twenty-five; and it is also gratifying to know that their training is under the direction of an en-

gineer, Mr. L. W. Wallace, a member of this Society, who is combining his knowledge of the industries with his qualifications as a teacher and as an engineer to give the soldiers a practical training of such a character that they may become capable wage earners. Mr. Wallace is conducting this work with enthusiasm, in full confidence of its successful outcome.

The men receive four distinct lines of training: (1) preparatory, (2) vocational, (3) in avocations, and (4) in recreation. All the men learn Braille, typewriting, English and self-expression and parliamentary law so that they may keep informed and be able to convey their ideas correctly and effectively by the written and spoken word. They learn the usual occupations taught to blind people, such as playing musical instruments, weaving, basketry, carpentry, etc., only to give the men a pastime. Their vocational work is much more serious and important. A careful study has been made of many of the operations in the industries to determine which of these can be performed without the use of the eyesight. For example, it has been found that certain operations in the manufacture of automobile tires, on the inside of the tire, can be done by the blind, and a group of blind men are expected to find employment in the works of the Goodyear Rubber Co. under the direction of a blind lieutenant who is already at the plant making a study of the work.

The training and education of these men of the army, while worthy as a direct accomplishment, has much greater significance than is generally understood. It is aimed to make the Institute a permanent institution for training blind civilians of whom there are estimated to be 80,000 in this country alone. If this training of the soldiers by scientific engineering methods is as successful as expected, it will constitute a great inspiration and a bright ray of hope to this great army of peacetime beings, and particularly to the young. All success to this great work which constitutes another example of the varied duties which an engineer may be called upon to perform in the practice of his profession!

Employers Plan National Organization

A national organization of employers, into a body to look out for managerial interests in the United States in the same way that the unions are protecting labor, was launched in Chicago during September by the Illinois Manufacturers' Association.

Charles Piez, Mem.Am.Soc.M.E., formerly with the U. S. Shipping Board, but now returned to the Link Belt Company, has been named as chairman of the committee for organization throughout the country. Other members of the committee are: Alba B. Johnson, president, Baldwin Locomotive Co.; H. H. Merrick, president, Chicago Association of Commerce; Thomas Creigh, Cudahy Packing Co.; and John M. Glenn, secretary, Illinois Manufacturers' Association.

The chief work of the new organization will be to make felt the wishes of the business interests that concern the welfare of the entire nation in Washington. The first steps of the organization committee will be to bring together trade bodies, chambers of commerce, and other groups of business men and impress them with the need of a national organization. Resolutions which deplore the spread of radicalism, urge a return to thrift and industry, and advise that a federation of employers be formed were recently passed by the recent "Our Country First" conference held in Chicago and have been sent out to business organizations all over the United States.

John M. Glenn is the originator of the idea of a national organization. He recently said: "Three million laboring men affiliated with the unions have made themselves heard in Washington. Manufacturers have found this out. This organization will do the same thing for the manufacturers."

Commenting on the situation, Charles Piez said: "Manufacturers are awakening to the fact that they must present their views to Congress collectively, if they are to get what is their due in the way of legislation. Labor has had the advantage while employers have been organized into comparatively small organizations. It must not be inferred that this federation is to be an anti-union body. We are not out to fight anyone. We intend, merely, to look out for the interests of business."

Employers organizations represented on the permanent committee are: Illinois Manufacturers' Association; Minnesota Employers' Association; National Conference of State Manufacturers' Associations; National Association of Manufacturers; Railway Business Association; Mississippi Valley Association; American Institute of Industrial Engineers; Railway Age; Ohio Manufacturers Association, and various associations representing different trades and classes of business.—H. T. L.

President Wilson's Conference on Capital and Labor

As announced in the daily press, President Wilson, before leaving Washington, wrote a letter to the presidents of several national organizations representing labor, farming, and financial interests, calling upon them to select delegates to the Capital and Labor Conference which he has called to meet in Washington on October 6.

The President's letter was addressed to Magnus W. Alexander (Mem.Am.Soc.M.E.), director of the National Industrial Conference Board, Boston; President Samuel Gompers, American Federation of Labor; President William G. Baker, Jr., of the Investment Bankers' Association, Baltimore; President J. H. Tittamore, American Society of Equity, Omro, Wis.; President Oliver Wilson, National Grange, Peoria, Ill.; President C. S. Barrett, National Farmers' Union, Union City, S. D., and President Homer L. Ferguson, Chamber of Commerce of the United States, Newport News, Va.

In his letter the President fixes the representation at the conference as follows: American Federation of Labor, 15; Chamber of Commerce, 5; National Industrial Conference Board, 5; farming organizations, 3; investment bankers, 2; selected by the President, 15. Total, 45.

The President stated the purposes of the conference to be:

1 To canvass every relevant feature of the present industrial situation.

2 To work out coöperatively a practicable method of association based upon real community of interest which will redound to the welfare of all the people.

A copy of the President's letter received by Mr. Magnus W. Alexander, managing director of the National Industrial Conference Board, was transmitted to The American Society of Mechanical Engineers as one of the members of the National Board. This was accompanied by a letter from Mr. Alexander to the Society asking for suggestions of men to nominate to the President, and urging the importance of a definite and constructive program for presentation at the conference at Washington. At the time of going to press the selection of names for recommendation is having consideration.

Free Coal?

In the Engineering Survey in this issue is given an abstract of an article in *Power* discussing low-temperature coal distillation. This article makes a statement, apparently well borne out by recent experiences, to the effect that a plant consuming 50 tons of coal or more per day of 24 hrs. and operating on a 24-hr. schedule, can, by adopting the comparatively inexpensive process of low-temperature coal distillation, secure enough by-products to pay for the cost of the raw material (coal) and have enough fuel left for its own use to generate all the power that it needs. Particularly would this be the case if this low-temperature process were combined with that of the by-product gas producer, such as the Mond, whereby ammonium sulphate might be recovered from the coal.

In other words, a plant operating under the above conditions would not only have its fuel free, but would materially conserve the supply of coal for other purposes. If future research and experience shows the process to be practicable, it is an extremely important development from two points of view.

In the first place, the majority of our public service utilities belong to the class of concerns consuming more than 50 tons per

day and operating on a 24-hr. schedule. They also belong to the class of concerns which were hardest hit by the rise in the cost of labor and materials, in particular the cost of fuel, and the result of low-temperature distillation of coal with its attending saving might help them to pass through an unusually bad business contingency.

But even more important is the promise of fuel conservation held out by the new development. What it amounts to really is an improvement of about 100 per cent in the utilization of the resources contained in our coal, and if the installation of a comparatively simple and cheap process may produce such a tremendous saving what greater promises does the near future hold out to us.

Post-Graduate Course in Gasoline Engine Design

The design of gasoline engines for automobiles was a comparatively simple matter. An automobile engine nine times out of ten operates at less than overload and at full load is usually relieved by the use of a gear shaft. If an automobile engine meets a load it cannot handle it stalls and the driver takes it in a friendly spirit.

Moreover, an automobile engine operates under fairly uniform conditions of air pressure and when these conditions change materially, as in taking a car from a sea-level country to high altitudes, special carburetor adjustments for which sufficient time is allowed are considered to be in order and are made without objections.

With the aeroplane engine the case is different. It is many times as powerful as an automobile engine; in fact, as regards power output an aeroplane engine just about starts off where the automobile engine stops. Coupled with this greater power output is the necessity of keeping the weight of the aeroplane engine to the lowest possible limit consistent with safety, which means an immeasurably finer design of every part and a much deeper knowledge of the strains of the parts and the physical properties of the materials used. To a certain extent, however, this disadvantage is counterbalanced by the fact that at least the question of cost did not come in as a material consideration in the design of aeroplane engines.

The aeroplane engine is further supposed to run all the time at or near full load, which, of course, stresses the engine far more than the more leisurely operation of an automobile engine.

A new requirement brought about by the war, and which presented a difficult problem for the engine designer to solve, was to produce an engine capable of delivering a high power output at high altitudes. It was attempted to solve this problem in three ways, the first and most obvious of which was for the flier to carry a supply of oxygen, either as gas compressed in cylinders or in the form of some material having a very high oxygen content. This was the method used by Captain Schroeder at McCook Field, Dayton, Ohio, last summer, in the flights made for the United States Army. The second method was to add another element to the fuel at high altitudes, as in some flights in France, for example, where wood alcohol was used.

The third method was that of direct supercharging, mainly by means of a centrifugal blower operated by a turbine driven by exhaust gases. In this connection some very fine work was done by Professor Rateau in France and Messrs. Sherbondy and Sanford A. Morse, Mem. Am. Soc. M. E., in this country. This method was devised by the British Napier and Sons Company, in their Lion machine. The engine of this machine was really designed to operate at densities far below atmospheric, so that if operated at atmospheric density at full throttle for any length of time it would probably fly to pieces. By a skillful proportioning of parts, however, the engine has been designed so that it can operate at ground level at part throttle, but develops its full rate of power at full throttle at an altitude of about 10,000 ft.

The solution of all of these problems represents what might be called a post-graduate course in gasoline engine design and it is predicted that we shall soon see material changes in the design of motorcar engines generally, brought about by the greater experience gained in the design of aeroplane engines.

Movement in Germany Toward Union of Technical Men

The following interesting translation of a German report was prepared by Sir Robert Hadfield, and shows the important steps being taken in Germany to bring about a Union of Technical Men, from foremen to technical chiefs. The report relates to the inaugural meeting of the Union held in Berlin, November 25, 1918.

TECHNICAL MEN: JOIN! FORGET WHAT SEPARATES YOU!
YOUR FUTURE DEPENDS ON IT!

RAPID FORMATION OF LOCAL SECTIONS AN URGENT NECESSITY

The objects of the Union are as follows:

1 To ensure that Technologists may bring their influence to bear on Government, Parliament, and the Economic Life of the country.

2 To attain this object it will use every endeavour to bring the representatives of all branches of Technical Practice, from the Foreman to the Technical Chief, into one comprehensive organization.

3 The programme of the Union will be based on the foundations of a free, democratic Constitution.

4 The Union desires the active collaboration of its members in public life. In order to realize this programme, the Union will—

a *Inside Work:* Ensure its members a more clear comprehension of the conditions under which the people live, of national life, of legal machinery, administration, economy, politics, and cultural matters, with special reference to the systematic training of members capable of acting as the representatives of technology on public bodies.

b *Outside Work:* Explain to other circles of society the importance of technical work for the life of the people and the maintenance of civilization at the proper level of culture, and the necessity of leaving technical questions to be settled by technical men only.

5 The Union repudiates any unconstitutional attitude towards other circles of the population, and will use every endeavour to secure intelligent coöperation, based on trust and respect, with the working classes.

6 The Union declares it as necessary for securing its objects that its activities should provide means for an adequate existence for every one belonging to the technical trades or professions, in order that he may work independently of his own or outside support.

The first general meeting of the Union took place in the Rheingold, Berlin, on November 25, more than 2,000 technical men belonging to all branches and grades of the calling being present. On December 2 representatives met from all the larger technical societies of Greater Berlin, and agreed on the necessity for the formation of the Union and on the correctness of its aims. The majority of those present declared themselves ready to coöperate actively for the expansion of the Union.

The declaration containing this and other resolutions was signed, among others, by representatives of:

Committee of Technical Officials of the Ministry of Marine
Society of Architects
Automobile and Aeronautical Society
Society of German Engineers
Society of German Civil Engineers
German Technical Society
German Union of Technologists
Electro-Technical Society
Society of Naval Architects
Union of Academical Architects' Societies
Union of German Electrical Engineers
Society of German Patent Agents
Society of Surveyors
German Chemical Society
German Foundrymen's Society
Society of German Mechanical Engineers.

Negotiations with other bodies are under way and promise complete adherence to the objects.

NEWS OF THE ENGINEERING SOCIETIES

Reports of Meetings of Western Society of Engineers and American Steel Treaters' Society

Western Society of Engineers Discusses Transportation Situation

Remedies designed to bring about a readjustment of the transportation situation, particularly among electric railway lines, were presented by James Roland Bibbins, Mem.Am.Soc.M.E., associated with Bion J. Arnold, Chicago, and three other speakers, at the first regular fall meeting of the Western Society of Engineers, Chicago, on September 8.

The general subject of the evening's program, The Economic Future of Transportation Facilities, brought out a large crowd of public-spirited engineers. While the electric railway was used by all speakers as an illustration of a public utility, yet the discussion was so broad and far-reaching in its character that the plans as outlined might embrace a utility of any public nature, such as steam railroads, water works, lighting systems, etc.

The various alternatives named by Mr. Bibbins, and left to the body of engineers to determine whether or not they are equitable, were:

Capital may be scaled down, but by so doing we admit that the railway industry in its present form is a failure.

Operating deficits may be met by general taxation, but misplaces a burden on the man too poor to use the service.

The zone fare system would increase the number of short riders, but would tend to interfere with the freedom of inter-city transit.

Labor might accept a reasonable profit sharing plan.

Cities should assume a responsibility of providing special lighting, paving, etc., for the companies.

Cities might waive their share of the profits in order to reduce the price of fares or increase the service.

Lastly, the public might assume the risks of carrying a deficit through a system of municipal ownership.

Mr. Bibbins, who is a recognized authority on transportation problems, declared that the five-cent fare is a psychological fact which has been bred into the minds of the people. Should the transportation companies revert to the old system of the five-cent fare and establish fare zones the population would become much more dense in the cheaper districts and tend to defeat the purpose of a cheaper fare—of getting the public away from the city into the suburbs. Only a study of the railway problem in its three phases, past, present and future, will bring about a happy medium of control. Public control of utilities should not be subjected to destructive radicalism or reaction, he declared.

The public, today, wants to pay only rates based on the depreciation value of utilities, Mr. Bibbins said, and it is for that reason that the continued hostility between the owners and the public has reached such a critical state. To offset the loss through depreciation, companies should have set aside at the time of beginning operations a depreciation reserve. The purchasing power of the five-cent fare has declined in comparison with the purchasing power of our currency and has decreased stability in the operating companies.

The speaker illustrated his discussion with a brief but thorough history of an electric railway company, operating in one of the large cities of this country, which electrified its roads in 1890 on an investment less than one-third of that of today. Because of ill-considerate competitive construction permitted by the city, extensions did not become normal until ten years later. During this period net earnings vanished. After 1900 the earnings of the company continued at a much lower rate until the beginning of the war. To lay the earnings are negligible.

To establish electric railway companies on a paying basis for the future, one or more of the several alternatives outlined by Mr. Bibbins must be adopted only after an intelligent and comprehensive survey of existing conditions has been made. He urged that the engineering profession lend its ability and weight in rectifying the mistakes that have been made in the past in handling technical problems of utility development.

Col. P. J. Kealey, president of the Kansas City Railway Company, who was unable to attend the meeting, sent a written discussion on valuation in which he declared that the ultimate solution of the present problems before the railway companies and the people will be private ownership and operation with municipal supervision of service. "The car rider should not be made pay for anything more than transportation," Colonel Kealey wrote. "In order to do this traction companies must be relieved of all indirect taxes." Public opinion is the only medium which can bring about a settlement of the labor problem for during the past two years seemingly promising settlements have been disrupted by the union.

The next regular meeting of the society will be held October 4 but section meetings are held every Monday evening throughout the month.

Harold T. Elliston,
Office of *Western Society of Engineers*.

Convention of Steel Treaters' Society

The National Convention of the American Steel Treaters' Society was held at the 7th Regiment Armory, Chicago, September 23rd to 27th.

The purpose of the convention was to promote the science and art connected with the heat treatment of steel and to bring into closer relationship, the members of the profession.

Eighty exhibitors placed for public inspection the latest developments of heat-treating appliances and products. The papers discussed cover every branch of the field. Notable among the speakers were Shipley N. Brayshaw, London; E. F. Collins, General Electric Company; W. G. Dauncey, associate editor, *Iron and Steel*, Montreal, Canada; Fred Grotts, Holt Manufacturing Co.; Wilfred Hanby, Rotherham, England; W. G. Lottes, International Harvester Co.; and Prof. A. E. White, University of Michigan.

The promoters of the exhibition were greatly elated over the success of the convention and predicted that a national convention, only on a much larger scale, would be held next year.

The American Steel Treaters' Society is a comparatively new organization but its influence is already being felt in the building up and advancement of the steel industry. Local chapters of the organization have been established in Chicago, Cleveland, Pittsburgh, Milwaukee, Philadelphia, Cincinnati, Buffalo, Rochester, and New York City. Others are to be organized in industrial centers.—H. T. E.

New England Water Works Association

The thirty-eighth annual convention of the New England Water Works Association was held at Albany, N. Y., September 30—October 3. In addition to a number of important committee reports, a number of interesting technical papers were presented. Norman J. Howard discussed the operation of a new drifting sand filter system at Toronto. The Schoharie development of New York City's water supply formed the subject of an address by J. Waldo Smith, Chief Engineer, Board of Water Supply. Another paper by Leonard Metcalf and William T. Barnes, of the firm of Metcalf & Eddy, consulting engineers, Boston, was devoted to the 10,000,000-gallon covered reservoir at Dayton, Ohio. Two papers on pumping engines were also presented: The first was by Creed W. Fulton of the Gould's Manufacturing Co., and the second by D. A. Decrow of the Worthington Pump & Machinery Corporation.

ENGINEERING COUNCIL

Engineering Council[1] is an Organization of National Technical Societies of America, Created to Consider Matters of Common Concern to Engineers, as Well as Those of Public Welfare in Which the Profession is Interested

Classification and Compensation of Engineers

In Mechanical Engineering for July (p. 632) there was presented the substance of a preliminary report of the Committee on Classification and Compensation of Engineers. Since that time there has also been made public a report prepared by the Canadian Civil Service Commission, which dealt with the same problem, and it is of interest, therefore, to compare this report with that prepared by the Council. The letter from the chairman of the Committee on Classification and Compensation of Engineers, accordingly follows:

New York, August 27, 1919.

Mr. Alfred D. Flinn, Secretary, Engineering Council,
29 West 39th St., New York.

Dear Sir:

From time to time within the past few weeks, you have forwarded to me various letters addressed to you concerning the proposed "Classification of the Civil Service of Canada" as recommended by Arthur Young & Company of Chicago, Toronto, and New York. The copy of this classification, which was also received, indicates that its preparation was authorized by the Canadian Parliament and that the work upon it was done under the direction of the Civil Service Commission.

Your correspondents offer objections to the classification, particularly on the ground that the compensations proposed for higher grades of service are inadequate. In view of the investigation now being made on behalf of Engineering Council as to the classification and compensation of engineers in Federal, State, Municipal, and Railroad service, this report is of more than usual interest, and especially so since Council's Committee is informed that Arthur Young & Company are performing a similar service for the Congressional Committee on Reclassification and Compensation of Government Employees, including engineers.

Engineering Council's Committee on Classification and Compensation for the State and Municipal services has tentatively proposed that all positions in these services be limited to 13 in number, of which 7 are distinctly professional, while the remaining 6 are in a class directly leading to professional work, but not necessarily of a professional character. In the questionnaire recently issued by the Committee the views of the responsible heads of the services affected are being sought, and in the responses which have been received up to the present writing, there has been practically unanimous agreement on the classification. The inquiry has not progressed for enough to warrant any expression as to the views concerning compensation other than to say that there is an unquestionably strong belief that if the engineering service is to be maintained on a proper plane, there must be a very substantial increase in pay.

The Canadian report appears to cover every position in the civil service. It is arranged alphabetically and in the absence of grouping, a complete analysis of the engineering service involves a task of a magnitude greater than I have found time for. I have attempted, however, to make such examination as time permitted and am impressed with a belief that the objections raised are well founded. No attempt seems to have been made to standardize titles. Consequently there are in the engineering service at least 157 independent titles as compared with the 13 titles proposed by our Committee. It is recognized that qualification of a general title to show the nature of the service rendered, is quite proper, but in the judgment of the writer there is no reason for treating similar positions as entirely unrelated and as warranting entirely independent specifications.

The report states that the compensations proposed are intended for "normal times" and that pending restoration of such times, the rates recommended should be "supplemented by a bonus," but no information appears as to the magnitude of the bonus.

From my study of the report it would appear that the groups and ranges of compensation, tabulated as far as practicable, under the classification tentatively proposed by Engineering Council's Committee are about as given in the accompanying table.

In general, promotion through most of the grades is by increments of about \$120, the minimum and maximum rates of each being respectively higher and lower than the rates fixed for the grades below and above, thus resulting in a comparatively small salary range for each position and, in this respect corresponding with what seems to have been the general practice heretofore. This treatment is one which would seem desirable to modify, to the end that the relative ability and experience of men performing similar work may be given adequate recognition.

Exceptions are noted in the case of "Topographical Engineer," where a salary range of from \$2,160 to \$3,120 is proposed, and in the case of promotion from "Junior Electrical Engineer" at a maximum salary of \$1,980 to "Electrical Engineer" with a minimum salary of \$2,640, each of the two latter grades having an extreme salary range of only \$360. In the case of "Chief Draftsman," "Structural Engineer," and "Chief Topographical Engineer" maximum salaries are proposed of \$3,000, \$3,240, and \$3,840, with no provision for promotion to other engineering grades, although for each position the qualifications required are such as to indicate ability to progress to high positions in the service. The table also shows that only 6 engineering positions are open to compensation at a rate of more than \$6,000 per annum.

It would seem to the writer that this report is open to serious criticism on the grounds that it fails to group engineering service along orderly lines, that it provides too narrow limits for promotions within a grade, and that the compensation proposed for all grades, is inadequate for the service rendered. The latter criticism seems particularly pertinent in comparison with the rates now being demanded by organized labor. The practicability of properly meeting present day conditions by the addition of a "Special War Bonus" to the proposed rates in order to meet the present high cost of living is also to be questioned on the ground that, and as set forth in the circular letter issued by Council's Committee on Classification and Compensation of State and Municipal Engineers, the "revolutionary change in the cost of living" is one which "unless modified by further economic disturbance is likely to be permanent or to continue for a long time to come."

Very truly yours,
(Signed) Arthur S. Tuttle.
Chairman, Committee on Classification and Compensation of Engineers, and of State and Municipal Section.

TABULATION OF TITLES AND SALARIES FOR ENGINEERS IN CANADIAN CIVIL SERVICE REPORT UNDER CLASSIFICATION PROPOSED BY COMMITTEE OF ENGINEERING COUNCIL

Tentative Classification of Positions in State and Municipal Service Proposed by Engineering Council's Com. on State and Munic. Serv.	No. of Titles provided in proposed Canadian Classification.	Salary Range Proposed for Canadian Service				Qualifications proposed for Canadian Service
		Usual		Extreme		
		Min.	Max.	Min.	Max.	
Consulting Engineer	1	\$6,000	.....	.....	.....	Professional Engr. 12 years' experience (7 in ch'ge.)
Chief Engineer (major work)	5	6,000	.....	\$4,800	..	Professional Engr., 7-12 yrs.' exper. (3-7 in charge)
Chief Engineer (minor work)	7	3,900	\$4,800	3,600	\$6,000	Professional Engr 7-12 yrs.' exper. (3-7 in charge)
Chief Engineer—Deputy	8	3,900	4,800	3,600	5,700	Professional Engr. 7-12 yrs.' exper (3-7 in charge)
Engineer	37	3,300	4,020	3,000	4,500	Professional Engr. 5-10 yrs.' exper (2-5 in charge)
Senior Ass't Engineer	40	2,640	3,000	2,400	3,480	Professional Engr. 3 yrs.' exper. (2-3 in charge)
Assistant Engineer	23	2,100	2,580	2,040	3,120	Professional Engr. 3 yrs.' exper.
Junior Assistant	15	1,680	2,040	1,680	2,160	Professional Engr. 2 yrs.' exper.
Senior Draftsman	..		Inclu	ded in	Profes	sional Service
Draftsman	8	1,260	1,560	.....	.....	3 years' experiece
Junior Draftsman	4	900	1,200	.....	....	2 years' experience
Chief Instrumentman	.		Inclu	ded in	Profes	sional Service
Instrumentman	5	1,260	1,560	....	......	3 years' experience
Rodman	4	900	1,200	..	..	2 years' experience

[1] Officers of Engineering Council: J. Parke Channing, *Chairman*, Alfred D. Flinn, *Secretary*; Engineering Societies Building, 29 West 39th Street, New York.

NATIONAL SERVICE COMMITTEE

Contributed by the Washington Office[1]

An Explanation of the Proposed Department of Public Works

THE name Department of Public Works at once leads to a misconception of its scope. Public Works is a poor name but such a name, or its equivalent in other languages, has been almost universally adopted to embrace tangible property owned by a Government or that over which a Government has direct sovereign jurisdiction, together with all official functions and activities related thereto and necessary to public utility. There can be no fixed and comprehensive definition of public works, because that which may be considered a part of public works in one country may be altogether lacking in such qualifications in another.

It is, therefore, natural that the bill which proposes to establish a Department of Public Works in this country (see MECHANICAL ENGINEERING for August, page 709, for the terms of the bill) should fail to propose public works jurisdiction over several Government properties or activities which, under strict construction of the definition, should be included. Conversely it includes Government bureaus, certain parts of which may not appropriately fall under a Public Works Department but which, at present, and pending reorganization, are so inextricably interwoven with purely public works functions that their separation is not now regarded as expedient. Because of this it appears desirable to explain many points of the bill which have puzzled those who are not in touch with the legislative and departmental situation in Washington. Such explanations therefore follow:

Why Is It Proposed to Transform the Department of the Interior Instead of Creating a New Department? First, because there are already enough Executive Departments to perform Government business, if the functions were properly corelated, and second, because there is a natural reluctance on the part of Congress to create new Departments. This latter reason, of course, would be an enormous handicap to any public works legislation.

Why Is It Proposed to Divide Control of the Duties of the Office of Indian Affairs? The main purpose of the Office of Indian Affairs is to educate the American Indian who is now a ward of the Nation, provide for his social welfare, and eventually create citizens. Therefore, the principal functions of this office fall under the branches of education and labor. When these objects are accomplished the Office of Indian Affairs will automatically go out of existence. The greatest and most important engineering work connected with this office, namely the construction of irrigation systems, is now and has for many years been performed by the Reclamation Service. Therefore, the proposal to divide the functions does little more than to continue a very advantageous arrangement already in effect.

Why Is It Proposed to Transfer from the War Department the Jurisdiction Over Rivers and Harbors? Because, entirely aside from the decidedly adverse opinions that the great body of engineers entertains as to the fitness of the Corps of Engineers, U. S. A., and its past performances, rivers and harbors improvements for navigation constitute a purely civil function which is merely one phase of our rivers and harbors development and utilization, and the whole cannot go forward effectively and economically without thorough coördination. Navigation improvements are public works, and are so defined the world over, and the fact that in an early day in the history of our Republic they were placed under the Corps of Engineers, as a purely emergency measure, which has since been continued by well directed influence and legislative inertia does not constitute the slightest reason why an illogical arrangement should be perpetuated.

Why Is It Proposed to Include the Construction Division of the Army in the Department of Public Works? Because this division is made up almost entirely of civilian engineers highly experienced in construction work who have, in connection with the war emergency, performed the most extensive and remarkable achievements in engineering construction ever performd by any one organization in the history of the country; because it has worked out a most effective plan of organization and operation which is in a large degree responsible for the results achieved and which could be amalgamated most efficiently with many of the peace-time construction operations of the Government; because the War Department has not provided for the perpetuation of this organization, as such, in its plan for a new military establishment, which is now the subject of investigation by Congress, and, at least by inference, proposes to allow the Construction Division to lapse or to merge its functions with certain old-line military departments where it will be in an environment entirely foreign to the spirit and practice which has caused it to be so unqualified a success; because the construction work which this Division has accomplished is for the most part, not military engineering at all, and the only military significance which it has is derived from the subsequent utilization thereof for military purposes; because when the United States entered the Great War it was necessary to organize the Construction Division under an extreme emergency attended by costly delay, and there should be an active construction organization in the service of the Government, which in the case of a future war could be made to function at an instant's notice as a construction branch of the military establishment. The only way by which this can be accomplished is to have such an organization in active practice in peace time work.

What Is the Reason for Including the Forest Service in the Department of Public Works? While it is true that the science of forestry, so far as its sylvicultural aspects are concerned, is an agricultural science the real problems of operation and maintenance of a National forest, as they occur under the conditions prevailing in this country, are more truly related to engineering than to agriculture. In the first place, forest reserves are unquestionably public works. They are properties owned by the Government and set apart for public purposes. The harvesting of lumber, fire prevention, the construction of roads and trails, the conservation of water, and the administration of water powers are unquestionably engineering operations. There is yet a third phase of the subject which is perhaps more important than the other two from the standpoint of efficient public administration. The bill retains within the proposed Department of Public Works certain bureaus of the Interior Department which have largely to do with public lands. These are the General Land Office, the Geological Survey, the National Park Service, the Reclamation Service, and the Bureau of Mines. These Services are concerned in a more or less intimate way with public land boundaries, surveys and the classification of the land for one or another purpose under the public land laws. It is of unquestionable advantage and productive of large economies to have these bureaus under one roof. The Forest Service, however, has quite as intensive relation to public land matters as has any of the other bureaus above mentioned—indeed, a far more intimate relation in many respects. Therefore, in view of the multiplicity of engineering functions necessarily comprised in the administration of forest reserves, together with the obvious public advantage of coördination in land administration, there seems to be no question but that distinct public advantage would result by including the Forest Service in the Department of Public Works, notwithstanding the fact that one of the important functions of such a service is pure forestry.

What Is the Explanation of the Section Providing for Four Assistant Secretaries? Much doubt has been expressed as to the ability of the Government to secure qualified men to accept these positions of Assistant Secretary at a compensation of $7,500 per annum. It is admitted that such compensation is inadequate but the figure was determined upon with full recognition of present legislative expediency. A compensation of $7,500 per annum is about 50 per cent greater than the present average salary of the Assistant Secretaries of Federal Departments. A saving factor is provided, however, in that these Assistant

[1] Washington Office in charge of M. O. Leighton, *Chairman*, National Service Committee, McLachlen Building, 10th and G Streets

Secretaries shall be included within the scope of civil service retirement laws. Such laws have been advocated for nearly a generation and the principle constantly gains strength. Undoubtedly some suitable law will be enacted in the near future. Properly qualified men will, in many cases, be content with moderate compensation during active life provided they are assured of suitable retirement pay after they have become superannuated. We are familiar with many notable examples in the Army and Navy. Every man who enters these two branches of the service faces a life of moderate income supplemented by retirement pay. This has attracted and will in the future attract good men who recognize that in practically every other walk of life there can be no certainty of income, either large or small.

Some good friends of this cause have questioned the plan concerning the assignment of duties to Assistant Secretaries according to the character of the work. They contend that if the work of any one Bureau should involve all the functions designated in the section, that is, engineering, architectural, surveys, and law, the said Bureau would have four commanding officers instead of one and confusion and loss of efficiency would result. This criticism is a result of misconception of the language. These Assistant Secretaries will not be chiefs of bureaus but merely arms of the Secretary of Public Works. The chief of any bureau will, as at present, have executive authority over all of the operations of his bureau. His ultimate superior will in all cases be the Secretary of the Department of Public Works. Were it possible to secure an omnipotent person as head of the Department, Assistaut Secretaries would not be necessary, but as at present the world is not producing omnipotent men it is necessary to give a Secretary of Public Works the advantage of specialized brains. The four Assistant Secretaries proposed are in effect merely additional lobes of the Secretary's brain and are a part of his official entity. Instead of reporting to an individual as done under the present practice, the bureau chief will report to and take counsel of an expert.

The Engineer Corps Under the Proposed Army Reorganization

The so-called Army Reorganization Bill now before Congress provides for a largely increased Corps of Engineers. The total engineer personnel under the Regular Army organization now provided by law is 12,933, while the bill now before the Senate Committee on Military Affairs authorizes an enrollment of 28,338. The reorganization scheme provides that the Chief of Engineers shall have the rank of Major General, whereas under the present law he is a Brigadier General. Two Brigadier Generals are provided and the number of Colonels is increased from 23 to 43; Lieutenant Colonels from 30 to 52; Majors from 72 to 134; Captains from 152 to 322, and First Lieutenants from 148 to 431.

There is much speculation, inside as well as outside of the service, as to the source from which this largely increased personnel of engineer officers will be secured. It seems apparent that a large number of the newly created commissions must be filled through the Reserve Corps or otherwise. Unless some fundamental change is made in the method of selecting engineer officers from among West Point graduates a large proportion of the engineer officers in service will lack those exclusive qualifications, which have heretofore characterized the Corps, by reason of the fact that engineer officers are, under the present law, selected from West Point graduates who have attained the highest rank in academic studies.

It is reported that since the signing of the armistice about 1500 Regular Army officers have presented their resignations, and these include a number of engineer officers of the highest usefulness whose loss to the Corps will be severely felt. The Chief of Engineers in recent testimony before a committee of Congress commented upon the present low state of morale among Regular Army officers and it has been assumed that he included in this category the officers of his own department, as well as those in others. In any event the situation is interesting from the point of view of the civilian engineer because unless some expedient is adopted, the nature of which is at present not quite clear, it may occur that the enlarged engineering program of the War Department may make it possible for duly qualified civilian engineers to render service to the country via the military route, even in time of peace.

War Department Equipment for Trade, Technical Schools and Universities

A bill which was proposed in the last session of the 65th Congress,—" providing further educational facilities by authorizing the Secretary of War to sell at reduced rates certain machine tools not in use for Government purposes to trade, technical schools, universities and other recognized educational institutions,"—was re-introduced early in the present session of Congress and has just been reported favorably by the Military Affairs Committee.

An amendment has been affixed to this bill whereby the educational institutions are to pay 20 per cent of the purchase price of the tools even when depreciation is taken into consideration instead of 10 per cent as proposed in the original bill. In the meantime, the Director of Sales announces that the machine tool section is operating with representatives of the several bureaus of the War Department which have surplus machine tools and is fixing prices at which all standard tools held by the Department will be offered for sale. Because of the large and greatly diversified stock of these tools now held by the War Department, it is contemplated that the requirements of the technical schools can be amply and quickly taken care of following the passage of the proposed bill.

The Alaskan Railroad

When it became apparent that the Alaskan Engineering Commission would be unable to complete the Alaskan Railroad with the original appropriation of \$35,000,000, a new bill was introduced into the House appropriating an additional \$17,000,000 for this work. Up to September 15 the bill had passed the House and been favorably reported to the Senate calendar by the Committee on Territories.

The engineer of the Commission, J. L. McPherson, explained to the Committee why it was more economical to construct the line in two sections, and further explained that the original appropriation was insufficient because wages had increased 59 per cent, cost of material had increased up to 161 per cent, and cost of transportation up to 147 per cent. The average cost per mile of the completed line will not exceed \$73,300, which is regarded by Mr. McPherson as a very good showing when the difficulties of railroad work in Alaska are considered. The road consists of 601 miles of track, including sidings.

The greatest expense yet to be met is for new work on various sections. One of the heavy items of expense will be the bridge over the Tanana river, which it is estimated will cost \$1,220,298. Approximately \$14,000,000 of the proposed appropriation is required for new work; the remainder is for reconstructing the Alaska Northern Railway, rehabilitating the Chatanika branch, constructing terminals and bridges, and for rolling stock and expenses in excess of revenue.

It is expected that the development made possible by this road will be comparable to the development which followed the construction of transcontinental lines in the United States. This is especially true if the main line of the road is connected with the base of Mt. McKinley.

Investigations of the Committee indicated that in addition to the mineral resources of Alaska which this road will open up, there is every prospect of Alaska becoming an important producer of agricultural crops. Investigation further developed that private capital had probably not built a line through this country because the government owns 99 per cent of the area of Alaska, which makes the government the logical interest to construct such a railway.

NECROLOGY

EDWARD PAYSON BATES

Edward Payson Bates, a life member of the Society, died on August 3, 1919, in Butte, Mont. Mr. Bates was born on March 3, 1841 in Savannah, Ga. His parents were of New England stock; his father, Levi Whitcomb Bates, was a descendant of Clement Bates, who came to this country from England with his brother Joseph. They, in turn, were descendents of John Bate (or Bates) of Lydd, England, who was a mayor of the town and justice in the court. His mother was Ruth Ann Bailey. She was born in Meredith, Delaware County, N. Y. Her father, Timothy Bailey, was a skillful mechanic and inventor, having invented the knitting frame which made underclothes and made radical changes in the spinning jenny which tended to save time and decrease the cost of producing cloth. This knitting frame was first used in Cohoes, N. Y. and is in use there to this day.

Edward Payson Bates

Mr. Bates was a born mechanic, his ideas running in that direction from the time he could handle a hammer and saw, which was very early in his experience. At the age of seventeen he entered the machine shop of Hobart B. Bigelow, in New Haven, who was afterward one of the beloved governors of the State of Connecticut. He remained there only a short time when he moved to New York State in the vicinity of Albany and entered a machine shop. After two years he could do all the ordinary work skillfully and correctly. He received a journeymen's wages for the second year of his experience, during that time learning to assemble a locomotive and operate it on the road. His next move was to New York City where he learned how to build a marine engine and install it in a ship. He studied at nights with a professor connected with Cooper Institute, was granted his marine license and for several years went to sea as an engineer.

During the Civil War he saw service on a transport which was bearing home the wounded from Libby Prison. Soon after this, Willis Warner, widely known in engineering circles, his childhood friend, induced him to enter his employ to learn how to erect steam-heating apparatus, with the idea of opening a branch business in Syracuse, N. Y. That business he was thereafter engaged in, the character changing much from time to time. He added to it ventilation, hot-water heating, factory equipment, power plants, sprinkler work, and various contracts of a similar nature. He was in Mr. Warren's employ for several years when the latter's sudden and unexpected death threw him on his own resources. He was enabled by fortuitous circumstances to buy out the business and it was known thereafter as Bates & Johnson Co. Upon taking over the business he increased the number of branches until at one time there were offices of the concern in eleven cities. As conditions changed and trade unions made drastic rules he found it advisable to cut off business conducted at a distance and limit himself to two offices—the principal one at Syracuse and a branch at Utica. At the beginning of 1917 Mr. Bates incorporated the business under the laws of New York State and was the new company's first president, Mrs. Bates being one of the directors. The company proposed to carry on the same line of business which Mr. Bates, himself, organized and maintained.

Mr. Bates was a member of the Society of Naval Architects and Marine Engineers, charter and life member of the Technology Club of Syracuse, life member of the Mayflower Society of Massachusetts, life director of the American Bible Society, life member of the Archæological Institute of America, member of the Robert Fulton Memorial Association, life member of the Bates Association and director of the Syracuse Museum of Fine Arts. In 1910, Mr. Bates was appointed official delegate of the Society of Naval Architects and Marine Engineers to the Fiftieth Anniversary of the foundation of the Institution of Naval Architects, which was held in London.

In the middle of March, 1919, Mr. and Mrs. Bates started on an extended trip that took them southward to New Orleans by steamer, through Texas into Southern California, north to Alaska, then through Yellowstone Park; a singularly happy and delightful trip which was interrupted in Butte, Mont., by his peaceful death.

CHARLES H. McGWIRE

Charles H. McGwire, assistant chief engineer for the Board of Public Utilities, Los Angeles, Cal., died on August 6, 1919. Mr. McGwire was born in 1868 in High Ridge, Conn. He studied for one year in Cornell University. He was formerly connected for varying periods with the following firms: Daniels & Fisher Store Co., Denver, Colo.; Barber Asphalt Paving Co., Denver; Frazer Mountain Copper Co., Twining, N. M.; Longmont Sugar Co., Longmont, Cal.; Pacific Electric Railroad Co., Los Angeles, and the Busch-Sulzer Bros. Diesel-Engine Co., Los Angeles. Mr. McGwire became a member of the Society in 1909.

CARL ANTHONY HEILMANN

Carl Anthony Heilmann, Captain, 5th Engineers, U. S. A., died July 12, 1919, as a result of an accident near Camp Humphreys, Alexandria, Va., when an army motor truck plunged over the side of a bridge.

Captain Heilmann was born in Brooklyn, N. Y., January, 1886. He was a graduate of Manual Training High School, and also studied at Worcester Polytechnic Institute for two years, graduating in 1908 as a mechanical engineer from Purdue University, where he completed the studies begun in Worcester. He served his apprenticeship in various machine shops during summer vacations. He was associated with the Ideal Portland Cement Company, Portland, Colo., as draftsman; with the Monett Electric Light Company, Monett, Mo., where he had charge of the electrical equipment and construction; with the Green Fuel Economizer Company in the capacity of sales engineer; with the American Radiator Company as engineering representative, Philadelphia, Pa.; and with Warren Webst r and Company, as district manager, Washington, D. C.

Carl Anthony Heilmann

Captain Heilmann had been stationed at Camp Humphreys after eight months of arduous service in France, with the First Division, having returned to the United States in order to make a lecture tour of the country. He entered the service shortly after the declaration of war and was commissioned as first lieutenant, Engineer Corps, at Fort Myer, Va., in June, 1917. He was promoted to Captain soon after his return to the United States. Captain Heilmann was elected to membership in the Society in 1913.

THEODORE COOPER

Theodore Cooper, for 30 years one of New York's best known consulting engineers, and an authority on bridge design and construction, died August 24 at his home in New York City. Mr. Cooper was born at Cooper Plains, N. Y., January 12, 1839. He was an engineering officer in the Navy during the Civil War, and assistant professor at the Naval Academy from 1865 to 1868. He was one of the five expert engineers selected by the President to determine the Hudson River bridge span and a member of the board of experts on the Manhattan Bridge plan in 1903. He had also been consulting engineer for the New York Public Library and the Quebec Bridge. He retired ten years ago.

PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by October 15 in order to appear in the November issue.

CHANGES OF POSITION

Robert P. McCarty has become associated with the Electric Boat Company, Groton, Conn. He was formerly connected with the Knox Motors Company, Springfield, Mass.

J. Harland Billings has resigned his lectureship in machine design in the University of Toronto, to become professor of mechanical engineering at Drexel Institute, Philadelphia, Pa.

Arthur S. Lewis, formerly with Flint and Chester, Inc., New York, as assistant to the president, has become affiliated with the Barco Manufacturing Company, Chicago, Ill.

George N. Somerville, until recently, chief engineer, Skandia Pacific Oil Engine Company, Oakland, Cal., has joined the staff of the Pacific Marine Review, San Francisco, Cal.

Carleton A. Orr has become associated with the Baker Steam Motor Car and Manufacturing Company, Inc., Pueblo, Colo. He was formerly connected with the Arkansas Valley Railway, Light and Power Company, Pueblo, Colo., in the capacity of superintendent of power plant and shops.

C. H. Vickers, formerly with the Willys-Morrow Company, Elmira, N. Y., has accepted the position of machine designer with the Utah Copper Company, Garfield, Utah.

Robert B. Stanton, Jr., has entered the service of the United Cast Iron Pipe and Foundry Company, New York. He was, until recently, sales engineer with the Worthington Pump and Machinery Company, New York.

Paul A. Cushman, formerly assistant professor of mechanical engineering, Pennsylvania State College, State College, Pa., has become affiliated with the mechanical engineering department, The Polytechnic Institute, Brooklyn, N. Y.

Noyes D. Farmer has become associated with the Carborundum Company, Niagara Falls, N. Y. He was formerly connected with the Atlantic Corporation, Portsmouth, N. H., in the capacity of supervisor of costs.

C. C. Wilcox has assumed the duties of chief engineer of the Durant Building Corporation, Detroit, Mich. He was recently assistant to consulting electrical engineer, Hodenpyle, Hardy and Company, Jackson, Mich.

Millard F. Cox has assumed the duties of first vice-president and consulting engineer, Louisville Fire Brick Works, Highland Park, Ky. He was formerly connected with the Louisville and Nashville Railroad Company, Louisville, Ky., in the capacity of assistant superintendent of machinery.

Eric L. Bergland has entered the employ of Brokaw-Eden Company, New York. He was, until recently, engineer with the E. I. duPont de Nemours and Company, Wilmington, Del.

Axtell A. Lloyd, formerly maintenance draftsman, Hillsboro Mills, Wilton, N. H., has accepted the position of designer, Springfield Armory, Springfield, Mass.

Walter C. Setzer, formerly instructor, mechanical engineering department, University of Pennsylvania, Philadelphia, Pa., has accepted the position of mechanical engineer for The H. B. Smith Company, of the same city.

Clarence W. Lewis, until recently with the Empire Gas and Fuel Company, Eldorado, Kan., has entered the service of the National Petroleum Corporation, New Orleans, La., in the capacity of district engineer.

James T. Enes has become associated with Perin and Marshall, of New York. He was formerly designer, Garfield Works of the Tennessee Coal, Iron and Railroad Company, Birmingham, Ala.

Harry S. Badger has accepted the position of resident engineer, American Cities Company, Houston, Tex. He was formerly connected with Vanderbilt University, Nashville, Tenn., in the capacity of engineer.

J. E. Fricker, formerly superintendent, liquid air division, Air Nitrates Corporation, New York, and more recently with the American Cyanamid Company, Niagara Falls, Ont., in a consulting capacity, has assumed the duties of superintendent with the Niebling-Markstein Company, of Cincinnati, Ohio.

Henry R. Trotter has assumed the duties of president of the Trotter-Patterson Corporation, consulting engineers, Hartford, Conn. He was formerly connected with the S K F Industries, Inc., in the capacity of chief engineer.

Leon K. Davis, until recently fire protection engineer, U. S. Railroad Administration, Washington, D. C., has become affiliated with the New York Reciprocal Underwriters, N. Y.

Charles T. Owens has accepted the position of one of the assistant chief inspectors with the U. S. Shipping Board, New York. He was formerly in the employ of the Alabama Power Company, Birmingham, Ala.

Morris Wenk, formerly engineering draftsman, G. M. Standifer Construction Corporation, Vancouver, Wash., has assumed the position of instructor in mechanical drawing at Oregon Agricultural College, Corvallis, Ore.

Byron F. Stowell, for many years connected with the Hendee Manufacturing Company, Springfield, Mass., as master mechanic and mechanical engineer, is now associated with the Napier Saw Works, Inc., of Springfield, Mass., as mechanical engineer.

Fred J. Queripel, formerly with the Electric Furnace Construction Company, Philadelphia, Pa., as chief draftsman, is now doing plant engineering work for the National Aniline and Chemical Company, Marcus Hook, Pa.

S. J. Millard, until recently instructor in industrial engineering, Pennsylvania State College, State College, Pa., has become associated with the Scranton Technical High School, Scranton, Pa.

B. F. Safberg, formerly with the production department of the Emergency Fleet Corporation, Plainfield, N. J., is now a member of the Technical Advisory Committee of the War Claims Board, Washington, D. C.

V. Edgar Walters has severed his connection with the Savage Arms Corporation, Utica, N. Y., to accept a position with the General Motors Corporation, Detroit, Mich.

Howard E. Degler has accepted the position of mechanical engineer with the McClintic-Marshall Construction Company, Pottstown, Pa. He was formerly instructor in automobile technique, United States Training Detachment, Hampton Institute, Hampton, Va.

Harry C. Buffington, formerly motor engineer, Minneapolis Steel and Machinery Company, Minneapolis, Minn., has assumed the position of chief engineer, The Holt Manufacturing Company, Peoria, Ill.

William H. Baker has resigned from the Atlas Portland Cement Company and has joined the staff of the Hardinge Conical Mill Company, New York, as vice-president.

Robert W. Rogers, until recently employed by the United States Government as a training expert in the Department of Labor Training Service, is now directing the Shop Training Department which has recently been established by the Wilson Foundry and Machine Company, Pontiac, Mich.

Irving E. Tuttle, formerly with Meyer, Strong and Jones, consulting engineers, has become president of the Nate-Earle Company, New York, engineering contractors in power plants, heating and ventilating systems and piping of all descriptions.

L. H. Schickedanz, until recently assistant mechanical engineer with the Cleveland Cliffs Iron Company, Ishpeming, Mich., has become connected with the United States Fuel Company, Westville, Ill.

Harold B. Bernard has been relieved as assistant superintendent, Sinclair Cudahy Pipe Line Company, Tulsa, Okla., to become general superintendent of the gasoline department of the Sinclair Companies, Tulsa, Okla.

Walter K. Cabot has accepted a position with the American Can Company, New York. He was formerly assistant manager with William Underwood Company, Boston, Mass.

Robert S. Drummond has become affiliated with the American Pressweld Radiator Corporation, Detroit, Mich. He was until recently general manager of the Wilson Welder and Metals Company, Inc., New York.

F. W. Leahy has resigned from the Emergency Fleet Corporation to assume charge of the marine department of the Diamond Power Specialty Company, Detroit, Mich.

F. J. Schlink, associate physicist, Bureau of Standards, and for the past two years technical assistant to the director of the Bureau, has resigned to accept a position as physicist with the Firestone Tire and Rubber Company, of Akron, Ohio.

Burt A. Waltz has severed his connection with the B. F. Goodrich Company, of Akron, Ohio, and has become associated with the Osborn Engineering Company, consulting engineers of Cleveland, in the capacity of assistant mechanical engineer.

J. H. Sengstaken, formerly associated with Lewis A. Riley, of New York, as engineer, has assumed the duties of assistant works superintendent of The Green Fuel Economizer Company, Beacon, N. Y.

Louis J. Pelissier, formerly mechanical superintendent at the works of the Marlin Rockwell Corporation, Tacony division, has become connected with the Edison Lamp Works of the General Electric Company, Harrison, N. J., in the capacity of foreman in the experiment and development department.

Alvin L. Smith has accepted the position of engineer with the Coldwell Lawn Mower Company, of Newburgh, N. Y. He was, until recently, plant engineer with The Griest Manufacturing Company, New Haven, Conn.

ANNOUNCEMENTS

I. E. Moultrop has been elected chairman of the Technical and Hydro-Electric Section of the National Electric Light Association.

W. S. Hazzard has become affiliated with Adams, Evans and Company, New York.

Alfred S. Kellogg has consolidated his engineering office with that of the architects, Brainerd, Leeds, of Boston. The new firm, under the name of Brainerd, Leeds and Kellogg will devote its entire energies to the design of complete structures, including architecture and engineering.

E. Everett Buchanan, Jr., has accepted the position of assistant in the metallurgical department of the Willys-Morrow Company, Elmira, N. J.

S. R. Willock has entered the employ of The Woodard Machine Company, Wooster, Ohio.

Lieut. Fred E. Hosmer, Aviation Section, Ebbetts Field, Tonoke, Ark., has become affiliated with the Gulf Production Company in the capacity of chief engineer.

The production division of the American Car and Foundry Company will be directed by William C. Dickerman who will be designated as vice-president in charge of operations. Mr. Dickerman has been connected with the company since its incorporation in 1899 advancing from apprenticeship in the shop to his present position.

Franklin R. Magill, Sergeant Q. M. C., N. A., Motor School, Camp Holabird, Baltimore, Md., has become identified with the Poole Engineering and Machine Company, New York.

C. B. Veal has become associated with the Curtiss Aeroplane and Motor Corporation, New York.

W. D. Hoxie, formerly vice-president of the Babcock and Wilcox Company, New York, has been elected president of the company.

Henry L. Wilson, Lieutenant, Q. M. C., A. E. F., has accepted the position of mechanical engineer with the Atlantic Dyestuff Company, of Boston, Mass.

K. Jellum, 2d Lieut., 308th Engineers, has become connected with the Western Electric Company, Chicago, Ill., as designer of special machinery.

Henry S. Johnson has become associated with the engineering department of E. I. duPont de Nemours Company, Wilmington, Del.

Robert P. Messenger, for the past nine years connected with the International Harvester Company, has now been promoted to the position of inspector general of European experiments of the same company, with headquarters in Brussels, Belgium.

A. L. DeLeeuw, formerly associated with the Singer Manufacturing Company, Elizabethport, N. J., has opened a consulting engineering office, at 149 Broadway, New York, for the building and equipping of industrial plants, specializing in machine shop problems to economic production.

Joseph S. String, Major Ordnance, U. S. A., has received his discharge from the Army and has become associated with Charles A. Lunn under the firm name of String-Lunn Company, engineers and contractors, industrial and power-plant equipment, with headquarters in New Haven, Conn.

Lee E. Barrows, formerly with the Texas Company, Fort Worth, Tex., has assumed the position of superintendent, gasoline division, producing department of the Houston, Tex., office of the company.

Levin A. Moore has assumed the duties of treasurer and general manager of H. W. Schrimpf and Company, Perth Amboy, N. J.

Howard M. Ingham has resumed his professional practice as industrial engineer after 18 months of service in the U. S. Naval Reserve Force, in the capacity of assistant naval inspector of ordnance, in charge of inspection in several plants engaged in the manufacture of ordnance, and is again prepared to take up problems in all phases of industrial engineering. He has associated himself with the firm of C. D. Giles and Company, accountants and auditors, New York.

John E. Taylor, Private, Company F, 31st Engineers, A. E. F., has accepted a position with the Locomotive Superheater Company, New York.

William H. Gref, Captain Ordnance Department, Frankfort Arsenal, Philadelphia, Pa., has become associated with the T. B. Foster and Brother Company, of Providence, R. I.

O. N. Edgar has left the Chamber of Commerce, Houston, Tex., where he had been in the capacity of engineer in charge of the industrial department, and has opened an office for industrial engineering work in a consulting capacity.

Leland G. Knapp, formerly affiliated with the Wisconsin Motor Manufacturing Company, Milwaukee, Wis., has become a member of the firm of Goodwin and Knapp industrial engineers, of Chicago, Ill.

George B. Massey, who was engaged in mine-laying work in the North Sea during the war, has left the United States Navy and has resumed his work as consulting engineer on excavation, with offices in Chicago, Ill.

George W. Mixter, vice-president of Deere and Company, Moline, Ill., has been named vice-president and general manager of the Pierce-Arrow Motor Car Company, Buffalo, N. Y. Mr. Mixter will retain his business relations with Deere and Company.

Ulysses G. Rogers, formerly in charge of the plant of the Smurr and Kamen Machine Company, of Chicago, Ill., manufacturers of turret lathes and special wire-working machinery, resigned his position August 1, and with W. W. Franklin and C. E. Schryver has organized the Commercial Engineering Association, Chicago, Ill., designers and builders of machinery, tools and equipment for the wire-working industry.

Francis L. Hill, Captain, 55th Infantry, A. E. F., is now assistant in graphics and descriptive geometry, Virginia Polytechnic Institute, Blacksburg, Va.

James F. Cyphers, Captain, Ordnance Department, U. S. A., Picatinny Arsenal, Dover, N. J., has entered the engineering department of E. I. duPont de Nemours and Company, Wilmington, Del.

W. T. Ayer has entered the employ of the Hercules Powder Company, Wilmington, Del.

James M. Forsyth, First Lieutenant, U. S. A., Air Service, is a member of the firm of Forsyth Engineering Company, Temple, Tex., which was organized by soldiers who were assigned to duty at the Aviation Repair Depot at Dallas, Tex., for the purpose of operating a first class machine shop.

APPOINTMENTS

William H. Timbie, until recently head of the Department of Applied Science, Wentworth Institute, Boston, Mass., has been appointed associate professor of electrical engineering, Massachusetts Institute of Technology, Cambridge, Mass.

Sverre Petersen has been appointed head of the technical department of the Roxana Petroleum Company of Oklahoma, St. Louis, Mo.

Paul J. Kiefer, formerly with the Towne Scientific School, University of Pennsylvania, and recently released from active service as Lieutenant, U. S. Naval Reserve Force, has been appointed assistant professor of steam engineering, University of Illinois, Urbana, Ill.

Joseph W. Roe, formerly assistant professor, mechanical engineering, Sheffield Scientific School, Yale University, New Haven, Conn., has been appointed secretary to Dr. W. F. M. Goss, Past-President, Am. Soc. M. E., president of the Railway Car Manufacturers Association, New York.

LIBRARY NOTES AND BOOK REVIEWS

BOILER FEED WATER. A Concise Handbook of Water for Boiler-Feeding Purposes (Its Effects, Treatment and Analysis). By Percy G. Jackson. J. B. Lippincott Co., Philadelphia, 1919. Cloth, 5 x 7 in., 102 pp., $2.

Contents: Mineral Constituents; Corrosion; Softening; Selection of Softening Plates; Priming; Scale, Grease and Overheating; Methods of Analysis; Analysis of Scale; Control Tests for Water Softening; Sampling; Solutions. Appendix: List of Factors; List of Atomic Weights; Clark's Table of Hardnesses.

This volume is intended to be a reliable, concise and practical compendium of information on boiler waters and feed-water troubles. It is based on long experience as chemist to an English boiler insurance company.

ELECTRIC POWER TRANSMISSION. Principles and Calculations, including a Revision of "Overhead Electric Power Transmission." By Alfred Still. Second Edition. McGraw-Hill Book Co., Inc., New York. 1919. Cloth, 6 x 9 in., 407 pp., illus., tables, $3.50.

"Overhead Electric Power Transmission" was written to provide a discussion of the fundamental principles and scientific laws determining the correct design of overhead transmission lines, suited to the needs of the office engineer in charge of calculations and specifications. The addition of a chapter on underground conductors has now made it necessary to alter the title. The work has also been thoroughly revised, obsolete matter has been omitted and new material added.

MANUAL OF THE CHEMICAL ANALYSIS OF ROCKS. By Henry S. Washington. Third edition. John Wiley & Sons, Inc., New York, 1919. Cloth, 6 x 9 in., 283 pp., 1 pl., tables, $2.50.

The author's object is to present a selection of methods for the analysis of silicate rocks, especially those of igneous origin, adapted to the needs of chemists, mining engineers, etc., who have not made a particular study of quantitative analysis. The present edition has been thoroughly revised and considerably enlarged.

MECHANICAL DRAWING FOR HIGH SCHOOLS. A Text with Problem Layouts. By Thomas E. French and Carl F. Svensen. First edition. McGraw-Hill Book Co., Inc., New York, 1919. Cloth, 6 x 9 in., 221 pp., illus., tables, $1.25.

The object of this book is to present mechanical drawing as a definite educational subject by which the student's power of visualization may be developed and his constructive imagination strengthened, while he is also taught to think exactly, to understand and make mechanical drawings and to know modern drafting-room practice. The course outlined covers two years' work and is a complete textbook and book of problems.

THE NAVAL ARCHITECT'S, SHIPBUILDER'S AND MARINE ENGINEER'S POCKETBOOK. By Clement Mackrow and Lloyd Woollard. Twelfth edition. The Norman W. Henley Publishing Co., New York, 1918. Flexible cloth, 4 x 7 in., 760 pp., illus., tables, $6.

The twelfth edition of this pocket-book appeared two and one-half years after the eleventh, from which it differs by the correction of errors and the addition of seventeen pages containing supplementing notes on various sections of the book and an article on estimating the weight and cost of a merchant vessel. In addition to the subjects usually discussed in such works, articles on aerodynamics and aeronautics are included.

PRACTICAL HELPS for the Electric Railway Shop, Track, Power, Line and Rolling Stock Departments. Compiled from the Mechanical and Engineering edition of *Electric Railway Journal*. First edition. Published by *Electric Railway Journal*. McGraw-Hill Book Co., Inc., New York, 1919. Cloth, 6 x 9 in., 331 pp., illus., tables, $2.

Contents: Track and Structures, by R. C. Cram; Power Generation, by Hartley Leh Smith; Power Transmission, by Charles R. Harte; Car Design, by Norman Litchfield; Car Equipment, by C. W. Squier.

These extended articles have been selected from a series published in the *Electric Railway Journal*, which was prepared for the information of men responsible for the upkeep of the physical equipment of an electric railway system. These articles cover the fundamentals of the various subjects in a broad practical manner.

PUMPING MACHINERY. A Treatise on the History, Design, Construction and Operation of Various Forms of Pumps. By Arthur M. Greene, Jr. Second edition, revised. John Wiley & Sons, Inc., New York, 1919. Cloth, 6 x 9 in., 703 pp., 504 illus., tables, $4.

Gives a brief, historical review of the development of pumping machinery, describes the action of a number of common forms of pumps and states the methods of design of pumping apparatus. It is intended to develop certain general principles of mechanics which are applicable to pumping machinery as well as to train the student in application of the theoretical portions of an engineering course. The descriptive chapters on modern pumps have been prepared from the catalogs and bulletins of manufacturers and from current technical literature. A full bibliography is included.

SHORE PROCESSES AND SHORELINE DEVELOPENT. By Douglas Wilson Johnson. First edition. John Wiley & Sons, Inc., New York, 1919. Cloth, 6 x 9 in., 601 pp., 149 illus., 73 pl., $5.

Professor Johnson has recorded in compact form the results of an extended study of the scattered literature on shore processes and shoreline forms. Water waves, the work of waves, current action, the development of the shore profile and the shoreline, shore ridges and minor shore forms are discussed, and a statement of the fundamental principles which seem best established is given. The author hopes that the book will prove useful to engineers, geologists, and geographers. Full lists of references and a bibliography are included.

STANDARDIZATION OF MINING METHODS. By Charles A. Mitke. A series of important articles reprinted from *Engineering and Mining Journal*. First edition. Published by *Engineering and Mining Journal*. McGraw-Hill Book Co., Inc., New York, 1919. Cloth, 5 x 7 in., 110 pp., 47 illus., 6 charts, 4 tables, $1.50.

As mining engineer for the Phelps Dodge Corporation the author has studied mining practices in detail, with a view to the establishment of standard methods. The present volume is based on his experience and is an account of the standardization of various mining practices in the interests of safety and economy.

STUDIES IN THE CONSTRUCTION OF DAMS: EARTHEN AND MASONRY. Arranged on the Principle of Question and Answer for Engineering Students and Others. By Prof. E. R. Matthews. J. B. Lippincott Co., Philadelphia, 1919. Paper, 6 x 9 in., 43 pp., 30 illus., $1.50.

This book is intended for students preparing for examinations, especially those for associate membership in the Institution of Civil Engineers, or the Institution of Municipal and County Engineers, or for the degree of bachelor of science in engineering in universities.

A TEXT-BOOK OF HEAT ENGINES. By Andrew Jamieson. Vol. 1; eighteenth edition. Revised by Ewart S. Andrews. J. B. Lippincott Co., Philadelphia, 1919. Cloth, 5 x 8 in., 551 pp., $3.

This volume is a revised edition of Professor Jamieson's "Textbook on Steam and Steam Engines," with the omission of the chapters on steam turbines and boilers. The omitted chapters, with others on thermodynamics, entropy and internal combustion engines will appear in volume two.

CENTRIFUGAL COMPRESSORS

(Continued from page 799)

c DETERMINATION OF THE BASIC CHARACTERISTIC FROM A GIVEN PRESSURE CHARACTERISTIC

From magnitudes obtained by measurement can be determined the average temperature T_1 at the entrance to the groups, the average temperature of the cooling water T_2 and the average ratio of temperatures $\frac{T_2}{T}$. The average ratio of pressures of the groups is again

$$\frac{p_2}{p_1} = \left(\frac{p\ \text{II}}{p\ \text{I}}\right)^{\frac{1}{i}}$$

Further, the total work of compression E_s has to be measured. If, for a certain speed of rotation in revolutions n_n a certain load be taken as normal there follows from equation [17] the average admission ε_m of the groups corresponding to any weight of the air flowing through the compressor G. Equation [4-b] permits determining the value of $\left(\frac{m}{\eta_i}\right)_m$. From this, by using Equation [16] and an estimated value of T_m (which is closer to T_2 than T_1), the magnitude of the pressure head m may be determined and from this may be determined the coefficient of efficiency η_m by using the expression $\left(\frac{m}{\eta_i}\right)_m$. This gives the corresponding points of the basic characteristic and all that remains to be done is to determine the coefficient of heat transmission k_n and the exponent q. The best way to do this is to insert into Equation [1] various arbitrary values of a until the value of the ratio of temperatures $\frac{T_2}{T_1}$ is secured, which agrees with the average value obtained by direct measurement. If this be properly done equation [13] ought to be satisfied also (this gives a test of the correctness of the value of T_m. Thereafter from Equation [14] may be computed the value of

$$z = k_n\left(\frac{G}{G_n}\right)^{1-q}$$

If this determination be carried out for several points of a given characteristic and if in accordance with Fig. 5

$$\log Z = \log k_n + (1-q)\log\frac{G}{G_n} \quad \ldots\ldots\ldots\ldots [18]$$

be plotted as a function of $\log\frac{G_n}{G}$, the straight line AB may be drawn through these points, and then

$$OC = \log k_n$$

$$\frac{OC}{OA} = 1 - q$$

This determines the value of k_n and q.

As has been shown in a previous investigation of the author concerning a new process for the calculation of centrifugal compressors Equation [11] holds good under the assumption that the coefficient of heat transmission is the same throughout the entire group of stages. This is, however, actually not so, and in order to take this factor into consideration it is necessary in accordance with Fig. 5 to set the end temperatures $T_2 - T_{a2}$ as well as T_m and T_a in Equations [11], [15] and [17] somewhat higher than corresponds to their actual values.

GAGE LIMITS IN INTERCHANGEABLE MANUFACTURING

(Continued from page 805)

If both mating parts of the work have errors in lead in the same direction, the work will go together easier, because these errors in lead in the work require enlarging the threaded hole and reducing the screw to receive the gages their whole length, and when these mating parts come together, the errors being in the same direction, the flanks of the threads coincide, and the above-mentioned compensation in diameter for lead error makes the mating parts loose. This condidition is often blamed on the gages, when, as a matter of fact, the error in lead on the work reduces the tolerance in order to allow the work to mate, and the gage only insures the mating.

As master gages cannot be made exactly to the component dimensions, except at a prohibitive cost, the inaccuracy comes out of the working tolerance for the reasons before stated, and on close work this should be taken into account when setting the component tolerance. If the minimum screw plug gage has an error in angle, it necessitates that the nut be made larger in pitch diameter than that of the gage in order to be accepted, therefore errors in angle on the minimum plug gage reduce the working tolerance.

If the maximum screw plug gage has an error in angle, it facilitates the approval of the work or adds to the working tolerance, as will be plainly seen if a maximum gage with thread angle 50 deg. be used to check a nut whose thread angle is 60 deg. The pitch diameters being alike, the plug would "no-go" into the threaded hole, thereby passing the work which is off on the angle. Therefore, these gage angle errors off-set each other, and do not rob the tolerence. From what has been said before, it is plain that errors of lead in the "go" screw thread gage rob the tolerance slightly, and this should be taken into account on close fitting work.

The "no-go" thread gage is not expected to go more than a couple of threads, hence the lead error in the "no-go" gage can be neglected. The total errors then which can affect the final working tolerance, if all are in the same direction, are two diametrical errors, and the diametrical equivalent of the lead error of the "go" gage.

Some engineers think that the law of averages ought to apply in this condition by assuming that on an average only half of the errors ought to be present in one set of gages, and that the allowance on the tolerances as affected by master gages should be one half of the sum of the three above-mentioned errors.

The new Webster's Collegiate Dictionary and Webster's New International Dictionary fail to give any shade of difference in meaning between the use of the words "electrical" and "electric," and yet those of us who constantly mingle with men of the electrical engineering profession know there is a decided difference in usage.

For instance we hear constantly of an "electrical" engineer, never an "electric" engineer, and almost universally we hear of "electric" toasters, and quite infrequently do we hear of "electrical" toasters. By study of such instances as these we are able to formulate a rule that will guide us in the most elegant or choice use of these words.

It would seem that the use of the word "electric" is preferred where a piece of machinery or apparatus is involved that is worked or operated by electricity and in almost all cases where inanimate things are to be modified. Thus we have "electric" current, "electric" baker (meaning a stove operated by electricity), "electric" trolley, "electric" supply company (a store that deals in "electric" supplies).

On the other hand, when matters pertaining to things or people connected with "electrical" affairs but not necessarily involving the direct use of electricity are considered, especially where people and organizations are described, the word "electrical" is preferred in its use. Thus we have "electrical" baker (one who operates an "electric" baking apparatus), "electrical" engineer, "electrical" supply jobbers' association, "electrical" contractors and dealers' association, "electrical" engineering profession, and among inanimate uses, "electrical" science, "electrical" affairs and such other instances as may be cited where electricity is not directly employed but which pertain merely to matters "electrical." (*Journal of Electricity.*)

Oct. 1920

THE ENGINEERING INDEX

Published Monthly by The American Society of Mechanical Engineers

The Engineering Index was Founded in 1884 *by the Association of Engineering Societies; Published from* 1895 *to* 1919 *by The Engineering Magazine Company; and Acquired January* 1919 *by The American Society of Mechanical Engineers*

THE following pages form a descriptive Index to articles on engineering and related subjects in current periodicals. In its preparation the Society's engineering staff regularly examines all of the technical journals and society publications received by the Engineering Societies Library, which form one of the greatest and most complete collections of scientific periodicals in the world, comprising upward of 1100 distinct publications in some ten languages. Cross-references are freely introduced in the Index, and in all cases where the titles of articles are not sufficiently descriptive, explanatory sentences are appended. The main abbreviations used in the items are given at the bottom of this page.

PHOTOSTATIC COPIES OF ARTICLES LISTED

THE Society is prepared to supply photostatic copies (white printing on black background) of any of the articles listed. Copies of the periodicals themselves, or clippings of articles, cannot be supplied.

Price of each print (up to 11 x 14 in. in size), 25 cents plus postage. A separate print is required for each page of the larger-size periodicals, but where possible two pages will be photographed together on the same print. Bill will be mailed with the prints.

Those holding coupon books for clippings formerly issued by The Engineering Magazine Company may use the coupons in payment for photostatic prints. In ordering, state plainly

(1) Page number of Index on which item appears
(2) Title of article
(3) Name of periodical.

Orders should be sent to

Harrison W. Craver, *Director,*
Engineering Societies Library,
29 West 39th Street, New York City.

DIVISIONS OF THE ENGINEERING INDEX

MECHANICAL ENGINEERING

Air Machinery
Corrosion
Forging
Foundries
Fuels and Firing
Handling of Materials
Heat Treating
Heating and Ventilation
Hoisting and Conveying
Hydraulic Machinery
Internal-Combustion Engines
Lubrication
Machine Elements and Design
Machine Shop
Machinery, Metal-Working
Machinery, Special
Machinery, Woodworking
Materials of Construction and Testing of Materials
Measurements and Measuring Apparatus
Mechanical Processes
Mechanics
Motor-Car Engineering
Pipe
Power Generation
Power Plants
Power Transmission
Producer Gas
Pumps
Refractories
Refrigeration
Research
Standards and Standardization
Steam Engineering
Textiles
Thermodynamics
Welding
Varia

ORGANIZATION AND MANAGEMENT

Accounting
Education
Export
Factory Management
Finance and Cost
Inspection
Labor
Legal
Lighting
Public Regulation
Reconstruction
Safety Engineering
Salvage
Transportation
Varia

ELECTRICAL ENGINEERING

Electrochemistry
Electrodeposition
Electrophysics
Furnaces
Generating Stations
Generators and Motors
Lighting and Lamp Manufacture
Measurements and Tests
Power Applications
Standards
Telegraphy and Telephony
Transformers, Converters, Frequency Changers
Transmission, Distribution, Control
Wiring
Varia

CIVIL ENGINEERING

Bridges
Building and Construction
Cement and Concrete
Earthwork, Rock Excavation, etc.
Harbors
Materials of Construction
Municipal Engineering
Roads and Pavements
Sanitary Engineering
Water Supply
Waterways

MINING ENGINEERING

Alloys, Ferrous
Base Materials
Coal and Coke
Copper
Explosives
Geology and Mineralogy
Iron
Lead
Major Industrial Materials
Mines and Mining
Minor Industrial Materials
Oil and Gas
Precious Minerals
Rare Minerals
Tin
Transportation
Varia

METALLURGY

Aluminum
Blast Furnaces
Copper
Flotation
Iron and Steel
Non-Ferrous Alloys
Occluded Gases
Waste Recuperation

AERONAUTICS

Aeroplane Parts
Aerostatics
Aircraft Production
Applications
Auxiliary Service
Design
Dynamics
Engines
Gliders
History
Instruments
Materials of Construction
Mechanics
Meteorology
Military Aircraft
Models
Planes
Propellers
Specifications, Aeroplane
Transatlantic Flight

MARINE ENGINEERING

Auxiliary Equipment
Salvage
Ships
Yards
Varia

INDUSTRIAL TECHNOLOGY

RAILROAD ENGINEERING

Electric Railroads
Electrification
Equipment
Foreign
Labor
Locomotive
Maintenance
New Construction
Operation and Management
Permanent Way and Buildings
Rails
Rolling Stock
Safety and Signaling Systems
Shops
Special Lines
Street Railways
Terminals

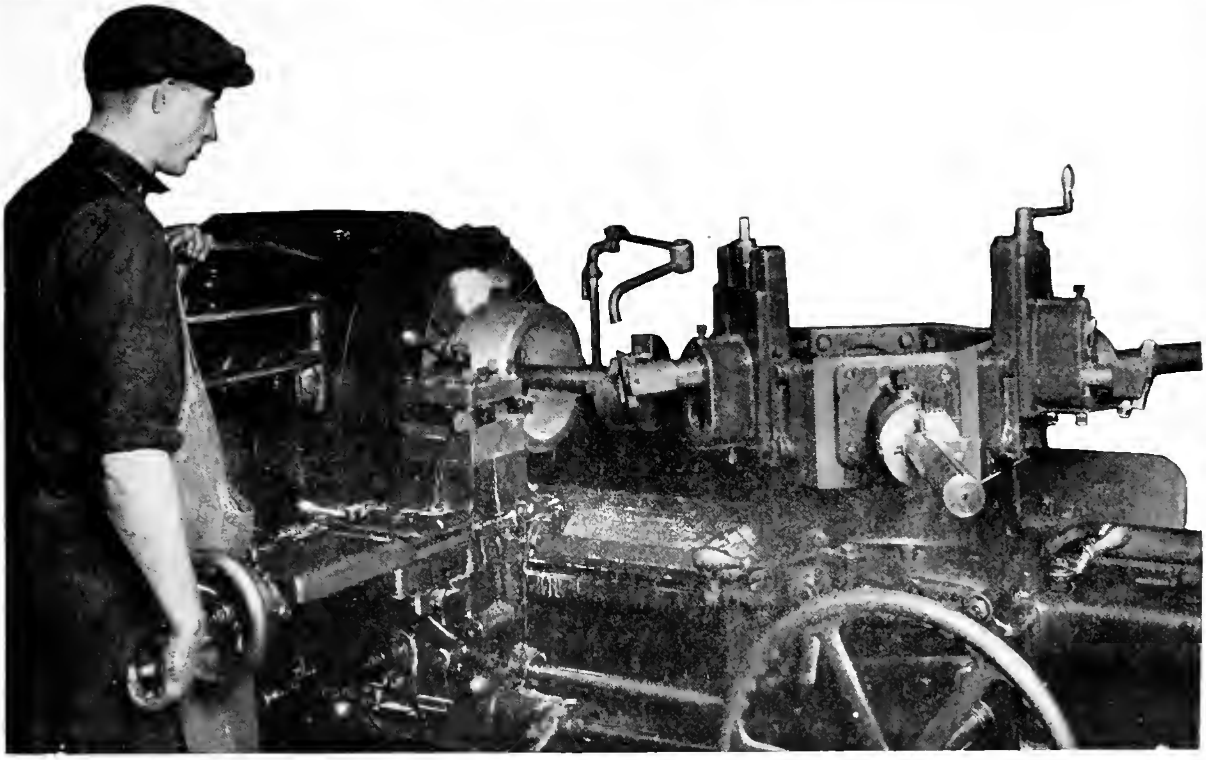
MUNITIONS AND MILITARY ENGINEERING

GENERAL SCIENCE

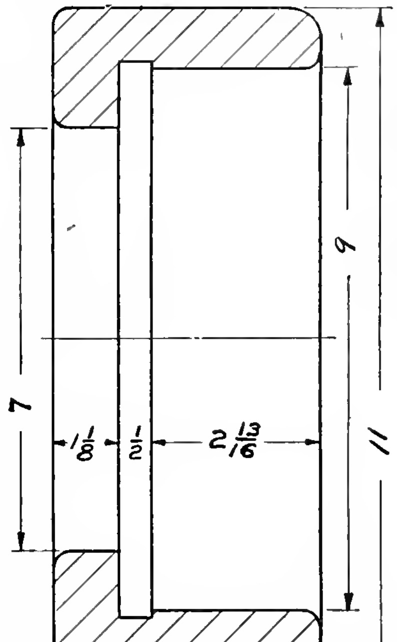
Chemistry
Mathematics
Physics

Note.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
New York (N. Y.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
Ventilating (Vent.)
Western (West.)

LIST OF TOPICS
THE ENGINEERING INDEX
OCTOBER, 1919



Breaks Another Time Record



The Hahn Manufacturing Company, a jobbing machine shop in Cleveland, reduced production time one-half on this drop forged Clutch Ring when the work was transferred from an engine lathe to a

No. 3-A Universal Hollow Hexagon Turret Lathe

Because of the flexibility of the tool equipment of the No. 3-A, the jobbing shop finds it adaptable for finishing small lots of different pieces as well as long runs of the same piece. Then the time saved by operating both square and hexagon turrets simultaneously, and the wide range of feeds and speeds for all classes of work makes the Universal Hollow Hex the machine for the jobber.

No. 4 Universal, 1½" x 10",	**16" Swing**
No. 2-A Universal, 2½" or 3¼" x 29",	**16½" Swing**
No. 3-A Universal, 3½" or 4½" x 44",	**21½" Swing**

THE WARNER & SWASEY COMPANY

CLEVELAND, OHIO, U. S. A.

TURRET LATHES—TURRET SCREW MACHINES—BRASS WORKING MACHINE TOOLS

NEW YORK Office—Singer Bldg. **Boston Office**—Oliver Bldg. **Buffalo Office**—Iroquois Bldg. **Detroit Office**—Ford Bldg. **Chicago Office and Show Room**—618-622 Washington Blvd.

FOREIGN AGENTS: Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. Allied Machinery Company, Paris, Turin, Barcelona, Zurich and Brussels. Stokvis & Zonen, Rotterdam. Wilhelm Sonesson Company, Malmo, Copenhagen, Gotenburg and Stockholm. Yamatake & Co., Tokio. Benson Brothers, Sydney and Melbourne. A. Asher Smith, Sydney. A. R. Williams Machinery Co., Ltd., Toronto, St. John, Winnipeg and Vancouver. Williams & Wilson, Ltd., Montreal.

Mechanical Engineering

AIR MACHINERY

Air Chambers

Installation and Use of Air Chambers, H. D. Fisher. Power, vol. 50, no. 6, Aug. 5, 1919, pp. 209-210, 6 figs. Arrangement which is said to have the advantage that by throttling valve it can be arranged to deliver just the quantity of air required and that it will work indefinitely without attention.

Air Receiver

[illegible] Receiver, Frank Richards. Compressed Air Mag., vol. 24, no. 8, Aug. 1919, pp. [illegible]-256. Suggestions in regard to design and installation.

Fans

Centrifugal Fans, Frank S. Townsend. Popular Engr., vol. 12, no. 2, Aug. 1919, pp. 13-15, 3 figs. Their application in gas engineering practice. Paper read before Midland Junior Gas Association, England.

Transportation

The Utilization of Compressed Air in Transportation (Die Verwendung der Pressluft in der Verkehrstechnik). Kasten, Zeitschrift f. komprimierte u. flüssige Gase, vol. 19, no. 11, 1917-18, pp. 97-100, 4 figs. Pneumatic mail tubes in Berlin.

Wind Motors

Wind Motors: Their Possibilities and Limitations, Faville C. Poulton. Jl. Roy. Soc. Arts, vol. 67, no. 3480, Aug. 1, 1919, pp. 590-594. Argues that there is room for wind motor in these days of super-economy because a modern wind motor properly installed gives 15 per cent efficiency while a modern steam plant using coal of 15,000 B.t.u. per lb. gives 13 per cent only.

CORROSION

Copper

Corrosion of Copper—VII, G. F. Bengough and O. F. Hudson. Metal Industry, vol. 15, no. 2, July 11, 1919, pp. 26-28. Tables giving results of immersion tests in both distilled water and sea water. From fourth report of Corrosion Committee of Inst. of Metals.

Earth Currents

Corrosion through Earth Currents from Electric Traction (Die Korrosion durch Erdströme elektrischer Bahnen). Elektrotechnik u. Maschinenbau, vol. 37, no. 6, Feb. 9, 1919, pp. 56-57. Report of the Swiss Electrotechnical Soc. regarding corrosion of gas and water mains.

Rustproofing

Metallic Coatings for Rustproofing. Brass World, vol. 15, no. 8, Aug. 1919, pp. 242-245. Methods of testing coatings. Recommendations concerning coatings.

FORGING

Drop Stamping

Drop-Stamping, Drop-forgings, etc.—VI, Joseph Horner. Mech. World, vol. 66, no. 1700, Aug. 1, 1919, p. 55, 5 figs. Example in which entire forging must be stamped at one time in order to produce recessed form of web. (To be continued).

FOUNDRIES

Casting Machine

New Casting Machine for Pig Iron (Neue Masselgiessmaschine). Zeitschrift f. die gesamte Giessereipraxis, vol. 40, no. 9, Mar. 1, 1919, pp. 109-110, 3 figs. Consists of two turntables holding cast-iron molds; while the specially constructed ladle pours a regulated amount into mould of first table, the second table automatically advances one mold. It is claimed that ingots made by this process are of even size and weight.

Chinese Foundries

Chinese Iron Foundries, F. A. Foster. Am. Mach., vol. 51, no. 8, Aug. 21, 1919, pp. 345-352, 30 figs. Notes the specially remarkable thinness and smooth finish of products in spite of crudeness of method of production.

Condensers

Making and Casting Cylindrical Condensers—I, Ben Shaw. Mech. World, vol. 66, no. 1700, Aug. 1, 1919, pp. 54-55, 3 figs. Illustrating instances where company built cast iron condenser "as one means of reducing the work required to be done by riveters."

Electric Casting

Electric Casting and Welding (Elektrisches Giess- und Schweissverfahren). Zeitschrift f. die gesamte Giessereipraxis, vol. 40, no. 7, Feb. 15, 1919, pp. 81-83. With special reference to Dr. Zerener's method.

Engine Cylinder Casting

Marine Gasoline Engine Cylinders, R. H. Palmer. Foundry, vol. 47, no. 329, Aug. 15, 1919, pp. 567-569, 5 figs. Foundry problems encountered in marine-engine shop.

Gating

Method of Gating Test Bars Affects Results, A. W. Sorgenz, Foundry, vol. 47, no. 329, Aug. 15, 1919, pp. 559-560, 4 figs. Double annealing recommended.

Ingot Mold Foundry

Bethlehem's Ingot Mold Foundry, E. C. Kreutzberg. Iron Trade Rev., vol. 65, no. 8, Aug. 21, 1919, pp. 495-498, 7 figs. Capacity is 10,000 tons of ingot molds, stools and bottom plates per month. Attention is particularly called to arrangement for storing and charging coke and method of pouring molds from long platform.

Layout

A Dayton Foundry of Progressive Design. Iron Age, vol. 104, no. 6, Aug. 7, 1919, pp. 355-356, 3 figs. Method of distributing air for heat and ventilation, use of transferable jib crane, and storage of sand in pits below foundry floor level quoted as interesting features.

Malleable Iron

Insure the Integrity of Malleable, Enrique Touceda. Foundry, vol. 47, no. 329, Aug. 15, 1919, pp. 551-552. Writer believes that soundness of metal in castings is secured by eliminating chills and strict adherence to use of feeding heads to furnish metal at proper pressure. Paper presented before American Foundrymen's Assn.

Molding

Long Castings From Short Patterns, R. R. Clarke. Foundry, vol. 47, no. 329, Aug. 15, 1919, pp. 561-564. Hints on molding light and heavy bushings.

Molding Machines

Molding Machine That Throws Sand, Pat Dwyer. Foundry, vol. 47, no. 329, Aug. 15, 1919, pp. 535-538, 6 figs. Also in Iron Trade Rev., vol. 65, no. 9, Aug. 28, 1919, pp. 567-579, 6 figs. Device in which projectile principle is employed for ramming sand. Sand is thrown by rapidly revolving head.

Patterns

Gear Patterns, Joseph A. Shelly. Machy. (N. Y.), vol. 25, no. 12, Aug. 1919, pp. 1133-1137, 10 figs. Methods of laying out and constructing patterns for spur and bevel gears and wormwheels.

Ship Castings

Castings for Ship Construction—VIII, Ben Shaw and James Edgar. Foundry, vol. 47, no. 329, Aug. 15, 1919, pp. 540-544, 15 figs. Concerning care necessary in preparing mold for propeller shaft brackets to insure proper allowances for contraction of metal. Writers hold that large flasks are not necessary.

Standardization

Standardization of Foundry Practice, S. W. Wis. Mech. World, vol. 66, no. 1701, Aug. 8, 1919, pp. 69-70. Tabulated records of different conditions under which various foundry operations are conducted are presented as evidence to justify writer's belief that it is well-nigh impossible to approach anything like uniform practice. He suggests idea of a foundry equivalent to National Laboratory. Paper read before Newcastle Branch of British Foundrymen's Assn.

FUELS AND FIRING

Alcohol

Alcohol Motor Fluid. Engineer, vol. 128, no. 3314, July 4, 1919, pp. 17-18. Also in Jl. Soc. Chem. Industries, vol. 38, no. 13, July 15, 1919, pp. 250R-252R, and in Eng. & Indus. Management, vol. 2, no. 3, July 17, 1919, p. 67. Report of committee appointed by British Government to consider and report upon available sources of supply, methods of manufacture and cost of product; suitability, either alone or in admixture with other combustibles, for use in internal-combustion engines, and modifications of existing types of such engines which may be necessary to attainment of efficiency, and question of denaturing alcohol, and alterations to be made in present excise arrangements.

Fuel Saving

Fuel Saving in Industrial Plants. John F. Tinsley. Mech. Eng., vol. 41, no. 9, Sept. 1919, pp. 750-751. Manner in which Worcester, Mass. Fuel Conservation Committee conducted campaign during war.

Gaseous Fuel

Utilization of Gaseous Fuel in Commercial Practice, F. W. Epworth. Metal Industry, vol. 15, no. 2, July 11, 1919, pp. 21-25, 9 figs. With consideration of types of gas-fired furnaces and methods for their control.

Low-Grade Fuel

The Production of Steam from Low Grade Fuel and a Chemical Works Power Plant, P. Parrish. Chem. Industry, vol. 38, no. 14, July 31, 1919, pp. 234T-239T and (discussion) 239T-241T, 5 figs. Details of Crosthwaite's patent forced-draft air tubes.

Metallurgical Furnaces

Fuel for Metallurgical Furnaces, Rose Demorest. Blast Furnace & Steel Plant, vol. 7, no. 8, Aug. 1919, pp. 386-389. Bibliography of oil fuel for metallurgical furnaces compiled from chief sources of technical literature.

Powdered Coal

The Use of Pulverized Coal—II, Leonard C. Harvey. Engineer, vol. 128, no. 3315, July 11, 1919, pp. 26-28, 5 figs. Notes on various types of burners.

Waste Heat Boilers and Pulverized Fuel in Chemical Factories, C. J. Goodwin. Chem. Industry, vol. 38, no. 14, July 31, 1919, pp. 213T-220T and (discussion) 220T-222T, 6 figs. Typical installations at various English works.

High Efficiency of Powdered Coal as Fuel—I. Coal Trade Jl., vol. 50, no. 33, Aug. 13, 1919, pp. 981-982, 1 fig. Quigley system. (To be continued.)

The Use of Pulverized Coal, L. C. Harvey. Engineering, vol. 108, no. 2796, Aug. 1, 1919, pp. 160-164, 13 figs. Systems of Locomotive Pulverized Fuel Co. and Powdered Coal Engineering Co. (Concluded.) Paper read before Iron and Steel Inst.

The Use of Pulverized Coal, L. C. Harvey. Engineering, vol. 108, no. 2795, July 25, 1919, pp. 125-128, 11 figs. Particulars of various systems. (Continuation of serial.) Paper read before Iron and Steel Inst.

Pulverized Coal as a Fuel for Boilers, Edward R. Welles and W. H. Jacobi. Mech. Eng., vol. 41, no. 9, Sept. 1919, pp. 744-749 and p. 787, 5 figs. General study of its characteristics and the operating conditions met with in its commercial applications; also a discussion of the nature of flame, types of burners and of a design of pulverized-fuel furnace for a 500-hp. boiler.

High Efficiency of Powdered Coal as Fuel—II. Coal Trade Jl., vol. 50, no. 34, Aug. 20, 1919, pp. 1018-1019, 2 figs. Description of controller and burner. Comparison of other fuels.

FURNACES

Heat-Treating Furnaces

Heat Treating Furnaces for Heavy Artillery, William J. Harris, Jr. Blast Furnace & Steel Plant, vol. 7, no. 8, Aug. 1919, pp. 378-380, 2 figs. Vertical steel shell-type furnace installed at U. S. Government arsenal at Watertown, Mass. for heat treatment of gun tubes and other parts of heavy artillery.

Heating Furnaces and Annealing Furnaces—VIII, W. Trinks. Blast Furnace & Steel Plant, vol. 7, no. 8, Aug. 1919, pp. 390-393, 9 figs. Diagram for determining generator size.

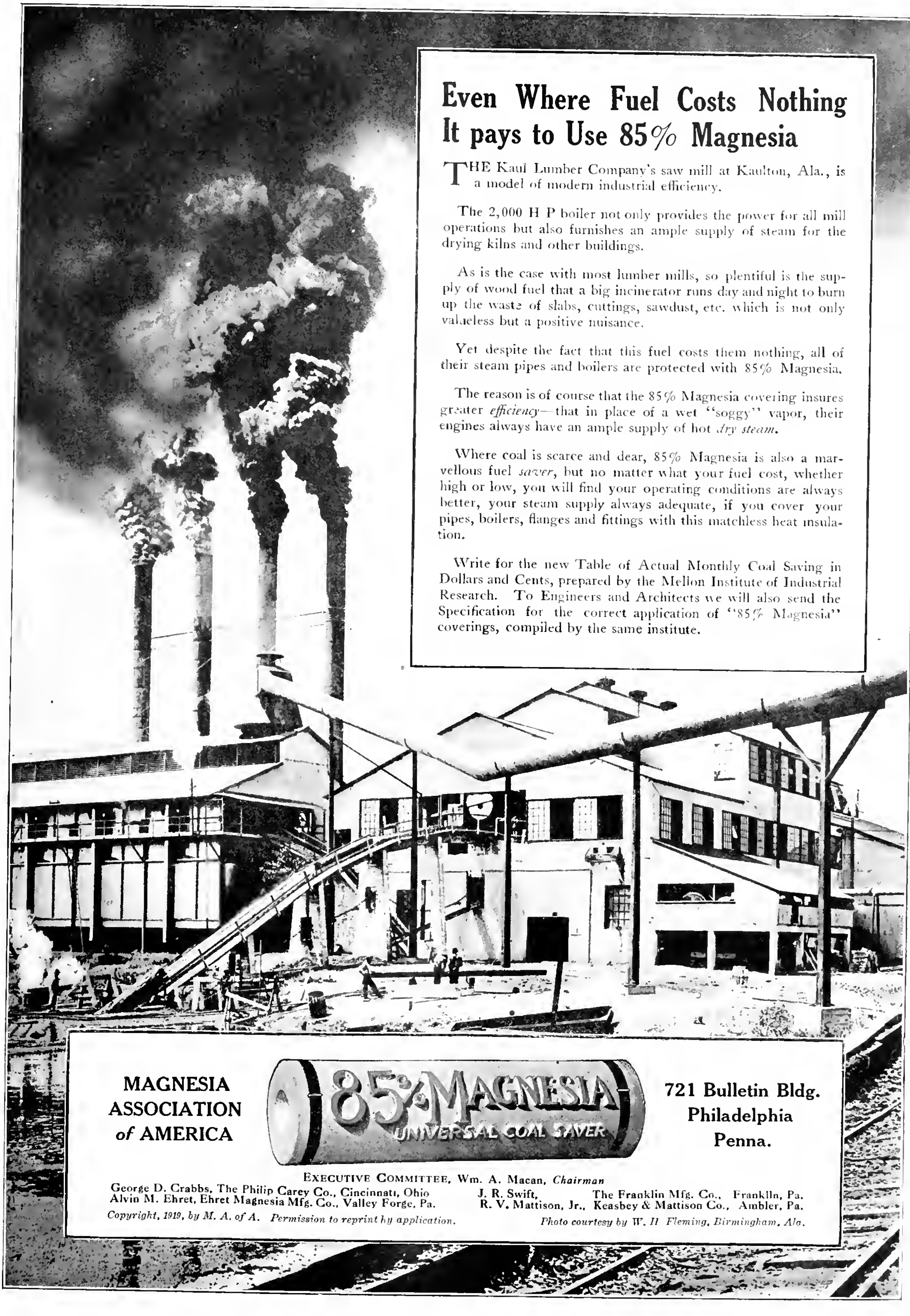
GAGES

Grinding Gages

Producing Screw Thread Gauges by Grinding, C. Edgar Allen. Machy. (Lond.), vol. 14, no. 356, July 24, 1919, pp. 504-507, 9 figs. Method which utilizes disintegration of wheel during grinding to yield ultimate thread form.

Newall Gages

Newall Measuring Machines and Gauges. Engineering, vol. 108, no. 2795, July 25, 1919, pp. 104-105, 12 figs., partly on two supplement plates. Details of test room specially noted.



Even Where Fuel Costs Nothing It pays to Use 85% Magnesia

THE Kauf Lumber Company's saw mill at Kaulton, Ala., is a model of modern industrial efficiency.

The 2,000 H P boiler not only provides the power for all mill operations but also furnishes an ample supply of steam for the drying kilns and other buildings.

As is the case with most lumber mills, so plentiful is the supply of wood fuel that a big incinerator runs day and night to burn up the waste of slabs, cuttings, sawdust, etc. which is not only valueless but a positive nuisance.

Yet despite the fact that this fuel costs them nothing, all of their steam pipes and boilers are protected with 85% Magnesia.

The reason is of course that the 85% Magnesia covering insures greater *efficiency*—that in place of a wet "soggy" vapor, their engines always have an ample supply of hot *dry steam.*

Where coal is scarce and dear, 85% Magnesia is also a marvellous fuel *saver*, but no matter what your fuel cost, whether high or low, you will find your operating conditions are always better, your steam supply always adequate, if you cover your pipes, boilers, flanges and fittings with this matchless heat insulation.

Write for the new Table of Actual Monthly Coal Saving in Dollars and Cents, prepared by the Mellon Institute of Industrial Research. To Engineers and Architects we will also send the Specification for the correct application of "85% Magnesia" coverings, compiled by the same institute.

MAGNESIA ASSOCIATION *of* AMERICA

85% MAGNESIA
UNIVERSAL COAL SAVER

**721 Bulletin Bldg.
Philadelphia
Penna.**

EXECUTIVE COMMITTEE, Wm. A. Macan, *Chairman*

George D. Crabbs, The Philip Carey Co., Cincinnati, Ohio
Alvin M. Ehret, Ehret Magnesia Mfg. Co., Valley Forge, Pa.
J. R. Swift, The Franklin Mfg. Co., Franklin, Pa.
R. V. Mattison, Jr., Keasbey & Mattison Co., Ambler, Pa.

Photo courtesy by W. H. Fleming, Birmingham, Ala.

Taft-Peirce Measuring Machine

Taft-Peirce Measuring Machine, F. J. B[illegible]. Inspector, vol. 1, no. 3, Aug. 15, 1919, pp. 9 and 17, 1 fig. For checking dimensions of plug gages and similar objects.

Tolerances

Tolerances as Affected by Workshop Conditions, A. Whitehead. Engineering, vol. 108, no. 2798, Aug. 15, 1919, pp. 201-203, 1 fig. Article deals with shafts and holes such as occur in motor chassis and smaller works under conditions associated with intensive production.

GAS ENGINEERING

Cleaning Gas

Cleaning Gas By Effective Method, George B. Cramp. Iron Trade Rev., vol. 65, no. 8, Aug. 21, 1919, pp. 506-507, 4 figs. Corrugated baffle plates built on interior of gas washer said to give large cleaning area and uniform condition throughout washer.

Distribution Under Pressure

Report on the Distribution of Gas under Pressure at a Distance (Rapport sur la distribution du gaz sous pression à distance), M. A. Schmidt. Bulletin de la Société Industrielle de Mulhouse, vol. 84, no. 6, June-July Aug. Sept. 1911, pp. 453-460, 1 fig. Question of economical distribution studied with reference to Monnier-Pohl expression. Diameter of conduit, pressure and quantity delivered.

Gas-Main Connection

Standardized Method for Connecting Gas Mains, Duncan D. Randsdell. Gas Age, vol. 44, no. 4, Aug. 15, 1919, pp. 137-139, 2 figs. Experience of Washington Gas Light Co. in cutting in sections of cast-iron gas mains.

Gas Production to Standards

Fuel Economy at the Apedale Works of the Midland Coal, Coke and Iron Company, Limited, William Hill and J. A. Cork. Iron & Coal Trades Rev., vol. 99, no. 2682, July 25, 1919, pp. 106-107. Special attention is said to be given to gas purification, regular heating value of gas, constant pressure of gas at engine stop valves, provision of circulating water at constant pressure and free from impurities, and means to enable foregoing conditions to be automatic. Paper read before North Staffordshire Inst. of Min. Engrs.

Great Britain

Present Conditions in the British Gas Industry, D. Milne Watson. Gas Age, vol. 44, no. 3, Aug. 1, 1919, pp. 97-98. Address delivered to British Board of Trade.

Low-Temperature Distillation

Low Temperature Distillation of Coal, C. M. Garland. Power, vol. 50, no. 7, Aug. 12, 1919, pp. 248-251, 4 figs. Recommends for power plants with constant load burning over 50 tons of coal per day, combination of low-temperature process with by-product gas producer to recover greater percentage of ammonium sulphate. Claimed economical advantages are pointed out.

Measurement of Gas

Electrical Method for Commercial Measurement of Gases, G. A. Sharland. Iron & Coal Trades Rev., vol. 99, no. 2680, July 11, 1919, pp. 37-38, 4 figs. Meter gives in standard units graphic record of actual amount of gas passing during any specific interval of time.

Natural Gas

Methods for More Efficiently Utilizing Our Fuel Resources—XXX, Samuel S. Wyer. Gen. Elec. Rev., vol. 22, no. 8, Aug. 1919, pp. 636-648, 11 figs. Natural gas.

Providence Gas Company

Manufacturing Plant of the Providence Gas Co.—III, Walter M. Russell. Chem. & Metallurgical Eng., vol. 21, no. 3, Aug. 1, 1919, pp. 147-153, 8 figs. Installation and operation of battery of 40 Koppers cross-regenerative, combination, by-products ovens. Coal and coke-handling apparatus. Paper read before Am. Inst. Chemical Engrs.

HANDLING OF MATERIALS

Coal Handling

Insuring Adequate Coal Supply with the Least Expenditure, George E. Wood. Elec. Ry. Jl., vol. 54, no. 7, Aug. 16, 1919, pp. 312-315, 10 figs. Layout of coal-handling equipment and storage facilities of Conn. Company at New Haven.

HEAT-TREATING

Steel

Some Remarks concerning the Heat Treatment of Steel and Their Application to the Treatment of Steels Used for Airplane Motors, Albert Sauveur. Jl. Franklin Inst., vol. 188, no. 2, Aug. 1919, pp. 189-197. Distinguishing between three treatments: softening treatment, strengthening treatment and hardening treatment.

Notes on Heat Treatment of Steel, T. D. Lynch. Proc. Engrs. Soc. of Western Pa., vol. 35, no. 5, June 1919, pp. 215-237 and (discussion), pp. 238-242, 11 figs. Materials of design; standardized treatments; results of standard heat treatment.

HEATING AND VENTILATION

District Heating System

The Transmission of Steam in a District Heating System by Means of High-Velocity Feeders, Norman W. Calvert. Heat. & Vent. Mag., vol. 16, no. 8, Aug. 1919, pp. 32-35, 3 figs. Notes connection for reducing flow velocity at end of feeder.

Fan Heating System

A Fan Heating System Installed Without the Use of Galvanized Iron, F. B. Rowley and John R. Allen. Heat. & Vent. Mag., vol. 16, no. 8, Aug. 1919, pp. 17-23, 11 figs. Temporary work at Univ. of Minn. while preparing building for prospective registration of 5,000 men in S. A. T. C.

Farm Building Ventilation

Farm Building Ventilation, W. B. Clarkson. Trans. Am. Soc. Agricultural Engrs., vol. 12, Dec. 1918, pp. 51-57. Asserts that there is need for more specialization on subject by those who will assume responsibility for good results.

Homes

Coal and Electricity Compared for the Heating of Homes. Heat. & Vent. Mag., vol. 16, no. 8, Aug. 1919, pp. 24-28. From report of Hydro-electric Power Commission of Ontario.

Oil Elimination from Condensation

Removing Oil from Condensation, Charles L. Hubbard. Domestic Eng., vol. 88, no. 7, Aug. 16, 1919, pp. 301-303 and 332. Devices eliminating oil from condensation in steam-heating systems. Their installation and operation.

Radiating Surface

Placing Hot Water Radiators Below Boiler Level, Wm. Hutton. Domestic Eng., vol. 88, no. 7, Aug. 16, 1919, pp. 297-299, 2 figs. Method of proportioning radiating surface to promote circulation at various levels.

Schools

The Mechanical Equipment of Washington School, Bayonne, New Jersey, Donald G. Anderson. Am. Architect, vol. 116, no. 2278, Aug. 20, 1919, pp. 251-256, 8 figs. Heating, ventilating and electric wiring.

Testing

Testing Modern Plumbing Installations, Robert J. Gordon. Domestic Eng., vol. 88, no. 7, Aug. 16, 1919, pp. 294-296, 5 figs. How to test sewers, drains, soil, waste and vent piping by water, air and smoke.

HOISTING AND CONVEYING

Conveyor Control

The Curtis Bay Pier of the B. & O. R. R.—II. Coal Trade Jl., vol. 50, no. 33, Aug. 13, 1919, pp. 985-986, 3 figs. Automatic control of conveyor and balancing pin described.

Conveyor, Portable

Modernizing Freight-Handling Methods. Iron Trade Rev., vol. 65, no. 6, Aug. 7, 1919, pp. 351-355, 6 figs. Illustrating uses of portable conveyors.

Crane, Breakdown

35-Ton Steam Breakdown Crane, Great Northern Railway, H. N. Gresley. Ry. Gaz., vol. 31, no. 4, July 25, 1919, pp. 118-119, 3 figs. Locomotive portion and jib supported upon ten-wheeled carriage; wheelbase of engine truck is 21 ft.; engine is equipped with two high-pressure cylinders.

Crane, Reinforced Concrete

Traveling Crane of Reinforced Concrete. Eng. & Contracting, vol. 52, no. 5, July 30, 1919, p. 127, 1 fig. Capacity three tons; span 32.8 ft. Translated from Génie Civil.

Cranes, Floating

The World's Largest Floating Cranes. Coal Trade Jl., vol. 50, no. 32, Aug. 6, 1919, pp. 956-957, 1 fig. Cranes with lifting capacity of 150 tons at radius of 105 ft. recently completed and installed at Navy Yards at Norfolk, Va., and Mare Island, Cal.

Cranes for Steel Works

Special Cranes with Electric Drive for Steel Works (Beispiele neuer elektrisch betriebener Spezialkräne für Stahlwerke), Ernst Blau. Elektrotechnik u. Maschinenbau, vol. 37, no. 9, Mar. 2, 1919, pp. 81-86, 7 figs. Scrap-iron loading crane with lifting magnet and tray arrangement and trough-charging crane of the Ardelwerke, Berlin.

Cranes, Quarry

Ship Cranes for Quarrying Operations. Rock Products, vol. 22, no. 16, Aug. 2, 1919, pp. 21-24, 13 figs. Features of pit-type quarry and crushing plants in Montreal.

Elevators, Electric

Future Possibilities of Push Button Control for Electric Elevators, Alexander Marks. Am. Architect, vol. 116, no. 2276, Aug. 6, 1919, pp. 187-194, 8 figs. Possibilities opened up by removal of mandatory restrictions against such type of operation, notably at New York City.

Grain Elevator

Portable Pneumatic Grain Elevator; Duckham System, George Frederick Zimmer. Engineering, vol. 108, no. 2797, Aug. 8, 1919, pp. 191-192, 7 figs. partly on two supplement plates. Mounted upon railway rolling stock.

Portable Grain Elevator. Engineering, vol. 108, no. 2796, Aug. 1, 1919, p. 145, 5 figs. Consists of hopper supported by three columns from wagon-type body.

Gravity Runways

The Utility of Gravity Runways. Ry. Gaz., vol. 31, no. 3, July 18, 1919, pp. 87-88. Notes on their application and operation.

Ore Unloader

An Automatic Iron-Ore Unloader. Eng. & Min. Jl., vol. 108, no. 8, Aug. 23, 1919, pp. 305-307, 3 figs. Wellman-Seaver-Morgan electrically driven machines used for the moving of cargoes from lake steamers to cars or stock-piles ready for shipment to furnaces.

Rock Conveyors

Roe's Patent Rope Conveyor, George Frederick Zimmer. Eng. & Indus. Management, vol. 2, no. 3, July 17, 1919, pp. 89-91, 5 figs. Total length is 1800 ft. It consists of two endless ropes running around a pair of edge sheaves at either terminal, the drive being taken through one pair while the other pair is mounted on a low trolley attached to tensioning arrangement.

Tipping Bucket

Refuse Tipping Bucket. Colliery Guardian, vol. 118, no. 3058, Aug. 8, 1919, pp. 373, 3 figs. Consists of bucket supported on angle-iron rings which rest on rollers fixed in frame provided with wheels that run upon track or roller to top of bing.

HYDRAULIC MACHINERY

Ontario Power Company's Plant

Extension to the Ontario Power Company's Plant. Elec. News, vol. 28, no. 16, Aug. 15, 1919, pp. 23-30, 15 figs. Features are wood-stave pipe 13½ ft. in diameter and 6700 ft. long, differential surge tank of 60 ft. outside diameter and 78 ft. high, and power house with walls designed to withstand 40 ft. rise in tail water. Added capacity is 30,000 kva.

Seewer Regulating System

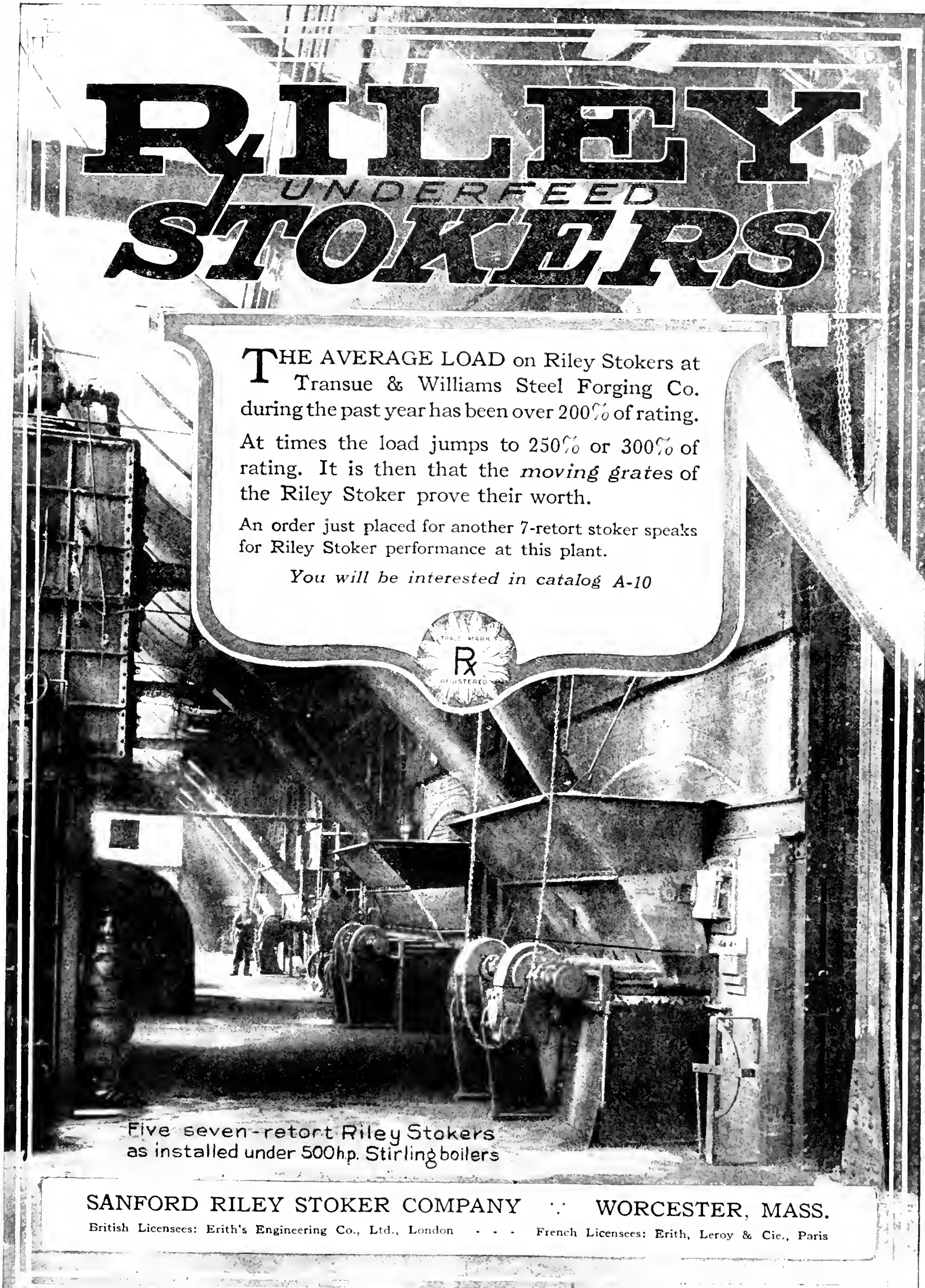
See Turbine Governors.

Turbine Design

Progress in Water-Turbine Design, A. H. Wilson and A. J. McDougall. Can. Engr., vol. 37, no. 8, Aug. 21, 1919, pp. 241-242. From annual report of Can. Elec. Association's Committee on Prime Movers.

Turbine Governors

Seewer's Universal Regulating System for High-Pressure Pelton Turbines (Universal-Regulierung System Seewer für Hochdruck Pelton Turbinen), Franz Prasil. Schweizerische Bauzeitung, vol. 73, no. 23, June 7, 1919, pp. 263-267, 9 figs. Curves, tables and tachograms of tests made.


RILEY
UNDERFEED
STOKERS
THE AVERAGE LOAD on Riley Stokers at Transue & Williams Steel Forging Co. during the past year has been over 200% of rating.
At times the load jumps to 250% or 300% of rating. It is then that the *moving grates* of the Riley Stoker prove their worth.
An order just placed for another 7-retort stoker speaks for Riley Stoker performance at this plant.
You will be interested in catalog A-10
TRADE MARK
RX
REGISTERED
Five seven-retort Riley Stokers as installed under 500h.p. Stirling boilers
SANFORD RILEY STOKER COMPANY WORCESTER, MASS.
British Licensees: Erith's Engineering Co., Ltd., London
French Licensees: Erith, Leroy & Cie., Paris

Turbine Testing Station

Turbine Testing Station of Mechanical Works at Vevey, S. A. Bulletin Technique de la Suisse Romande, vol. 45, no. 15, July 26, 1919, pp. 145-150, 2 figs. Built specially for connecting Francis types under all running conditions.

Water Hammer

Water Hammer in Conduits under Pressure (Note sur le calcul du coup de bélier dans les conduites sous pression). Bulletin Technique de la Suisse Romande, vol. 45, nos. 15 and 16, July 26 and Aug. 9, 1919, pp. 153-155 and 161-166, 12 figs. July 26: Application of theory to various examples. Aug. 9: Illustrating application of formulæ in actual computations.

INTERNAL-COMBUSTION ENGINES

Carburetors

Mathematical Study of Operation of Spray Constant Level Carburetors (Étude mathématique du fonctionnement des carburateurs à giclage et à niveau constant), M. Carbonaro. Génie Civil, vol. 75, no. 5 and 6, Aug. 2, 1919 and Aug. 9, 1919, pp. 96-99 and pp. 120-124, 7 figs. Laws of flow of gasoline through capillary passages. Relation between gasoline-air ratio and depression caused by motor in admission pipe. (To be continued).

The Zephyr Carburetter. Autocar, vol. 43, no. 1240, July 26, 1919, pp. 131-132, 4 figs. Operates on submerged jet principle.

Engine Tests

Some Experiments on a Small Engine, Harry R. Ricardo. Automobile Engr., vol. 9, no. 129, Aug. 1919, pp. 236-240, 6 figs. Tests to investigate performance of Continental engine as fitted to Morris-Crowley car.

Hot Spot

Accessibility and Hot Spot Device for Vaporizing of Fuel Feature New Gray Truck Engine. Commercial Vehicle, vol. 21, no. 1, Aug. 1, 1919, pp. 28-29, 3 figs. Engine is of valve-in-head type.

Marine Oil Engines

The Ansaldo-San Giorgio Marine Oil Engine. Engineering, vol. 108, no. 2794, July 18, 1919, pp. 80-82, 1 fig. Four-cylinder two-cycle type with valve-controlled port scavenging.

Rotary and Radial Engines

Rotary and Radial Engines, T. L. Sherman. Automobile Engr., vol. 9, no. 129, Aug. 1919, pp. 248-249. Comparative review of dynamic and various minor problems as they effect these two types.

Starters

A New Development in Motor Starters. Engineer, vol. 128, no. 3315, July 11, 1919, pp. 32-33, 7 figs. "Navy" type starter designed for submarine work.

Tars, Raw, as Fuel

The Use of Raw Tars as Fuels for Diesel Engines, Harold Moore. Engineering, vol. 108, no. 2797, Aug. 8, 1919, pp. 167-168. Summary of chemical and physical properties of tar oils and of practical experience of their behavior in Diesel engines.

Thermal Efficiency, Limits

The Limits of Thermal Efficiency in Internal Combustion Engines, Dugald Clerk. Engineering, vol. 108, nos. 2794, 2795, 2796, July 18, 26 and Aug. 1, 1919, pp. 77-79, 130-132 and 157-159, 22 figs. July 18: Technical discussion of future possibilities of obtaining motor power by gas and liquid fuel in most effective manner. July 25: Variation of engine weight with increasing dimensions. Aug. 1: Determination of heat loss and varying specific heat of flame and products of combustion in engine cylinder by Clerk zigzag diagram. Also abstracted in Engineer, vol. 128, no. 3315, July 11, 1919, pp. 40-42, 1 fig.

LUBRICATION

Bearing Lubrication

Oiling and Lubricating Devices, Otto Abdt. Machy. (N. Y.), vol. 25, no. 12, Aug. 1919, pp. 1146-1147, 4 figs. Some methods of lubricating inaccessible bearings.

MACHINE ELEMENTS AND DESIGN

Crank Analysis

An Analysis to Distinguish Between a Crank and an Eccentric as Driving or Driven Elements, H. S. Dickinson. Trans. Am. Soc. Agricultural Engrs., vol. 12, Dec. 1918, pp. 96-124, 18 figs. Formula and diagrams comparing resultant moments.

Riveted Joints

Riveted Joints for Steel Penstocks and Tanks, H. A. Babcock and J. R. Montagne. Can. Engr., vol. 37, no. 6, Aug. 7, 1919, pp. 195-200, and 209, 8 figs. Formula and tables of their design. Examples of solution of maximum joint efficiency.

Roller Bearings

Roller Bearing Types and Applications. Raw Material, vol. 1, no. 5, July 1919, pp. 265-267, 7 figs. Construction features of various makes of roller bearings and their applications to various types of machinery and machine tools. (To be continued).

Screw Grading

A Pitch Engagement System of Grading Screws. Machy. (Lond.), vol. 14, no. 357, July 31, 1919, pp. 529-532, 5 figs. Screw threads graded on number of threads in engagement.

MACHINE SHOP

Gear-Cutting Machines, Setting Operations

Setting Operations on Gear-Cutting Machines, Fred Horner. Machy. (Lond.), vol. 14, no. 357, July 31, 1919, pp. 521-527, 29 figs. As practiced at various English shops and at works of Oerlikon Machine Tool Co. of Switzerland.

Grinding Cutters

Latest Practice in Cutter Grinding—III, IV & V. Am. Mach., vol. 51, nos. 6, 7 & 8, Aug. 7, 14 & 21, 1919, pp. 251-254, 323-325, and 369-371, 24 figs. Angular cutter grinding and grinding of form cutters and taps. Modern practice in hand and chucking reamer grinding for steel, cast iron and bronze; tables giving vertical adjustment for above center for both cutting clearance and second clearance. Methods used by Cincinnati Milling Co. in grinding hand reamers for steel and also chucking reamers for cast iron, bronze, or steel, both roughing and finishing. (Concluded.)

Motor-Truck Repair Work

Equipment Required for Upkeep of 54 Gasoline Trucks, George Heron. Commercial Vehicle, vol. 21, no. 2, Aug. 15, 1919, pp. 52-55, 8 figs. Itemized list of machines used for repair work.

Plano-Milling Practice

Plano-Milling Practice in Automobile Plants —II. Machy. (Lond.), vol. 14, no. 355, July 17, 1919, pp. 461-465, 9 figs. Milling operations on cylinder blocks and heads of typical American engines.

Small-Shop Work

General Work in the Small Shop—XXII. Mech. World, vol. 66, no. 1698, July 18, 1919, pp. 26-27, 6 figs. Cutting of wormwheels to suit V-thread worms. (Continuation of serial).

Standardized Part Production

Jigs, Tools, and Special Machines with Their Relation to the Production of Standardized Parts, H. C. Armitage. Mech. World, vol. 66, no. 1699, July 25, 1919, pp. 39-40, 4 figs. Comparative cost results between three schemes small production, large production and maximum production. (Concluded.)

MACHINERY, METAL-WORKING

Chucking and Turning Machines

Semi-Automatic Chucking and Turning Machine. Machy. (Lond.), vol. 14, no. 355, July 17, 1919, pp. 472-474, 7 figs. Swing of 12¼ in. diameter over bed or 8 in. diameter over cross slide is possible and turning limit is 8 in. diameter with standard tools supplied.

Crankshaft Lathe

A Record Smashing Crankshaft Lathe, Ethan Viall. Am. Mach., vol. 51, no. 9, Aug. 28, 1919, pp. 395-399, 8 figs. For machining sides of webs and turning ends of crankpins on all of throws at the same time. Machining time is claimed to be reduced from thirty to two days.

Drill Heads

Novel Portable Electrical Drill Heads, Frank C. Perkins. Can. Machy., vol. 22, no. 7, Aug. 14, 1919, pp. 177-178, 4 figs. Operation of English and German types illustrated.

Grinding Machines

Machine and Fitting Shop Practice, Fred Horner. Mech. World, vol. 66, no. 1699, July 25, 1919, pp. 38-39, 5 figs. Types used in internal grinding machines. (Continuation of serial.)

Hand Tools

Portable Motor-Driven Hand Tools for Wood and Metal Working. Elec. Rec., vol. 26, no. 2, Aug. 1919, pp. 91-97, 33 figs. Details concerning construction and operating features.

Lathes

Recent Machine Tool Developments—II & III, Joseph Horner. Engineering, vol. 108, no. 2794 and 2797, July 18 and Aug. 8, 1919, pp. 70-73 and 172-176, 46 figs. Forms of beds, legs, standards, framings, slides, and tool and work supports. Illustrating typical example of longitudinal outlines of lathe beds, legs and equipment.

See also Crankshaft Lathe.

The Design and Construction of a 4½-in. Lathe Tail-stock. Model Eng. & Elecn., vol. 41, no. 951, July 17, 1919, pp. 61-64, 4 figs. Operations required in construction and fitting of tailstock to old lathe. (To be continued.)

Milling Machines

Tilted Rotary Milling Machine. Machy. (Lond.), vol. 14, no. 355, July 17, 1919, pp. 481-484, 5 figs. In addition to allowing machine to be used as continuous rotary miller, provision is made for using it as indexing machine.

Tooling Equipment for Piston Rings

Tooling Equipment for an Automobile Piston Ring. Machy. (Lond.), vol. 14, no. 355, July 17, 1919, pp. 475-477, 7 figs. Performing two operations—splitting on each side and peening until strung together—at one time.

Vice

"Fland" Machine Vice. Engineering, vol. 108, no. 2796, Aug. 1, 1919, pp. 140-141, 13 figs. Constructed on "three point of suspension" principle, usually two jaws of vice being replaced by three sliding blocks.

MACHINERY, SPECIAL

Farm Machinery

A Study of the Plow Bottom and Its Action upon the Furrow Slice, E. A. White. Trans. Am. Soc. Agricultural Engrs., vol. 12, Dec. 1918, pp. 42-50, 13 figs. Machine for studying mathematical action of plow bottoms.

See also Equalizers and Hitches.

Draft Tests of Farm Machiery, E. J. Stirniman. Trans. Am. Soc. Agricultural Engrs., vol. 12, Dec. 1918, pp. 9-25. Result of series of drawbar tests and power required to operate various power machines.

Plow Bottom Design, C. A. Bacon. Trans. Am. Soc. Agricultural Engrs., vol. 12, Dec. 1918, pp. 26-40, and (discussion) pp. 40-42, 10 figs. It is observed that search for material that would withstand erosive influence of silicon led to manufacture of chilled plow. Reference is made to experiments with different shaped plow bottoms.

Standardization of Farm Machinery, A. B. Dinneen. Trans. Am. Soc. Agricultural Engrs., vol. 12, Dec. 1918, pp. 151-159. Review of accomplishments.

Gimbals

Gimbal Stabilization, V. Bush. Jl. Franklin Inst., vol. 188, no. 2, Aug. 1919, pp. 199-215, 9 figs. Analysis of effectiveness of gimbals of various designs for maintaining horizontal platform on shipboard and of gyroscopic stabilizing of such devices.

Gun, Machine, Tripod

High-Production Tooling Methods as Applied to the Machine-Gun Tripod, Model 1918—II, Albert A. Dowd and Donald A. Baker. Am. Mach., vol. 51, no. 9, Aug. 28, 1919, pp. 401-407, 7 figs. Tools for machining pintle.

Pintle Machining

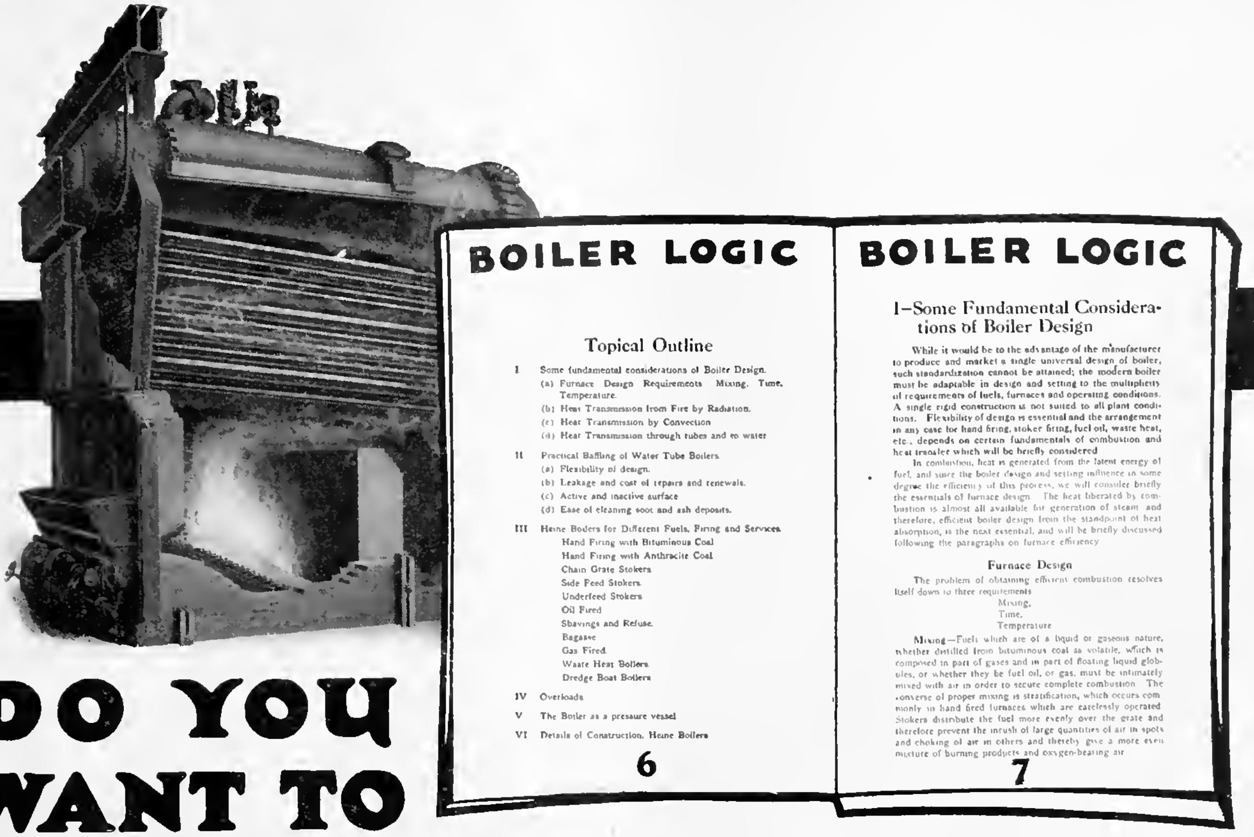
See Gun, Machine, Tripod.

Plow Bottoms

See Farm Machinery.

Sine Bars

Universal Sine Bar for the Toolmaker, J. B. Gray. Machy. (N. Y.), vol. 25, no. 12, Aug. 1919, pp. 1159-1162, 8 figs. Also Machy. (Lond.), vol. 14, no. 357, July 31, 1919, pp. 533-535, 8 figs. Method of making, and application to various classes of precision work.



BOILER LOGIC

Topical Outline

I Some fundamental considerations of Boiler Design.
(a) Furnace Design Requirements Mixing, Time, Temperature.
(b) Heat Transmission from Fire by Radiation.
(c) Heat Transmission by Convection
(d) Heat Transmission through tubes and to water

II Practical Baffling of Water Tube Boilers.
(a) Flexibility of design.
(b) Leakage and cost of repairs and renewals.
(c) Active and inactive surface
(d) Ease of cleaning soot and ash deposits.

III Heine Boilers for Different Fuels, Firing and Services.
Hand Firing with Bituminous Coal
Hand Firing with Anthracite Coal
Chain Grate Stokers
Side Feed Stokers.
Underfeed Stokers
Oil Fired
Shavings and Refuse.
Bagasse
Gas Fired.
Waste Heat Boilers.
Dredge Boat Boilers

IV Overloads

V The Boiler as a pressure vessel

VI Details of Construction, Heine Boilers

6

BOILER LOGIC

1–Some Fundamental Considerations of Boiler Design

While it would be to the advantage of the manufacturer to produce and market a single universal design of boiler, such standardization cannot be attained; the modern boiler must be adaptable in design and setting to the multiplicity of requirements of fuels, furnaces and operating conditions. A single rigid construction is not suited to all plant conditions. Flexibility of design is essential and the arrangement in any case for hand firing, stoker firing, fuel oil, waste heat, etc., depends on certain fundamentals of combustion and heat transfer which will be briefly considered

In combustion, heat is generated from the latent energy of fuel, and since the boiler design and setting influence in some degree the efficiency of this process, we will consider briefly the essentials of furnace design. The heat liberated by combustion is almost all available for generation of steam and therefore, efficient boiler design from the standpoint of heat absorption, is the next essential, and will be briefly discussed following the paragraphs on furnace efficiency

Furnace Design

The problem of obtaining efficient combustion resolves itself down to three requirements

Mixing,
Time,
Temperature

Mixing—Fuels which are of a liquid or gaseous nature, whether distilled from bituminous coal as volatile, which is composed in part of gases and in part of floating liquid globules, or whether they be fuel oil, or gas, must be intimately mixed with air in order to secure complete combustion. The converse of proper mixing is stratification, which occurs commonly in hand fired furnaces which are carelessly operated. Stokers distribute the fuel more evenly over the grate and therefore prevent the inrush of large quantities of air in spots and choking of air in others and thereby give a more even mixture of burning products and oxygen-bearing air

7

DO YOU WANT TO KNOW—

Why the boiler is not subjected to greater stress when overloaded?

How vertical and horizontal baffles affect boiler operation?

Why the header or waterleg construction influences free circulation in a steam boiler?

How to reduce dead corners and increase the percentage of active boiler heating surface?

Why efficient combustion depends on mixing, time and temperature?

✦ BOILER LOGIC TELLS HOW ✦

It gives all this information and more of practical value to the Chief Engineer interested in steam boilers, boiler theory and boiler practice.

Your copy is ready—send for it
Mail the coupon today

HEINE SAFETY BOILER CO.

5321 Marcus Ave., St. Louis, Mo.

✦ ***Return Coupon*** ✦

HEINE SAFETY BOILER COMPANY, 5321 Marcus Ave., St. Louis, Mo.

Without obligation or cost to me please send a copy of Boiler Logic to

Name ....Position ....

Firm ....Address ....

Steam-Hammer Work

Hand Tools for Steam Hammer Work, A. S. Hesse. Am. Mach., vol. 51, no. 6, Aug. 7, 1919, pp. 247-250, 19 figs. Auxiliary equipment needed for such operations as flanging, pressing, stamping, bending, shearing, drop forging etc.

Tube-Shaping Machine

Forming Machine for Shaping Steel Tubes. Blast Furnace & Steel Plant, vol. 7, no. 8, Aug. 1919, pp. 369-372, 2 figs. Work is spun while applied against nest of three rolls. Machine for forming various shapes of noses in steel cylinders and tanks suitable for commercial transportation of explosive gases and liquids.

Vacuum Evaporators

Industrial Vacuum Evaporators. N. Frank Coxon. Mech. World, vol. 66, no. 1698, July 18, 1919, p. 30, 2 figs. Concerning sizes of steam and vapor pipes. (Concluded.)

MACHINERY, WOODWORKING

Pattern Manufacture

Wood Patterns Made in a Factory. Iron Trade Rev., vol. 65, no. 7, Aug. 14, 1919, pp. 429-431, 4 figs. How shop was organized for quantity production.

MATERIALS OF CONSTRUCTION AND TESTING OF MATERIALS

Boiler Plates

Physical Tests of Boiler-Steel Plates, Frederick Biggam. Power, vol. 50, no. 7, Aug. 12, 1919, pp. 252-253. Instances quoted to show that despite persistence with which bending tests recur in amended rules of inspection societies, "these tests . . . have not the finality that such persistence would seem to imply."

Exposure Tests of Sheeting Material

Exposure Tests of Sheeting Material, Samuel L. Hoyt. Chem. & Metallurgical Eng., vol. 21, no. 3, Aug. 1, 1919, pp. 142-144, 7 figs. Tests are interpreted as indicating that best sheeting material is copper-bearing steel with 0.20 to 0.25 per cent copper.

Fatigue in Metals

Fatigue Phenomena in Metals. Mech. Eng., vol. 41, no. 9, Sept. 1919, pp. 731-738, 7 figs. Summary of available facts and theories relating to fatigue failure and discussion of some unsolved problems. Progress report of Committee on Fatigue Phenomena in Metals, which is acting under joint auspices of Eng. Foundation, and Div. of Eng. of Nat. Research Council.

A Fatigue Testing Machine, F. M. Farmer. Am. Mach., vol. 51, no. 6, Aug. 7, 1919, pp. 271-273, 4 figs. Apparatus developed at electrical testing laboratories for Research Sub-Committee of Welding Committee of the Emergency Fleet Corporation. Purpose was to obtain information in regard to relative durability of electrically welded joints in ½-in. ship plates when subjected to repeated reversed stresses.

Firebrick Testing

A Machine for Testing the Hot-Crushing Strength of Firebricks, H. G. Schurecht. Jl. Am. Ceramic Soc., vol. 2, no. 8, Aug. 1919, pp. 602-607, 7 figs. partly on supp. plate. Designed by Bureau of Mines.

Foundry Materials

Foundry Materials (Die Materialien der Giesserei), E. Schutz. Zeitschrift f. die gesamte Giessereipraxis, vol. 40, no. 6, Feb. 8, 1919, pp. 66-68. Vanadium, ferrovanadium. Specific weights and analysis.

Hardness Measurement

Some Recent Advances in the Measurement of Hardness in Metals, F. C. Thompson. Jl. Soc. Chem. Indus., vol. 38, no. 13, July 15, 1919, pp. 241R-243R. Account of recent investigations, noting tendency to modify Brinell test by working with constant deformation.

Malleable Iron

What is Modern Malleable Iron, H. A. Schwartz. Ry. Mech. Engr., vol. 93, no. 8, Aug. 1919, pp. 479-481. Sketch of methods of manufacture and characteristics of material.

Manganin

Manganin, M. A. Hunter and J. W. Bacon. Thirty-six General Meeting of Am. Electro-Chem. Soc. Sept. 23, 1919, advance copy, paper no. 2, pp. 9-21, 3 figs. Experiments for measuring effect of small variations in percentage of manganese, nickel and iron and electrical resistivity and on temperature coefficient of resistivity. Writers conclude that small variations in manganese affect resistance but not its temperature coefficient and that small quantities of iron affect temperature coefficient considerably.

Notched-Bar Resistance

Resistance of Notched Bars to Shock (Sur les essais de flexion par choc de barreaux entaillés), André Cornu-Thénard. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 26, June 30, 1919, pp. 1315-1318. Tests cited as having shown that within limits of testing machines generally used in France, action of velocity may be considered as practically negligible.

Paper, Waterproofed

The Industrial Possibilities of Waterproofed Paper Products, Judson A. DeCew. Jl. Eng. Inst. Can., vol. 2, no. 8, Aug. 1919, pp. 558-559. It is considered as very difficult to make a paper product that will not absorb moisture and thus expand and contract to some extent. It is asserted, however, that paper and board can, without difficulty, be made so that it will resist further penetration or absorption of water after their fibres have taken up a quantity of moisture equal to about one-fifth their weight. This is considered sufficient for commercial uses.

"Stainless" Steels

Corrosion Proof Steels, F. Rowlinson. Sci. Am., vol. 121, no. 7, Aug. 16, 1919, p. 156. Present uses of nickel steels, copper steels, nickel-copper steels and chromium "stainless" steels.

Steel, Mechanical Properties of

The Various Mechanical Properties of Steel. W. H. Hatfield. Can. Machy., vol. 22, no. 8, Aug. 21, 1919, pp. 204-205, 2 figs. Takes up consideration of question of brittleness, together with investigation of failures of various kinds. (Continuation of serial.)

Mechanical Properties of Steel and Iron. Iron Age, vol. 104, no. 9, Aug. 28, 1919, pp. 565-568. Compilation made public by Bur. of Standards to secure criticism for purposes of revision.

MEASUREMENTS AND MEASURING APPARATUS

Acceleration Determination

An Apparatus for the Direct Determination of Accelerations, B. Galitzin. Proc. Roy. Soc., vol. 95, no. A 673, July 15, 1919, pp. 492-507, 8 figs. Instantaneous value of acceleration due to any arbitrary function determined by means of simple pendulum.

See also Accelerograph.

Accelerograph

Accelerograph (Sur un accélérographe), Auclair and Boyer-Guillon. Comptes rendus des séances de l'Académie des Sciences, vol. 169, no. 1, July 7, 1919, pp. 24-26, 3 figs. For measuring periodic movement without having fixed points of reference, for example, vibrations of a ship's deck.

Air Meters

See Meters.

Calibration of Instruments

The Calibration Function in Indicating Instruments, Frederick J. Schlink. Engineering, vol. 108, no. 2798, Aug. 15, 1919, pp. 204-106, 4 figs. The relation of apparent to virtual calibration function.

Calorimeters

An Adiabatic Bomb Calorimeter, E. B. Holland, J. C. Reed, and J. P. Buckley. Chem. & Metallurgical Eng., vol. 21, no. 4, Aug. 15, 1919, pp. 190-191, 1 fig. Adapting Berthelot Mahler Kroecker calorimeter to control of temperature required in adiabatic work by fitting it with double-walled copper jacket.

Coal Weighing

Weighing Methods for Boiler Plants. Coal Trade Jl., vol. 50, no. 34, Aug. 20, 1919, pp. 1015-1017, 2 figs. Descriptions of various methods and devices for use in weighing coal consumed at boiler plants.

Dynamometers

Commercial Dynamometers—XIII, P. Field Foster. Mech. World, vol. 66, no. 1699, July 25, 1919, pp. 13-14, 8 figs. Bevis and Gibson flash-light meter built on optical principle. (Continuation of serial.)

Gas Meters

See Meters.

Indicators

Indicator and Indicator Diagram (Der Indikator und das Indikatordiagramm), W. Wilke. Prometheus, vol. 27, no. 30, Apr. 22, 1919, pp. 472-476, 11 figs. Construction of recent types, with special reference to those made by Rosenkranz, Schaffer & Budenberg, Lehmann & Michels and Maihak.

Meters, Air and Gas

Differential Pressure Meters for Measuring Air, Gas and Steam Flows, John L. Hodgson. Chem. Industry, vol. 38, no. 14, July 31, 1919, pp. 222T-228T, 8 figs. "Curved tube" manometer developed by writer for use with pitot tube. It consists of reservoir containing oil, which is connected to upstream pressure hole and curved tube connected to downstream pressure hole, and so shaped that equal increments in velocity past pitot tip will cause equal movements of oil meniscus along its length.

Micrometer, Fluid Gage

The Prestometer Fluid Gage, Charles E. Coats. Inspector, vol. 1, no. 3, Aug. 15, 1919, pp. 5-8, 10 figs. Liquid micrometer gage. Deflection of center of diaphragm causes liquid to leap up in tube. Least count of instrument said to be 0.001 in.

Prestometer Gage

See Micrometer, Fluid Gage.

Pyrometers

Temperature Indicating and Controlling Systems, Franklin D. Jones. Machy. (N. Y.), vol. 25, no. 12, Aug. 1919, pp. 1138-1145, 16 figs. Pyrometers for controlling furnace temperatures automatically and for recording the temperature variations in a single furnace or in several furnaces which are successively connected with the recording instrument. Second article.

Devices and Methods for Measuring High and Low Temperatures with Special Reference to Engineering Problems, Herman Henry Albers. Stevens Indicator, vol. 36, no. 2, April 1919, pp. 67-103, 31 figs. Classified and discussed according to basic principles upon which they operate. Recommendations offered for selecting instrument or method best suited for various specific purposes.

Scales

See Coal Weighing.

MECHANICS

Acceleration, Infinite

Infinite Acceleration, A. Johnson. Automobile Engr., vol. 9, no. 129, Aug. 1919, pp. 245-246, 1 fig. Technical illustration of serious character of stresses developed in mechanism, notably of kind where operation of cams is involved, when velocity of part is suddenly changed from zero to some finite magnitude.

Beams, Ferro-Concrete

The Design of Continuous Beams in Ferro-Concrete, H. Brodrick. Soc. Engrs., vol. 10, no. 6, 1919, pp. 199-211, 8 figs. partly on supp. plate. Review of comparison of methods adopted by different designers particularly in dealing with question of minimum deformation.

Catenary

The Catenary in Engineering (Die Kettenlinie im Ingenieurwesen), J. Brunner. Schweizerische Bauzeitung, vol. 74, no. 2, July 12, 1919, pp. 13-14, 5 figs. Practical application in constructions involving long stretched cables, chains or wires.

Centrifugals, Sugar, Pressure in

Pressure in Sugar Centrifugals, J. J. Munson. Sugar, vol. 21, no. 8, Aug. 1919, pp. 410-411, 1 fig. Calculation of factors which determine total pressure exerted on top of centrifugal.

Columns, Engine

The Design of Engine Columns—I, W. K. Wilson. Mach. World, vol. 66, no. 1701, Aug. 8, 1919, p. 66, 2 figs. Calculation of bending stresses.

Crankshaft, Whirling

The Whirling of a Crankshaft, J. Morris, Aeronautics, vol. 17, no. 299, July 10, 1919, pp. 15-46, 2 figs. Illustrates method of determining whirling speed by application to case of single-cranked crankshaft.

Graphical Velocity of Shaft (Velocità critiche), P. E. Brunelli. Revista Marittima, vol. 52, no. 6, June 30, 1919, pp. 307-344, 6 figs. Calculations and formulæ.

To cut down the cost per cut

A Matter of Teeth

The efficiency of a hack saw blade depends almost entirely upon the rake, the "set," and the pitch or number of teeth to the inch.

There's no overhanging "hook" to the teeth on a Starrett blade. With proper adjustment of weight or pressure, they'll cut just as fast on the last cut as on the first. The teeth are uniform in shape, "set" and spacing. That's why every blade in a box of Starrett saws cuts alike.

Starrett Hack Saws are made in varying pitches or number of teeth to the inch, from 10 to 32, according to the work they are intended for.

Different kinds and shapes of metal need different blades for economical cutting. Get Starrett blades, use them according to the Starrett Hack Saw Chart and watch your cost per cut decrease. Write for Catalog No. 21 "LD," it's free.

THE L. S. STARRETT CO.
The World's Greatest Toolmakers
Manufacturers of Hack Saws Unexcelled
ATHOL, MASS.

the blade

Starrett Hack Saws Cut Quicker Last Longer

Use Starrett Hack Saw Blades

42-93

Equalizers and Hitches

Equalizers and Hitches, E. A. White. Trans. Am. Soc. Agricultural Engrs., vol. 12, Dec. 1918, pp. 124-135, 11 figs. Mechanical analysis of distribution of pull between draft animals.

See also Farm Machinery.

Hitches

See Equalizers and Hitches.

Knife Edges Under Pressure

The Form of Knife Edges Under Pressure, C. A. Briggs. Scale Jl., vol. 5, no. 11, Aug. 10, 1919, p. 7, 3 figs. Experiments made with gelatin cubes placed against gelatin plate interpreted as representing on highly magnified scale what takes place with steel knife edges.

Plane Lamina, Two-Dimensional Motion

The Two-Dimensional Motion of a Plane Lamina in a Resisting Medium, S. Brodetzky. Proc. Roy. Soc., vol. 95, no. A-673, July 15, 1919, pp. 516-532, 9 figs. Mechanics of problem.

Shafts, Critical Speed

See also Crankshafts, Whirling.

Stresses

See Acceleration, Infinite.

Stress, Combined, Theory

Practical Application of the Combined Stress Theory, N. Barnes Hunt. Machy. (N. Y.), vol. 25, no. 12, Aug. 1919, pp. 1171-1172. Formula based upon true stresses in structural members and applicable to cases where an axial tensile or compressive stress acts in combination with a transverse shearing stress. Reference is made to Mansfield Merriman's Mechanics of Materials, and discussion of combined stresses by A. Lewis Jenkins in Jl. Am. Soc. Mech. Engrs. for August 1917.

Wet Sand, Angle of Repose

On the Angle of Repose of Wet Sand, A. G. Webster. Proc. Nat. Acad. Sciences, vol. 5, no. 7, July 1919, pp. 263-265, 1 fig. Experiments gave 33 deg. for dry sand and various other values for moist sand, including 12 deg. for composition of 10 lb. of sand and 5 lb. water.

MECHANICAL PROCESSES

Abrasive Wheels

The Manufacture of Abrasive Wheels, S. C. Linbarger. Jl. Am. Ceramic Soc., vol. 2, no. 8, Aug. 1919, pp. 638-646. Account of process.

Drying

Drying by Heat in Conjunction with Mechanical Agitation and Spreading, Eustace A. Alliott. Jl. Soc. Chem. Indus., vol. 38, no. 13, July 15, 1919, pp. 173T-183T, and (discussion) pp. 183T-185T, 24 figs. Report of experiments performed to determine influence of both initial and final moisture on length of drying and other factors.

Glass Pots

Note on the Casting of Porcelain Glass Pots, J. W. Wright and D. H. Fuller. Jl. Am. Ceramic Soc., vol. 2, no. 8, Aug. 1919, pp. 659-663. Mixtures used in Pittsburgh Laboratory by Bur. of Standards.

The Equipment of a Casting Plant for the Manufacture of Glass Pots, Frank H. Riddle. Jl. Am. Ceramic Soc., vol. 2, no. 8, Aug. 1919, pp. 647-658, 5 figs. Proposed plans for plant suitable for casting ten 600-lb. glass pots per day.

Hot-Rolling

Theories of Hot Rolling (Les théories du laminage à chaud), P. Maringer. Revue Universelle des Mines, de la Métallurgie, vol. 1, no. 2, Feb. 1919, pp. 177-308, 105 figs. Physical study of phenomena which takes place in steel. (To be continued.)

Interchangeable Manufacture

Principles of Interchangeable Manufacturing-I, Earle Buckingham. Machy. (Lond.), vol. 14, no. 355, July 17, 1919, pp. 466-471. Economy of interchangeable manufacturing. Design as it affects success in interchangeable manufacturing. Manufacturing tolerances. Production problems as related to interchangeable manufacturing.

Internal Gear, Williams

The Williams Internal Gear, Reginald Trautschold. Am. Mach., vol. 51, no. 6, Aug. 7, 1919, pp. 255-258, 4 figs. Notes on manufacture of Williams gear and its comparison with other forms in regard to economy and simplicity.

Machinery, Various, Manufacture of

Manufacture of Machinery at Plant of C. F. Braun & Company. Metal Trades, vol. 10, no. 8, Aug. 1919, pp. 339-343, 18 figs. Company manufactures pumps, both reciprocating and centrifugal, heat exchanges, including condensers, feedwater heaters, oil coolers and heaters, cooling towers, evaporators, and smaller specialties.

Motorcycles

Motorcycle Production has peculiar problems, P. M. Heldt. Automobile Industries, vol. 41, no. 6, Aug. 7, 1919, pp. 259-264, 17 figs. Methods of forming side-car panels and electroplating installation mentioned as peculiar to this industry.

Roller Bearings

Making Roller Bearings—I. Machy. (Lond.), vol. 14, no. 356, July 24, 1919, pp. 498-503, 13 figs. Methods of heat-treating and inspecting Timken roller bearings.

Sheet Manufacture

Features of the Iron and Steel Sheet Industry. Raw Material, vol. 1, no. 5, July 1919, pp. 255-260, 6 figs. Recommends careful selection of base metal in sheet bars. (To be continued).

Manufacture of Sheet Iron in South Russia (La Fabrication des toles minces dans la Russie méridionale). Génie Civil, vol. 75, no. 2, July 12, 1919, pp. 34-36, 2 figs. Scheme showing arrangement of machines at works at Briansk and Taganrog. (Concluded.)

Sprocket Chain

Making Diamond Sprocket Chain, Edward K. Hammond. Machy (N. Y.), vol. 25, no. 12, Aug. 1919, pp. 1165-1170, 9 figs. Operations involved in making no. 9 bicycle chain at works of Diamond Chain & Mfg. Co., Indianapolis. Number corresponds to standards prepared by Chain Standards Committee of Am. Soc. Mech. Engrs. and Soc. Automotive Engrs. First of two articles.

Turbo-Gear Manufacture

Turbo-Gear Manufacture, E. A. Suverkrop. Am. Mach., vol. 51, no. 8, Aug. 21, 1919, pp. 357-363, 22 figs. By Poole Eng. and Machine Co., of Baltimore. Mechanism is of planet internal-ring gear type and is comparatively light in weight.

Turbine, Small Steam, Manufacture

Problems in Designing Small Turbines for Industrial Purposes, Sanford A. Moss. Gen. Elec. Rev., vol. 22, no. 8, Aug. 1919, pp. 620-630, 19 figs. Manufacture on quantity basis of type L turbines from standardized and interchangeable parts.

Wheels, Cast-Iron

The Manufacture of Cast Steel Road Wheels. Engineer, vol. 128, no. 3314, July 4, 1919, pp. 5-6 and 12, 11 figs. Foundry at works of Thwaites Brothers, Ltd., of Bradford, England. It is said that during war material used for casting consisted of some 80 per cent of steel turnings, remainder being scrap.

Williams Internal Gear

See Internal Gear.

MOTOR-CAR ENGINEERING

Albion

The Albion 30 Cwt. Chassis. Motor Traction, vol. 29, no. 750, July 16, 1919, pp. 47-48, 5 figs. Design allowing of alternative gears to suit different purposes.

Austin

The New 20 h.p. Austin. Autocar, vol. 43, no. 1241, Aug. 2, 1919, pp. 161-165, 13 figs. Specifications: Four cylinders, 95 x 127 mm. bore and stroke (3601 cc.); unit construction, light balanced reciprocating parts; single-plate clutch; spiral bevel final drive; semi-elliptic springs.

British Tractors

Originality in Design Shown in New British Tractors. Automotive Industries, vol. 41, no. 6, Aug. 7, 1919, pp. 253-255, 4 figs. Notes on tractor exhibit at Annual Show of Royal Agricultural Society.

Caterpillar Vehicle, Steering of

Steering of Caterpillar Vehicles (Das Steuern von Raupenfahrzeugen), E. Seiler. Motorwagen, vol. 22, no. 9, Mar. 31, 1919, pp. 162-164, 4 figs. Difficulties in short curves considered as due to impossibility of entirely cutting out one of caterpillars and braking it efficiently, so that vehicle can turn when other caterpillar chain is accelerated.

Cleveland

Specially Designed Engine and Axle for Cleveland Car. Automotive Industries, vol. 41, no. 7, Aug. 14, 1919, pp. 304-306, 7 figs. Engine is six-cylinder, block-cast, with overhead valve; camshaft is in crankcase and valves in line in head assembly.

Darracq

The New 15 h.p. Darracq. Autocar, vol. 43, no. 1241, Aug. 2, 1919, pp. 177-178, 5 figs. Features of 1919 model of French firm.

Enfield-Allday

Unconventional Design of a British After-War Car. Automotive Industries, vol. 41, no. 7, Aug. 14, 1919, pp. 312-315, 7 figs. Enfield-Allday with five-cylinder, radial, air-cooled engine.

A British Light Car. Engineer, vol. 128, no. 3315, July 11, 1919, pp. 40-41, 5 figs. Fitted with five-cylinder, radial air-cooled engine. Chassis weighs 7 cwt.

Kerosene for Farm Tractors

Kerosene as a Fuel for Farm Tractors, John A. Secor. Trans. Am. Soc. Agricultural Engrs., vol. 12, Dec. 1918, pp. 171-187. Summary of experiments and research, and conclusions in regard to possibilities and future developments.

Military Transport Chassis

Military Transport Chassis-XVI. Automobile Engr., vol. 9, no. 129, Aug. 1919, pp. 241-244, 5 figs. Performance of 40-hp. Pagefield W. D. type chassis under war conditions. Article refers to development of this type of heavy motor vehicle as interesting example resulting from the war.

Military Trucks, German

Extremely Heavy Frames for German Military Trucks-III, Arthur J. Slade. Automotive Industries, vol. 41, no. 8, Aug. 21, 1919, pp. 360-363, 5 figs. Sketches of most notable of frames handed over by Germans to A. E. F. Writer remarks that there was little effort at standardization and that some unimportant features required special dies.

No Standardization of Parts of the German Army Trucks-II, Arthur J. Slade. Automotive Industries, vol. 41, no. 7, Aug. 14, 1919, pp. 307-311, 12 figs. Tabulation of 47 types as to weight and drives. Attention is called to lack of standardization and difficulty in making repairs. Article based on study of German trucks delivered to A. E. F.

Morris

Morris 1919 Light Cars. Autocar, vol. 43, no. 1241, Aug. 2, 1919, pp. 169-172, 10 figs. Morris-Oxford and Morris-Cowley models. Specifications: 11.9 hp., four cylinders, 69x100 mm. bore and stroke (1495 cc.); engine and gear box in one unit; multiplate clutch; three speed and reverse gear box; spiral bevel final drive.

Radial-Engined Car

See Enfield-Allday.

Reo

Revised Manifold and Detachable Head among Reo Engine Changes, J. Edward Schipper. Automotive Industries, vol. 41, no. 6, Aug. 7, 1919, pp. 256-258, 4 figs. Changes in design claimed to provide greater vaporization of fuel, increased accessibility of intake valve assembly, increased engine speed and cleaner design.

Standardization

See Military Trucks, German.

Steering

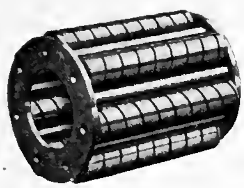
See Caterpillar Vehicle, Steering.

Tire Substitutes

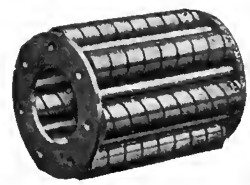
Tire Substitutes. Autocar, vol. 43, no. 1240, July 26, 1919, p. 120, 7 figs. Emergency spring wheels used by German transport vehicles.

Trailers

Trailer Lessons from the Allied Army Service, W. F. Bradley. Automotive Industries, vol. 41, no. 8, Aug. 21, 1919, pp. 354-359, 13 figs. Writer claims that automobile trailers in use with ordinary trucks having normal capacity of 1.5 to 5 tons proved valuable during war as means of economizing cost of road transportation.



A Frank Discussion



We wouldn't attempt to tell you that the Hyatt Roller Bearing is the "ideal" bearing—because right away you'd say "bunk" to yourself and probably read no further.

But while we're on this subject of bearings, let's consider a moment. For instance, what would be some of the qualifications of YOUR "ideal" bearing? Lowest possible friction? A positive method of lubrication? Durability? Ability to absorb sudden shocks and jars? Dependability? Minimum lubrication requirements? Freedom from attention?—Wouldn't these be the essential qualifications of your "ideal" bearing?

Well, we still won't claim that the Hyatt Roller Bearing is your "ideal" bearing, but we do say that there is no bearing on the market today which so nearly meets your "ideal" specifications as the Hyatt Roller Bearing.

Now and then we come across a design for which our Engineers will not recommend the Hyatt Roller Bearing, knowing that some other type will give better results under the given conditions. But for the great majority of applications we believe the Hyatt Roller Bearing to be the most practical bearing which can be used.

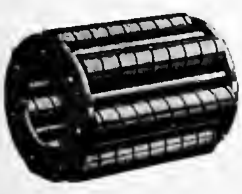
We feel, that as an Engineer, responsible for the design of modern, dependable machinery, you owe it to yourself to carefully investigate the many advantages of Hyatt Roller Bearings.

We will gladly send you our complete Engineering Data covering the class of machinery in which you are interested.

MOTOR BEARINGS DIVISION
DETROIT, MICHIGAN

HYATT ROLLER BEARING COMPANY
INDUSTRIAL BEARINGS DIVISION
METROPOLITAN TOWER, NEW YORK

TRACTOR BEARINGS DIVISION
CHICAGO, ILL.



Manufacturers of Bearings for Mine Cars, Ore Cars, Steel Mill Cars, Roller Tables, Trolleys, Cranes, Hoists, Machine Tools, Line Shafts, Countershafts, Concrete Machinery, Textile Machinery, Conveyors, Lift Trucks, Industrial Trucks, Railway Service Cars, Storage Battery Locomotives, etc.

Trucks, Electric

Electric Trucks, J. Humphrey. Iron & Coal Trades Rev., vol. 99, no. 2680, July 11, 1919, pp. 46-47, 2 figs. General features of types made by various firms.

Wheels, Steel Truck

Steel Truck Wheels, P. Klinger. Jl. Soc. Automotive Engrs., vol. 5, no. 2, Aug. 1919, pp. 160-161. Strength of wood and metal wheels compared.

PIPE

Concrete Sewage Pipe

Large Concrete Sewage Pipe, Eng. World, vol. 15, no. 3, Aug. 1, 1919, pp. 40-42, 9 figs. Units are 72 in. inside diameter, 8 ft. long, with wall thickness of 7 in., and are designed to carry sewage at pressure of 20 lb. per sq. in.

Fuel Pipeline

The Admiralty Oil Fuel Pipeline. Petroleum Times, vol. 2, no. 28, July 19, 1919, pp. 53-56, 4 figs. System is divided into three sections each approximately 12 miles in length. Details of line and of pumping stations are given.

Steel Pipe

Machinery and Pipe Arrangement-XIX, C. C. Pounder. Mech. World, vol. 66, no. 1698, July 18, 1919, pp. 31-32, 5 figs. Deciding on pipe lengths when designing steel pipes.

POWER GENERATION

Bavarian System

Central Station of Walchen Lake and Bavarian System of Electric Distribution at 100,000 (La station centrale du lac Walchen et le réseau bavarois de distribution d'électricité à 100,000 volts). Génie Civil, vol. 75, no. 3, July 19, 1919, pp. 61-62, 2 figs. System extends over 250 miles; aluminum overhead conductors used. From Frankfurter Zeitung (technical supp.) April 18, 1919.

Water Power in Bavaria (Bayerns Wasserkräfte und die deutsche Volkswirtschaft), K. Meyer. Technik u. Wirtschaft, vol. 12, no. 4, April 1919, pp. 195-205. According to writer's calculations the total amount of power that could be used by German industries is around 1,800,000 hp. in Bavaria alone.

Canada

Hydro-Electric Development on the Segnin River. Can. Engr., vol. 37, no. 8, Aug. 21, 1919, pp. 231-234, 11 figs. Municipally-owned plant being constructed for town of Parry Sound, Ont., designed to generate from 2200 to 2900 hp. Dam is of gravity type and is made of concrete.

Electric Power Collection

Electric Power Collection, Chas. P. Steinmetz. Gen. Elec. Rev., vol. 22, no. 8, Aug. 1919, pp. 565-567. Proposes use of small generator installations with simple switches and fuses to make use of our small water powers and thus conserve our fuel resources.

Foreign Water Power

Water Power on the Farm, J. S. Fitz. Trans. Am. Soc. Agricultural Engrs., vol. 12, Dec. 1918, pp. 88-96, 8 figs. Considerations in regard to choosing a suitable site for water-power development.

France, Laws

New Law Regarding Utilization of Hydraulic Energy (Le nouveau projet de loi sur les forces hydrauliques). Industrie Electrique, vol. 28, no. 651, Aug. 10, 1919, pp. 283-290. General conditions of exploitation and classification of hydraulic enterprises. (Continuation of serial.)

Legislation Relative to Utilization of Hydraulic Energy in France (Le régime légal des chutes d'eau en France), G. Tochon. Génie Civil, vol. 75, no. 3, July 19, 1919, pp. 51-56. Project adopted by Chamber of Deputies on July 10, 1919. (Concluded.)

Iowa

Utilizing Old Mills for Hydroelectric Power Plants, F. I. Clark. Elec. Rev., vol. 75, no. 5, Aug. 2, 1919, pp. 181-182, 2 figs. Iowa electric transmission lines supplying farming districts.

Japan

The Undeveloped Water Powers of Japan, Hachiji Higo. Jl. Electricity, vol. 43, no. 4, Aug. 15, 1919, pp. 163-164, 2 figs. Data presented in official report of Director General of Bureau of Electrical Exploitation of Japan.

New England

New England Hydroelectric Developments. Eng. World, vol. 15, no. 3, Aug. 1, 1919, pp. 46-49, 5 figs. Includes description of expansion joints used at Rumford Falls, Me.

New Hampshire

Potential Water Power and Coal Saving. Elec. World, vol. 74, no. 8, Aug. 23, 1919, pp. 401-404, 3 figs. U. S. Geol. Survey field investigations and engineering estimates place available utilization of additional storage sites in New Hampshire at 490,000,000 hp-hr. more yearly than is now produced in Connecticut and Merrimac Rivers.

New Zealand

Hydroelectric Development in Canterbury, New Zealand, L. Birks. Jl. Electricity, vol. 43, no. 4, Aug. 15, 1919, pp. 155-156, 2 figs. Outline of scheme to utilize outlet of lake, carrying normally 100 to 200 cusecs of water, at site 500 ft. below lake level.

St. Maurice River

Power Developments on the St. Maurice River, F. T. Kaelin. Can. Chem. Jl., vol. 3, no. 8, Aug. 1919, pp. 245-249, 3 figs. At Shawinigan Falls. Combined generating capacity is 330,000 hp. Further developments are expected to raise this to over 600,000 hp.

POWER PLANTS

Ash Removal

The Mechanical Removal of Ashes from Power Houses, George Frederick Zimmer. Eng. & Indus. Management, vol. 2, no. 7, Aug. 14, 1919, pp. 217-222, 7 figs. Methods of handling ashes mechanically, independently of use of gravity buckets on similar conveyors.

Boilers, Heat Absorption

Factors Affecting Heat Absorption of Boilers, Robert June. Elec. Rev., vol. 75, no. 7, Aug. 16, 1919, pp. 270-273, 5 figs. Also Cement, Mill & Quarry, vol. 15, no. 4, Aug. 20, 1919, pp. 41-45, 5 figs. Advantages of mechanical soot blowers.

Boiler-Plant Data

Exact Data on the Running of Steam Boiler Plants, D. Brownlie. Engineering, vol. 108, nos. 2795 and 2796, July 25, and Aug. 1, 1919, pp. 101-104 and 138-139, table on supplement plate. Working details of 100 typical colliery steam boiler plants in Great Britain presented as contribution to fund of specialized knowledge writer considers it is necessary to accumulate in order to undertake efficiently question of national coal economy.

Coal Analyses

Coal Analyses Made at the Power Plant, E. D. Hummel. Power, vol. 50, no. 9, Aug. 26, 1919, pp. 332-335, 5 figs. Proposed method with Parr standard calorimeter and Parr sulphur photometer.

Condensers

See Turbines.

Notes on Surface Condensing Plants, with Special Reference to the Requirements of Large Power Stations, R. J. Kaula. Jl. Instn. Elec. Engrs., vol. 57, no. 283, June 1919, pp. 440-446, and (discussion) pp. 447-464. Suggests use of parallel-flow principle on syphonic circulating-water systems; recommendations also made concerning selection of material for various units and in regard to operating practices.

Culm

The Puget Sound Traction, Light and Power Company's Pulverized Coal Plant. Stone & Webster Jl., vol. 25, no. 2, Aug. 1919, pp. 96-109. Results of tests and availability of culm dump of over 225,000 tons led to decision to use pulverized coal as fuel for plant.

Domes, Manholes and Nozzles

Domes, Manholes and Steam Nozzles, W. H. Wakeman. Power, vol. 50, no. 9, Aug. 26, 1919, pp. 338-339, 11 figs. Writer's experience with various forms in present use.

Economizers

Performance Tests of Economizers, B. M. Baxter. Power, vol. 50, no. 8, Aug. 19, 1919, pp. 299-300. Suggested method of making and reporting economic tests.

Feed Water

Curing Boiler Trouble Due to Impure Water, J. N. Helpenbringer. Elec. World, vol. 74, no. 6, Aug. 9, 1919, pp. 296-297, 2 figs. Experiments made in Kansas City plant that are said to have shown how to prevent priming in water-tube boilers of vertical tube type at an average cost of $645 per boiler.

Grates

Fletcher's Rolling-Bar Furnace Grate. Engineering, vol. 108, no. 2798, Aug. 15, 1919, pp. 208-209, 3 figs. Intended to obviate difficulties experienced when burning coal containing high percentage of ash.

Manholes

See Domes, Manholes and Nozzles.

Nozzles

See Domes, Manholes and Nozzles.

Plant Revamping

Making Three Boilers Do the Work of Five, J. J. Spangler. Power, vol. 50, no. 6, Aug. 5, 1919, pp. 206-208, 6 figs. Accomplished, it is said, by revamping plant.

Steam Economy

Steam Economy of Power Plants, James M. Taggart. Steam, vol. 23, no. 2, August 1919, pp. 36-37, 1 fig. Curves for efficiency and power equivalent. Initial pressure and back pressure are taken as constants.

Stokers

The Functioning of the Chain-Grate Stoker, T. A. Marsh. Power, vol. 50, no. 9, Aug. 26, 1919, pp. 342-344, 5 figs. Including analysis showing why ash is always at bottom of fuel bed.

Superheaters

Superheaters at British Collieries, M. Meredith. Coal Age, vol. 16, no. 7, Aug. 14, 1919, pp. 267-268. Said to have resulted in effecting considerable economy in coal.

Turbines

Turbines and Condensers. Power Plant Eng., vol. 23, no. 16, Aug. 15, 1919, pp. 718-721, 2 figs. Abstract of report of Committee on Prime Movers read before Nat. Elec. Light Assn.

Vacuum System

Vacuum—I, Roger Taylor. Power Plant Eng., vol. 23, no. 16, Aug. 15, 1919, pp. 716-717, 2 figs. Technicalities of vacuum system in power-plant practice.

Waste Heat

Fuel Economy in Power Production, W. T. Lane. Proc. South Wales Inst. of Engrs., vol. 35, no. 1, July 18, 1919, pp. 171-210, 11 figs. Also Colliery Guardian, vol. 118, no. 3068, Aug. 8, 1919, pp. 360-361, 2 figs. Description of Draper washer and discussion of utilization of waste heat in relation to carbonization and generation of steam.

POWER TRANSMISSION

Belting

Why Belting is Superior to Individual Electric Drives, Harrington Emerson. Belting, vol. 15, no. 4, Aug. 20, 1919, pp. 21-23. Electric drive described as luxurious magnificence, actual usage being cited to show economy of belting.

Rope Driver

Manila Rope Drives, H. T. Hesselmeyer. Metal Trades, vol. 10, no. 8, Aug. 1919, pp. 351-354, 3 figs. Advantages claimed, care required in installation, and performance obtained.

PRODUCER GAS

Suction Gas Traction

Suction Gas Traction. Motor Traction, vol. 29, no. 753, Aug. 6, 1919, pp. 122-124, 2 figs. Report of Gas Traction Committee upon results of road tests of different producer-plant systems. Some of tests were conducted in conjunction with War Department.

PUMPS

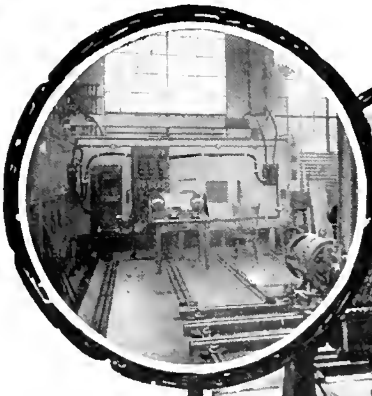
Calumet Pumping Station

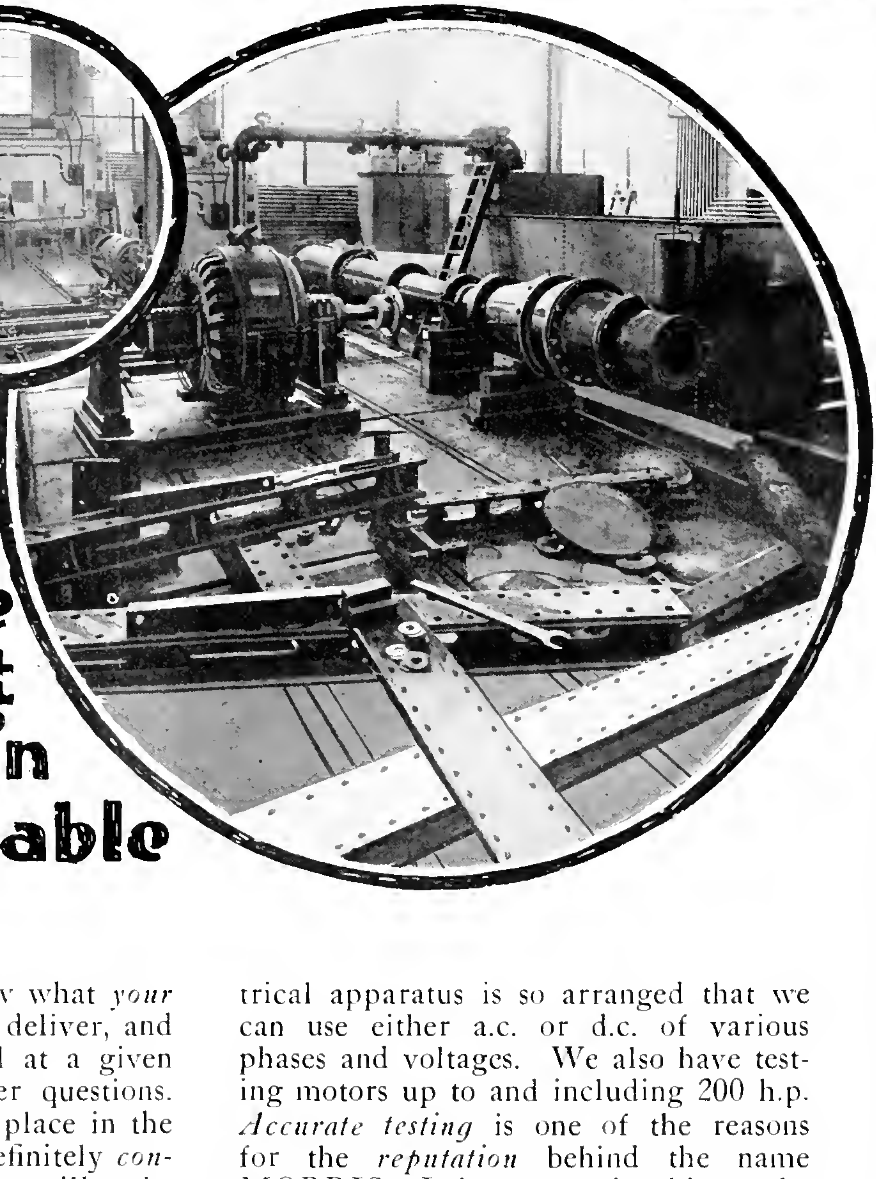
Calumet Pumping Station and Intercepting Sewer, W. T. Christine. Eng. World, vol. 15, no. 4, Aug. 15, 1919, pp. 23-27, 11 figs. Steel building with brick and stone finish, 80 x 185 ft. and about 56 ft. high. Pumping arrangement and features of plant outlined.

Centrifugal-Pump Tests

High Efficiency Pumping Units, F. W. Capellen. Power Plant Eng., vol. 23, no. 16, Aug. 15, 1919, pp. 725-726, 2 figs. Official tests of

MORRIS





Here is where You can test Your Pump in any Conceivable manner—

Of course you want to know what *your* pump will do—what it will deliver, and how—its capacity and head at a given speed—and numberless other questions. There is probably no other place in the country where you can so definitely *convince yourself* that your pump will make good as in our testing room. Here we have every type of necessary checking device. We have a complete set of venturi meters giving us a range of tests on pumps from 5 gals to 13,000. Our electrical apparatus is so arranged that we can use either a.c. or d.c. of various phases and voltages. We also have testing motors up to and including 200 h.p. *Accurate testing* is one of the reasons for the *reputation* behind the name MORRIS. It is a very wise thing to be *sure* of your equipment. This "pump laboratory"—plus the experience and facilities of this company—give you this surety, no matter what type of Centrifugal you require.

Builders of Centrifugal Pumps, Hydraulic Dredges and Steam Engines

SEE OUR DATA IN 1919 A.S.M.E. CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT

MORRIS MACHINE WORKS, BALDWINSVILLE NEW YORK

Branch Offices in Principal Cities

motor-driven centrifugal pumps at Minneapolis are said to have shown high efficiency and low cost, using off-peak current.

History of the Principles of Centrifugal Pumps, J. H. Moore. Can. Machy., vol. 22, no. 6, Aug. 7, 1919, pp. 151-156, 10 figs. Description of Rees-Ro-Turbo type of water pump. Design comprises a single or a series of pressure drums (number depending on nature of work), rotating inside cast-iron casing at high speed.

Pumping Machinery of A. E. F.

Pumping Machinery Used by the Service of Supply of the American Expeditionary Forces in France, W. B. Gregory. Proc. La. Eng. Soc., vol. 5, no. 3, June 1919, pp. 208-215. Records of operation.

Pump Troubles

Pump Troubles, Charles Labbe. Eng. & Min. Jl., vol. 108, no. 6, Aug. 9, 1919, pp. 217-222, 1 fig. Suggestions in regard to installation and operation of pumps.

Quarry Pumps

Pumps in Quarry Service—H. Stone, vol. 40, no. 8, Aug. 1919, pp. 361-362, 2 figs. Experiences at various quarries.

REFRACTORIES

Clay

On the Effect of Extraction Upon the Plasticity of Clay, W. A. Homer and H. E. Gill. Jl. Am. Ceramic Soc., vol. 2, no. 8, Aug. 1919, pp. 595-601. It was found experimentally that a certain place after being treated with organic solvents was less plastic than original materials.

A Study of Some Light-Weight Clay Refractories, M. F. Beecher. Jl. Am. Ceramic Soc., vol. 2, no. 5, May 1919, pp. 336-350 and (discussion) 350-355, 3 figs. Experiments established that working properties and drying behavior of a fire clay mixture are affected by additions of sawdust in same manner as by additions of grog.

Firebrick

Preventable Defects on Fire Brick, C. E. Nesbitt and M. L. Bell. Iron Trade Rev., vol. 65, no. 7, Aug. 14, 1919, pp. 423-426, 9 figs. Illustrating how irregularities in bricks may be detected by careful visual inspection and by other means. Paper presented at meeting of Am. Soc. for Testing Materials.

Porcelains

A Study of High-Fire Porcelains, Chi C. Lin. Jl. Am. Ceramic Soc., vol. 2, no. 8, Aug. 1919, pp. 622-637, 3 figs. Results of investigation to determine effect of composition on strength.

Japanese Porcelains from Chemical Point of View, and How to Improve Them. Chem. & Metallurgical Eng., vol. 21, no. 4, Aug. 15, 1919, pp. 183-185. Indicating ranges of chemical composition both in bodies and glazes which analyses show to be much wider than has been believed by ceramists.

The Progress of Vitrification and Solution in Some Porcelain Mixtures, Arthur S. Watts. Jl. Am. Ceramic Soc., vol. 2, no. 5, May 1919, pp. 400-409, 7 figs. Microscopic examinations interpreted as indicating that development of sillimanite starts in feldspar grains and progresses as fusion progresses.

Special Spark-Plug Porcelains, A. V. Bleininger and F. H. Riddle. Jl. Am. Ceramic Soc., vol. 2, no. 7, July 1919, pp. 564-575. Experimental tests claimed to have shown injurious quality imparted to electrical porcelains by use of feldspar as flux, and desirability of replacing quartz by minerals or synthetically prepared materials which are more constant in volume when heated.

REFRIGERATION

Compressors, Ammonia, Racing of

Unusual Causes of Racing of Ammonia Compressors, E. W. Miller. Power, vol. 50, no. 8, Aug. 19, 1919, pp. 298-299. Following causes mentioned: Dry compressor valves sticking at extreme of travel; working loose of valve disk in section line shutting off flow of gas; breaking of springs holding false head in place.

Economy

Refrigerating Plant Efficiency, George T. Taylor. Refrig. World, vol. 54, no. 8, Aug. 1919, pp. 27-28 & 35. Helpful rules and information of correct proportioning considered as one of essentials for maximum plant economy.

Ice Machines, Dense-Air

Experience with a Dense-Air Ice Machine, C. H. Willey. Power Plant Eng., vol. 23, no. 16, Aug. 15, 1919, pp. 732-734, 1 fig. Diagram of dense-air ice machine and suggestions in regard to its operation.

Ice Plant

Electrically Driven Raw Water Ice Making Plant. Ice & Refrigeration, vol. 57, no. 2, Aug. 1, 1919, pp. 45-50, 8 figs. Plant is of 120 tons daily capacity, using 400-lb. stationary cans. The ice dumps are placed in center of tank room.

See also Ice Machines, Dense-Air; Methyl Chloride Ice Machines.

Methyl Chloride Ice Machines

Methyl Chloride Ice Machines, Charles H. Herter. Refrig. World, vol. 54, no. 8, Aug. 1919, pp. 12-14. Data concerning chemical action of ethyl and methyl chlorides upon cast iron.

Non-Condensible Gases

Non-Condensible Gases, John E. Starr. Refrig. World, vol. 54, no. 8, Aug. 1919, pp. 11-12. Reasons and suggested remedies for troubles experienced with non-condensible gases in absorption machinery.

Packing-House Refrigerating Plant

Making a Packing-House Refrigerating Plant Carry Its Load, J. C. Moran. Power, vol. 50, no. 9, Aug. 26, 1919, pp. 328-329, 2 figs. Unable to put more coil surface in the coolers, brine circulation over the direct-expansion coils was provided and the temperatures lowered and maintained.

Ships, Refrigerator

Equipped Nine Refrigerator Ships. Mar. Rev., vol. 49, no. 9, Sept. 1919, pp. 417-418, 4 figs. How nine ships of 6400 deadweight tons each, which were commandeered by Shipping Board at outbreak of the war, were fitted out with insulating material and cooling coils.

Vapor Refrigeration Processes

Vapour Refrigeration Processes, P. Ostertag. Cold Storage, vol. 22, no. 256, July 17, 1919, pp. 177-180, 8 figs. Entropy diagrams. From Schweizerische Bauzeitung.

RESEARCH

High Voltage Laboratory

See Purdue University.

Lausanne University

Mechanical, Physical and Chemical Testing Laboratory of Engineering School of Lausanne University (Le laboratoire d'essais mécaniques, physiques et chimiques de l'école d'ingenieurs de l'Université à Lausanne). Bulletin Technique de la Suisse Romande, vol. 45, nos. 14 and 15, July 12 and 26, 1919, pp. 137 and 148-151, 6 figs. July 12: Torsion machine. July 26: Apparatus for taking photomicrographs of metals.

National Physical Laboratory

The National Physical Laboratory. Engineering, vol. 108, no. 2795, July 25, 1919, pp. 107-108. Thermometer-testing; radium and X-ray work. (Concluded.)

Purdue University

High-Voltage Laboratory at Purdue University, C. Francis Harding. Elec. World, vol. 74, no. 6, Aug. 9, 1919, pp. 284-285, 2 figs. Design and layout of equipment intended for investigation and testing with potentials up to 600,000 volts.

Research Work Results

How Research Work Brings Results, H. E. Diller. Foundry, vol. 47, no. 329, Aug. 15, 1919, pp. 545-549, 10 figs. Experiments at laboratories of General Elec. Co. undertaken primarily to develop control system for electric furnaces brought benefits in unexpected directions.

Works Testing Laboratory

Equipment of a Works Testing Laboratory, H. S. Primrose. Metal Industry, vol. 15, no. 3, July 18, 1919, pp. 41-44, 4 figs. Recommendations in regard to selection of equipment and coördinating work.

Money Saved by Testing Laboratory, H. R. Simonds. Foundry, vol. 47, no. 329, Aug. 15, 1919, pp. 556-559, 9 figs. Practice of Eastern Malleable Iron Co. in watching composition of pig iron and of finished product in order to prevent undue irregularity of metal in castings.

SPECIFICATIONS

Plates for Tank-Car Construction

Specifications for Plates for Forge-Welding in Tank-Car Construction. Ry. Mech. Engr., vol. 93, no. 8, Aug. 1919, pp. 477-478. From report of sub-committee II of committee A-1 on steel, presented at annual meeting of Am. Soc. of Heat Treating Materials.

STANDARDS AND STANDARDIZATION

Machine Parts

Standardization of Machine Parts (Die Normalisierung der Maschinenelemente). Zietschrift f. die gesamte Giessereipraxis, vol. 40, no. 10, Mar. 8, 1919, pp. 121-122. Standardization Committee appointed by Soc. of German Engineers has already started to publish standard specifications for such articles as split couplings, flange couplings, wall brackets, boiler rivets, etc.

STEAM ENGINEERING

Alignment Chart for Steam

Alignment Chart for Finding the Properties of Saturated and Superheated Steam, Clinton E. Pearce. Power, vol. 50, no. 6, Aug. 5, 1919, pp. 224-227, 1 fig. Construction of chart explained and its application to various problems illustrated.

Boiler Horsepower Chart

Boiler Horsepower, R. L. Wales. Natl. Engr., vol. 23, no. 8, Aug. 1919, pp. 392-396, 3 figs. Graph for computing horsepower.

Boilers, Surface Combustion

Recent Developments in Surface Combustion Boilers, William A. Bone. Chem. Industry, vol. 38, no. 14, July 31, 1919, pp. 228T-233T and (discussion) 233T-234T, 10 figs. Experiments which led to introduction of Bonecourt system of surface combustion.

Steam Chart

See Alignment Chart.

Turbine Machinery for Destroyers

Development of Turbine Machinery for Torpedo-Boat Destroyers. Engineering, vol. 108, no. 2796, Aug. 1, 1919, pp. 139-140 and 148, 4 figs. on two supplement plates. Progress in (1) reduction of weight of plant and space occupied, (2) more economical generation of power, and (3) improvement in manœuvring and sea-keeping capabilities of vessel.

WELDING

Arc Welding

See Electric Welding.

Electric Welding

Notes and Regulations for Arc Welding, H. M. Sayers. Eng. & Indus. Management, vol. 2, no. 4, July 24, 1919, pp. 107-109, 1 fig. Regulations for ship building practice drawn up by Admiralty Committee from records of experience in England and communications received by Admiralty from U. S. Research Committee.

Electric Arc Welding Methods, H. L. Unland. Elec. Ry. Jl., vol. 54, no. 7, Aug. 16, 1919, pp. 343-344, 4 figs. Function and practical operation of various types of equipment for carbon- and metal-electrode welding.

Electric Arc Welding Equipment, H. L. Unland. Metal Trades, vol. 10, no. 8, Aug. 1919, pp. 355-359, 1 fig. Table showing approximate kilowatt-input required for various systems; also classification of different types of welding equipment and discussion of uses of each.

Electric Welding: Its Theory, Practice, Application and Economics, H. S. Marquand. Elecn., vol. 83, nos. 2149, 2150 and 2151, July 25, Aug. 1 and 8, 1919, pp. 91-92, 116-118 and 139-141, 29 figs. July 25: Tests to determine strength of electrically welded flanges. Aug. 1: Examples of welding an anchor and locomotive frames: Aug. 8: Example of repairing main drive wheel of Atlantic type locomotive, in which three of spokes gave way by cracking in neighborhood of coupling rod crankpin boss.

Electrodes

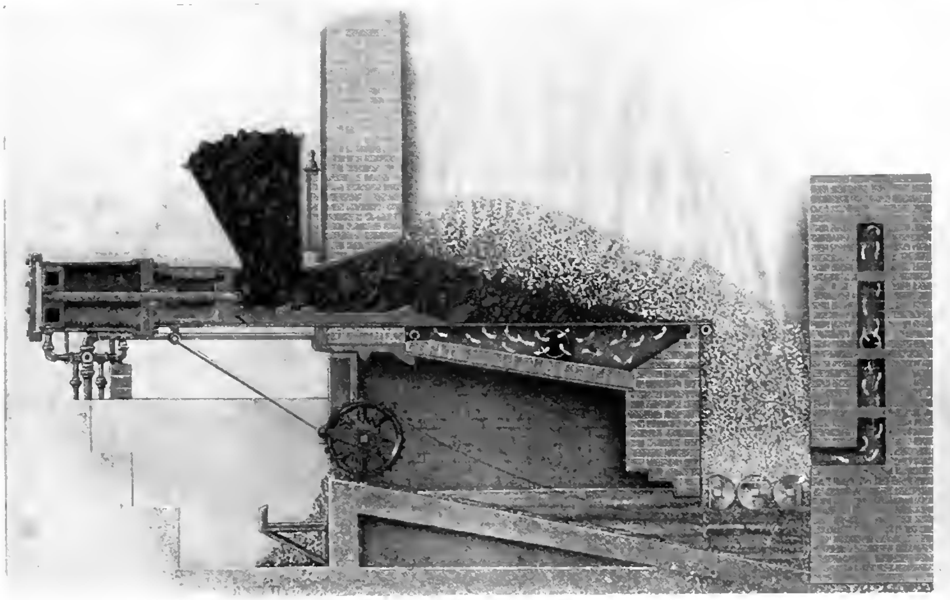
Composition of Electrodes. Iron Age, vol. 104, no. 8, Aug. 21, 1919, pp. 503-504, 8 figs. Tests to determine effect of chemical composition on physical characteristics of weld made by Wilson Welder and Metals Co., New York City.

Effects of Chemical Composition of the Electrode on the Welded Material, Decey Welder. Welding Engr., vol. 4, no. 8, Aug. 1919, pp. 42-44, 9 figs. Results of analysis.

Fusion Welding

Fusion Welding as Applied to Drop-Forging, S. W. Miller. Am. Mach., vol. 51, no. 8, Aug. 21, 1919, pp. 378-382, 29 figs. Consideration given to both electric-arc and oxy-acetylene processes. Physical effects that may occur in weld and in adjoining sections of metal due to heat developed and method of application of processes illustrated with photomicrographs.

Our Guarantee Is 90% Stoker Efficiency On 13,500 B.T.U. Fuel



Longitudinal section of a typical installation, showing main and supplemental combustion chambers as well as one method of automatically removing ashes outside the furnace walls.

It is not necessary to take any chances on performance when you buy a Stoker.

You are assured of satisfactory operation when you install the **Universal Automatic Under-Feed Stoker,** *because we make definite guarantees in our contract with you.*

We are able to do this because the Universal is especially designed to reproduce just such results. The main point is to carry combustion to the degree of completeness desired, in each case, to approach chemical perfection needed, as nearly as possible.

This aim is accomplished principally in the stoker combustion chamber by careful dimensional proportioning, proper fuel distribution, agitation of the fuel bed by the automatic breaker bar, and admission of the proper amounts of air and supplemental gases. In the supplemental combustion chamber, extraction of the remaining available heat units is carried to completion; additional air being supplied, preheated when practical.

Hard, vitreous or sticky clinkers never make their appearance in Universal Stokers.

Chemical and mechanical interference with the formation of such clinkers is a special feature of this stoker. Space does not permit of full explanation of this feature. Ask us about it.

From coal hopper to ash dump inclusive, every operation is automatic, so that need of attention is reduced to a minimum. One man per shift, with mechanical coal and ash systems, is easily able to operate any number of Universals.

Our guarantees are based on investigation of your plant conditions by our engineers.

The Universal Automatic Under-Feed Stoker is suitable for a single unit or the largest Power Plant, Metallurgical Furnaces, Kilns, etc.

We will give a definite guarantee of the percentage of B.t.u., in commercial grades of soft coal, that we can deliver over the bridge wall, based on the heat content of the quality you use.

Let us tell you what we will do for your specific case.
This involves no expense or obligation to you.

The Universal Automatic Under-Feed Stoker Co.

JOHNSTOWN, PA.

THE UNIVERSAL

Hydraulic-Press Cylinder, Welding of

Welding a Badly Broken Cylinder of a 200 Ton Capacity Hydraulic Press, Nels Johnson Welding Engr., vol. 4, no. 8, Aug. 1919, pp. 34 36, 2 figs. Work done at Soo Line Railroad shops at Minneapolis, Minn.

Liberty Engine Welding Plant

Liberty Engine Welding Plant, Otis Allen Kenyon. Elec. World, vol. 74, no. 8, Aug. 23, 1919, pp. 396-399, 9 figs. Closed-circuit arc welding system used to eliminate distortion. Description of joints which are adapted to this process. Special control boards and their operation.

Malleable-Iron Welding

Some Considerations Affecting the Welding of Malleable Iron, H. A. Schwartz. Welding Engr., vol. 4, no. 8, Aug. 1919, pp. 21-23, 9 figs. Photomicrographs illustrating various kinds of welds.

Oxy-Acetylene Welding

Filling Cavities and Putting on Parts by the Oxy-Acetylene Process, J. F. Springer. Ry. & Locomotive Eng., vol. 32, no. 8, Aug. 1919, pp 233-234. Cases in which cavities in castings may be filled and thus save expense of recasting.

Oxy-Acetylene Welding Investigation, J. H Davies. Can. Manufacturer, vol. 39, no. 8, Aug. 1919, pp. 33-34. Concerning conditions for securing good results; also results of carbon-steel experiments. Paper read before Instn. Mech. Engrs.

Building Special Work with an Oxygen-Acetylene Cutting and Welding Outfit, Montelle C. Smith. Elec. Ry. Jl., vol. 54, no. 7, Aug. 16, 1919, pp. 317-319, 8 figs. Construction of frogs, switches, switchmates, and similar work jobs.

Preparing Work

Preparing Work for Electric Arc Welding, E. Wanamaker and H. R. Pennington. Ry. Elec. Engr., vol. 10, no. 8, Aug. 1919, pp. 265-270, 20 figs. Methods used for welds of various kinds, noting precautionary measures taken for expansion and contraction.

Wrought-Iron Welding

Welding Wrought Iron and Steel, H. L. Unland. Welding Engr., vol. 4, no. 8, Aug. 1919, pp. 52-56, 7 figs. Suggestions in regard to operating details. Also Iron Age, vol. 104, no. 6, Aug. 7, 1919, pp. 365-367, 3 figs.

WOOD

Wood Preservative Treatment

Modern Developments and Practical Details in the Preservative Treatment of Wood, Kurt C. Barth. Trans. Am. Soc. Agricultural Engrs., vol. 12, Dec. 1918, pp. 75-87, 5 figs. Details of (1) pressure and (2) nonpressure processes. Also specifications for refined coal tar creosote oil treatment of U. S. Shipping Board Emergency Fleet Corporation.

VARIA

Chemical Federation, Inter-Allied

Inter-Allied Chemical Federation, William Pope. Chem. Industry, vol. 38, no. 14, July 31, 1919, pp. 208T-211T and (discussion) 211T-212T. Its motives and objects.

Engineering Societies, Rand, South Africa

Notes on the Closer Working and Joint Housing of Technical and Scientific Societies on the Rand, Percy Cazalet. Jl. of Chem., Metallurgical and Min. Soc. of South Africa, vol. 19, no. 11, May 1919, pp. 228-238 and (discussion) pp. 238-240. Proposed scheme provides freedom of action for each society together with possibility of full amalgamation when time is ripe and evolution of some scheme of federation resulting "from the mere fact of joint and harmonious action over a period.

Engineers in Public Affairs

Civic Duties and Opportunities of the Engineer, Howard C. Parmelee. Eng. & Min. Jl., vol. 108, no. 8, Aug. 23, 1919, pp. 318-320. Value of scientific societies to Government. Advisability of utilizing services of engineers in public affairs.

Engineer's Work in South America

The Engineers' Part in the International Situation, Charles Lyon Chandler. Monad, vol. 4, no. 7, Aug. 1919, pp. 11-13. Examples of successful engineering enterprises in South America conducted by American engineers.

Fractional Notation

Fractional Notation. Automobile Engr., vol. 9, no. 129, Aug. 1919, pp. 246-247, 1 fig. Standard dimensions table suggested for use in conjunction with fortieth scales.

Government Machine Tools, Fixing Prices

Fixing Prices of Government Machine Tools. Iron Age, vol. 104, no. 6, Aug. 7, 1919, pp. 377-379, 3 figs. How selling prices are determined. Method and conditions of making sales of stocks of standard machines, both used and unused.

Instructional Factory, Loughborough Technical College

Loughborough Technical College Instructional Factory. Iron & Coal Trades Rev., vol. 99, no. 2684, Aug. 8, 1919, pp. 172-174, 6 figs. Education of institution combining technical with practical training.

Interchangeable Manufacturing, Terminology

Terms Used in Interchangeable Manufacturing, Earle Buckingham. Machy. (N. Y.), vol. 25, no. 12, Aug. 1919, pp. 1118-1121, 5 figs. Definitions of terms and illustration of meaning of some of them.

Patents

Patents in Relation to Industry. Elecn. vol. 83, no. 2151, Aug. 8, 1919, pp. 150-153. Conference held at British Sci. Products Exhibition.

Photometric Scale

The Photometric Scale, Herbert E. Ives. Jl. Franklin Inst., vol. 188, no. 2, Aug. 1919, pp. 217-235, 3 figs. Compilation of data and practices relative to definitions, standards and photometric measures, with particular reference to work of Bureau of Standards.

Organization and Management

ACCOUNTING

Cost Factors

Arranging Industrial Cost Factors, M. H. Potter. Iron Trade Rev., vol. 65, no. 8, Aug. 21, 1919, pp. 508-510, 6 figs. Charts illustrating relation of machine rates to production factors; also forms for tabulating various elements.

Cost Systems

Manufacturing Cost Systems, M. H. Potter. Metal Indus., vol. 17, no. 8, Aug. 1919, pp. 366-368, 4 figs. Author deals with economic production and consequent efficiency in operation of metal shop.

German Costing Systems

Costing Systems in Sulphuric Acid Works, H. J. Bush. Chem. Age, vol. 1, no. 3, July 5, 1919, pp. 58-59. Method pursued at one of large chemical works in South Germany.

Overhead

Overhead and General Costs in Manufacturing, Thomas R. Deacon. Jl. Eng. Inst. Can., vol. 2, no. 7, July 1919, pp. 505-506, 1 fig. Shows importance of overhead expense, and how failure of legitimate business "can be traced to inadequate provision for indirect or overhead expense."

Standardized Accounting Systems

Standardized Accounting System. Jl. Electricity, vol. 43, no. 4, Aug. 15, 1919, pp. 168-170, 1 fig. Outlined in committee report of Nat. Elec. Contractors and Dealers' Assn.

EDUCATION

Apprentices

Recording the Progress of Apprentices. Machy. (N. Y.), vol. 25, no. 12, Aug. 1919, pp. 1155-1156, 3 figs. Plan followed by Westinghouse Elec. & Mfg. Co.

The Training of Engineering Pupils and Apprentices, George Knox. Proc. South Wales Inst. of Engrs., vol. 35, no. 1, July 18, 1919, pp. 59-80 and (discussion) pp. 81-115. Urges establishing junior technical schools for preparatory training of apprentices; also addition of scientific departments in secondary schools for preparatory training of pupils. Scheme for apprentice and tutelage courses is outlined.

Architectural Instruction

The Need of Architectural Instruction in American Colleges, George C. Nimmons. Am. Architect, vol. 116, no. 2276, Aug. 6, 1919, pp. 169-172 and 175-176. Argument is based on assistance which understanding of arts, particularly architecture, is claimed would be in acquiring of good taste and refinement, and appreciation of and preference for finer and better things of life.

Factory Training

An Efficient Training Department in a Large Plant. Am. Mach., vol. 51, no. 9, Aug. 28, 1919, pp. 420-421. Bulletin issued by U. S. Training Service, Washington, D. C.

Machine Tool Builders

Training for the Building of Machine Tools, Edward A. Kraus. Am. Mach., vol. 51, no. 8, Aug. 21, 1919, pp. 353-356. Details of elimination of those undesirable or not suited to fit into production organization; training green workers for simple operations; studying personnel of factory with view to possibility of upgrading and studying to straighten out problem of misplaced help.

Vocational Training

Vocational Training, A. P. Fletcher. Jl. Cleveland Eng. Soc., vol. 11, nos. 5 & 6, Mar.-May 1919, pp. 283-289 and (discussion) pp. 289-291. Suggests getting for boys in schools half-time jobs with employers that will pay their way through school the other half of time. Instances of thus placing boys reported.

EXPORT

British Machine Tool Trade

British Machine Tool and Metal Industries, Alexander Luchars. Iron Age, vol. 104, no. 9, Aug. 28, 1919, pp. 573-577. Report issued by Am. Trade Commissioner sent abroad by Dept. of Commerce.

The Machine Industry in England and France, A. C. Cook. Am. Mach., vol. 51, no. 7, Aug. 14, 1919, pp. 331-335. Present economical aspect and plans being laid for future development.

China

China's Industrial and Commercial Outlook, Julean Arnold. Jl. Electricity, vol. 43, no. 4, Aug. 15, 1919, pp. 157-158, 1 fig. Writer sees great possibilities in electrical development and railroad building.

Cement

International Trade in Cement. Cement, Mill & Quarry, vol. 15, no. 4, Aug. 20, 1919, pp. 19-25. Export opportunities for American producers.

France

See British Machine Tool Trade.

Greece

Engineering Opportunities in Greece. Engineer, vol. 128, no. 3315, July 11, 1919, pp. 30-31. Calls attention to various engineering projects being contemplated.

Latin-American Markets

Entering the Latin American Markets, Percy F. Martin. Eng. & Indus. Management, vol. 2, no. 5, July 31, 1919, pp. 142-143, 1 fig. Opening for farming machinery pointed out.

Siberia

Resuming Trade with Siberia. Jl. Electricity, vol. 43, no. 4, Aug. 15, 1919, pp. 153-154, 1 fig. Conditions and possibilities of stable trading. Report of U. S. Bureau of Commerce based on recent investigation undertaken by Sub-Committee on Markets and Supplies of Canadian Economic Commission in Siberia.

South America

West Coast Electrical Trade with South America. Jl. Electricity, vol. 43, no. 4, Aug. 15, 1919, pp. 150-152, 4 figs. Conditions of market indicating disadvantages and opportunities for business as reported by trade commissioner sent by Bureau of Foreign and Domestic Commerce to investigate field.

Spain

American Progress in Spanish Industry. Iron Age, vol. 104, no. 8, Aug. 21, 1919, p. 513. From document prepared by British Department of Overseas Trade concerning conditions and prospects of iron and steel industries and engineering projects in Spain.

FACTORY MANAGEMENT

Bonus System

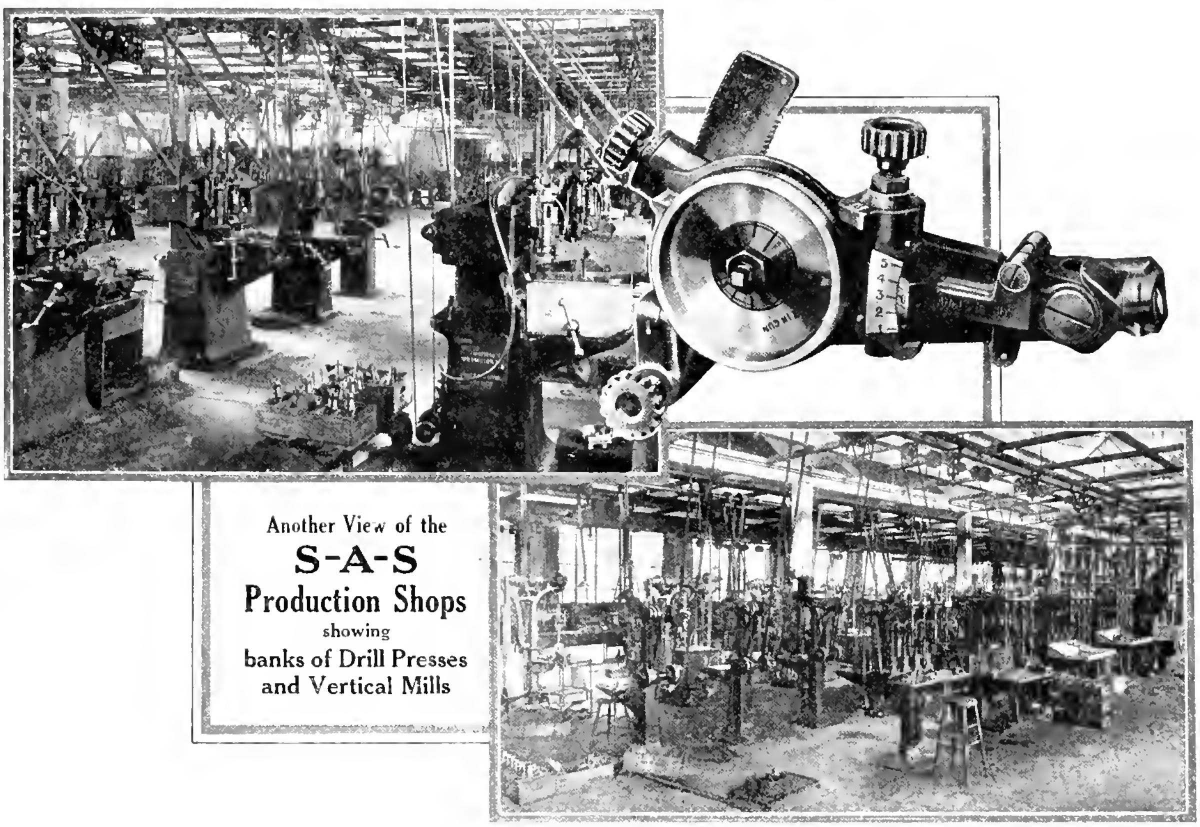
Management of the Power Plant, Robert June. Textile World Jl., vol. 56, no. 5, Aug. 2, 1919, pp. 93-95, 3 figs. Principles and ad-

Production Work
As you want it — and when you want it

Production Shops—
where quantity work is produced accurately and on time

Be your requirements large or small, complex or easy—let us show you new standards in production—standards that mean better work, elimination of production troubles for you and economy in production costs. Not only have we a large plant and modern equipment to make high standard production possible—but we have the men—men trained to produce accurate work.

The insert in the illustration below shows the 4.7 Range Quadrant which was never made outside of government arsenals. We were the only manufacturer for the U. S. Government and produced 1386 of them on record time—another achievement in S-A-S Production. The work was of most delicate and exacting nature, requiring utmost accuracy and finest technical skill—another example of S-A-S production



Another View of the
S-A-S
Production Shops
showing
banks of Drill Presses
and Vertical Mills

S-A-S Production Service Par Excellence

A detailed statement of "Why" and "How" we render superiority in service and finished product would prove a recital that you would scarcely have time to read or we to write. Suffice to say we are "big" and thorough in everything we do—big in designing and developing, big in organization, big in equipment and big in trained men—and big in work produced.

If you are facing difficult problems in development or production—our services are at your command, and if necessary we will assume management of your product—its development and production

Our staff of experts and shops are especially organized to meet every production need

Let us relieve you of the responsibility of production and thus save time and money for you.

This is the seventh of a series of advertisements telling about our plant, our methods and the work we are doing—another view of our production shops in the next issue.

SLOCUM, AVRAM & SLOCUM
LABORATORIES, Inc.
Production Plant: NEWARK, N.J. *New York Office:* Woolworth Bldg., N.Y.

Special Machinery QUANTITY PRODUCTION Jigs, Fixtures and Gages

SLOCUM-AVRAM-SLOCUM MANAGEMENT

ministration of bonus systems in boiler rooms Fourteenth article.

Bonus System for Boiler Room Employees, Robert June. Refrig. World, vol. 54, no. 8, Aug. 1919, pp. 25-26, 2 figs. Experience of various plants after applying system and suggestions in regard to principles on which to base system.

Business Organization

Visualizing the Management's Part in Business for Employees, Henry Tipper. Automotive Industries, vol. 41, no. 8, Aug. 21, 1919, pp. 378-381, 10 figs. Concerning talks on business organization given by president of American Multigraph Co. to all employees.

Administration of Industrial Enterprises (Pratique de la réorganisation administrative des entreprises industrielles), Paul Legler. Bulletin de la Société d'Encouragement pour l'Industrie Nationale, vol. 131, no. 3, May-June 1919, pp. 540-571, 14 figs. Illustrates with various examples necessity for administrative technique, based on H. Fayol's book, entitled "Administration industrielle et generale."

Control of Materials

Using Punched Cards for Controlling Materials, A. E. Van Bibber. Am. Mach., vol. 51, no. 7, 1919, pp. 295-300, 10 figs. Description of system used at Hog Island Shipyard, with reproduction of forms used, matter tabulated and examples of use of system.

Employment Management

Employment Management-IV, V, VI, A. Rowland-Entwistle. Eng. & Indus. Management, vol. 2, nos. 4, 5 and 7, July 24, 31 and Aug. 14, 1919, pp. 102-106, 146-149 and 203-206, 7 figs. July 24: Suggests forms for labor requisition, interview forms, and forms for keeping employment record. July 31: Applications of psychology and the reading of character. Aug. 14: Comparison of labor turnover in America and in England.

Applying Army Methods of Selecting Men for Industry, P. N. Golden. Am. Mach., vol. 51, no. 9, Aug. 28, 1919, pp. 409-411, 7 figs. Experience of army described as having resulted in prevention of much lost motion and expense by sorting out applicants for employment before they get into shop.

Heat-Treating Plant

Methodic Organization of Metallurgical Plant (Essais d'organisation méthodique dans une usine métallurgique), G. Charpy. Bulletin de la Société d'Encouragement pour l'Industrie Nationale, vol. 131, no. 3, May-June 1919, pp. 572-606, 35 figs. How Taylor system was introduced at heat-treating plant of Saint-Jacques of Montluçon.

Industrial Relations

The Works and Products of Messrs. Barr and Stroud, Limited. Engineering, vol. 108, no. 2796, Aug. 1, 1919, pp. 133-134. Administrative methods and industrial relations of works manufacturing range-finders. (To be continued.)

Job Planning

Planning a New Job, Otto Knaak. Am. Mach., vol. 51, no. 7, Aug. 14, 1919, pp. 313-316, 2 figs. Procedure of H. H. Franklin Manufacturing Co., Syracuse, N. Y., noting forms which permit coöperation between designers and shopmen in planning out sequence of operations.

Machinery Handling

Relation of Large Machine Units to Production, Arnold P. Yerkes. Trans. Am. Soc. Agricultural Engrs., vol. 12, Dec. 1918, pp. 136-150, 1 fig. Urges extending use of efficient machines and methods on farms.

Plant Layout

The Works and Products of Messrs. Barr and Stroud, Limited. Engineering, vol. 108, no. 2798, Aug. 15, 1919, pp. 198-200, 10 figs. Arrangement of buildings. (Continuation of serial.)

Progress Department

Planning a Progress Department-IV, V, W. J. Hiscox. Eng. & Indus. Management, vol. 2, nos. 3 and 6, July 17 and Aug. 7, 1919, pp. 79-80 and 163-166, 7 figs. July 17: For motor car factory. Aug. 7: On plant manufacturing a.c. and d.c. electric motors.

Rate Setting

Time Study and Rate Setting in a Machine Tool Plant. Machy. (Lond.), vol. 14, no. 356, July 24, 1919, pp. 493-497, 8 figs. Review of methods used by R. K. Le Blond Machine Tool Co. in making time studies and setting bonus rates.

Restaurants

Plant Restaurant Managed by Employees. Iron Age, vol. 104, no. 8, Aug. 21, 1919, pp. 489-492, 6 figs. Experiment at Wisconsin Steel Works. To convince men that restaurant was operated solely for service and with no idea of profit, company turned over management of institution to employees. Plan said to have proven great success.

Scientific Management

Scientific Management-I, II, III, Henry Atkinson. Eng. & Indus. Management, vol. 2, nos. 3, 5 and 7, July 17, 31 and Aug. 14, 1919, pp. 71-73, 137-140 and 197-199, 1 fig. July 17: Its meaning and object. July 31: Its rapid rise since Taylor expounded his system before Am. Soc. M. E., an indication of its more recent tendencies. Aug. 15: On Taylor's fundamental principles of management.

Works Management. Eng. & Indus. Management, vol. 2, no. 6, Aug. 7, 1919, pp. 168-169, 2 figs. Suggestions in regard to promoting efficient organization in factory.

Application of Taylor System in large Government Powder Works (Essai d'application du système Taylor dans un grand établissement d'Etat), E. Nusbaumer. Bulletin de la Société d'Encouragement poud l'Industrie Nationale, vol. 131, no. 3, May-June 1919, pp. 495-539, 17 figs. With tables giving detailed statements of manufacturing costs.

Ship Yards

Results of Applying Working Methods in Ship Yard Employing 3,000 Workers (Resultats obtenus par l'application des nouvelles méthodes de travail dans un chantier de 3,000 ouvriers), L. Lavallée. Bulletin de la Société d'Encouragement pour l'Industrie Nationale, vol. 131, no. 3, May-June 1919, pp. 441-494, 24 figs. Noting especially forms used in keeping records of work and workmen and indicating arrangements by which time was saved in various operations.

Sites

Some factory Sites Not Cheap, Even as a Gift. Can. Machy., vol. 22, no. 6, Aug. 7, 1919, pp. 146-148. Discussion of geographic position in relation to supply of raw material and market for finished product, transportation facilities, labor supply, health statistics, educational facilities, and cost of land and taxation assessments, as factors for selecting location of factory.

Storeroom

Definitions for Storeroom Material, H. B. Twyford. Iron Age, vol. 104, no. 6, Aug. 7, 1919, pp. 357-359, 2 figs. Method adopted by manufacturing establishment for standardizing material and small articles.

See also Tool Stores.

Stock Parts and Their Routing, Luther D. Burlingame. Machy. (N. Y.), vol. 25, no. 12, Aug. 1919, pp. 1109-1114, 12 figs. Method said to have proven successful in actual practice.

Keeping Record of Iron in Storage, D. C. Kickler. Foundry, vol. 47, no. 329, Aug. 15, 1919, pp. 538-539, 2 figs. Recommendations in regard to taking drillings.

Sugar-Mill Equipment

Better Results by Better Management, L. W. Alwyn-Schmidt. Sugar, vol. 21, no. 8, Aug. 1919, pp. 402-405, 2 figs. Suggestion in regard to selecting equipment in sugar mill. (Continuation of serial.)

Tool Stores

The Modern Tool Stores-IV, Herbert C. Armitage. Eng. & Indus. Management, vol. 2, no. 4, July 24, 1919, pp. 99-101, 4 figs. Arrangement, organization, construction and equipment. (Concluding article.)

Track Layout

Ideal Track Layout for Gravel Plant. Rock Products, vol. 22, no. 16, Aug. 2, 1919, pp. 32-33, 2 figs. Yard layout of Western Indiana Sand and Gravel Co. cited as effective design which permits handling large number of cars with minimum switching.

Working Staff, Handling

Maintenance of Works Departments. Ry. Gaz., vol. 31, no. 3, July 18, 1919, pp. 89-91. Suggests how to make more effective use of and obtain better results from working staff.

LABOR

Business Information for Employees

How to Make Your Business a Human Story for Employees, Harry Tipper. Automotive Industries, vol. 41, no. 7, Aug. 14, 1919, pp. 330-332. Tells how one company put all transactions before employees so that all could see, step by step, why a big business machine was needed.

Clubs

Making the Factory a Place of Both Work and Play. Machy. (N. Y.), vol. 25, no. 12, Aug. 1919, pp. 1130-1131, 5 figs. Employees' club built by Globe Machine & Stamping Co., Cleveland.

Farms for Employees

"Opportunity": The Anaconda Company's Farm for Employees, Oliver E. Jager. Min. & Sci. Press, vol. 119, no. 5, Aug. 2, 1919, pp. 159-162, 4 figs. How good will was created in consequence of establishment.

Fatigue

Fatigue induced by Labour, A. F. Stanley Kent. Eng. & Indus. Management, vol. 2, no. 3, July 17, 1919, pp. 82-85. Experiments and researches undertaken by various investigators are quoted and their conclusions summarized and applied to study effects of cumulative fatigue and similar phenomena. Paper read before Bristol Medico-Chirurgical Soc.

Hawaiian Islands

Some of the Factors in the Industrial Development of the Hawaiian Islands, J. N. S. Williams. Jl. Roy. Soc. Arts, vol. 67, no. 3479, July 25, 1919, pp. 571-579, 1 fig. Including features of plan of coöperation entered into by planters in 1882 in order to remedy labor shortage which became acute during that year.

Health

The Care of the Human Machine, Thomas Darlington. Eng. & Min. Jl., vol. 108, no. 8, Aug. 23, 1919, pp. 311-313, 1 fig. Wholesome food and proper care of body as aids in conservation of health and to promote efficiency. Address delivered before Min. & Metallurgical Soc. of Am.

Hours of Work

Hours of Work as Related to Output and Health of Workers. Nat. Indus. Conference Board, Research Report no. 18, July 1919, 62 pp. Including data collected in metal trades proper, foundries, automobile plants, hardware, electrical equipment and various miscellaneous establishments.

Industrial Relations

Solving the Labor Problem, K. H. Condit. Am. Mach., vol. 51, no. 7, Aug. 14, 1919, pp. 301-304. Account of H. F. G. Porter's early attempts to introduce democratic principles in industrial relations at plants of Nernst Lamp Co. and Nelson Valve Co., and later at those of Hercules Powder Co., and results of experiment. Also exposition of Int. Harvester Co. scheme.

Golden Rule Best Labor Plan, W. A. Grieves. Iron Trade Rev., vol. 65, no. 9, Aug. 28, 1919, pp. 565-566. Points out that too much democracy is as bad as too little and that loyalty is result of honest purpose and common-sense action.

Securing the Coöperation of your Employes, William A. Rockenfield, Machy. (N. Y.), vol. 25, no. 12, Aug. 1919, pp. 1128-1129. How man at head of concern determines conditions throughout plant, "not only because the men holding minor executive positions under him will reflect his ideas, but also because he will, in the first place, select the type of men for these positions who are capable of dealing with labor in the same way as he would."

Relations Between Employer and Employee, William M. Leiserson. Blast Furnace & Steel Plant, vol. 7, no. 8, Aug. 1919, pp. 394-396, and 410. Suggestions in regard to operating labor administration machinery.

Labor Problems

A Constructive Labor Program, T. N. Carver. Jl. Soc. Automotive Engrs., vol. 5, no. 2, Aug. 1919, pp. 155-158. Economical aspect of labor problem.

Rating Employees

Rating Each Workman According to Merit, W. D. Stearns. Factory, vol. 23, no. 2, Aug. 1919, pp. 297-299. Proposes dealing with employee as individual but without anything that savors of paternalism, and suggests plan.

Road Labor

The Organization of Efficient Concrete Road Gangs, Halbert P. Gillette. Concrete Age, vol. 30, no. 4, July 1919, pp. 9-11. Suggestions to college engineers.

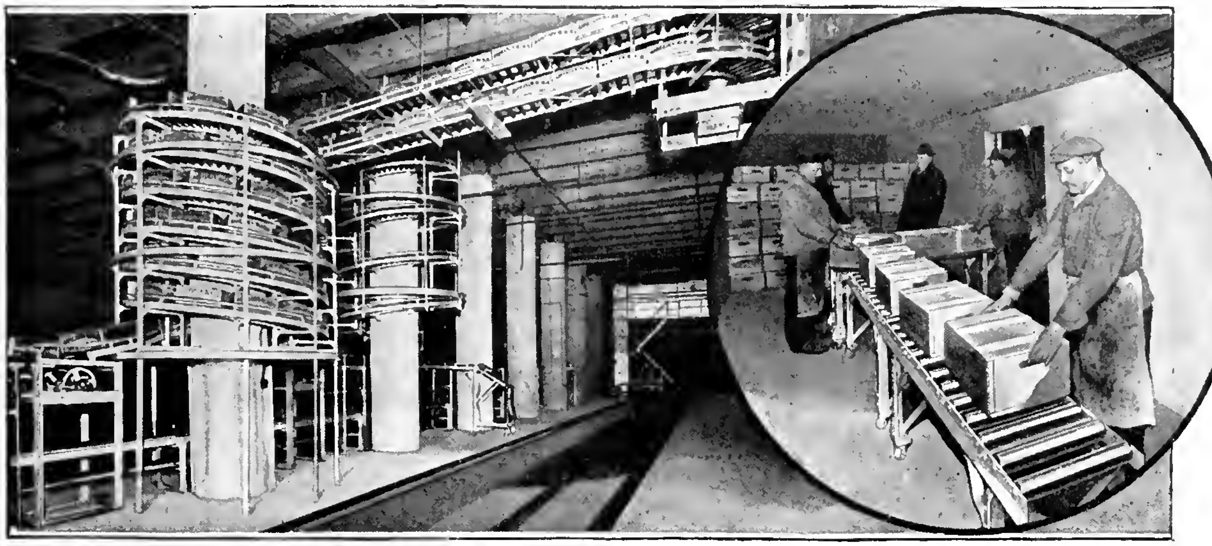
Wage Adjustments

Salary and Wage Adjustment, Mett McKune. Metal Indus., vol. 17, no. 8, Aug. 1919, pp. 375-376. Plan provides for classification of all help, adoption of minimum rate to be paid at beginning of service, for periodic increase, minimum to be attained at end of period when it is assumed employee has attained highest degree of efficiency.

Wage-Payment Systems

Wage Payment Systems in Machine Shops, W. D. Stearns. Machy. (N. Y.), vol. 25, no.

Lamson Conveyors



Notice the double spiral that feeds freight cars in two different sections of the building; the slat conveyor and portable unloading stations. Small insert shows boxes landing on short sections of gravity; in the freight car itself.

Miles of Bevo Cases Flowing to Shipment with Clock-like Regularity

With the regularity of clockwork, an endless stream of cases of filled Bevo bottles rolls uninterruptedly from the sixth floor of the Anheuser-Busch Bevo Plant into storage below or direct to freight cars.

As quickly as Bevo bottles are filled, sealed and inspected on top floor they pass downward over Lamson Spiral Conveyors—the cases are conveyed to shipping floor or may be switched into storage on intermediate floors.

At the foot of the spirals a horizontal slat conveyor provides means for passing boxes to any one of several freight cars. From the slat conveyors boxes are readily deflected on to gravity conveyors, which deliver directly to the stackers in the freight cars in which the cases are shipped.

From receiving door to shipping platform, human hands do not touch Bevo cases. Every operation is made as near automatic as possible. No trucking. No carrying. No lifting. No confusion or congestion. No wasting of precious floor space. No wasting of still more precious human labor. Overhead charges reduced to rock-bottom because underfoot expense has been practically eliminated.

No matter what your plant makes, if it's your job to *get the goods out of the works*, you owe it to yourself to talk problems over with a Lamson engineer, or send for book on Conveying, showing the versatility of the Lamson System for carrying *all* kinds of things. No obligation.

THE LAMSON COMPANY

100 BOYLSTON ST., BOSTON, MASS.

Selling Agents

Boston,	100 Boylston St.	Cleveland,	2063 East 4th St.	Los Angeles,	221 San Fernando Bldg.
New York,	15 West 44th St.	Cincinnati,	119 East 5th St.	St. Louis,	709 Pine St.
Philadelphia,	1200 Walnut St.	Indianapolis,	Cor. Washington and Illinois	Dallas,	905½ Elm St.
Pittsburgh,	319 Third Ave.	Chicago,	6 No. Michigan Ave.	Seattle,	215 Stewart St.
Baltimore,	Equitable Building	Minneapolis,	221 Tribune Annex	Washington, D. C.	426 Colorado Bldg.
Rochester,	194 Main St. East	Omaha,	15th and Dodge Sts.	Atlanta,	30 Moore Bldg.
Detroit,	97 Woodward Ave.	San Francisco,	617 Mission St.	Montreal,	Jones & Glassco Co., Reg'd., St. Nicholas Bldg.
Toronto,	136 Simcoe St.	Vancouver, B. C.,	603 Hastings St.		

Service Stations

Denver, 1622 Arapahoe St. New Orleans, 124 St. Charles St. Albany, 22 So. Pearl St. Buffalo, 194 Main St. Kansas City, 200 New Ridg Bldg.

LAMSON LS SERVICE

[illegible] 1115-1117. Method evolved [illegible] W. [illegible] & Mfg. Co. after review [illegible] tices.

Welfare Work

Maintaining the Efficiency of the Working Force. Erik Oberg. Mach'y (N. Y.), vol. 25, no. 12, Aug. 1919, pp. 1149-1152, 5 figs. Methods employed in welfare work, health supervision, and medical care by R. K. Le Blond Machine Tool Co. of Cincinnati.

Women

Efficiency of Both Sexes in the Machine Industry. L. W. Alwyn-Schmidt. Am. Mach., vol. 51, no. 6, Aug. 7, 1919, pp. 281-282. Based on report of N. Y. Dept. of Labor and statistics compiled by Nat. Industrial Conference Board.

SAFETY ENGINEERING

Accident Prevention

The Work of Accident Prevention. William Conibear. Eng. & Min. Jl., vol. 108, no. 6, Aug. 9, 1919, pp. 226-227. Low accident rates said to be dependent in large measure on overcoming of carelessness when miners work at high speed.

Electrical Inspection

The Demands of Electrical Inspection. E. F. Hensler. Jl. Electricity, vol. 43, no. 3, Aug. 1, 1919, pp. 118-119. Value of regular inspection of electrical installations and appliances in their relation to safety standards.

Explosion of Chemicals

The Explosion of Chemicals. II. Workmen's Compensation Acts. Chesla C. Sherlock. Chem. & Metallurgical Eng., vol. 21, no. 3, Aug. 1, 1919, pp. 131-132. Notes that theory of compensation acts is not based upon fault at all, but upon idea that all injuries suffered by accident in course of employment should be compensated.

Fire Protection

Fire Protection for Schools. H. W. Forster. Nat. Fire Protection Assn., vol. 13, no. 1, July 1919, pp. 20-60, 28 figs. Detailed analysis of conditions and statistics of fire accidents lead writer to conclusion that what country needs is national team work in fighting fire waste. Schools, he says, have a double responsibility and opportunity in the premises first, to put their own houses in order and second, to wield a powerful educational influence.

See also Sprinklers.

Fire Hazards of Cotton Seed Oil Mills. T. C. Taliaferro. Nat. Fire Protection Assn., vol. 13, no. 1, July 1919, pp. 75-81. Scheme of subdividing oil mills into six fire divisions.

Fire Hazards Met in Storage of Fuel Oil. J. W. Lord. Eng. News-Rec., vol. 83, no. 9, Aug. 28, 1919, pp. 415-416. Precautions necessary in the installation of fuel-oil tanks in industrial plants, observed by insurance companies. Paper read before Am. Concrete Inst.

Fire Protection in Factories. Charles E. Rigby. Eng. & Indus. Management, vol. 2, no. 6, Aug. 7, 1919, pp. 180-184, 3 figs. Advises taking into consideration construction, character and arrangement of processes, protection and hazard from adjoining property.

Exits, Fire Alarms and Drills. Textile World Jl., vol. 56, no. 7, Aug. 16, 1919, pp. 47-49 and p. 63, 3 figs. Recommendations of National Safety Council.

Press Accidents

Reducing Press Accidents by Same Treatment. Can. Machy., vol. 22, no. 8, Aug. 21, 1919, pp. 197-200, 14 figs. Description of various safety devices.

Safety Committees

Organization of Safety Committees. Eng. & Indus. Management, vol. 2, no. 3, July 17, 1919, pp. 74-77, 2 figs. Means adopted by large company for accident prevention in their works.

Safety Devices

Report of Engineers of the Northeastern Iron and Steel Works Cooperative Association for 1917 (Aus dem Jahresbericht 1917 der technischen Aufsichtsbeamten der Nordöstlichen Eisen und Stahlberufsgenossenschaft). Zeitschrift f. die gesamte Giessereipraxis, vol. 40, no. 5, Feb. 1, 1919, pp. 26-27, 7 figs. Safety devices and safety measures, especially for lathes, winches, stamping presses and turntables.

Sprinklers

Impairment of Automatic Sprinkler Protection in Refrigerator Rooms. Nat. Fire Protection Assn., vol. 13, no. 1, July 1919, pp. 64-74, 9 figs. Basing conclusions on report rendered by several inspection departments and on detailed examinations conducted by Canadian Fire Underwriters Assn., Montreal, and also developments indicated by test apparatus.

SALVAGE

Scrap Reclamation

Scrap Handling and Reclamation. Chicago Rock Island & Pacific Ry. A. T. Kipping. Ry. Rev., vol. 65, no. 7, Aug. 16, 1919, pp. 219-222, 4 figs. Methods of practice employed in conducting operations at Silvis Scrap Dock and reclamation plant at Silvis, Ill.

TRANSPORTATION

Motor Cars on Rails

A Railroad Service for the Automobile. D. A. Hampson. Can. Machy., vol. 22, no. 7, Aug. 14, 1919, pp. 173-175, 3 figs. Results of operating two motor cars on 15-mi. standard-gage road.

Refuse Collection

Horses vs. Motor Trucks in Refuse Collection. E. W. Stribbling. Mun. Jl. & Public Works, vol. 47, nos. 7 and 8, Aug. 16 and 23, 1919, pp. 110-111 and 119-120. Comparison of cost of maintaining and operating each, from experiences of various cities.

Electrical Engineering

ELECTROCHEMISTRY

Copper Sulphate Solutions

Electrical Conductivity and Other Properties of Saturated Solutions of Copper Sulphate in the Presence of Sulphuric Acid. H. M. Goodwin and W. G. Horsch. Chem. & Metallurgical Eng., vol. 21, no. 4, Aug. 15, 1919, pp. 181-182, 3 figs. Gives specific electrical conductance at 25 deg. cent. of solutions saturated with copper sulphate and containing sulphuric acid ranging in concentration from 0.15 equivalent to 3.6 equivalents per liter.

ELECTRODEPOSITION

Copper Deposition

Electrolytic Deposition of Copper in the Leaching of Roasted Ore and Concentrate. Percy R. Middleton. Min. & Sci. Press, vol. 119, no. 5, Aug. 2, 1919, pp. 149-150, 3 figs. Results of experimental work.

Deposition of Metal, Time Element

A Compilation of Tables Showing the Time Required to Deposit a Given Thickness of Metal. W. G. Knox. Metal Industry, vol. 15, no. 3, July 18, 1919, pp. 46-48. Table showing time required for thickness of deposit in inches of nickel-cobalt. Calculated on basis of 100 per cent cathode efficiency.

Galvanizing Plant

Planning and Operating a Galvanizing Plant. E. P. Later. Metal Industry, vol. 15, no. 2, July 11, 1919, pp. 30-32. Concerning advisability of isolating plant from rest of factory, material to use for kettles, coating tanks used for cold acid solutions, etc.

Nickel Plating

The Re-Nickeling of Surgical Instruments. Joseph Haas, Jr. Metal Indus., vol. 17, no. 8, Aug. 1919, pp. 364-365. Results of investigations carried on in Medical Repair Dept. Laboratory established by A. E. F. in France during war.

ELECTROPHYSICS

Coils, Electromagnetic

Calculation of Electromagnetic Coils (Sur le calcul des bobines des électro-aimants). Ad. Curchod. Revue Générale de l'Electricité, vol. 6, no. 3, July 19, 1919, pp. 74-77. Formulæ for determining dimensions for a required field.

See also Solenoids.

Conduction in Liquid Dielectrics

Conduction in Liquid Dielectrics. J. E. Shrader. Elec. Jl., vol. 16, no. 8, Aug. 1919, pp. 334-338, 10 figs. Test cup developed at Westinghouse Research Laboratory.

D. C. Armature in A. C. Field

Direct-Current Armature in an Alternating Field (Der Gleichstromanker im wechselfeld). Robert Moser. Elektrotechnik u. Maschinenbau, vol. 37, no. 3, Jan. 19, 1919, pp. 25-28, 2 figs. Deduces general formulæ for any desired position of brushes, any form of field, and any period.

Eddy Currents

Problems of Eddy Currents (Wirbelstromprobleme). Milan Vidmar. Elektrotechnik u. Maschinenbau, vol. 37, no. 8, Feb. 23, 1919, pp. 69-77, 5 figs. Tests made by writer to investigate problems of heat losses in eddy currents, with special reference to turbo-generators and large transformers. Discusses also use of aluminum in construction of electric machinery.

Electromagnetism

General Laws of Electromagnetism and Induction in Circuits Having no Resistance (Lois générales de l'électromagnétisme et de l'induction dans les circuits sans résistance). G. Lippmann. Annales de Physique, vol. 12, May-June 1919, pp. 245-253. Theory developed after making $r = 0$ in expression of coefficient of self-induction in terms of resistance, intensity and electromotive force. Since phenomena of electromagnetism and induction are independent of nature of conductor, while resistance depends on this nature, writer considers as more logical to investigate laws of electromagnetism and induction by disregarding resistance.

Elongation and Magnetization

The Elongation Due to Magnetization. C. Barus. Proc. Nat. Acad. Sciences, vol. 5, no. 7, July, 1919, pp. 267-272, 3 figs. Experiments with contact lever. Interest is chiefly concentrated in continued increase of contractions, due to magnetization obtained in strong fields after magnetization has reached a maximum.

Galvanometry

Contribution to Galvanometry (Contribution à la galvanométrie). D. Germani. Revue générale de l'Electricité, vol. 6, no. 4, July 26, 1919, pp. 99-101, 2 figs. Graph showing "ballistic constant" in times of resistance of galvanometric circuit.

Harmonics in Alternating-Current Waves

Order and Amplitude of Harmonics in Voltage Wave Forms With Indicating Instruments. Leslie F. Curtis. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 8, Aug. 1919, pp. 947-958, 13 figs. Method for determining order and percentage of various components of alternating wave of e.m.f., using indicating meters and other similar apparatus. Oscillograms are included to show various phenomena and to check results of calculations. Value of so-called standards for indication of wave form is questioned.

High-Frequency Electric Waves

Production and utilization of Electrical Waves Maintained at High Frequencies (Production et emploi des ondes électriques entretenues à haute fréquence). M. Boutaric. Industrie Electrique, vol. 28, no. 649, July 10, 1919, pp. 250-255, 4 figs. Alexanderson alternator with which it is said to be possible to obtain a frequency of 100,000 periods per second. (Concluded.)

Loading Coils, Inductance

Elementary Considerations of the Inductance of Loading Coils and Their Insertion in Cables. E. S. Ritter and A. Morris. Post Office Elec. Engrs. Jl., vol. 12, no. 2, July 1919, pp. 76-87, 9 figs. General requirements of loading coil design.

Solenoid Magnetic Field

Magnetic Field of a Solenoid (Champ magnétique d'un solénoïde). O. Billieux. Revue Générale de l'Electricité, vol. 6, no. 3, July 19, 1919, pp. 67-70, 1 fig. Formula for determining self-induction, mutual induction, etc.

Transmission Circuits

Electrical Characteristics of Transmission Circuits. H. Wm. Nesbit. Elec. Jl., vol. 16, no. 8, Aug. 1919, pp. 314-326, 12 figs. Details for determining reactance of conductor directly from its resistance.

Waves

See Harmonics and High Frequency Waves.

FURNACES

Electric Furnaces (Consideraciones generales sobre hornos electricos). José M. Navarrete. Energia Eléctrica, vol. 21, no. 11, June 10, 1919, pp. 125-130. Comparative study of arc, resistance and induction types.

Ajax-Wyatt

Ajax-Wyatt Electric Furnace. C. H. Clamer. Metal Indus., vol. 17, no. 8, Aug. 1919, pp. 362-363, 2 figs. Diagrammatic sketch. Furnace is of induction type. Paper read before Am. Chem. Soc.

Carbons

Electric Furnace Carbons. Thomas Robson Hay. Raw Material, vol. 1, no. 5, July 1919, pp. 262-264, 4 figs. It is held that while both

graphitic and amorphous carbons have their advantages, latter is considered as having superior strength and lasting qualities.

Manufacture and Application of Carbon Electrodes for Electric Furnaces, Thomas Robson Hay. Elec. Rec., vol. 26, no. 2, Aug. 1919, pp. 72-74, 7 figs. Noting particularly improvements in design and practice evolved during war.

Experimental Furnace

Electric Furnace for Experimental Work, F. A. J. Fitzgerald and Grant C. Moyer. Thirty-sixth General Meeting of Am. Electrochem. Soc., Sept. 23, 1919, advance copy, no. 4, pp. 27-31. Type which has been found convenient and satisfactory for small-scale experiments at Fitzgerald Laboratories of Niagara Falls, N. Y.

Heat-Treating Furnace

Vertical-Cylindrical Electric Furnaces for Heat-Treating and Shrinking, A. M. Clark. Chem. & Metallurgical Eng., vol. 21, paper no. 4, Aug. 15, 1919, pp. 205-207, 5 figs. Types developed by General Elec. Co., notable low-temperature furnaces (up to 950 deg. fahr.) which have been used primarily for shrinking jackets over gun barrels.

Operation

Effect of Actions Inside Furnaces on Performance, W. K. Booth. Elec. World, vol. 74, no. 5, Aug. 2, 1919, pp. 236-237, 2 figs. Causes of fluctuation in load, limitations to short-circuit current, stabilization of arc and high-power-factor furnaces from service viewpoint.

Radiant Resistor Furnace

Radiant Resistor Furnace, F. A. J. Fitzgerald. Thirty-sixth General Meeting of Am Electrochem. Soc., Sept. 23, 1919, advance copy, paper no. 1, pp. 1-7, 4 figs. Unit built and operated at Fitzgerald laboratories for distillation of low-grade or scrap zinc. It is said that with current of approximately 845 amp. at 65 volts output was about 50 kg of refined zinc per hour.

Transformers

See Transformers, Converters, etc.

GENERATING STATIONS

Ground in Disturbances

See Overloading.

Operation in Parallel

Some Problems in the Operation of Power Plants in Parallel, E. C. Stone. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 8, Aug. 1919, pp. 973-996, 6 figs. It is observed that in order to operate two power plants satisfactorily in parallel, the transmission line which ties them together must have sufficient synchronizing power as well as sufficient carrying capacity. Factors determining synchronizing power are mentioned and limiting values for synchronizing power of lines under various operating conditions are given.

Paralleling Alternators-I, F. Ashton. Mech. World, vol. 66, no. 1701, Aug. 8, 1919, pp. 64-65, 3 figs. Precautions to take.

Overloading

Recent Progress Made in Preventing Overloading of Electric Installations (Die jüngsten Fortschritte in der Beurteilung und Bekämpfung von Ueberspannungen in elektrischen Anlagen), W. Kummer. Schweizerische Bauzeitung, vol. 74, no. 4, July 26, 1919, pp. 39-41, 4 figs. Grounding disturbances and how to remedy them. (To be concluded.)

Paralleling

See Operation in Parallel.

Rates

Central-Station Rates in Theory and Practice, H. E. Eisenmenger. Elec. Rev., vol. 75, no. 7, Aug. 16, 1919, pp. 266-269. How diversity of demand affects demand cost. Sixth article.

Central-Station Rates in Theory and Practice, H. E. Eisenmenger. Elec. Rev., vol. 75, no. 8, Aug. 23, 1919, pp. 304-307. Consumer cost, what it includes and how it varies. Seventh article.

Rice Rips Station

Construction Costs of Rice Rips Station, J. A. Leonard. Elec. World, vol. 74, no. 5, Aug. 2, 1919, pp. 228-230, 3 figs. Hydroelectric power plant of 2000-kva. capacity designed to carry peak loads rather than base loads.

Swiss Central Station

Central Station at Massaboden near Brig of the Swiss State Railroads (Das Elektrizitätswerk Massaboden bei Brig der Schweiz. Bundesbahnen), H. Eggenberger and A. Dänzer. Schweizerische Bauzeitung, vol. 73, no. 25, June 21, 1919, pp. 287-291, 10 figs. Pressure pipes during construction; description of water chamber; plan and cross-sections of pressure pipes and reservoir.

Switch, Air-Break

A 5000-Kva., 100,000-Volt New-Type Air-Break Switch, George T. Couthgate. Elec. World, vol. 74, no. 8, Aug. 23, 1919, pp. 407-409, 7 figs. Designed to interrupt charging current drawn by 125 miles of 100,000-volt line, it is said to have broken current of 100-mile line.

Switch House

Layout of Modern Switch House, C. A. Conney. Elec. World, vol. 74, no. 6, Aug. 9, 1919, pp. 286-290, 6 figs. Special consideration given to future requirements, safety of operators, continuity of service, economy of materials and relation to rest of generating station.

Tata Power Plant

The Tata Hydro-Electro Power-Plant, Bombay-II. Indian & Eastern Engr., vol. 44, no. 6, June 1919, pp. 187-190, 6 figs. Details of pipe line. Power house is designed for generating total of 108,000 hp.

Vienna Municipal Central Station

Municipal Central Station in Vienna (Die städtischen Elektrizitätswerke in Wien). Elektrotechnik u. Maschinenbau, vol. 37, no. 4, Jan. 26, 1919, pp. 35-40. Has seven substations with 18 steam turbines and 6 water turbines of a total horsepower of 155,095 and 21 reciprocating steam engines of 41,000 hp.

GENERATORS AND MOTORS

Bipolar Diagram

On Some Properties of the Bipolar Diagram of Synchronous Alternators in a Constant-Potential Network (Quelques propriétés du diagramme bipolaire des alternateurs synchrones (moteurs ou récepteurs) sur un réseau à potentiel constant), André Blondel. Comptes rendus des séances de l'Académie des Sciences, vol. 169, no. 1, July 7, 1919, pp. 12-16. Derivation of equation of polar curve of internal power of alternator.

Breakdowns

Some Causes of Breakdown to Electrical Machinery, W. C. Worral. Elec. Rev., vol. 75, no. 8, Aug. 23, 1919, pp. 308-312. Examination of typical examples of breakdowns met in industrial plants.

Generator Plants, French

Uses of Generator Groups During the War (Emploi des groupes électrogènes à le guerre), A. Soulier. Revue générale de l'Electricité, vol. 6, no. 4, July 26, 1919, pp. 111-118, 10 figs. Illustrating general arrangement of Ballot, Aster, and Delieuvin gas engine and dynamo units.

Grounded Neutral

Grounded Neutral on Alternating-Current Generators, S. L. Henderson. Elec. Jl., vol. 16, no. 8, Aug. 1919, pp. 340-343, 10 figs. Method of grounding neutral.

Induction Generator Plants, Automatic

Automatic Induction Generator Plants, E. A. Quinn. Power Plant Eng., vol. 23, no. 16, Aug. 15, 1919, pp. 730-732, 4 figs. Abstract of Eng. Committee report of Pacific Coast Section, Nat. Elec. Light Assn.

Induction Motors

Induction Motors Driving Centrifugal Pumps, Fraser Jeffrey. Power, vol. 50, no. 9, Aug. 26, 1919, pp. 324-327, 11 figs. Adaptability of various types of motors to different kinds of pumping work, with reference to several existing installations.

Rolling-Mill Motors

Regulation Without Loss of Three-Phase Rolling-Mill Motors (Über den derzeitigen Stand der Frage der verlustlosen Regelung von Drehstrom-walzenzugmotoren), H. Hermanns. Elektrotechnische Rundschau, vol. 36, nos. 5/6, 7/8 and 9/10, Feb. 5, Feb. 19, and Mar. 5, 1919, pp. 17-18, 25-26 and 33-34, 13 figs. Commutator-motor regulation by brush adjustment; various connection schemes. (Concluded.)

Siemens Machinery

Siemens Electrical Equipment (Equipment électrique Siemens). Génie Civil, vol. 75, no. 6, Aug. 9, 1919, pp. 117-120, 6 figs. At steel works of Skinningrove Iron Co. of Yorkshire. Rolls require 19,000 hp. to operate.

Transient Phenomena

Transient Phenomena of a Polyphase Motor at Starting and Those of a Direct-Current Motor (In Japanese), J. Takenchi. Denki Gakkwai Zasshi, no. 372, July 10, 1919.

IGNITION APPARATUS

Condensers

Function of the Condenser in High-Tension Magnetos, Harry F. Geist. Automotive Industries, vol. 41, no. 6, Aug. 7, 1919, pp. 267-272, 6 figs. Diagram showing difference between induced voltages that occur both with and without condenser.

Magnetos

Aircraft Magneto Adapted to Four Cylinder Car. Automotive Industries, vol. 41, no. 8, Aug. 21, 1919, pp. 364-366, 9 figs. British war product in which aluminum enters very largely into construction. Special feature, makers claim, is use of laminated polesboes.

LIGHTING AND LAMP MANUFACTURE

Delco

Lighting Plant Capacity Increased to 3 Kw., P. M. Heldt. Automotive Industries, vol. 41, no. 8, Aug. 21, 1919, pp. 370-374, 7 figs. Unit designed for Delco line for use on large estates, hotels and similar plants, has single-cylinder air-cooled engine with anti-friction crankshaft bearings, direct-connected to six-pole generator.

Gas-Filled Lamps

The Gas-Filled Lamp and Its Effect on Illuminating Engineering. Francis W. Willcox. Illuminating Engr., vol. 12, no. 6, June 1919, pp. 142-161 and (discussion) 161-171, 43 figs. Features of gas-filled lamps that have modified lighting practice and effects of this type of lamp in various fields of lighting, with notes on lighting codes adopted in various parts of U. S.

Incandescent Burners, Inverted

The Regenerative Effect as Influencing the Lighting Efficiency of the Inverted Incandescent Burner, J. S. G. Thomas. Gas Jl., vol. 147, no. 2930, July 8, 1919, pp. 77-78, 2 figs. Experiments interpreted as indicating that increased lighting efficiency is obtained when gaseous mixture of coal gas and primary air is preheated.

Industrial Lighting Systems

Design of Industrial Lighting Systems—II, Ward Harrison and H. H. Magdsick. Elec. World, vol. 74, no. 5, Aug. 2, 1919, pp. 232-234, 5 figs. Concerning selection of correct size and type and location of lighting unit.

Photometers

Extending the Use of the Relative-Photometer (Erweiterte Anwendung das Relativphotometers), L. Weber. Zeitschrift für Beleuchtungswesen, Heizungs- u. Lüftungstechnik, vol. 25, no. 1/2, Jan. 1919, pp. 8-9, 3 figs. For determining intensity of illumination in proportion to the sky, for comparing two illuminating intensities and for comparing two intrinsic brilliances.

Safety Orders, Lighting

General Lighting Safety Orders. Jl. Electricity, vol. 43, no. 4, Aug. 15, 1919, pp. 173-174. Issued by Industrial Accident Commission under Workmen's Compensation Insurance and Safety Act.

Stage Lighting

The Art of Stage Lighting, J. B. Fagan. Illum. Engr., vol. 12, no. 5, May 1919, pp. 118-124 and (discussion) pp. 124-133. Historical account of development of art and notes on practices followed in various countries.

Workshops

Auxiliary Lighting Apparatus for Use in Engineering Workshops, J. Beaumont Harrison. Electrical Review, vol. 85, no. 2175, Aug. 1, 1919, pp. 131-132, 2 figs. Hand lamp-test set. Arrangement consists of bank of connecting sockets, indicator lamps, contactor switch, main fuse and main switch.

MEASUREMENTS AND TESTS

Amplifiers

Use of Amplifiers for Measuring Small Differences of Potential (Emploi des amplificateurs pour la mesure des différences de potential faibles), A. Blondel. Revue générale de électricité, vol. 6, no. 6, Aug. 9, 1919, pp. 163-178, 18 figs. Laboratory methods in which audions may be introduced—thermo-ionic balance, static or deviation bridges, potentiometer methods and oscillations. (To be continued.)

Condenser, High Voltage

Half-Million-Volt Condenser for Testing. Elec. World, vol. 74, no .8, Aug. 23, 1919, pp. 404-405, 4 figs. Built for frequencies up to 60,000 cycles and combined with Poulsen arc converter and inductance for the purpose of testing high-voltage insulators.

Frequency Determination

A New Method for the Absolute Determination of Frequency, Ashutosh Dey. Proc. Roy. Soc., vol. 95, no. A 673, July 15, 1919, pp. 533-545, 1 fig. Principle of method is maintenance of oscillations of sub-synchronous frequency by a periodic field of force.

Hysteresis Curve

The Determination of the Hysteresis Curve, M. Schleicher. Elecn., vol. 83, no. 2148, July 18, 1919, pp 67, 2 figs. By ring method similar to that used for determining commutating curves. From Elektrotechnische Zeitschrift.

Insulator Tester

The Keokuk Insulator Tester, R. B. Howland. Stone & Webster Jl., vol. 110-113, Aug. 1919, 7 figs. on five supp. plates. Said to be specially suited for locating suspension-type insulator units which have become defective, and which can be used to advantage during night hours.

Motors, Railway

Manufacturers' Tests of Materials for Railway Motors, J. S. Dean. Elec. Ry. Jl., vol. 54, no. 7, Aug. 16, 1919, pp. 320-325, 20 figs. Tests, apparatus used and results obtained for determining physical and electrical properties of material entering into construction of railway motors.

Motor Selection

Motor Testing in Industrial Plants, Philip Chapin Jones. Elec. World, vol. 74, no. 6, Aug. 9, 1919, pp. 298-296, 6 figs. Question of selecting motors of correct size to offset their increased cost.

Power Factor Measurement

Measuring Power Factor with Unbalanced Load, Willard S. Wilder. Elec. World, vol. 74, no. 5, Aug. 2, 1919, pp. 239-240, 2 figs. Method of securing permanent record of maximum value and time of occurrence.

Short-Circuit Current Calculation

Calculating Short-Circuit Currents in Networks, W. R. Woodward. Elec. Jl., vol. 16, no. 8, Aug. 1919, pp. 344-345, 4 figs. Testing with miniature networks.

MATERIALS OF CONSTRUCTION

Aluminum Conductors

Aluminum Electrical Conductors (Les conducteurs d'électricité en aluminium), E. Dusaugey. Supplement to Revue générale de l'Electricité, vol. 6, no. 4, July 26, 1919, 20 pp. Recent developments in electrical uses of aluminum and mechanical and physical properties of aluminum presented to show that employment of aluminum as substitute for copper is both feasible and economical. Report of Committee of l'Union des Syndicats de l'Electricité.

Cadmium

Cadmium, C. E. Siebenthal. Brass World, vol. 15, no. 8, Aug. 1919, pp. 246-249. Its use as a substitute for tin and in bronze telegraph and telephone wires.

Insulating Materials

Electrical Insulating Materials, R. P. Jackson. Elec Jl., vol. 16, no. 8, Aug. 1919, pp. 326-333. Classification under two general divisions—organic and inorganic. Characteristic properties of each and of various combinations of several of them.

Industrial Insulators (Etude des diélectriques industriels), Raymond Bonzon. Revue générale de l'Electricité, vol. 6, nos. 5 and 6, Aug. 2 and 9, 1919, pp. 137-148 and 181-187, 20 figs. Aug. 2: Definition of specific qualities of insulators, description of apparatus used for measuring them, their standardization and application. Aug. 9: Manner of measuring losses in insulators due to alternating currents; results of experiments.

POWER APPLICATION

Construction Work

Largest Use of Electric Power on Construction Work. Eng. News-Rec., vol 83, no. 9, Aug. 28, 1919, pp. 417-420, 5 figs. How and why Dayton flood protection works use 8000 hp. from central plant, in motors of 5 to 500 hp., for pumps, excavators, concrete mixers and other equipment scattered over 1000 square miles.

Dredges, Hydraulic

Features of Electrically Operated Hydraulic Dredge, Charles W Geiger. Elec Rev., vol. 75, no. 7, Aug. 16, 1919, pp. 263-265, 5 figs. Advantages of electric drive and savings effected by its operation by City of Oakland, Cal.

Gold Mining

Notes on the Electrical Equipment at the Circular Shaft, New Modderfontein Gold Mining Company, Ltd., R. H. Copeland. Trans. of South African Inst. Elec. Engrs., vol. 10, no. 5, May 1919, pp. 62-69 and (discussion) pp. 69-72, 6 figs., partly on supp. plate. Energy brought to transformer house at 20,000 volts and there stepped down to 2100 volts and 525 volts for direct motor use; mine transformers get it down again to 200 volts between phases and 115 volts between phases and earthed neutral or to $57\frac{1}{2}$ volts for lighting.

Rice Industry

Electricity Makes Rice Industry Possible, W. E. Camp. Jl Electricity, vol. 43, no. 3, Aug. 1, 1919, pp 102-104, 9 figs. Electrical pumps used in irrigation works.

Tube Mills

An Electrically Driven Tube Mill. Iron & Coal Trades Rev., vol. 99, no. 2683, Aug. 1, 1919, p. 139, 3 figs. Principal feature noted is direct driving of two Pilger mills by motor running at speed of mill and driving without flywheel.

Typewriter Industry

Electric Heat in the Typewriter Industry, A. M. Clark. Thirty-sixth General Meeting of Am. Electrochem. Soc., Sept. 23, 1919, advance copy, paper no. 3, pp. 23-26, 2 figs. Electrically heated oven for baking japan on various parts of typewriters. Comparative tables show better economy and larger capacity of electrically heated oven compared with gas- or oil-heated oven.

TELEGRAPHY AND TELEPHONY

Antenna

Calculation of Antenna Capacity, L. W. Austin. Jl. Wash. Acad. Sci., vol. 9, no. 14, Aug. 19, 1919, pp. 393-396. Table giving observed values of capacity of elongated parallel wire antenna, and comparison of capacities calculated according to Bur. Stand. formula.

Cables, Telephone

Investigation and Examination of Telephone Cables. Telephone Engr., vol. 22, no. 2, Aug 1919, pp. 70-73, 3 figs. Francke machine for determining damping effect of homogeneous or composite lines; also account of tests performed with it. From Elektrotechnik u. Maschinenbau.

Direction Finders

The Marconi Direction Finder. Elecn., vol. 83, no. 2151, Aug. 8, 1919, pp. 142-143, 4 figs. Installation having components arranged as separate unit.

Duplex Apparatus

Universal Duplex Apparatus—In Use by the Western Union Telegraph Company. Telegraph & Telephone Age, vol. 15, no. 869, Aug. 1, 1919, pp. 374-377, 2 figs. Circuits of repeater when working differentially on both west and east sides. (Continuation of serial.)

Electrostatically Coupled Circuits

A Study of Electrostatically Coupled Circuits, W. Orland Lytle. Proc. Inst. Radio Engrs., vol. 7, no. 4, Aug. 1919, pp. 427-444, 60 figs. Claims to have found by theory and also by experiment that by one method of tuning, as circuits are coupled closer, one wave length remains constant while other approaches infinity, thereby concentrating and increasing proportion of energy in one wave. It is shown by curves and by Braun tube figures that when ratio of the two wave lengths is a whole number, the root-mean-square value of the current is a maximum.

French Telegraph Construction

Notes on French Telegraph Construction, Capt. P. Dunsheath. Post Office Elec. Engrs. Jl., vol. 12, no. 2, July 1919, pp. 87-91, 7 figs. Comparing French with British methods.

Overland Work

Radio Telegraphy in Competition with Wire Telegraphy in Overland Work, Robert Boyd Black. Proc Inst. Radio Engrs., vol. 7, no. 4, Aug. 1919, pp. 391-407, 1 fig. Recommends radio duplex circuits, reception with loud-speaking receivers and amplifiers, trunk and way circuits from large radio centers of traffic and relaying stations as means to overcome obstacles in way of successful competition of overland radio service versus wire service. Organization and operation of Pacific coast chain of duplex radio stations of Federal Telegraph Company are described.

Quenched Gap

On the Multi-Section Quenched Gap, M. Shuleikin and I. Freiman. Proc. Inst. Radio Engrs., vol. 7, no. 4, Aug. 1919, pp. 417-425, 5 figs. Writers consider relation between breakdown voltage of series of quenched gap sections and that of a single section. Relation of direct proportionality is found not to hold because of electric flux leakage from each plate to nearby plates and neighboring conductors. Limiting value of breakdown voltage of a number of gaps of given length is shown graphically for various values of flux leakage and breakdown voltage of gaps.

A Special Type of Quenched Spark Radio Transmitter, D. Galen McCaa. Proc. Inst. Radio Engrs., vol. 7, no. 4, Aug. 1919, pp. 409-415, 4 figs. Apparatus is so arranged that capacity in highly damped primary circuit is that between a special extra antenna and ground, and primary and secondary circuits are partly capacitively coupled by capacity between special antenna and usual secondary antenna, and partly inductively coupled through common inductance in ground lead.

Radio-Telephones

Radio-Telephone Development in Army, Nugent H Slaughter, Francis Gray and John W. Stokes. Elec. World, vol. 74, no. 7, Aug. 16, 1919, pp. 340-343, 7 figs. Historical and technical summary.

Sending and Receiving

Simultaneous Sending and Receiving, Ernst F. W. Alexanderson. Proc. Inst. Radio Engrs., vol. 7, no. 4, Aug. 1919, pp. 363-378, and (discussion) pp. 379-390, 19 figs. System described involves transferring received speech from separate receiving antenna at some distance from receiving antenna to subscriber's line, and transferring speech originating at subscriber's station to radiophone transmitter. A directional combination of aperiodic antennæ, with unilateral directional characteristic "barrage receiver" is also described.

Telephone Cable Tunnels

Conduit Construction in Telephone Cable Tunnels. Elec. Rev., vol. 75, no. 8, Aug. 23, 1919, pp. 301-303, 6 figs. Average length is about 700 ft. and depth beneath level of sidewalk varies from 80 ft. to 90 ft. Tunnels are built entirely of concrete.

Telephone Control System

West Ham's Telephone Control System. Electric Ry. Jl., vol. 54, no. 8, Aug. 23, 1919, pp. 397-398, 4 figs. Introduction of system for control of traffic conditions in London suburb said to have reduced accident costs.

Telephone Exchanges

Comments on Automatic-Manual Consolidation, H. E. Brockwell. Telephone Engr., vol. 22, no. 2, 1919, pp. 55-58. Converting present central energy manual equipment in Winnipeg exchanges to automatic mechanical operation.

Telephone Line, Current Propagation

Propagation of a Current in a Homogenous Telephonic Line (Propagation du courant sur une ligne téléphonique homogène), J. B. Pomey. Revue Générale de l'Electricité, vol. 6, no. 5, Aug. 2, 1919, pp. 131-134. Formulæ applicable to artificial line formed of identical sections.

Telephone Repeater

The Telephone Repeater. Post Office Elec. Engrs. Jl., vol. 12, no. 2, July 1919, pp. 70-75, 6 figs. Diagram of equal potential system which is used in some cases where Edison difference in circuit has been found unstable. (Continuation of serial.)

Telephone Signalling System

A Modified Common Battery Signalling Telephone System, H. W. White. Post Office Elec. Engrs. Jl., vol. 12, no. 2, July 1919, pp. 115-118, 7 figs. Suggested for use in centers where suitable power supply for charging secondary cells does not exist.

Telephone Systems

Unification of the Manual and Automatic Telephone Systems, D. E. Wiseman. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 8, Aug. 1919, pp. 1011-1026, 10 figs. Operating and construction methods contained in plans for physical union of Bell manual and Automatic Electric telephone systems of Los Angeles, Cal.

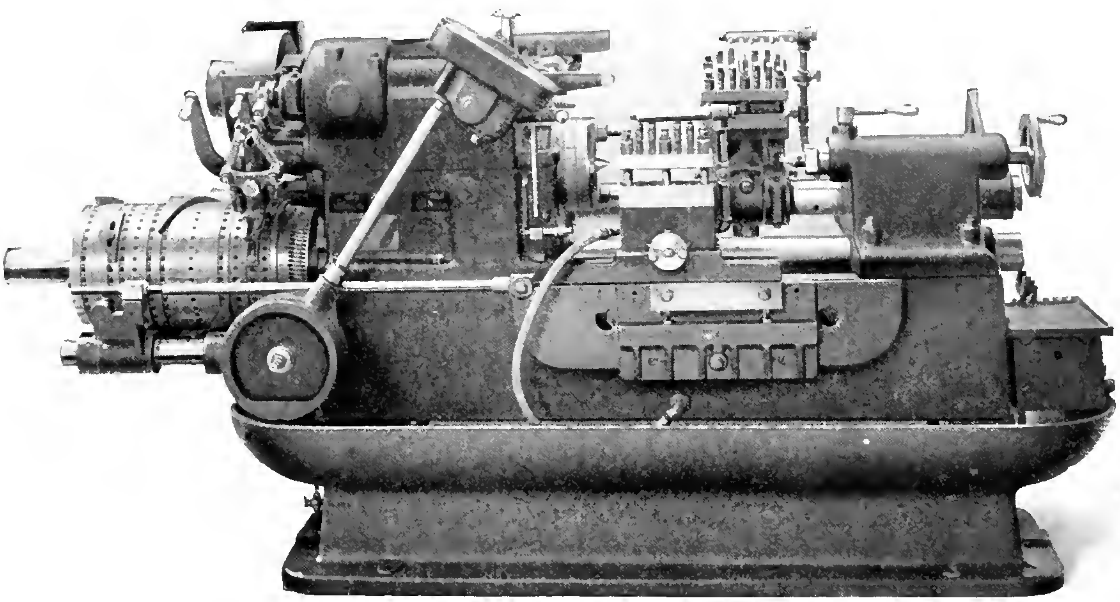
Waves, Electric

The Scientific Problems of Electric Wave Telegraphy, J. A. Fleming. Jl. Roy. Soc. Arts, vol. 67, no. 3481, Aug. 8, 1919, pp. 597-605. Theory of generation and radiation of electric waves.

Wireless Telephone Transmitter

Wireless Telephone Transmitter for Seaplanes. Elec. Rev., vol. 75, no. 6, Aug. 9, 1919, pp. 237-241, 5 figs. Light-weight but powerful set developed for use by Navy's flying boats during war.

The Fay Automatic Lathe



An automatic machine for simultaneous turning, facing and shouldering cuts on bar stock and centered forgings, such as pinion shafts, steering knuckles, cam shafts, etc.

An automatic machine for second operations on work held on centered arbors, such as spur and bevel gear blanks, hubs, pulleys, etc.

Designed with strength and driving power to carry all the tools, speed, and feed the work will stand under balanced cuts.

JONES & LAMSON MACHINE COMPANY

SPRINGFIELD, VERMONT, U. S. A.

109 Queen Victoria Street, London, E. C.

France, Spain and Belgium: F. Auberty & Co., 91 Rue de Maubeuge, Paris
Holland: Spliethoff, Beeuwkes & Co., Rotterdam

SEE OUR DATA IN 1919 A.S.M.E. CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT

C2

TRANSFORMERS, CONVERTERS, FREQUENCY CHANGERS

Amplifiers

Amplifiers for Direct Currents and for Currents of Very Low Frequency (Amplificateurs pour courants continus et pour courants de très basse fréquence), Henri Abraham and Eugène Bloch. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 26, June 30, 1919, pp. 1321-1323. Interconnections by means of auxiliary batteries.

Cores and Coils

Cores and Coils for Transformers-I, Arthur Palme. Power, vol. 50, no. 6, Aug. 5, 1919, pp. 212-215, 16 figs. Structural details.

Electric-Furnace Transformers

Static Transformers for Use with Electric Furnaces. Elecn., vol. 83, nos. 2148 and 2149, July 18 and 25, 1919, pp. 69-70 and 89-90, 6 figs. July 18: Characteristics of British Westinghouse types. July 25: Layout of furnace plant. Also in Iron & Coal Trades Rev., vol. 99, no. 2681, July 18, 1919, pp. 71-72, 5 figs. and Electrical Rev., vol. 85, no. 2174, July 25, 1919, pp. 124-126, 7 figs.

Loading

Loading a Bank of Dissimilar Transformers, H. B. Dwight. Elec. World, vol. 74, no. 5, Aug. 2, 1919, pp. 230-231, 1 fig. Calculations proposed for determination of current in each transformer for balanced load.

Phase Changers

Predetermination of Synchronous Phase-Modifier Performance, Hubert V. Carpenter. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 8, Aug. 1919, pp. 997-1003, 4 figs. Reviews method for showing behavior of transmission lines as developed by Perrine and Baum and then shows how it can be used in determining effect of use of synchronous motor operating without load for improving power factor. Effect of losses in motor shown both on line alone and on line with step-up and step-down transformers.

Rotary Converters

Pulsation of the D. C. Terminal Voltage in Rotary Converters, J. K. Kostko. Elecn., vol. 83, no. 2148 and 2149, July 18 and 25, 1919, pp. 61-63 and 86-88, 3 figs. Pulsations due to the reverse M.M.F. of armature in single-phase converters. Self-induction coefficient of a distributed winding. (Concluded.)

Secondary Connections

Secondary Connections for Constant-Current Transformers, L. Arnold. Gen. Elec. Rev., vol. 22, no. 8, Aug. 1919, pp. 632-633, 4 figs. Single circuit vs. multi-circuit.

Windings

Cores and Coils for Transformers-II, Arthur Palme. Power, vol. 50, no. 7, Aug. 12, 1919, pp. 254-256, 8 figs. Types of windings in modern transformer practice.

See also Cores and Coils.

TRANSMISSION, DISTRIBUTION, CONTROL

Feeders, Voltage Regulation

Selecting Voltage Regulators for Feeders, Frank Hersey. Elec. World, vol. 74, no. 7, Aug. 16, 1919, pp. 344-346, 2 figs. Recommendations regarding application of single and polyphase regulators for lighting and power loads.

Grounded Neutral Transmission Line

Grounded Neutral Transmission Line, W. E. Richards. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 8, Aug. 1919, pp. 1005-1010, 3 figs. Conditions on system which was originally delta-connected. In order to overcome trouble experienced whenever short-circuit occurred specially with synchronous apparatus connected to line, transmission was changed to Y-system with neutral grounded. Effect of short-circuit with new connection is alleged to have been decidedly minimized.

Load-Dispatching

Reinforcing System Operator's Memory, Frank Gillooly. Elec World, vol. 74, no. 7, Aug. 16, 1919, pp. 347-350, 5 figs. Electric chart used in load-dispatching system at Philadelphia Electric Company's plant.

Long-Distance Transmission

Transmission of Electrical Energy at Long Distances (Sur les longes lignes de transmission d'énergie électrique), P. Bunet. Revue Générale de l'Electricité, vol. 6, no. 5, Aug. 2, 1919, pp. 148-158. Comparison of direct-current with alternating-current systems.

Merz-Price System of Cable Protection

The Merz-Price System of Cable Protection, C. W. Marshall. Electrical Review, vol. 85, no. 2176, Aug. 8, 1919, pp. 165-166, 5 figs. Action depends on principle that when feeder is sound the current is the same at both ends; whereas when it is faulty, there is a difference either in magnitude or in phase between currents at two ends.

Network Calculations

Development of Analytical Solutions, Charles Fortescue. Elec. Jl., vol. 16, no. 8, Aug. 1919, pp. 350-352. Suggests separation of networks into invariable and variable portions, the latter constituting supply and load circuits.

Analytical Solutions, Robert D. Evans. Elec. Jl., vol. 16, no. 8, Aug. 1919, pp. 345-349, 21 figs. Concerning methods of solving network of power circuits.

Overhead Conductors

Overhead Conductors (Canalisations Aériennes), Ch. Vallet. Industrie Electrique, vol. 28, no. 649, July 10, 1919, pp. 246-247. Formula for computing maximum length of suspended portion of cable. (Continuation of serial.)

Overhead Mainis: Some Reflections, S. G. Leech. Electrical Rev., vol. 85, no. 2174, July 25, 1919, pp. 99-101, 6 figs. Instances of overhead installations presented as proof that such installations can be erected without visual offence.

Poles

Impregnating Poles for Aerial Lines (über gesetzmässige Aufnahmen von Imprägniermitgesetzmässige Aufnahmen von Imprägniermit-Elektrotschnik u Maschinenbau, vol. 37, no. 11, Mar. 16, 1919, pp. 105-108, 3 figs. It has been found that wood of the same kind, impregnated by the same process, under the same conditions, shows various degrees of saturation and, therefore, of resistance to rotting. Curves given show saturation points of pine poles in tests made by writer.

The Selection of Proper Wooden Poles for Aerial Cables (Uber die wahl geeigneter Holzmaste für elektrische Freileitungen), Willy Kinberg. Elektrotechnik u. Maschinenbau, vol. 37, no. 2, Jan. 12, 1919, pp. 13-17, 3 figs. Tables showing strength ratio, load ratio, breaking stress ratio, etc., of E and D poles.

Power-Factor Correction

Power Factor Correction, J. Humphrey. Colliery Guardian, vol. 118, no. 3056, July 25, 1919, pp. 228-229, 4 figs. Methods used and advantages claimed for each.

Three-Wire Systems

Three-Wire Systems, Burton McCollum and E. R. Shepard. Elec. Traction, vol. 15, no. 8, Aug. 1919, pp. 504-506, 2 figs. Diagrammatic representation of sectionalized three-wire system.

Transient Phenomena

Problems in High Tension Power Transmission, W. P. Dobson. Sibley Jl., vol. 33, no. 6, July-Aug. 1919, pp. 74-78, 6 figs. With special reference to line transients.

Transmission-Line Construction

Analysis of Transmission-Line Construction, D. D. Ewing. Elec. World, vol. 74, no. 8, Aug. 23, 1919, pp. 406-407, 4 figs. Empirical equation and graphs establishing relations between line voltage and line length, service capacity, spacing of conductors and tower height.

WIRING

Wire Capacity

Selecting Conduit Size for Power-Plant Wiring, A. R. Zahorsky. Elec. World, vol. 74, no. 8, Aug. 23, 1919, pp. 399-400, 2 figs. Curves for determining wire capacity of wrought iron in conduit.

Wire Joints and Connections

Various Types of Wire Joints and Connections, Ry. Elec. Engr., vol. 10, no. 8, Aug. 1919, pp. 281-284, 22 figs. With notes on selection of splices according to size of conductors and kind of service required.

VARIA

Appraisals

Practice in making Electric Utility Appraisals, Charles W. McKay. Elec. Rev., vol. 75, no. 6, Aug. 9, 1919, pp. 226-230, 4 figs. Methods used in inventory of land, buildings and outside plant.

Switchboard

A Lighting and Experimental Switchboard, R. Drilhon. Model Engr. & Elecn., vol. 41, no. 951, July 17, 1919, pp. 49-51, 6 figs. Features of board made for controlling light in a photographic dark room and for providing necessary current for electrical experiments.

Theory of Probabilities

Theory of Probabilities Applied to Failures of Suspension Insulators, L. M. Klauber. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 8, Aug. 1919, pp. 959-972, 3 figs. After finding minimum number of insulators per string required for any given operating conditions, writer points out method of determining amount of extra insulation desirable from an insurance standpoint according to law of probabilities. Equations are developed from which probability of failure for any given case or ratio between probabilities for any pair of cases may be determined directly.

Civil Engineering

BRIDGES

Arches

Flat Arches on High Piers, South Side Bridge, Fairmont. Eng. News-Rec., vol. 83, no. 6, Aug. 7, 1919, pp. 270-272, 7 figs. Three equal 116-ft. flat-arch spans preferred to other designs because of symmetrical proportion and simplicity, which are said to have resulted in lower cost.

Cofferdam

Cofferdam Experience at a Bridge in Chicago River, Hugh E. Young and William A. Mulcahy. Eng. News-Rec., vol. 83, no. 6, Aug. 7, 1919, pp. 268-269, 2 figs. Flooding due to inaccurate record of old tunnel. Movement of wall in deep water led to heavier construction.

Condemned Bridge

Rondout Creek Bridge Design Condemned for Excessive Load on Batter Piles. Eng. News-Rec., vol. 83, no. 7, Aug. 14, 1919, pp. 329-332, 3 figs. Outline of design condemned by N. Y. State Highway Commissioner because of considered foundation dangers and belief that superstructure design was not adapted to site.

Concreting

Concreting the Winnipeg Aqueduct. Contracting, vol. 9, no. 3, Aug. 1, 1919, pp. 69-70, 9 figs. Structure consists of concrete conduit having horseshoe-shape cross-section varying from 5 ft. 5 in. high by 5 ft. 4 in. wide to 9 ft. high by 10 ft. 9 in. wide and containing 310,000 yd. of concrete.

Electric Equipment

Utilizing Electric Power at Movable Bridges, Mark H. Reasonu. Ry. Elec. Engr., vol. 10, no. 8, Aug. 1919, pp. 285-287, 4 figs. Methods used in group of five railway bridges built side by side over Calumet river at South Chicago, Ill.

Portland

Cross-River Traffic Problems at Portland, W. A. Scott. Eng. World, vol. 15, no. 4, Aug. 15, 1919, pp. 38-40, 3 figs. Data relative to type and construction of several existing bridges.

Repairs

Extraordinary Repairs Made to a 1900-Ton Drawbridge, Thomas D. Fulton. Eng. News-Rec., vol. 83, no. 8, Aug. 21, 1919, pp. 366-369, 7 figs. Turntable, wheels and drum failing. Number of wheels was increased and new upper treads placed. Drum parts restored by heating and jacking.

Timber Bridges

Timber Bridge Problems on the Alaska Railway. Eng. News-Rec., vol. 83, no. 9, Aug. 28, 1919, pp. 420-422, 5 figs. Standard designs for 121-ft. spans on sheathed pile piers.

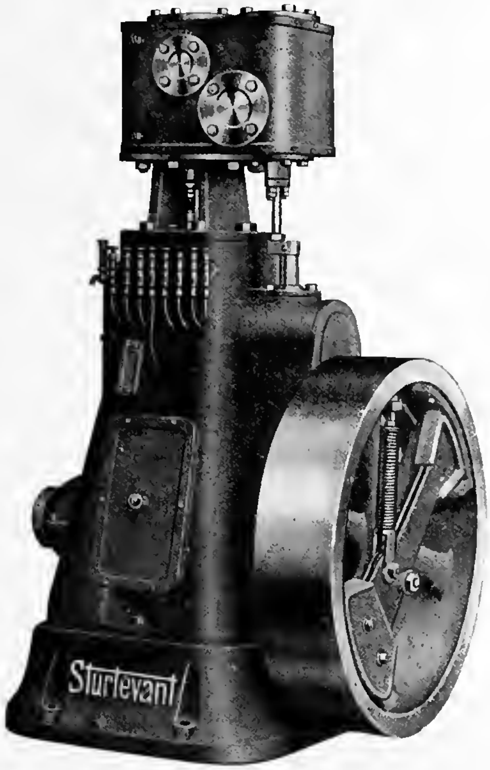
Viaducts

The Bloor Street Viaduct, Toronto, Ontario, Thomas Taylor. Jl. Eng. Inst. Can., vol. 2, no. 7, July 1919, pp. 485-498, 17 figs. Including practice in grading of sand, and testing concrete and other miscellaneous materials.

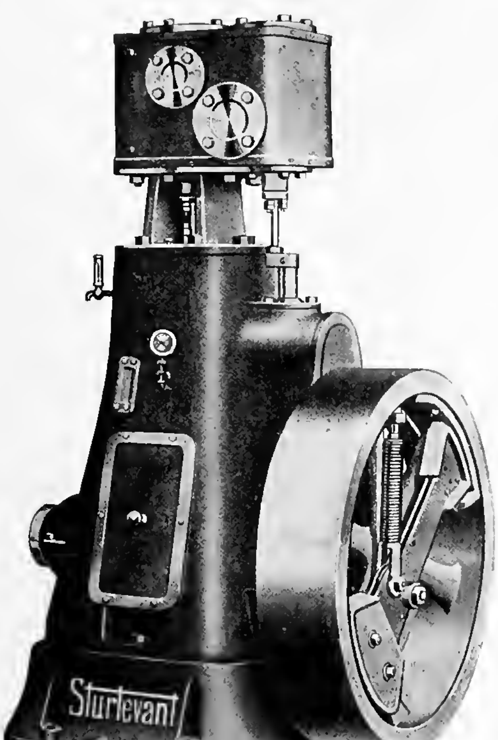
BUILDING AND CONSTRUCTION

Appearance

Aesthetic Treatment of Plant Structures. Iron Age, vol. 104, no. 7, Aug. 14, 1919, pp. 427-429, 6 figs. Details of buildings erected by Steel & Tube Co. of Am. at its Iroquois and Mark plants, which were designed with a view to meet needs of employees.



VS-7 Engine showing sight oil feeders of gravity oiling system



VS-8 Engine with forced feed lubrication

Sturtevant

(REG. U. S. PAT. OFF.)

STEAM ENGINES

are now made in two types only:

VS-7 & VS-8 (Vertical, Single Cylinder)

All others have been eliminated to enable us to meet the demand for these two types.

The difference between these two is one of lubrication—VS-7 is gravity, while the VS-8 is forced feed—both systems have their friends.

These engines were designed to fulfill the U. S. Navy specifications, which means that they must have the utmost reliability under all conditions of service.

Our engine department was 100% engaged in government work, and we are proud of the fact that our standard engines were accepted without a single alteration.

These engines are both used for direct connection to blowers, fans, generators, and for independent power service, automatic and throttling.

There is so much to tell that we have prepared a special catalog, No. 239, giving complete details. It is worth reading, and is yours for the asking.

B. F. STURTEVANT COMPANY

Hyde Park, Boston, Mass.

AND IN ALL PRINCIPAL CITIES

Beams

Reinforced-Concrete Structures (Construcciones de mamposteria armada). L. Ivanissevich. Ingenieria, vol. 23, no. 10, May 16, 1919, pp. 617-628, 9 figs. Formulæ for designing beams.

Block Yard

Block Yard Cheaply Improvised from Old Equipment. Eng. News-Rec., vol. 83, no. 8, Aug. 21, 1919, pp. 356-357, 6 figs. How contractor is being able to produce output of 60 blocks per man per day.

Bridge Construction

Electricity Cuts Construction Plant Power Costs. Eng. News-Rec., vol. 83, no. 7, Aug. 14, 1919, pp. 311-312, 3 figs. System for handling concrete in large arch bridge construction.

Caissons

Telescopic Foundation Caissons Sunk in Bank Basement. Frank H. Eastman. Eng. News-Rec., vol. 83, no. 8, Aug. 21, 1919, pp. 369-370, 1 fig. Support 275-ton vault of Central Union Trust Co., New York City. Columns rest on brick piers supported on quicksand only one ft. below cellar floor.

Cement Stucco

Practice for Portland Cement Stucco. Contract Rec., vol. 33, no. 31, July 30, 1919, pp. 741-743. Recommendations of Am. Concrete Inst. Committee.

See also Finishing.

Churches

Some Principles of Design and Construction in Church Building. Charles H. Moore. Architectural Record, vol. 46, no. 2, Aug. 1919, pp. 115-122. Simple design intended to suit needs of rural community; also considerations in regard to future developments of this branch of architecture in America.

Community Houses

The Community House as a War Memorial. Martha Candler. Am. Architect, vol. 116, no. 2277, Aug. 13, 1919, pp. 195-201 & 205-207, 10 figs. Plans and details of Read Memorial Community House at Purchase, N. Y.

New Principles Governing Planning of Civic Buildings. William Roger Greeley. Am. Architect, vol. 116, no. 2277, Aug. 13, 1919, pp. 208-211, 4 figs. Illustrating various plans for community buildings.

Concrete Foundations

Building Concrete Foundations. Ernest Irving Freese. Building Age, vol. 41, no. 8, Aug. 1919, pp. 250-251, 5 figs. How to proportion mix to make them waterproof.

Cottages

Erect 66 Sea Shore Cottages of Concrete. Concrete, vol. 15, no. 2, Aug. 1919, pp. 51-54, 17 figs. Features of design. Walls are of monolithic construction; cost was 22.4 cents per cu. ft.

Docks

The Building of the Municipal Docks at St. Louis. M. Serkes. Am. City, City Edition, vol. 21, no. 2, Aug. 1919, pp. 113-116, 2 figs. Built with coöperation of city and federal governments.

Factories

Modern Daylight Factories. Albert M. Wolf. Eng. World, vol. 15, no. 3, Aug. 1, 1919, pp. 21-26, 8 figs. Economic value of installing modern improvements in factory buildings.

Finishing

Methods of Finishing Cement Stuccos. Contract Rec., vol. 33, no. 32, Aug. 6, 1919, pp. 753-754. Dash, sand float, and exposed aggregate finishes. From committee report presented to Am. Concrete Inst.

Frame Houses

Bolts in Field Connections of Steel-Frame Buildings: a Study of Data and Experience. R. Fleming. Eng. News-Rec., vol. 83, no. 7, Aug. 14, 1919, pp. 316-321, 4 figs. Experimental investigation to determine whether substitution of bolting for riveting of steelwork can be satisfactorily effected in specifications for steel-frame buildings.

Gardens

Ottawa Housing Commission Has Prepared Ideal Garden Development Plan. Contract Rec., vol. 33, no. 33, Aug. 13, 1919, pp. 775-778, 1 fig. One-eighth of area set aside for open spaces.

Gypsum Construction

Gypsum Construction for Railway Terminals. Curtis F. Columbia. Eng. World, vol. 15, no. 4, Aug. 15, 1919, pp. 33-37, 5 figs. Claimed advantages based on laboratory experiments.

Housing

Keeping the Costs of Building the Government Houses. John C. Prior and Herbert P. Green. Eng. News-Rec., vol. 83, no. 6, Aug. 7, 1919, pp. 252-261, 7 figs. System reporting progress and cost used by U. S. Housing Corporation.

Modern Housing Standards at Dawson, New Mexico. Charles F. Willis. Coal Age, vol. 16, no. 6, Aug. 7, 1919, pp. 220-224, 20 figs. Types of houses erected by Phelps-Dodge Corpn. for use of mine workers.

Workingmen's Houses in Italy-I. Alfredo Melani. Architectural Record, vol. 46, no. 2, Aug. 1919, pp. 176-185, 7 figs. Legislation enacted relative to construction of such dwellings by State.

Solving the Problem of the Low Cost House. Am. Arcaitect, vol. 116, no. 2278, Aug. 20, 1919, pp. 229-234, 14 figs. Typical designs erected by various shipbuilding plants by U. S. Shipping Board Emergency Fleet Corporation.

The Engineering Aspect of the Housing Problem. Eng. Rev., vol. 33, no. 1, July 15, 1919, pp. 9-10. Points out manner of effecting economy in connection with internal woodwork.

The New London Housing Project. Louis L. Tribus. Man. Jl. & Public Works, vol. 47, no. 7, Aug. 16, 1919, pp. 102-104, 4 figs. General plan of procedure in carrying out project involving a million and a quarter dollars.

Japanese Design

The Principles of Japanese Design. Francis Taylor Piggott. Jl. Roy. Soc. of Arts, vol. 67, no. 3478, July 18, 1919, pp. 555-563 and (discussion) pp. 563-566, 13 figs. Architectural characteristics in their relation to artistic beauty.

Moving Houses

Moving Reinforced Concrete Building to a New Site. Jack L. Schnitz. Concrete, vol. 15, no. 2, Aug. 1919, pp. 60-62, 4 figs. Three-story, 3000-ton structure, 60 ft. x 95 ft. moved one city block at Detroit.

Quillet System of Construction

Quillet System of Construction (Système de construction Quillet). Bulletin Technique de la Suisse Romande, vol. 45, no. 16, Aug. 9, 1919, pp. 157-160, 8 figs. Cement bricks are provided with gudgeons which permit them to hold rigidly together, thus making construction quasi-monolithic.

Reservoir

St. Paul Covered Reservoir. Cement & Eng. News, vol. 31, no. 8, Aug. 1919, pp. 24-26, 2 figs. Reinforced-concrete 30,000,000-gal. reservoir built with movable concrete-mixing and spouting plant.

Roofing

Roofing Ordinance Proposed for Indianapolis. Construction, vol. 8, no. 6, June 1919, pp. 273-274. For the purpose of insuring safety against fire in construction.

German Regulations for Reinforced Concrete Roofs (Der neue Ministerialerlass über ebene Steindecken vom 23 November 1918). Beton u. Eisen, vol. 18, no. 4/5, Mar. 5, 1919, pp. 51-52. Stipulate composition of concrete and strength and bending moment of slabs for flat roofs.

Barn Roof Design. J. L. Strahan. Trans. Am. Soc. Agricultural Engrs., vol. 12, Dec. 1918, pp. 57-75, 6 figs. Observes that Shawver truss is not a true truss in the sense that it is truly rigid. Writer recommends modifications to make it so.

Stirrups in Concrete Beams

Diagram for Locating Stirrups in Concrete Beams. M. J. Lorente. Eng. News-Rec., vol. 83, no. 7, Aug. 14, 1919, pp. 310-311, 2 figs. Graphs for spacing vertical stirrups in uniformly loaded beam for two methods of stress distribution.

Tanks

Concrete Fuel-Oil Tank Design and Construction. Eng. News-Rec., vol. 83, no. 7, Aug. 14, 1919, pp. 322-323. Precautions to be observed in building small oil-storage reservoirs for use in industrial plants.

Reinforced Concrete Tanks. F. W. Frerichs. Popular Engr., vol. 12, no. 2, Aug. 1919, pp. 10-12, 3 figs. Details of large storage tanks for ammoniacal liquors. Paper read before Am. Inst. Chem. Engrs.

Tank Construction—XXX. Ernest G. Beck. Mech. World, vol. 66, no. 1699, July 25, 1919, pp. 42-43, 6 figs. Methods of supporting wall sheeting in tanks of large depth. (Continuation of serial.)

Tile Houses

Damp-proofing Hollow Tile Houses. Perry R. MacNeille. Construction, vol. 8, no. 6, June 1919, pp. 279-284, 3 figs. Account of various practices.

CEMENT AND CONCRETE

Boiler House

Concrete Used in Boiler-House Structure and Fittings. George S. Nobles. Eng. News-Rec., vol. 83, no. 6, Aug. 7, 1919, pp. 262-263, 4 figs. Coal hoppers, forced-draft air ducts, and boiler breeching made of reinforced concrete at Brooklyn Navy Supply Base heating plant.

Concrete-Block Casting

Efficient Plant for Casting Concrete Blocks for Miami River Revetment. Eng. & Contracting, vol. 52, no. 8, Aug. 20, 1919, pp. 214-215, 4 figs. Blocks are molded in small flat cars, 16 blocks per car, remaining on cars from time they are cast till they are unloaded in storage yards.

Gravel

Missouri Sand and Gravel-I. Cement, Mill & Quarry, vol. 15, no. 4, Aug. 20, 1919, pp. 11-17, 21 figs. Method of production. From report of Missouri Bur. of Geology and Mines.

Rodding

Effect of Rodding Concrete. F. E. Giesecke. Can. Engr., vol. 37, no. 7, Aug. 14, 1919, pp. 217-218, 2 figs. Tests made at University of Texas to determine physical properties as determined by relative quantity of cement. From University Bul. no. 1815.

Cause of Adherence of Concrete to Steel in Reinforced-Concrete Structures (Sur le cause de l'adhérence du béton au fer dans les constructions en béton armé). Vasilesco Karpen. Comptes rendus des séances de l'Académie des Sciences, vol. 169, no. 1, July 7, 1919, pp. 21-23. Arguments offered in proof that cohesion is due to friction.

Texas, Concrete Aggregate

Tests of Concrete Aggregates Used in Texas. J. P. Nash. Univ. of Texas Bulletin, no. 1771, Dec. 20, 1917, 80 pp., 8 figs. Aggregates were tested by incorporating them in concrete and determining various properties of resultant concrete. Data are given regarding water used, age, crushing strength, number of specimens tested, weight of concrete and amount of cement per cu. yd. of laid concrete.

Waste-Heat Utilization

The Manufacture of Cement at Bellevue, Mich. C. M. Wright. Cement & Eng. News, vol. 31, no. 8, Aug. 1919, pp. 37-39, 1 fig. Practice in shutting down kiln and method of utilizing waste heat.

Wood for Reinforcing Concrete

Wood as Reinforcement for Concrete (Holz und Schilf als Ersatz des Eisens in der Zugbewehrung). v. Emperger. Beton u. Eisen, vol. 18, no. 4/5, Mar. 5, 1919, pp. 46-48, 7 figs. Well-seasoned impregnated wood, completely covered with concrete, said to have given satisfactory results at Vienna.

EARTHWORK, ROCK EXCAVATION, ETC.

Conduits Under Dams

Miami District Completes Conduits Under Dams. Eng. World, vol. 15, no. 4, Aug. 15, 1919, pp. 13-16, 4 figs. Purpose of conduits is to convey normal discharge of respective streams under dams without holding back water of streams, except during flood stages. Conduits were built in sections with both horizontal and vertical joints.

Dams

Protective and Restoration Work at Chandpatha Dam, Sipri. S. K. Gurtu. Indian Eng., vol. 65, no. 18, May 3, 1919, p. 250, 5 figs. on supp. plate. Examining entire foundation and restoring portion carried away by uplift.

See also Conduits under Dams.

Big Eddy Dam on Spanish River. Contract Rec., vol. 33, no. 34, Aug. 20, 1919, pp. 787-790, 4 figs. Dam is of gravity type, containing approximately 80,000 cu. yd. of slag concrete, 1 :3 :6 mix. Methods of foundation work with caissons described.

The Construction of the Grand River Roller Crest Dam. O. T. Reedy. Reclamation Rec., vol. 10, no. 8, Aug. 1919, pp. 374-378, 8 figs. Dam consists of six bays, each 70 feet wide.

Foundations in Quicksand

Foundations in Quicksand and Watery Gravel. Eng. News-Rec., vol. 83, no. 9, Aug. 28, 1919, pp. 414-415, 2 figs. Sinking wells for concrete cylinder piers for building foundations for Canal St. viaduct in Chicago.

Hudson River Tunnel

Hudson River Tunnel Problems, Walter C Parmley. Eng. World, vol. 15, no. 3, Aug. 1, 1919, pp. 31-34, 2 figs. Structural and construction problems of proposed tunnel.

Hydraulicking

Hydraulicking Dam Embankment on Miami Flood Control Project. Eng. News Rec., vol. 83, no. 8, Aug. 21, 1919, pp. 371-373, 3 figs. Glacial drift excavated by draglines, hauled by train to hog boxes, mixed with water and then pumped to dam.

Piercing

Piercing the Mountain Barrier between France and Spain, F. Honore. Sci. Am., vol. 121, no. 8, Aug. 23, 1919, pp. 186-187, 9 figs. Outline of projects for piercing.

Subways

New Construction Methods in Subway Work Under Philadelphia City Hall. Eng. News-Rec., vol. 83, no. 7, Aug. 14, 1919, pp. 300-309, 16 figs. Subway built from roof downward by continuous underpinning; method determined by poor character of foundation of building.

Tunnels

Chicago's Tunnels for Electric Light and Power Cables, G. B. Springer. Eng. World, vol. 15, no. 3, Aug. 1, 1919, pp. 53-58, 10 figs. Construction methods employed. Relative advantages of tunnels and conduits.

See also Piercing.

Design and Construction of the Telephone and Telegraph Tunnel Under the Chicago River at Harrison Street, William Artingstall. Mun. & County Eng., vol. 57, no. 2, Aug. 1919, pp. 58-59. Tunnel is approximately 500 ft. long and 90 ft. below street surface. Reference is made specially to shaft sinking.

The Austrian Alpine Tunnels. Ry. Engr., vol. 40, no. 475, Aug. 1919, pp. 168-171, 6 figs. Tauern, Karawanken and Wochein. Methods of construction. (Continuation of serial.)

HARBORS

Curtis Bay Pier, B. & O. R.R.

The Curtis Bay Pier of the B. & O. R. R.—I, M. A. Long. Coal Trade Jl., vol. 50, no. 32, Aug. 6, 1919, pp. 953-955, 3 figs. General features of pier said to be capable of handling 12 million tons per annum.

Dock, Stone-Shipping

Stone-Shipping Dock is patterned after Ore-Bin Type. Cement & Eng. News, vol. 31, no. 8, Aug. 1919, pp. 34-35, 1 fig. Cylindrical steel bins, loaded from cars above, discharge by gravity to steamers. Capacity 7880 tons.

Duluth Ore Dock

Duluth Ore Dock is the Largest in the World, W. H. Hoyt. Ry. Age, vol. 67, no. 8, Aug. 22, 1919, pp. 345-348, 9 figs. Dock has length of 2438 ft. and is 84 ft. above water. It has electric-light masts reaching to 120 ft. above water. Reinforced-concrete slab used for foundation.

Pearl Harbor Dry Dock

Completion of the Pearl Harbor Dry Dock, A. Russell Bond. Sci. Am., vol. 121, no. 9, Aug. 30, 1919, pp. 202-203, 11 figs. Method of construction necessitated by reason of peculiar geological conditions.

Unique Construction of Pearl Harbor Graving Dock. Contracting, vol. 9, no. 3, Aug. 1, 1919, pp. 77-79, 9 figs. Transverse floor sections built and floated to site in dry dock.

Portsmouth Navy Yard Dock

World's Largest Dry Dock Completed at Portsmouth Navy Yard at Cost of $4,000,000. Cement & Eng. News, vol. 31, no. 8, Aug. 1919, pp. 42-43, 1 fig. Basin is 1022 ft. in length; width of coping lines is 144 ft. and width of floor bottom 112 ft.

Purfleet Jetty and Viaduct

Purfleet Jetty and Viaduct. Ferro-Concrete, vol. 10, no. 12, June 1919, pp. 355-364, 11 figs. Structure equipped with cranes for discharging collier steamships. Total river frontage is 586 ft. in length.

HYDRAULIC ENGINEERING

Flood Water

Concrete Channel for Stream Over Fractured Mine Outcrop, Harley A. Coy. Eng. News-Rec., vol. 83, no. 7, Aug. 14, 1919, pp. 327-328, 3 figs. Flood water which formerly backed up creek and seeped through into mine below is now carried past broken ground.

See also Storm Water.

River Banks Erosion

The Causes of Erosion of River Banks, Col. Hoc. Eng. & Contracting, vol. 52, no. 5, July 30, 1919, pp. 123-125, 9 figs. Tendency of river to assume sinuous course explained by analysis that curve of current of liquid is like bending of loaded flexible column. Translated from Génie Civil.

River Banks Protection

Protecting the Banks of Savannah River Through Augusta, E. C. Garvin. Eng. News-Rec., vol. 83, no. 9, Aug. 28, 1919, pp. 410-412, 1 fig. Development of methods used and data on cost of rock face revetment placed in pre-war and war years.

Sand in Suspension

The Determination of the Amount of Sand in Suspension in Water, G. J. Gibbs. Central (Jl. of Old Students of City and Guilds Eng. Col., Lond.), vol. 16, no. 45, June 1919, pp. 13-20, 2 figs. Method for ascertaining amount of sand carried in suspension by running water, developed as part of problem of dealing with growth and disappearance of sand banks in estuary of river.

Storm Water

Graphical Method for Estimating Storm-Water Run-Off, Ralph W. Horner. Eng. News-Rec., vol. 83, no. 6, Aug. 7, 1919, p. 282, 1 fig. Graph constructed from formula $Q = ciA$ where Q is total run-off, c run-off coefficient of area, i intensity of rainfall, and A drainage area.

Water Storage

The General Principles of the Development and storage of Water for Electrical Purposes, J. W. Meares. Jl. Instn. Elec. Engrs., vol. 57, no. 283, June 1919, pp. 426-439, 8 figs. Also Engineering, vol. 108, no. 2798, Aug. 15, 1919, pp. 222-224, 5 figs. Examines subject from view point of delivering, and continuing to deliver, water to prime mover. Collection, storage and delivery of water on high, medium and low falls are discussed.

MATERIALS OF CONSTRUCTION

Gravel

See Sand and Gravel.

Road Making Materials, Sampling

Instructions Governing the Sampling and Inspection of Road Making Materials in New Jersey, William G. Thompson. Mun. & County Eng., vol. 57, no. 2, Aug. 1919, pp. 66-69. Prepared by State Highway Engineers.

Sand and Gravel

Properties of Sand and Gravel, A. Ledoux. Cement, Mill & Quarry, vol. 15, no. 3, Aug. 5, 1919, pp. 21-26, 4 figs. Morphological and physical; also tabulated results of granular metric analysis showing difference in percentage of fineness between several grades of sand and gravel.

MUNICIPAL ENGINEERING

Boston

Replanning Boston's Most Congested District, Elisabeth M. Herlihy. Am. City, City Edition, vol. 21, no. 2, Aug. 1919, pp. 107-112, 5 figs. Recommendations of Boston City Planning Board for providing right living conditions in "North End."

City Planning

See also Portland.

Niagara District

Regional Planning of the Niagara District, Thomas Adams. Can. Engr., vol. 37, no. 5, July 31, 1919, pp. 187-189. Future purposes of industrial development, sub-division of land, housing, transportation, sources and distribution of power, water supplies and sewerage, and general amenities. Address at Nat. City Planning Conference.

Portland

City Planning for Portland. Mun. Jl. & Public Works, vol. 47, no. 8, Aug. 23, 1919, pp. 116-118, 5 figs. Zone plans for several districts prepared by City Commission. (To be continued.)

Water Rates

Water Rates and Fire Protection Charges. Mun. Jl. & Public Works, vol. 47, nos. 5-6, Aug. 2 & 9, 1919, pp. 70-72 & 88-90. Data from several hundred cities of United States; maximum and minimum rates; changes since before the war; receipts for public hydrants and private fire protection. (To be continued.)

RECLAMATION AND IRRIGATION

Drainage Plant, Codigoro

The New Drainage Plant at Codigoro (Die neue Entwässerungs-Anlage in Codigoro), G. Müller. Schweizerische Bauzeitung, vol. 74, no. 2, July 12, 1919, pp. 14-16, 7 figs. Reinforcing the substructure for the new boiler and machine house; new pumping station. (To be continued.)

Lindsay-Strathmore Irrigation District

Construction Details of the Lindsay-Strathmore Irrigation District, California, E. Court Eaton. Eng. News-Rec., vol. 83, no. 8, Aug. 21, 1919, pp. 348-351, 6 figs. Cement-lined canals and wood and asphaltum-impregnated felt-covered steel pipe lines used.

Miami Flood Works

Miami Flood Works Involve Radical Railway Changes. Eng. News-Rec., vol. 83, no. 7, Aug. 14, 1919, pp. 313-315, 4 figs. Railways crossing flood-retarding basins shifted to high ground. Levees guard stretches crossing low-lying areas.

Naches-Selah Irrigation Canal

Reconstruction of the Naches-Selah Irrigation Canal, Elbert M. Chandler. Eng. News-Rec., vol. 83, no. 6, Aug. 7, 1919, pp. 276-279, 4 figs. Parts of old sidehill canal in disrepair replaced, under war conditions, by concrete-lined tunnels, reinforced-concrete flumes, and canal with wire-reinforced concrete.

ROADS AND PAVEMENTS

Asphaltic Pavements

Asphaltic Pavements at Ashokan, R. R. Barrett. Good Roads, vol. 18, no. 8, Aug. 20, 1919, pp. 95-96, 3 figs. Method employed in applying asphalt cement for the seal coat of bituminous-concrete roads.

Canada

Progressive Method of Road Improvement, Gabriel Henry. Can. Engr., vol. 37, no. 6, Aug. 7, 1919, pp. 203-206. Points out advantages of adopting this method in Province of Quebec. Paper read before Can. Good Roads Assn.

Concrete Roads

Stresses in Concrete Road Slabs from Wheels of Heavy Trucks, A. T. Goldbeck. Eng. & Contracting, vol. 52, no. 6, Aug. 6, 1919, pp. 165-166. Conclusions from tests conducted by U. S. Bur. of Public Roads.

See also Standard Details.

A Study of Aggregates in Concrete Paving, R. W. Scherer. Cement & Eng. News, vol. 31, no. 8, Aug. 1919, pp. 32-33, 3 figs. Opinions expressed by various investigators and engineers having had experience in road building.

Convicts

Convicts on Road Work. Mun. Jl. & Public Works, vol. 47, no. 5, Aug. 2, 1919, pp. 64-67, 4 figs. Experience with use of convicts in States of Arizona, Florida, Idaho, Illinois, Louisiana, Maryland, Nebraska, New Jersey, Oklahoma, Rhode Island, Utah, West Virginia, and Wyoming.

France

Some Lessons from French Roads, E. A. Kingsley. Mun. Jl. & Public Works, vol. 47, no. 6, Aug. 9, 1919, pp. 82-85. Bituminous treatment claimed to have proven beneficial.

Grade Crossing Elimination

Civic and Engineering Features of Grade Crossing Elimination, Allen L. Golinkin. Mun. & County Eng., vol. 57, no. 2, Aug. 1919, pp. 61-63, 1 fig. Suggested sections for railway track-depression scheme permits passengers an unobstructed view to original ground level.

Granite

Paving of Streets and Aisles, Brooklyn Army Supply Base. Eng. News-Rec., vol. 83, Aug. 28, 1919, pp. 400-402. Granite used for heavy traffic, asphalt blocks for medium and special construction, and bitulithic for light traffic.

Guards

Steel Paving Guards, Chas. F. Puff, Jr. Am. City, Town & Country Ed., vol. 21, no. 2, Aug. 1919, pp. 141-142; also Am. City, City Ed., vol. 21, no. 2, Aug. 1919, pp. 141-142, 1 fig. Results of two years' experience in Philadelphia mentioned as evidence that guard used as edge protection is direct success.

Highways Transport Committee

Highways Transport Committee for New York. Good Roads, vol. 18, no. 6, Aug. 6, 1917, pp. 77-78. Text of Reconstruction Commission's report recommending establishment of

a State Highways Transport Committee to promote marketing of farm produce by rural motor express.

Macadam Roads

Construction of Water-Bound Macadam Roads, A. Paradis. Can. Engr., vol. 37, no. 5, July 31, 1919, pp. 175-178 and 193. Experience of Quebec Province Highway officials, particularly in regard to maintaining roads subject to heavy automobile traffic. Translation of paper read in French before Can. Good Roads Assn.

Recommended Method of Resurfacing an Old Macadam Road that is Filled with Ruts and Holes, William N. Bosler. Mun. & County Eng., vol. 57, no. 2, Aug. 1919, pp. 69-70. Practice in Central Kentucky.

Water-Bound Macadam in Multnomah County, Ore., H. B. Chapman. Am. City, Town & County Ed., vol. 21, no. 2, Aug. 1919, pp. 111-114, 3 figs. Advocates construction of water-bound macadam where travel is not too great.

Maintenance

Maintenance Costs of Primary Highways in Washington for Two-Year Period, George F. Cotterill. Mun. & County Eng., vol. 57, no. 2, Aug. 1919, pp. 51-56. State funds from motor-license revenue apportioned to counties for purposes of maintenance and repairing highways. Rules, regulations and requirements are prescribed by State Highway Board.

See also Patrol System.

High Cost of Maintenance of Light Macadam Highways, Frederick Stuart Greene. Eng. News-Rec., vol. 83, no. 8, Aug. 21, 1919, pp. 353-355. Commissioner's answer to inquiry resulting from published statement that only concrete pavement would be built hereafter in New York State.

Highway Maintenance in Wisconsin—I, II, III, J. T. Donaghey. Good Roads, vol. 18, nos. 7, 8 and 9, Aug. 13, 20 and 27, 1919, pp. 87-89, 97-98 and 105-106 and p. 108, 2 figs. Aug. 13: Plan adopted by Wisconsin Highway Commission for taking care of highways by patrol system. Duties of patrolmen. Aug. 20: Specifications approved by Highway Commission. Concerning use of graders, drags and dragging. Aug. 27: Use of road planers and graders. Methods for sandy and clayey roads.

Methods of Maintaining Highways Systems Prior to Construction by the State or County, Frederic E. Everett. Am. City, Town & County Ed., vol. 21, no. 2, Aug. 1919, pp. 107-110. Particularly experience of New Hampshire.

Material-Handling Plant

Labor Saving Material Handling Plant for Concrete Road Construction, A. R. Losh. Eng. & Contracting, vol. 52, no. 6, Aug. 1919, pp. 172-173, 2 figs. Materials are received at central storage and loading plant and are sent direct to mixer in batch units by means of industrial railway equipment. From Public Roads.

Patrol System

Lessons from 1918 Experiences of Patrol System of Road Maintenance in Wisconsin. Eng. & Contracting, vol. 52, no. 6, Aug. 6, 1919, pp. 158-159, 1 fig. Data compiled by State Highway Commission. Maintenance in Wisconsin was carried out under a patrol system, supplemented in practically all counties by small gangs, for reconstruction and heavy repair work.

Road Machinery

The Selection and Use of County Road Machinery, J. R. Johnson. Mun. & County Eng., vol. 57, no. 2, Aug. 1919, pp. 64-66. Concerning factors influencing selections and precautions to take for maintaining equipment in good conditions.

Economic Utilization of Labor Saving Road Machinery, Chas. M. Upham. Good Roads, vol. 18, no. 6, Aug. 6, 1919, pp. 75-76, 2 figs. Advantages of central loading method of handling material in construction of cement-concrete pavements in Delaware. Paper presented before Am. Road Builders' Assn.

Rural Roads

Proportion and Reasonable Economy in Rural Road Design, W. G. Harger. Eng. News-Rec., vol. 83, no. 7, Aug. 14, 1919, pp. 324-327, 1 fig. Discussion of correct alignment, grades, surfacing and foundations. Comparison of recent practice with that of 10 years ago.

Recommended Practice of Mississippi Valley State Highway Departments for Concrete Road Construction. Eng. & Contracting, vol. 52, no. 6, Aug. 6, 1919, pp. 166-167. From report of conference of Mississippi Valley Assn. of State Highway Dept., held at Chicago to consider questions relating to rural concrete-road construction.

Standard Details

Standard Details of New Jersey State Highway Department Minor Features of State Roads. Eng. & Contracting, vol. 52, no. 6, Aug. 6, 1919, p. 163, 6 figs. Standard concrete gutter, standard method of banking on curves, standard wooden guard rail and standard details for catch basins and culvert pipes.

Monolithic Brick Road

New Mechanical Methods Employed with Marked Success in Building Monolithic Brick Road from Ashtabula to Conneaut, Ohio, F. A. Churchill. Mun. & County Eng., vol. 57, no. 2, August 1919, pp. 57-58, 1 fig. By means of two automatic templets which were used for fashioning concrete foundation of monolithic brick road, constructor is said to have been able to build from 1000 ft. to 1100 ft. of monolithic 16-ft. pavement in a day, including foundation and final grouting.

Standard Sections

Standard Sections of State Highway Department of Pennsylvania for Road Pavements. Eng. & Contracting, vol. 52, no. 6, Aug. 6, 1919, p. 156, 11 figs. For bituminous, concrete telford, macadam, wood-block and stone-block roads; also showing construction of car tracks.

SANITARY ENGINEERING

Cleaning

The Cleaning of Receiving Basins and Grit Chambers by Hydraulic Methods, Charles E. Gregory. Am. City, Town and County Ed., vol. 21, no. 2, Aug. 1919, pp. 151-153. Practice in Borough of Manhattan, N. Y. City.

Grease Interception from Sewage

Grease Interception from House Sewage, H. J. Belmont. Domestic Eng., vol. 88, no. 6, Aug. 9, 1919, pp. 249-251 and 285, 5 figs. Grease traps of various kinds.

Grit Chambers

See also Cleaning.

Incinerators

Incinerators Used at Cantonments. Mun. Jl. & Public Works, vol. 47, no. 8, Aug. 23, 1919, pp. 120-122, 6 figs. Details of design prepared by Construction Division of army for camp of twenty thousand men.

Receiving Tanks

See also Cleaning.

Refuse

Collection and Disposal of Refuse in the Future, F. W. Brookman. Can. Engr., vol. 37, no. 6, Aug. 7, 1919, pp. 207-208. Suggestions in regard to choice of wagons, in view of facilities available in consequence of war. Paper read before Inst. of Cleansing Superintendents, England.

Sewage Tanks

The Cantonment Sewage Tanks. Mun. Jl. & Public Works, vol. 47, no. 4, July 26, 1919, pp. 46-50, 3 figs. Difficulties experienced in operating, reasons therefor in opinion of several experts and means devised for their elimination; sewage of unusual concentration and high grease content.

Sewage Treatment

Electrical Treatment of Sewage: The Landreth Direct Oxidation Process, Henry Germain, Maude Creighton and Benjamin Franklin. Jl. Franklin Inst., vol. 188, no. 2, Aug. 1919, pp. 157-187, 9 figs. Description of million gallon plant erected at Easton, Penna., for demonstration purposes. Account of experimental results.

Results of the Test Run of the Direct Oxidation Experimental Sewage Treatment Plant at Easton, Pa., C. A. Emerson, Jr. Mun. & County Eng., vol. 57, no. 2, Aug. 1919, pp. 70-75, 1 fig. Consideration of performance led to conclusion that combined action upon sewage of fine screen, line treatment and electrolytic cell render sewage in such a condition that after sedimentation in properly designed tanks effluent can be discharged into a stream, affording a reasonable dilution of relatively clean water, without danger of creating nuisance.

Sewage-Treatment Works at Langley Field, Virginia, Thorndike Saville and Carl L. Weil. Eng. News-Rec., vol. 83, no. 8, Aug. 21, 1919, pp. 374-377, 6 figs. Imhoff tank with receiving bowls, inlet channels, bar screen, distributing channel with downtakes. Dosing chamber, ventilated sprinkling filters, and final settling tanks to be added.

Town Sewerage

Town Sewerage, Edward B. Savage. Surveyor, vol. 56, no. 1435, July 18, 1919, pp. 40-43 and (discussion) pp. 43-44. Concerning provision of manholes and of ventilation and freezing of sewers.

SURVEYING

Twist in Conformed Mapping

On the Twist in Conformed Mapping, T. H. Gronwall. Proc. Nat. Acad. Sciences, vol. 5, no. 7, July 1919, pp. 248-250. Importance of twist in comparison of maps of different regions.

WATER SUPPLY

Chlorination

See also Water Treatment

Gallery Water-Collecting System

Special Features of the Gallery Water Collecting System of the Des Moines Water Co., Des Moines, Ia., A. F. Luce. Mun. & County Eng., vol. 57, no. 2, Aug. 1919, pp. 75-77, 4 figs. Constructional features of each one of the infiltration galleries, with notes on geology of region.

Metering

Metering and Water Consumption, H. P. T. Matte. Can. Engr., vol. 37, no. 5, July 31, 1919, pp. 181-184. Effective installing of water meters upon consumption of water. Comparison of usage in various cities. Paper read before Western Soc. of Engrs.

Water-Purification Units, Portable

Motor Truck Mounted Water Purification Units, William J. Orchard. Eng. World, vol. 15, no. 3, Aug. 1, 1919, pp. 35-38, 7 figs. Description and operation of unit developed for A. E. F.

Water Treatment

Water Facilities for Southern at Monroe. Ry. Maintenance Engr., vol. 15, no. 8, Aug. 1919, pp. 270-272, 4 figs. Treatment given to turbid and muddy water in sedimentation basin and coagulating system.

Feed Water Treating and Purifying Plant, S. H. McKee. Blast Furnace & Steel Plant, vol. 7, no. 8, Aug. 1919, pp. 401-405, 4 figs. Treating capacity is 300,000 gal. per hr. It is noted that plant was laid out so that a 25 per cent extension can be made to give ultimate treating capacity of 375,000 gal. per hr.

Chlorination Treatment of London Water Supply Proves Pronounced Success. Contract Rec., vol. 33, no. 33, Aug. 13, 1919, pp. 779-781. Comments on speed and cost.

Action of Sodium Hyposulphite on Hypochlorites (Action de l'hyposulfite de sodium sur les hypochlorites), F. Dienert and F. Wandenbulcke. Comptes rendus des séances de l'Académie des Sciences, vol. 169, no. 1, July 7, 1919, pp. 29-30. Experiments to determine quantity of sodium hyposulphite necessary to combine with free chlorine in treatment of water.

Mining Engineering

BASE MATERIALS

Gypsum

Important Developments of Gypsum. Cement, Mill & Quarry, vol. 15, no. 3, Aug. 5, 1919, pp. 36-42. Tentative specifications for crude gypsum and calcined gypsum and for gypsum plasters proposed by Am. Soc. for Testing Materials' Committee.

Genesis of the Gypsum Industry. Curtis F. Columbia. Cement, Mill & Quarry, vol. 15, no. 4, Aug. 20, 1919, pp. 27-32, 5 figs. Brief review of the origin, mineralogical properties and geological distribution of gypsum.

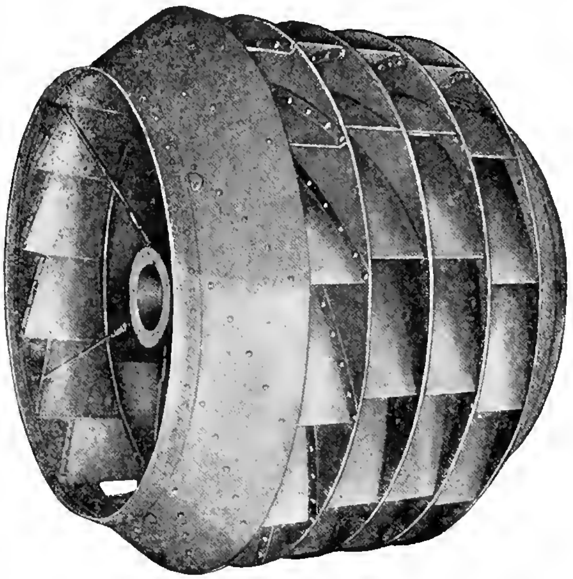
Lime

Chicago Union Lime Works Pit Deepest in Country, William B. Eastwood. Cement, Mill & Quarry, vol. 15, no. 3, Aug. 5, 1919, pp. 11-15, 6 figs. Shaft now reaches 320 ft. into dolomite deposit more than 1300 ft. in depth near center of city. Method of quarrying indicated.

Magnesite

Developments in Magnesite Industry, W. C. Phalen. Cement, Mill & Quarry, vol. 15, no. 3, Aug. 5, 1919, pp. 27-30. Outline of salient features of domestic industry, as noted by writer on recent trip to various plants in California and Washington.

More Draft for Less Power



GREEN'S
HI-EFFICIENCY HI-SPEED
RADIAL FLOW FANS

require less power and operate at higher speeds, thereby allowing direct connection to smaller motors or turbines than are generally required.

These fans are built in two types—" RB " and " RR "—for forced and induced draft respectively.

The fan housings are exceptionally large and are formed to minimize restrictive losses.

All fans are built with ample ring oiling bearings. With induced draft outfits, water-cooled bearings are used.

The " RR " rotors are so designed that the tips of the blades are radial. With this arrangement all dust and other solid matter are thrown off the blades, due to centrifugal force, and the wheel is always clean and in good running balance, even under the most trying conditions of induced draft, such as are found in cement kiln and steel mill waste heat service.

Our engineers will be glad to submit data covering the requirements of your individual draft problems.

Let us send full details. Write.

THE GREEN FUEL ECONOMIZER Co.
BEACON, N. Y.

Phosphate Rock

Process in Preparation of Phosphate Rock, R. W. St[illegible]. Rock Products, vol 22, no. 16, Aug. 2, 1919, pp. 10-12, 6 figs. Washing, dry [illegible] mining processes.

COAL AND COKE

Allegheny River Mine

A Large Coal Mine on the Allegheny River, Ralph W. Mayer. Coal Age, vol. 16, no. 8, Aug 21, 1919, pp. 316-318, 3 figs. Describing mining operations and various notes of mine. Output 500,000 tons per year.

Carbon Fuel Company

Nine Mines of the Carbon Fuel Company. Black Diamond, vol. 63, no. 6, Aug 9, 1919, pp. 126-138, 34 figs. Methods of mining, preparing and shipping coal. 1918 production of district approached ten million tons.

Classification

Composition and Classification of Domestic Coals, A. C. Fieldner. Gas Age, vol 44, no. 3, Aug. 1, 1919, pp. 104-106, 3 figs. Conclusions drawn from U. S. Bur. of Mines investigation.

Coal Formation

The Formation of Coal, J. D. Kendall. Can. Min. Inst. Bul., no. 88, Aug. 1919, pp. 877-882, 2 figs. Organic remains found in rocks.

Conditions of Formation of Coke (Sur les conditions de formation du coke), Georges Charpy and Gaston Decorps. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 26, June 30, 1919, pp. 1301-1305. Tabulation of experimental results in which effects of preliminary compression and coking temperature were specially studied.

Coke Ovens

New Vertical Coke Ovens—Pintsch Bolz type—at the Gas Works in Düsseldorf (Die neue Vertikalofenanlage "System Pintsch-Bolz" für 100,000 cbm. Tagesleistung mit zugehörigen Koks—und Kohlentransportanlagen auf dem Gaswerk zu Düsseldorf), W. Schweizer. Journal für Gasbeleuchtung u. Wasserversorgung, vol. 59, no. 16, Apr. 15, 1919, pp. 215-221, 11 figs. (To be concluded.)

Coking

The Coking of Illinios Coal in Koppers Type Oven, R. S. McBride and W. A. Selwig. Chem. & Metallurgical Eng., vol. 21, no. 3, Aug. 1, 1919, pp. 122-128, 6 figs. Operating test at plant of Minnesota By-Product Coke Company conducted jointly by Nat. Bur. of Standards and U. S. Bur. of Mines. Test is said to have clearly demonstrated that some of Illinois coals can be coked in "chamber-type" oven without radical change in operating methods for production of coke which can be successfully used in blast furnace.

See also Missouri Camel Coals and Orient Coke.

Carbonizing Illinois Coal, R. S. McBride and W. A. Selvig. Gas Rec., vol. 16, no. 3, Aug. 13, 1919, pp. 11-17, 6 figs. Results of tests made at St. Paul coke oven plant by U. S. Bur. of Mines.

Drills, Electric

Electric Coal Drills, A. H. Telfer. Iron & Coal Trades Rev., vol. 99, no. 2681, July 18, 1919, p. 79, 1 fig. Suggestions in regard to working of thin seams.

Electrical Machinery

Electricity Applied to the Mechanical Mining of Coal, C. S. B. Reed. Assn. Iron & Steel Elec. Engrs., July 1919, pp. 1-13, and (discussion) pp. 13-24. Trend of practice in selecting machine types.

Electrical Operation

St. Vincent Mine of the Mount Pleasant By-product Coal Co., P. B. Rule. Coal Age, vol. 16, no. 7, Aug. 14, 1919, pp. 264-267, 7 figs. Electrically operated mining plant with ultimate capacity of 1,500 tons a day.

Europe

Alarming Shortage of Coal in Europe, George S. Rice. Coal Industry, vol. 2, no. 8, Aug 1919, pp. 311-314. Giving coal situation in allied and neutral countries, Germany and Eastern Europe. Writer believes that countries formerly supplied by England must turn to America.

Extraction

A P[illegible] in Coal Extraction. Coal Age, vol 16, no. 6, Aug. 7, 1919, pp. 234-235, 1 fig. Account of mining conditions and present practice in coal field where present extraction varies from 10 to 50 per cent. Discussion is invited with view to development and adoption of methods that will permit better recovery.

Mining Methods

A Model Illinois Coal Mine, S. Bowles King. Mine & Quarry, vol. 11, no. 3, July 1919, pp. 1172-1185, 24 figs. Mining methods.

A Modern Mine in a Progressive State, Andrews Allen. Coal Industry, vol. 2, no. 8, Aug. 1919, pp. 303-309, 11 figs. Notes on layout and operation of Kathleen mine of Union Colliery Co. located at Dowell, Ill. Holdings consist of approximately 3143 acres of coal. Seam is from 7 to 9 ft. thick at average depth of 200 ft.

Fuel Economy in Power Production, W. T. Lane. Iron & Coal Trades Rev., vol. 99, no. 2683, Aug. 1, 1919, pp. 135-137, 4 figs. How to reduce (1) losses incurred by having to leave large pillars of coal for various purposes, (2) losses due to unsuitable methods in working seams, (3) losses due to non-working of thin seams of coal and (4) losses due to "gobbing" of small coal. Paper read before South Wales Inst. of Engrs.

Winning and Preparation of Coal, John H. Anderson. Trans. Inst. Marine Engrs., vol. 31, no. 243, June 1919, pp. 23-124, 77 figs., partly on 19 supp. sheets. Account of methods followed at various English mines. Incidentally writer suggests greater use of mechanical appliances to make it possible to work seams of coal that otherwise could not be reached.

Missouri Cannel Coals

The Carbonization of Missouri Cannel Coals. Bul. School of Mines & Metallurgy, University of Missouri, Technical Series, vol. 5, no. 1, Aug. 1919, pp. 7-49, 11 figs. Tests in which five different cannel coals were subjected to destructive distillation in gas-fired horizontal retort and compared with bituminous coal coked under similar conditions, are reported to have shown that decomposition temperature of cannel coals is much lower than that of bituminous coal.

Orient Coal

Experimental-Retort Tests of Orient Coal, R. S. McBride and I. V. Brumbaugh. Chem. & Metallurgical Eng., vol. 21, no. 4, Aug. 15, 1919, pp. 171-174, 3 figs. Investigation on influence of coking temperature upon quantity and quality of coke produced. Comparison with results obtained when using other coals.

Roof Actions

Graphic Illustrations of Roof Actions, R. Z. Virgin. Coal Industry, vol. 2, no. 8, Aug. 1919, pp. 320-321, 4 figs. Method for using wire rope to strengthen timbers suggested.

Stripping

Coal Stripping in the United States—VI. Wilbur Greely Burroughs, Coal Industry, vol. 2, no. 8, Aug. 1919, pp. 322-328, 4 figs. Approximate cost and efficiency of operations, care of stripping machinery, and tables of what has been accomplished.

Timbering

See Roof Action.

Washeries

Some Suggestions for the Standardizing of Guarantees for Coal Washeries, Sherwood Hunter. Colliery Guardian, vol. 118, no. 3056, July 25, 1919, p. 229. How to interpret "free coal" and "free dirt" in terms of specific gravity.

Washers

Further Improvements on the "Draper" Washer, J. M. Draper. Proc. of South Wales Inst. of Engrs., vol. 35, no. 1, July 18, 1919, pp. 21-32 and (discussion) pp. 32-39, 8 figs. It is claimed for this type of coal washer that it effects perfect separation without requiring skilled attention by direct upward flow of water at a rate slightly exceeding velocity fall of coal, without pulsators or mechanical motion.

Waste Utilization

Utilization of Coal Waste (L'utilisation des déchets de houille), H. Copaux. Chimie & Industrie, vol. 2, no. 6, June 1919, pp. 656-660. Extraction of by-products. Report of special committee appointed by Société de Chimie Industrielle.

COPPER

Horwood Process

The Horwood Process as Applied to the Copper-Zinc Ore of the Afterthought Mine, A. H. Heller. Min. & Sci. Press, vol. 119, no. 5, Aug. 2, 1919, pp. 151-158, 4 figs. Construction of 300-ton plant at California mine where tests with Horwood process are said to have given very promising results.

Huntingdon Mine

The Huntingdon Copper Mine, Quebec, Reginald E. Hore. Can. Min. Jl., vol. 40, no. 31, Aug. 6, 1919, pp. 582-584, 4 figs. Account of mining operations.

Slag

Method of Handling Granulated Slag in Anaconda, Oliver E. Jager. Min. & Sci. Press, vol. 119, no. 4, July 26, 1919, pp. 118-120, 6 figs. Combination of granulation and haulage methods.

EXPLOSIVES

Detonators

Equipment for Detonation of Explosives by Electricity. Eng. & Contracting, vol. 52, no. 8, Aug. 20, 1919, pp. 220-221, 1 fig. Developed by U. S. Army during the war.

Permissible Explosives

Permissible Explosives, John E. Miller. Coal Age, vol. 16, no. 6, Aug. 7, 1919, pp. 225-227, 18 figs. Safety rules and suggestions prepared by Bur. of Mines.

GEOLOGY AND MINES

Calcite Crystals

Some Notes on Japanese Minerals, Shimmatsu Ichikawa. Am. Jl. of Sci. (Fourth Series), vol. 48, no. 284, Aug. 1919, pp. 124-131, 3 figs. Concerning natural etchings of calcite crystals.

Coral-Reef Zone

The Coral-Reef Zone During and After the Glacial Period, Reginald A. Daly. Am. Jl. of Sci. (Fourth Series), vol. 48, no. 284, Aug. 1919, pp. 136-159. Theory explaining their origin based on geological facts.

Crystallography of Carbonates

Refraction Indices of Rhombohedric Carbonates (Sur les indices de réfraction des carbonates rhomboédriques), Paul Gaubert. Bulletin de la Société Française de Minéralogie, vol. 42, no. 1-3, Jan.-Mar. 1919, pp. 88-120. Measurements on crystals belonging to isomorphous series.

Deep-Level Temperatures

The Maximum Temperature in Large Tunnels and Deep Wells With a Trial Empirical Formula, F. Butavand. Eng. & Contracting, vol. 52, no. 5, July 30, 1919, pp. 119-120. Temperatures obtained by U. S. Geological Survey in wells located about five miles north of Clarksburg, W. Va., found to agree closely with those determined by suggested metrical formula. Translated from Génie Civil.

Dissociation of Carbonate Rocks

An Apparatus for Studying the Dissociation of Carbonate Rocks, G. A. Bole. Jl. Am. Ceramic Soc., vol. 2, no. 5, May 1919, pp. 410-417, 2 figs. Victor Meyer vapor density apparatus, in which steam jacket has been replaced by an electrical tube furnace.

Earthquakes

A Seasonal Variation in the Frequency of Earthquakes, Richard Dixon Oldham. Quarterly Jl. of Geological Soc., vol. 74, no. 294, July 9, 1919, pp. 99-104 and (discussion), pp. 104-105, 1 fig. on separate supp. plate. Records of observations of earthquakes occurring at time of great Indian earthquake of 1917.

Fire Clays

Notes on Fire Clays of the Northern Appalachian Coal Basin, Ellis Lovejoy. Jl. Am. Ceramic Soc., vol. 2, no. 5, May 1919, pp. 374-385 and (discussion), pp. 385-390, 1 fig. Classification into four chief flint fireclays; occurrence and properties of each.

Japanese Minerals

See Calcite Crystals.

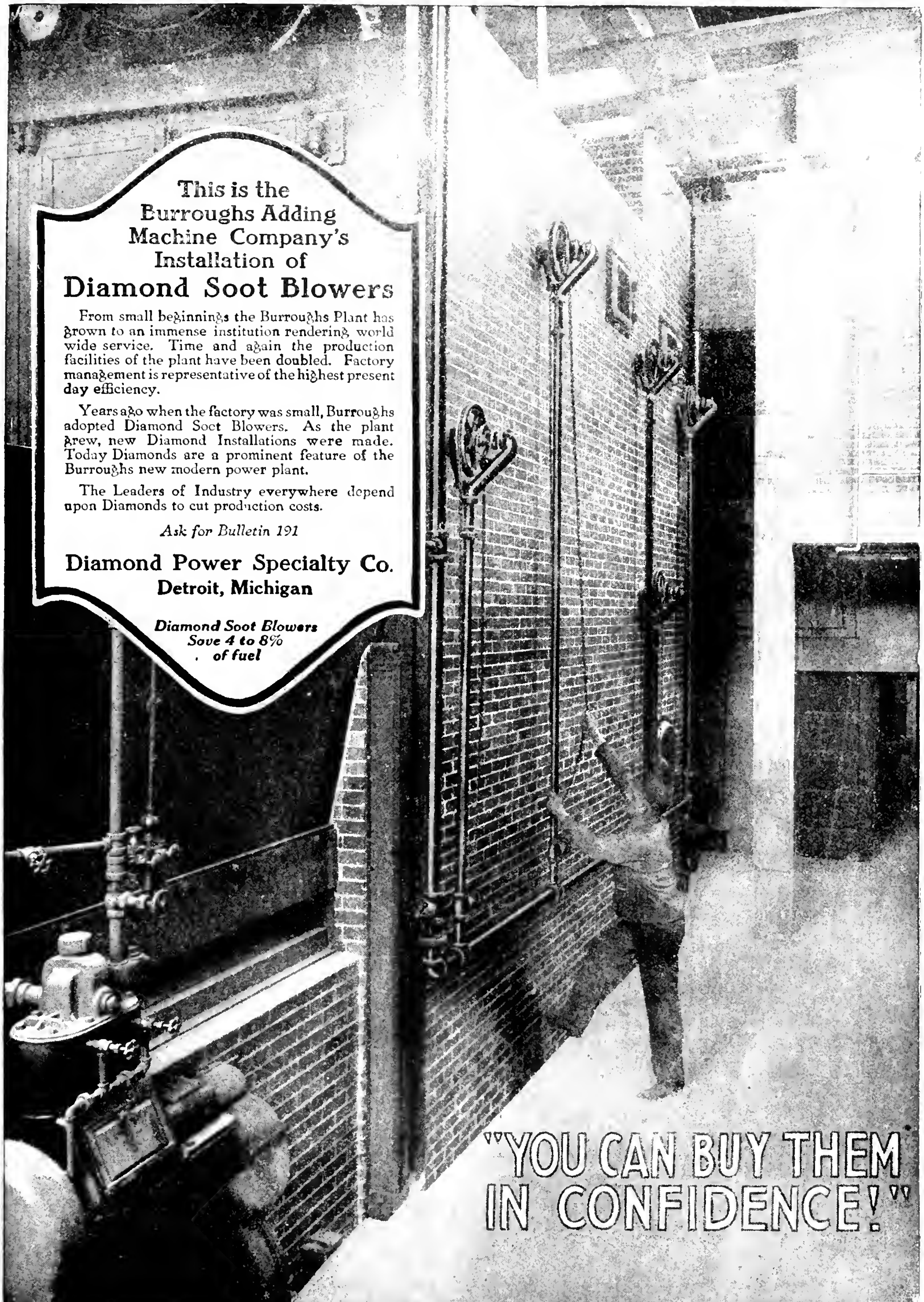
Mississippi

Mississippi—Its Geology, Geography, Soil and Mineral Resources, E. N. Lowe. Miss. State Geological Survey, Bul. no. 14, 1919, 346 pp., 20 figs. Popular presentations of previous published reports of State Geological Survey.

Pre-Cambrian

Relation of Regional Deformations to the Distribution of Ore in the Pre-Cambrian, Ellsworth Y. Dougherty. Min. & Sci. Press, vol. 119, no. 7, Aug. 16, 1919, pp. 227-230, 1 fig. Concerning hypothesis that ore deposits of hydrothermal and igneous types can be referred to igneous activity of well-marked epochs.

Some Stratigraphic and Structural Features of the Pre-Cambrian of Northern Quebec—IV, H. C. Cooke. Jl. Geology, vol. 27, no. 5, July-Aug. 1919, pp. 367-382, 1 fig. Explorations of northern Quebec show existence of fairly sharp boundary line on one side of which limestone is member of Grenville while on the other it does not appear. From theoretical conditions writer concludes that this line represents an ancient topographic break, either a shore line or a boundary of a submerged plateau.


This is the
Burroughs Adding
Machine Company's
Installation of
Diamond Soot Blowers
From small beginnings the Burroughs Plant has grown to an immense institution rendering world wide service. Time and again the production facilities of the plant have been doubled. Factory management is representative of the highest present day efficiency.
Years ago when the factory was small, Burroughs adopted Diamond Soot Blowers. As the plant grew, new Diamond Installations were made. Today Diamonds are a prominent feature of the Burroughs new modern power plant.
The Leaders of Industry everywhere depend upon Diamonds to cut production costs.
Ask for Bulletin 191
Diamond Power Specialty Co.
Detroit, Michigan
Diamond Soot Blowers
Save 4 to 8%
of fuel
"YOU CAN BUY THEM
IN CONFIDENCE!"

Sedimentation

Inequalities of Sedimentation. E. M. Kindle. Jl. Geology, vol. 27, no. 5, July-Aug. 1919, pp. 339-366. Points out various factors which make for periodic variability in rates of deposition and cites examples on existing lakes and seas to illustrate sharp contrasts in rate at which sediments accumulate at different points near the same coast line.

IRON

Canada

The Production of Coal and Iron Ore in Canada Considered in Relation to the Iron and Steel Industries. F. W. Gray. Iron & Steel of Can., vol. 2, no. 8, Aug. 1919, pp. 177-179, 2 figs. Based on statistics compiled by Dept. of Mines.

LEAD, ZINC, TIN

Lead Mines, Wanlockhead

The Wanlockhead Lead Mines. John Mitchell. Min. Mag., vol. 21, no. 1, July 1919, pp. 11-20, 3 figs. General description of South of Scotland mining district and account of records of working Leadhills and Wanlockedhead mines.

Zinc in Belgium

Zinc Industry in Belgium, March F. Chase. Dept. of Interior, Bur. Mines, Minerals Investigations Series, no. 18, May 1919, 8 pp. Economical position of industry before the war and statistics of production from 1913 to 1918.

MINES AND MINING

Air in Mines

Notes on Defective Air in Disused Raises and Backstopes. C. J. Gray. Jl. of Chem., Metallurgical & Min. Soc. of South Africa, vol 19, no. 11, May 1919, pp. 240-243 and (discussion), pp. 243-246. Result of analysis with Haldane's tube of air at various points in a disused raise in one of Witwatersrand mines.

See also Carbon Dioxide.

Apex Law

An Unusual Apex Case. R. T. Walker. Min. & Sci. Press, vol. 119, no. 8, Aug. 23, 1919, pp. 262-264, 1 fig. How litigation between two companies led to disclosure of unusual type of vein structure.

Canada, Western

The Resources of Western Canada. R. C. Wallis. Jl. Eng. Inst. Can., vol. 2, no. 8, Aug. 1919, pp. 551-554. Geological and topographical notes, together with historical account of development of mining industry.

Carbon Dioxide

A "Safety First" Method for the Estimation of CO_2 in Mine Air. H. R. S. Wilkes. Jl. of Chem., Metallurgical & Min. Soc. of South Africa, vol. 19, no. 11, May 1919, pp. 246-249. Based on standard method except that quantities used are tenths and operation of titration with oxalic acid is eliminated.

Cement Gun

Results Obtained from the Use of the Cement Gun at the Cadogan Mine. Fred Norman. Coal Age, vol. 16, no. 7, Aug. 14, 1919, pp. 269-270, 4 figs. States difficulties in operation due to bad, friable top rock, and notes how such difficulties were overcome by use of cement gun.

Dredges

A Platinum Dredger. Engineer, vol. 128, no. 3317, July 25, 1919, pp. 90-91, 4 figs. Consists of large steel-framed and plated pontoon with unusual weight for bucket ladder.

Drills

Pneumatic Electric Rock Drill and Some of the Tools Used in Its Construction. H. Frank A. Stanley. Am. Mach., vol. 51, no. 6, Aug. 7, 1919, pp. 263-266, 7 figs. Jigs and fixtures provided for operations involved in finishing of parts.

Modern Rock Drill Practice. David Penman. Min. Mag., vol. 21, no. 1, July 1919, pp. 21-28, 13 figs. Particulars of Holman piston drill, Climax Imperial hammer drill and Ingersoll Rand hammer drill. (To be continued.)

Gas Detectors

Gas Detectors for Miners' Electric Lamps. T. J. Thomas. Colliery Guardian, vol. 118, no. 3058, Aug. 8, 1919, pp. 361-362. Possibilities of research. (Concluded.)

See also Carbon Dioxide.

Laws, Mining

Common Violations of the Mining Laws. W. J. Heatherman. Coal Industry, vol. 2, no. 8, Aug. 1919, pp. 315-316. Failure to set proper timbers, shooting off solid, riding on trips, lack of adequate means of egress and ingress, recklessness and ignorance considered chief obstacles to mining safety. Paper presented before W. Va. Coal Min. Inst.

See also Apex Law.

Maps, Mine

Conventional Symbols for Mine Maps. Lester C. Uren. Min. & Sci. Press, vol. 119, no. 7, Aug. 16, 1919, pp. 231-234, 4 figs. Used by engineering students in mine mapping at Univ. of Cal.

Quarries, Ironstone

Stripping and Working Ironstone Quarries. F. H. Hatch. Quarry, vol. 24, no. 270, Aug. 1919, pp. 211-216, 5 figs. Practice in English mines. Lecture delivered at Royal School of Mines.

Roasting

Experiments in Magnetizing Roasting. George J. Young. Eng. & Min. Jl., vol. 108, no. 5, Aug. 2, 1919, pp. 176-177, 2 figs. Experimental results of tests made with pyritic concentrate.

Safety

Importance of Safety in Mining and Metallurgical Industries. W. R. Plank. Coal Age, vol. 16, no. 6, Aug. 7, 1919, pp. 228-231, 5 figs. Proposes establishment of safety departments, greater coöperation between employer and employee and continued training in first-aid and mine rescue work, as means of curtailing accidents.

Signaling Systems

Mine Electric Signaling Practice. Terrell Croft. Coal Age, vol. 16, no. 8, Aug. 21, 1919, pp. 308-312, 11 figs. Particulars of various signaling systems.

Skip-Change

Skip-Changing Device at the Steward Mine. Oliver E. Jager. Min. & Sci. Press, vol. 119, no. 6, Aug. 9, 1919, pp. 187-190, 5 figs. Device is of hinged guide and crawl type.

U. S. Production, 1916

Mineral Production of the United States in 1916. H. D. McCaskey and Martha B. Clark. Dept. of Interior, U. S. Geological Survey, Series 13A, June 28, 1919, 70 pp., 1 fig. Statistics including comparison with earlier years.

MINOR INDUSTRIAL MATERIALS

Tungsten

Tungsten and Its Importance in Industry (Wolframmetall und seine Bedeutung für die Industrie). Hugo Lohmann. Elektrotechnische Zeitschrift, vol. 25, no. 11-12, Feb.-Mar. 1919, pp. 141-143. As a substitute for diamonds in tool manufacture, for the chemical industry (crucibles, tubes), for the manufacture of electric bulbs, etc.

Tungsten and the Utilization of Slag in the Mining Industry (Wolframgewinnung und Schlackenverwertung im Bergwerksbetriebe). Zeitschrift f. die gesamte Giessereipraxis, vol. 40, no. 6, Feb. 8, 1919, pp. 65-66. Tungstic acid recovered from some tin slag amounted to from 10 to 15 per cent.

OIL AND GAS

England

Oil in England. J. Ford. Iron & Coal Trades Rev., vol. 99, no. 2682, July 25, 1919, pp. 110-111, 3 figs. Account of Derbyshire investigations which led to finding free oil.

Gas, Natural

Transportation and Distribution of Natural Gas. H. A. Quay. Gas Age, vol. 44, no. 3, Aug. 1, 1919, pp. 102-103. Improvements obtained by installation of meters.

Metering

See Gas, Natural.

Mississippi

Oil and Gas Prospecting in Mississippi. E. N. Lowe. Miss. State Geological Survey, Bul. no. 15, 1919, 78 pp., 2 figs. Condensation of reports of actual investigations and of data presented in publications of various scientific organizations.

Prospecting

See Mississippi.

Sealing

Sealing Formations by Slime-Laden Fluid. Seth S. Langley. Eng. & Min. Jl., vol. 108, no. 7, Aug. 16, 1919, pp. 268-271, 4 figs. Methods for controlling gas pressure, preventing migration of oil, gas, and water, and preparing wells for abandonment.

Shales

Oil Shales. Louis Simpson. Chem. & Metallurgical Eng., vol. 21, no. 4, Aug. 15, 1919, pp. 176-178. Suggestions in regard to selecting method of retort.

Well Drilling

The Rotary Method of Well Drilling. Albert G. Wolf. Eng. & Min. Jl., vol. 108, no. 5, Aug. 2, 1919, pp. 171-175, 5 figs. Process of sinking oil and gas wells in unconsolidated strata by means of bits used in alternating hard and soft formations.

PRECIOUS MINERALS

Aspen

See Silver Ore.

Ontario

West Shining Tree Gold District, Ontario. L. H. Goodwin. Eng. & Min. Jl., vol. 108, no. 7, Aug. 16, 1919, pp. 261-264, 4 figs. Notable feature of prospects in area is said to be presence of spectacularly rich specimen ore carrying heavy gold.

Silver Ore

Deep-Level Development in Aspen. Frederick W. Foote. Eng. & Min. Jl., vol. 108, no. 5, Aug. 2, 1919, pp. 178-180, 4 figs. Concentration by jigs and tables. Camp contains silver-ore deposits in sedimentary rocks.

Metallurgy

BLAST FURNACES

British Blast-Furnace Plant

The Glengarnock Works of David Colville and Sons, Limited. Engineer, vol. 128, no. 3317, July 25, 1919, pp. 75-78, 19 figs. partly on four supp. plates. Arrangement and details of blast-furnace, bessemer, open-hearth, structural and by-product departments.

Charger, Blast-Furnace

A German Blast-Furnace Charger. Iron & Coal Trades Rev., vol. 99, no. 2680, July 11, 1919, pp. 40-41, 5 figs. Automatic skip for charging furnace in lieu of hand labor. Output capacity of new furnace is 400 tons in 24 hours, involving handling of about 1200 tons of ore and about 500 to 600 tons of coke. From Stahl und Eisen.

COPPER AND NICKEL

Speiss Smelting

Melting Copper Speiss in Electric Furnace (Fusion de speiss de cuivre au four électrique). P. Papencordt. Journal du Four Electrique, vol. 28, no. 14, July 15, 1919, pp. 98-100. Experiments to determine economy of recuperating metals contained in speiss.

FERROUS ALLOYS

Electrical Production of Ferroalloys

Electrical Production of Ferroalloys (La producción eléctrica de aleaciones férreas). José María Navarrete. Energía Eléctrica, vol. 21, no. 12, June 25, 1919, pp. 137-140. Concerning types and sizes of furnaces used in United States, France, England, and Switzerland.

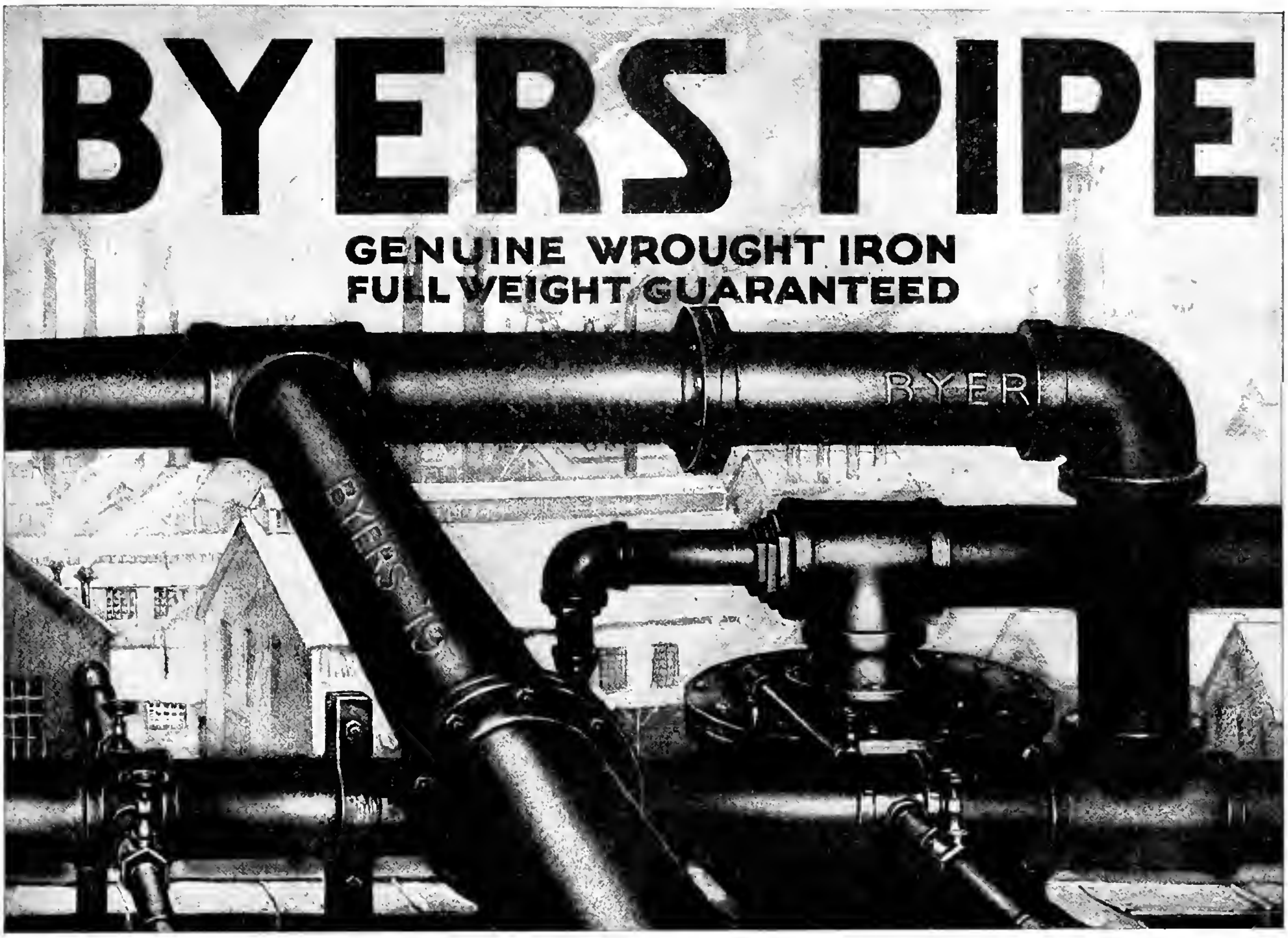
Nickel-Chromium Steels

Nickel-Chromium Steels. J. H. S. Dickenson. Jl. West of Scotland Iron & Steel Inst., vol. 26, no. 8, April 1919, pp. 110-123 and (discussion) pp. 123-125, 15 figs. on 8 supplement plates. Account of their commercial development and of results obtained in tests of various samples which were all oil hardened and tempered alike and afterward cooled off at different rates. Tensile and notched-bar test results are given in tabulated form.

FLOTATION

Spain

Status of Flotation in Spain. Eng. & Min. Jl., vol. 108, no. 8, Aug. 23, 1919, pp. 316-317. Possibility of utilizing process for recovering mineral content of dumps dating back to early Rome.



The Life of Pipe

To a child's mind, the most fragile penny toy conveys no impression of weakness—until after it is broken.

To the young or inexperienced, the question of durability of materials usually is viewed with optimism.

To the old or experienced, promises for the future, if not based on past performance, are of questionable value. Scepticism grows with experience.

That is why Byers pipe is so largely in evidence in the construction and operation of large and important enterprises, entrusted to the care of experienced men who have wisely blended technical knowledge with practical observation.

Write for literature

A. M. BYERS COMPANY

Established 1864 PITTSBURGH, PA.

New York Boston Chicago Dallas

Look for the Name and Year in Every Length

FURNACES

Electric Furnaces

Electric Furnaces for Melting Non-Ferrous Metal. The Baily Furnace. Metal Trades, vol. 10, no. 8, Aug. 1919, pp. 366-370, 6 figs. Of resistance type, its heating element consisting essentially of granular carbon placed in silicon carbide trough.

Electric Smelting

Electric Smelting with Special Reference to Canadian Conditions, Robert M. Keeney. Can. Min. Inst. Bul. no. 88, Aug. 1919, pp. 846-853. Also Colo. School of Mines Mag., vol. 9, no. 8, Aug. 1919, pp. 219-222. Electric furnace is seen not as competitor of combustion furnace, but as means of treating certain ores and of working out certain processes in a more advantageous manner than it is possible to do in a combustion furnace, or treat ores that exist in certain districts in Canada where, owing to local conditions of cheap power and expensive coal and coke, combustion furnaces are not practicable.

Slags

Losses in Furnace Slags, Edward H. Robie. Eng. & Min. Jl., vol. 108, no. 7, Aug. 16, 1919, pp. 265-267, 2 figs. Results of tests at smeltery of International Nickel Co., Copper Cliff, Ont., to determine influence of slag and matte composition and temperature on copper content of slags.

IRON AND STEEL

Cobaltcrom Steel

Making Cobaltcrom Steel Tools. Machy. (N. Y.), vol. 25, no. 12, Aug. 1919, pp. 1173-1174, 2 figs. Interesting feature of this steel is said to be that dies, milling cutters, etc., made from it can be cast to shape, teeth in cutters, for example, being cast directly in blank and requiring no other machining than grinding and boring or sometimes only reaming of hole.

Fibrous Structure in Steel

Fibrous Structure in High Carbon Steel, A. W. Lorenz. Chem. & Metallurgical Eng., vol. 21, no. 4, Aug. 15, 1919, pp. 203-204. Facts and data in connection with a certain ordnance contract.

Flakes in Steel

Flakes in Alloy Steel, Ernest Edgar Thum. Chem. & Metallurgical Eng., vol. 21, no. 3, Aug. 1, 1919, pp. 145-146. Recapitulation and discussion of various articles on flakes in gun tubes and other large forgings of alloy steels.

France

Metallurgy of Iron (La métallurgie du fer). Métallurgie, vol. 39, 31 and 33, July 23, July 30 and Aug. 13, 1919, pp. 1935-1936, pp. 2010-2011, and pp. 2162-2164. From general report on conditions in French industry published by Ministry of Commerce.

Magnet Steel

Steel for Magnets—V. Mech. World, vol. 66, no. 1700, Aug. 1, 1919, pp. 57-58, 4 figs. Essential physical changes taking place during hardening process in case of magnet steels. (Continuation of serial.)

Malleable Iron

The Manufacture of Malleable Iron, Henry A. Johnson. Machy. (N. Y.), vol. 25, no. 12, Aug. 1919, pp. 1163-1164. With reference to physical and chemical phenomena that take place during process and mention of ordinary limits for chemical analysis for white-iron castings.

Metallurgical Calculations

Modern Steel Metallurgical Calculations, Charles H. F. Bagley. Blast Furnace & Steel Plant, vol. 7, no. 8, Aug. 1919, pp. 373-377. Synthetic method of calculating consumption of materials and technical results of manufacture of steel. Different kinds of pig iron and various standard processes are considered. Paper read before British Iron & Steel Inst.

Open-Hearth Processes

The Yields and Waste in Open Hearth Processes, J. E. Fletcher. Managing Engr., vol. 6, no. 3, July 1919, pp. 59-64, 5 figs. Photomicrographs illustrating progressive refining of white (eutectic) iron containing about 4 per cent carbon. Paper read before Stoke-on-Trent Engrs.' & Eng. Students' Assn. (To be continued.)

Soaking Pits, Electrically Heated

Electrically Heated Soaking Pits, Re-Heating and Annealing Furnaces, and Automatic Furnaces, for Heat Treatment, as Applied to the Steel Industry, Thaddeus F. Baily. Iron & Steel of Can., vol. 2, no. 8, Aug. 1919, pp. 180-186, 5 figs. Paper read before Iron & Steel Inst. of America.

Tool Steel

Modern High Speed Tool Steel, John A. Mathews. Ry. Mech. Engr., vol. 93, no. 8, Aug. 1919, pp. 489-492. Origin and development of modern high-speed steel; hardening and tempering qualities. Paper read before Am. Soc. for Testing Materials.

MICROPHOTOGRAPHY

Etching

See Polishing and Etching.

Polishing and Etching

Notes on Practical Metallographic Methods, Austin B. Wilson. Blast Furnace & Steel Plant, vol. 7, no. 8, Aug. 1919, pp. 380-386, 15 figs. Methods of polishing and etching for advanced research work.

Radiometallography

Radiometallography. Engineer, vol. 128, no. 3317, July 25, 1919, pp. 80-81, 8 figs. Arrangement of Coolidge tube for radiographic examination. Reproduction of various radiographs of castings.

The Examination of Materials by X-Rays. Engineering, vol. 108, no. 2794, July 18, 1919, p. 76, 4 figs. Radiographs of aluminum castings.

NON-FERROUS ALLOYS

Aluminum Bronzes

Relation of Microstructure to Phase Changes in Heat-Treated Aluminum Bronzes, L. R. Seidell and G. J. Horvitz. Chem. & Metallurgical Eng., vol. 21, no. 4, Aug. 15, 1919, pp. 179-181, 13 figs. Tests of bronze of composition 90 per cent copper and 10 per cent aluminum, and conclusions in regard to adptability of this bronze for bearing and corrosion-resistant metal.

Brass Melting

Melting of Some Non-Ferrous Metals and Their Alloys in the Electric Furnace, E. F. Collins. Jl. Cleveland Eng. Soc., vol. 11, no. 5 & 6, Mar.-July 1919, pp. 293-314 and (discussion) pp. 314-320, 19 figs. Requirements for economical brass-melting furnaces, and comparison of electric melting with fuel-fired furnaces.

Monel Metal

Monel Metal, Hugh R. Williams. Sci. Am. Supp., vol. 88, no. 2276, Aug. 16, 1919, pp. 98-99, 3 figs. Claimed points of superiority of this new natural alloy in all fields for noncorroding steel.

OCCLUDED GASES

Preventing Occlusion of Gases, Robert Hadfield. Iron Trade Rev., vol. 65, no. 8, Aug. 21, 1919, pp. 504-505. Silicon found by Terre Noire Co., France, to assist materially in reduction of unsoundness and blowholes and to tend to rid steel of absorbed gases. From paper presented before Faraday Soc., Lond.

VARIA

Silicon-Manganese

Silicon-Manganese from Electric Furnaces, B. G. Klugh. Iron Age, vol. 104, no. 7, Aug. 14, 1919, pp. 438-440. Manufacturing data for various compositions. Manganiferous slags as raw material. Uses for the alloy. Paper read before Am. Electrochemical Soc.

Aeronautics

AIRCRAFT

B-Class Airships

See United States.

British Airships

The British Navy Airship S. R. 1, Italian "M" Type. Flight, vol. 11, no. 30, July 24, 1919, pp. 979-981, 10 figs. Semi-rigid type. Dimensions are: Length, 290 ft.; diameter, 58 ft.; overall height, 72 ft.; disposable lift, 7700 lb.

See also R-34.

Lighter-Than-Air Craft, T. R. Cave-Browne-Cave. Jl. Soc. Automotive Engrs., vol. 5, no. 2, Aug. 1919, pp. 167-175, 3 figs. Structural characteristics of British naval types. Paper read before Roy. Aeronautical Soc. of Gt. Britain.

C-Class Dirigible

See United States.

R-34

H. M. Dirigible R-34, A. E. Bishop. Rudder, vol. 35, no. 8, Aug. 1919, pp. 353-357, 5 figs. With notes on development of airships.

Rigid Airships

General Fundamentals of Rigid Airship Design, R. H. Upson. Jl. Soc. Automotive Engrs., vol. 5, no. 2, Aug. 1919, pp. 117-119, 1 fig. From study of British and German types.

Stresses in a Rigid Airship Due to Bending, E. H. Lewitt. Aeronautics, vol. 17, no. 299, July 10, 1919, pp. 48-50, 5 figs. Technical study leads to assertion that ordinary bending formula $M/I = f/y$ may be applied to rigid airship with diagonal bracings of wire, providing that section of ship can be inscribed in circle and that transverse girders are of equal length, the longitudinals being assumed to take all the bending.

Rigid Airships (Les dirigeables rigides), E. Gonault. Génie Civil, vol. 75, no. 4, July 25, 1919, pp. 69-78, 18 figs. Constructional details of R-34 and other dirigibles.

United States

Airship Engineering Progress in the United States, J. G. Hunsaker. Aviation, vol. 7, no. 2, Aug. 15, 1919, pp. 72-76, 7 figs. Development of B class. (To be concluded.)

U. S. Navy Class "C" Dirigible. Aerial Age, vol. 9, no. 24, Aug. 25, 1919, pp. 1095-1098, 6 figs. General specifications. "C" type is 192 ft. long, 43 ft. wide, and 46 ft. high; it has capacity of 180,000 cu. ft.

APPLICATIONS

India

Aviation as Affecting India, Lord Montagu of Beaulieu. Jl. Roy. Soc. Arts, vol. 67, no. 3477, July 11, 1919, pp. 543-551 and (discussion) pp. 551-554, 2 figs. Suggested routes from England to India.

War Period

Progress of Aviation in the War Period, Leonard Bairstow. Engineer, vol. 128, nos. 3317 and 3318, July 25 and Aug. 1, 1919, pp. 93-94 and 115-117, 8 figs. July 25: Reference is made to B. E. 2C. In discussing developments during war, writer considers unfortunate that growth has not been accompanied with usual concurrent growth of civil demand. Graph is given illustrating aerodynamic disadvantages of high speed. Aug. 1: Accelerometer records of loads and records of pitching oscillations. Paper read before Roy. Aeronautical Soc., Great Britain.

AUXILIARY SERVICE

Hangars

Reinforced Concrete Hangars for the Naval Aviation Center of Algiers, E. Carret. Eng. & Contracting, vol. 52, no. 5, July 30, 1919, pp. 132-133, 2 figs. Translated from Génie Civil.

Parachutes

The Smith Parachute. Aerial Age, vol. 9, no. 21, Aug. 4, 1919, p. 974, 4 figs. Of flat type, 28 ft. in diameter, with 42-in. patent shock-absorbing vent supported by 40 silk shroud lines of 250 lb. breaking strength.

Photography

Photographic Industry and National Defense (L'industrie photographique française et la défense nationale), L. P. Clerc. Bulletin de la Société d'Encouragement pour l'Industrie Nationale, vol. 131, no. 3, May-June 1919, pp. 614-627, 9 figs. Military and civil uses of aerial photography in France.

Respiratory Apparatus

Automatic Respiratory Apparatus for High-Altitude Flights (L'Appareil respiratoire automatique pour vols à haute altitude), M. Garsaux. Aérophile, vol. 27, nos. 11-12, June 1-15, 1919, pp. 176-179, 6 figs. Showing scheme of installation and manner in which it operates.

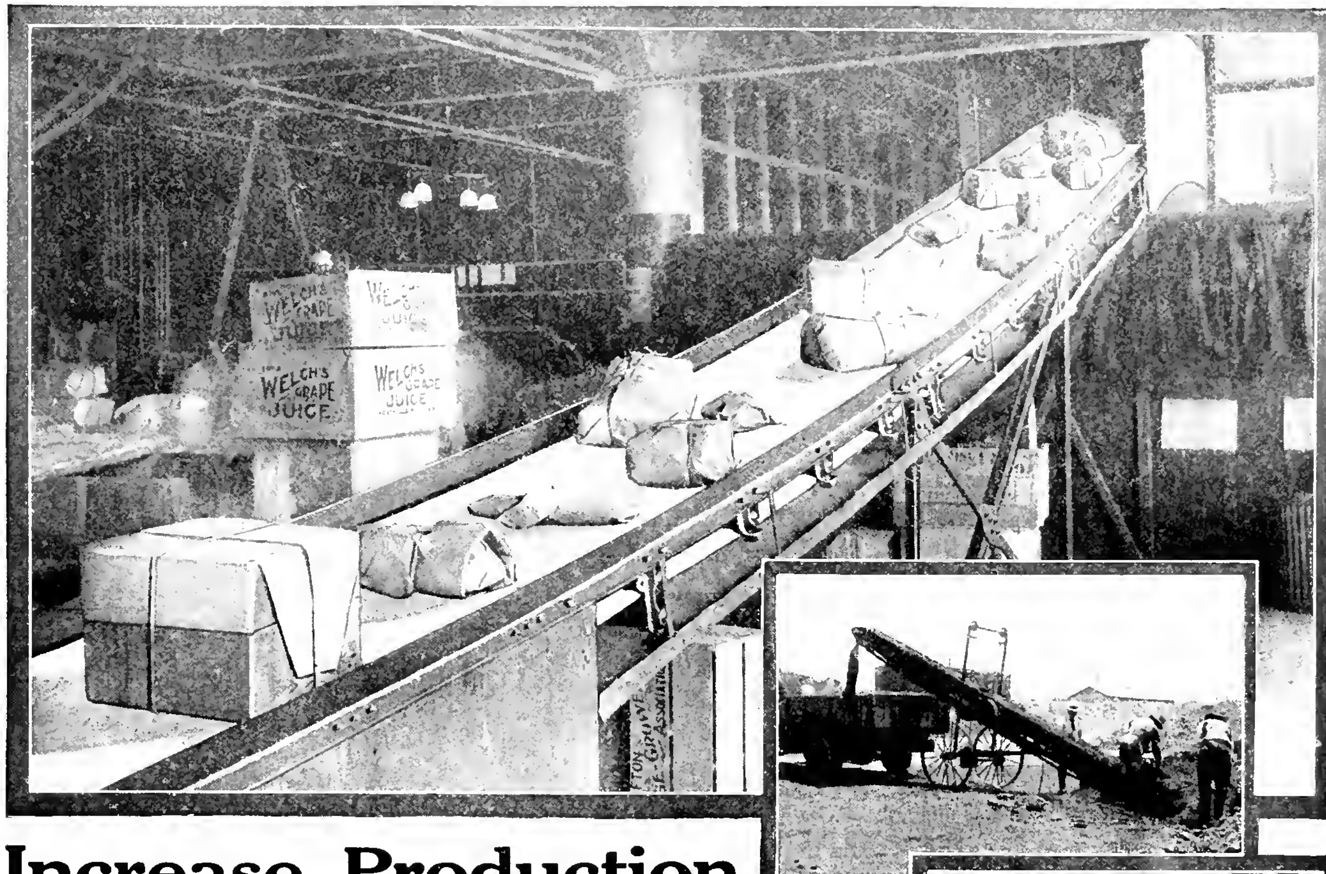
Tanks, Gasoline

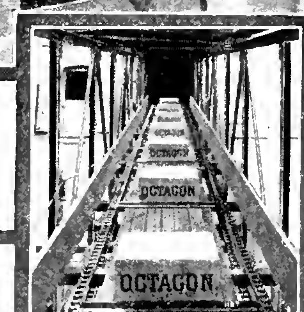
The Imber Self-Sealing Gasoline Tank, George F. McLaughlin. Aerial Age, vol. 9, no. 22, Aug. 11, 1919, no. 1009-1011, 7 figs. Resilient outer rubber covering protects tank so that when inside pressure exceeds a certain point, tank yields and rubber stretches out from side under pressure. This covering also permits self-sealing of tank when struck by bullet.

DESIGN

Horsepower of Resistance

The Horsepower of Resistance in Aeroplane Design, N. I. Lieberman. Mech. Eng., vol. 41,





Increase Production at Lower Costs

YOU can do it, just as hundreds of other concerns are doing it, by installing Link-Belt Labor-Saving Machinery.

Release your hand-labor for more profitable work. Labor is scarce—therefore make use of YOUR labor wisely.

One of our standard elevators or conveyors may be just the thing you need to help speed up your work. Link-Belt Conveyors require little attention and their operation is practically automatic.

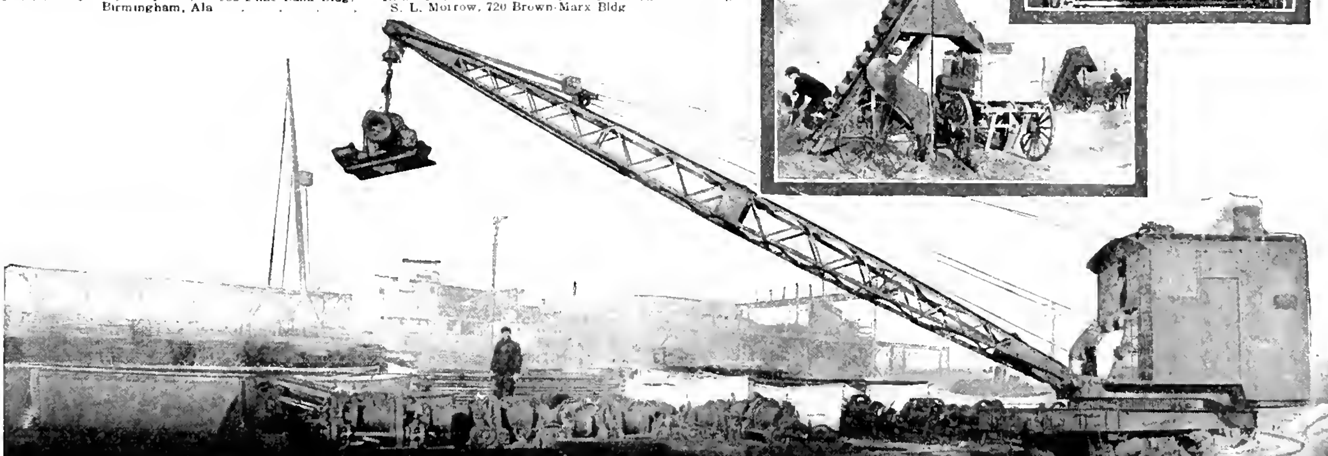
Get in touch with our nearest local office and put your problem up to our experienced engineers. No matter what kind of material you ask us to elevate, convey or handle, Link-Belt Machinery can be adapted to it. Catalog and literature on request.

LINK-BELT COMPANY

371

PHILADELPHIA CHICAGO INDIANAPOLIS

New York	299 Broadway	Kansas City, Mo.	306 Elmhurst Bldg.
Boston	49 Federal St	Seattle	576 First Ave., S.
Pittsburgh	1501 Park Bldg	Portland, Ore	First and Stark Sts
St. Louis	Central National Bank Bldg	San Francisco	682 Market St.
Buffalo	547 Ellicott Square	Los Angeles	163 N. Los Angeles St
Wilkes-Barre	2nd National Bank Bldg	Toronto, Can.	Canadian Link-Belt Co. Ltd.
Huntington, W. Va.	Robson Prichard Bldg	Denver	Lindrooth, Shubart & Co., Boston Bldg
Cleveland	429 Rockefeller Bldg.	Louisville, Ky.	Frederick Wehle, Starks Bldg
Detroit	932 Dime Bank Bldg.	New Orleans	C. O. Hinz, Hibernia Bank Bldg
Birmingham, Ala		S. L. Morrow, 720 Brown-Marx Bldg	



no. 9, Sept. 1919, pp. 721-727 and p. 792, 11 figs. Summary of experimental results obtained by Langley, Lanchester, Foppl, Prandtl, Reynolds and Zahm in regard to resistance coefficients for various types of fuselages, total panel area required and distribution of horsepower consumption. Article concludes with a theoretical study on the probable size of craft, fuel load and power equipment necessary to accomplish a transatlantic flight.

Ceilings

Approximate Ceilings of Aeroplanes. Automobile Engr., vol. 9, no. 129, Aug. 1919, p. 259, 2 figs. Charts given as fairly representative of what may be expected from aeroplanes as at present constructed.

Loads and Stresses

The Loads and Stresses on Aeroplanes, John Case. Aeronautics, vol. 17, no. 300, July 17, 1919, pp. 72-74, 4 figs. Lateral distribution of pressure. Distribution of load between front and rear trusses. (Continuation of serial.)

Metal Construction

Metal Construction of Aircraft, A. P. Thurston. Engineering, vol. 108, nos. 2796 and 2797, Aug. 1 and 8, 1919, pp. 142-144 and 176-180, 34 figs. Aug. 1: Notes on comparative advantages of wood and metal. Aug. 8: Details of metal parts.

Performance

Analysis of Aeroplane Performance in Relation to Height, S. C. S. Part. Aeronautics, vol. 17, no. 300, July 17, 1919, pp. 75-77, 3 figs. How various alterations may be compared when fullest particulars required for Soreau type of curve are not available.

Radiators, Nose Resistance

Resistance Due to Nose Radiator. Aerial Age, vol. 9, no. 21, Aug. 4, 1919, pp. 972-973, 6 figs. Results of wind tunnel experiments. It is concluded that resistance of fuselage with streamline nose is increased more by removing streamline nose and substituting a radiator than it is by adding equivalent free-air radiator and retaining streamline nose.

Resistance of Nose Radiators. Aviation, vol. 7, no. 1, Aug. 1, 1919, pp. 28-29, 6 figs. Report of Nat. Advisory Committee for Aeronautics.

Struts

The Design of Hollow Interplane Struts, Armin Elmendorf. Aviation, vol. 7, no. 2, Aug. 15, 1919, pp. 85-86, 2 figs. Effect of modulus of elasticity on strength, position of material to obtain maximum strength, shear stresses and buckling of hollowed struts considered.

Tail Skids

Theory of Sprung Tail Skids on Aeroplanes. Aerial Age, vol. 9, no. 24, Aug. 25, 1919, pp. 1098. Expression for reaction between skid and ground deduced from equation of motion about axle. From Oesterreichische Flug-Zeitschrift, Dec. 1918.

War Developments

Some Developments in Aircraft Design and Application During the War, Lord Weir. Engineering, vol. 108, no. 2794, July 18, 1919, pp. 93-99, 31 figs. Also Flight, vol. 11, no. 30, July 24, 1919, pp. 987-991, 16 figs. General development in wing construction; progress of design and construction of propellers.

Wing Design

Elements of a General Theory of Airplane-Wing Design, Walter C. Durfee. Mech. Eng., vol. 41, no. 9, Sept. 1919, pp. 728-729, and (discussion) pp. 729-730 and p. 787, 3 figs. Following subjects considered: Vortex theory of lift; theory of initial motion around wings; vortex theory of shape; hydrodynamic-electromagnetic analogy; action of vortices with reference to each other; action on vortices with reference to their images; influence of local wind; laws of energy content in trailing vortex; friction and head resistance; and explosion of eddies.

ENGINES

B.H.P.

The "B. H. P." Aeroplane Engine. Engineering, vol. 108, no. 2796, Aug. 1, 1919, pp. 135-137, 5 figs. Six-cylinder, double-ignition water-cooled type; output at normal speed of 1400 r.p.m., 240 b.hp.

Carburation, High Altitude

Carburation at High Altitudes (La Carburation aux hautes altitudes), Aérophile, vol. 27, nos. 11-12, June 1-15, 1919, pp. 185-186, 3 figs. Keeping mixture constant by means of turbo-compressors. Scheme of operation.

Maintaining Constant Pressure Before the Carburettors of Aero Engines Regardless of the Altitude, Leslie V. Spencer. Flight, vol. 11, no. 33, Aug. 14, 1919, pp. 1086-1090, 5 figs. Survey of experimental research with notes on supercharger developed by E. H. Sherbondy for Aircraft Production Bureau. (To be concluded.)

Fuels

An Investigation of Airplane Fuels, E. W. Dean and Clarence Netzen. Jl. Soc. Automotive Engrs., vol. 5, no. 2, Aug. 1919, pp. 126-130. Conducted by Bur. of Mines to ascertain whether or not selection of proper grade of fuel would materially help training fields in getting maximum service from a limited number of planes.

Hispano-Suiza

The Hispano-Suiza Airplane Engine—III, IV, H. O. C. Isenberg. Am. Mach., vol. 51, nos. 6 and 8, Aug. 7 and 21, 1919, pp. 259-261 and 365-368, 23 figs. Aug. 7: System of mounting cylinder blocks. Aug. 21: Preparation and making of complete molds.

Liners, Steel

Aircraft Engine with Steel Liners in Aluminum Cylinder Blocks. Automotive Industries, vol. 41, no. 8, Aug. 21, 1919, pp. 367-369, 8 figs., partly on supp. plate. Puma six-cylinder vertical type with output of 260 hp. at 1500 r.p.m.

Napier Lion Engine

The Napier Lion Aircraft Engine. Automobile Engr., vol. 9, no. 129, Aug. 1919, pp. 250-258, 29 figs. Said to be lighter per horsepower than any other water-cooled aero engine yet produced. (Weight per b.hp., less fuel and oil, 2.51 lb.) Engine holds altitude record of 30,500 ft.

Rotary Engines

See Zeitlin Aero Engine.

Shock Recorders

Development of an Airplane Shock Recorder, A. F. Zahm. Jl. Franklin Inst., vol. 188, no. 2, Aug. 1919, pp. 237-244, 4 figs. Apparatus consists of many vertical styluses supported individually by springs and recording on a single chronograph drum.

War Developments

Some Developments in Aircraft Design during the War, Lord Weir. Automobile Engr., vol. 9, no. 129, Aug. 1919, pp. 263-266, 10 figs. Also Engineering, vol. 108, no. 2795, July 25, 1919, pp. 108-111, 19 figs. Emphasizes particularly the fact that experience and research work had culminated in production at time of the armistice of various types of machines which represented distinct advance on anything previously used. From paper presented before Northeast Coast Instn. of Engrs. and Shipbuilders.

Zeitlin Aero Engine

The Zeitlin Aero Engine. Aerial Age, vol. 9, no. 22, Aug. 11, 1919, pp. 1012-1014 and 1027, 10 figs. Four-stroke cycle, 9 cyl. rotary type. Fundamental difference with other similar engines is said to be that piston stroke is not of uniform length in each of four movements constituting complete cycle.

MATERIALS OF CONSTRUCTION

Duralumin

See Steel and Duralumin.

Pitch Pockets

Pitch Pockets and Their Relation to the Inspection of Airplane Parts, J. R. Watkins. Jl. Franklin Inst., vol. 188, no. 2, Aug. 1919, pp. 245-253, 3 figs. Résumé of theories advanced to account for presence of pitch pockets and results of tests made at Forest Products Laboratory.

Sheets, Metal, Thin

Metal Construction of Aircraft, A. P. Thurston. Engineering, vol. 108, no. 2798, Aug. 15, 1919, pp. 224-226, 5 figs. Influence of cold work on physical properties of thin sheets. (Concluded.) Paper read before Royal Aeronautical Soc.

Steel and Duralumin, Comparison of

Metal Construction of Aircraft, A. P. Thurston. Aviation, vol. 7, no. 1, Aug. 1919, pp. 18-21, 2 figs. Comparative values of steel and duralumin. From paper read before Roy. Aeronautical Soc.

METEOROLOGY

Algue Barocyclonometer

See Barocyclonometer.

Aneroids

Aneroids (Ueber Aneroide), E. Warburg and W. Heuse. Zeitschrift f. Instrumentenkunde, vol. 39, no. 2, Feb. 1919, pp. 41-55, 2 figs. Experimental work for reducing influence on the instrument of temperature and of after-effects of former pressures which are more pronounced the greater the difference between the previous pressures and those to be measured is.

Atmospheric Pressure Waves

On the Explosion at Okhta, B. Galitzin. Proc. Roy. Soc., vol. 95, no. A-673, July 15, 1919, pp. 508-515, 3 figs. Records of atmospheric-pressure wave obtained at various observatories in neighborhood used to compute characteristics of motion of wave.

Barocyclonometer

The Algué Barocyclonometer, Robert G. Skerrett. Rudder, vol. 35, no. 8, Aug. 1919, pp. 368-370, 7 figs. Combination of aneroid barometer and device called cyclonometer or wind disk. Used for foretelling coming of hurricane.

Stratosphere

See Wind Velocity.

Wind Velocity

Wind Velocity in the Stratosphere (Sur la vitesse du vent dans la stratosphère), J. Rouch. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 25, June 23, 1919, pp. 1281-1283. Data obtained by aerologic soundings.

MILITARY AIRCRAFT

Bomb Dropping

The Science of Bomb Dropping from Airplanes, A. Wilmer Duff. Jl. Worcester Polytechnic Inst., vol. 22, no. 4, July 1919, pp. 322-338, 2 figs. Technical discussion of principles involved.

Naval Aircraft

Progress in Naval Aircraft—I, J. C. Hunsaker. Am. Mach., vol. 51, no. 7, Aug. 14, 1919, pp. 305-311, 4 figs. Also U. S. Naval Inst. Proc., vol. 45, no. 198, Aug. 1919, pp. 1347-1368, 8 figs. Tells of causes leading up to building of N C boats and gives some details of their design, construction and performance. Paper presented before Soc. of Automotive Engrs.

Torpedoplane

The Torpedoplane—The New Weapon which Promises to Revolutionize Naval Tactics, Henry Woodhouse. Flying, vol. 8, no. 7, Aug. 1919, pp. 597-602, 9 figs. Account of mystery airplanes of British Navy as given by various periodicals and in various reports of the Admiralty.

PLANES

Austin "Whippet"

The Austin "Whippet." Flight, vol. 11, no. 33, Aug. 14, 1919, pp. 1076-1078, 7 figs. Single-seater tractor biplane with all-steel fuselage, folding wings, and no bracing wires.

B.A.T.

The B. A. T. Type F. K. 26 Transport Airplane. Aviation, vol. 7, no. 1, Aug. 1, 1919, pp. 22-23, 2 figs. Machine is tractor biplane fitted with cabin which affords accommodation for either four passengers or their equivalent weight in goods or mails.

Bristol

The Bristol Aeroplanes. Aerial Age, vol. 9, no. 23, Aug. 18, 1919, pp. 1049-1052, 8 figs. General features of design and records of performance.

Caproni

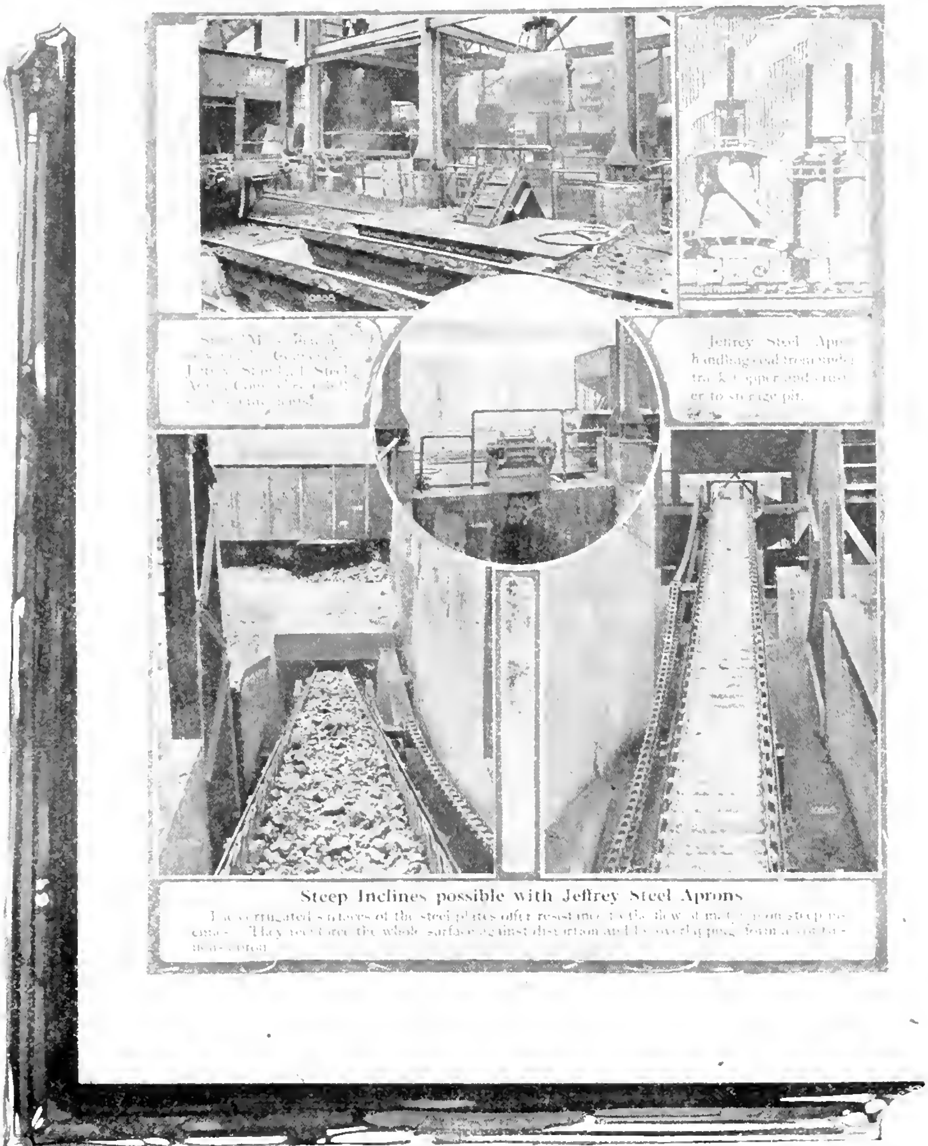
See Liberty Caproni.

De Havilland

The De Havilland Aeroplanes. Aerial Age, vol. 9, no. 21, Aug. 4, 1919, pp. 969-971 and 982, 3 figs. Comparison of various "Airco" types.

German Machines

The Large Land Airplane in German Practice, Erik Hildesheim. Aviation, vol. 7, no. 1,



A Specimen Page from Our New Catalog on Standard Apron Conveyers

This catalog contains 72 pages devoted to installations showing Standard Steel and Wood Apron Conveyers in service in Steel and Iron and other industries; Specifications, General Dimensions and other important data of vital interest to the purchaser. They are so arranged that you can easily select a conveyer which will completely meet your requirements.

This catalog will be of especial advantage to you in the saving of time and expense heretofore required in making drawings and layouts for your own particular needs. In addition to saving this expense you will be further benefited by quick delivery, and saving in cost of special designing, of chains, flights, etc., as under our system of Standardized Units all tools and patterns have been made, and chains, flights, etc., carried in stock.

Write today for copy of Catalog No. 258-L.

THE JEFFREY MFG. CO., 904 North Fourth Street, Columbus, O.

New York Philadelphia Scranton Chicago Detroit Dallas Denver Seattle
Cleveland Boston Pittsburgh St. Louis Birmingham Milwaukee Montreal

Handle it Mechanically

Aug. 1, 1919, pp. 23-25, 5 figs. Notes on development of giant airplane and outline of principal features of Linke-Hoffman machine.

Gosport Flying-Boats

The Gosport Flying-Boats. Flight, vol. 11, no. 31, July 31, 1919, pp. 1006-1009, 12 figs. Drawings and specifications of six commercial types which range from large ten-seater of over 100-ft. span to small single-seater of only 23 ft. span.

Liberty Caproni

The Liberty Caproni Biplane. Aerial Age, vol. 9, no. 24, Aug. 25, 1919, pp. 1089-1091 and 1108, 6 figs. General specifications and performances.

Linke-Hoffman

See German Machines.

Nieuport "Night Hawk"

The Nieuport "Night Hawk" Single-seater Scout—I. Engineer, vol. 128, no. 3319, Aug. 8, 1919, pp. 132-134, 8 figs. Fitted with 320-hp., nine-cylinder, fixed-radial, air-cooled A. B. C. "Dragon-Fly" engine. Designed to travel at 135 m.p.h. at altitude of 15,000 ft.

Vickers Vimy

The Vickers "Vimy-Commercial" Biplane. Flight, vol. 11, no. 29, July 17, 1919, pp. 936-941, 15 figs. Except for fuselage, machine is identical to "Vimy" bomber. Description is confined to fuselage.

War Developments

Some Developments in Aircraft Design and Application During the War, Lord Weir. Flight, vol. 11, nos. 29, 31 and 32, July 17, 31 and Aug. 7, 1919, pp. 955-959, 1013-1016 and 1048-1053, 42 figs. July 17: Aerodynamic features of progress and design. July 31: One-seater and two-seater fighters; progress in engine design. Aug. 7: Navigation and meteorology.

PROPELLERS

Aerodynamic Calculations

Aerodynamical Considerations in the Design of a Propeller, H. Levy. Automotive Industries, vol. 41, no. 7, Aug. 14, 1919, pp. 316-320, 10 figs. Method of calculating required dimensions and probable performance of propeller on basis of airfoil theory.

Wood Propellers

Some Problems in the Design of Wood Propellers, Leslie V. Spencer. Aerial Age, vol. 9, no. 23, Aug. 18, 1919, pp. 1053-1054 and 1059, 5 figs. Relative value of different woods. Advantages and disadvantages of different methods of blade tipping.

VARIA

Government Organization of Industry

Single Government Department for All Aeronautics Urged by Mission, Allen Sinsheimer. Automotive Industries, vol. 41, no. 7, Aug. 14, 1919, pp. 297-303, and pp. 323-327. Industry created by war fast disappearing, declares report of American Aviation Mission which has been studying European aeronautics. They urge establishment of agency equal to war department.

International Air Navigation Convention

International Air Navigation Convention. Flight, vol. 11, no. 31, July 31, 1919, pp. 1029-1032, 2 figs. Annexes dealing with marking of aircraft, rules as to lights and signals, international aeronautical maps and ground markings, collection and dissemination of meteorological information and customs. Additional to account given in issue of May 8.

Time Determination

An Easy Method of Getting the Greenwich Mean Time, Franklin Van Valdenburgh. U. S. Naval Inst. Proc., vol. 45, no. 198, Aug. 1919, pp. 1343-1345, 1 fig. Chart constructed by drawing lines representing loci of all places having same GMT at same time.

Tunnel, Aerodynamic

The Aerodynamic Experimental Tunnel, W. Knight. Aviation, vol. 7, no. 2, Aug. 15, 1919, pp. 77-80, 18 figs. Principles to be followed in designing, with notes of features adopted in tunnel built for Instituto Centrale Aeronautico in Rome.

Marine Engineering

SHIPS

Barges

Construction of Steel Barges, Thomas Leach. Proc. Engrs. Soc. Western Pa., vol. 35, no. 5, 275-282, 24 figs. Details of types being built for U. S. Railroad Administration for Erie June 1919, pp. 243-274 and (discussion) pp. Canal service.

Bulkhead Stiffeners

Investigation into Bulkhead Stiffeners—II. Int. Mar. Eng., vol. 24, no. 8, Aug. 1919, pp. 554-557 & 561, 1 fig. Calculation of stresses in bulkheads which form boundaries in trimming tanks, peak tanks or deep ballast tanks.

Cargo Vessels

S. S. Poughkeepsie, Standard 8,800-Ton Deadweight Cargo Vessel built by Newburgh Shipyards, Inc. Int. Mar. Eng., vol. 24, no. 8, Aug. 1919, pp. 531-535, 7 figs., partly on supp. plates. Two-deck, single-screw steamship fitted with water-tube boilers and geared turbines. Arranged for both coal and oil fuel.

New Type American Freighters. Mar. Rev., vol. 49, no. 9, Sept. 1919, pp. 413-414 and 437, 2 figs. Luckenbach steamers of 12,500 dead weight tonnage commandeered by U. S. Government.

SS. "Kediri." Shipbuilding & Shipping Rec., vol. 14, no. 3, July 17, 1919, p. 68, 2 figs., partly on supp. plates. Cargo vessel having capacity of 6,300 tons d.w. on 21 ft. 6 in. draft. Built in Holland.

Concrete Ships

The U. S. Shipping Board's Work with Concrete, J. Glaettli. Concrete, vol. 15, no. 2, Aug. 1919, pp. 69-72. In connection with designing concrete ships. Paper read before Am. Concrete Inst.

Concrete Ships, J. W. Sadler. Jl. Electricity, vol. 43, no. 3, Aug. 1, 1919, pp. 122-123, 2 fifs. Greater weight of concrete hull, and consequent need for lighter equipment indicate, writer believes, that electrical drive will be preferred for concrete ship.

Structural Action of Concrete Ship Members, W. A. Slater. Contract Rec., vol. 33, no. 32, Aug. 6, 1919, pp. 749-753. Laboratory investigations and problems in design of concrete vessels, undertaken by Concrete Ship Section of Emergency Fleet Corpn. in coöperation with U. S. Bur. Standards. Paper read before Am. Concrete Inst.

Electric Propulsion

A General Description of the Electric Propulsion of the U. S. S. California. Pacific Mar. Rev., vol. 16, no. 8, Aug. 1919, pp. 131-136, 12 figs., partly on supp. plates. Machinery is to consist of two turbo-generators, operating four motors, one connected with each line of shafting.

The Electric Plant of the Battleship Tennessee, R. L. Weber. U. S. Naval Inst. Proc., vol. 45, no. 198, Aug. 1919, pp. 1397-1408, 5 figs. Discussion is confined to ship's propelling machinery.

Freighters

See Cargo Vessels.

Mother Ships for Airplanes

H. M. S. "Furious." Engineering, vol. 108, no. 2798, Aug. 15, 1919, pp. 203-204, 6 figs. Partly on two supplement plates. Adopted as floating platform for flying ships. Dimensions and particulars.

Motor Ships

Italian Motorship Ansaldo San Giorgio I, Arthur Benington. Int. Mar. Eng., vol. 24, no. 8, Aug. 1919, pp. 525-529, 7 figs. Vessel is of single-deck type and is designed to leave cargo holes entirely unobstructed by pillars or stanchions.

Motor Tugs

Motor Tug "Grove Place." Shipbuilding & Shipping Rec., vol. 14, no. 7, Aug. 14, 1919, pp. 181-182, 3 figs. Length, 55 ft.; breadth, 14 ft.; depth, 8 ft. Used for Thames service.

Ore Carriers

Ore Carriers for Ocean Service, V. G. Iden. Mar. Rev., vol. 49, no. 9, Sept. 1919, pp. 420-423, 5 figs. Being built by Bethlehem Steel Corporation. They are 11,669 dead-weight tons each, are equipped with geared turbines capable of 2,400 shaft hp., and are specially designed to facilitate loading.

Oil-Fuel Installation

Oil Fuel Installation in Passenger Steamships. Shipbuilding & Shipping Rec., July 31, 1919, vol. 14, no. 5, pp. 123-124. Instructions issued by British Board of Trade.

Sediment in Marine Boilers

Sediment in Marine Boilers, W. R. Austin. Int. Mar. Eng., vol. 24, no. 8, Aug. 1919, pp. 552-553, 1 fig. Quotes three instances where sediment may cause trouble.

TERMINALS

Motor Trucking

Motor Trucks and the Problem of Efficient Marine Freight Terminal Operation—I, Merrill C. Horine. Int. Mar. Eng., vol. 24, no. 8, Aug. 1919, pp. 518-524, 9 figs. Survey of terminal operation field. Interrelation of carriers, railroads, transfer drays and steamship.

VARIA

Charts

The World's Air and Ocean Routes, B. J. S. Cahill. Pacific Mar. Rev., vol. 16, no. 8, Aug. 1919, pp. 90-92, 2 figs. Illustrating illusion of distance and direction on Mercator's chart.

Japanese Shipbuilding

1853—A Brief History of Japanese Shipbuilding—1919, Andrew Farrell. Pacific Mar. Rev., vol. 16, no. 8, Aug. 1919, pp. 71-79, 19 figs. Particularly as affected by policy of Japanese Government.

YARDS

Concrete Shipyards

Layout and Equipment of Government Concrete Ship Yards, A. L. Bush. Concrete, vol. 15, no. 2, Aug. 1919, pp. 73-77, 4 figs. Noting specially standardized schemes adopted for various structures.

Cost Accounting

Uniform Cost Accounting in Ship Building, J. L. Jacobs. Int. Mar. Eng., vol. 24, no. 8, Aug. 1919, pp. 539-543. Plan adopted by Atlantic Coast Shipbuilders' Assn. for uniform methods of cost accounting in steel shipbuilding.

A Cost System for Shipyards—II, Creighton Churchill. Int. Mar. Eng., vol. 24, no. 8, Aug. 1919, 545-548. Symbols used in collecting cost data.

Fore River

Shipbuilding Equipment and Methods at Fore River II—Shop Routing and Group Labor Systems. Eng. News-Rec., vol. 83, no. 8, Aug. 21, 1919, pp. 362-365, 2 figs. Features specially noted are shop routing system which schedules and keeps track of hull material from mold loft to berth, and special group labor system which has been applied to many of outside departments, chiefly the fitting-out and trial departments.

The Fore River Plant of the Bethlehem Shipbuilding Corporation, Ltd., Austin E. Potter. Rudder, vol. 35, no. 8, Aug. 1919, pp. 358-362, 9 figs. Details of organization.

Industrial Technology

Acetylene

Acetylene, R. A. Witherspoon. Can. Chem. Jl., vol. 3, no. 8, Aug. 1919, pp. 250-253. General properties and its application in industry.

See also Carbide.

Alcohol

Notes on the Production of Synthetic Alcohol, E. K. Rideal. Chem. Age, vol. 1, no. 1, June 21, 1919, pp. 9-11, 1 fig. Potentialities of wood cellulose as raw material.

Asphalt

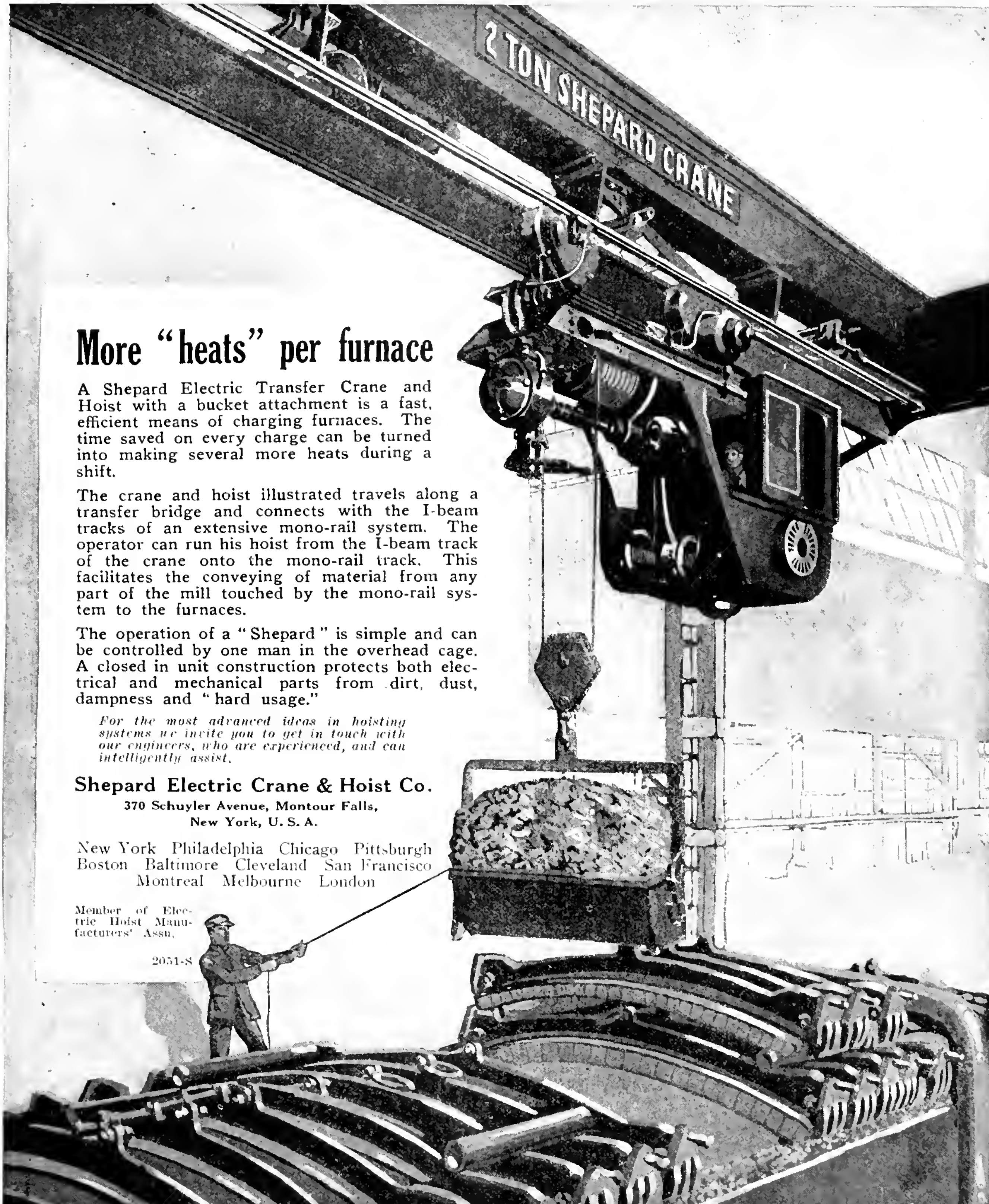
The Municipal Asphalt Plant of the District of Columbia, G. B. Hunt. Am. City, City Edition, vol. 21, no. 2, Aug. 1919, pp. 119-120, 2 figs. Record of operation for 1918, with cost data.

Bleaching

See Cotton Bleaching.

Calcination

See Gypsum.


2 TON SHEPARD CRANE

Carbide

The Canada Carbide Company, Limited. J. C. King. Can. Chem. Jl., vol. 3, no. 8, Aug. 1919, pp. 262-264, 2 figs. Brief history of carbide industry and description of its growth and development at Shawinigan Falls.

Cellulose

Reactions of Cellulose. Florence B. Seibert and Jessie E. Minor. Paper, vol. 24, no. 23, Aug. 13, 1919, pp. 15-20, 4 figs. Study of development of oxycellulose in papermaking.

Chemical Industry, American

The Economic Status of American Chemical Industry. Frederick E. Breithut. Chem. & Metallurgical Eng., vol. 21, no. 3, Aug. 1, 1919, pp. 129-131, 10 figs. Charts based on specifications given in Census of Manufacturers for 1914.

Chemicals, Prices

Prices of Chemicals During the War. Frederick E. Breithut. Chem. & Metallurgical Eng., vol. 21, no. 4, Aug. 15, 1919, pp. 174-176, 2 figs. Charts showing movement away from pre-war level.

Chlorine

The Nelson Electrolytic Chlorine Cell. C. F. Carrier, Jr. Chem. & Metallurgical Eng., vol. 21, no. 3, Aug. 1, 1919, pp. 133-136, 4 figs. History, description and record of commercial application. From paper read before American Electrochemical Soc.

Electric Installations of Works Manufacturing Chlorine (Les installations électriques de l'usine "Le Chlore Liquide"), Jacques de Soucy. Chimie & Industrie, vol. 2, no. 6, June 1919, pp. 627-640, 13 figs. Current supplied at 26,000 volts is stepped down to 3200 volts and partly to 1850 volts.

Coal Tar

Continuous Process for Distilling Coal Tar. Gas Age, vol. 44, no. 4, Aug. 15, 1919, pp. 149-152, 11 figs. Description of plant erected at Gas Works of Geneva, Switzerland. From Journal des Usines & Gaz.

Column Apparatus

Column Apparatus in Chemical Industry, Sydney J. Tungay. Chem. Age, vol. 1, no. 1, June 21, 1919, pp. 11-14, 6 figs. Discussion of principles regarding use of towers, columns and filling materials manufactured from acid-resisting iron. Special reference is made to type to distillation and washing column patented by Kubierschky.

Cotton Bleaching

Bleaching of Cotton (Blanchiment du Coton). Robert Weiss. Bulletin de la Société Industrielle de Mulhouse, vol. 84, no. 6, Oct.-Nov.-Dec. 1914, pp. 499-506. Experiments with strontium as substitute for lime.

Crucibles

See Graphite.

Cyanides

The Recovery of Cyanides from Coal. Chem. Age, vol. 1, no. 4, July 12, 1919, pp. 90-92, 1 fig. Extraction process of hydrocyanic acid resulting from distillation of coal.

Glass

The Cooling of Optical Glass Melts, Howard S. Roberts. Jl. Am. Ceramic Soc., vol. 2, no. 7, July 1919, pp. 543-563, 7 figs. Conditions to be attained when melt of optical glass is cooled in the pot.

The Volatilization of Iron from Optical Glass Pots by Chlorine at high Temperatures, J. C. Hostetter, H. S. Roberts and J. B. Ferguson. Jl. Am. Ceramic Soc., vol. 2, no. 5, May 1919, pp. 356-372, 5 figs. Experiments said to have indicated beyond doubt that iron can be readily removed from pots by this method.

Glues

Water-Resistant Glues. F. L. Browne. Chem. & Metallurgical Eng., vol. 21, no. 3, Aug. 1, 1919, pp. 136-138, 3 figs. Including bibliography on casein and casein glues.

Graphite

Structure of Graphite in Relationship to Crucible Making. Reinhardt Thiessen. Jl. Am. Ceramic Soc., vol. 2, no. 7, July 1919, pp. 508-542, 39 figs. Crucibles containing Ceylon graphite were examined; also English crucible containing Madagascar graphite, several American crucibles containing American graphite and one Japanese crucible of unknown graphite origin. They all showed flake formation excepting Ceylon graphite, which evidenced granular form.

Effect of Variable Pressure and Tar Content on the Briquetting of Alabama Graphite. R. T. Stull and H. G. Schurecht. Jl. Am. Ceramic Soc., vol. 2, no. 5, May 1919, pp. 391-399, 8 figs. Results of experiments.

Gypsum

Gypsum Wall Plaster of France. C. F. Columbia. Cement, Mill & Quarry, vol. 15, no. 3, Aug. 5, 1919, pp. 17-19. Methods of extraction and account of French process of calcination.

Hydrocyanic Acid

See Cyanides.

Japans

Water Japan. Wheeler P. Davey. Gen. Elec. Rev., vol. 22, no. 8, Aug. 1919, pp. 634-635. Characteristics of emulsion. Electric-dip and hot-dip methods for applying it.

Leather

Leather from the Sea, Robert G. Skerrett. Sci. Am., vol. 121, no. 8, Aug. 23, 1919, pp. 182-183, 2 figs. Work done in adaptation of skins of sharks, rays, dogfish, backfish, etc., to general purposes of leather worker.

Oils

Suggestions Regarding the Selection of Drying Oils, Henry A. Gardner. Educational Bur., Scientific Section, Paint Manufacturers' Assn. of U. S., no. 66, Aug. 1919, 3 pp. Including contents of specifications for raw, boiled, and refined linseed oils, as recommended by the U. S. Interdepartmental Committee on Standardization of Paint Specifications.

Soya Oil, Henry A. Gardner. Educational Bur., Scientific Section, Paint Manufacturers' Assn. of U. S., no. 67, Aug. 1919, 16 pp. Summary of data regarding composition, physical properties and industrial uses.

Marine Animal Oils in Paints and Varnishes, Henry A. Gardner. Educational Bur., Scientific Section, Paint Manufacturers' Assn. of U. S., no. 68, Aug. 1919, 7 pp. Survey of results obtained and practices developed by various investigators.

Driers for Soya Oil, Henry A. Gardner. Educational Bur., Scientific Section, Paint Manufacturers' Assn. of U. S., no. 69, Aug. 1919, 12 pp. It is concluded as result of experiments that raw soya oil may be dried almost as rapidly as boiled linseed oil. Drier combinations that produce best results are given.

Paper

Paper Pulp Manufacture in Australia. Gerald Lightfoot. Paper, vol. 24, nos. 23 and 24, Aug. 13 and 20, 1919, pp. 22-23 and 27-30. Aug. 13: Investigation of possibilities of production prompted by shortage of raw materials. Aug. 20: Investigations on pulping qualities of Young Kutri timber.

Paper Mill Bark As Tanning Material. Vance P. Edwardes. Paper, vol. 24, no. 24, Aug. 20, 1919, pp. 18-21, 1 fig. The utilization of waste hemlock bark from pulp mills for tanning purposes. Experiments at Forest Products Laboratory.

Peat-Fuel Process

Willmarth Peat Fuel Process, C. A. Willmarth. Jl. Am. Peat Soc., vol. 12, no. 3, July 1919, pp. 113-122, 5 figs. For making peat coke and extracting by-products.

Photography

The Crystallography and Optical Properties of the Photographic Sensitizing Dye, Pinaverdol, Edgar T. Wherry and Elliot Q. Adams. Jl. Wash. Acad. Sci., vol. 9, no. 14, Aug. 19, 1919, pp. 396-405, 4 figs. This dyestuff, formerly made only in Germany, is now being produced in England and the U. S.

Potash

American Potash. Herbert H. Roe. Min. & Sci. Press, vol. 119, no. 6, Aug. 9, 1919, pp. 195-202, 11 figs. Review of recent achievements.

Potash Recovery at Cement Plants, Alfred W. G. Wilson. Canada Dept. Mines, bul. no. 29, May 6, 1919, 34 pp., 10 figs., partly on supp. plates. Based upon investigations undertaken under instructions from chairman of Committee of Reconstruction and Development of the War Trade Board.

The Alsatian Potash Industry, Frank K. Cameron. Am. Fertilizer, vol. 51, no. 4, Aug. 16, 1919, pp. 49-54. Cubic contents of potash estimated as 275,000,000 tons.

The International Potash Situation. Chem. Age, vol. 1, no. 5, July 19, 1919, pp. 131-133. Statistics and war time experience. Pre-war and future cost of production; natural deposits outside Germany; potash from felspars, leucites, etc.

Rubber

Chemistry of Rubber, S. C. Bradford. Sci. Am. Supp., vol. 88, no. 2275, Aug. 9, 1919, pp. 82-83. Historical account of researches and constitution and inventions relating to process of vulcanization.

Crude Rubber to the Front. Raw Material, vol. 1, no. 5, July 1919, pp. 246-251. Varieties of crude rubber, their trade names, qualities and market forms.

The Nature of Vulcanization, H. P. Stevens. Jl. Soc. Chem. Indus., vol. 38, no. 13, July 15, 1919, pp. 192T-196T. Two theories noted: (1) vulcanization is primarily an absorption process, or (2) a chemical combination of sulphur with rubber hydrocarbon. Writer quotes experiments undertaken to determine whether or not technical effect of vulcanization can be produced without chemical combination between sulphur and hydrocarbon taking place.

Sulphate of Ammonia

Report of Alkali Works Inspector. Iron & Coal Trades Rev., vol. 99, no. 2683, Aug. 1, 1919, pp. 146-147. Concerning production for 1918 of sulphate of ammonia in bulk as by-product.

Tannin

Hemlock Bark as a Source of Tannin, Vance P. Edwardes. Chem. Engr., vol. 27, no. 8, Aug. 1919, pp. 178-182, 1 fig. Results of investigations conducted by Forest Products Laboratory.

See also Paper.

Tetrachlorethylene

Preparation of Tetrachlorethylene, H. B. Weiser and G. E. Wightman. Jl. Phys. Chemistry, vol. 23, no. 6, June 1919, pp. 415-439. Survey of results obtained by various investigators and account of experiments undertaken by writers.

Wood Distillation

A New Method of Distilling Both Green and Seasoned Hardwoods. Chem. & Metallurgical Eng., vol. 21, no. 4, Aug. 15, 1919, pp. 193-194. Chief point of advantage claimed for process used by Kingsport Wood Reduction Company is method of briqueting sawdust or finely divided woodwaste and of distilling wood briquets under controlled conditions of temperature and pressure in multitubular retorts.

Railroad Engineering

FOREIGN

African Railways

African Railway System (La gran red de ferrocarriles africanos). D. Enrique Morales. Revista de Obras Publicas, vol. 67, no. 2283, June 26, 1919, pp. 305-309. Economic significance of establishing direct railway service between Europe and Africa through Strait of Gibraltar. (Concluded.) Paper read before Spanish Inst. of Civil Engrs.

British Railway Shops

British Railway Workshops in War Time—IV. Engineer, vol. 128, no. 3318, Aug. 1, 1919, pp. 104-105, 3 figs. Insulated meat van designed for use overseas.

French Railways

The Reconstruction Program for French Railways.-II. Robert E. Thayer. Ry. Age., vol. 67, no. 6, Aug. 8, 1919, pp. 251-255, 9 figs. Standards for types of material and equipment used on railroads, developed by Ministry of Public Works.

Venezuela

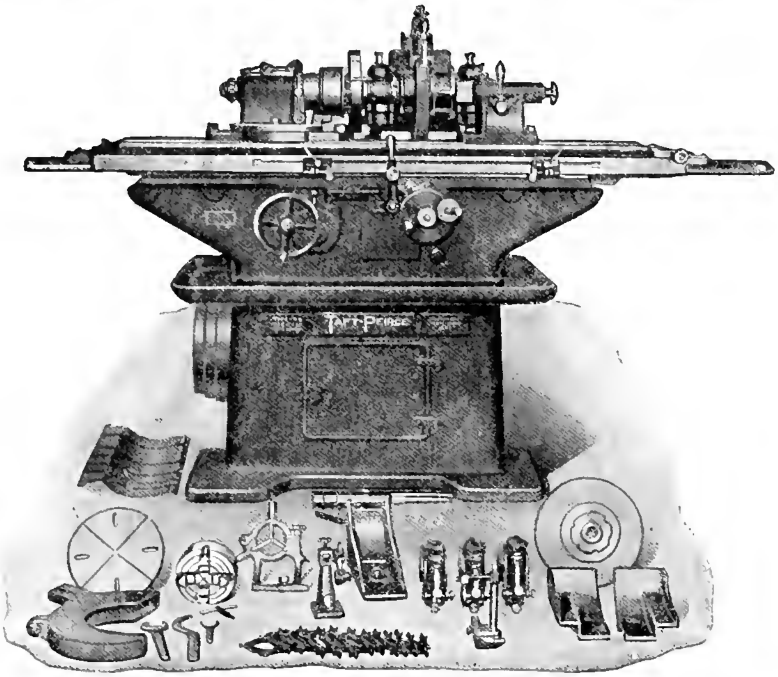
The Railways of Venezuela, Charles W. Jones. Ry. Rev., vol. 65, no. 6, Aug. 9, 1919, pp. 181-185, 7 figs. Survey of adverse conditions to be encountered makes it manifest, in writer's opinion, that Venezuela offers small inducements of investment of foreign capital in new railway lines, except under strict governmental guarantees faithfully fulfilled.

CONSTRUCTION

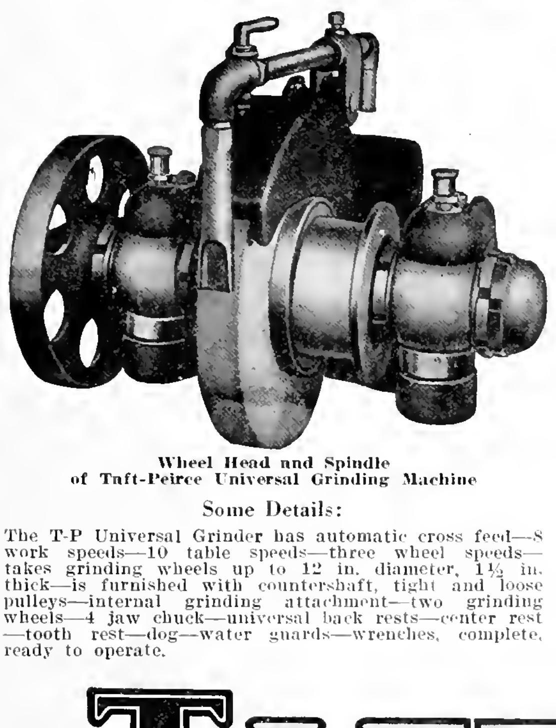
Bridges

Elevating Illinois Central Tracks and Building the New Bridges, W. T. Christine. Eng. World, vol. 15, no. 3, Aug. 1, 1919, pp. 15-19, 9 figs. Fill necessary aggregated more than 550,000 cu. yd. Bridges are of reinforced-concrete construction.

Universal Grinding Machine



The Taft-Peirce No. 2 Universal Grinding Machine, 10-in. x 30-in. Capacity



Wheel Head and Spindle
of Taft-Peirce Universal Grinding Machine

Some Details:

The T-P Universal Grinder has automatic cross feed—8 work speeds—10 table speeds—three wheel speeds—takes grinding wheels up to 12 in. diameter, 1½ in. thick—is furnished with countershaft, tight and loose pulleys—internal grinding attachment—two grinding wheels—4 jaw chuck—universal back rests—center rest—tooth rest—dog—water guards—wrenches, complete, ready to operate.

A compact, versatile machine for straight or tapered, plain, cylindrical or internal grinding.

Eight spindle speeds and ten table feeds provide capacity for a wide range of work and at the same time extreme accuracy of grinding.

A disc clutch and brake are provided in the head stock so that the spindle can be stopped and started at will, without stopping any part of the countershaft.

Send for descriptive bulletin No. 103N.

TAFT-PEIRCE
Woonsocket, R.I., U.S.A.

New York: Woolworth Building
Chicago: 6701 East End Ave.

Detroit: Majestic Building
Cleveland: 10708 Hampden Ave.

TAFT-PEIRCE PRODUCTS CARRIED IN STOCK BY

Syracuse Supply Company, Syracuse, Buffalo, Rochester 2068

Cadillac Tool Co., Detroit Wm. M. Pattison Supply Co., Cleveland Sherritt & Stoer Co., Philadelphia

Track Work

Track Special Work of the Municipal Railways of San Francisco, Leslie W. Stocker. Elec. Traction, vol. 15, no. 8, Aug. 1919, pp. 500-503, 3 figs. Development of standards of material and workmanship.

Labor Saving Devices for Railway Track Work. Can. Ry. and Mar. World, no. 258, Aug. 1919, pp. 421-424, 5 figs. Committee report presented at annual meeting of Roadmasters' and Maintenance of Way Assn.

Track Elevation on the Indianapolis Union Railroad. Eng. News-Rec., vol. 83, no. 6, Aug. 7, 1919, pp. 265-266, 2 figs. Methods necessitated in consequence of traffic of 165 trains daily.

Kanawha & West Virginia

The Kanawha & West Virginia Builds a New Line. Ry. Age, vol. 67, no. 7, Aug. 15, 1919, pp. 297-299, 5 figs. Remarking specially heavy grading involved.

ELECTRIC RAILROADS

Drop in Voltage

Drop in Volts for Track or Steel Conductors, E. Goolding. Tramway & Ry. World, vol. 46, no. 3, July 17, 1919, pp. 16-18, 5 figs. Tables for simplifying calculations.

Generator Suspension

Why One Road Changed Its Generator Suspension, J. H. Burcham. Ry. Elec. Engr., vol. 10, no. 8, Aug. 1919, pp. 271-272, 4 figs. Modifications in method of suspending Bliss truck.

History of Development

Electric Railway Development, H. C. Eddy. Aera, vol. 7, no. 12, July 1919, pp. 1187-1194, 19 figs. Historical account.

Locomotives

Electric Locomotives in the Express Service of Trunk Lines (Studien über elektrische Lokomotiven im Schnelizugsdienste der Vollbahnen). Elektrotechnische Rundschau, vol. 36, nos. 5-6, and 7-8, Feb. 5 and 19, 1919, pp. 18-20 and 27-28, 2 figs. Comparison between steam and electric service on line between Tours and Paris.

ELECTRIFICATION

Argentine

Electrification of Central Argentine Railway (La traction électrique sur le chemin de fer central argentin). Revue Générale de l'Electricité, vol. 6, no. 3, July 19, 1919, pp. 77-83, 3 figs. Comprises central station of 15,000 kw. and 60 miles of high-tension transmission lines, 5 sub-stations and electric equipment for 100 miles of single track. A. c. generated at 20,000 volts and converted to d. c. at 800 volts for traction purposes.

Electrification

Railroad Electrification (Electrificacion de ferrocarriles), Jose Luis Valenti y Dorda. Revista de Obras Públicas, vol. 67, nos. 2284 and 2286, July 3 and 17, 1919, pp. 317-321 and 344-349. Technical advantages and comparison with steam operation. Economical advantages.

Railroad Electrification Facts and Factors, A. J. Manson. Ry. Elec. Engr., vol. 10, no. 8, Aug. 1919, pp. 277-279, 2 figs. Auxiliary apparatus required in the locomotive in addition to the main driving motors.

Electrification of Federal Railways (Electrification des chemins de fer fédéraux). Bulletin Technique de la Suisse Romande, vol. 45, no. 14, July 12, 1919, pp. 133-136, 8 figs. Tests of Hoeter concrete poles. (Concluded.)

Great Britain

The Electrification of British Railways, F. W. Carter. Electrical Review, vol. 85, no. 2173, July 18, 1919, pp. 68-69. Included in program of reconstruction drawn up by Minister-designate of Ways and Communications not merely because "of the service it can render or of the saving it can effect," but because "electrical operation can show advantages over all other methods." (To be concluded.)

Operation

Some Possibilities of Steam Railway Electrification as Affecting Future Policies. Ry. Gaz., vol. 31, no. 2, July 11, 1919, pp. 56-57. Electrification is considered as offering a fundamentally different method of train propulsion because it is said limitation of steam locomotive disappears and the strictly limited motive power is replaced by one that is practically unlimited. Consequent modifications in railroad operation are visualized.

Overhead Construction

Overhead Construction in Electric Railways (Elektrische Bahnen). Elektrotechnik u. Maschinenbau, vol. 37, no. 1, Jan. 5, 1919, pp. 11-12, 6 figs. German and Austrian patents relating to catenary suspension.

Sweden

Electrification Work to be Pushed Forward in Sweden. Elec. Ry. Jl., vol. 54, no. 5, Aug. 2, 1919, pp. 225-227. Government aid for water-power development.

EQUIPMENT

Loading Table

A Standard Loading Table for British Railway Bridges, Conrad Gribble. Ry. Gaz., vol. 31, no. 4, July 25, 1919, pp. 116-118, 2 figs. Establishes that a complete loading table for bridges should consist of a series of conventional train loads, and a set of tables giving (1) equivalent uniformly distributing loads for bending moment, (2) maximum shears at center and end of spans, and (3) maximum concentrations on cross-girders of various spacings.

Turntables

New Turntable for the Pennsylvania Railroad. Ry. Rev., vol. 65, no. 4, July 26, 1919, pp. 117-121, 12 figs. Three-point-supporting turntable with vertical adjustable center bearing.

LOCOMOTIVES

Locomotive Failures

Injuries from Locomotive Failures, John L. Mohun. Ry. Mech. Engr., vol. 93, no. 8, Aug. 1919, pp. 458-463, 2 figs. Suggestions for their reduction based on examination of Interstate Commerce Commission locomotive inspection reports.

Mallet Heavy

Carolina, Clinchfield & Ohio Freight Locomotives. Ry. Age, vol. 67, no. 7, Aug. 15, 1919, pp. 317-319, 4 figs. Mallet heavy 2-8-8-2 type with tractive effort of 103,560 lb. and total weight in working order of 523,600 lb. on drivers.

Heavy Mikado and Mallet Type Locomotives, Ry. Rev., vol. 65, no. 4, July 26, 1919, pp. 122-123, 2 figs. Comparison of Carolina, Clinchfield & Ohio Ry. types with similar ones of the U. S. Railroad Administration standards.

Pensylvania Mallet Compound Locomotive. Ry. Rev., vol. 65, no. 5, Aug. 2, 1919, pp. 157-159, 4 figs. Capable of exerting 100,000-lb. tractive power and designed to operate over maximum grades of 5 per cent and around curves of 18 deg. radius.

Rail Loads

Internal Disturbing Forces and Variations in Rail Load. Ry. Gaz., vol. 31, no. 2, July 11, 1919, pp. 63-65, 3 figs. Forces due to cylinder incline and finite connecting-rod length, with particular reference to three-cylinder locomotives.

Spark Arresters

Prevention of Forest Fire Losses, Smith Riley. Am. Forestry, vol. 25, no. 308, Aug. 1919, pp. 1260-1263, 7 figs. Form of spark arrester which has been employed with success on locomotives in Colorado.

Stoking, Mechanical

Mechanical Stoking of Locomotives, W. S. Bartholomew. Ry. Mech. Engr., vol. 93, no. 8, Aug. 1919, pp. 465-469, 6 figs. Factors determining necessity of applying stokers; operating results secured by stoker firing.

Valve Gears

The Metamorphosis of the Locomotive—II, III, H. Holcroft. Engineer, vol. 128, no. 3318-3319, Aug. 1 and Aug. 8, 1919, pp. 103-104, and 126-129, 6 figs. Valve gears for variable-expansion and compound locomotives.

MAINTENANCE

Piles, Creosoted

An Unusual Record for Creosoted Piles. Ry. Maintenance Engr., vol. 15, no. 8, Aug. 1919, pp. 278-280, 1 fig. Over 14,000 creosoted piles said to have been in service in Southern Pacific Long Wharf at Oakland, Cal. for periods ranging from 22 to 29 years. Notes on their condition and treatment they received.

Terminal Tracks

The Correct Maintenance of Terminal Tracks J. B. Baker. Ry. Maintenance Engr., vol. 15, no. 8, Aug. 1919, pp. 275-276, 1 fig. Methods and practice of Pennsylvania Railroad.

Track Chisel

The Use and Abuse of the Track Chisel, Howard C. Mull. Ry. Maintenance Engr., vol. 15, no. 8, Aug. 1919, pp. 264-265, 5 figs. Suggestions in regard to handling so as to prolong life of tools.

OPERATION AND MANAGEMENT

Alphalt Shipping

The Advantages of Tank Car Shipments of Asphalt, Charles E. Murphy. Eng. & Contracting, vol. 52, no. 6, Aug. 6, 1919, pp. 160-161, 3 figs. Claims tank-car shipments have proved to be economical, have reduced labor of transportation, and have effected quicker, safer and easier handling of materials. Rules for unloading are suggested.

Engineering Side of Operation

The Operation of Railways as an Engineering Problem, V. I. Smart. Jl. Eng. Inst. Can., vol. 2, no. 8, Aug. 1919, pp. 539-550, 9 figs. Emphasizes that actual use of means of transportation is just as much an engineering problem as is design, construction and care of means of transportation, and suggests that railroads utilize, in Transportation Department, men from these two recognized engineering departments.

Fair Value

Determining "Fair Value." Elec. Ry. Jl., vol. 54, no. 5, Aug. 2, 1919, pp. 222-225. Items to be considered in estimating fair value for rate making, as outlined by Com. of Am. Elec. Ry. Assn.

Principles Underlying Determination of "Fair Value." Eng. News-Rec., vol. 83, no. 9, Aug. 28, 1919, pp. 425-428. Report of Committee on Valuation of Am. Elec. Ry. Assn. defining bases for appraising public-utility properties for rate making.

Junction Operation

Single Line working at Double Line Junctions. Ry. Gaz., vol. 31, no. 2, July 11, 1919, pp. 60-62, 9 figs. Examples of junction working during obstruction.

Passenger Traffic Analysis

Methods of Observing and Analyzing Passenger Traffic, R. H. Horton. Aera, vol. 7, no. 12, July 1919, pp. 1174-1181, 13 figs. Practice of Philadelphia Rapid Transit Co.

PERMANENT WAY AND BUILDINGS

Ashpits

Double-Track Water-Type Ashpit, Pennsylvania Railroad. Eng. News-Rec., vol. 83, no. 9, Aug. 28, 1919, pp. 408-410, 4 figs. Noting special consideration given to safety of men working at pit.

Embankments Sliding

Has the Real Cause of Sliding of Railroad Embankments Been Found? (Is de eigenlijke oorzaak van den spoorwegdam-afschuiving verklaard), J. M. K. Pennink. Ingenieur, vol. 34, no. 26, June 28, 1919, pp. 488-490. Writer criticizes conclusions arrived at by special committee appointed for this purpose by Dutch Government Dept. of Building and Hydraulics, and states his hypothesis.

Oil-Storage Tanks

The Storage of Railway Fuel Oil. Ry. & Locomotive Eng., vol. 32, no. 8, Aug. 1919, pp. 227-229, 1 fig. Dimensions and location of storage tanks.

Subgrade Construction

Concrete in Subgrade Construction. Ry. Maintenance Engr., vol. 15, no. 8, Aug. 1919, pp. 282-283, 12 figs. Installation in service under steam-railway tracks and results secured.

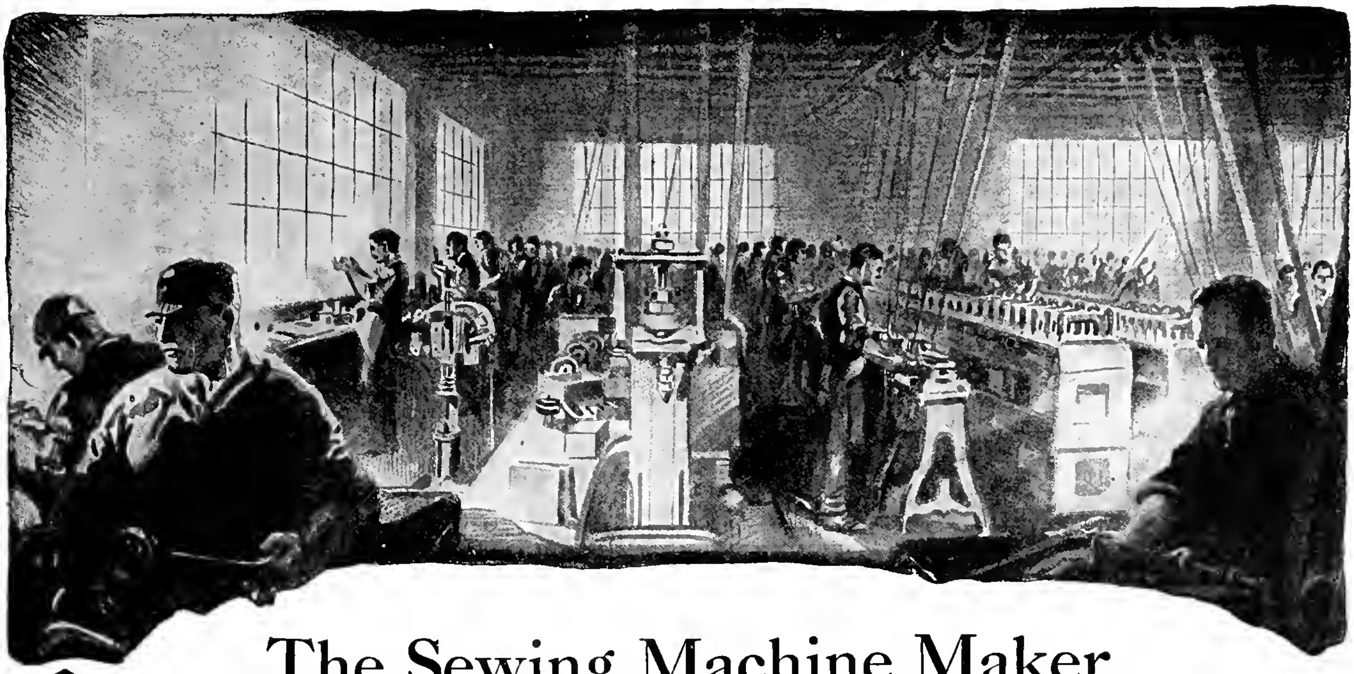
Terminal Tunnels

Montreal Terminal Tunnel from an Economic Point of View, H. K. Wicksteed. Ry. Rev., vol. 65, no. 5, Aug. 2, 1919, pp. 145-151, 7 figs. Paper read before Eng. Inst. of Canada.

Track Maintenance

War Time Progress in Maintenance of Way, John B. Tinnon. Elec. Ry. Jl., vol. 54, no. 5, Aug. 2, 1919, pp. 220-221. Writer believes that better track will result if less money is spent on construction and more on maintenance. Paper presented before Illinois Elec. Ry. Assn.

Maintenance of Permanent Way—II. Ry. Engr., vol. 40, no. 475, Aug. 1919, pp. 163-168, 2 figs. Concerning reballasting, relaying, resleepering and widenings. (Continuation of serial.)



The Sewing Machine Maker Who Made His Own Tools

Gun Tap

Acorn Die

Snap Gage

MANY manufacturers make their own screw-cutting tools—and believe they are saving money.

One of the largest sewing machine makers was among this number. Not until the problem of rising costs confronted him did he make a real investigation.

Then he sent for a GTD engineer.

The GTD man said, "Your machines can be assembled more quickly — and more cheaply—if the threaded parts are made better and more accurately."

To prove it, the GTD laboratories cut threads with Greenfield taps and dies and photographed them. Then they cut the same size threads with tools made by the manufacturer and photographed those.

The pictures at the bottom of this page tell the story. They convinced the manufacturer that he could not only *buy* better screw-cutting tools than he could *make*, and buy them cheaper, but that he could save thousands of dollars formerly lost through assembling difficulties caused by imperfect threads.

The Greenfield Tap & Die Corporation invites every manufacturer who is making his own taps and dies to try this experiment

Send to Greenfield a thread cut by your own tools and let it be *micro-shadographed* by our special high-powered projection cameras.

In nine cases out of ten the thread will be ragged and crude compared with the threads which GTD taps and dies produce.

This offer is a part of our service which enables manufacturers of machines, motors, implements and appliances, to make use of our 46 years of screw-cutting experience. The suggestions of our men may save you time, money and materials now being wasted.

Our booklet "Tools and Dividends" suggests ten questions every executive, plant superintendent or purchasing agent ought to ask. Your copy is ready for mailing.

GTD

Fig. 1—Projection photos revealed these imperfections in a screw thread. This screw was cut by tools made by a sewing machine maker for his own use, and supposed to be perfect.

Fig. 2—This screw was cut by a GTD tool. Its clean threads, when highly magnified, showed entire freedom from imperfections, ensuring an accurate easy fit in the parts of the machine.

GREENFIELD
TAP & DIE CORPORATION
Greenfield, Massachusetts, U.S.A.

World's Largest Manufacturers of Screw Cutting Tools

Track Supports, Concrete

Concrete Track Supports Cut Railway Maintenance Costs, A. C. Irwin. Concrete, vol. 15, no. 2, Aug. 1919, pp. 63-68, 16 figs. Types of construction proposed. Paper presented before Am. Concrete Inst.

RAILS

Rail Fissures

Limiting of Transverse Rail Fissures, Paul Kreuzpointner. Iron Age, vol. 104, no. 6, Aug. 7, 1919, pp. 360-362. Effect of non-diffusion of elements. Factors contributing to formation of fissures.

ROLLING STOCK

Box Cars

C. P. R. Double Sheathed Box Cars. Ry. Mech. Engr., vol. 93, no. 8, Aug. 1919, pp. 475-477, 3 figs. Also Ry. Age, vol. 67, no. 6, Aug. 8, 1919, pp. 257-259, 4 figs. Length is 36 ft.; weight 39,500 lb.; have steel underframe, wood superstructure and metal roof.

Box-Car Reconstruction

Reconstruction of 5-ft. Gauge Box Car Equipment to Suit the Indian State Railway 5 ft. 6 in. Gauge. Ry. Gaz., vol. 31, no. 3, July 18, 1919, pp. 92-94, 4 figs. Quoted as example of possibilities of converting rolling stock from one gage to another.

Instruction Car

New Instruction Car for the Southern Pacific. Ry. Age, vol. 67, no. 8, Aug. 22, 1919, pp. 365-366, 2 figs. Equipment includes apparatus for presenting operating problems graphically to employees.

SAFETY AND SIGNALING SYSTEMS

Accident in Holland

Railroad Accident near the Bridge over the Merwede Canal on September 13, 1918 (Het verzakken van den spoorwegdijk bij de brug over het Merwedekanaal nabij Weesp op 13 September 1918), van den Thoorn. Ingenieur, vol. 34, no. 30, July 26, 1919, pp. 540-549, and (discussion) pp. 549-557, 11 figs. Report of Commission appointed by State Department of Building and Waterways Construction.

Block-Signaling Practice

Block Signaling Practice on a British Railway, F. B. Holt and A. B. Wallis. Ry. Signal Engr., vol. 12, no. 8, Aug. 1919, pp. 277-280, 2 figs. Use of electrically controlled ground frames, fouling bars, telephone and telegraph communication, automatic signaling, electrically operated switches and locomotive cab signaling on Midland Railway of England.

Statistics on Signals

I. C. C. Statistics and Tables on Signals. Ry. Signal Engr., vol. 12, no. 8, Aug. 1919, pp. 270-274, 1 fig. Annual report pertaining to block signals and telegraph and telephone transmission of orders.

SHOPS

Firebox Repairs

Jacobs-Shupert Firebox Repairs, H. Louis Hahn. Ry. Mech. Engr., vol. 93, no. 8, Aug. 1919, pp. 485-487, 5 figs. Methods and tools used to repair stay sheets and cracked and distorted sections.

Milling Practice

Milling Practice in Locomotive Shops, Edward K. Hammond. Machy. (N. Y.), vol. 25, no. 12, Aug. 1919, pp. 1122-1125, 7 figs. Methods of milling heavy forgings for the side rods, connecting rods and side frames of locomotives.

Repair Shops

The Design of Modern Locomotive Repair Shops, Gustave E. Lemmrich. Ry. Age, vol. 67, no. 6, Aug. 8, 1919, pp. 261-265, 3 figs. Study of considerations entering into an efficient layout for maintenance of engines.

Springfield Shops

New Springfield Shops of the Ohio Electric Railway. Elec. Traction, vol. 15, no. 8, Aug. 1919, pp. 473-478, 18 figs. Reinforced-concrete structures.

SPECIAL LINES

Lines with Steep Gradients

Safety Devices for Lines with Steep Gradients (Sicherungsvorrichtungen an Steilbahnen), Siegfried Abt. Zeitschrift für Kleinbahnen, vol. 26, no. 2, Feb. 1919, pp. 53-63, 26 figs. Anchors and brake tongs for cable railways on trestles; also anchors and guides for rack railways.

Narrow-Gage Railway Statistics

Statistics of Narrow-Gage Railways During 1915-1916 (Statistik der schmalspurigen Eisenbahnen für das Betriebsjahr 1915-1916), F. Zezula. Zeitschrift für Kleinbahnen, vol. 26, no. 2, Feb. 1919, pp. 64-94. Tables showing length of roadbed, capital invested per kilometer, type of railway, capacity and fuel consumption of locomotives (steam and electric) for Norweian, Swiss, and German railroads.

STREET RAILWAYS

Battery Exchange

Electric Vehicle Standardization, Hilding Lubeck. Jl. Soc. Automotive Engrs., vol. 5, no. 2, Aug. 1919, pp. 131-141, 7 figs. Particularly with a view to establishing system of battery exchange.

Coasting

Coasting Results on the Chicago Elevated, H. A. Johnson. Elec. Ry. Jl., vol. 54, no. 6, Aug. 9, 1919, pp. 277-279, 2 figs. Coasting has been increased to 35 per cent. First year of operation said to have shown saving of 21,162,217 kw.-hr.

Fare Handling

Mechanical Aids in Handling Fares. Elec. Ry. Jl., vol. 54, no. 5, Aug. 2, 1919, pp. 217-220, 6 figs. Detroit United Ry. uses labor-saving device which is said to permit sorting and counting of receipts with 25 per cent of force required for hand operation.

Fare Systems

Revolutionary Change in Public Service Railway Fare System. Elec. Ry. Jl., vol. 54, no. 6, Aug. 9, 1919, pp. 282-284. Mile zones, low initial zone charge and the elimination of transfers are important elements in new system.

Tramway Fares and Services, Wm. L. Magden, Electrical Review, vol. 85, no. 2175, Aug. 1, 1919, pp. 132-134. Discussing conditions in the United Kingdom, writer points out how it appears to him that controlling bodies have considerable responsibility for failure of tramway systems to produce adequate financial return to proprietors.

Rolling Stock

New Cars for Baltimore, A. T. Clark. Elec. Traction, vol. 15, no. 8, Aug. 1919, pp. 495-497, 3 figs. Arranged to operate in one, two or three-car units.

Telephone Traffic Control

Telephone Traffic Control for Tramways. Tramway & Ry. World, vol. 46, no. 3, July 17, 1919, pp. 9-14, 8 figs. Central control station in telephonic touch with officials all over the system.

A System of Railway Traffic Control by Telephone, T. F. Lee, Post Office Elec. Engrs. Jl., vol. 12, no. 2, July 1919, pp. 105-115, 7 figs. System used by one of largest English companies and which is said to be independent of "earth" connections and therefore not to any considerable extent affected by "earth" faults.

Zone Fares

The Zone Fare in Practice. London County Council I & II, Walter Jackson. Elec. Ry. Jl., vol. 54, nos. 5 & 6, Aug. 2 & 9, 1919, pp. 210-215 and 270-275, 15 figs. Lines said to be earning 40 cents per car mile. Fares were increased in May and June 1918 chiefly by introducing a three-section penny stage, averaging 1.8 miles and by abolishing children's and fractional fare tickets. Forms of Ticket Dept. Works.

Zone Fare Collection on Front-Entrance Center-Exit Cars. Elec. Ry. Jl., vol. 54, no. 7, Aug. 16, 1919, pp. 327-328, 2 figs. On interurban line between Youngstown and Warren, Ohio, Mahoning & Shenango Ry. & Light Co. uses plan involving two types of identification checks.

TERMINALS

Terminal Power Plants

Power Plant Operation on an Efficient Basis, Paul R. Duffey. Power, vol. 50, no. 9, Aug. 26, 1919, pp. 330-331. Deals principally with power plant of railroad terminal.

Munitions and Military Engineering

Ballistics

Equations of Differential Variations in Exterior Ballistics, W. E. Milne. Jl. U. S. Artillery, vol. 51, no. 2, Aug. 1919, pp. 154-159, 1 fig. Suggested modifications in method of derivation devised by F. R. Moulton.

Trajectories and Their Corrections, A. G. Kirk. U. S. Naval Inst. Proc., vol. 45, no. 198, Aug. 1919, pp. 1375-1395, 7 figs. Method of computation by mechanical integration.

Camouflage

The Dazzle Paintings of Ships, Norman Wilkinson. Engineering, vol. 108, no. 2797, Aug. 8, 1919, pp. 192-195, 5 figs. Origin and development, and reasons for its adoption as opposed to painting a ship with a view to achieving invisibility.

Chemical Warfare

Innovations of the Recent War, William L. Sibert. Jl. Cleveland Eng. Soc., vol. 11, no. 5 & 6, Mar.-May 1919, pp. 272-281. Chemical work involved, particularly in connection with gas warfare, with notes on policy followed by Chemical Warfare Service.

Chronograph

The Aberdeen Chronograph. Sci. Am., vol. 121, no. 6, Aug. 9, 1919, pp. 131 and 145, 5 figs. Device for timing flight of projectile developed by Army Ordnance Dept.

Coast Defense

Coast Defenses Constructed by the Germans on the Belgian Coast, Augustus Norton and Donald Armstrong. Jl. U. S. Artillery, vol. 51, no. 2, Aug. 1919, pp. 160-181, 35 figs. Battery on Belgian coast consisted of four 28-cm. guns.

Discussion of Method of Indirect Firing for Coast Defense (De toepassing van de methode der indirecte richting bij kustgeschut), H. D. S. Hasselman and P. Post Uiterweer. Artilleristisch Tijdschrift, no. 8, Aug. 1919, pp. 474-489, 1 fig.

Explosion of Charges at Sea

Science and Its Application to Marine Problems, J. C. McLennan. Engineer, vol. 128, no. 3317, July 25, 1919, p. 92. Investigations of characteristics of pressure waves generated by explosion of charges in sea. (Concluded). Paper read before North East Coast Instn. of Engrs. and Shipbuilders.

Gun Mounts

Building 5-inch Gun Mounts at Brantford, J. H. Moore. Can. Machy., vol. 22, no. 6, Aug. 7, 1919, pp. 143-145, 7 figs. Milling operations and inspection. Second installment.

See also Naval Guns.

Gun Operation

Operations on the British 9.2-in. Gun—I, II, III, William Chubb. Am. Mach., vol. 51, nos. 6, 8 and 9, Aug. 7, 21 and 28, 1919, pp. 275-280, 373-377 and 423-427, 26 figs. Aug. 7: Noting particularly difference in production operations from practice on ordnance in United States. British 9.2 army gun is very similar in design and construction to guns of British navy. Aug. 21: Manufacture of various sizes of rings from one forging by combined processes of trepanning, turning and boring. Aug. 28: Rifling, building and inspection.

Illuminating Devices

Illuminating Devices in the Great War—I, II. M. Brayton. Sci. Am. Supp., vol. 88, no. 2277, Aug. 23, 1919, pp. 114-115 and p. 127, 1 fig. Account of aerial lighting devices and their development from 1914 to the armistice.

Motor Transport Corps

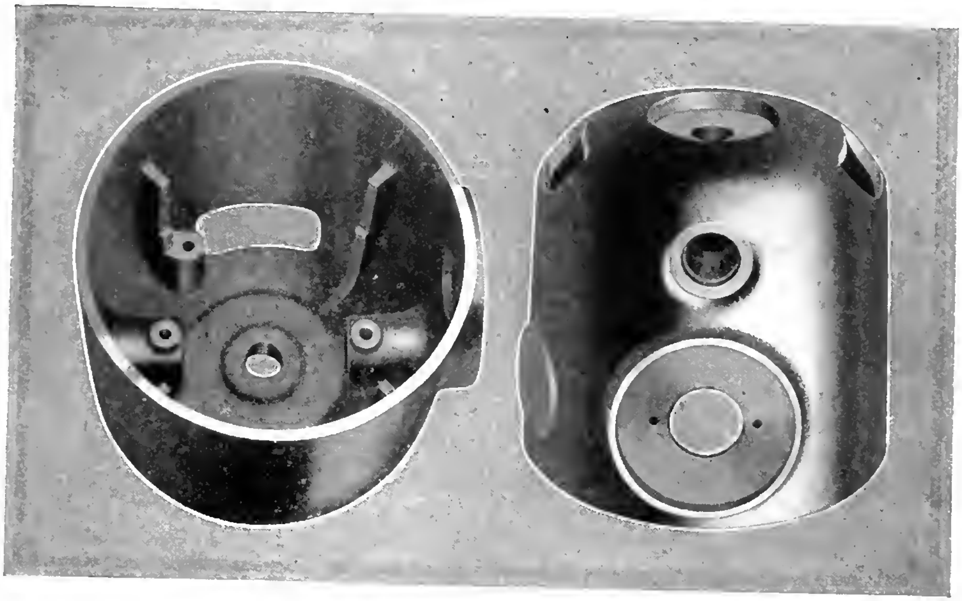
The Automotive Industry and the Motor Transport Corps, B. F. Miller. Jl. Soc. Automotive Engrs., vol. 5, no. 2, Aug. 1919, pp. 148-154. Concerning maintenance engineering features of Motor Transport Corps.

Naval Guns

Transportation and Mounting of Naval Guns at the Front (Trasporto e montamento dei cannoni navili alla fronte), Guiseppe Fioravanzo. Rivista Marittima, vol. 52, no. 6, June 30, 1919, pp. 293-305, 13 figs. Types of both mobile and fixed mountings developed by Italian army.

Navy, British

The New Navy—VII. Mar. Engr. & Naval Architect, vol. 42, no. 503, Aug. 1919, pp. 7-11, 4 figs. Details of "Courageous" and "Glorious



Die Casting Complicated Pieces

THE correct die casting of any complicated piece. such as the electric motor housing shown above, necessitates the skill and experience of the best engineers. Dies can be designed to do the work at the lowest cost, and to give the correct shape and finish to the castings. Teeth on small gears and pinions, threads, cored holes, webs, flanges and other parts of intricate castings will be absolutely accurate in shape with a clean, smooth finish if the dies are scientifically correct. Sometimes two or more pieces can be combined into one by the use of properly designed dies.

Stewart engineers have made the use of die casting possible for many manufacturers and have lowered the cost for others. No matter how complicated your parts may be, just send a sample or a blue print to us and get the report of the Stewart engineers on the possibilities of die casting for YOUR product.

STEWART MANUFACTURING CORPORATION
4500 FULLERTON AVENUE CHICAGO

Stewart

ons.[?] These ships are in large light cruiser category and form unique class.

Powder Gases

On the Possible Form of the Equation of State of Powder Gases, A. G. Webster. Proc. Nat. Acad. Sciences, vol. 5, no. 7, July 1919, pp. 286-288. Examination of most general form possible for equation of state that will permit of variability of specific heats, but maintain constancy of their difference.

Pressure Measurement in Guns

A New Instrument for Measuring Pressure in a Gun, A. G. Webster and L. T. E. Thompson. Proc. Nat. Acad. Sciences, vol. 5, no. 7, July 1919, pp. 259-263, 4 figs. Apparatus which is said to register pressure at any time while projectile is in barrel.

Repair Shops

Portable Repair Shops for the Army, Harold S. Lord. Am. Mach., vol. 51, No. 7, Aug. 14, 1919, pp. 317-322, 6 figs. Including lists of tools and accessories carried by (1) machine shop, (2) blacksmith shop, and (3) carpenter shop, and also list of regular equipment for material truck.

Salvaging Submarines

A Salvaging Submarine, Hawthore Daniel. Sci. Am., vol. 121, no. 7, Aug. 16, 1919, pp. 154-155 & 166-168, 7 figs. Combination of surface vessel and diving bell, so arranged that whether diving bell is submerged or not, surface workmen can readily pass from surface vessel to bell and vice versa.

Shell Manufacture

Researches in regard to Various Points in the Manufacture of Shells (Researches sur différents points de la fabrication des obus), Léon Guillet. Revue de la Métallurgie, May 1917, 36 pp., 125 figs., partly on 34 supp. plates. Micrographic examinations and chemical analysis to determine influence of form of punch, rapidity of its wear, process of piercing, temperature of metal and of punch.

Submarine Defense

Science and Its Application to Marine Problems, J. C. McLennan. Shipbuilding & Shipping Rec., vol. 14, no. 5, July 31, 1919, pp. 123-124. Also Engineering, vol. 108, no. 2795, July 25, 1919, pp. 128-130. Development of antisubmarine measures and devices. Paper read before Northeast Coast Instn. Engrs. and Shipbuilders.

Torpedo-Boat Destroyers

Torpedo-Boat Destroyers in the Making, James Reed. Mech. Eng., vol. 41, no. 9, Sept. 1919, pp. 739-743, and p. 781. Historical review of modern American torpedo craft. Non-technical description of the "Ward," which was launched 64 per cent complete and only 17½ days after laying of keel.

General Science

CHEMISTRY

Acetylene Analysis

A Modified Method for the Analysis of Mixtures of Ethylene and Acetylene, William H. Ross and Harlan L. Trumbull. Jl. Am. Chem. Soc., vol. 41, no. 8, Aug. 1919, pp. 1180-1183, 3 figs. Gas holder used by writers applying method outlined by Chavastelon (see Compt. rend., 125, 245, 1897), for determination of acetylene in gaseous mixture.

Analysis

A New Method of Chemical Analysis, A. W. Hull. Jl. Am. Chem. Soc., vol. 41, no. 8, Aug. 1919, pp. 1168-1175, 9 figs. Method consists in reducing to powder form substance to be examined, placing it in small glass tube, sending beam of monochromatic X rays through it, and photographing the diffraction pattern produced.

See also Glass, Carbon Bisulphite, Matte and Slag, Rubber, Flue Gas, Gas, Acetylene and Ethylene.

Carbon Bisulphide

Estimation of Carbon Bisulphide. A Critical Examination of the Various Methods Usually Employed, Percy E. Spielmann and F. Butler Jones. Jl. Soc. Chem. Indus., vol. 38, no. 13, July [illegible], 1919, pp. 185 T-188 T. With regard to their relative value, conditions of best results, and limits of accuracy of each.

Colloids

See Soaps.

Electrical Conductivity of Elements

Is the Electrical Conductivity of the Elements Conditioned by the Presence of Isotopes? F. H. Loring. Chem. News, vol. 119, no. 3091, July 11, 1919, pp. 14-16. Table showing proportionate number of isotopes and percentages of higher values in various metals discloses that electrical conductivity is conditioned by proportion of isotopes present.

Ethylene Analysis

See Acetylene Analysis.

Fuel-Gas Analysis

Combustion Control in Mill Boiler Plant—III, Robert June. Blast Furnace & Steel Plant, vol. 7, no. 8, Aug. 1919, pp. 398-400, 4 figs. Flue-gas analysis.

Gas Analysis

Industrial Analysis of gaseous Mixtures by refractometric Method (Analyse industrielle des mélanges gazeux par la méthode réfractométrique), Marcel Ponchon. Chimie & Industrie, vol. 2, no. 6, June 1919, pp. 647-655, 6 figs. How to use Lord Rayleigh's interferential refractometer.

Gas Measurement

Apparatus for Measuring Volume of Gas Liberated in a Chemical Reaction (Appareil pour mesurer le volume gazeux dégagé dans une réaction chimique), P. Nicolardot and M. H. Robert. Chimie & Industrie, vol. 2, no. 6, June 1919, pp. 641-646, 1 fig. Modification of apparatus described in Bul. Soc. Chim. de France, vol. 11, p. 406, 1912. Change consists in using water instead of mercury.

Glass Analysis

The Rapid Electrometric Determination of Iron in Some Optical Glasses, J. B. Ferguson and J. C. Hostetter. Jl. Am. Ceramic Soc., vol. 2, no. 8, Aug. 1919, pp. 608-621, 3 figs. Discusses results of application of electrometric determination of iron with stannous chloride and potassium dichromate.

Helium

See Structure of Matter.

Magnetite

Determination of Magnetite in Matte and Slag, F. G. Hawley. Eng. & Min. Jl., vol. 108, no. 8, Aug. 23, 1919, pp. 308-310. Writer holds that qualitative tests are of little significance, and claims that quantitative method has been proved to be sufficiently accurate and is also rapid.

Rubber

The Use of Hydrometers to Determine the Rubber Content of Latex, O. de Vries. India Rubber Jl., vol. 58, no. 2, July 12, 1919, pp. 17-18, 1 fig. Explanation for anomalous results obtained with experiments such as metrolac of R. G. A. or Griffin's latexometer. From Archief voor de Rubber-cultur.

Soaps

Colloid-Chemical Studies on Soaps, Martin H. Fischer. Chem. Engr., vol. 27, no. 8, Aug. 1919, pp. 184-193, 12 figs. Non-aqueous lyophilic soap colloids.

Structure of Matter

The Structure of Atoms and the Octet Theory of Valence, Irving Langmuir. Proc. Nat. Acad. Sciences, vol. 5, no. 7, July 1919, pp. 252-259. Concerning extension of Lewis' theory of cubical atom.

The Arrangement of Electrons in Atoms and Molecules—II, Irving Langmuir. Gen. Elec. Rev., vol. 22, no. 8, Aug. 1919, pp. 587-600, 13 figs. Writer points out what he terms uncertainties attached to textbook conceptions of valency, and suggests much more general theory of valence which he subsequently applies in elucidating structure of a number of organic and inorganic compounds. (To be continued.)

Helium Atom According to Bohr's Theory (Sur l'atome d'Helium selon la théorie de Bohr), Franz Tank. Archives des Sciences physiques et naturelles, vol. 1, May-June 1919, pp. 240-241. Table giving Δ n for neutral helium.

Ritz's Formula and Theory of Quanta (La formule de Ritz et la théorie des quanta), L. Bloch. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 25, June 23, 1919, pp. 1271-1273. As to whether by slightly complicating structure of atom it is possible by calculations similar to Bohr's to arrive at Ritz's formula.

Sulphions

"Sulphions" formed by Sodium, Rubidium and Cassium Iodides (Sur les sulfones formées par les iodures de sodium, de rubidium et de caesium), R. de Forcrand and F. Taboury. Comptes rendus des séances de l'Académie des Sciences, vol. 168, no. 25, June 23, 1919, pp. 1253-1257. Experiments to confirm accounts reported by various writers relative to transformations of certain salts in presence of sulphurous anhydrites.

Ternary System

The Ternary System, J. B. Ferguson and H. E. Merwin. Am. Jl. of Sci. (Fourth Series), vol. 48, no. 284, Aug. 1919, pp. 81-123, 17 figs. Experimental research of solidus-liquidus relations.

Weighing

The Single Deflection Method of Weighing, Paul H. M.-P. Brinton. Jl. Am. Chem. Soc., vol. 41, no. 8, Aug. 1919, pp. 1151-1155. Writer claims to have found method practicable and reliable after critical investigation.

MATHEMATICS

Abelian Varieties

Real Hypersurfaces Contained in Abelian Varieties, S. Lefschetz. Proc. Nat. Acad. Sciences, vol. 5, no. 7, July 1919, pp. 296-298. Number of algebraically distinct real hypersurfaces which abelian variety of genus p and rank one, if real, may have.

Curve Generation

On a Certain Generation of Rational Circular and Isotropic Curves, Arnold Emch. Bul. Am. Math. Soc., vol. 25, no. 9, June 1919, pp. 397-404. Establishes necessary and sufficient conditions for form of parametric representation of rational circular, in particular of rational isotropic curve, and their generation by rational transformation in a complex plane.

PHYSICS

Acoustics

Acoustical Impedance, and the Theory of Horns and of the Phonograph, Arthur Gordon Webster. Proc. Nat. Acad. Sciences, vol. 5, no. 7, July 1919, pp. 275-282, 5 figs. Introducing complex ratio defining impedance in study of oscillating system into which a volume of air periodically enters under a given excess pressure.

Benzine

See Vapor Pressures.

Cyclohexane

See Vapor Pressures.

Gas Law Alignment Chart

Alignment Chart for the Gas Laws, Alan G. Wikoff. Chem. & Metallurgical Eng., vol. 21, no. 4, Aug. 15, 1919, p. 195, 1 fig. Temperature scales so graduated that scale reading in deg. cent. corresponds to logarithm of absolute temperature.

Heat Transformation Into Electrical Energy

Direct Transformation of Heat Into Electrical Energy Otherwise Than by Means of Electrothermic Couples (Sur la transformation directe de la chaleur en energie électrique par d'autres voies que les couples thermoélectriques), Albert Perrier. Archives des Sciences physiques et naturelles, vol. 1, May-June 1919, pp. 243-246. Consequences derived from magnetic and electric asymmetries of matter.

Magnetic Isothermals

Ferromagnetism and Characteristic Equation of Fluids (Ferromagnétisme et équation caractéristique des fluides), Pierre Weiss. Archives des Sciences physiques et naturelles, vol. 1, May-June 1919, pp. 163-185, 8 figs. Interpretation of magnetic isothermals of nickel in vicinity of Curie's point.

Phonographs

See Acoustics.

Relativity

On the Theory of Relativity (Sur la théorie de la rélativité), Edouard Guillaume. Archives des Sciences physiques et naturelles, vol. 1, May-June 1919, pp. 246-250. Concerning introduction of single pyrometer to represent time.

Spectrum

New Lines in Iron Spectrum (Une nouvelle répartition de raies dans le spectre du fer), Aug. Hagenbach. Archives des Sciences physiques et naturelles, vol. 1, May-June 1919, pp. 231-235, 1 fig. Observed by writer in vicinity of $500\mu\mu$.

Army Motor-Transport Vehicles

By JOHN YOUNGER,[1] PITTSBURGH, PA.

This paper contains a discussion of the types of vehicle best adapted to various military needs. Motor-transport vehicles have been classified by the Army under ten broad heads, ranging from the motorcycle to the 5-ton truck, and such a classification has been found to be a most satisfactory one. The ultimate ideal is of course to standardize a single type of vehicle for each class, and with that point in view the writer discusses the various vehicles used. Numerous photographs are presented as illustrative of American design and construction, and in the complete paper tables and curves will be found giving data on the various types used during the war.

IN considering the subject of motor-transport vehicles used by the U. S. Army the writer believes it is unnecessary to go into any detail regarding the history of motor-vehicle transportation in military use. It is of interest in passing, however, to note that steam vehicles were successfully used years ago, reaching their highest point of development in the British South African war. Motor road transportation does not come into great prominence again until the Great War of 1914, when its use exceeded the estimates of even the most radical. During the war motor vehicles were used by the tens of thousands. They paralleled the railroads, they crossed the railroads, they radiated in all directions. Motor trucks, loaded with shells in the Midlands, were driven straight to the channel ferry and run right up to the front line in France, without any changing of load, the saving in time being of course enormous. It is a matter of record that the fight for Verdun was fought and won largely through aid furnished by motor-vehicle equipment. The railroad was at the mercy of the enemy, and a military highway accommodating four streams of trucks was built, thus saving the city.

These are matters of history pointed out principally to illustrate a new mechanical feature which has arisen in warfare. The successful army, as of old, is in large measure the one which possesses the characteristic of great mobility. The internal-combustion-engine motor vehicle has in the past decade accomplished a revolution in military mobility and it is proper, therefore, that attention should be directed to the technical features underlying this great change. However, to go into detail concerning their mechanical points would be merely to recapitulate their catalog specifications. It is felt advisable, therefore, to try to form some measure of classification so that the whole broad array of motor equipment, ranging from the small motorcycle to the huge 5-ton cargo-carrying truck, can be studied intelligently and with a view to seeing in what direction we should plan in the future to take care of our military needs.

Fig. 1 Standard "B" Truck Fully Equipped for Cargo Purposes

Classification of Vehicles

Such a classification would be as follows below, and as the war progressed it was found more and more that this classification was a scientific one into which the various types of vehicles tended to concentrate, so that in the ultimate ideal there would be one standard-type vehicle in each classification. This particular point is one, however, which will be studied later.

1 Motorcycles
2 Light Passenger Cars, suitable for carrying five passengers
3 Heavy Passenger Cars (enclosed or limousine type) for carrying staff personnel
4 Ambulances
5 ¾-Ton Trucks, for carrying cargo or personnel
6 1½-Ton Trucks (either pneumatic or solid tires) for carrying cargo or personnel
7 3-5-Ton Trucks on solid tires
8 Trucks of the 4-wheel-drive type
9 Cargo-carrying track-laying type of vehicle
10 Trailers—¾-1½-3-5 or 10-ton.

Special Army Requirements

Before proceeding with a discussion in detail of each of the types in the foregoing classification, it would be well to consider whether the Army has or has not special requirements which render necessary the special design in their equipment. The inability of the motor vehicle to work economically on poor roads has called forth a general demand for improved highways which has resulted in the spending of millions of dollars on state highways this year alone. These state highways are chosen in location just as the railroad is—because of the economic purpose the road will serve, either in our commercial life or in our recreation. The very small minority that operate pleasure cars on poor roads have to pay the

[1] Asst. to Pres. Standard Steel Car Co., Pittsburgh, Pa. Mem.Am.Soc.M.E.

For presentation at the Annual Meeting, New York, December 1919, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and advance copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

penalty, and even more so with motor trucks. A great volume of business lies in the cities where exceptionally good roads are met, whereas the number of trucks operating outside of the cities is very small.

The problem of the Army, however, is different, for rarely, if ever, does it operate in a big city, its operations being confined to the open country. It has to take roads as it finds them and sometimes it has even to make its own roads. In this connection it is of interest to examine the roads on the borderlands between this country and Mexico and to observe that they actually barely exist. The needs of the Army must therefore be considered from the military standpoint and neither political nor commercial considerations should be allowed to block the main issue, namely, that the Army must have proper motor transportation suitable to insure its mobility under any possible circumstances in which it will be called to fight. Stress is laid on this point as there have been arguments pro and con as to the advisability of the army using commercial vehicles. The war in France brought little light on this subject because for years the battle line was practically stationary

Fig. 2 Ordnance Design of 4-Wheel-Drive "Tractor-Truck"

and the country behind the lines had innumerable highways of high-grade construction of an antiquity reaching back way beyond the days of Napoleon—actually to the days of Julius Cæsar. The motor vehicle, therefore, for military use should be considered from the military aspect and we should not necessarily try to foist on the Army vehicles which are of proven value only in the commercial field.

Discussion of Types

Motorcycles. These proved of tremendous use in warfare. Where despatches had to be carried over exceedingly rough ground, where high speed was essential, where transportation under fire was necessary, the motorcycle proved its value. Two of the commercial makes of motorcycles manufactured in this country proved that in general they were satisfactory from a military standpoint. Military use, it is true, developed certain weaknesses which were ultimately remedied, but the experience of the war indicated that the present-day motorcycle of standard construction suitable for side-car use would survive as a standard of equipment, and that a light-weight machine—not over 250 lb. in weight—should be developed for "solo" work.

Light Passenger Cars. Two American machines were used in great quantities, the Ford and the Dodge. Both gave good satisfaction, but it is felt that still better satisfaction could be obtained by concentration on one passenger machine of a somewhat more rugged design. There are, however, commercial aspects in this case as machines such as the above have a tremendous market off the beaten highway and their economic and satisfactory use by farmers and the like over poor roads, or over no roads at all, furnishes sufficient test to warrant the army considering very seriously in this case the commercial vehicle. On the whole, it was found that the car of the Dodge type gave the most satisfactory results. This type of vehicle was used for officers in their work involving the covering of territory, in the transportation of light supplies, as an emergency repair wagon, and in all kinds of ways which will suggest themselves to any student of military affairs. It is the writer's personal opinion that there is no necessity for two types of cars—one type alone will be ample. Only in cases of sudden emergency, where a tremendous increase in the army would be required, would it be advisable to increase the number of types.

Heavy Passenger Cars. For staff use it is essential that a more powerful car, capable of maintaining a high speed over long distances, should be provided. This car should be preferably of the sedan or limousine type to insure comfort to the occupant. The staff officer in directing troop movements is often required to make long journeys at night in such a car, and all facilities should be provided to insure rest. This car should be provided with facilities for carrying maps, reports, etc., and with necessary lights so that such could be studied during the night. This car will only have a limited use and will be used almost exclusively along the highways, so that a commercial type of car would be quite suitable. During the war the Cadillac was used exclusively for this purpose by the American Army and its specifications would stand today as being typical of what would be required for future use.

Ambulances. The ambulance is a peculiar type of vehicle in the sense that while its load consists of only four or five passengers, the shape of the load (the patients, of course, being recumbent) necessitates almost a box-van construction for the body. Furthermore the fact that the patients have to be carried with great care necessitates special attention being paid to the springing and the comfort generally of these vehicles, particularly when it is realized that they must operate as closely as possible to the firing line and in all probability some distance away from the good roads, and subject to shell fire. The writer feels that for this purpose the chassis used for passenger carrying is one which will be found most desirable for this use, with a possible change in the direction of lengthening the wheelbase to insure better adaptation to the body.

During the war there were two types of ambulances used, one a simple 4-patient ambulance mounted on a long-wheelbase Ford chassis; the other, a more elaborate one mounted on the ¾-ton G.M.C. truck. Both ambulances had their distinct use, the Ford type being used close to the firing line, while the G.M.C. was used more behind the lines from the rest stations to the base hospitals. In view, however, of the limitation in number of our standing army, it is believed in the interest of concentration of equipment that it would be advisable to have only the one chassis used for this purpose. It is felt unnecessary to go into the details of this chassis.

Passenger-Carrying Heavy Vehicles. The passenger-carrying heavy vehicle calls for special mention as it differs from the cargo-carrying type. In connection with artillery work it is necessary to carry a band of men for special work. Reconnaissance also calls for a crew of men to go out with range finders, various binoculars, instruments and tools for marking so that a proper site can be selected for the placement of field guns. The vehicle for this purpose must be provided not only with seats carrying the necessary personnel, but also with proper compartments for carrying the various tools required. The vehicle for this purpose should be capable of traveling over rough ground and should be, as are the others, of sturdy construction. Another type of passenger-carrying vehicle is what is usually known as a staff observation car. This is a large car — sometimes of the omnibus type — in which as many as nine or more passengers can comfortably be carried. This is used on occasions when the staff, particularly in the artillery, wishes to make an observation run or for the purpose of visiting

different posts. The 1½-ton cargo-carrying chassis with pneumatic tires is quite suitable for this work.

The ¼- and 1½-Ton Pneumatic Tire Trucks. The ¼- and 1½-ton pneumatic-tire trucks can be grouped together as their work is very similar. A high state of development was found in these capacities of commercial trucks from the Army standpoint, this being most certainly a result of the fact that both these capacities are used in large numbers in country districts where bridges and other limitations do not interfere with their use. These vehicles are used for carrying modern loads, the smaller size being used for emergency repair work, carrying emergency stores, and for final distribution of supplies from the main dump or from one or other of the advanced stations. They are also used in large numbers in connection with the Air Service, furnishing supplies of all kinds not only for the airplanes but for the personnel. Airplanes, of course, had their stations off the road in the fields, and naturally the lighter trucks were found necessary.

Special attention is called to the use of pneumatic tires. It was found in trucks up to 1½-tons capacity that pneumatic tires allowed running on very poor roads and over comparatively soft surfaces, such as a grass field, under conditions that would have prohibited the use of solid tires. It was also found that high speeds could be maintained for long periods with practically no damage to the vehicle. For example, a 1½-ton capacity cargo truck could be driven at a speed of 30 m.p.h. over give-and-take roads for long periods. This, of course, has a tremendous value in mobility and also in emergency cases where supplies can be rushed forward. Under certain conditions, such as operating over sandy roads (as are found in many parts of the country), these moderate-capacity trucks with large pneumatic tires would be practically the only trucks that would be of any value.

Much discussion has ranged over the use of pneumatic tires, whether they should be single or dual on the rear. European practice has been to use dual tires on the rear, the front and rear size being the same, thus eliminating the necessity of carrying two spare tires and tending toward interchangeability. American practice has been to use one size of tire on the front, such as for example, 38 in. by 7 in. and a larger (40 in. by 8 in.) single tire on the rear. Both types have worked out successfully during the war and it is felt that a little longer period of development is necessary before a decision could be arrived at as to which is likely to be the surviving type, if not both.

FIG. 3 EXPERIMENTAL TYPE OF TRACK-LAYING AMBULANCE USING THE FORD CHASSIS

The 1½-Ton Solid-Tire Trucks. The 1½-ton cargo-carrying truck with solid tires can be looked upon in the Army as the maid-of-all-work. Cargo of all kinds, men, supplies, food, and munitions are carried on this steady-going vehicle. This is the vehicle which has in motorized equipment taken the place of the standard mule escort in the old Quartermaster Department. Able to run at 16 m.p.h., of sufficiently light weight that it can go over any average bridge, thoroughly worked out over a period of years in commercial life, in the Army found but little change necessary in adapting it for their purposes. In the selection of one type for standardization it was found very difficult to distinguish which among a number was the best, and it is no slur on any of the types not approved when, for various reasons not always connected with their technical worth, they were rejected.

The 3-5-Ton Cargo-Carrying Trucks. The 3-5-ton truck was not used during the Mexican War and it remained for the Great War to establish its status as one of the standard vehicles of the Army. It was around this capacity of truck that tremendous discussion raged during the early stages of the war. The Army, in considering the various heavy capacity trucks on the market, came to the conclusion that these were unsuitable for military use. The

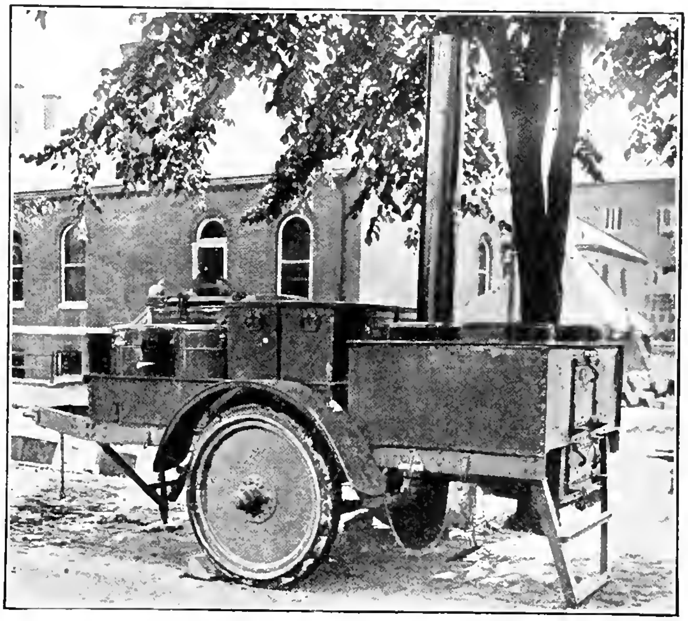


FIG. 4 ARMY ROLLING KITCHEN READY FOR MOVING

5-ton truck of commerce is used almost solely around the cities. Bridge and load limitations have been, of course, partially preventive of its use in outlying districts, but the big obstacle has been the fact that the industry requiring a truck of this capacity is almost invariably located in the larger cities and requires this purely for city use. The commercial vehicle of this capacity has therefore been developed, consciously or unconsciously, along good-road conditions. It was found that, in operation over poor roads, it had insufficient ability to proceed at a regular speed through heavy mud holes or heavy winter conditions. This point will of course be argued by those responsible for the average heavy-capacity truck, and while it is true that such trucks could operate under such conditions, the penalty paid was nevertheless tremendous.

For this reason, the Government saw fit, in 1917, to design and develop a truck of its own, this being known variously as the "Liberty" truck or "B" Type truck, the latter being its official title. Fig. 1 shows this truck fully equipped for carrying cargo. It was developed by the coöperative efforts of the engineers of the industry and the Government and was put into production, approximately 18,000 being manufactured to meet the demands. In this vehicle the special points that were required by the military use were built into the truck and were not added as an afterthought. The ability of this truck (piston displacement per 1000 lb. moved 1 ft.; or the torque at the rear wheels' circumference) is approximately 50 per cent greater than that of similar capacity in commercial trucks. This is more noticeable on the low or first-gear drive. In driving around on the various trucks, watching their performance under heavy conditions, one could not but be impressed with the ease with which this truck operated over extremely heavy going.

This capacity of truck was developed as a larger brother to the

$1\frac{1}{2}$-ton truck. Its military advantages were not at first seen but later they became obvious. Its overall length was less than 10 per cent greater than that of the $1\frac{1}{2}$-ton truck and similarly with its width. Carrying two or three times as much cargo as the smaller truck, it offered virtually the same target on the road and in convoy work was almost 66 per cent less in length. From the standpoint of what might be called the direct labor problem of the Army, the number of men required to operate the heavy truck was exactly the same as that for the lighter truck; thus, for given amount of cargo it released more men for the firing line. The work of repairing, the number of spare parts necessary, maintenance and cost of running were also almost identical with those of the lighter truck and it is not surprising, therefore, to find that although this class of truck was introduced in the Army at a late date, it made tremendous strides, outnumbering any other capacity of truck. Another advantage that showed itself, due to capacity and ability to put on large platforms, was that this vehicle offered means of using trucks for all kinds of work where mobility was essential.

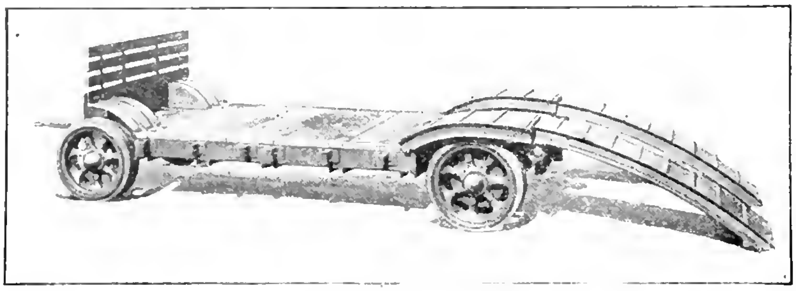


FIG. 5 ARTILLERY 10-TON TRAILER FOR TRANSPORTING TRACK-LAYING TRACTORS, SMALL TANKS OR GUNS

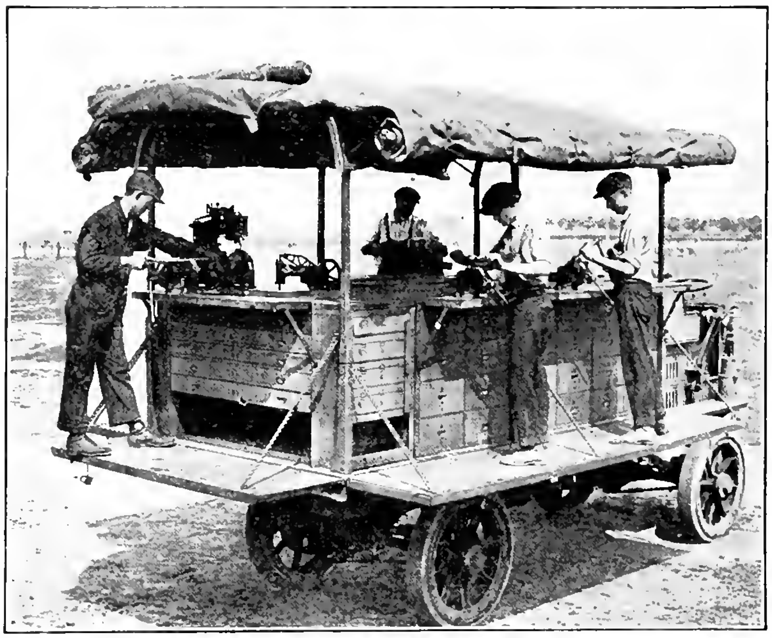


FIG. 6 ORDNANCE MOBILE REPAIR SHOP

It is felt that this "B" type truck will be the standard heavy cargo-carrying truck for the Army. It will undergo normal developments with time, and, in peace conditions, prove itself of tremendous value in military operations. During war times, if there be any kind of highway system, it will also demonstrate its value. It is also believed that, with the proper organization and with the proper help from the Engineer Corps in improving the existing highways and bridges, it will be able to operate almost anywhere that the army operates.

The 4-Wheel-Drive-Type Truck. The 4-wheel-drive truck shown in Fig. 2 is that type of vehicle in which the driving power is conveyed to all the four wheels and in which the full weight of the truck is available for traction purposes. Sometimes this type of truck steers on all four wheels, and sometimes only on the two front ones. Almost invariably, however, there is some type of differential locking or partial locking device which insures power being delivered to each wheel, whether or not that wheel is on a slippery or hard surface.

This type of truck is also subject to great argument; either its users are very strongly for it or they are very much against it — there seems to be very little middle ground in the discussion. On analysis, the reason for this shows itself. In military work and in emergencies it is essential that certain supplies be carried from one point to another, no matter what the terrain may be like. Sometimes the conditions are so bad that men must carry the supplies themselves or by mules; sometimes the conditions, while severe and absolutely prohibitive of the use of the ordinary vehicle, will yet allow the use of the 4-wheel-drive truck. With driving chains on all four wheels and with an extremely low-gear reduction, every ounce of power is available for traction and the 4-wheel-drive truck accomplishes its mission. Feats like these of regular daily occurrence in the Army have made military people, particularly in the Ordnance Department and Artillery Corps whose work is mostly "off-road," staunch adherents of the 4-wheel-drive truck. It must be realized, however, that during this work the strain on the truck is enormous. Only the heaviest jobs are given to this type of vehicle and under these severe conditions, it is not difficult to understand that the maintenance problem is tremendous. It is from this last viewpoint, in comparison with the 2-wheel-drive vehicles, that the 4-wheel-drive type has suffered, and suffered, it must be said, unfairly. Over good or reasonably good roads there is no necessity for a 4-wheel-drive type of truck, but over almost impassible roads the 4-wheel-drive truck will justify its existence. In the service of the Marine Corps, for example, where weight limitations are necessary and where the ability to go anywhere is essential, the $1\frac{1}{2}$-2-ton capacity 4-wheel-drive truck is standard. It should also be noted that the 4-wheel-drive type of truck proved its value as a tractor for hauling guns over roads where the track-laying type of vehicle was almost prohibited. In hauling trailers and in the general haulage work required, this 4-wheel-drive type of vehicle became a necessary part of the equipment.

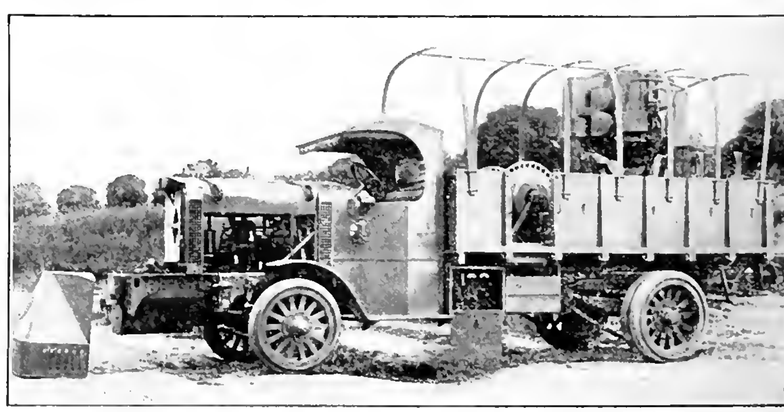


FIG. 7 SEARCHLIGHT EQUIPMENT USED BY ENGINEERS CORPS, MOUNTED ON SPECIAL 6-TON CHASSIS

Track-Laying Cargo-Carrying Trucks. First of all, this type was developed for agricultural-tractor purposes, the idea then being seized upon and used by the British in the design of their tank. It was natural that the caterpillar of track-laying type of vehicle should eventually be discussed in its relation to carrying cargo over "off-road" conditions. As practically all production capacity was used in the manufacture of tanks and what spare capacity there

was, was used for agricultural tractors it was almost impossible to develop the cargo-carrying track-laying type of vehicle during the war, but all indications pointed to the necessity for considering this design very seriously for the future in order to still further attain the ideal of perfect mobility. Small progress was made however, but still enough to show that the attention of military designers should be directed largely to this type. For winter conditions, for example, this may be found necessary; and for shell-torn fields, otherwise impossible to traverse, a track-laying vehicle may give the solution of the problem of transportation. One drawback to its use at present is the fact that over hard roads the wear and tear on the vehicle is greatly exaggerated and the maintenance problem is very severe. There is no question, however, but that these mechanical problems will be solved in time. An interesting application of the track-laying type of vehicle is shown in Fig. 3.

Trailers. These vehicles, strictly speaking, are not automotive vehicles, but their use is so linked with the others that it is necessary to consider them all together. Broadly their capacities fall under the same headings as do the cargo-carrying trucks, but experience has demonstrated the necessity for a much heavier type of trailer of the capacity of 10 tons. Apart from the commercial use of trailers they were first used by the Army as a means of getting around the shortage of engine-transmission and motive-axle production, in other words, to furnish some means of transportation. It was later found that apart from this, they were of great value.

Their use is indicated where extreme mobility is not required, as certain functions of the Army can be carried out, not on the firing line, but at a more or less permanent base. For example, advance repair shops need not be as mobile as the fighting army, but rather sufficiently immobile so as to allow the work being done. There should be, however, sufficient mobility to allow of eventually catching up with the advance forces. Such equipment as small repair shops, camp kitchens (see Fig. 4), partially mobile offices, X-ray surgical laboratories, cranes, etc., can also be conveniently mounted on trailers.

Other uses of trailers are indicated where for special reasons the truck or tractor is insufficient; for example, a field gun mounted on its own wheels is not able to traverse mile after mile of hard road at high speed. It is, therefore, advisable to draw this gun on the trailer platform such as shown in Fig. 5 and tow it behind the truck. Similarly, tanks and caterpillar tractors were prohibited from traveling along the French roads, due to the damage they were said to create, and furthermore it was found advisable, on account of their slow speed, to have them proceed at a much faster pace. They were, therefore, also driven under their own power on to the platform of a trailer and towed along the roads at a comparatively high speed. In addition to the foregoing there is also a certain use in connection with ordinary cargo-carrying trucks, where a small number of trailers have been found advantageous in helping out the trucks in the carrying of supplies.

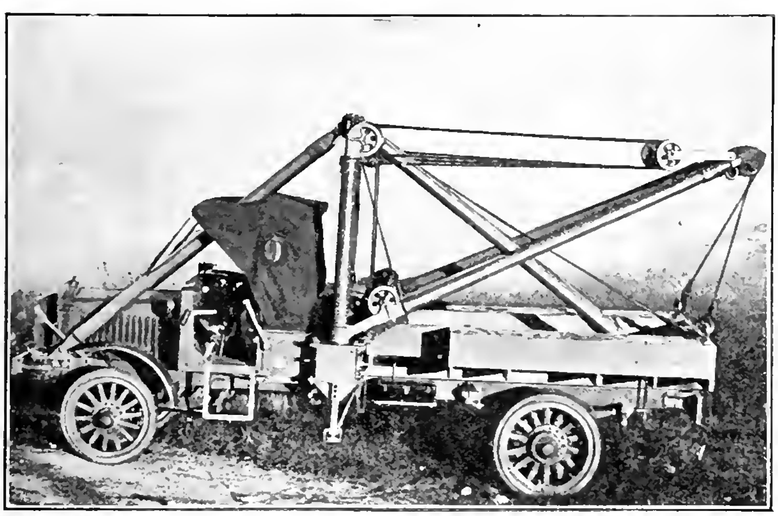


FIG. 8 A SPECIAL TYPE OF WRECKING APPARATUS MOUNTED ON A "B" TRUCK

It is believed that standardization of trailers for military use will have to proceed along somewhat different lines than the standardization of trucks. The trailer is especially for emergency uses and all kinds of special work, whereas the platform will vary with the requirements. There is no reason, however, to prevent the standardization of the running gear, such as, for example, the structural framework, the axles, springs, wheels, etc., and the draft gear for towing.

There will undoubtedly be discussion as to whether 2-wheel-drive trailer or 4-wheel-drive type trailer will be advisable. The solution of this is again limited by lack of experience and information which will have to be digested, analyzed and the result derived therefrom. It would appear as if the 2-wheel type of trailer will be of value in the smaller size and the 4-wheel type in the larger size from 2 tons upward.

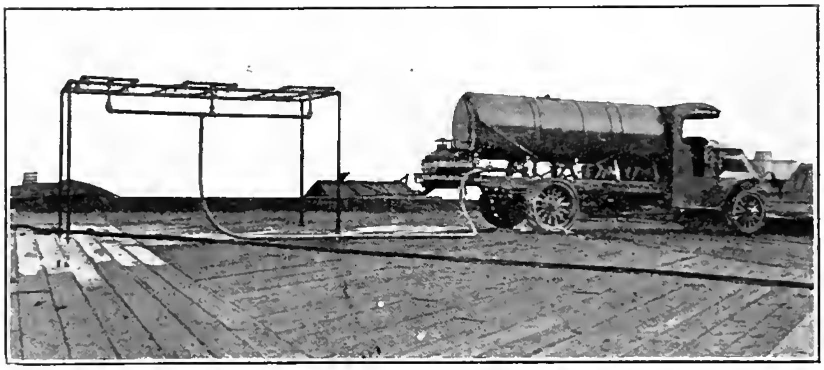


FIG. 9 MOBILE SHOWER BATH, DEGASSING OR DELOUSING OUTFIT

SPECIAL TYPES

In the military use of motor vehicles, first of all for cargo purposes it became obvious to inventive minds that here was not only an idea which would enable functions previously carried out in a slow way to be speeded up, but an idea which would establish new function. Special vehicles were asked for and were produced; mobile repair shop (see Fig. 6), vehicles carrying searchlights driven from the engine of the truck as generator, searchlights carried on the platform of the truck operated from their own engines (see Fig. 7), chemical laboratories, vehicles for the special purification of the water supply, photographic laboratories, lithographic laboratories, vehicles in which the power of the engine was geared to a large winch for the maneuvering of large observation balloons or to a crane thus creating a wrecking car (see Fig. 8), vehicles with integral wireless apparatus, with X-ray apparatus, with special tanks and pumping equipment and heating equipment for degassing and delousing soldiers, disinfecting vehicles, laundry vehicles, etc. Where action was necessary these thoroughly mobile vehicles could be brought forward at once.

An interesting case is that of the "degassing outfit," shown in Fig. 9. It was found that the effects of mustard gas could be greatly minimized, if not altogether prevented, by treating those exposed to a heavy shower of warm water shortly after contact. The soldier would be stripped, given a hot shower, under pressure, for about fifteen seconds, then sprayed with liquid soap, then lathered, then washed off; the whole operation taking about one minute. He would then receive new disinfected and deloused clothing and a new gas mask and be fit for immediate service again. A large tank

(*Continued on page 892*)

Scientific Development of the Steam Locomotive

By JOHN E. MUHLFELD,[1] NEW YORK, N. Y.

Despite the fact that marked progress has been made in the development of the steam locomotive, there still remains considerable opportunity for further improvement, and the general lines along which such improvement should be made form the supporting data of the following paper. The author first briefly outlines the factors involved in the determination of the tractive power of a locomotive. He next discusses such items as boiler feedwater, types of fuel, combustion, heat distribution, steam pressures, superheating, and steam generation and utilization. The acceleration and deceleration of a locomotive are also considered, and the paper is concluded with a discussion of the methods of saving fuel and labor, both of which should produce a higher standard of operation and economy.

STEAM railroads, to be successful, must, through executive foresight and engineering progressiveness, respect the same law of additions and betterments that applies to other profitable industries and which demands continuous modernization of plant and equipment in order to effectively and economically meet the necessity for greater production and speed by means and methods that will result in the least possible artificial age being capitalized in the improvements when installed.

Marked progress has been made in the development of the steam locomotive as the result of superior engineering ability, and the results have in many respects been exceedingly effective. This progress, however, has been confined largely to an increase in size, weight, evaporation capacity and hauling power, and while the general use of superheaters and firebox baffle walls during the past ten years has substantially assisted in improving sustained boiler capacity and increasing thermal efficiency as well as in keeping the steam locomotive in advance of the electric locomotive, the opportunity for further improvement in thermal and machine efficiency and to reduce smoke, cinders, gases and noise is untold.

The desiderata in a steam locomotive may be summed up as: a reasonable first cost; maximum capacity for the service within roadway weight, curvature and clearance requirements; ability to handle the heaviest gross tonnage practicable at the highest permissible speed; positive control of mechanical operation; economy as regards fuel and water consumption and repairs; minimum manual labor for road and terminal handling; construction of the least number of parts, and capacity to perform continuous mileage without failure.

Modern types of steam locomotives fulfill quite satisfactorily all of these requirements with the exception of wastefulness in fuel, water and steam consumption as may be gathered from the fact that the thermal efficiencies now obtained are only from 50 to 65 per cent at the boiler, from 60 to 75 per cent for combined boiler and superheater, and from 4 to 6 per cent at the drawbar. These as compared with thermal efficiencies of from 3 to 5 per cent at the drawbar of an electric locomotive, 18 to 19 per cent at the switchboard of a modern steam-electric central power station, 25 to 30 per cent for internal combustion engines, and 40 to 45 per cent as claimed for the full range of from one-quarter to full load for combination internal-combustion and steam motors.

The increase in the first cost and in the cost for labor, fuel, material and supplies for operation and maintenance of the steam locomotive has been most marked during the past ten years, particularly since the war. It is now being operated and maintained by highly paid enginemen and mechanics, with high-priced materials and supplies, and the machine and its performance must be brought up to a more respectable basis of engineering efficiency if it is to be perpetuated.

The supporting data of this paper, which apply to the United States, present the reasons why the general improvement of the steam locomotive should embrace the following changes which, it may be opportune to here state, are now being embodied in the design, specification and construction of a new type of locomotive, the first of which it is planned to have in regular service in 1920 on a prominent and progressive Eastern railroad:

a Steam at a pressure of about 350 lb. to be employed, superheated to about 300 deg. fahr.
b Improved boiler, furnace and front-end design and appliances
c Greater percentage of adhesive to total weight, and a lower factor of adhesion
d More efficient methods of combustion
e Use of exhaust-steam heater and flue-gas economizer for boiler feedwater
f Better steam distribution and utilization
g Reduced cylinder clearances and back pressure
h Lighter and properly balanced reciprocating and revolving parts
i Lower heat, frictional and wind-resistance losses
j Improved safety and time-, fuel- and labor-saving devices

[At this point in the complete paper the author gives brief particulars regarding the existing steam-locomotive stock under the control of the United States Railroad Administration, following which he quotes an opinion reported to have been expressed by Director General William G. McAdoo, to the effect that the great unused water power in the western part of this country should be developed for national electrification of the railroads; and after discussing at length the reasons for the perpetuation of the steam locomotive, he points out why national electrification is neither practical nor desirable. After enumerating the factors governing the design and specification for a new steam locomotive, he then takes up the problems involved in its scientific development, and extended extracts from this section of the paper immediately follow.—Editor.]

Design, Material and Workmanship

In this country the steam locomotive has not been classified as a refined piece of engineering mechanism, such as a marine or stationary steam engine, due primarily to the indifferent conditions under which it has had to be operated and maintained and the relatively low cost for its fuel and supplies. However, with existing public demands for greater safety, speed, comfort, efficiency and economy in the movement of traffic, only by greater refinement in construction can requisite operating results be produced to offset the increased cost of equipment, supplies and labor.

Therefore the designing should now be done along more scientific lines through the substitution of boiler, cylinder and drawbar horsepower and drawbar-pull calculations for tractive power; thermal efficiency for evaporation results; distributed for centralized thrusts, strains and stresses; light high-grade alloy and high-carbon steels and other metals for heavy low-grade plates, forgings and castings; and in the more general use of high-grade engineering practice in lieu of rule-of-thumb methods.

Adhesive Weight, Tractive Power and Factor of Adhesion

Adhesive Weight. The extended use of non-productive trailing wheels and the four-wheel leading truck has become an expensive fashion in that it has greatly reduced the percentage of total engine weight on drivers for adhesive purposes.

Boiler design and weight distribution should be so correlated to the running gear as to make the use of trailer wheels unneces-

[1] Railway and Industrial Engineers, Inc. Mem.Am.Soc.M.E.

For presentation at the Annual Meeting, New York, December 1919, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and advance copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

sary, except where required by wheel-load limitations, and with the more recent improvement in constant resistance leading truck designs any four-wheel arrangement, except for high-speed passenger service, should be entirely satisfactory.

Tractive Power. In calculating tractive power the usual practice is to use 85 per cent of the indicated boiler pressure in lb. per sq. in. for two- and three-cylinder single-expansion, and 52 per cent for two- and four-cylinder compound engines. However, for a superheated-steam locomotive the use of a higher percentage of the indicated boiler pressure should receive due consideration when making tonnage-rating schedules before the train load is finally determined upon, as dynamometer tests have indicated that as high as 92 per cent for two-cylinder single-expansion locomotives is permissible for train-loading purposes.

Factor of Adhesion. The coefficient of static friction or adhesion between driving wheel tires and very dry, clean rails reaches a maximum of about 0.35, and for moist, muddy, greasy and frosty rails a minimum of from 0.15 to 0.20, giving factors ranging from 2.85 to 6.65.

In general, the factor of adhesion should be as low as practicable, in order that the maximum power will always be available to start trains that can be easily handled when in motion, and should about equal the ratio between the limiting friction in pounds and the weight on driving wheels in pounds, which, for average dry rail is from 3.5 to 4.

Tracking, Curving and Riding

With the increased length, higher center of gravity, extended front and back overhang and smaller proportion of spring-borne weight there have been many difficulties to overcome in order to maintain proper tracking, curving and riding qualities in locomotives of great power, and in the majority of cases these have been met with unusually satisfactory results.

As the reciprocating forces must be neutralized by means of a revolving body, which cannot produce a perfect balance, it is of the greatest importance that every allowable effort be made to reduce the weights of pistons, crossheads and main rods and divide all weights as uniformly as practicable over all driving wheels, in order that excess balance may be reduced to the minimum and the greatest possible static weight permitted on the driving wheels.

Boiler Feedwater

No item in the operation and maintenance of steam locomotives contributes to greater unnecessary cost than boiler feedwater containing excessive incrusting, corrosive and foaming elements.

Observations and experiments indicate that any scale porous to water has little effect on boiler economy. However, such scale when dried out or hardened next to the metal by the expulsion of the carbonic acid, as usually occurs when boilers are forced, will not only become an excellent heat insulator and cause a heat loss of about 10 per cent when 1/8 in. thick, but it exposes the sheets and staybolts to overheating and "mud burning," with resulting leakage and shopping for repairs and cleaning.

In view of the increasing size of locomotive boilers and the high ratings to which they are subjected, the importance of purifying unsuitable water to prevent incrustation, corrosion, leakage and burning, as well as to eliminate delays and cost for cleaning, repairing and extra fuel consumed, cannot be overestimated, and until the many existing conditions of this kind are corrected, neither the existing nor improved steam locomotives can be expected to render satisfactory and economical service.

Boiler-Feedwater Purifying

When an adequate and suitable supply of boiler feedwater cannot be obtained from the usual sources, then the proper treatment of the available unsuitable water becomes necessary by settling; filtration; chemical treatment in treating plants, supply tanks or tenders; or, in the case of suspended matter and carbonates, by partial purification in a combination open and closed type of exhaust-steam feedwater heater on the locomotive.

Fuel

The principal fuels now used in steam locomotives are the commercial grades of bituminous and anthracite coal and fuel oil. While millions of tons of the by-products of anthracite and bituminous coal mining are available, as yet practically no progress has been made in their utilization, although satisfactory means and methods are now developed. This applies as well as to the enormous deposits of sub-bituminous coal and lignite that are only awaiting mining operations to come into their effective and economical use as locomotive fuel.

Regardless of the kind of fuel now used by steam locomotives, more general attention is being given to its proper preparation for the class of service to be performed and the method of firing to be followed, before it is supplied to tenders. However, the factors of kind and size of coal and method of firing must each be carefully considered and coördinated in order to insure the best results as may be shown by Table 1, which gives comparative performances of a stoker-fired modern Mikado type of locomotive with superheater and firebrick baffle wall supported on water circulating tubes.

TABLE 1 COMPARATIVE TESTS OF A STOKER-FIRED MIKADO-TYPE LOCOMOTIVE USING DIFFERENT SIZES AND KINDS OF COAL

Item	Test No.	1	2	3	4
1	Coal, kind	Bituminous	Bituminous	Bituminous	Bituminous
2	Coal, class	Gas	Gas	Soft	Soft
3	Coal, grade	Nut, pea and slack	Slack	Run-of-mine	Screenings
4	Coal, moisture, per cent	1.23	1.57	0.75	0.81
5	Coal, volatile, per cent	36.47	35.74	18.17	17.52
6	Coal, fixed carbon, per cent	53.94	52.78	69.07	70.06
7	Coal, ash, per cent	8.36	9.91	12.01	11.61
8	Coal, sulphur, per cent	2.59	3.30	3.33	2.31
9	Coal, B.t.u. (calorimeter)	13,910	13,790	13,880	13,970
10	Total miles run	505	505	505	505
11	Kind of firing	Stoker	Stoker	Stoker	Stoker
12	Pounds of coal per average drawbar hp-hr.	3.74	4.19	4.14	4.89
13	Boiler efficiency, per cent	46.60	41.90	46.10	38.00
14	Relative pounds of coal fired, per cent	100	111.87	110.54	130.56
15	Relative cost of coal, per cent	100	102.14	123.58	143.64

It will be noted from Table 1 that while the heat value (Item 9) of each of the four fuels tested was practically the same, there is a difference of over 30 per cent in the quantity fired, and of over 43 per cent in the fuel cost for the same work done, when comparing the poorest with the best performance, and that the use of either grade of soft coal is absolutely prohibitive so long as either grade of gas coal can be obtained.

With the cost for locomotive fuel on tenders practically doubled during the past two years, and next to labor the largest single item of railway operating expense, the best methods for its use will now begin to receive the consideration that this large item of operating cost justifies.

Combustion

A comparison of the figures of 65 years ago with the average saturated-steam-locomotive performance of today will show little improvement has been made in the average road service.

The locomotive fuel bill for the year 1918 was approximately $750,000,000, and while full recognition is given to the fact that from 25 to 50 per cent of the available energy in the fuel is still needlessly wasted, and that present methods of mechanically firing, as compared with the average hand firing, and burning coal on grates or in retorts increase this waste, but little has been accomplished in regulating combustion so that this loss may be reduced.

The combustion rate generally follows the increase in draft until about 100 lb. of bituminous and about 50 lb. of anthracite coal are burned per square foot of grate area. After this the additional coal supplied is not effectively consumed, due to the difficulty in supplying sufficient air, equally distributed, through the grates and fuel bed to oxidize the fixed carbon and volatile matter in process of combustion without a large excess of air, such as obtains when forcing takes place, and it becomes necessary to open the fire door so that combustion can be completed by the admission of air above the fuel bed.

The greatest loss in heat is that due to the heat carried off in the stack gases, sparks and cinders, which usually results in a smokebox temperature of from 560 to 750 deg. fahr. for the best practice. Adding to this the heat losses due to combustible in ash, vapors of combustion, carbon monoxide and otherwise, leaves an average of from 25 to 40 per cent of the heat in the fuel as fired unabsorbed by the boiler and superheater.

With the best hand firing, when using dry bituminous coal averaging 14,100 B.t.u. and 60 per cent fixed carbon, 32 per cent volatile and 8 per cent ash, the fuel rates in Table 2 will usually obtain:

TABLE 2 CONSUMPTION OF DRY BITUMINOUS COAL BY LOCOMOTIVE WITH BEST HAND FIRING

Total indicated horsepower of locomotive	Dry coal per i.hp-hr.
500	2.8
750	2.7
1,000	2.6
1,250	2.5
1,500	2.6
1,750	2.8
2,000	3.0
2,250	3.2
2,500	3.4

As compared with hand firing, stoker firing will result in an increase of from 10 to 25 per cent in the fuel fired, while if the same coal be pulverized and burned in suspension there will be a decrease of from 15 to 25 per cent in the amount of fuel fired.

As the locomotive firebox, which in the best practice represents only from 7 to 10 per cent of the total boiler evaporating surface, must generate all and absorb from 30 to 40 per cent of the heat energy that is converted into drawbar horsepower, the fuel effectively consumed, not fired, is the measure of work done. Therefore the largest permissible combination of firebox and combustion-chamber volume, heating surface and grate area should be provided and equipped with an arrangement of firebrick baffle walls placed on water-circulating supports in a manner to produce long flame travel, high firebox temperature and the maximum radiant heat for absorption by the surrounding water.

With the usual limitations in firebox volume, too much importance cannot be placed on the arrangement of heat-absorbing and radiating walls for the purpose of flame and radiant-heat propagation. Carefully conducted tests have shown that the best results are obtained from solid firebrick baffle walls, and that the unburned gas, coal-dust, spark, cinder and smoke losses are reduced with an increase in their length and gas-passage arrangement.

The greatest difficulty in controlling combustion occurs at high horsepowers and long cut-offs, and where grates are used, and for the best results the air openings should be equal to about 50 per cent and those in the ashpans to about 15 per cent of the total grate area, so that firebox temperatures of from 2000 to 2500 deg. fahr. can be obtained and the unburned solid fuel, carbon monoxide and excess air over the fuel bed reduced to a minimum.

As with dry pulverized coal of 12,130 B.t.u. value, an average boiler efficiency of 69.2 per cent at 1080 boiler hp., and an average combined boiler and superheater efficiency of 78.1 per cent at 1220 boiler hp., with an equivalent evaporation averaging 42,100 lb. of water per hour from and at 212 deg. fahr., has already been obtained on a Mikado simple-cylinder type of locomotive hauling fast freight trains over a 113-mile division, the possibilities for reducing the steam-locomotive fuel consumption are practically unlimited, and much remains to be done in this direction by good hand firing, through a combination of the fireman's eyes, brain and brawn, provided the thermal efficiency of the modern locomotive at the drawbar is brought up to where it can and should be.

Boiler-Water Circulation

In designing a boiler it is extremely desirable to secure the most rapid circulation practicable, as with high combustion rates and temperatures and the abnormal state and behavior of the water film in contact with the heating surfaces, the load on the firebox sheets is very intense, the conduction rate averaging from 75,000 to 100,000 B.t.u. per sq. ft. of evaporating surface per hour.

Therefore, in order to avoid resistance to heat transfer, with resultant overheating of metal and reduced efficiency, a relatively high velocity of circulation and at least a rate of 125 ft. per min. in the most sluggish locality is very essential.

The average locomotive boiler does not present ideal water-circulation possibilities, but the enlarging of contracted spaces, increasing of water-leg, flue and tube clearances, and provision of suitable outlets from choked water pockets will not only reduce the resistance to the "slip" of the steam bubbles through the water, but will enable the accelerated action of the former to increase the velocity of the latter and thereby improve general circulation and heat transfer results.

Heat Radiation, Convection, and Conduction

Heat Radiation. In a locomotive boiler the efficiency of combustion heat transfer through the firebox plates and boiler flues and tubes is from 20 to 25 per cent greater as applying to those heating surfaces directly affected when subjected to the radiant effect of the incandescent combustible and non-combustible particles which have passed through the minimum distance, than the heat-transfer efficiency when convection only is available. For example, when coal is hand or stoker fired and burned on grates or in retorts the radiant heat is at a minimum and applies only to the heat-absorbing surfaces adjacent to the fire bed, while the heat of convection is at a maximum; whereas when the coal is burned in pulverized form in suspension this condition is reversed. The locomotive boiler of the future will undoubtedly depend more largely on radiant heat.

With respect to the loss of power through radiation to the atmosphere, there is sufficient justification for completely and properly lagging the boiler, firebox, cylinders and heads, steam chests and all other radiating surfaces, as well as for polishing certain machinery parts, in order to reduce the dissipation of heat that now takes place through these parts from the existing steam pressures and superheat.

Heat Convection. In the present locomotive boiler by far the greatest proportion of the heat is imparted to the evaporating and superheater surfaces by convection.

To secure the fullest benefit from heat convection the combustion volumes and gas areas must be so coördinated as to establish a "velocity pressure" or " frictional" action between the gases and the heat-absorbing plates and tubes in order to increase the rate of heat transmission. Likewise must the boiler circulation be expedited in order to quickly disengage and release the steam bubbles from the water side of the same plates and tubes in the final heat transfer.

The possibilities for improving heat transmission by convection in the locomotive boiler, with its high water rate, i.e., a boiler horsepower for an average of less than 2 sq. ft. of total evaporating surface, fully justifies additional study.

Heat Conduction. The transmission of heat from one body of high temperature to another body of low temperature by contact, or from one part of a body to another part, is termed external and internal conduction, respectively.

Any increase in the rate of external conductivity, considering the present kinds and thicknesses of firebox, flue and tube materials as practically fixed, must be through an increase in the rate of flow of the heated gases, and this in turn means the expenditure of a greater amount of energy to pull these gases through the boiler.

While there is no difficulty in now obtaining a boiler horsepower from each 1½ to 2 sq. ft. of total evaporating surface, whatever

further improvement can be made in this direction will provide just that much more margin of boiler over cylinder horsepower requirements and produce a corresponding gain in efficiency.

Steam Generation

In present locomotive operation the quality of the steam, i.e., the percentage of vapor in a mixture of vapor and water, is one of the most important and least-referred-to factors in road and laboratory test reports, particularly as the average modern locomotive boiler is notorious for delivering saturated steam to the superheater or to the steam pipes with a high percentage of entrained moisture.

Road tests recently conducted on modern Mikado types of locomotives showed an average quality of from 94.7 to 96.3 per cent for the saturated steam as delivered to the superheater, indicating from 5.3 to 4.7 per cent of moisture, which is valueless so far as its power for doing work is concerned, but which greatly increases the work to be performed by the superheater by throwing upon it work which should properly be done in the boiler.

The delivery of dry saturated steam from the boiler is an item that has been given but little consideration in steam-locomotive practice, the principal idea having been to produce evaporating capacity and depend upon the superheater to perform auxiliary boiler functions. Many changes can and should be made to improve this condition.

Steam-Pressure Increase

One of the greatest and simplest improvements to be made in the steam locomotive can be effected by an increase in the boiler pressure in combination with greater quantity and better quality of saturated-steam production, higher and more uniform superheat, and compounding.

The writer advocated a steam pressure of 250 lb. in 1902 when with the Canadian Government Railways, and inaugurated the use of 235 lb. boiler pressure in combination with 21-ft. boiler tubes in 1903 in the Baltimore and Ohio Railroad Mallet articulated compound locomotive No. 2400, with excellent results from both an operating and maintenance standpoint. This at a time when the general tendency was to reduce rather than to increase locomotive steam pressures from an established practice of about 200 lb.

During recent years stationary-boiler engineers have not only determined upon their efficiency, but have inaugurated the use of relatively high steam pressures, and with the urgent necessity for keeping the cylinders as small in diameter and the reciprocating and revolving parts as light as practicable, there would appear to be no good reason for not now utilizing saturated steam of 350 lb. pressure, which, in combination with 300 deg. fahr. of superheat should provide, in addition to the many other advantages, a much greater opportunity for economy in power generation.

Steam Superheating

The use of superheated steam has done more to increase sustained hauling power, reduce fuel and water consumption and increase thermal efficiency than any of the other means and methods that have been generally adopted on the steam locomotive since its introduction, either singly or in combination.

With the average superheat now used, from 175 to 250 deg. fahr., the drawbar pull at a speed of 20 miles per hour is increased about 15 per cent, and at 50 miles per hour about 40 per cent, and due to the combination of superheat, larger diameter of cylinders and reduced cylinder back pressure—resulting from the use of superheated steam—it is possible to increase train tonnage about 30 per cent at speeds of about 30 miles per hour.

In the best existing steam-locomotive practice the superheat generally increases with the cut-off up to 50 per cent cut-off, beyond which there is usually a falling off in the superheat. Furthermore, with short cut-off a fair water rate, i.e., about 19 lb. per i.hp., can be maintained, but if the cut-off at the same speed is increased to over 50 per cent the superheat must be increased to about 300 deg. fahr. in order to maintain the same water rate, or otherwise, for example, at 67 per cent cut-off, the steam consumption will increase to 21 lb. or more per i.hp. This for the reason that as the amount of superheat is increased the range of temperature in the cylinder during the stroke of the piston is decreased until with sufficient superheat the changes in temperature cease entirely.

While the increased superheat results in a greater number of B.t.u. being exhausted from the cylinder, any such loss of a marked degree is more than offset by the smaller amount of heat exhausted per stroke, due to the fewer B.t.u. admitted to the cylinder per stroke at a given cut-off.

The use of highly superheated steam results in a saving of about 35 per cent of the total water evaporation per unit of power and in from 10 to 45 per cent saving in fuel when using steam, depending upon the power output.

Existing fire-tube superheaters produce the maximum superheat only when the locomotive is forced to its boiler capacity, whereas the maximum economy is more desirable when the locomotive is working under average conditions at economical cut-offs and when the superheater should give as nearly as possible a uniform degree of high superheat under all conditions of working, regardless of the boiler evaporation. For example, if the degree of superheat obtainable at speeds of 50 miles per hour with 50 per cent cut-off could be obtained at 25 per cent cut-off, a water rate of considerably less than 15 lb. could be obtained as compared with existing rates of about 19 lb. Therefore, as the present limitation in the hauling power of the modern superheated-steam locomotive is the capacity of the boiler to produce continuously sufficient dry saturated steam of high pressure and of the superheater to maintain a uniform high degree of superheat, the possibility of improving it by means of average higher boiler pressures and superheat temperatures and better utilization of fuel, steam and waste heat, in combination with radical changes in the design and arrangement of the boiler and superheater equipment and in the saturated- and superheated-steam connections, offers one of the greatest opportunities to increase efficiency and economy. This applies particularly to the larger locomotives, many of which consume more fuel and water and do less work than the smaller locomotives of the same general design and equipment.

While the superheater has generally been considered as a part of the boiler, particularly as regards its evaporation of entrained moisture in the saturated steam, it has no relation whatsoever thereto in so far as its individual functioning is concerned, and the more that the saturated-steam-conducting and superheated-steam-delivering conduits, as well as the superheater equipment in itself, can be divorced from the boiler and front-end connections and their proper functions, without introducing separately fired apparatus, the better will be the general results from the standpoint of efficiency, maintenance, operation and economy of the locomotive as a whole.

The steam temperature should be uniform for the variable speeds and capacities of operation. At the present time high temperatures obtain only at high speeds and capacities. A minimum temperature of 650 deg. fahr. quickly after starting, and of 700 deg. at maximum power and speed, would be much more effective and economical.

Steam Distribution and Utilization

Modern types of locomotives have developed at low speeds 3000 i.hp. and at high speeds 3200 i.hp., and comparative average

TABLE 3 COMPARATIVE WATER RATES OF LOCOMOTIVES WHEN USING SATURATED AND SUPERHEATED STEAM

Cylinders	Steam	Water rate per i.hp-hr., lb.
Single-expansion	Superheated	16 to 20
Single-expansion	Saturated	24 to 29
Double-expansion	Superheated	15 to 18
Double-expansion	Saturated	19 to 22

water rates through the complete range of the effective capacity of the locomotive, with piston speeds of from 600 to 1000 ft. per min., have been obtained as shown in Table 3.

At piston speeds of less than 600 ft. per min. the water rate of the double-expansion saturated-steam locomotive will approximate that of the single-expansion superheated-steam locomotive.

Compounding. With the exception of the Mallet articulated type of compounding, the multiple-expansion system of steam utilization, which has been so successful in marine and stationary practice, has not made the progress in this country that it has in Europe.

The failure of various types of cross, four-cylinder, four-cylinder balanced and tandem double-expansion locomotives, introduced from 25 to 15 years ago, to produce the predicted economy was due largely to factors of indifferent design, low boiler pressure, excessive condensation, lack of proper maintenance and operation, cheap fuel and road failures. Clearance limitations also restricted the size and arrangement of the low-pressure cylinders, while at the same time the single-expansion cylinder superheated-steam locomotives gave opportunity for greater hauling capacity and economy.

There is no doubt but that a properly designed superheated cross-compound locomotive embodies many advantageous features, such as greater starting and hauling capacity per unit of weight, less evaporating surface per indicated horsepower, reduced fuel and water consumption and less boiler repairs, and that it will return to favor for freight service in combination with higher boiler pressures and superheat, due to the necessity for greater drawbar pull and horsepower and for utilizing all superheat before its final exhaust.

Valve-Motion Gear. The Stephenson valve gear, through its variable lead for different points of cut-off, gives one of the best and most flexible steam distributions for locomotives. However, its undesirable and inaccessible location between frames and driving wheels and heavy revolving and suspended reciprocating wearing parts caused the writer, in 1903, to introduce the Walschaerts valve gear, a Belgian invention, in connection with the design of the Baltimore and Ohio Railroad Mallet articulated compound No. 2400.

The Walschaerts, as well as other outside valve gears now generally used, has the disadvantages of a constant lead and of being affected by the vertical displacement of the axle. By eliminating these disadvantages, however, and adding certain improvements for the purpose of increasing the ratio of expansion and shortening the ratio of compression, the tractive effort can be increased at lease 10 per cent at all points of cut-off and the fuel consumption reduced 5 per cent through ability to develop the same drawbar pull with a shorter cut-off. Such a change will add greatly to the efficiency of the steam locomotive, particularly when it is recalled that the average inside or outside valve gear slightly out of adjustment represents considerable loss in hauling power and in fuel economy. Tests made show that valves out of adjustment are responsible for from 8 to 21 per cent increase in fuel consumption per ton-mile as compared with valves properly set.

Where compound cylinders are used a steam-expansion regulator should be incorporated with the motion gear to effect the automatic independent adjustment of the cut-off for each of the high- and low-pressure cylinders for the purpose of obtaining certain cylinder ratios and at the same time bring the cut-offs in harmony at the center of the quadrant. In this way a compound locomotive of the Mallet articulated type can be made to develop at least 55 per cent of its rated tractive power at a speed of from 8 to 10 miles per hour, when operating at 25 miles per hour, and there will be a gain in tractive power of about 15 per cent at 25, and of about 10 per cent at 30 miles per hour.

Cylinder Clearance. The inauguration of the use of the inside-admission piston valve and of superheated steam has brought with it the wasteful effects of larger cylinder clearance, due principally to the use of a valve of too large diameter and an indifferent design of valve chest and ports in combination with the cylinder castings.

The use of smaller-diameter piston valves located close to the cylinder and connected with properly designed expanding steam ports will, in combination with improved material and workmanship, correct these generally existing deficiencies.

Cylinder Back Pressure. About 75 per cent of the cylinder back pressure is due to the use of the exhaust steam to produce draft for combustion, evaporation and superheat.

Much remains to be done in the way of enlarging exhaust-steam openings from the cylinder to the atmosphere and in reducing existing sharp turns, cramped passages and obstructions to the free passage of steam through them; and also in the development of an exhaust stand and nozzle that will combine the advantages of the single and double types.

Valves and Cylinders. Various tests on and many years' experience with inside-admission piston valves have demonstrated through the better use of steam and the resulting reduction of jerking, pulling and stresses on valve stem and gear, unbalanced pressure, frictional contact, valve and bushing wear, leakage, and lubrication, the practical advantages of a minimum diameter and weight of valve with the circumference no greater than the length of a slide-valve port and with every inch of bushing port made effective and designed in conformity with the well-known principles governing the flow of gases so as to eliminate eddies and baffling in the steam flow between valve and cylinder.

Piston Speeds. Frequent errors have been made in not properly proportioning the driver-wheel diameter and stroke of the piston. Slow speed and high ratios of expansion are factors particularly favorable to superheated steam and piston speeds of from 700 to 1000 ft. per min. will insure the best results.

Waste-Heat Distribution and Utilization

As a reasonable estimate would show that 40 per cent of the heat in the steam and in the products of combustion is exhausted from the stack, any considerable part of this heat that can be reclaimed for preheating boiler feedwater will add greatly to the overall efficiency of the locomotive and to the saving in fuel.

The principal means through which to accomplish this saving, in a practical way, are exhaust-steam heaters and flue-gas economizers, both of which can be readily adapted to a modern steam locomotive.

Exhaust-Steam Heaters. From actual service tests of closed types of heaters made on modern superheated-steam locomotives, using a portion of the main-engine exhaust steam only, it has been found that a feedwater temperature approximating 240 deg. fahr., or within 15 deg. of the exhaust-steam temperature, can be obtained without interfering with the draft required for maximum steam and superheat generation.

Flue-Gas Economizers. An economizer will heat the feedwater to a higher temperature than an exhaust-steam heater and will recover most of the waste heat resulting from high steam pressure and high superheat, as it is able to recover low-temperature heat that has escaped from the boiler evaporating or superheater surfaces because the average temperature of the feedwater within the economizer — which should, if practicable, be brought up to the boiler evaporating temperature — is much lower than the temperature of the water in the boiler.

As locomotive-smokebox superheaters, now obsolete, have demonstrated that 50 deg. of superheat may be obtained from flue gases at 600 deg. fahr., there should be no difficulty in devising a locomotive economizer that will produce very effective results in combination with high boiler pressures, superheat and draft, without baffling the boiler draft and evaporating capacity. In fact, with an average boiler efficiency of 60 per cent and an economizer efficiency of 50 per cent the possibility of recovering from 25 to 50 per cent of the stack-gas losses and increasing the thermal efficiency of the entire unit, is within the limits of possibility.

Friction and Resistance

Friction. The only form of useful friction to which the steam locomotive is subject is that which occurs between the driving wheels and rails for adhesive purposes. All other friction due to oscillation, concussion, rolling, wheel flanges and treads, journals, cylinders, valves, valve gear, crossheads, center and side bearings, coupled side play and the like, absorbs a considerable percentage of the power developed by the steam.

During the past ten years the increased rigid wheelbase and axle loads, greater lateral rigidity, larger cylinders, valves and revolving and sliding bearings, substitution of grease for oil lubrication, and greater number of frictional parts have tended to increase the machine friction and consequently the horsepower, drawbar pull, and steam and fuel losses, all of which are factors that should receive proper consideration in new designs.

Resistance. Other than the resistances resulting from machine friction, the locomotive is subject to those due to grades, curves, weather, wind and head air, which latter is more particularly affected by the general design.

While the complicated design of a steam locomotive, particularly as regards the application of its accessories, makes the use of relatively smooth outside surfaces generally impracticable, still much has been done along this line on some of the European railroads that can be adopted by us to good advantage.

Acceleration

In a steam locomotive the effects of inertia are distributed throughout the machine, due to the variable speed and action of the locomotive as a whole as well as of its reciprocating and revolving parts, and in order to indicate the force necessary to overcome this inertia and produce a particular speed in a given time, per ton of 2000 lb. of engine and tender, exclusive of the resistance due to grade, curvature and friction, the data in Table 4 may be of interest.

TABLE 4 FORCE REQUIRED IN LOCOMOTIVE ACCELERATION

From rest to given speed in miles per hour	Time allowed in seconds	Average force required per ton of engine and tender to overcome inertia only, lb.
10	60	16
20	60	32
30	60	48
40	60	64
50	60	80
60	60	96
70	60	112
80	60	128

As the train resistance increases and the drawbar pull of the locomotive decreases due to speed, acceleration rapidly becomes a diminishing quantity. Therefore in order to expedite train movement locomotives should be designed and adjusted so as to permit of the highest possible rate of acceleration in the shortest distance after starting, in order that the maximum desired running speeds can be reached in the minimum of time during which the greatest evaporating capacity of the boiler is available.

Deceleration

The deceleration or retardation of a steam locomotive is now universally produced by brake shoes brought against the treads of the driving and truck wheels by various means, the ideal method being where the maximum stopping effort is at all times under the positive control of the engineer. While the reversing of the engine with or without the use of steam effects varied degrees of stopping power without the use of brake shoes, this method is generally too slow and cumbersome for present-day requirements.

With the best existing air-brake practice a Pacific-type passenger locomotive weighing about 90 tons on 80-in.-diameter driving wheels and from 200 to 220 tons total for engine and tender in working order, will, when braked to from 110 to 90 per cent of the total weight, make stops on straight level track under good rail conditions, from a speed of 60 miles per hour, in distances of from 1200 to 1600 ft., and in from 25 to 30 sec., respectively, whereas from a speed of 30 miles per hour, under otherwise identical conditions, stops can be made in distances of from 275 to 325 ft., in from 12 to 13 sec., respectively. When braked at 150 per cent the stopping distance from a speed of 60 miles per hour can be reduced to about 1000 ft.

Deceleration is as much a factor in expediting train movement as acceleration, particularly with long and heavy trains and grades, and improved brake-shoe design, material, flexibility and bearing area in combination with clasp types of brakes for all wheels would do much toward providing greater stopping control over large and high-speed steam locomotives and thereby avoid the necessity for resorting to the use of the engine-cylinder back pressure to produce adequate braking power without liability for skidding and flattening the driving wheels.

Lubrication

It is false economy to restrict the quantity of lubricants used or to employ inferior lubricants to the extent that results in excessive friction, wear and tear, and any saving thus effected is many times over expended in delays, repairs, and fuel. At the same time probably no locomotive supplies are handled more wastefully or ignorantly than oil and grease, due to the lubricant not being applied or used in the proper manner.

Difficulty of access to the various bearings to be lubricated and the necessity for frequent hand oiling have no doubt contributed to lubrication waste and trouble, but during the past 15 years the substitution of grease for oil on many bearings, the use of larger driving wheels and lower piston speeds, and greater accessibility to certain parts as obtains from the use of outside instead of inside valve gears and journals, have brought about a substantial improvement.

Special Appliances

The steam locomotive, other than the boiler, engine, frame, running gear and tender proper, is largely an assembly of special appliances for firing, combustion, superheating, steam distribution and utilization, feedwater delivery, lubrication, insulation, heating, lighting, safety, and labor saving, and of devices such as trucks, axles, wheels, tires, springs, bearings, brakes, draft gear and boiler fittings.

These appliances and devices are the result of highly specialized research, designing and experimenting by the railway supply and equipment companies, who in turn are largely responsible for the development of the steam locomotive which has occurred during the past fifteen years.

With the cost for locomotive fuel and repairs averaging over 75 cents per mile run, or five times what it was ten years ago, the cost for the essential design, material, construction and equipment of the locomotive must now be placed on an engineering rather than on a purchasing price basis in conformity with other high-class machinery if more efficient and economical operation and maintenance results are to be obtained.

Power for Accessories

The steam locomotive must not only produce superheated steam for the development of drawbar pull, but also supply saturated steam to various accessories of its own and for train operation. For example, a modern passenger locomotive is required to supply power to operate locomotive and train air brakes and signals as well as train lighting, heating and ventilating equipment, and hot- and cold-water systems, and in addition it must supply steam or compressed air for the operation of a multitude of devices. As high as 20 per cent of the fuel as fired for an average divisional run may be used for these accessories.

Not only has the use of compressed air been found to be most expensive for the working of these accessories, but the reserve supply for train braking has been frequently drawn upon for their operation. As power reverse gears, fire doors, water scoops, coal pushers, ashpan doors and like devices can be equipped for steam operation, such substitution offers possibilities for less drain on the boiler and much-needed economy in the cost for this auxiliary power production. Moreover, as all of this power for accessories is produced by saturated steam, some means for substituting the use of superheated steam for those purposes where it is more suitable and economical should be given due consideration.

Octaval Notation in Shop Measurements

By ALFRED WATKINS, HEREFORD,[1] ENGLAND

This paper is an argument for the adoption of a system for measuring binary inch fractions. At present there are two systems: the first divides the unit into halves, quarters, eighths, etc., and the second makes use of a decimal notation. The author proposes to replace these by an octaval notation in which eight is to be used as the radix. After explaining the method of constructing such a notation, the author discusses its application. A description of various types of measuring instruments with octaval notation shows its many advantages. The following instruments are discussed in detail: octaval rule, simple vernier calipers, double vernier calipers, single-screw micrometer, and two-screw micrometer. The author states that it is not his intention to propose the substitution of octavals for decimals in all branches of engineering, but he does advocate their use to denote the British binary inch fractions in the workshop and on workshop measuring instruments.

A RECENT investigation into the usage of coinage, weights and measures of all kinds, summed up in the author's pamphlet, Must We Trade in Tenths, showed two distinct and clashing tendencies. The first, which is prevalent in all branches of commerce and craft, is to divide a unit into halves, quarters, eighths, etc., down to sixty-fourths. The second tendency is on the part of the man who has more to do with computation than actual exchange or craft. He, finding a decimal notation all cut and dried and usable with easy facility, is thoroughly impatient with any other method, and wants his to be universal and compulsory. To this class belongs the counting-house man, the schoolmaster and the scientist, who have never entered into the unexplored science of commerce and handicraft. And as we all, with a slight exception in dozens, count upward from unity in a ten grouping, many of us are apt to decide that the ten grouping is also an inevitable division of the unit downward. But this ignores the general fact that no market man or craftsman does divide a unit into tenths until forced by the counting house into doing so. The figure ten only halves once into a whole number, and after that each halving adds an additional decimal place. The ten grouping is not the only scale of notation and such textbooks as Hall & King's Elementary Algebra point out those with a basis or radix of 6, 8, 12, 16, or any other numbers and give rules for the conversion of one notation to another. It is exceedingly unlikely that we shall disturb the ten grouping for our counting from unity upward. But there is not the slightest difficulty in expressing parts of a unit in modern fractions of some other radix than 10.

Unfortunately there is no notation which fits perfectly with all fractions used in commerce or craft. The three groups of fractions most used are 3ds, 6ths and 12ths; 5ths and 10ths; and the binary group, 4ths, 8ths, down to 64ths. The last group is undoubtedly used more than all the others put together, especially in the mechanical division of a unit of length, and a numeration with a binary radix is best. As a radix of 16 would necessitate the selection of six new numbers, 8 is the scale of notation to select, and it fits the engineer's binary inch fractions to perfection.

An octaval fraction is distinguished from a decimal fraction by a special mark, the small circle or "pip," originated by the author, and placed in the same position as the decimal point. Octaval fractions can be added, multiplied, etc., with much the same facility as decimals and far easier than vulgar fractions, as for example:

Vulgar	Octaval
$\frac{1}{2}+\frac{33}{32}=\frac{32}{64}+\frac{33}{64}=\frac{65}{64}=1\frac{1}{64}$	$_{\circ}4$ $_{\circ}41$ $1_{\circ}41$

Note that as 8 is the radix, it becomes 10 in all octaval arithmetic.

In the structure of octavals, just as 0.2345 in decimals

$$=\frac{2}{10}+\frac{3}{10^2}+\frac{4}{10^3}+\frac{5}{10^4}$$

$$=\frac{2}{10}+\frac{3}{100}+\frac{4}{1000}+\frac{5}{10{,}000}$$

$$\text{so, } {}_{\circ}2345 \text{ in octavals} =\frac{2}{8}+\frac{3}{8^2}+\frac{4}{8^3}+\frac{5}{8^4}$$

$$=\frac{2}{8}+\frac{3}{64}+\frac{4}{512}+\frac{5}{4096}$$

Application to Inch Fractions

The foregoing explanation leads up to the subject of this paper, which is the practical application of octaval notation to the construction of micrometers, calipers and measuring rules, and the great ease and facility it imparts to the measurement of the allowances and limits so much used in precision work. Our present crude blend of decimal allowances with standard binary fractions is complex and illogical, and it would seem that as a "limit" table is based on the square root of the diameter of the part, it can be more accurately and simply compiled in octavals than in decimals. The structure of an octaval fraction is much on the lines of a mechanic's mental conception of the fraction. Thus $_{\circ}42$ ($\frac{4}{8}+\frac{2}{64}$) for the fraction usually called $\frac{17}{32}$ is obviously half an inch plus a thirty-second. It should be also noted that the octaval figures are continuous, so that adjacent fractions as $\frac{1}{2}$ and $\frac{33}{64}$, so inconveniently expressed now, are in octavals $_{\circ}4$ and $_{\circ}41$, obviously adjacent. With an octaval radix the counting omits 8 and 9, and goes directly from $_{\circ}7$ to $_{\circ}1$, from $_{\circ}17$ to $_{\circ}2$ and so on until $_{\circ}77$ is reached, when the next value upwards is 1 0 or unity. The

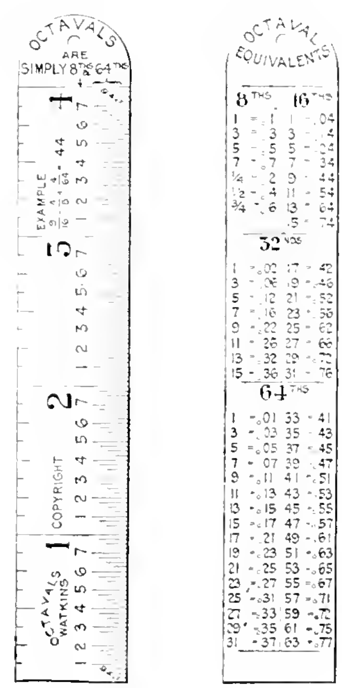


Fig. 1 Octaval Rule

[1] The Watkins Meter Company.

For presentation at the Annual Meeting, New York, December 1919, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and advance copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

octaves of the eighties and nineties are omitted as well as the single figures 8 and 9.

Measuring Instruments with Octaval Notation

It will be noticed that in the instruments illustrated (Figs. 1-4) all, or almost all, the divisions can be marked with figures indicating their value, and that, except in the case of the rule, there are no very fine divisions to try the eyes. It should also be noted that in each case there is a separate scale for each place in the fraction, each figure of it being read separately, so that no addition is necessary to get the results.

Octaval Rule. The octaval rule, Fig. 1, shows that all the eighths are figured, and the figures form the first place in the octaval fraction. The writer has devised an original way of indicating the subdivisions of the eighths (the sixty-fourths) in staircase fashion which enables the alternate even numbers to be marked, and these numbers constitute the second place in the octaval fraction. This method of a different length of line for 2, 4 and 6 allows the value of the indicated division to be known, even if it is not uncovered by the thimble or sliding bar of a measuring instrument. It is applicable to decimal divisions and to ordinary and slide rules.

Simple Vernier Calipers. The simple vernier calipers shown in Fig. 2 measures down to 64ths, and yet the divisions are scarcely finer than eighths. The vernier method is used, and every division is figured. The index line points to the first figure of the fraction, or beyond it, short of the next division, and the vernier line which coincides with any upper division is marked with the second figure of the fraction. A partial dislike to the vernier method is probably due to their usual association with fine eye-straining divisions.

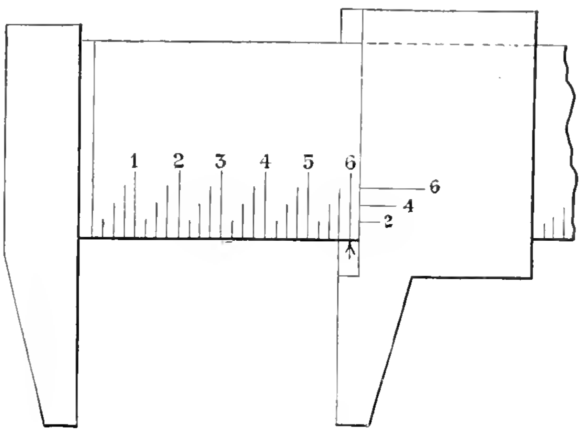


Fig. 2 Simple Vernier Calipers

Double Vernier Calipers. A flat model of the double vernier calipers is illustrated in Fig. 3 in order to show its action more plainly, although it is quite probable that a model with a circular stock will be the commercially useful one. The standard fraction is set, in two places of octavals, exactly as in the instrument already described. A fine movement for the 3d and 4th octaval places is frictioned on the coarser movements. It is a double wedge with a taper of 1 in 32, and a movement of 1/16 in. on this cross slide moves the calipers $\frac{1}{512}$ or ${}_0001$ in the third place of octavals. The 4th octaval place is indicated by a vernier scale. In this, as in the next instrument, the 1st, 2d, 3d and 4th scales are lettered *A*, *B*, *C* and *D*. The advantage to which reference has been made of devoting two scales to the main fraction and the two others to the allowance, shows up very strongly in this instrument, for there is a separate plus and minus scale for the allowance. The mechanic has therefore only to set one part of the calipers for his main fraction and the other part for his allowance, either plus or minus, and has no pencil or mental calculation to make. No decimal instrument can do this unless the standard main fractions adopted are tenths or hundredths. It will be noticed that the construction remedies a fault in previous beam calipers which had the pull of the fine adjustment on one side of the main axis of the instrument. When used to caliper the exact size of an unknown dimension, the jaws are adjusted to the size, and a front clamping screw, not shown, is tightened on the beam, the rear screw being left loose. The fine adjustment is then worked so that a vernier line on the scale *B* coincides with an upper division. The *C* and *D* scales then indicate the variation from the standard fraction. It should be noted that this construction makes the reading of the second place of the fraction different from previous instruments. With this one it is always set exactly for the precise standard fraction, and the fine adjustment does not alter this setting, but indicates how much more, or less, than the standard the dimension is, or is intended to be.

Two-Screw Micrometer. The two-screw micrometer shown in Fig. 4 is the result of the author's conviction that the separation of the scale for the main fraction from that of the allowance, rendered possible by their being expressed by different places in octavals, is a great practical convenience. In this instrument the standard fraction is measured by the usual screw on the right hand. It is of 8 pitch, probably 4 threads. It indicates the first octaval place,

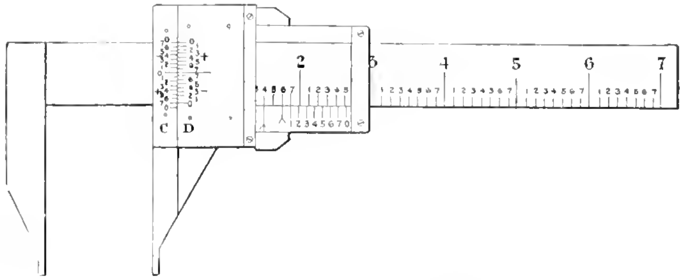


Fig. 3 Double Vernier Calipers

eighths on the index line, which also points to the 8 divisions on the thimble for the second octaval place. For measurement of the main fractions this is all that is required. The end usually occupied by a fixed anvil is fitted with a measuring screw for the allowances, 3d and 4th octaval places, which is kept at zero until required. This is a 32-pitch screw, it has a range of one revolution only, and its thimble has a double scale starting each way from 0 for plus or minus allowances. The 4th octaval place is read by a vernier scale. The workman, therefore, sets his standard fraction on the coarse screw, turns the micrometer round and sets his plus or minus allowance on the fine adjustment, there being no calculation either for him or for the draftsman. As illustrated, the fine adjustment was used left-handed, but it would probably be figured to use it on

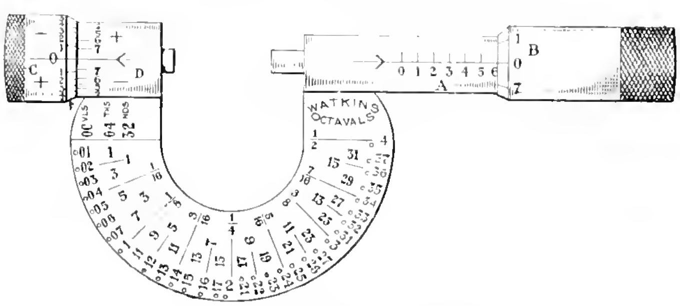


Fig. 4 Two-Screw Micrometer

the right hand, and the position and the use of the vernier would then be exactly those that workmen are familiar with in the present instruments.

To measure an unknown dimension in four places of octavals, the coarse adjustment is first set to the article which is withdrawn, and the screw screwed in to register the nearest (smaller) standard fraction. The final measurement is then made with the fine screw which would probably be fitted with a ratchet, and the instrument would then read for the four places of octavals expressing the dimension. The fine adjustment end can be used alone for measuring fine dimensions less than 1/64 or the coarse-adjustment screw alone for the main fractions.

(Continued on page 905)

Thread Forms for Worms and Hobs

By B. F. WATERMAN,[1] PROVIDENCE, R. I.

The use of worm gearing is steadily increasing, and accompanying it, perhaps the cause, is a corresponding increase in efficiency and durability which is the result of a better understanding of both the theoretical and mechanical problems involved. The following paper is a discussion of these and failure to take them into consideration in the past has often led to the discrediting of this form of drive. This paper also suggests methods for bringing about a uniform and satisfactory practice in worm gearing.

IT is only recently that engineers have considered a worm gear in any other light than that of a necessary evil, and this is probably due to the fact that heretofore the finer points of manufacture were not appreciated and were not obtained except in those places where this type of gear had received more than the usual amount of study. The actual manufacture of the worm and gear, however, presents certain mechanical difficulties and inaccuracies

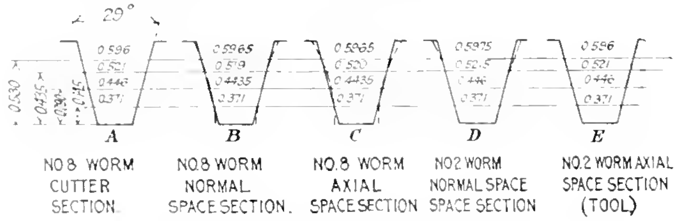


Fig. 1 Double-Threaded Worm

which are not apparent in any theoretical discussion of the subject. These difficulties appear in making the worms and hobs, especially with multiple threads, in fact it might be said they appear in making worms or hobs whose helix angle is greater than 18 deg., and although no attempt has been made to show these difficulties mathematically enough models have been made to clearly indicate them. These uncertainties are due to the differences in the thread forms produced by the different methods of cutting the worms; first, with an axial tool, the use of which is limited to a rather low helix angle; second, with a normal tool which has no limit for angle; and third, with a rotary cutter.

The most common worm has a single thread. This is usually made with the sides of the threads on the axis forming an included angle of 29 deg., and it can be cut with a lathe tool of 29 deg., the cutting edge of which is set parallel either to the axis or to the normal section. It can also be cut with a rotary cutter of the same included angle in a thread milling machine. In other words, the hob which must be backed off with a tool, set either to the normal or on the axis, can be made either way, and the wheel produced will mesh properly with the worm made in either of the three ways just mentioned.

To demonstrate the difference above mentioned, 13 worms were made to the dimensions given in Tables 1 and 2, which also gives all the necessary working information for producing them. The pitch diameter and axial pitch are the same for all, and this applies equally well to double threads, except that in the case of double threads the difference between the normal and axial sections begins to be noticeable. In the case of worm No. 8, Table 1, which was cut with a straight-sided milling cutter, it will be noticed that the thread is perceptibly convex. This difference is shown in Fig. 1, where the dimensions of the cutter which cut worm No. 8 is shown at *A* with the dimensions of tools fitted to the normal and axial sections at *B* and *C*. In all the references to the normal or axial sections, it is to be understood that the space section is meant.

[1] Browne and Sharpe Manufacturing Company.

For presentation at the Annual Meeting, New York, December 1919, of The American Society of Mechanical Engineers. The paper is here printed in abstract form, and advance copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

This method of analysis permits a visual inspection of any difference in shape of thread, as the model or dummy worm can be held to the light and the difference readily seen. The figures show in

TABLE 1 DATA FOR WORMS

No. of Worm	No. of Threads	Outside Diam.	Angle of Thread with Axis, deg.-min.	$90° - \alpha = \delta$, deg.-min.	Cutting Tool Used	Included Angle of Tool Used, deg.	Tool Cut on Axis or Normal	Diam. Cutter	Addendum, S	$D+f$	Normal Thickness, t	Lead	Bottom Diam.
1	Sin.	3.50	83-39	6-21	Lathe tool	29 on axis	Axis	Same Tool as No. 2	.3183	.6866	.497	1.00	2.127
2	Dou.	3.50	77-28	12-32	"	"	"	Same Tool as No. 1	.3183	.6866	.488	2.00	2.127
3	Tri.	3.467	71-33	18-27	"	"	"	. .	.302	.651	.475	3.00	2.165
4	Five	3.420	60-56	29-4	"	"	"	. .	.278	.600	.437	5.00	2.220
5	Five	3.50	60-56	29-4	"	"	"	. .	.3183	.6866	.437	5.00	2.127
7	Sin.	3.50	83-39	6-21	Cut.	29	Normal	3½	.3183	.6866	.497	1.00	2.127
8	Dou.	3.50	77-28	12-32	"	"	"	"	.3183	.6866	.488	2.00	2.127
9	Tri.	3.467	71-33	18-27	"	"	"	"	.302	.651	.475	3.00	2.165
10	Five	3.420	60-56	29-4	"	"	"	"	.278	.600	.437	5.00	2.220
11	Five	3.420	60-56	29-4	"	50	"	"	.278	.600	.437	5.00	2.220
12	Sin.	3.500	83-39	6-21	"	29	"	6	.3183	.687	.497	1.00	2.127
13	Five	3.420	60-56	29-4	"	50	"	6	.278	.600	.437	5.00	2.220
14	Five	3.420	60-56	29 4	Hob.	29	"	. .	.278	.600	.437	5 00	2.220

All dimensions are in inches. Worms are in every case 2.8634 in. Pitch Diam. and 1 in. Axial Pitch

α = Angle of thread with axis
δ = Helix angle
S = Addendum = top of thread to pitch line
t = Thickness of thread at pitch line
$D + f$ = Whole depth of thread

thousandths of an inch what the difference is, the dotted lines showing divergence of the sides of the teeth from the straight line in an exaggerated way.

A tool fitted to the normal of worm No. 2, Table 1, is shown at *D* in Fig. 1, and can be compared to the axial section shown at

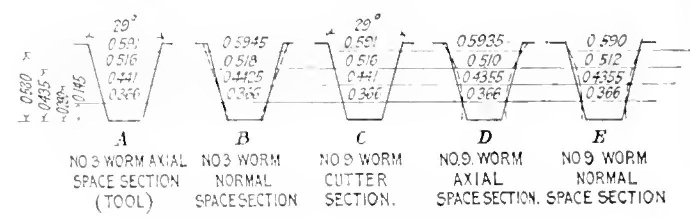


Fig. 2 Triple-Threaded Worm

E. While the difference in shape is noticeable and measurable for a double-threaded worm for all practicable purposes, the statement made about a single-threaded worm holds true for a double-thread. When a triple-threaded worm is considered, the method of cutting becomes of greater importance, since the difference in form between the axial and normal sections (which results from the different methods of cutting) is great enough to require that the hob teeth shape be made exactly like that of the worm. This appears to be a superfluous statement, but it is the exception for a purchaser of a hob to state how he intends to cut the worm, no matter how many threads it has.

Worms No. 3 and No. 9 are triple-threaded, No. 3 being cut with an axial tool in a lathe, and No. 9 with a rotary cutter. The difference in the normal and axial sections of worms No. 3 and No. 9 are shown in Fig. 2. The difficulty just mentioned as to

cutting clearance on the axial lathe tool may also be experienced with a hob that has axial grooves, so that when the angle becomes 18 deg. or greater, it is well to use spiral grooves, as the hob, unless it has ample radial clearance, may drag on one side.

A more extreme case, but now a very common one, is a five-threaded worm where the helix angle is approximately 30 deg. The angle of the thread at the root governs the clearance angle on the tool, and in the case of worm No. 4, the bottom helix angle is 35 deg., 39 min., and in worm No. 5 the helix angle at the bottom is 36 deg., 48 min. The depth of worm No. 4 is based on the normal pitch, while the depth of No. 5 is based on the axial pitch. The shallower tooth eliminates some of the difficulties experienced with these extreme helix angles, and it is good practice to use the normal depth as soon as 18 deg. angle is reached, or when spiral grooves are used in the hob. With a helix angle of 45 deg., which is quite common with axial depth, and 29 deg. thread, either axial

TABLE 2 TOOTH PARTS FOR DIFFERENT WORMS
All dimensions are in inches

No. of Threads	Applies to Worms Nos.	Thread Angle, 90-a = δ deg., min.	Top Angle, deg., min.	Bottom Angle, deg., min.	Addendum, Axial	Addendum, Normal	t Axial	t Normal	$D+f$ Axial	$D+f$ Normal	Lead
Single	1-7-12	6-21	5-12	8-31	.3183	..	.500	.497	.6866	..	1.00
Double	2-8	12-32	10-18	16-40	.3183	..	.500	.488	.6866	..	2.00
Triple	3-9	18-27	15-24	23-48	..	.302	.500	.475	..	.651	3.00
Five	4-10-11-13-14	29-4	24-57	35-38	..	.278	..	.437	..	.600	5.00
Five	5	29-4	24-27	36-48	.3183	..	.500	.437	.6866	..	5.00

or normal, it is very difficult to make the hob, as the tool must have such excessive clearance at the point that it may not be possible to make the hob with a tool that can be sharpened without changing its thickness. Also, the hob tends to drag on the side, and any distortion in the hob or in the worm, due to hardening, interferes very much with the meshing of the worm and wheel. The differences in the shape of the various sections of a five-

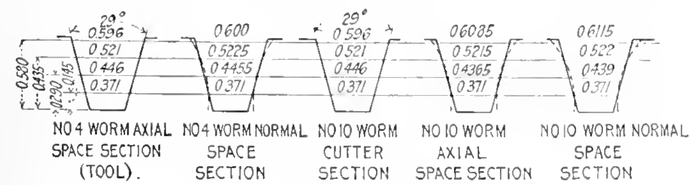


Fig. 3 Five-Threaded Worms

threaded worm as made with the straight-sided tool are shown in Fig. 3.

Worm No. 10 has five threads, and was cut with a 29-deg. included-angle cutter, 3½ in. diameter, and the differences in shape between tools fitted to the normal and axial sections of No. 10 worm may be compared with the normal and axial sections of worm No. 4.

When the helix angle is greater than 18 deg., it is well to consider using a greater pressure angle. To illustrate, worms No. 11 and 13 were made and cut with a cutter whose sides formed an included angle of 50 deg. No. 11 was cut with a cutter of 3½ in. in diameter and No. 13 with one 6 in. in diameter. This change in size of cutter was made to show the difference in shape produced by two cutters of different diameters.

The most durable pair of worm gears is that with a hardened and ground worm. If the worm is to be ground, the shape of the worm thread must be such that the thread surface can be readily reached, and when the wide angle cutter is used this is possible. The best cutter to use is the one that will give ample working space. This angle should be no greater than is necessary to obtain such results, as the smaller the angle the better, because the pressure on the bearings varies about as the tangent of the angle of pressure.

Worm No. 13 might be considered as having been ground with a wheel 6 in. in diameter, and the difference in the shape on the axial and normal sections between Nos. 11 and 13 is shown in Fig. 4. A worm might be cut as No. 11 with a cutter 3½ in. in diameter and ground readily with a wheel 6 in. in diameter. The error is principally at the outside of the worm thread, since there

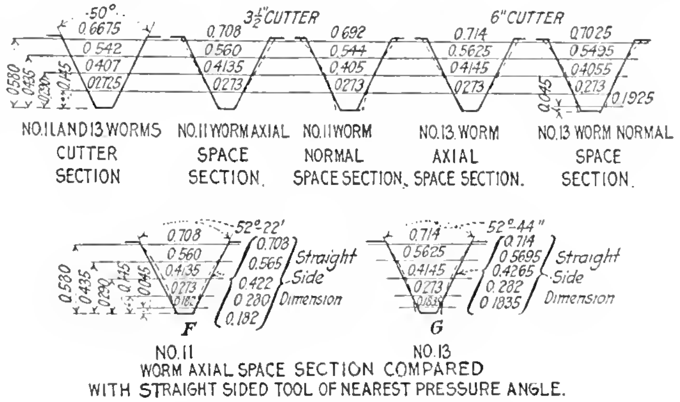


Fig. 4 Five-Threaded Worms

is a decided rounding off at this point. The hob made to conform to the finished worm would produce a shape to suit the ground worm. Fig. 4 shows, at F and G, how nearly straight the sides of the teeth are on both No. 11 and No. 13, a tool fitted to the axial section being compared with a straight-sided tool. This is also interesting, as it forestalls the fear that there may be a loss in efficiency due to the lack of straight-sided teeth on the axial section. Another advantage of this cutter is that it has straight sides, which, as a starting point to make a worm or hob,

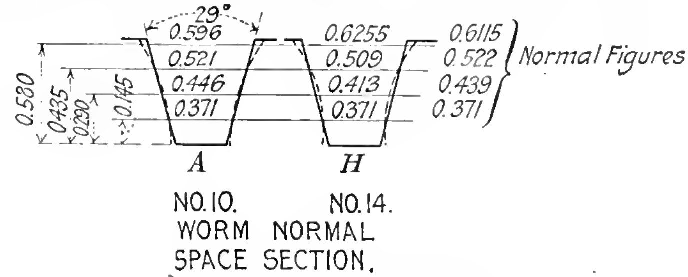


Fig. 5 Five-Threaded Worms

is most simple. This cutter can also be made as an ordinary milling cutter which cuts more freely than a formed cutter which must be used if the section is other than that produced with a straight cutter.

If it is known that a given included angle is the basis for the cutter, it can be produced by any one, even if its diameter is not known, as quite a difference in cutter diameters can be used without any serious difference in shape. It must be borne in mind, however, that the greater the angle of the cutter, the less is the variation in shape due to the diameter of cutter.

Another method of producing worms with five threads would be to hob them. Worm No. 14 was cut with a single-threaded 14½-deg. pressure angle hob (29 deg. included angle), and the shape of the space on the normal is shown by dotted lines in Fig. 5, at H; this is compared with the normal section of worm No. 10, Fig. 3, and is reproduced at A, Fig. 5. It is apparent that this method produces something quite different and a shape that cannot be readily ground. If a hob of 25 deg. pressure angle or 50 deg. included angle on the axis was used, the shape produced would be much nearer that of worms Nos. 11 and 13.

That there is a general lack of knowledge of the foregoing facts is apparent to any one who is familiar with the manufacture of worm gears and the tools for producing them. It would be desirable to establish and follow a standard line of procedure as the use of worm gears is increasing rapidly. Any method adopted, however, should be based on simple principles, such as straight-sided cutters with a change in pressure angle at some stated angle of helix and a change from axial to normal depth at the same point, and the desirability of this latter method is due to its mechanical advantages and not to any theoretical ones.

Modern Electric Furnace Practice in Foundries

By W. E. Moore,[1] Pittsburgh, Pa.

In this paper the author first enumerates the superior properties of electric steel and then points out the advantages of the electric furnace over the open-hearth method. He also discusses the features of the various classes of arc furnaces which have made that type practically supreme in the field. Following this the crucible and converter processes are briefly described and it is shown how the acid type of furnace is best suited for foundry work. Comparative operating costs of producing liquid steel by the converter and electric-furnace processes are also given, and these bring out the marked economy of the latter. The paper concludes with notes on the employment of the electric furnace in malleable-iron foundries, and on the selection of the most suitable type of furnace for a given installation.

Up to the present time the electric furnace has seen its largest commercial development, first, in the manufacture of aluminum, second, in the manufacture of steel, third, in the manufacture of ferroalloys, and fourth, in the manufacture of calcium carbide. At the end of 1913 there were only nineteen electric furnaces installed in the steel-making industry in America. This number had increased to 136 at the end of 1916, and to 269 at the end of 1917. At the present time the number of steel-making furnaces in use in various industrial countries of the world is 815, of which 290 are in the United States and 45 in Canada.

The average capacity of these furnaces in America is 0.37 tons per heat when used for ingots, and in the foundry business, 1.7 tons per heat, though the ordinary size now most generally used in foundries is the 3-ton. More than 99 per cent of all the steel-making furnaces are of the arc type, less than 1 per cent being of the induction type, which was popular in the early days of the art.

Electric furnaces are used for the following principal purposes in the metal industries:

a Forging steels, tool steels, alloy steels, etc.
b Making steel castings in foundries
c Making high grades of strong cast iron for difficult or fine castings
d Melting brass, bronze and other non-ferrous metals.

Properties of Electric Steel

Primarily, electric steel became popular because of its superior physical properties. While such steel can be made with a more satisfactory chemical analysis, using a given grade of raw materials, than by other processes, experience has abundantly demonstrated that when made according to the same chemical analysis it will have about 15 per cent greater tensile strength or ductility, depending upon its heat treatment, and that it is more resistant to shock and better able to receive heat treatment. The reason for this is that the steel, being made in a closed furnace and in a reducing atmosphere away from the contaminating influences of combustion gases, is more solid, freer from gases, and less prone to non-metallic inclusions of slag oxides. As an example, the tests in Table 1, made by R. W. Hunt and Company, Chicago, January 30, 1919, for the Chicago Surface Lines, illustrate the physical properties of A.E.R.A. specification heat-treated electric-furnace axle steel. It was heated from 1450 to 1460 deg. fahr. held one hour, quenched in 65-deg. oil, drawn from 1185 to 1200 deg. fahr. for one hour and then slowly cooled in the furnace. The open-hearth steel was also heat-treated in the same manner.

TABLE 1 COMPARISON OF OPEN-HEARTH AND ELECTRIC-FURNACE STEEL

	Open hearth	Electric furnace
Elastic limit, lb. per sq. in.	41,060	64,850
Tensile strength, lb. per sq. in	89,100	105,140
Per cent elongation in 2 in.	21.5	22.0
Per cent reduction of area	31.74	52.37
Elastic torsion	16,750	33,700
Character of fracture	Granular	Silky cup

The Bureau of Standards reports regarding the superior qnalities of electric steel as follows:

The characteristics of electric steel are great homogenity and freedom from segregation. It is somewhat higher in tensile strength and elastic limit than other steels and owing to its greater density, shows a marked resistance to fatigue.

Being absolutely "dead" when properly made and averaging lower in sulphur, electric steel in the foundry is less liable to show shrinkage cracks between ribs of castings, and, being more fluid, it is not so liable to piping, blowholes, cold shuts or misruns, and in tool steel it takes heat treatment more effectively and will stand greater abuse in heating.

The electric furnace is especially useful for making alloy steels. Since the metal is treated in a reducing atmosphere, there need be no large losses of the added elements, such as silicon, manganese, vanadium and chromium, which in the ordinary open-hearth practice are oxidized in large quantities and carried to waste in the slag, thus producing uncertain mixtures. Indeed, the added elements in open-hearth practice frequently show losses of from 30 to 50 per cent, while in the electric furnace they will be practically nil.

With the electric furnace it is much easier to carry the finishing operation to a more exact limit in carbon and silicon content than is practicable in the case of the open-hearth furnace. Gases of solution and inclusion, such as oxygen and nitrogen, are also eliminated.

Electric Versus Open-Hearth Furnaces

In open-hearth furnaces it is impracticable to melt down fine scrap, such as turnings in quantity without excessive additions of pig iron, for the reason that the oxidizing flames, which furnish the heat to the furnace, will reduce the metal when in an attenuated form to a mass of oxide before it becomes molten, whereas with the electric furnace it is entirely practicable to melt turnings exclusively, which, under ordinary market conditions, are purchasable at a price from five to ten dollars per ton lower price than that for the heavy melting grade of steel required in open-hearth practice.

In the electric furnace it is possible to obtain a heat-transfer efficiency of from 60 to 70 per cent of the heat energy of the electric power supply put into the molten charge, whereas with open-hearth practice the efficiency ranges from 8 to 15 per cent and in a crucible practice from 2 to 6 per cent. The fuel-developed heat unit of the open-hearth furnace is, however, bought in a much cheaper form than the heat unit supplied by electric power, and if the electric furnace did not have the other advantages mentioned it could not at present compete against the open-hearth furnace on the basis of cost.

On account of the very intense heat of the electric arc, it is entirely feasible to melt down and refine a charge of foundry steel in one hour or less which in the open-hearth furnace might require from 6 to 14 hours. In other words, a 12-ton electric furnace may be practically equivalent to an 80-ton open-hearth furnace, so far as steel output is concerned, and involve far less installation cost.

The Arc Type of Electric Furnace

The arc type of electric furnace is practically the only one being installed for steel making today, although induction-type fur-

[1] Director of Research Laboratory, Aluminum Castings Company, Cleveland, Ohio.

For presentation at the Annual Meeting, New York, December 1919, of The American Society of Mechanical Engineers. The paper is here printed in abstract form, and advance copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

naces are in use. At first glance the induction-type furnace appears to have many advantages over the arc-type furnace, but practice has shown that it is in no way a competitor of a properly constructed arc furnace. In large sizes the power factor is extremely low, the efficiency of the furnace poor, and the cost of replacing the refractories very high.

Arc furnaces may again be classified into long-arc and short-arc types. There are many theoretical inducements for using the long-arc furnaces. With a given energy input, the electrode is correspondingly smaller and the electrode cost therefore reduced proportionately. With the water-cooled bottom-contact type of furnace either the furnace size must be kept small or the voltage must be greatly increased in order to keep the current low and prevent that form of contact from overheating; hence, it is the custom to operate the bottom-electrode furnace with quite a long-arc and low current, and in small sizes only.

Arc furnaces may again be classified into single-phase, two-phase and three-phase types. The single-phase furnace is ideally simple but is poorly adapted to modern power-plant conditions, as central-station power today is universally generated and transmitted in three phases. The long-arc single-phase furnaces, too, have the very great disadvantage of operating on extremely low power factor, thus causing a great waste in transformer, line, and generator capacity, which usually makes them prohibitive from the central-station man's viewpoint in any but quite small sizes, say ¼-ton to 1-ton capacity per heat.

The two-phase furnace may be operated either from two or three-phase power, but when operated from the usual three-phase power the phases have to be transformed by Scott-connected transformers, which are more costly, less efficient and frequently unbalance the power system. The two-phase furnace is usually built with four arcing electrodes and, while it gives a theoretically balanced load on the power system, it has the objection of requiring an additional electrode, which increases the electrode consumption 33 per cent over the three-phase furnace.

The three-phase furnace for installations of moderate and large size is the most universally satisfactory and popular furnace, fulfilling all the conditions as to balanced load and high-power factor required by the central stations, at the same time giving the minimum electrode loss and the simpliest form of automatic-electrode-adjusting gear.

It is possible to obtain satisfactory operation of the direct-arc-type furnace for melting non-ferrous metals only where the content of metals which volatilize at low temperatures is small, as, for instance, in making bronze and low-zinc metals. Where the zinc or aluminum content is high, as in yellow brass, Muntz metal, etc., this type of furnace is very unsatisfactory and results in great waste of the more volatile metals and the making of porous castings. Consequently special furnaces of the resistor, rocking, rolling, tumbling induction or distributer-arc types are required, the latter referring to furnaces in which the heat of the arc is transmitted by radiation alone.

Disadvantages of Crucible Furnaces

The crucible furnace is the oldest method for making steel castings and of making first-class tool steels. However, it is now being practically displaced by the electric furnace, which has many advantages such as rapidity and reduced cost, and the ability to make sounder castings and better tool and alloy steels. Due to the absorption of carbon from the crucible, it is difficult to make castings low enough in carbon to obtain the ductility desired for many purposes. Furthermore, the steel reduces the silica from the clay of the crucible, tending to run the silicon content of the product high. The overpowering objection to the crucible process, however, is the high cost of the products, due to:

a High cost of pure melting stock, as no refining is practicable

b Very high labor cost on account of the small heats handled

c Extravagant fuel consumption, sometimes using 3 tons of coal per ton of steel

d High cost of crucible renewals, often averaging two to four crucibles per ton melted and costing \$9 to \$11 each or \$18 to \$44 per ton.

For these reasons the crucible-melting shop is rapidly going out of use for castings, as well as for tool steels.

The Converter Process in Steel Founding

During recent years the side-blow converter process has become very popular in steel foundries making castings of medium and small size. This process requires high-grade, high-silicon, low-phosphorous and low-sulphur pig iron to be melted in a cupola furnace with the finest grade of coke obtainable. The advantages of the converter process are: The steel may be made fluid enough for reasonably thin castings; the heats, usually running one to two tons, are of convenient size to be poured off quickly before cooling; the fuel consumption is moderate, averaging from 400 to 600 lb. of coke per ton; the first cost of the apparatus is low, and the process is available for intermittent service.

The disadvantages are: The metal must be handled twice in the ladle; the metal picks up sulphur and phosphorus and nitrides from contact with the fuel and the air blast; the losses in the cupola and converter are quite high, running from 16 to 24 per cent, further concentrating and increasing the percentages of impurities in the original metal and wasting costly melting stock; the steel is full of oxides and gases and requires large quantities of expensive ferroalloys to kill; the quality of the steel physically, as well as chemically, is below par; a heat once blown too cold cannot again be brought up in heat enough to cast and must be "pigged"; only the highest grades of melting stock may be used, costing generally \$15 to \$25 per ton more than for the acid open-hearth furnace and \$20 to \$35 per ton more than for the electric furnace; and the refractory maintenance is high, as the cupola and converter linings must be repaired after each 10-hr. run. Liquid-metal costs of converter steel frequently run up to from \$60 or \$80 per ton.

The electric furnace is the most modern steel-producing agency and is gaining in popularity more rapidly than all others. It is the most compact furnace, and the rapidity with which it will melt down cold charges adapts it splendidly to the making of steel castings, as well as forging and tool steels. It is the cleanest and most certain method of making steel, and its small bulk makes it feasible to locate the furnace near the center of the floor where the metal need be transported short distances only.

Acid-Type Electric Furnace for Foundry Work

The acid-type furnace is best suited for foundry work and the most popular size has a capacity of 3 tons per heat, though sometimes 1.5-ton or smaller furnaces are required. The more highly powered and rapid furnaces for such work turn out from 8 to 16 heats in 24 hr., and with a power consumption of from 500 to 650 kw-hr. per ton of liquid steel and considering the ultimate efficiency of the large modern turbo-generator power house at, say, 1.5 lb. of coal per kw-hr., its fuel consumption might be said to be equivalent to from 750 to 900 lb. of coal per ton melted, and the coal need not be of high grade nor low in sulphur and phosphorus as is necessary with fuel-fired furnaces. Basic furnaces require more time and power, heats ranging from four to eight per day, and since the charge is melted in a reducing atmosphere there is practically no oxidation of the metal; consequently thin scrap, light turnings or scrap of other forms such as can be conveniently charged into the furnace, may be melted. Such scrap on the present market sells for approximately from \$5 to \$10 per ton less than low-phosphorous, heavy melting scrap necessary with the ordinary acid open-hearth melting-furnace installation.

The furnace atmosphere, being of a reducing nature, makes it easier to refine and kill the steel, resulting in a saving amounting frequently to half of the ferroalloys necessary with converter steel, effecting a saving of, say, \$2 per ton. The melting losses in the electric furnace are much the lowest of any modern process, aver-

aging from 2 to 5 per cent as against 6 to 9 per cent in the open-hearth and from 16 to 21 per cent in the converter process.

The electric furnace does not contaminate the metal as do fuel-heated furnaces and an acid electric will therefore readily make No. 3-U.S.A. specification steel, whereas it nowadays is practically impossible to find melting stock sufficiently pure to do so with the converter process. The saving alone in the cost of melting stock will more than pay for the entire conversion cost of electric steel. The greatest points in favor of the electric furnace are the much higher grades of steel produced and the higher percentage yield in castings and bars.

Comparative Costs of Electric and Converter Steel

With the electric furnace, men can more readily make and check their steel to an exact percentage of carbon, manganese and silicon and can more easily keep the undesirable sulphur and phosphorus to low limits than by any other process. The steel may be readily alloyed with nickel, chromium, and vanadium to make the higher grades of steel castings to replace forgings and for special purposes, such as may be required for parts of unusual strength, ductility or for cutting tools. It is entirely feasible to make castings which will run up to an ultimate strength of 130,000 lb. per sq. in., or to cast high-speed-steel milling cutters and reamers to form for grinding. The figures in Tables 2 and 3 show present-day comparative operating costs for liquid steel in the ladle under favorable conditions as in a steel foundry under 24-hr.-per-day operation.

TABLE 2 AVERAGE COST PER TON FOR TWO TONS OF CONVERTER STEEL DIVIDED INTO FOUR CUPOLA CHARGES

Two-ton Converter Charge	Cost per ton of liquid steel
Low-phosphorous pig iron	$14.09
Bessemer pig iron	7.89
Steel scrap	10.14
Silicon and spiegel	5.55
Coke, 863 lb.	1.01
Cost of material per ton of liquid steel	$38.68
Additions per ton of steel:	
10 lb. 80 per cent ferromanganese at 6 cents	$0.60
6 lb. 50 per cent ferrosilicon at 5 cents	0.30
2 lb. aluminum at 30 cents	0.60
Power for blower motors	1.25
Cost of materials and power per ton of liquid steel	$41.43
Average cost of cupola and converter linings	1.20
Labor costs	3.00
Cost of converter steel per net ton in ladle	$45.63

TABLE 3 AVERAGE COST PER TON FOR THREE-TON ACID-LINED, RAPID-TYPE, POLYPHASE, ELECTRIC FOUNDRY FURNACE STEEL

Three-ton Electric Furnace Charge	Cost per ton of liquid steel
Axle turnings (included above 3 per cent losses, 200 lb.)	$12.40
Mill scale (included above 60 per cent losses, 60 lb.)	0.09
Electrodes at 7 cents	1.40
1650 kw hr. (550 per ton) at cent per kw-hr.	5.50
Losses in melting 260 lb.:	
80 per cent ferromanganese	0.40
50 per cent ferrosilicon	0.25
Aluminum at 30 cents	0.15
Cost of material per ton of liquid steel	$20.19
Average cost of linings and roofs	0.40
Labor cost on furnace attendance	1.00
Cost of electric steel per net ton in ladle	$21.59

G. K. Elliott reports a cupola iron showing a transverse load of 2950 lb. with a 0.10-in. deflection in a standard arbitration test bar. After 25 min. treatment in the electric furnace, using 104 kw-hr. per ton, a similar bar was cast and broke at 4400 lb. with a 0.115-in. deflection.

Very fine results have been obtained with malleable iron made by treating cupola metal or by melting cold scrap in an electric furnace. The ability to refine for sulphur and phosphorus and to add ferroalloys to adjust the mixture to the proper malleabilizing formula, together with its very rapid operation, give the electric furnace a decided advantage in malleable-iron foundries, particularly in working on high-phosphorous southern irons.

In the non-ferrous-metal industry the electric furnace has shown remarkable economies, due to the saving of cost of crucibles and the greatly reduced metal losses caused by oxidation and volatilization. For such work special types of furnaces designed to avoid localized heating are necessary.

Selection of an Electric Furnace

As to the most suitable type of electric furnace for a given installation, if the scrap be inferior and high in sulphur and phosphorus, then the extra cost, slower operation, and shorter refractory life of the basic furnace must be endured to obtain the lower limits of sulphur and phosphorus not practicable to reach with the acid furnace using poorer grades of scrap. At present the call is for acid-lined furnaces, and cheap, good scrap is available in large quantities for foundries, and basic furnaces for alloy and tool steel. The acid furnace is simpler, cheaper and faster to operate and the steel casts more easily, while the basic furnace is essential for tool steels.

It is strongly recommended in any case that a furnace be so designed and constructed that it is adaptable to basic operation. This means that the furnace shell must be of large diameter and the bath of large area and shallow. The furnace should not, it is thought, be of the long-arc type, nor of the small-diameter, deep-bath type if the best and most rapid work is contemplated. Indeed, even for acid melting there is a noticeable difference in the quality of the steel obtained from the large-diameter, shallow-bath furnaces compared with that made in the deep bath-type furnace, for with the latter it is not feasible to obtain the same mechanical reactions from the additions put in to refine and kill the steel as when the bath is of the shallower type. Nor is it possible so thoroughly to deoxidize the metal by maintaining a reducing atmosphere in the furnace.

It is quite important that the furnace should operate at the highest practicable power factor that can be obtained without undue disturbance of the power company's load, for by so doing the electrode, transformer, line and generator losses are maintained at a minimum. Engineering skill of a high order is required to forecast and select the best type of equipment, under the many varied power-supply conditions which obtain in different localities.

By reason of the now generally acknowledged superior quality of the product, greater flexibility of operation, quicker, more-convenient-sized heats, and saving in alloys and in cost of melting stock, the electric furnace is rapidly coming to the front in the steel foundry and alloy- and tool-steel works wherever suitable power is available and progressive policies are in vogue. It is making possible the profitable operation of widely distributed small steel foundries to an extent not generally realized and greatly reducing the investment cost required in tool-steel works.

That weaknesses are developed in steel by aggregations of impurities, notably sulphur, which are forced into position in the processes of rolling or forging, is asserted in a paper by Mr. Portevin, published in *Comptes rendus des séances de L'Académie des Sciences,* for August 11, 1919. In the *Journal of the Iron and Steel Institute,* vol. 85, 1912, p. 379, Roger has outlined a method of applying an acid solution of silver bromide to uneven surfaces by using a plastic mixture of clay, wax and vaseline. Mr. Portevin examined the variation in the appearance of fractures in steel, test pieces, according to the direction of the line of fracture with respect to the fiber of the steel, given to it in the process of rolling or forging, by substituting for Roger's mixture a paste composed of gelatine, glycerine and water covered with an emulsion of silver bromide. Evidences of aggregations of sulphur were found in all specimens thus examined. It would appear, therefore, that the only means to prevent such aggregations is to keep the sulphur out of the ingot. This can be best effected in the opinion of Mr. Portevin by reducing the disengagement of gas in the pouring of the ingot and employing ingots of as small size as compatible with the use to which steel is to be put.

A Perfected High-Pressure Rotary Compressor

By CHESTER B. LORD,[1] ST. LOUIS, MO.

Of the three types of rotary compressors, namely, the centrifugal blower, the gear type and the eccentric rotor with telescopic blade, the last is the least efficient. Particulars are given by the author of a new and improved construction of this type in which leakage, friction and packing troubles have been eliminated to such an extent that a volumetric efficiency of 92 per cent at seven compressions (100 lb. per sq. in.) is said to be commercially obtainable. It is also stated that this compressor will, without adjustment or alteration, handle gas, air, or a liquid, or a gas and a liquid at the same time, and that it is possible to obtain a pressure of 500 lb. in a single-stage machine and 1000 lb. in three stages with the three units on the same shaft. The uses of the rotary compressor are also enumerated in the paper and its special advantages are set forth, these being (1) small weight per unit of capacity, (2) small amount of floor space required, (3) small initial cost of installation, (4) employment of direct drive, (5) small amount of headroom required, (6) simplification of construction and small amount of adjustment or repair, and (7) self-lubrication.

Any one familiar with the various lines of mechanical endeavor must realize that no vital change has been made in compressors in the last thirty years or more. There have been improvements in the way of better valves, a little higher speed and minor matters of this kind, but none of them has changed the principle of the machine or resulted in any great economy either in weight, operating space required, or cost of installation. Moreover, these machines require a great deal of attention, and necessary repairs are expensive because in almost every case the machines must be partly taken down in order to get at the parts to be repaired, the bearings are numerous and are lubricated with difficulty, and the valves must be adjusted in a very delicate manner to give best efficiency. Because of all these disadvantages in the reciprocating machine we are constantly striving to get on a unidirection basis in the mechanical world. We are replacing the reciprocating planer with a unidirection miller and introducing the uniflow principle in the reciprocating engine. The automotive world is searching for the unidirection gasoline unit, and the Patent Office records are full of rotary valves, rotary engines, and rotary pumps.

The rotary principle, however, is so valuable that in spite of their deficiencies three general types of rotary compressors have been retained, namely, the centrifugal blower, the gear-type compressor, and the eccentric rotor with a telescopic blade. The centrifugal blower depends more upon the velocity of the air than upon compression and requires several stages to secure any considerable degree of compression. The gear-type compressor which, roughly speaking, compress air between two gears with their teeth in mesh (taking it in at one side of the teeth and delivering it at the other) has a very low efficiency, but is able to compress to a higher degree, single-stage, than either of the other types. None of them, however, compresses to over 8 or 10 lb. single-stage.

The eccentric-rotor-with-telescopic-blade type of rotary compressor has been faulty in several respects. The first and greatest was that it was necessary to maintain a seal at one point between the rotor and the cylinder. This was a source of large friction losses and the seal was soon broken by wear. Second, the blade pressure against the end plates and the inner surface of the cylinder created great friction loss and still further wore the cylinder at the contact point between the rotor and the cylinder wall. Third, the pressure being all on one side of the blade created such friction that the blade did not work in and out freely. It was also found impossible to devise a method of packing square corners, and hence the only commercial application of this type was in the pumping of oil or water at a comparatively high velocity, which service produced the least friction and no important losses.

The New Rotary Compressor

As the result of long, patient research and the ingenious application of obvious principles, these faults enumerated have been eliminated and a new compressor perfected by W. G. E. Rolaff, of Belleville, Ill.

The difficulty of maintaining a seal at one point between the rotor and the cylinder is fundamental. Some years ago a Mr. Hermansen developed an engine in which the cylinder revolved at the same peripheral speed as the rotor and was, in fact, carried by the rotor. Having both moving parts traveling at the same peripheral speed, not at the *same angular* speed, means that there is no slip between the two, consequently, little or no friction. It also reduces to a minimum the blade friction against the outside of the cylinder because the movement of the blade on the wall of the cylinder per compressive revolution is only that represented by the difference in the circumferences of the outside of the rotor and the inside of the cylinder. In other words, in a 100-cu. ft. size with a cylinder 10⅝ in. in diameter and a rotor 10 in. in diameter, the blade travel per compressive revolution is only the difference between 31.41 in. and 33.38 in., or less than 2 in., so that it requires approximately 17 revolutions of the rotor for one revolution of the blade upon the cylinder wall. There are no valve openings in the cylinder, and as it travels always in the same plane it makes no difference whether the cylinder is revolving with the rotor, standing still or reversing itself, as far as compression is concerned. Hermansen's principle, by itself valueless, was evolved by Mr. Rolaff who at that time was unaware of the Hermansen patent which he afterward acquired.

The difficulty of excessive end pressure was overcome by floating plates at the ends of the cylinder held in intimate contact with the rotor by pressure generated by the machine itself. The pressure upon the outer surface of the plates is greater than upon the inner surface by reason of the difference of the area exposed to this pressure. This supplemental pressure is always in direct proportion to the pressure generated by the machine, hence the additional friction is only what is necessary to keep the cylinder heads in close contact with the rotor and cylinder ends, and where the pressure is even slightly greater on the outside than on the inside there can be no leakage. Any motion imparted to the rotor shaft will immediately be communicated to the cylinder by reason of the metal-to-metal contact between the two. In other words, if the rotor is revolved the cylinder will revolve with it and the cylinder plates will float with the cylinder or piston or between the two, as the case may be. The friction developed is merely the friction of the wiping contact between the rotor ends and the cylinder plates, since there is very little or no friction in the rolling contact between the rotor and the cylinder.

There still remained the question of packing square corners and of friction between the ends of the blades and the end plates. When the rotor is revolved, the piston blades which fit loosely in the slot fly out by centrifugal force and remain in contact with the cylinder wall and the cylinder heads, since centrifugal force acting on a wedge keeps them in such contact. This is the principal point of friction. But calculating this friction on the basis of speed in feet per minute, we find, for instance, that on a machine capable of compressing 100 cu. ft. of free air per min. the piston-blade travel is approximately ⅝ in., and since a machine of this type would run at about 900 r.p.m. we have the following calculation: $\frac{5}{8} \times 2 \times 900$, which gives 93 cu. ft. and since the surface in contact with the cylinder heads is very small, the total amount of friction generated by this reciprocating action of the piston blade is proportionately small.

[1] Cons. Mechanical Engineer, Wagner Electric Manufacturing Company, St. Louis, Mo. Mem.Am.Soc.M.E.

For presentation at the Annual Meeting, New York, December 1919, of The American Society of Mechanical Engineers. The paper is here printed in abstract form, and advance copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

These blades as developed are of two types, centrifugal and pressure. At present, the centrifugal type shown in Fig. 1 is used commercially. This blade consists of four parts, one of which, *A*, is cut away as shown and on it are imposed three thin blades, *B* and *C*, of any desired metal. The two outside pieces *B* are beveled and the center piece *C* fits between these, forming a wedge, and the top of *C* is cut away to allow of movement vertically. Revolving at speed the center piece *C* is thrown out by centrifugal action, the force exerted on the pieces *B* being in the direction of the arrow. This presses the *B* pieces against the sides and ends of the cylinder. These blades are self-aligning and self-adjusting, also self-compensating. The force with which these blades *B* strike against the corners is regulated by the angle of their inner sides and the weight of the center piece. There are no springs whatever and the blade is balanced for back pressure by having both sides exposed to chamber pressure with a seat at the top of the slot in back, and as oil from the cylinder wall is scraped off by the blade into the slot, an effective seal is maintained. The blade *A* is about 1/32 in. short on each end and makes contact with the cylinder wall except at the extreme corner and side. The discharge valve is immediately in front of this blade. In machining the rotor and the cylinder where a rolling contact is maintained between the two, the turning of the cylinder too large or the rotor too small would destroy contact. For making contact, a circular wedge is used. This is an eccentric cradle carrying the bearings for the revolving cylinder and is made with a threaded stud led through the outer casing. In practice the rotor and cylinder are assembled without contact and

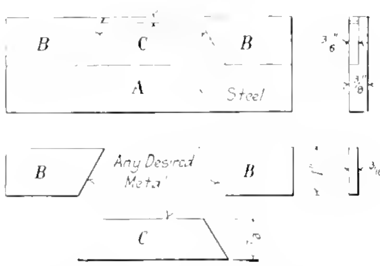


Fig. 1 Centrifugal Type of Blade for Use in Rotary Comressor with Eccentric Rotor

started on test. After a time, by drawing up on the wedge, the proper contact is made. When this is found, the nut is backed off about 1/4 turn, so that on a 500-cu. ft. compressor the space is about 0.01 in., the oil making a proper seal and contact. Capacity can be increased by taking a cut off the cylinder or rotor, or both.

One of the greatest advantages of the compressor is that it may be direct-connected. It can be run at any speed at which a prime mover can be run safely. A 100-ton refrigerating machine is run at 600 r.p.m., a 1-ton or 5-cu. ft. size at 1800 r.p.m. That the piston speed is not too high for efficiency is shown by data on a reciprocating compressor of 14-in. stroke and having 100 cu. ft. capacity at 200 r.p.m. The piston speed would be 466 ft. per min., or over 200 per cent in excess of a rotary compressor of the same capacity run at 900 r.p.m., with a relative speed of 150 ft. per min. between the rotor and cylinder. The next advantage is in its space requirements. A 100-ton rotary compressor on its base with its prime mover requires only 60 sq. ft. of floor space, whereas a horizontal reciprocating unit of the same capacity requires approximately 1200 sq. ft. plus a building, plus a boiler room, and weighs 100 lb. per ton capacity as against approximately 8 lb. for the rotary. It is usually possible to replace any pump or compressor with a machine weighing less than the flywheel of the displaced unit. With the high-pressure rotary compressor, the volumetric efficiency at 100 lb. pressure is 90 to 92 per cent, depending on size, as against 65 to 85 per cent with the reciprocating machine.

The rotary compressor without adjustment or alteration will pump gas, air, or liquid, or all three. When ammonia condenses in the coils of a refrigerating machine and a "slug" happens to get into the compressor, usually a valve or a cylinder head is blown off. A 5-gal. tank of oil can be poured into a rotary compressor running at full speed under load, as fast as the inlet pipe will take it. Since the end plates are held to the cylinder only by differential pressure, if the oil entering the cylinder cannot be discharged fast enough by the valves, the end plates open up, allow the oil to pass out and then close. It is obvious that when pumping fluid continuously the pressures inside and out would again be different and be relatively maintained, so that no leakage would occur. In other words, the loose end plates act as safety valves without effort, as any necessary area of exit is secured and the oil leaves the cylinder at just sufficient pressure to raise the end plates. This feature is valuable in pumping hot water, or gas and oil.

Another feature of this construction is the possibility of making the compressor double-acting by placing two blades 180 deg. apart, which would add 60 to 70 per cent to the capacity of the machine. Until recently, however, no effort has been made to do this as it requires an intake valve, which is troublesome. In the simple type no intake valve is used, the seal between the rotor and cylinder acting as such. The major trouble with all air compressors, reciprocating or otherwise, lies in the valves, and the same trouble was found initially in the rotary compressor. It was aggravated somewhat in the rotary by the fact that cracking or splitting of the valve in its cage was not immediately preceptible, and it was possible for a valve to gradually break up into fine pieces and get into the cylinder. Experiments were undertaken to find a suitable material, and this has been done for cases where the temperatures do not exceed 200 deg. fahr. In the 100-ton size the discharge valve is about 24 in. long by 1/2 in. wide, so it will be seen that the problem differs from that of the reciprocating machine.

Uses of the Rotary Compressor

The uses of the rotary compressor include every one possible to a compressor of the reciprocating type and some that are not. It is possible to get 500 lb. pressure single-stage; to get 1000 lb. pressure in three stages with the three units on the same shaft; to make it a low-pressure machine, giving it any desired capacity by making the rotor relatively small; and to give even more than 1000 lb. pressure single-stage by reducing the displacement. As a vacuum pump it will pull 28 1/2 in. against a pressure of 180 lb., but to do this continuously with a compressor it is necessary to shut off the oil pipe, and for commercial practice it would be necessary to have a self-contained oiling system. The firm handling the rotary compressor in question has already been asked to consider the making of blowing engines for blast furnaces, as compressors of the rotary type do not take up more than 5 per cent of the room now necessary.

These rotary compressors are in use at the present time as boosters on refrigerating units for both high and low pressures. The small household refrigerating business has not grown because it had been found impossible to secure a dependable compressor. One manufacturer is at present building units using this rotary compressor. It is a 0.5-cu. ft. size, runs at 1760 r.p.m., is direct-connected and is perceptibly noiseless, as are all other sizes of this compressor. The rotor in this size is 1 7/8 in. in diameter and 1 in. long. Another manufacturer is making the 3-ton refrigerating size. Still another has a contract on which is guaranteed a minimum of 10,000 cu. ft. per year for street-car compressors. Another use is as a small individual unit for refrigerating cars, run either from the axle direct, or with a motor from a turbine in the engine. Upon arrival at terminals, instead of the expense and waste of icing, it will only be necessary to plug in.

Used as an air compressor, the rotary compressor is ideal as the air is taken off at the center and the oil thrown out centrifugally to the periphery. No rotary pump is at present made that will prime itself, but this is not true of the compressor when used as a pump. Further, although no reciprocating pump manufactured handles CO_2 successfully for any length of time without need of repairs because of the high efficiency and the character of its cylinder construction, there would seem to be little doubt of the rotary's ability to handle CO_2 continuously without repairs. This is in the future and also applies to hydraulic applications.

(*Continued on page 905*)

Common Errors in Machining of Bearings

By CHRISTOPHER H. BIERBAUM,[1] BUFFALO, N. Y.

The machining of bearings is a subject which has received but slight attention, and this despite the fact that it is an important one. To place on record some of the more common errors prevalent in this type of work, the author in his paper discusses the disadvantages of tight-fitting bushings, the methods of finishing brasses to provide for expansion while running, and the methods of clamping bearings during tooling. He also takes up the matter of the tools employed and shows by numerous photomicrographs of finished surfaces the importance of using sharp tools with the proper rake, in order that the crystalline structure of the surface material of the bearing may not be so crushed that it will fail to function as a normal bearing alloy.

IN the construction of journal bearings one matter which is very frequently neglected, perhaps most often because it is not thoroughly understood, is that of driving in bushings. As all bearing alloys have a temperature coefficient of expansion higher than that of cast iron, and as the bearing is directly subject to the friction of the journal, it follows that the bearing is at a higher temperature than the cast-iron housing and that all bearings must have an appreciable outward expansion when in operation. For this reason bushings should be driven in with just enough pressure to prevent looseness during operation.

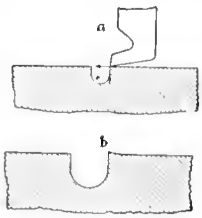


Fig. 1 Sharp Edge Produced at the Edge of an Oil Groove by an Ordinary Lathe Tool

The practice of driving in bushings so tight that they require reaming before they can be put into service cannot be condemned too severely. The subsequent reaming does not remedy the evil, in that a bushing driven in so tight will and must continue to contract inwardly when in operation, since the outside pressure upon it is not removed by the reaming. In the tooling of a bearing a definite amount of clearance should be provided for, in order to insure the best service conditions. When a bushing is driven in too tight, although it has been reamed before being placed in service, the amount of clearance which it will then have becomes a matter of guesswork and the amount of oil-film space provided an uncertainty. This condition frequently gives rise to heating and bearing troubles, even though the amount of internal contraction may not be sufficient to positively grip or stop the journal. The idea that bushings must be driven in tightly in order to hold them in place is fundamentally wrong, and excessive tightness of the bushing in its housing should always be avoided. For all ordinary machinery it will suffice if a bushing may be driven in place with a blow of the hand or with a small block of wood. The provision of fastening the bushing in place should be such that it will not bind or clamp the latter against outward expansion.

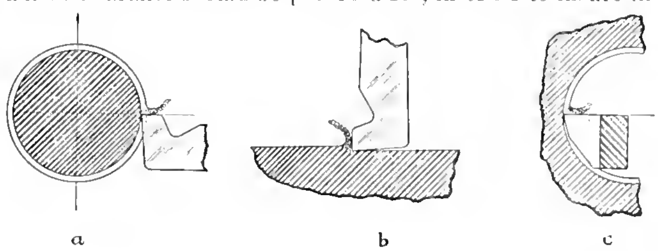


Fig. 2 Improper Forms of Lathe, Planer and Boring Tools

Method of Finishing a Crankpin Bearing

The finishing of bearings in such a manner that they may expand while warming up is of very considerable importance, and this can be done in many cases by simply giving the matter the full consideration which it deserves. The two edges of the two half-bearings should be "brass bound," that is, they should bear solidly against each other and should exert a pressure against each other somewhat in excess of the maximum crankpin load. The outer surfaces of both bearings near these edges should be relieved so as not to bear upon the straps. The four corners of the bearings should be relieved in like manner so that the horizontal thrust will be mainly borne upon the surfaces falling within the area of the horizontal projection of the crankpin. A bearing thus constructed expands with the first slight increase of temperature, relieving the crankpin instead of clamping it as when these precautions are not taken.

Clamping of Bearings for Tooling

Another matter very often overlooked is that of the manner in which bushings or bearings in general are clamped during tooling. With a 5/8-in. 16-thread set screw and the application of, say, a 50-lb. pull upon a 12-in. monkey wrench, a pressure of 50,000 lb. can be carelessly exerted upon the bushing in question, and it must be remembered that the composition of a bearing material is never one that would be selected for maximum strength. Bushings tooled when clamped in this manner seldom have a bore that even approaches a true cylindrical surface, and if they are then driven upon an arbor and finished on the outside a very inaccurate product is the result, a bushing that can never give the most satisfactory service. The best and most satisfactory method of holding bushings for tooling is that of clamping them endwise. The importance of this is very generally underestimated; in general, bearings should be held in a manner such as to produce the least possible amount of strain and distortion.

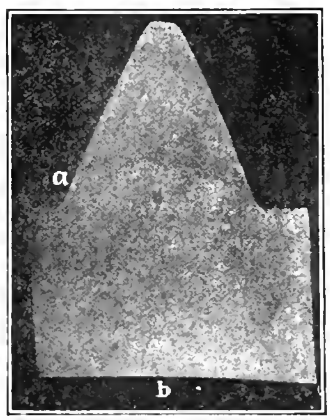


Fig. 3 Cross-Section of One of the Teeth of a Motor-Truck-Drive Worm Wheel

Chamfering of Oil Grooves Edges

The matter of chamfering oil-groove edges deserves special attention in that all advance edges of a bearing should be rounded and chamfered off, and the fact that this work should be done last, after all of the other tooling of the bearing has been completed, is important. At *a* in Fig. 1 is shown an ordinary lathe tool at the edge of a groove on a finished surface. It is obvious that there are being exerted two forces upon any surface which is being tooled,

[1] Vice-Pres. Lumen Bearing Company, Buffalo, N. Y. Mem.Am.Soc.M.E.

For presentation at the Annual Meeting, New York, December 1919, of The American Society of Mechanical Engineers. The paper is here printed in abstract form, and advance copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

one horizontal or parallel to the finished surface and the other vertical or in a direction normal to that surface. The resultant of these two forces is a force indicated by the dotted arrow, in a direction tending to deflect the edge of the groove obliquely downward; producing an effect which is shown somewhat exaggerated at *b*, Fig. 1. It can readily be appreciated what an injurious effect is produced in a bearing if any tooling is done after the oil grooves have been cut, especially so if the direction of rotation of the journal is opposite to that of the tooling. In all cases sharp edges of the groove prevent the formation of an adequate oil film and should be carefully avoided.

FIG. 4 PHOTOMICROGRAPH OF FIELD AT *a*, FIG. 3 (60 MAGNIFICATIONS), SHOWING DISTURBANCE OF CRYSTALLINE STRUCTURE DUE TO THE USE OF A DULL HOB IN TOOLING

WHY BEARING SURFACES SHOULD BE MACHINED WITH SHARP TOOLS

For best results it is very necessary and it is also general practice that a cutting tool should have rake. The tools shown in Fig. 2 would be readily condemned even by a person with a very limited shop experience, and no journeyman machinist would think of setting a lathe tool as shown at *a*, a planer tool as at *b*, or a boring tool as at *c*. In the case of the latter, the amount of normal or radial pressure which it exerts upon the finished surfaces is far in excess of what is necessary. Consider now the standard multiple-cutting-edge reamer which is very often used in finishing bearings. A 2½-in. reamer would have, say, 14 edges and the amount of bursting or internal pressure that it would exert within a bushing would be at least 14 times that exerted in case the bushing were reamed with only one improper tool as shown at *c*, Fig. 2. This practice is one that cannot be condemned too severely.

The final finishing in bearings should be done by reamers or cutting heads having only one or a very limited number of cutting edges, and these cuting edges should have the proper amount of rake, such as would be given to any other proper cutting tool. Experiments made in a large manufacturing plant on bushings of the same dimensions, from the same lot of material, finished at the same time (some, however, being reamed with the standard multiple-cutting-edge reamer and others with a single cutting blade) showed that after a storage of six months those bushings which had been reamed with a proper single cutting edge retained their accuracy and shape much better than those finished with the so-called standard reamer. The latter bushings exhibited a decided tendency to decrease in inside diameter and to assume inaccurate elliptical forms. It was also brought out at this time, that not only did a superior product result from the use of a proper tool, but that by its use the production could be increased from 15 to 20 per cent.

DEFECTS IN BEARING SURFACES REVEALED BY THE MICROSCOPE

Another reason why bearing surfaces should be tooled with sharp tools having the proper amount of rake is brought out by a microscopic study of bearing surfaces. In order to obtain the full value of bearing alloys it is necessary that these alloys should be presented as bearing surfaces having their natural crystallization undisturbed. The reason for this is given in the report of the Society's Research Sub-Committee on Bearing Metals.[1] The hard or bearing crystals should be embedded in a softer material, permitting the former to adapt themselves to the journal surface; the softer crystals under proper service conditions will wear slightly below the surface of the harder crystals. In order to retain these conditions it is necessary to preserve the natural crystallization upon the bearing surfaces, but this cannot obtain where they have been mutilated by improper tooling. This mutilation of the bearing surfaces gives rise to the crushing of the harder crystals and embeds these crushed particles into a compressed material which does not function as a normal bearing alloy.

A very forcible illustration of this is furnished by the bronze worm wheel of a certain motor-truck drive in which the teeth had been finished with a dull hob, Fig. 3, showing a cross-section of one of the teeth. After giving unsatisfactory service the worm wheel was examined in the usual way by chemical and physical tests, neither of which showed any defect whatsoever. On the other hand microscopic examination showed that the trouble was due to improper tooling. Fig. 4 shows a photomicrographic section of a field at *a* in Fig. 3. This view clearly shows that the natural crystallization of the greater part of the area has been disturbed, and that the edge of the tooth has had a cold-rolled or wire-drawn effect produced upon it by improper tooling. It is true this effect is not very deep, nevertheless it is the very surface which is brought into play when the worm wheel is put in operation. Fig. 5 shows a part of Fig. 4 more highly magnified, in which the cold-rolled effect upon the surface is seen to be even more complete, a condi-

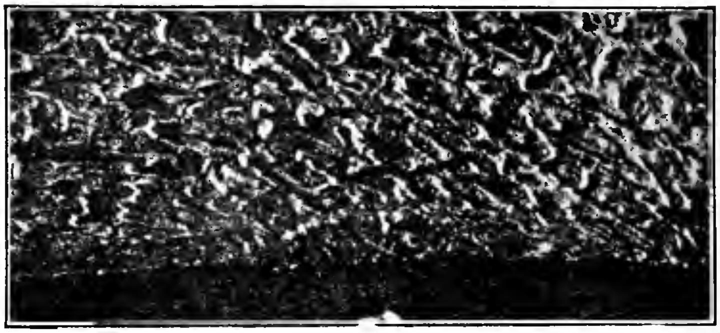


FIG. 5 PORTION OF FIG. 4 MORE HIGHLY MAGNIFIED (120 MAGNIFICATIONS), SHOWING CLEARLY THE COLD-ROLLED EFFECT ON THE BEARING SURFACE OF THE TOOTH

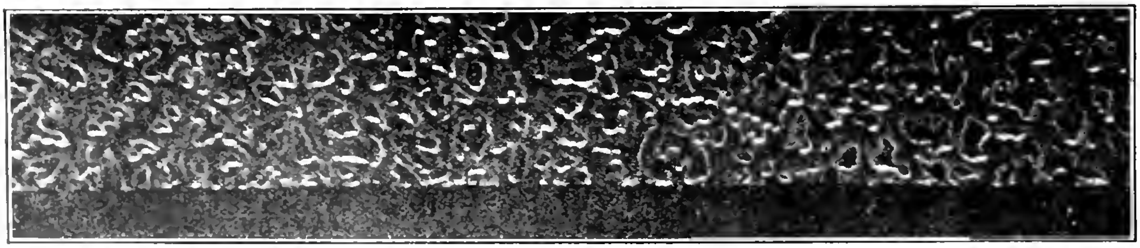


FIG. 6 PHOTOMICROGRAPH OF EDGE *b*, FIG. 3 (90 MAGNIFICATIONS), SHOWING THAT A SHARP TOOL WITH SUFFICIENT RAKE WILL NOT DISTURB THE CRYSTALLINE STRUCTURE

(*Continued on page 907*)

[1] Presented at the Spring Meeting, June 1919.

Kerosene as a Fuel in High-Speed Engines

By LAWRENCE F. SEATON,[1] LINCOLN, NEB.

Although considerable work has been done toward the use of kerosene as a fuel for internal-combustion engines, there still exists a controversy regarding the correct design of a vaporizing system, and very little work has been done toward determining the distribution of the heat evolved by the fuel. To study these problems the author made a series of tests on a high-speed heavy-duty type of engine using kerosene as a fuel. These tests form the basis of the paper, and the apparatus used and the manner of conducting the tests, are discussed in detail.

At the present time there is a great deal of controversy among the designers of high-speed gas engines regarding the correct design of a vaporizing system to successfully handle kerosene. There has also been very little done in regard to determining the distribution of the heat of the fuel, which is used in high-speed engines. Another idea, which is likewise much disputed, is the effect on the crankcase oil, due to particles of unvaporized fuel passing by the pistons and entering the crankcase, and it was therefore decided to fit up a high-speed engine in such a way that the foregoing conditions could be carefully and accurately studied.

Description of Apparatus

The apparatus used, and upon which these tests were conducted, is shown in Fig. 1. The motor which was tested was a $4\frac{1}{2} \times 5\frac{1}{2}$-in. high-speed, heavy-duty type and was equipped with a Kingston carburetor connected to a specially designed vaporizer. The exhaust gases were piped directly from the exhaust manifold to the calorimeter. There was also provided a bypass pipe from the top of the exhaust manifold through the vaporizer and back to the calorimeter, and by means of dampers any amount of the exhaust gas could be sent through the bypass making it thus possible to maintain any desired temperature in the vaporizer. Pyrometers were placed both in the bypass and in the main-line exhaust pipes. A thermometer was placed in the intake manifold leading to the motor block. The air leading to the carburetor was maintained at a constant temperature, by means of an electric heater. A manometer was connected to the intake opening into the carburetor, and in this way the suction pressure was measured.

Two Tabor engine indicators were used, one fitted with a 240-lb. spring for measuring the average combustion pressure, and the other with an 80-lb. spring for determining the compression pressure. A Dixie high-tension magneto provided with a starting coupling was used throughout the tests for ignition. A valve was placed in the bottom of the crankcase through which the oil could easily be drained in order that its temperature, gravity and weight might be accurately determined. A water-spray nozzle was located in the intake manifold in order that water might be introduced at high loads to prevent preignition.

The weighing system for the cooling water consisted of two large tanks and a scale, and the water was weighed every fifteen minutes. The fuel was weighed on a specially designed scale connected with a beam-bell contact, which thus made accurate readings possible. Fuel was piped from the fuel drum up to the kerosene tank, the drum being so arranged that air pressure could be used to force the fuel through the pipe into the tank on the scale. At high loads it was necessary to fill the tank between readings, and it was therefore necessary to correct only for the time which it took to fill the tank.

The calorimeter used consisted of a Wheeler surface condenser, the water passing through the tubes and the exhaust gas entering the shell. The exhaust gas thus coming in contact with the cold tubes was brought down to room temperature. Since the products of combustion were condensed in this apparatus, it was necessary to have a valve placed at the point where the gases entered the calorimeter and also one in the large handhole plate. By means of these it was possible to determine the amount of liquid condensed during each run. A gasoline tank, mounted on the side of the dynamometer, was used for starting purposes. A thermometer well was placed in the bypass line near the vaporizer so that the temperatures might be compared with those shown by the pyrometer, also placed in the bypass line.

The load carried by the engine was maintained by means of a Sprague electric dynamometer, and the load was so constant from this source that no governor was used on the engine. It was possible, therefore, to study the force of explosions under constant throttle opening. A water manometer was placed on the exhaust line to determine the back pressure at a point just before entering the calorimeter.

Manner of Conducting Test

The engine was started and brought up to a speed of 1100 r.p.m., the speed recommended by the makers, by means of a load connected to a throttle butterfly valve. The load was then put on the

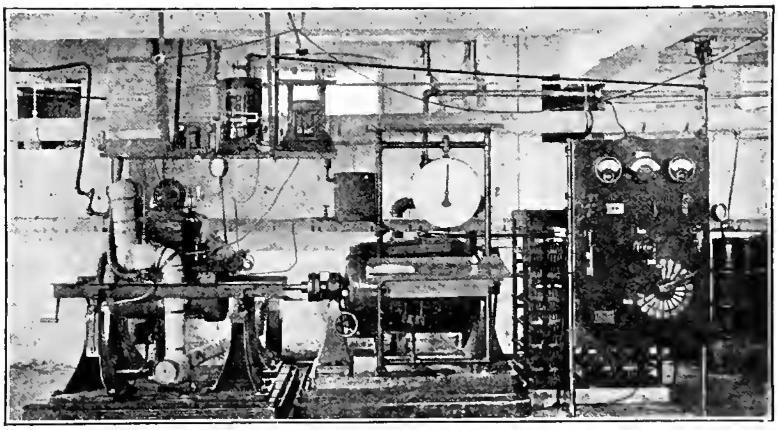


Fig. 1 Apparatus Used in Conducting the Tests

engine by means of the dynamometer. A series of tests was first run with various temperatures in the vaporizer, air entering the carburetor at a constant temperature. The temperature of the intake air was maintained at 115 deg. fahr. and the temperature around the vaporizer was increased from an initial 150-deg. by 100-deg. increments until a temperature of 650 deg. was maintained on the bypass pyrometer. This corresponds to a temperature of 785 deg. in the vaporizer, and in order to obtain this condition it was necessary to shunt all the gases through the bypass at low loads. The loads carried under this condition were approximately 5, 10, 15 and 20 hp. The length of test run on each load was two hours. These series of tests are known as tests 1, 2, 3, 4, 5 and 6, and the average results of tests 1, 3 and 5 for loads of 0, 5, 10 and 20 hp. are given in Table 1, which will be found in the complete paper.

Tests were also made increasing the temperature of the intake air by increments of 10 deg.; that is, the first test was run maintaining a temperature of 650 deg. on the bypass pyrometer and 125 deg. on the intake air. This test is known as E-1. The next test, with a constant temperature in the vaporizer, and another

[1] Prod. Mgr. Hibb Motor Company, Lincoln, Neb. Mem.Am.Soc.M.E.

For presentation at the Annual Meeting, New York, December 1919, of The American Society of Mechanical Engineers. The paper is here printed in abstract form, and advance copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

10-deg. rise in the intake air, is known as test E-2. This process was continued until a maximum was obtained at which it was thought practicable to run the engine, according to both the amount of power obtained from the engine and to the fuel consumption per hp. The average result of these tests will also be found in Table 1 of the complete paper.

At the end of the series of E tests, which was thought to cover all conditions commonly met in practice, it was decided to run a test in which the limit of the apparatus was reached as far as furnishing heat to the mixture was concerned. This test is known as Test F. All heat from the exhaust gases was thrown through the vaporizer and all possible current was passed through the heating coils in the air-heater. Indicator cards were taken at 15-min. intervals in order that the combustion pressure might be ascertained and also to determine the evenness with which the fuel was burning in the cylinder. The indicator drum was not connected to the engine but simply turned by hand, leaving the indicator cock open. The pressure of successive explosions was clearly shown at the end of each test,

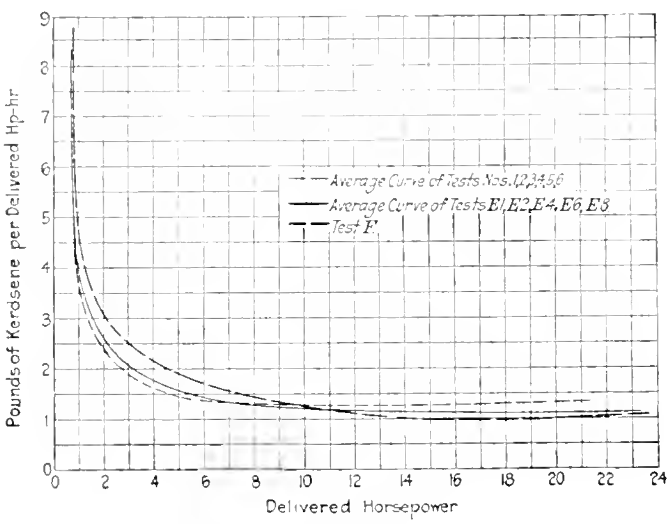


FIG. 2 CURVES OF DELIVERED HORSEPOWER VS. POUNDS OF FUEL

when the spark plug was short-circuited and a light spring used to determine the compression pressure. The oil was cleaned out of the crankcase at the end of each run, when the temperature, gravity and weight were determined. This was done in order that some definite information might be obtained as to the effect of kerosene on the lubricating oil, especially when run without sufficient heat to more or less perfectly vaporize the fuel.

RESULTS OF TESTS

From the summary of results and from the curves plotted between delivered hp. and lb. of kerosene per hp-hr., as shown in Fig. 2, it will be seen that the thermal efficiency of the engine was practically constant throughout all heat changes made as previously described. It will be observed, however, that the motor became much more flexible, especially when the temperature of the ingoing air was raised, as this in turn raised the temperature of the ingoing gas materially, much more, in fact, than was possible by increasing the temperature in the vaporizer, for the reason that a small area was exposed to the hot gases in the vaporizer. It was found that at low heats the motor would not idle down below 800 or 900 r.p.m. At the exceptionally high temperatures of the ingoing gases—about 375 deg.—it was found that the engine could be idled down to 150 r.p.m., and would pick up almost as well as when burning gasoline, and that the engine could be started on kerosene.

Since the fuel-consumption curves shown in Fig. 2 are practically identical throughout the conditions covered in these tests, it seems probable that about the same percentage of the fuel was burned in the cylinders under all the conditions covered in the test. This is also substantiated by the fact that the amount of kerosene deposited in the crankcase was practically constant for all conditions. The only advantage in heating the ingoing air and gas was that it made the motor more flexible. In fact, when the engine was kept up to speed it was found that a greater horsepower could be developed when a low temperature of gas was taken into the cylinders. It seemed quite evident that during all these tests a wet mixture was taken into the cylinders, and that in no case was the kerosene thoroughly vaporized before entering.

It was also observed that at any time during the test of higher heat conditions the engine could be made to preignite by lowering the temperature of the air entering the carburetor. A reasonable explanation of this seems to be that in the cracking process of the fuel a gas is formed which is quite explosive, and that when the conditions are slightly changed this explosive gas is not formed, which does away with preignition: it being fair to assume that this explosive gas, which probably is acetylene, is ignited instantly by the spark which in ordinary practice occurs several degrees before dead center.

The curves of Fig. 3 represent a typical heat distribution throughout the motor, and it will be observed that the maximum thermal efficiency is about thirteen per cent. The percentage of heat going to the cooling water slightly decreases after the load increases; while the percentage of heat to the exhaust gases increases after the load increases. It will also be observed that the

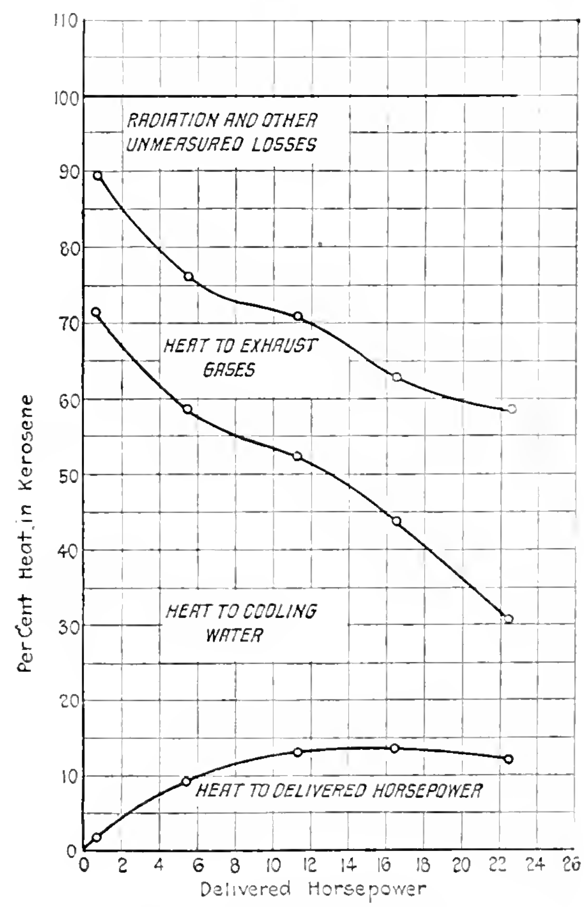


FIG. 3 A TYPICAL HEAT BALANCE

percentage of heat dissipated through radiation and other unmeasured losses, which includes the amount of fuel deposited in the crankcase, increases as the load increases. This, no doubt, accounts for the increase of unmeasured losses as the load increases.

It is the belief of the writer that a motor designed as follows would handle kerosene at all loads successfully: The piston displacement should be greater per horsepower than that commonly used, a higher compression pressure should be obtained, the intake passages should be large and short, and the intake gas should be heated to a temperature considerably above the boiling point of kerosene. This probably would be done with the exhaust gases, necessitating an automatic temperature control at all loads.

Oil Pipe Lines

By S. A. Sulentic,[1] Eldorado, Kan.

In this paper the author compares the cost of pipe-line transportation with that of rail and canal and shows the advantages of the oil engine as a means of economically transporting oil for long distances through pipes. He also derives simple formulae for calculating the pressure, net horsepower and brake horsepower necessary for the transmission of any quantity of oil per day through a pipe of known diameter.

The cheapest method of overland transportation of oil is by pipe line. The cost in comparison to rail transportation is low, and yet when the rail cost is based on every-day practices, the amount seems very small. For instance, the management of an eastern railway, wishing to impress upon its clerical employees the importance of economy, posted the following notice: "For every lead pencil you waste we have to haul one ton of freight one mile." The cost of a pencil has always been regarded as being insignificant, but when it is considered that it is equivalent to the cost of the above-mentioned haul, a similar comparison with pipe-line transportation should be interesting. The carrying of one ton of freight for one mile at the cost of a lead pencil is very cheap transportation, one or two cents per ton-mile being a low rate. Canal transportation, after allowing for the proper fixed and maintenance charges, may be lower than the rail charges by 60 per cent or more. Five or six cents per mile is not an uncommon charge.

In order to make a very crude estimate of the cost of transporting oil by pipe line when using equipment of the highest economy, assume a single line operating under the following conditions at a load factor of 80 per cent for 300 days per year:

Size of line	8 in.
Length of line	33 miles
Pressure in line	700 lb. per sq. in.
Rate of discharge	900 bbl. per hr.

At this rate the discharge would be 21,600 bbl. per day or 6,480,000 bbl. per year of 300 days. Assuming 6.5 bbl. per ton, the yearly discharge would approximate 1,000,000 tons. The work equivalent of this discharge would be 33,000,000 ton-miles, calling for the continuous expenditure of 257 hp. Assuming the mechanical efficiency of the engine to be 75 per cent, the actual horsepower necessary to install would be 342.

The assumed costs would be as follows:

Line: 33 miles at \$1.65 per ft.	\$287,500
Right of way at \$0.25 per rod	2,640
Freight: 79 cars at \$250	19,750
Haulage: 900 tons at \$14.50	13,050
Laying pipe at \$0.075 per ft.	13,060
Burying pipe at \$0.20 per ft.	34,850
Engines, pumps, installed accessories	68,500
Pump stations, buildings and foundations	30,000
Tanks { 2 — 55,000-bbl. at \$18,500 each	37,000
Tanks { 2 — 500-bbl. at \$500 each	1,000
Telegraph line: 33 miles at \$550	18,150
Superintendence	2,500
Incidentals	6,000
Total	\$534,000

The operating expense, including fixed charges based on the total assumed costs, would be as follows:

Interest at 6 per cent	\$32,040
Depreciation at 5 per cent	26,700
Administration	10,000
Attendance at pump stations and lines	11,500
Repairs to equipment, lines, etc.	4,000
Fuel for pumping — 3000 bbl. at \$2.65	7,950
Total	\$92,190

[1] Supv. Eng. Empire Gas and Fuel Company. Mem. Am. Soc. M. E.

For presentation at the Annual Meeting, New York, December 1919, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and advance copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

The cost of operation per ton-mile under the assumed conditions would therefore be: 92,190 ÷ 33,000,000 = \$0.0028. And as the relation between the cost of pipe-line transportation and rail transportation is in the ratio of 1 to 10, it is easily seen that the waste of a lead pencil in a pipe-line enterprise would be the equivalent of the cost of transporting 10 tons of oil one mile.

It should be noted, however, that almost all of the pipe-line costs are fixed and are mainly independent of the amount of oil pumped. As a result, the transportation cost per ton-mile will vary almost inversely with the load factor of the line. If this hypothetical pipe line should be operated only one-tenth of the time assumed, the unit transportation cost would equal the rail cost. Furthermore, these figures are based on a life of 20 years (5 per cent amortization). A railroad would probably be used for various classes of freight as long as it existed, but a pipe line is of service only as long as oil is presented for transportation. If the pipe line in question were to become obsolete in ten years through the exhaustion of the oil fields or other causes, the ton-mile cost would be greatly increased.

In this connection it may be of interest to give a few figures and examples showing the relations existing between pressure, capacity, diameter, length of line and power required.

Disregarding viscosity, the general hydraulic formula for friction head in a pipe discharging an uniform volume is

$$F = k\frac{v^2L}{2gD} \qquad [1]$$

in which

F = friction head in feet of water, lb. per sq. in. ÷ 0.433
k = friction coefficient for 38 gravity oil = 0.024
v = velocity of flow, ft. per sec.
g = acceleration of gravity = 32.2 ft. per sec.^{2}
L = length of line, ft.
D = diameter of line, ft.

The formula for pressure in the line may be stated as

$$P = 0.433\,k\frac{v^2L}{2gD} \qquad [2]$$

in which P = pressure in line in lb. per sq. in.

The discharge Q of the line, cu. ft, per sec. can be easily derived and stated as

$$Q = \pi\frac{D^2v}{4} \qquad [3]$$

in which Q varies directly as v. Since P varies directly as v^2 in Formula [2] and Q varies directly as v in Formula [3], it follows that P varies directly as Q^2.

The net horsepower required for a pipe line may be most readily calculated if we note that the pressure per square foot is equal to the number of foot-pounds required to displace 1 cu. ft. of oil, or

$$\text{Hp.} = \frac{144\,PQ}{550} \qquad [4]$$

For 1000 bbl. per day against a pressure of 1000 lb. per sq. in., the net hp. necesary by Formula [4] would be

$$\text{Hp.} = \frac{144 \times 1000}{550} \times \frac{1000 \times 5.61}{24 \times 60 \times 60} = 17$$

where 5.61 = cu. ft. per bbl.

Assuming a pump efficiency of 85 per cent, the horsepower of the engine would be 20. Here we have a very simple rule for calculating the horsepower from bbl. per day and pressure in lb. per sq. in.; namely,

(*Continued on page 914*)

Industrial Unrest

Problems Relating to Present Industrial Conditions Discussed by Two Leading Authorities on Economics and Sociology

Industrial Unrest has been the subject of two addresses recently delivered before the New York Section of The American Society of Mechanical Engineers. On the evening of September 17, Dr. William M. Leiserson, formerly Chief, Division of Labor Administration, Working Conditions Service, U. S. Department of Labor, outlined the history of industrial unrest, and in the course of his address described the various classes of strikes. At a meeting on October 9, Dr. Henry R. Seager, professor of political economy at Columbia University, discussed the subject more especially from the viewpoint of the employee. Summaries of the two papers follow.

INDUSTRIAL UNREST

By DR. WILLIAM M. LEISERSON

THE industrial unrest of today may be better understood by a study of the important facts concerning its growth. The labor problem is more than an industrial and economic problem, it is a social and political problem. We should not isolate such questions as strikes, production, closed shop, collective bargaining, unrest and Bolshevism, but should study the background and history of the labor problem, the character of the people that are restless, the different problems of industry from every point of view and obtain, if possible, a bird's-eye view of the whole problem, from the time when industrial unrest first began to appear to the present day.

The labor problem is a problem of controlling our great masses of individuals to a common purpose. It has always been argued that the mass is too ignorant to be capable of rising to a higher level. This principle was followed in the early centuries when society was held together by religious leaders who issued the orders of the priests and popes to the common mass. But however ignorant the majority may have been, there were some who rose out of the mass with a new purpose and led them to religious democracy.

Political democracy was the next big question. Kings and nobles and people with political power issued laws and orders through established forms. The ordinary common man was not expected to know anything about government. But here again, contrary to the expectations of those on the higher level, the mass rose, demanded some share in the government and won the right to vote.

"And now," to quote Dr. Leiserson, "that great mass of rank and file insists, 'We must have a say in the government, in the management of the industries in which we spend our lives.' You can say from now until doomsday that they don't know anything about industry. Well, they didn't know anything about government or religion. Certainly they knew very much less about government and religion than they know about industry, because they, at least, work in industry. And they now insist on a voice in the management of industry."

We can no longer argue that the mass is ignorant. The group of people who have held that the common people will always remain where they are is gradually giving way to two other groups; one of these believes that unless the whole mass rise at once the problem cannot be solved; the other group sees what is really happening, the gradual rise, stratum by stratum, of the working people. Dr. Leiserson illustrated this by referring to the rise and fall of prices.

"In the United States this industrial situation that you have today has repeated itself at least half a dozen times — the same sort of unrest, the same sort of thought that we are having now. We have had periods in the history of the country when proportionately we had more strikes than we have today. At every period of rising prices in the history of this country there have been great numbers of strikes, great numbers of rebellious movements among working people. In the History of Labor in the United States by Professor Tolman you will find a chart which really represents the backbone of the industrial question. It shows our prices rising, falling; rising, falling; rising, falling. And about 1819 there was a period of rising prices, and our first real labor movement began then. From 1827 to 1837 we had a very remarkable rise in prices. You remember that was the time of the wild-cat banks: and during that time we had a national labor organization in this country, back in 1837, and proportionately at that time there were probably as many union men, as many organized labor unions, in 1837, to the number of wage earners, as there are now. And particularly from 1835 to 1837, you had this remarkable number of strikes, and you had a workman's party at that time. And then from 1837 down to almost 1850 we had one of the longest industrial depressions that this country has ever known. The bottom seemed to have fallen out of society. And you had very little in the way of a labor movement at that time. From 1850 to 1855 prices went up again. In came the labor movement again, union. Then the slavery question knocked everything out, and the war came on, and prices went up, and you had labor unions and strikes and wage earners trying to get control of industry just the same as today; and after 1870 there was again a period of depression; and today this enormous rise in prices, in cost of living, is what is causing all your trouble, just the same as it did before."

Dr. Leiserson went on to analyze this situation. A rise in the cost of living affects the standard of living of the workingman. Then comes danger, not from the very poor, those on the starvation line, who have nothing to lose, but from those somewhat higher up, who have gotten used to a higher standard of living and do not want to give up what they have gained. During times of falling prices there is a great deal of talk of socialism or communism, such as the great socialistic movement from 1837 to 1842. But when prices are rising the workmen say, "Our standard of living is threatened and we must have more." This, it would seem, is the opportune time for the wage earner to improve his condition.

The character of these movements of the working people to better their conditions, to get a larger share in the products of industry, depends upon the character of the people who are the wage earners. Pure Americans made one kind of demands, Irish- and German-Americans another, and today Polish and Jewish and Italian and other European elements are making a different kind of a demand, and the problems are different. The first labor unrest in this country, for instance, was a political question. The situation was similar to that of today, except that the chief demand of the workmen in 1837 was the right of unpropertied people to vote. Later, after the Civil War, wage earners fought against the introduction of machinery. Then employers brought rural Americans into the cities rather than grant the demands of the organizing workmen. These, in turn, organized and employers brought in immigrants to take their places. And now it is this foreign element, introduced at the time of the great strike in Homestead, in 1882, and a big steel strike in the 90's, that is organized and striking that it may maintain the standard of living which it has adopted in America.

Keeping this general history of the labor problem in mind, it is possible to analyze the strikes which are a result of the industrial unrest of today. Their character is more important than their number.

The largest number of strikes, numerically, are unorganized

strikes. The strikers are unorganized bands of dissatisfied working people. In a typical strike of this class, the majority of the strikers were foreign born, ignorant and dissatisfied with their wages. The firm had no dealings with unions and professed to be of the open-shop type. But it had kept its employees in ignorance as to how to express their grievances. Without any organization or financial support, without any definitely formed demands, they revolted. They could not obtain the support of a union because they were not organized, and for the same reason their demands, later presented to the firm through a committee led by a young foreigner, were rejected. The strike gradually died out, the employees losing their immediate demands but gaining a knowledge of the value of organization.

The second type of unorganized strike is that of people never organized before, but just coming into an organization, the strike of federal employees, of teachers, of policemen, of firemen, etc. Their demand is the usual one; they want sufficient wages to maintain their standard of living. But have these people, who have obligations to the public, the right to organize and to strike? Should they affiliate with the American Federation of Labor? On this subject Dr. Leiserson said: "Personally I think the public is not ready to let them affiliate with the American Federation of Labor. But I think the public is wrong. It is exactly the same situation as when the people who were serving in the armies of the king said, 'We want the right to vote, to elect members of Parliament,' and so forth, and they said, 'For heaven's sake if you can vote, why, you would control the army, and you are the fellows that serve in the army.' But we fought it out. We vote. People who serve in the army vote and control the army. People who work for the Government vote. Society is not broken up on account of it, is it? Why? Because we are reasonable human beings. A union is not organized to strike. A union is organized to deal collectively with the employer, whether it be public or private, and if the employer will deal with it, why, there needn't be any strike. It is just a question of talking with the men, and conferring, and when they cannot agree, to put it up to an arbitration of some kind. We do it on the railroads. We do it in other industries. We do it in an industry with which I happen to be connected now, the clothing industry, where the employees agreed not to strike provided the employer will hear their case, and provided, further, that if they cannot agree, there will be a judge to decide who is right."

There is a third kind of unorganized strike which is just appearing, that of the clerical employees. The rising cost of living is also threatening their standard of living, and the time is not far distant when their growing dissatisfaction will result in organization and strikes.

On the other hand we have the organized strikes, guided by trade unions. The members of these unions are skilled workmen, men who have been organized for some time, and have very definite ideas of what they want. The American Federation of Labor has not organized the immigrant class which is found in many industries, but in the packing and steel industries it has been steadily working toward organization. In the packing industries a mediator was appointed by the War Department during the war, and difficulties are adjusted through him. In the steel industry, however, the corporations would have no dealings with unions. During the war they handled the situation by paying such high wages for overtime that there were no strikes. Now the American Federation of Labor has organized the employees of the steel industry, both foreigners and American, and because the corporation still holds to its position, a strike is imminent.

The main point of difference is this: The employees, through the union, want collective bargaining. The corporations avoid the issue by professing to want the open shop, which is not, as they conduct it, a fair partnership. Their statement is this: "If any man who has a grievance will come to us and tell us about it, we will fix it up; and if we don't, he is perfectly free to go somewhere else." They give the employee the choice of the little piece or none. When the corporation finds that the open-shop method is dangerous to its interests it declares the closed shop. It will not deal with unions, but when its own methods fails it is quick to adopt the tactics of the union. It also attempts to avoid collective bargaining by maintaining that the members of the unions and the employees who strike are not Americans, but are ignorant foreigners. In the organized strike Americans as well as foreigners take part.

"Do something to keep these side issues out of the industrial question," urged Dr. Leiserson. "The big thing that is up today in this country is the demand for collective bargaining. It comes in asking more wages, or firing a foreman, or a closed shop, or shorter hours, or something of that kind. Those are the immediate demands. But the important thing is collective bargaining, the right to sit down with the employer, to send a business agent, a lawyer, or whatever you want to call him, a man who knows how to bargain, if it is an ignorant foreigner, and to say to the employer, 'Here is our labor. You want to buy it. We want to talk business with you. You can't have it all your own way, and we will tell you how many hours we are going to work and what we are willing to take for it and so forth.' That is democracy. That is Americanism. That is the issue that has to be fought out now."

The revolutionary strikes are not the dangerous kind. The radical element draws a crowd but seldom gains its demands. "The real danger is when an organization that is strong makes conservative demands and is able to back them up, conservative demands such as the railroad brotherhoods have made; perfectly legitimate and legal." In the case of the railroad brotherhoods and also in the case of miners and others, they have gradually improved their condition to the point that they endanger industry. The railroads, for instance, cannot afford to pay the wages that the railroad brotherhoods are able to get. The only thing left for them to do is to improve their own condition by cutting out the capitalist and turning the railroads over to the Government.

This improvement in the condition of employee to the point where he proposes government ownership of industries is the real revolutionary thing in the industrial situation today. The railroads are in the hands of the Government. The mine workers have already passed a resolution for the government ownership of mines. The working people keep raising their standard of living, and if industry cannot support them on the high plane that they want, it must be revolutionized. This effective, conservative action, looking toward progress, is dangerous to the existing controllers of industry, and its advocates cannot be treated as Bolshevists or Socialists.

"The American Federation of Labor is growing stronger, because it is based upon the important principle of collective bargaining, which is the way we are going to get democracy in industry. Nobody has yet shown us any other way. Employers have said, 'We will have copartnership, profit sharing; workmen will be put on boards of directors.' That is not democracy. That is taking a fellow out of the working class and putting him into the capitalist class. Democracy means taking working people and letting them from day to day practice democracy, vote in industry, make decisions. You won't have any class spirit when the workman, as a workman, will be able to vote. We do not class people politically any more because the commonest man can vote. We won't have any industrial classes when the commonest man can decide, 'I will work so long; I will get so much!' He won't always get his way, any more than when you vote you get your way; but the majority will rule."

Today the radical opposition to the Federation of Labor has given place to a more conservative opposition. On both the labor side and the employers' side a new kind of unionism is challenging the Federation. The new unions, the labor union and the company union, are similar in their principles to the Federation and, therefore, especially dangerous to it. Each one, to some degree, is working for collective bargaining. If collective bargaining is going to succeed it ought to be centered in one organization. If the American Federation of Labor is to be this central organization it needs to improve its own efficiency, for some labor unions are in many ways superior to it. It must be able to understand this gradual uplift of the working people, satisfy their constantly increasing demands and help them maintain their standard of living without jeopardizing industry.

THE HUMAN FACTOR IN THE OPERATION OF INDUSTRY

By DR. HENRY R. SEAGER

DURING the war every country demonstrated that there was latent in its industrial population productive power of a volume that had not been imagined. Wherever it was possible to substitute for the ordinary productive-wages motive, the motive of desiring to do one's utmost to win the war, the productive result was amazing. The armistice had hardly been signed, however, when labor troubles began to prevent production equal even to that before the war.

The key to the solution of the labor problem, as it appears to Dr. Seager, is found in his statement: "The problem in essence is to try to carry over into the period of peace that lies before us some small part of that eager coöperation that we had between employer and employee in some of our munitions plants and in some of our other big producing plants while the war was going on, when both sides for the time being forgot their differences and threw themselves into the work of production."

Dr. Seager outlined *four* ways of handling the labor problem that are currently being tried. One of them is the method of the just and generous small employer, an illustration being found in the case of Mr. Endicott, a shoe manufacturer. Mr. Endicott states that the secret of his immunity from labor troubles for some 35 years is that he always met any one who wanted to see him, whether a labor organizer, or whoever he might be, and that he always tried, not only to keep in touch with the needs of his employees, but to anticipate their needs before they arose. But this method used by Mr. Endicott and also by Mr. Ford is applicable only to a limited range of industries; and, moreover, every employer in an industry cannot do better by his employees than every other employer, as is the case with Mr. Endicott and Mr. Ford in their particularly well-organized industries.

A second method that is being tried in a great many different ways and detail is the method of the giant corporations like the Steel Trust, which tries by means of welfare workers and by means of profit sharing to content its employees and discourage them from going in labor organizations. From a hardheaded business point of view this method has had much to commend it, but when the problem is studied from the point of view of the employee, we find that the wage earners consider welfare work and profit sharing as the tender of a mess of pottage in exchange for the best life of a free-born citizen in a free country. It does not develop loyalty to the employing corporation, because the employees feel that they are being bought, being deterred from doing something that they think they ought to have a perfect right to do, that is, belong to a labor organization and deal with the employer through representatives.

A third method, a method that is receiving a great deal of discussion at the present time, is the method of the shop committee. One employer told Dr. Seager that he had developed this method in his plant to a point where he believed he could leave even the determination of wages to the shop committee. He explained that he laid before the committee all the facts in reference to his business, and that as they were put in a position of responsibility for deciding all questions in the light of the facts, he could depend on their deciding them fairly. But the experience of this employer was possible only because it was a small-scale and rather simple business, employing rather high-class employees.

A fourth plan that is also beginning to receive a great deal of attention, more in the United Kingdom than in this country, is the plan of joint industrial councils. Up to the present time some 75 of the important industries of the United Kingdom have organized these joint industrial councils. In these industries labor and employers were already well organized, and were in the habit of dealing together. They organized this joint organization or council in which both sides are equally represented, which discusses the important problems of the industry that concerns the wage earner, and discusses it, not merely for a single plant, but for the whole industry. Underlying these joint industrial councils are shop committees or works committees, as they call them in England, and district councils, which bring together the representatives of the employers and the employees in the districts.

Of these four plans the last two have been developed on the basis of an attempt to understand the wage earner's point of view and to take account of his desire to have some share in determining the conditions under which he is to work. They differ from the plan of the Steel Corporation, in recognizing the right of the employees to organize and encouraging them to organize. They differ from the method of dealing with the labor organizations as they have been organized in this country, in that at the basis of them is an organization of the employees of the plant, shop committee or works committee, with negotiations between the shop committee and the representatives of the employer in the plant deciding as many issues as possible. Only issues that cannot be decided within the plant are carried up, as it is worked out in England, to a district council, which represents the industry a little more broadly, and only those which the district council cannot decide are carried up still higher to the joint industrial councils, representing the whole country.

We have passed away from the condition of small-scale production and entered a period in which production through giant corporations is becoming more and more the characteristic method of production. Along with that is lost inevitably the contact between the employer and the employee, as in the case of the Steel Corporation. The capital is provided by stockholders, and the business is controlled through a board of directors, which functions through smaller committees made up of men of large financial and business interests. These men naturally live in the financial centers of the country while the industry, on the other hand, is located in the industrial centers. Personal contact between the employer and the employee is out of the question.

There is no doubt of the economic advantages of an organization like the United States Steel Corporation, but such a corporation cannot follow the methods of Mr. Endicott and Mr. Ford. In considering these different plans, this new situation of the giant corporation dealing necessarily at long range with its employees must be kept in mind.

The qualities that, under these new conditions, an employer should have to deal successfully with the labor problem are, first of all, persistent good-will—an attitude of good-will toward his employees that will inspire them with confidence. If they feel that he is trying to get the better of them, their reaction can be counted upon with certainty. They will try to get the better of him at every point. Second, insistence on square dealing. There is nothing that the wage earner is so responsive to, one way or the other, as fair dealing. Third, a sympathetic understanding of the point of view of the employee. The real employer has good-will toward his men, and square dealing is very, very common. But on the third qualification, a sympathetic understanding of the point of view of the employee, of his legitimate desires and his aspirations, employers very often fall down. They very often fail to see the thing from the employee's point of view.

It is also important to consider what are the reasonable demands and legitimate aspirations of the employees. An advertisement for employees summarizes these as: "First, good pay with opportunity for advancement; second, reasonable hours with frequent resting periods; third, safeguards for health; fourth, ample provision for comfort and convenience; fifth, association with other worth-while people; sixth, protection against financial loss in case of sickness or accident; seventh, work that holds the worker's interest all the time." The last-named demand Dr. Seager believes to be the crux of the difficulty and the underlying motive of the different plans discussed. Holding the interest of the worker was the secret of the success of some of our war industries. The work itself was the same old work, divided more than before in many cases, but a tremendous interest was given it because every worker felt that he was working to do his bit for his country, to help win the war. From this point of view, Dr. Seager elaborates these four methods and speaks of others. He discusses several systems of paying wages, of which a most common one is the day-wage system.

Everybody who has had experience with employment feels that

the day wage ought to be about the last resort from the point of view of giving an employee an interest in his work. By itself it almost completely fails to accomplish the purpose, because, under this system, the employee is only too apt to be watching the clock and eager to get away from the factory as soon as the day's labor is over. To give a little stronger incentive, the piece-wage system is tried in many situations. It cannot be tried very generally, because the number of employments to which it is applicable is limited. Some of the difficulties of the piece-rate system were met in the shipbuilding industry during the war. The output was held down for two reasons, the fear that the piece worker would go beyond the limit of his endurance and the conviction of the employee that with increased production would come a cut in rates.

A more refined method of trying to give the worker a certain interest in his work is the premium or bonus plan, which in practice more often than not antagonizes the wage earner and therefore misses the result that it is intended to accomplish. Another plan that is being urged very strongly is profit sharing, which has very great merit in certain industries under certain conditions; but when applied to a large complex industry it largely fails of its purpose all by itself, because the small dribble of profits that goes to the individual wage earner is not enough to give him any special inducement to work better. His share of the profits is almost negligible. Moreover, the worker is intelligent enough to know that whether he works hard or not, the profits will be about the same. As an individual he is not going to effect the result very much; and so the more intelligent he is the less likely he is to respond. A group response cannot be obtained by promising a number of different people a small return if the whole group works together, for there will always be a number of people who will let some one else take the extra burden, reasoning that it will not make much difference to the result whether he works harder or not. A different system of representation is necessary if the employee is to be stimulated to make the right sort of response, if he is made to feel that he is coöperating with the employer in trying to turn out the largest volume of profits, so that he may have as his proportion a larger share as well as the employer. Recognition of the union and collective bargaining is a plan which Dr. Seager believes must be worked out. Organized labor unions tend to divert attention from the productive problem, which is after all the fundamental problem, to the problem of sharing the return of the industry. A plan of organization is needed that will bring home to every employee the fact that on his efforts depends the share that he is going to receive, and if he does not do what he can toward production, then he is bound to lose when it comes to distribution. Under the forms of labor organizations that are developed in this country the notion that there is only a certain amount of work to be done, is all too prevalent.

Dr. Seager said that from the point of view of the possibility of increasing the interest of the employee in his work, the shop-committee plan and the joint industrial plan contain this possibility as the other plans do on the same scale. The shop-committee plan is a plan that recognizes the desire of the employee to have sub-contracts with the larger aspects of the industry, to get out of his particular monotonous job into an appreciation of the higher aspects of the industry, so that he may feel that he has some part in the larger aspects, not in managing the industry exactly, but in understanding it, and seeing its relations to other industries. The employer who objects to this plan on the ground that the employee should not be given a share in the management of the business, looks at it from the wrong point of view. This shop-committee plan interests the employee in the larger aspects of the business. The thing that comes to the surface in almost every dispute is that the wage earners have little or no appreciation of the limitations that surround the employer. The shop-committee plan gives them a wider view of the problem and some insight into the employer's situation. The more they can be taught about the problem that confronts the employer, the more modest their demands will be and the greater their insight into these broad problems of industry.

A necessary accompaniment of the shop-committee plan is the development on the basis of shop committees of district councils and of joint national councils, because after all one plant cannot decide what wages would be fair, what hours would be reasonable and what conditions would be right. A more general view must be obtained in dealing with industries like the United States Steel Corporation, that is organized nationally with plants in all parts of the country, and the reasonableness of the wage-earner's demand that he organize nationally and deal collectively with a nationally organized trust like the Steel Trust, must be recognized.

Many people look upon the current labor unrest as the inevitable accompaniment of the readjustment that must go on because of the higher cost of living and other after-the-war conditions, and optimistically believe that after this readjustment this unrest will disappear. But before the war we were on the verge of the most serious series of strikes and the most awful period of industrial unrest in this country that we have ever experienced. The war came and temporarily it diverted attention. But no sooner was the armistice signed that the unrest began again on a scale greater than we had experienced before the war, and while much of it is due to necessary readjustments, a large part of it is due to a growing dissatisfaction on the part of the wage earner with our present system of industrial organization.

That new spirit, as it has been called, is brought out very strikingly in the sort of demands that are made prominent by representative groups of wage earners. In the Steel strike, for example, the dissatisfaction is not merely with wages or hours or working conditions, but fundamentally it is a demand for recognition of the union and the right of the men to organize and to deal through their chosen representatives with the Steel Corporation. In connection with the railroad situation, the railroad brotherhoods, who have been among our most conservative labor organizations and among the best led and best behaved, have come out strongly for government ownership of the railroads and management by the employees, the higher officials and the representatives of the lower officials. That represents a revolutionary change in the point of view of the leaders of the brotherhood. Before the war they would very generally have opposed the nationalization of the railways, but there is a new spirit and a new point of view, and their demands and their interests are not centered so much in the wage question or in the hour question.

In the same manner, in the coal-mining industry the United Mine Workers has committed itself to a demand for the nationalization of coal mines, an entirely new development, an entirely new angle. "This reflects," Dr. Seager said, "a state of mind that has come to stay, and not only has come to stay, but is becoming and going to become more influential as time goes on, rather than less influential. It represents a demand on the part of the wage earner for a more important relation to industry."

This change of mind has been brought about in a large degree by war conditions. Labor leaders and wage earners have been appealed to as fellow-citizens doing their part in the war to make the world safe for democracy. They have come in closer contact with the employers and have developed a new ambition and a new confidence in their ability to take a larger share in industry. In the stress of the Civil War Lincoln early sensed the fact that a country could not long exist half slave and half free. This new spirit that is so often referred to is the dawning appreciation of the fact that no more can a country long exist the mass of whose population is industrially subservient and controlled and at the same time be politically free and self-determining, the more one thinks of it the more one realizes that there is an inconsistency. If we can trust these men as fellow-citizens to share, man for man, the responsibilities of maintaining this Government, we have got to recognize the legitimacy of their demand for a larger share in connection with the regulation of industrial affairs.

Dr. Seager concluded with the statement: "For the sake of better relations between employer and employee; for the sake of the larger production that will result from better relations; for the sake of the larger incomes that we all may enjoy as a result of this larger production, and for the sake of preserving our democratic institutions by making our democratic Government not only safe but efficient through the lifting to a higher plane of the intelligence and the ability and the sense of responsibility of the wage earner, I believe we must heed this new spirit and this new attitude."

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A. S. M. E.

Classification of Information

To explain the method of classifying the various notes in the Division of Engineering Research, the classification prepared by the Industrial Research Committee of Engineering Foundation and the National Research Council has been used. Although it has been difficult to bring certain notes under this classification, an endeavor has been made to do so. In looking up a subject the question should be asked: "Under which of the general headings does the subject naturally fall?" It is hoped that this classification will materially aid the readers of Mechanical Engineering in finding references.

No.	Class	Cross-References
1	Abrasives	Carborundum, Emery, Sandpaper
2	Acids, Alkalies, Salts & Sundries	
3	Agricultural Equipment and Engineering	
4	Air	Air-Driven Machines, Air Products, Compressed Air
5	Aircraft	Aeronautics, Airplanes, Balloons, Dirigibles (See Internal-Combustion Motors)
6	Apparatus and Instruments (Chemical, Physical)	Balances, Compasses, Lenses, Telescopes, Transits, Microscopes
7	Astronomy	
8	Automotive Vehicles and Equipment	
9	Beverages, Non-Alcoholic	
10	Calorimetry, Pyrometry, Thermometry	
11	Cellulose and Paper	Pulp
12	Cement and Other Building Materials	Concrete, Marble, Slate
13	Chemistry, Analytical	
14	Chemistry, Biological	
15	Chemistry, General & Physical	
16	Chemistry, Inorganic	
17	Chemistry, Mineralogical and Geological	
18	Chemistry, Organic	
19	Chemistry, Pharmaceutical	
20	Computing, Recording & Talking Devices	Adding Machines, Phonographs
21	Concentration of Ores	Flotation
22	Dyes and Textile Chemistry	Inks, Pigments
23	Electrical Communication	Cable, Telegraph, Telephone, Wireless
24	Electricity, General	Economics, Insulation, Utilization
25	Electrical Instruments	
26	Electroplating	
27	Electric Power	Conversion, Distribution, Generation, Motors, Transmission
28	Electrochemistry	Electrochemical Processes, Storage Batteries
29	Explosives and Explosions	Dynamite, Power, TNT
30	Fats, Fatty Oils and Soaps	
31	Fire Prevention	Extinguishers, Sprinklers
32	Foods	Bakery, Biscuit, Cold Storage, Preservatives
33	Foundry Equipment, Materials and Methods	Casting, Molding
34	Fuels, Gas, Tar and Coke	Coal, Oil, Peat, Petroleum
35	Fuel Utilization	Boilers, Furnaces, Gas-Producers, Stokers
36	Gases, General	Pneumatics
37	Glass and Ceramics	Bricks, China, Porcelain
38	Heat	Thermal Physics
39	Hydraulics	
40	Illumination (Electric, Gas and Other)	
41	Internal-Combustion Motors	Diesel Engine, Gasoline Engine
42	Iron and Steel	Ferrous Alloys
43	Leather and Glue	
44	Light	Optics
45	Liquors, Fermented and Distilled	Beer and Wine
46	Lubricants	Graphite, Oil, Petroleum
46a	Machine Tools	
47	Magnetism	
48	Marine Engineering	
48a	Mathematics	
49	Mechanics, General	
50	Metal Manufactures, Miscellaneous	
51	Metallurgy and Metallography	
52	Meteorology	
53	Metrology	
54	Military & Naval Equipment	Ammunition, Armor, Ordnance, Torpedoes, Small Arms
55	Mining, General (Testing Drills, Ropes, Tools, Ore Dressing)	
56	Molecular Physics	
57	Non-Ferrous Metals	Aluminum, Brass, Bronze, Copper, Gold, Platinum, Silver, Tin
57a	Oils	
58	Paints, Varnishes and Resins	Dryers, Oil, Pigments, Putty
59	Petroleum, Asphalt and Wood Products	
60	Photography	Cameras, Developers, Films, Moving-Picture Equipment
61	Properties of Engineering Materials	
61a	Protective Devices	
61b	Pumps	
62	Railroad Rolling Stock and Accessories	Cars, Locomotives
63	Railroad Track and Signals	
64	Refrigeration	
65	Road Materials & Equipment	Highways
66	Rubber & Allied Substances	Guttapercha and Substitutes, Rubber Manufactures
67	Safety Devices (Transportation, Manufactures, Mines)	
68	Soils and Fertilizers	Nitrates, Phosphates
69	Sound	Acoustics
70	Steam Power	Economizers, Engines, Turbines
71	Subatomic Phenomena and Radioactivity	
72	Sugar	Sorghums, Syrups
73	Surgical, Dental and Hospital Equipment	
74	Textile Manufacture and Clothing	Cotton, Linen, Wool
74a	Transmission	
75	Water, Sewage and Sanitation	
75a	Wastes	
76	Welding	
77	Wood Products (other than Cellulose and Paper)	
78	Ventilation	

Coöperation in Research by the United States Government

In Mechanical Engineering for August (p. 691) there appeared a letter outlining the action of the British Government in aiding research. Our own country has taken a similar stand in regard to industrial research and the following letter from the Department of the Interior, Bureau of Mines, briefly outlines the manner in which this coöperative work is at present being carried out.

Department of the Interior, Bureau of Mines

Washington, D. C., September 6, 1919

Prof. A. M. Greene, Jr.,
Troy, N. Y.

Dear Sir:

Mr. Bancel calls attention, in the August issue of Mechanical Engineering, to the action of the British Government in subsidizing industrial research by the coöperation of Government and private effort. It may be of interest to call attention to a growing practice in coöperation in the Bureau of Mines, Interior Department.

The Bureau is charged with the duty of conducting "inquiries and scientific and technologic investigations concerning mining and the

preparation, treatment and utilization of mineral substances with a view to improving health conditions and increasing safety, efficiency, economic development and conserving resources through the prevention of waste in the mining, quarrying, metallurgical and other mineral industries." There are other organizations having similar aims in part, and it frequently happens that by combining effort there is mutual advantage in increased facilities and output.

During the fiscal year, 1918-1919, the Bureau of Mines had formal coöperative agreements with the following:

University of Arizona, Tucson, Ariz.
University of California, Berkeley, Cal.
Colorado School of Mines, Golden Colo.
University of Idaho, Moscow, Idaho.
State Geological Survey Div. of the State of Illinois, Urbana, Ill.
Engineering Experiment Station of the University of Illinois.
University of Minnesota, Minneapolis, Minn.
Ohio State University, Columbus, Ohio.
Bartlesville, Chamber of Commerce, Bartlesville Okla.
Oregon Bureau of Mines and Geology, Portland, Ore.
University of Washington, Seattle, Wash.
University of Utah, State School of Mines, Salt Lake City, Utah.
Pope-Shenon Mining Company, Salt Lake City, Utah.
Shannon Copper Company, Clifton and Tucson, Ariz.
Ocotillo Products Company, Indianapolis, Ind.
Sinclair Refining Company, Chicago, Ill.
Mid-West Refining Company and Ohio Oil Company, Denver, Colo.
J. B. Jenson, Salt Lake City, Utah.
Iron Mountain Alloy Company, Colo.

The kind of coöperation varied widely. In several cases the Bureau furnished technical direction and no funds, in other cases both parties furnished technical men and funds; altogether, the financial obligations were in excess of $350,000, about $200,000 being furnished by the Government.

Very truly yours,

(Signed) O. P. Hood,
Acting Director.

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulæ or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Apparatus and Instruments A13-19 Continuous Helium Recorder. The Bureau of Standards has installed an apparatus at Petrolia, Tex., which records continuously the amount of helium present in the natural gas. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Apparatus and Instruments A14-19 Tests on the Constancy of Precision Gages and End Standards. In examining several thousand gages remarkable constancy was found. Gages of 2, 3 and 4 in. changed from two to six-thousandths of an inch in a few months. To find the immediate effect of large temperature changes several gages were cooled in liquid air and then brought back to 20 deg. cent. Some returned to their original length within a few millionths of an inch, but one 3-in. gage was found to be 0.0022 in longer and a 4-in. gage 0.0023 in. longer after the treatment. Several were heated to a higher temperature and allowed to cool to 20 deg. cent. One 2-in. gage which had been heated to 110 deg. cent. was found to be 0.0002 in. longer, and a 4-in. gage heated to 200 deg. cent. was 0.0017 in. shorter after being carried through the temperature cycle. It seems probable that strains must have existed in the material which were relieved by the large changes in temperature. A permanent material is sought for by the Metallurgical Division of the Bureau of Standards. Various types of heat treatment are being proposed. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Apparatus and Instruments A15-19 Thermal Expansion. The linear thermal expansion coefficients of a large number of gages has been found to vary from 11×10^{-6} to 13×10^{-6} per deg. cent. It is necessary therefore to use gages at the temperature at which they have been calibrated. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Apparatus and Instruments A16-19 Contact Gages. The forces necessary to separate contact gages is 25 to 35 lb. per sq. in. in using ordinary finish. With high optical polish and tested for planeness by the optical method of interference, 100 lb. per sq. in. was required. The separating film between gages brought carefully into contact is less than two-millionths of an inch. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Boilers and Accessories A2-19 Chimneys. Stack Performance. Experiments on Stack at Johns Hopkins University showed that resistance thermometers would change in readings due to exposure to flue gases. Copper and copper-constantin couples were used with success. There were variations of 5 to 10 deg. fahr. in temperature across a given section. The drop in temperature in 130 ft. varied from 71 to 118 deg. fahr., as shown by table. The velocity of hot gas varied from 5 to 40 ft. per sec. and could not be read by pitot tubes using differential gages. Much leakage of air occurred in system. 10 per cent CO_2 in boilers was reduced to 5 per cent in stack. This cuts down efficiency of stack.

TEMPERATURES AND DRAFT PRESSURES

Series	A	B	C	D
Temperatures, deg. fahr.:				
Breeching	464	390	277	249
Bottom Landing	370	324	226	194
Top Landing	346	313	.....	.....
Top	328	270	206	173
Average from Curve	357	310	221	190
Outside Air	40	38	43	24
Pressures, inches:				
Barometer	30.06	30.00	29.63	30.27
Draft, bottom	0.772	0.697	0.518	0.555
Draft, top	0.038	0.032	0.048	0.05
Draft, for 130 ft.	0.734	0.665	0.470	0.500
Calculated draft for 130 ft.	0.752	0.685	0.492	0.504

See *Power*, September 16, 1919, or address Julian C. Smallwood, Johns Hopkins University, Baltimore, Md.

Properties of Engineering Materials A3-19 Zirconium Steel. The Bureau of Standards is preparing a report showing the heat treatment, impact test and tensile strength of a large number of plates submitted to the Navy for ballistic tests. Thirty-six samples of zirconium steel were analyzed at the Bureau. It has been found that steels which contain boron may be successfully rolled if the temperature is kept below 1000 deg. cent. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Properties of Engineering Materials A4-19 Manila Rope. The action of muriatic acid on manila rope as occurs when used to support swinging staging for washing down brick is such that the fumes weaken the rope seriously without any superficial trace of the action being noticeable to the eye. The only practicable remedy is to treat the rope with some acid-resisting compound. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Properties of Engineering Materials A5-19 Concrete Columns and Protective Plasters. The work of the Bureau of Standards previously reported has been carried on in making fire tests of full-size columns with different forms of protection and of different aggregate. It has been found that columns made from Cow Bay gravel which contains a large proportion of granite and gneiss pebbles and columns made from pure quartz gravel give results which are not quite so good as those from columns made from Pittsburgh gravel. The columns of this latter form had protective concrete spalled so badly that the steel and load-bearing concrete were exposed to the fire and failed before the completion of the four fire tests. Columns with coarse aggregate of trap rock showed no tendency to spall. To protect columns gypsum forms have been used in the construction of the columns and these forms are allowed to stay in place as a protective cover. These have given excellent protection. When the protective covering was made of plaster of portland cement and sand, the results were good but not so good as those from trap rock and slag. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

B—Research in Progress

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Air B4-19 Blowers. Performance of blowers operating in parallel. No. 797. U. S. Naval Experiment Station, Annapolis, Md. Address Bureau of Steam Engineering, U. S. Navy, Washington, D. C.

Air B5-19 Orifices. Flow of air through orifices from the atmosphere into a vacuum, No. 704. U. S. Naval Experiment Station, Annapolis, Md. Address Bureau of Steam Engineering, U. S. Navy, Washington, D. C.

Apparatus and Instruments B14-19 Screw Threads. Precision Measurements of Screw Threads. Pratt and Whitney Company, Hartford, Conn.

Electricity B1-19 Electricity in Mines by L. C. Ilsley. This investigation is to cover permissibility, explosion-proof motors, portable electric mine lamps, flame safety lamps, gas detectors, permissible electric headlights, electric lamps for rescue service, electric flash lamps, single-shot blasting units, multiple-shot blasting units, storage-battery locomotives, electric trip lamps, field investigation, laws and rules governing the use of electricity in mines. Bureau of Mines, Washington, D. C. Address Van H. Manning, Director.

Electric Power B4-19 Carbon Electrodes. An investigation on the manufacture of carbon electrodes to devise method for manufacture of large carbon electrodes from western material by L. C. Duschak,

Bureau of Mines, Washington, D. C. Address Van H. Manning, Director.

Gases, General B1-19 Production of hydrogen from crude oil for use in balloons, test 1097. U. S. Naval Experiment Station, Annapolis, Md. Address Bureau of Steam Engineering, U. S. Navy, Washington, D. C.

Gases, General B2-19 Production of hydrogen from steam and coal, and by electrolysis of salt solution, test 1161. U. S. Naval Experiment Station, Annapolis, Md. Address Bureau of Steam Engineering, U. S. Navy, Washington, D. C.

Hydraulics B4-19 Flow of oil through orifices and tubes, No. 665. U. S. Naval Experiment Station, Annapolis, Md. Address Bureau of Steam Engineering, U. S. Navy, Washington, D. C.

Hydraulics B5-19 Condenser Tubes. Investigation to determine the effect of temperature, tube length and water velocity upon friction loss in water flowing through condenser tubes, No. 789. U. S. Naval Experiment Station, Annapolis, Md. Address Bureau of Steam Engineering, U. S. Navy, Washington, D. C.

Internal-Combustion Motors B7-19 High-Altitude Performance. The Bureau of Standards is testing a 300-hp. Hispano-Suiza engine at conditions on the ground and at 25,000 ft. elevation at various speeds and under different openings of throttle. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Internal-Combustion Motors B8-19 Ignition. The Bureau of Standards is endeavoring to detect turbulence within a gas-engine cylinder and to determine its effect upon the velocity of flame propagation. Turbulence seems to be without effect in the vertical plane while with advanced spark the velocity of propagation increases. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Internal-Combustion Motors B9-19 German Truck engines. The Bureau of Standards is examining the engines of several German motor trucks. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Lubricants B4-19 Lubricating Oils. Investigations pertaining to the methods for the examination of lubricating oils in conjunction with Committee D-2, A.S.T.M., U. S. Naval Experiment Station, Annapolis, Md. Address Bureau of Steam Engineering, U. S. Navy, Washington, D. C.

Lubricants B5-19 Frictional qualities of paraffin- and asphaltic-base mineral oils and of animal oils. U. S. Naval Experiment Station, Annapolis, Md. Address Bureau of Steam Engineering, U. S. Navy, Washington, D. C.

Lubricants B6-19 A fractional distillation of lubricating oils before and after use. Continuation of the work reported in the Journal A.S.N.E., for May, 1917. U. S. Naval Experiment Station, Annapolis, Md. Address Bureau of Steam Engineering, U. S. Navy, Washington, D. C.

Lubricants B7-19 The cause of emulsifying properties of oils with water in turbine oils, test 680. U. S. Naval Experiment Station, Annapolis, Md. Address Bureau of Steam Engineering, U. S. Navy, Washington, D. C.

Lubricants B8-19 Methods of analyses of lubricating greases, test 822. U. S. Naval Experiment Station, Annapolis, Md. Address Bureau of Steam Engineering, U. S. Navy, Washington, D. C.

Machine Tools B3-19 Milling Hobs. Side Cutting of Thread-Milling Hobs. Address Pratt & Whitney Company, Hartford, Conn.

Machine Tools B4-19 Machine-Tool Investigations. To determine the power required and the action of various types of cutting tools and the effect of heat treatment of tool steel. A planer at the Bureau of Standards has been equipped with a dynamometer, and various pyrometers and potentiometers have been calibrated. This work is being carried out in connection with machine-tool manufacture. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Metallurgy and Metallography B7-19 Deep Etching of Steel. The Bureau of Standards is carrying on work on deep etching of steel which so far seems to reveal a chemical heterogeneity, mechanical non-uniformity and physical discontinuities. Steels which are highly stressed internally often split open spontaneously under the action of concentrated acids. Magnetic investigation locates defects in materials which had developed transverse fissures in service in the same manner that deep etching reveals this. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Metallurgy and Metallography B8-19 Crucibles. Microscopic investigations of graphite crucibles by A. C. Fieldner and Reinhardt Theissen. The aim of this investigation is to discover the merits of various graphites used in crucible making and whether or not American graphites can be substituted favorably for foreign graphites and to overcome difficulties in crucible making. Bureau of Mines, Washington, D. C. Address Van H. Manning, Director.

Metallurgy and Metallography B9-19 Electric-Furnace Work. Electric brass-furnace practice in the United States, by H. W. Gillett. Bureau of Mines, Washington, D. C. Address Van H. Manning, Director.

Metallurgy and Metallography B10-19 Ferroalloys, by H. W. Gillett. Continuation of War Materials Investigations on ferromanganese and silicomanganese, ferrouranium and ferrozirconium. Bureau of Mines, Washington, D. C. Address Van H. Manning, Director.

Metallurgy and Metallography B11-19 Studies of the effect of heat treatment on microstructure and properties of metals. Test 602, and tests of failed materials. U. S. Naval Experiment Station, Annapolis, Md. Address Bureau of Steam Engineering, U. S. Navy, Washington, D. C.

Metallurgy and Metallography B12-19 Sulphur and Phosphorus Content in Steel. The Bureau of Standards is planning a laboratory investigation and service tests involving the coöperation of steel manufacturers, users and the Bureau of Standards to determine the phosphorus and sulphur limits for specifications of various kinds of steel. Address Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Metallurgy and Metallography B13-19 Ferrous Metallurgy, by Francis B. Foley. An investigation in coöperation with the National Research Council to determine whether or not brittleness is induced in carbon steels by slow cooling from below the critical temperature, also to attempt to determine the cause and effect of certain defects in nickel ordnance steels. Bureau of Mines, Washington, D. C. Address Van H. Manning, Director.

Oils B2-19 Oil-Extraction Equipment. A study of present types of equipment for extracting animal and vegetable fats and oils from oleaginous material by means of volatile solvents, particularly from the standpoint of economy, ease of operation and quality of finished product. Address J. H. Shrader, U. S. Bureau of Agriculture, Washington, D. C.

Properties of Engineering Materials B4-19 Limestone tests are being made on Indiana Limestone to establish data for the grading of this stone. Panels are being erected exposed to the weather so as to find the cause of discoloration. Various mortars and various methods of waterproofing are used. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Properties of Engineering Materials B5-19 Frost-Action Tests. Commercial sandstones are being tested by the Bureau of Standards to determine the disintegration under freezing. High-grade sandstones have stood 300 freezings with but few signs of disintegration, while poorer grades were completely broken down in less than 100 freezings. Granite passed through 300 freezings without showing any signs of freezing, while porous limestone began to disintegrate after 150 freezings. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Textile Manufacture and Clothing B3-19 Determination of the permeability of balloon fabric by hydrogen. U. S. Naval Experiment Station, Annapolis, Md. Address Bureau of Steam Engineering, Washington, D. C.

Wastes B1-19 Wastes, Vegetable, Utilization of. Mechanical and Industrial problems connected with commercializing waste products either discarded or marketed disadvantageously at present. Address Dr. J. H. Shrader, U. S. Bureau of Agriculture, Washington, D. C.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession and especially the members of the A.S.M.E. of bibliographies which have been prepared. These bibliographies have been prepared at the request of members, and where the bibliography is not extensive this is done at the expense of the Society. For bibliographies of a general nature the Society is prepared to make extensive bibliographies at the expense of the Society on the approval of the Research Committee. After these bibliographies are prepared they are loaned to the person requesting them for a period of one month. Additional copies are prepared which are available for periods of two weeks to members of the A.S.M.E. or to others recommended by members of the A.S.M.E. These bibliographies are on file in the offices of the Society and are to be loaned on request. The bibliographies are prepared by the staff of the Library of the United Engineering Society, which is probably the largest Engineering Library in this country.

Air F4-19 Use of Compressed Air in Petroleum Oil Wells. A bibliography of 2½ pages. Search 2682. Address A.S.M.E., 29 West 39th St., New York.

Fuels, Gas, Tar and Coke F4-19 Coals Used in Producers. A bibliography of 1 page. Search 2681. Address A.S.M.E., 29 West 39th St., New York.

Fuels, Gas, Tar and Coke F5-19 Extraction of Gasoline from Natural Gas. A bibliography of 3¼ pages. Search 2717. Address A.S.M.E., 29 West 39th St., New York.

Oils F1-19 Extraction and Refining of Cocoanut or Copra Oil. A bibliography of 12½ pages. Search 2523. Address A.S.M.E., 29 West 39th St., New York.

Railroad Tracks and Signals F1-19 Mechanically Operated Railway Signals. A bibliography of 3 pages. Search 2704. Address A.S.M.E., 29 West 39th St., New York.

WORK OF THE BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York City.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in MECHANICAL ENGINEERING, in order that any one interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee in Cases Nos. 243, 244, 247-256, inclusive, as formulated at the meeting of September 26, 1919, and approved by the Council. In this report, as previously, the names of inquirers have been omitted.

CASE No. 243

Inquiry: Is the design of a vertical single-flue boiler, as shown in Fig. 2, which is formed of a seamless steel tube for the vertical flue, expanded into openings in the crown sheet and top head of the boiler, acceptable under the requirements of the A.S.M.E. Boiler Code?

Reply: A boiler of the vertical single-flue type, constructed with dished heads for crown sheet and top head, in order to come under the requirements of the Boiler Code, must conform to the requirements of Par. 195, dealing with a dished head having a flanged opening supported by an attached flue (see page 50, last sentence of Par. 195, Edition of 1918). To meet this requirement, the flue which connects the top head and crown sheet of the boiler should be attached by a riveted flanged connection at each head.

CASE No. 244

Inquiry: Will it be permissible to use lap-welded steel pipe for the grate headers used on down-draft furnaces of the Hawley type if the material conforms to any one of the specifications in the Boiler Code?

Reply: Under the requirements of Par. 9, pressure parts for grate headers on down-draft furnaces and of other similar parts to be used for boiler construction, may be constructed from material which in its initial form of plate or skelp, conforms to one or the other of the specifications given in the Boiler Code for wrought steel, or they may be constructed of cast steel of Class B grade. If the header referred to in this case is built of lap-welded steel, any steel that will conform with the requirements of the specifications in the Code may be used.

CASE No. 247

Inquiry: In fitting twin safety valves to a boiler, is it permissible to mount valves of different sizes, or shall the requirements of the Boiler Code be construed to require valves of equal sizes?

Reply: There is no requirement in the Boiler Code which covers this case. The Committee, however, recommends that the valves be made of equal sizes, if possible, and that in any event the smaller of the two valves shall have a relieving capacity of at least 50 per cent of that of the larger valve.

CASE No. 248

Inquiry: Is it necessary under the material requirements of the Boiler Code that a connecting pipe external to the boiler setting between the boiler and superheater be made of open-hearth quality lap-welded pipe, or may bessemer steel pipe be used?

Reply: It is the opinion of the Committee that pipe connections external to the boiler setting do not come under the requirements of the Boiler Code, but it is recommended by the Committee that since this is a part of the boiler proper in the sense that it cannot be closed off by intervening valves, pipe connections of open-hearth-steel material should be used.

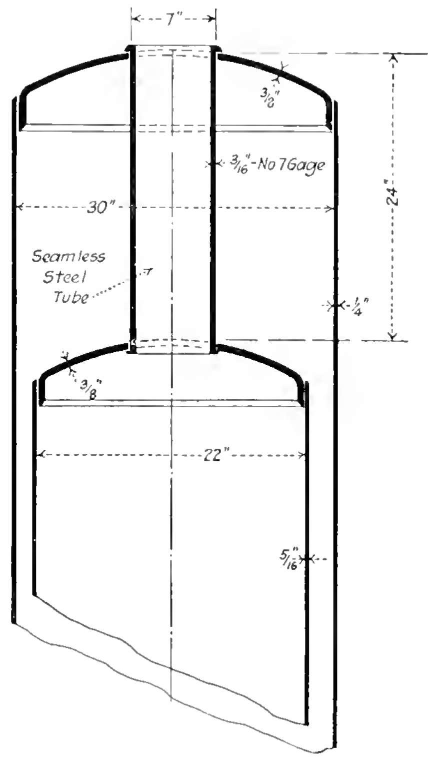


FIG. 2 A DESIGN OF VERTICAL SINGLE-FLUE BOILER

CASE No. 249

Inquiry: Is Par. 427*e* of the Boiler Code applicable to water glasses of the chain-pull, quick-closing type, in which there is a limit of movement of about one-third revolution of the valve stem? This requirement appears to be a practically impossible construction for an automatic gage of the quick-closing type.

Reply: It is the opinion of the Committee that for chain-pull, quick-closing-type water glasses, the requirements in Par. 427*e* can be met by the application of a pulley over which the chain-pull may be operated to turn the valve stem the necessary amount.

CASE No. 250

Inquiry: Is it permissible for qualified boiler inspectors to transfer stampings to the remnants from flange or firebox boiler plate which bear no identifying mark, yet are none the less available for use?

Reply: It is the opinion of the Committee that under the requirements of the material specifications of the Boiler Code, it is not permissible for boiler-plate stampings to be transferred by any one except an authorized mill agent or representative. Attention is called to the fact that under Par. 36 of the Code, markings are required to appear in the completed boiler only on shells, heads and butt straps.

CASE No. 251

Inquiry: Will the requirement in Par. 291 of the Boiler Code, which specifies that a gage glass shall be set not less than 2 in. above the lowest permissible water level, not be inclined to cause lifting of water through the steam outlet or by the operation of

the safety valve, in a small return tubular boiler having only a 12-in. segment above tubes and a fusible plug set 2 in. above tubes which would thus reduce the steam space from 12 to 8 in.?

Reply: It is the opinion of the Committee that a suitable internal collecting pipe or splash plate may be employed to advantage in such a case.

Case No. 252

(In the hands of the Committee)

Case No. 253

(In the hands of the Committee)

Case No. 254

Inquiry: Is it permissible to burn out tube holes with the oxy-acetylene torch, provided the amount of metal removed does not exceed that required by Par. 248 of the Boiler Code, and that they be finished as provided therein? Also is it permissible to burn off surplus metal from the edges of plate by means of the oxy-acetylene torch provided the full amount of metal is removed thereafter as required by Par. 257 of the Boiler Code? In other words, the purport of the above inquiries is in brief — may the burning process be substituted for the punching and shearing processes?

Reply: It is the opinion of the Committee that this method is allowable where punching or shearing is specified, and where the edges are afterward machined by drilling, reaming, chipping or planing to remove a specified amount of material as required by Pars. 248 and 257 of the Boiler Code.

Case No. 255

Inquiry: Does the requirement in the reply for Case No. 218 that headers and manifolds of superheaters must be constructed from material which in its initial form of plate or skelp conforms to one or the other of the specifications in the Boiler Code for wrought steel, or they may be constructed of cast steel of Class B grade, require that if the Specifications for Lap-welded and Seamless Boiler Tubes are to be met, that the flattening test be met and the material as specified for the tubes be also met?

Reply: It was intended in the reply to Case No. 218 to specify the quality of the material in its initial form of plate or skelp and not to require tests of the completed tube, so that the flattening tests referred to in the Specifications need not be considered in this connection.

Case No. 256

(In the hands of the Committee)

ARMY MOTOR-TRANSPORT VEHICLES

(Continued from page 863)

truck carrying 1200 gal. of water was fitted with a heating device taken from a steam car, enabling the water to be brought to a good temperature. A centrifugal pump at the front end of the tank, geared to the engine of the truck, pumped this hot water under pressure through hose pipe to a system of gas piping with spray nozzles allowing twenty-four soldiers to have shower baths simultaneously. Attached to this truck was a trailer or sometimes another truck carrying the cleaned clothing. Its mobility allowed it to be kept in close contact with the front line, where full service could be given. Incidentally, this was similarly used for delousing purposes and ordinary shower baths.

Special Features for Military Work

Military operation demands special equipment. Trucks operated in convoy over long periods of time tend to make the drivers "dopy"; the short space separating the trucks is not always sufficient to prevent one truck running into another either backward or forward, therefore ample rear and fore bumpers or guards must be provided. Proper towing hooks must also be provided front and rear to enable a disabled truck to continue its journey, for supplies must not be left behind. The standard artillery type of pintle hook is now universal at the rear of American military trucks and at the front two hanging towing hooks are provided, one on each side of the frame.

In running in convoy a tremendous amount of dust is raised and often drivers in the middle and rear are almost unable to see through this fog. This dust finds its way through the air intake into the carburetor, into the engine and causes rapid wear of the piston, cylinders and other parts. This is a problem peculiar not only to military operation, but also to agricultural-tractor operations. The remedy is found in the provision of an air-cleaning device to filter out the dust and grit, allowing only clean air to enter the engine.

Extra wide drivers' seats must also be provided. Provision must be made for two soldiers to sit alongside the driver, and soldiers with their heavy overcoats and various accouterment are necessarily bulky. A reserve supply of gasoline must likewise be provided for, and this was done in some of the military trucks by the provision of receptacles like milk cans. It is desirable to have special lamp equipment, on which there should be considerable research done in order to obtain sufficient light to operate, but insufficient for the enemy to notice. At the advanced front even a lit cigarette was not tolerated and driving was done either looking at the stars between the trees or by sound and, in some cases, by instinct. The motor-transport driver's job, contrary to general opinion, was among the most hazardous at the front and certainly was one of the hardest, and honor should be given to these men who kept motor transportation operating faithfully through periods of extreme stress in complete darkness, men who were as equal to their task as the machines beneath them.

Conclusions

At various points throughout this paper the question of the Army designing its own vehicles and the question of standardization have been brought out. In concluding the writer feels that it is insufficient merely to state the classification of vehicles used without drawing attention to the fact that they do not always remain new, but have to be repaired by Army help. In other words, this means using the help at one's disposal without the ability to obtain any other. Furthermore, the vehicles in order to be of economic use must be maintained and the maintenance problem must be simplified down to its very elements, and in this it is obvious that with the fewer the types of trucks the fewer will be the number of parts necessarily carried for replacement and the less the need for skilled mechanics. There should be a standardization of one type of vehicle in each classification. Perhaps the Army will decide to adopt some commercial type of vehicle as its standard; perhaps they may decide to develop their own. They should not be subject, however, to political agitation which would seek to provide them with vehicles unsuited for their direct needs. When this standard has been adopted it should be reasonably adhered to for a period of approximately five years before any serious change is contemplated (unless, of course, there is some tremendously radical alteration in motor-vehicle design).

Standardization of equipment, limitation of sizes of tires, of bodies, of lamps and tools and of all the hundred-and-one things that go to make up the various automotive equipment will be found not only desirable but highly essential. A long paper could be written on this subject alone, but it is felt sufficient to here only mention this part of the Army's problem and also state that by carrying this out the Army may be reasonably sure of having its vehicles give them a useful life of, say, ten years, if not more, without any scrappage or undue delays or economic waste due to failure to function.

A French concern has developed a traveling crane of reinforced concrete. The crane, as described in *Le Génie Civil,* has a capacity of 6600 lb. and a span of 32.8 ft. The rolling gear is removable and so attached that it can be adjusted to take care of any warping of the crane. The concrete used is made of 2.3 bbl. of cement to 1.18 cu. yd. of gravel and 0.52 cu. yd. of sand, a mixture which develops a crushing strength of about 780 lb. per sq. in. and a bond strength with the reinforcing of about 80 lb. per sq. in. To obtain a proper factor of safety, the maximum fiber stress in the concrete of compression members is limited to 498 lb. per sq. in even under the most favorable conditions.

ENGINEERING SURVEY

A Review of Progress and Attainment in Mechanical Engineering and Related Fields, as Gathered from Current Technical Periodicals and Other Sources

SUBJECTS OF THIS MONTH'S ABSTRACTS

BUREAU OF STANDARDS

A Relation Connecting the Derivatives of Physical Quantities, Mayo D. Hersey, Mem.Am.Soc.M.E. In this paper the author shows how the theory of dimensions may be used in a differential form, a procedure which appears particularly fruitful in investigating the effects of given sources of error on the performance of measuring instruments. Several examples showing the necessity for the application of this method are given and illustrated by experimental data. The application of the theory established is discussed in connection with the following cases:

(1) Variation of journal friction with size of bearing. Equations are given which enable one to predict the bearing losses of any slightly larger or smaller machine in the same geometrically similar series.

(2) The effect of gravity on a rolling-ball viscosimeter in terms of the effect produced by changing the size of the instruments.

(3) The effect of high pressure on the accuracy of a rolling-ball viscosimeter. In this case means are derived to predict the change in roll time due to any small change in liquid density such as would occur by using the tube under pressure by reference to an observation on the effect of changing the ball density. (*Scientific Papers of the Bureau of Standards,* No. 331, issued September 25, 1919, pp. 21-29, *t*4. Copies may be had by addressing the Bureau of Standards.)

Equilibrium Conditions in the System Carbon, Iron Oxide, and Hydrogen, in Relation to the Ledebur Method of Determining Oxygen in Steel, J. R. Cain and Leon Adler. It is shown that mixtures of iron oxide and acheson graphite are not, and mixtures of iron oxide with "cemented" iron or white iron (annealed or unannealed) are, reduced at 900 deg. cent. by the carbon in them when hydrogen is passed over them at rates of two liters per hour or faster. Because of these facts, it is probably impossible to determine by the Ledebur method more than 75 per cent of the oxygen present in steels as ferrous oxide. The effect of rate of passage of hydrogen on the Ledebur oxygen content of certain steels is shown. (*Abstract of Scientific Paper* No. 350, *U. S. Bureau of Standards, e*)

An Apparatus for Measuring the Relative Wear of Sole Leathers and the Results Obtained with Leather from Different Parts of a Hide, R. W. Hart and R. C. Bowker. A short paper dealing with the development of a simple machine for testing the wear resistance of sole leathers and giving the results of extensive research work on the relative resistance to wear in different parts of a bend. The machine, which is described at various stages of its development up to the present time, was designed to subject leather to an abrasive action similar to that which it undergoes on a shoe sole, and to accelerate the wear so that a test could be completed in 24 hr.

The results of three extensive tests on the resistance to wear in different parts of a bend are given with detailed description of the manner in which these tests were made,— one test showing the results of comparative wearing tests both on the machine and in actual service included in this paper. The results of all investigations show that the laboratory testing machine gives a proper indication of the wearing resistance of leathers. (*Abstract of Technologic Paper* No. 147, *U. S. Bureau of Standards, e*)

HYDRAULIC ENGINEERING

Water-Turbine Governing by Dispersion

Seewer Governor for High-Head Hydraulic Turbines of the Pelton Type, Dr. A. Strickler. Description of a turbine governor designed by a Swiss engineer, M. Seewer. In his system the primary method of governing, that is, the deviation of the water jet, is replaced by a simple dispersion which he secures by means of mobile guide elements located in the interior of the injection

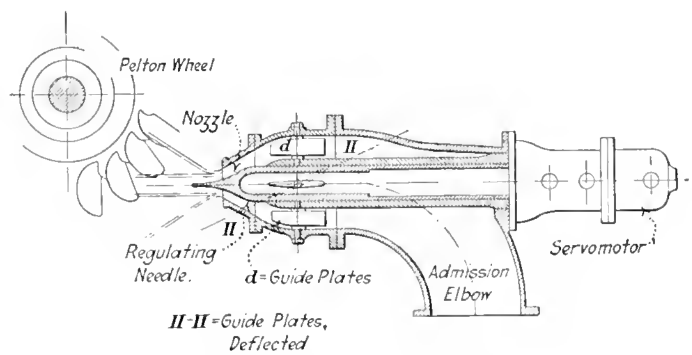


Fig. 1 Seewer Governor for Pelton Water Turbines

nozzle. This mechanism admits of eliminating practically entirely the stresses in the primary system and reduces the path of flow to a very considerable extent, this latter being entirely independent of the diameter of the jet and power output of the turbine. Because of this the system is capable of functioning practically instantaneously and permits the use of the same governor for all sizes of turbines, the only change being in the servomotor operating the needle. It has been extensively tested at the Laboratory of the Federal Polytechnic School at Zurich.

The fundamental principle if the Seewer system of governing is expressed by the author as follows:

"The device is one in which the governing of a high-speed hydraulic turbine is effected by a change in the shape of the jet, this latter being done by guide members located in the interior of the jet nozzle and so arranged that the jet may be either practically perfectly cylindrical or may be totally or partly dispersed in accordance with the position of the guide elements."

Fig. 1 shows diagrammatically the arrangement of the device. The guide elements which are flat plates of proper shape and in proper number are located around the jet needle. They can swing about a radial axis. When these guide plates are parallel to the axis of the jet tube, the jet is perfectly cylindrical as in Fig. 2. It is a well-known fact that when the water jet is even slightly

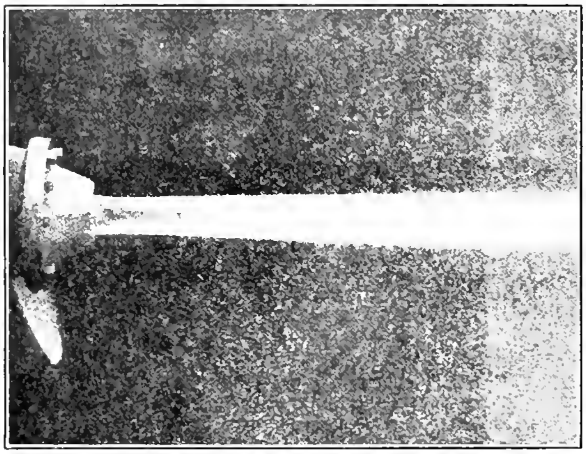


FIG. 2 FULL JET OF A PELTON TURBINE WITH SEEWER GOVERNOR AND GUIDE PLATES PARALLEL TO EACH OTHER

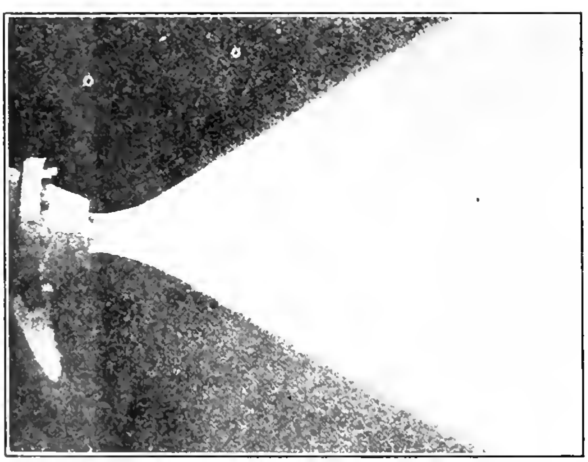


FIG. 3 DISPERSED JET OF PELTON TURBINE WITH SEEWER GOVERNOR AND GUIDE PLATES AT AN ANGLE OF 20 DEG.

dispersed this produces a material reduction in the hydraulic efficiency of the turbine, but a change in the position of the guide plates, such as shown in Fig. 1, by the line II-II, causes a complete dispersion of the jet as it comes out of the nozzle, because of which none of the water goes to the wheel in a manner to produce a useful power output.

It is easy to understand it by studying the relative path of the liquid fibers. Fig. 3 shows the dispersion of the jet caused by a displacement of the guide plates through an angle of about 20 deg.

Since the quantity of water coming out from the nozzle is practically the same with the deflected jet as with the solid jet, there is no material increase in pressure in the feed conduit, and the latter cannot suffer any harm because of a sudden deflection of the jet. *(Bulletin Technique de la Suisse Romande*, vol. 45, no. 17, Aug. 23, 1919, pp. 169-171, 3 figs. *de*)

ENGINEERING MATERIALS

ON THE STRUCTURE OF IRON-CARBON-CHROMIUM ALLOYS, Takejiro Murakami. This investigation forms the subject of the 24th Report of the Alloys Research Institute.

In the present case various iron-carbon-chromium and iron-chromium alloys have been investigated by magnetometric and thermal methods. The following are the conclusions arrived at by the author:

1 By utilizing magnetic analysis and microscopic observation the iron-carbon-chromium alloys containing less than 6 per cent of carbon have been systematically investigated, and a structural and constitutional diagram of their states has been obtained. The change of structure during heating and cooling up to 1200 deg. has also been discussed.

2 By microscopic observation a probable diagram for binary alloys of chromium and carbon containing less than 5 per cent of carbon has been determined, and this has confirmed the existence of a compound Cr_4C having a hexagonal crystal form, as put forward by Moissan, and also the formation of a eutectic consisting of the carbide and chromium dissolving the carbide.

3 Iron and chromium form a continuous series of solid solutions, whose critical point for the A_2 transformation decreases as the chromium content increases.

4 In the iron-carbon-chromium alloys there exist three ternary compounds, α, β and γ double carbides, having the probable formula $(Fe_3C)_{18}.Cr_4C$, $(Fe_3C)_9.Cr_4C$ and $Fe_3C.Cr_4C$, respectively. The former two crystallize in a scaly form, and the latter in a hexagonal prismatic form. The α carbide is a magnetic compound, whose critical point is 150 deg., while the other two are non-magnetic.

5 Under microscopic observation, these carbides can easily be differentiated from each other by means of a new reagent, an alkaline solution of potassium ferricyanide. By this reagent, γ carbide is intensely colored brown to blue in cold and β carbide equally colored by the same reagent at boiling temperature, while these carbides are not acted on by picrate boiling. α carbide is colored brown both by a boiling ferricyanide solution and also by picrate.

6 The lowering of the transformation point is caused by dissolved chromium. Above Ac_1 point the carbide Cr_4C dissolves in austenite and by heating to a suitably high temperature it dissociates according to the following scheme:

$$2\ Cr_4C = Cr_3C_2 + 5\ Cr$$

The higher the temperature, the more the above change proceeds from left to right. During cooling, the recombination of Cr_3C_2 and chromium to the carbide Cr_4C takes place only slowly, and therefore, in alloys containing the carbide Cr_4C, the carbide change is lowered by the normal cooling from a high temperature by the retarding action of the dissolved chromium.

7 The cooling rate has generally a marked effect on the position of the transformation points. If the rate be very large, the transformation is very conspicuously lowered, and in some cases is completely suppressed. On the contrary, if the rate of cooling through a range of 700 deg. be sufficiently slow, the carbide change takes place within the range.

8 The cooling magnetization-temperature curves of a specimen and its microstructure have a close connection with each other. A specimen having the normal transformation point shows the troostitic or pearlitic structure, the one having the lowered transformation the martensitic, and the other having the completely suppressed transformation the austenitic structure.

9 The self-hardening of a chromium steel is related to the lowering or complete suppression of the Ar_1 transformation; the hardness is caused by the solid solution of the carbide Cr_3C_2 in iron dissolving chromium.

10 The Ac_1 and Ar_1 points in chromium steels are raised as the chromium content increases, and the former becomes higher than the Ac_2 point from high-chromium steels. *(Science Reports of the Tohoku Imperial University*, First Series, vol. 7, no. 3, December 1918, pp. 219-276 and 20 plates, *etA*)

INTERNAL-COMBUSTION ENGINEERING

Diesel Engines Used in British Submarines

Vickers Diesel Engine. Some data on the design of the Vickers Diesel engine, which is of particular interest since practically the whole of the British submarine fleet is driven by these engines.

The engines described are mainly those of the Trefoil type, a war-time production built in the greatest hurry to meet a national emergency.

The eight cylinders of each set—17 in. bore by 27 in. stroke—are based upon the submarine design, and are of the simplest possible form, consisting of a plain liner, of which the head is held in a cast-steel entablature which is common to a pair of cylinders, and which forms the upper part of the water jacket (compare Fig. 4). The lower part consists of a light galvanized wrought-iron cylinder held by the entablature and jointed to the lower end of the liner by rubber rings. This design is not suitable, however, to purely commercial work. The cover is a simple steel casting carrying the inlet and exhaust valve and the fuel nozzle and relief valve, the cooling water passing direct from the cylinder jacket to the interior of the cover without the more usual little pipe connection.

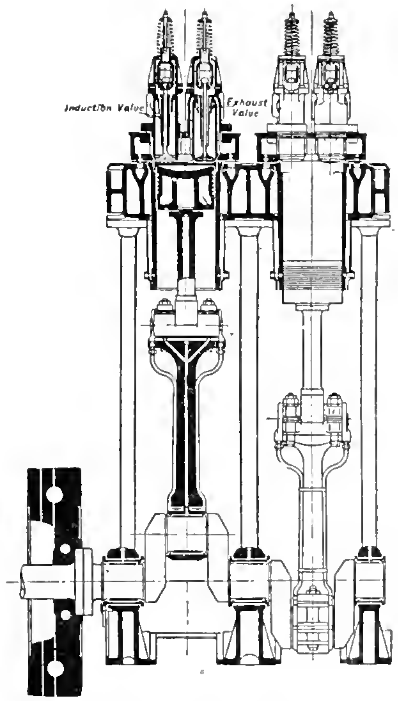


Fig. 4 Cylinder Construction of the Trefoil Type Vickers Diesel Engine

The submarine engine framing is shown in Fig. 5, which consists simply of an A-shaped piece of boiler plate placed athwartships between the cylinders, something less than an inch in thickness, lightened out and with a forged-steel flange top and bottom riveted on to take the cylinder and bedplate bolts, with light iron angles riveted along the sides to act as stiffeners and to take the splash plates. Increased lateral stiffness is obtained by horizontal fore and aft plates between each pair of columns, which improves the bottom of the water jacket. This kind of framing was suitable for the submarine engine with its trunk piece, but the engines of the Trefoil have ordinary crosshead and guide. Because of this, in the Trefoil engine each cylinder has a cast-iron box column at the back carrying the guide, and well splayed fore and aft at the foot, in addition to which there is a turned steel column in front at each main bearing.

The crosshead arrangement allows of a very short piston which is not water-cooled. As a cylinder only gives something less than 100 b.hp., the total power of each set of eight cylinders is 750 b.hp. at 1500 r.p.m.

The top end of the connecting rod is novel, as the whole of what is ordinarily the fork is used as a bearing surface for the gudgeon pin.

Solid injection is used and the four fuel pumps deliver into a common pipe for all the cylinders. From that pipe the spray valves are fed, the regulation of the fuel injected being effected by the adjusting the duration of opening of the spray valves, the

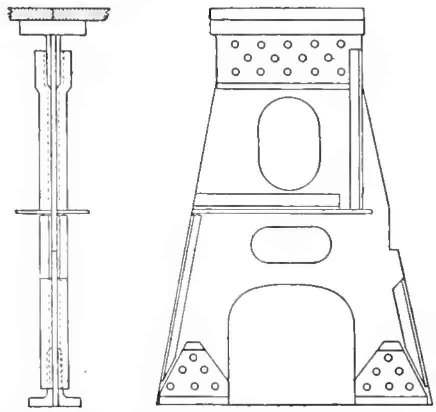


Fig. 5 Submarine Engine Framing Vickers Diesel Engine

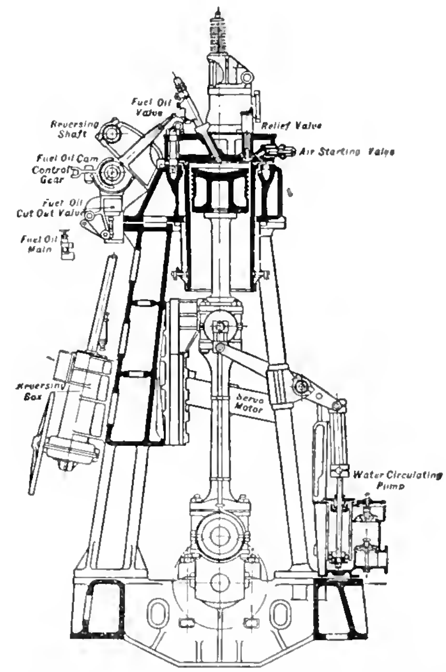


Fig. 6 Cylinder Construction and Reversing Arrangement of Trefoil Type Vickers Diesel Engine

fuel pressure in addition being reduced at low power from the 3750 lb. or so, used at full speed.

For reversing, a special reversing shaft is provided above the camshaft, which latter runs along the top of the cylinders and is driven by a vertical shaft through bevel gears. This reversing shaft carries two rockers for each valve on eccentric fulcra, so disposed (Fig. 6) with regard to each other that when one is engaged with its cam the other is clear, the two corresponding cams on the camshaft being fixed on that shaft for ahead and astern going, respectively. Thus, a half turn of the reversing shaft puts the inlet and exhaust valves right for the intended direction of rotation, but the fuel cam block with its ahead and astern cams has to slide along the shaft by means of a separate maneuvering shaft, and this can be done without the necessity of raising the rockers clear of the cams by reason of a slope on the side of the nose of the cams. Control of the period of fuel injection is ob-

tained in a very simple way by the eccentric mounting of the fulcrum of the fuel valve rocker.

When the cams are set in the proper position the master air valve is opened and air delivered to four little cam-operated valves, which deliver the air through separate pipes to non-return valves in each cylinder head, the valves and cams being on a vertical shaft and situated near the starting handles. (*The Engineer*, vol. 128, no. 3322, August 29, 1919, pp. 198-200, 4 figs., *d*. Compare also the reprint of the article in the *Journal of the American Society of Naval Engineers*, vol. 31, no. 3, August 1919, pp. 661-671, 5 figs.)

Novel Type of Heavy-Oil Engine and Its Governor

The Crossley Cold-Starting Heavy-Oil Engine. Description of an engine of British design in which the use of the lamp for starting has been done away with.

The engine belongs to the type of heavy-oil engines, but cannot be correctly described as being either a Diesel or semi-Diesel. In fact, it would appear as if the engine, in some respects, was in a class by itself. The essential characteristic feature of the engine is the shape of its combustion chamber, which, as shown in Fig. 7, *C*, is spheroidal.

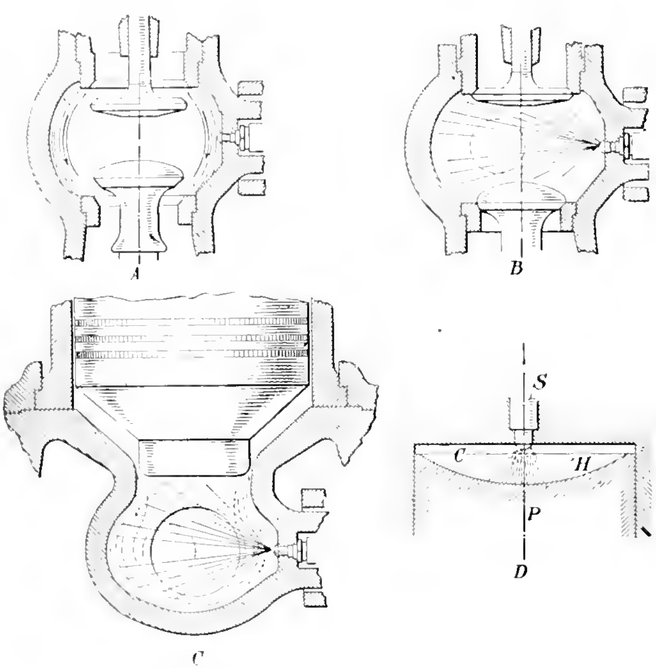


Fig. 7 Combustion Chamber in Crossley Heavy-Oil Engine

The theory underlying this construction is that a spherical chamber will give the least wall surface exposed to the water jacket, and will permit of a central core of air heated by compression and cooled as little as possible by contact with the walls. This core is relied on to fire the charge.

The change from spherical to spheroidal is rendered necessary by the cooling effect of the incoming charge of fuel which tends to transfer the central core towards the left, as indicated by the dotted circle in *C*. If the chamber were spherical this would bring it into contact with the water-cooled walls, but by making the chamber spheroidal a good clearance is provided between the hot core and the jacket. It is contended that this hot core is essential if a low compression pressure and low injection pressure are to be used, as it allows the fuel to be kept in contact with the heat for a longer period than would be the case in a Diesel engine. It is this feature that permits the Crossley engine to use a compression pressure as low as 300 lb. per sq. in. and a fuel injection pressure of only 1000 lb. with solid injection.

In order to further insure the thorough mixture of the air and fuel turbulence is produced by the shape of the top of the piston, which, at the top of the stroke, projects into the combustion chamber and forms a plug past which the air is driven at high speed by the rising piston round the walls of the chamber, but without disturbing the hot core, as shown by the dotted lines along the walls in Fig. 7, C.

Fig. 8 gives some test curves of the Crossley engine on various fuels, such as paraffin (kerosene), residual petroleum and tar oil. These figures were obtained from tests made by Professor Burstall on a single-cylinder engine 18½ in. bore by 28 in. stroke. The figure of 32.2 per cent thermal efficiency is unusual for such a simple single-cylinder engine.

The article also describes the governor gear of the engine. The governing of the engine is effected by the opening of a bypass or control valve *K*, Fig. 9, in the oil fuel pipe between the oil pump *J* and the oil sprayer at variable points in the pump delivery stroke, according to the load at which the engine is working. For instance, at medium load the control valve will be opened at about half-pump stroke, the remainder of the oil in the pump, instead of passing into the combustion chamber, being by-passed through the control valve *K* and pipe *T* to the funnel shown at *U* in Fig. 10, whence it flows back to the oil heater *V*. The means of operation of the control valve are shown in Fig. 9. The floating lever *F*, opposite the end of the control-valve spindle, is pivoted at its bottom end to an arm on the pump-lever spindle. The upper end of the lever *F* rests against a quadrant *H*, the position of which is controlled by the governor *G*. The quadrant has a cam-shaped periphery, and as the governor rises and falls the upper end of the floating lever is pushed to and fro in a direction toward or from the end of the control-valve spindle. When the pump plunger moves forward the upper end of the floating lever becomes the fulcrum of the lever, and the position of this fulcrum being shifted by the governor the control valve is opened at a varying time, according to the load and speed of the engine.

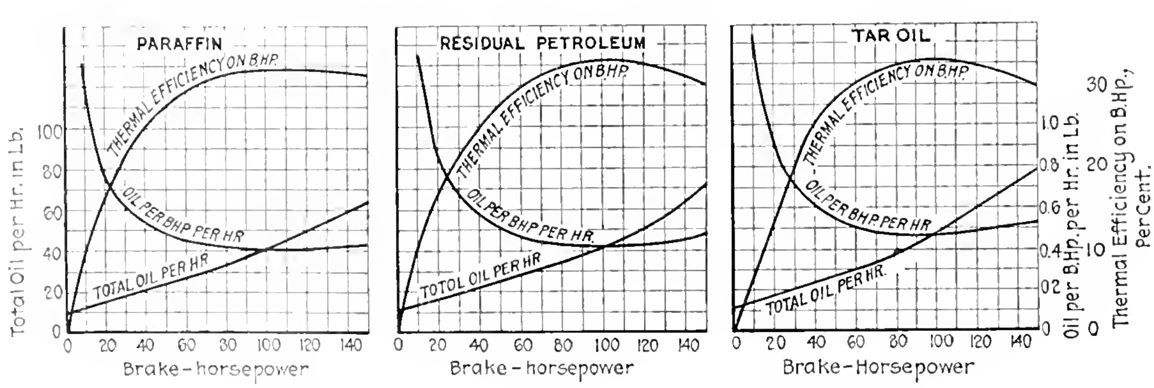


Fig. 8 Test Curves of the Crossley Engine on Various Fuels

When using viscous fuels which do not readily atomize at normal atmospheric temperatures a change-over fuel device is provided

to enable a less viscous fuel to be used for a few seconds or minutes when starting the engine. This change-over gear consists of an eccentric pin in the fuel pump placed between two suction valves and operated by the weighted hand lever shown at Y in Fig. 9. When this lever is in the position shown the lower valve is kept on its seat and a supply of less viscous fuel, such as paraffin, gas oil, or crude oil, poured into the cup X. When the engine is

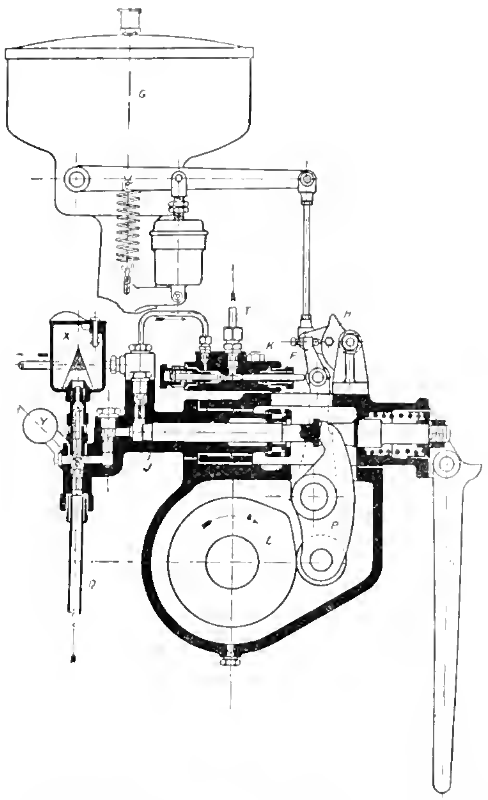


Fig. 9 Governor Gear of the Crossley Oil Engine

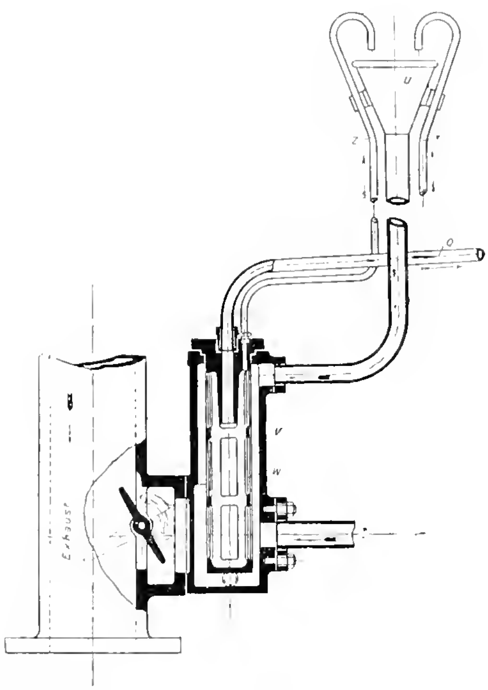


Fig. 10 Oil Heater of the Crossley Heavy-Oil Engine

started the pump will draw its supply from the cup. After a few revolutions the weighted handle Y is moved over, the upper valve being then closed and the lower valve opened, enabling the pump to suck its charges from the pipe Q, which is connected directly to the oil heater V shown in Fig. 10, through which the viscous oil is passed on its way from the oil tank to the pump to reduce its viscosity. The oil heater is attached to the exhaust pipe of the engine and the temperature of the heater can be adjusted by means of the large wing valve shown, which varies the amount of the exhaust gases which are allowed to pass through the connecting passages. A larger strainer W is fitted in the oil heater. In case any vapor is formed or frothing of the oil takes place in the oil heater, a vent pipe Z is fitted at the top of the heater and taken up to the top of the funnel, when any emission can readily be observed. A hand lever S is provided for filling the pump with oil before starting the engine.

To stop the engine a small screw-down valve is opened in the oil delivery pipe between the oil pump and the oil sprayer. The effect is to deliver all the oil to the funnel, and the combustion chamber being no longer supplied with fuel the engine immediately slows down and stops.

An interesting point is worthy of note in connection with the method of governing as described above, and this is that as the fuel, while being delivered, is actually producing power at that instant the cutting off of the supply of fuel at different points of the pump stroke, according to the position of the governor, means that the governing effect takes place at the identical moment that the fuel is being injected and burned, and therefore has an instantaneous effect between the fuel and the power. It is certainly a remarkable engine; it has the economy of many Diesel engines, and yet it has solid injection at low pressure and no air compressor; it has only 300 lb. compression pressure with the accompanying advantages of cheaper and lighter construction, and yet it can use the heavy oils, and it starts from all cold without the need for a lamp, and it should require only comparatively unskilled attention. (*The Engineer,* vol. 128, no. 3324, September 12, 1919, pp. 252-254, 5 figs., *d*)

Tractor Engines and Fuel Limitations, H. L. Horning, Mem. Am.Soc.M.E. Among other things the writer discusses the question of spark plugs, and gives the following specifications as to the location of the spark plugs and their design:

1 The plug should be located as near as possible to the center of gravity of the mixture in the combustion chamber when the mixture is about to fire
2 It should be so located as to be out of the exhaust-gas stream
3 It should be located so as to get the blast of this incoming rich mixture, or in such a place as will insure that the mixing surrounding this electrode will be highly explosive and not deadened by a residual charge
4 The cooling-water stream which has picked up a large volume of heat from the exhaust-valve environment usually insures temperature enough to keep a good clean plug and a cooling effect that will keep preignition out of the probabilities
5 No cylinder head should be designed which will demand a long spark plug to reach the mixture
6 A vertical spark plug is the only type which runs a long time without cleaning. The necessity of putting spark plugs at an angle if not horizontal in the head of a valve-in-head engine is one of the inherent defects of that type of engine. This is due to a cleaner oil drainage from the plug vertically placed
7 The plug should not be placed so as to get the direct sweep of gases passing by the piston and rings on the suction stroke.

The above considerations are particularly for the guidance of the engine designer. Beyond this he should keep in mind that the engine must work irrespective of where the farmer buys his plugs or their design.

Should the user desire advice as to the type of plug, it is only necessary to observe the following points:

1 The insulator should be of the best grade of porcelain or stone now available
2 The center electrode should be at least $\frac{5}{32}$ in. in diameter, well smoothed off, rounded, and the distance of its top

from the outside air a minimum. Cooling ribs are very desirable. No sharp corners or points should be presented to the combustion chamber

3 It is not easy to give general specifications for a good mica plug, although there are many. As a class they are to be avoided.

Aside from temperature problems the greatest difficulties with spark plugs arise out of the limitations of the fuel, resulting in a deposit of carbon. Excessive lubrication in the combustion chamber can result from heavy fuel and further favors the short-circuiting of the plug with oil and carbon. (*Journal of the Society of Automotive Engineers*, vol. 5, no. 3, September, 1919, pp. 265-271, 4 figs., *gp*)

Skew-Gear Type of Pressure Gas Turbine

Sanders Pressure Turbine. Essentially the turbine consists of two elements of a skew gear. At the points of mesh a tooth of one element in passing down the groove between two teeth of the other element is utilized as a constant-velocity piston traveling down the equivalent of a cylinder.

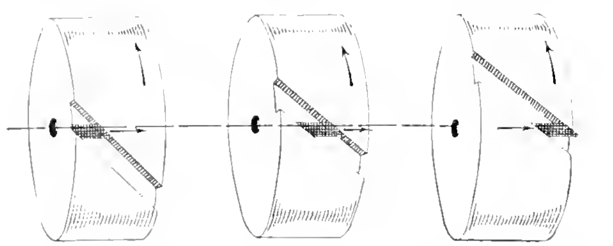


Fig. 11 Diagram Illustrating the Lateral Movement of Piston Tooth in a Diagonal Cylinder Slot of the Sanders Gas Turbine

Shrouding around these two elements allows a series of ports to be placed in positions which insure at various points of revolution, first, the admission of an explosive mixture under pressure; second, the uncovering of a small chamber containing a continuous sparking plug which fires the charge and, lastly, the emission of the exhaust gases (cp. Fig. 13 and discussion in a later part of this abstract).

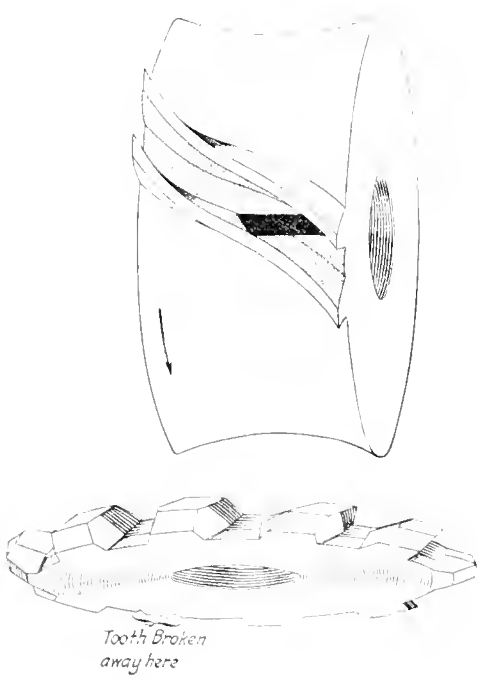


Fig. 12 Diagram Showing Relation between Skew-Gear Cylinder Wheel and Piston Wheel

This takes care only of two phases of the four-cycle system, namely, combustion and exhaust; and the experimental model receives its charge from an extraneous source, but it is intended to introduce a three-skew gear wheel into the train in order to provide for induction and compression within the turbine itself. No reciprocating parts or valves are necessary.

Fig. 11 gives a series of three diagrams, each of which shows a drum having a diagonal groove cut across its periphery. This groove forms three out of four walls of a rectangular-section "cylinder," the fourth wall being provided by a stationary casing or shroud around the drum not shown in the sketch. Within the cylinder groove appears a black diamond representing a piston free to move only in the direction of the dotted center line. The rotation of the drum in the direction of the arrow will cause the piston to travel across the face of the periphery, so that in moving from one side to the other it will travel down the length of the groove. If the drum be regarded as one skew gear wheel and the piston as one tooth on the periphery of a slice of a skew gear wheel, the principle of the turbine becomes clear.

Fig. 12 will help to understand it. It shows in the upper part between two teeth of one skew gear the groove forming a cylinder in which can be seen a piston consisting of a tooth broken off from the periphery of the thin skew gear shown in the lower part of the same figure. As the two gears shown in the figure are approximately correct in shape, it may be noted that the teeth of the "cylinder wheel" are not flat, but are hollowed with radii struck from the center of the "piston wheel" after the fashion of the Lanchester worm gear, which, with the slice form of piston, avoids the usual helical-gear clearance formulæ. This is, of course, essential to the turbine gearing, as the "piston-wheel" teeth must keep a gastight contact with the "cylinder-wheel" gears during the whole time of their meshing.

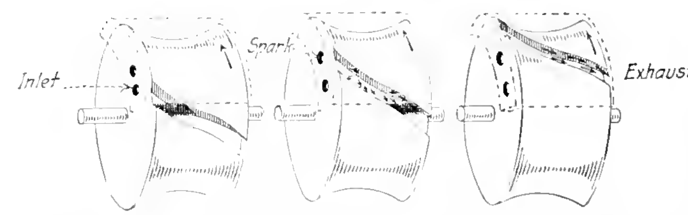


Fig. 13 Three Positions of the Piston Tooth and Cylinder Groove in the Sanders Turbine Relative to Ports in the Shroud at the Moments of Gas Admission, Firing and Exhaust

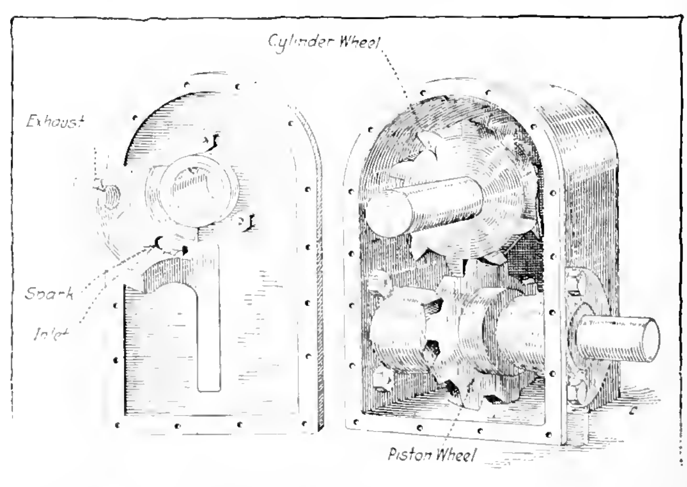


Fig. 14 Interior of Sanders Experimental Turbine (*right*) and Interior of the Cover and Shroud which fits into the Hollowed Periphery of the Top Rotor or Cylinder Wheel (*left*)

It is stated further that the piston wheel is purely an idler, and is not called upon to transmit any torque. Furthermore, when the

device is running, both the cylinder and the piston are in motion.

Fig. 13 shows the sequence of events in the power cycle. In this figure the periphery of the drum is hollowed out to the actual shape and the groove is given a semblance of its correct form.

In the first of these diagrams the left-hand end of a cylinder groove, after its piston has just entered, is opposite the inlet through which gas mixture under pressure is entering. Further rotation of the cylinder groove causes the latter to pass by and cut off the inlet, then to uncover the second port in which a constant spark is taking place. This position is shown in the second diagram. The explosion takes place, and the cylinder groove, after further rotation, is deserted by the piston and the exhaust gases are free to escape as in the third diagram.

The following are given as trial runs of the experimental model. Air pressure at 40 to 50 lb. per sq. in. was obtained from an outside compressor and the air before being drawn into the compressor obtains the necessary amount of gasoline in its passage through the carburetor. When the air compressor was turned on to the turbine the latter maintained a speed of about 1000 r.p.m. The instant, however, that the ignition was switched on the speed jumped to 4000 revolutions, accompanied by a roar of explosions from the exhaust pipe. No brake-horsepower tests were performed in the presence of the author.

For cooling, a small power blower passed a blast of cool air directly on the grooved wheel.

In the article is included a report by W. Morgan, professor of automobile engineering, University of Bristol, in which it is estimated that a unit with the 5.5-in. cylinder wheel and two piston wheels should be capable of developing 36 hp. at a speed of 10,000 r.p.m., and it is believed that far higher speeds are possible.

In view of these statements Fig. 14, showing the interior of the Sanders experimental turbine, may be of interst. (*The Autocar*, vol. 43, no. 1245, August 30, 1919, pp. 317-320, 8 figs., *d*)

Heavy-Fuel Carburetor-Type Engines for Vehicles, J. H. Hunt. The article discusses the combustion of heavy fuels, meaning thereby fuels of higher vaporization point than gasoline in engines of constant-volume type, and calls attention to two important facts:

First, the problems of carburation and distribution can hardly be separated. Further, when the mixture finally reaches the cylinder the heavy fuels do not burn in the same manner as the lighter hydrocarbons, and under certain conditions exceedingly severe knocking takes place. Investigation has shown that this knocking is due to the momentary existence of exceedingly high pressures in the engine.

The writer states experience has shown that it is possible to handle a wet mixture in an air-cooled, single-cylinder engine running under steady load conditions, which indicates that a high temperature in the combustion chamber will take care of the effects of previous lack of vaporization, and will tend to prevent the condensation and deposition of fuel.

On the whole, the author expresses the belief that so far no means have been shown by which the heavy-fuel carburetor engine will improve the fuel situation to any great extent. The equipments which have shown promising results in service have handled nothing heavier than kerosene, and at present only half as much so-called kerosene as gasoline is being produced. (*Journal of the Society of Automotive Engineers*, vol. 5, no. 3, September, 1919, pp. 202-207, *g*)

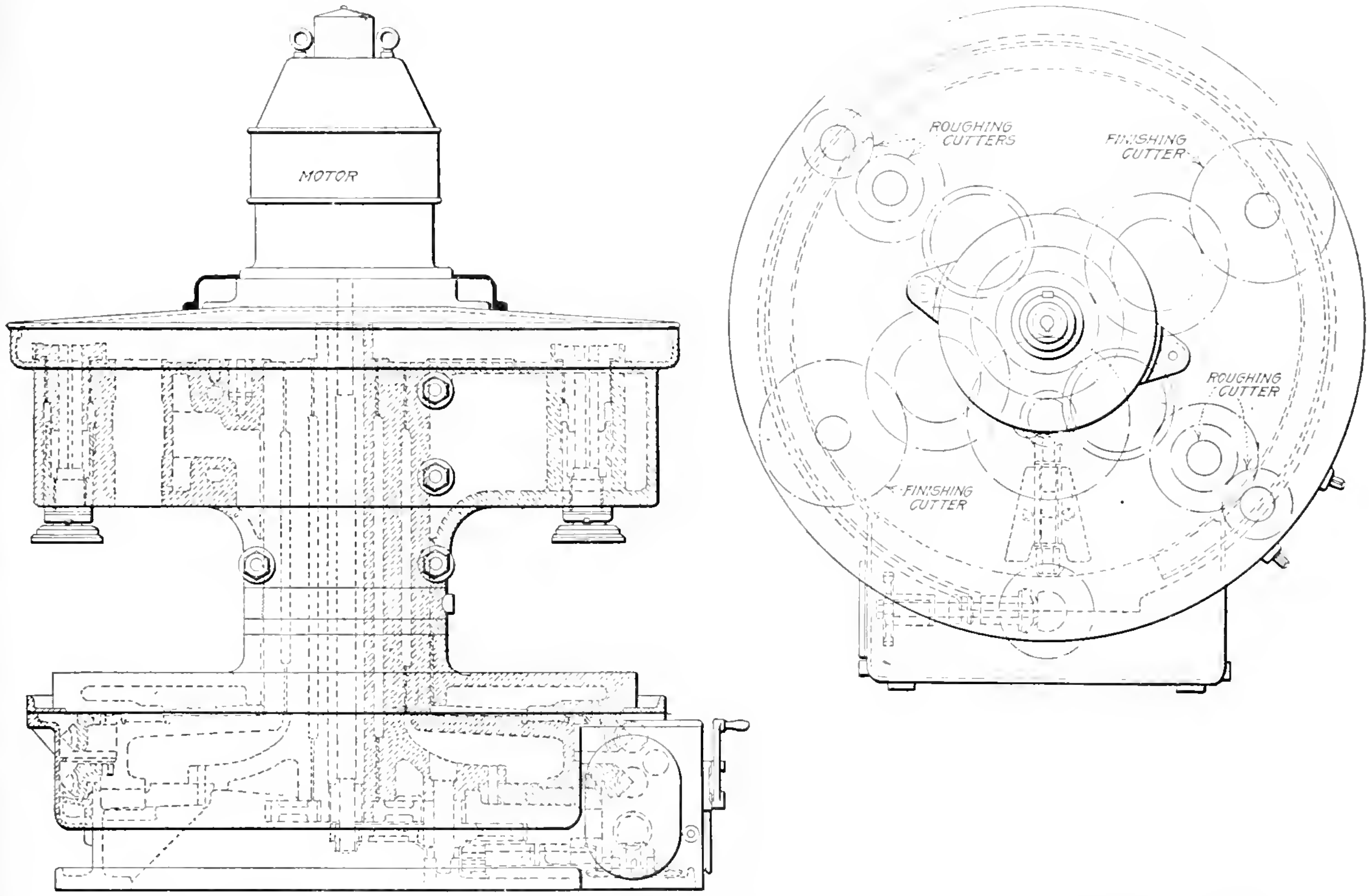


Fig. 15 Ingersoll Differential-Type Continuous Milling Machine (Sectional View of the Main Working Parts)

MACHINE TOOLS

Ingersoll Differential-Type Continuous Milling Machine, J. V. Hunter. Description of a new machine built by the Ingersoll Milling Machine Co. of Rockford, Ill., and designed essentially for

continuous milling operations. It is so built that it may have a multitude of working stations, but has only one loading and unloading station, so that only one operator is required to control all of its motions and results.

The main parts of the new machine are (Fig. 15) the lower or work-carrying table and the head carrying the milling-cutter spindles. Both of these revolve in the same direction, which accounts for the use of the term "differential" in the name of the machine. The difference is in the relative speeds of the two parts, and it constitutes the rate of feed of the cutter across the face of the work.

Vertically through the center of these two revolving parts is a large column about which the work table rotates and which, in its turn, carries and drives the heavy spindle head. The head carries a number of spindles, this number varying with the character of the work for which the machine has been planned, and is always one less than the number of work-holding fixtures which are carried upon the table. This permits the cutter spindles to be continuously operating at all times upon work, yet leaves one fixture idle at the loading station, which permits the operator to remove or replace work in this fixture before it travels around into a working position.

The entire upper structure or spindle head rotates toward the left of the operator as he faces the machine. The table carrying the work at the same time rotates in the same direction, but at a slightly lower rate of speed, so that the cutter spindles gain upon it at an average rate of 15 in. per min. at the average center of the work, which has been determined upon as the proper rate of feed for the job under consideration. The relative motion of the spindle head and work table are so timed that when the work table has made one complete revolution the spindle head has gained upon it a sufficient distance to carry one spindle completely across the face of the work. Because of this, normally a casting which was placed in any one fixture is, when returned to the loading station at the end of a complete revolution, entirely machined and ready for removal from the table.

The original article describes and illustrates some of the fixtures used in the machine.

The power drive is by a vertical electric motor mounted above the center of the machine. This feature permits the drive shaft to extend through the center of the column to the base below and saves floor space.

The number of the spindles on the machines so far built varies from four to seven. Regulation of the height of the spindles for the varying depths of cut is obtained by means of standard Ingersoll quills which extend through the housing near the base of a spindle. These permit the operator to alter the depth of cut at will be compensate for the wear or regrinding of any or all sets of cutters. Each spindle is provided with its individual attachment of this character.

One of the features to which particular attention is called in the original article is the absence of any necessity on the part of the operator of attending any station other than that which has been called the loading station; that is, the one where the work is put in and removed. (*American Machinist*, vol. 51, no. 14, October 2, 1919, pp. 645-650, 6 figs., *d*)

POWER PLANT ENGINEERING

ATMOSPHERIC POLLUTION FROM THE ENGINEER'S STANDPOINT. John B. C. Kershaw. The present article is based on the fourth report of the Advisory Committee attached to the Meteorological Office, dealing with the results obtained by the observations of atmospheric pollution in London, Manchester, Glasgow and other towns in the years 1917 and 1918.

An interesting point of view from which atmospheric pollution is considered is that of the degree to which it affects boiler feedwater, the opinion of the writer being that through air pollution dissolved impurities are traced into the rain water in the neighborhood of towns and cities and that ultimately this water gets into the boilers and produces quite undesirable results.

The general use of higher temperatures and pressure in steam boilers than was customary a few years ago renders it imperative that much greater care should be given to the purity of the water supply.

The data reported for the years 1917 and 1918 are compared by the writer with data previously published for pre-war use. A comparison of these data shows that there has been a nearly universal increase in the pollution of the air in the war period.

Of the materials found in rain water, tar, ash and some of the carbonaceous matter are insoluble, while other carbonaceous matter, chlorides, sulphates, ammonia and soluble ash are soluble. There have been found some variations between the amount of impurities in various English towns and also seasonal variations, the latter being particularly noticeable in the London group. (*The Engineer*, vol. 128, no. 3322, August 29, 1919, pp. 197-198, *p*)

SKIMMER IN 800-HORSEPOWER BOILER. Description of a baffle arrangement used by the Indianapolis Light and Heat Company to prevent particles of suspended matter from being carried over into the header with the steam by particles of water.

Before the skimmer was installed the company had a good deal of trouble because the feedwater was passed through water softeners and on coming out contained a quantity of suspended matter.

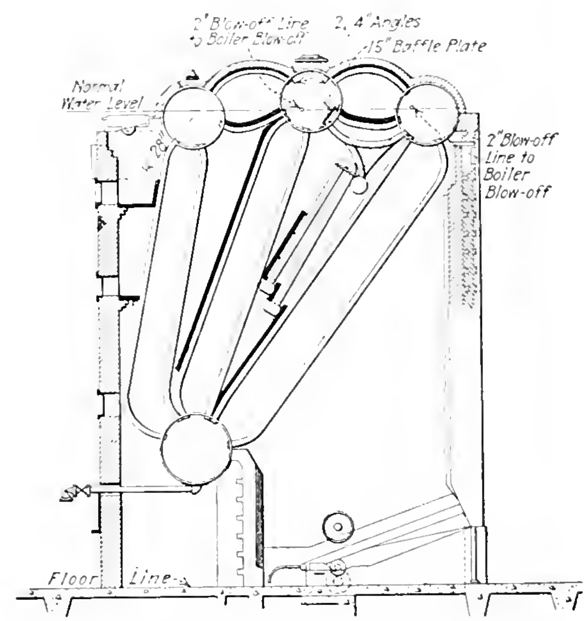


FIG. 16 BAFFLE SKIMMER FOR ELIMINATING SUSPENDED MATTER IN BOILER

When the boilers were operated at high rating particles of this suspended matter were carried over, causing a decrease in superheat and clogging up the lines and turbine blading.

The arrangement adopted is shown in Fig. 16. Two 4 x 4 in. angle irons were placed lengthwise in the middle steam drum, just above the steam-circulating tubes. In addition to this one No. 12 sheet-iron baffle 15 in. wide was installed lengthwise in the middle steam drum. It is 14.5 ft. long, and so located that it breaks the force of the water entering from the front drum, while the other angle irons check the upward rotation of water within the drum.

A 2-in. blow-off line is installed just below the normal water line in both the middle steam drum and the front drum. These blow-off lines run the length of the drum and are led into the boiler blow-off lines, valves being provided for their control.

It is stated that the device costs only a few dollars to install and does away entirely with the trouble previously experienced. (*Electrical World*, vol. 74, no. 11, September 13, 1919, pp. 581-582, 1 fig., *d*)

POWER TRANSMISSION

Converting Machines to Individual Drives. Description of methods used in converting a plant doing electrotyping on a large scale.

One make of motor and one speed (1800 r.p.m.) were used in order to realize the advantages of interchangeability and standardization, the motors being of the two-phase 220-volt type. Belt transmission between motors and driven machines was employed.

The article is of interest in that it describes in some detail and illustrates the way the various drives were installed and also gives a table showing the rating of motors driving electrotyping machines. (*Electrical World,* vol. 74, no. 12, September 20, 1919, pp. 637-640, 2 figs., *dp*)

REFRIGERATION

Test of a 2-Ton Clothel Refrigerating Machine, M. C. Stuart, Mem.Am.Soc.M.E. Data of a test recently conducted at the U.S. Naval Engineering Experiment Station at Annapolis.

The refrigerating medium in this machine is ethyl chloride, C_2H_5Cl, a neutral chemical having a boiling point of 54.5 deg. fahr. at atmospheric pressure. The unit consists of a motor-driven rotary compressor, a condenser, separator, expansion trap and brine cooler.

The construction of the rotary compressor is shown in Fig. 17. The rotor is located eccentrically in the cylinder, which is bored elliptically on a special machine. The top of the rotor makes contact with the top of the cylinder, thereby forming a seal between the suction and pressure sides of the cylinder. The blades are fitted into four slots milled radially in the rotor, and into the outer edges of the blades are fitted half-round packing strips which are machined to conform to the inside of the cylinder. The blades and packing strips are held out by spacing pins which pass through the center of the shaft. The seal between blade and cylinder wall is therefore positive, and contact between blade and cylinder wall does not depend upon springs or upon centrifugal force acting on the blades. The rotor is keyed to the steel shaft, which is carried on ball bearings mounted in the cylinder heads. The apparatus is lubricated by chemically pure glycerine passed through a glycerine strainer.

The original article shows the arrangement of the refrigerating apparatus. From the compressor the refrigerant in the form of gas flows to the condenser, this latter consisting of U-tubes arranged in two passes with condensing water flowing through the tubes. After being condensed the liquid refrigerant, together with the lubricant, flows into the separator where the lubricant, being heavier than the refrigerant, is drained back to the compressor and the liquid refrigerant is led to the expansion trap. From there the refrigerant passes to the brine cooler, the construction of which is similar to that of the condenser, the refrigerant being in the shell and the brine passing through U-tubes arranged in two passes. In the brine cooler the refrigerant is vaporized by the heat which is abstracted from the brine and in the form of a vapor passes to the compressor where the cycle of operations starts over again.

The principal results obtained on the test are given in a table, from which it appears that the refrigerating effect is increased with higher brine temperatures and lower circulating water temperatures. With a circulating water temperature of 70.1 deg. fahr. and a brine temperature of 14.57 deg. fahr. the net refrigerating effect was 2.13 tons per day. (*Journal of the American Society of Naval Engineers,* vol. 31, no. 3, August 1919, pp. 624-634, 6 figs., *dt*)

Testing and Measurements

Notched-Bar Tests, Dr. W. C. Unwin. Discussion of some of the questions bearing on the subject of the title of the article, with special reference to the Report of the Committee on Impact Tests of the British Association (Report for 1918, page 17 et seq.)

On the basis of this report, and other data, the author points out that the results of tests on a given material vary with the size of the test bar. Because of this, if notched-bar tests could always be made on bars of the same dimensions the work of fracture per square centimeter of the section of the notch would be a sufficient practical guide to the quality of the material; but actually it is not possible to test different materials in different cases with bars of uniform size, which makes the results not directly comparable.

Furthermore, the author shows that the work of rupture is not proportional to the volume of the bar. The ratio of the resistance of different sizes is up to the present undetermined and tests on bars of different sizes cannot be compared. In this connection the writer complains that the ratios of kilogram-meters per square centimeter obtained for different materials for each pair of testing machines are so divergent in published report of tests, including the British Association report, that often it is impossible to make anything out of them.

Quoting the empirical formula of reduction for notched-bar tests given by Charpy and Thenard, the author adds the following:

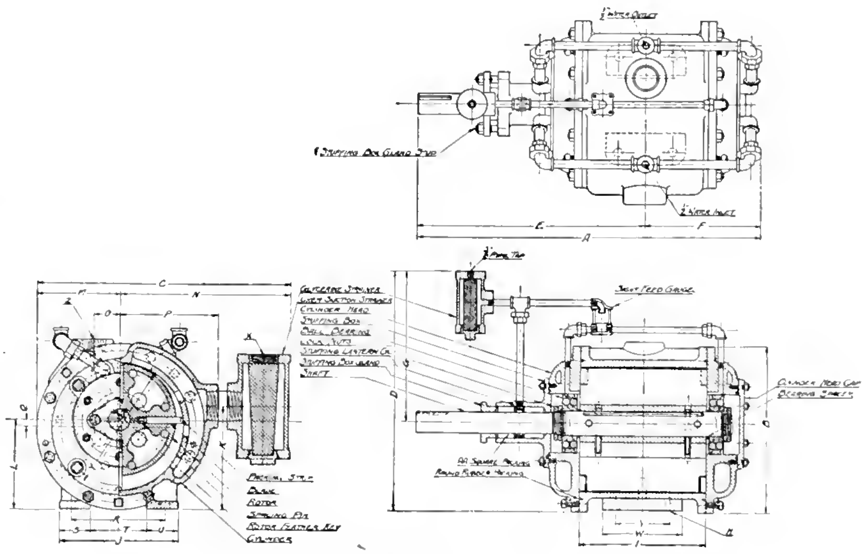


Fig. 17 Rotor Compressor of the Clothel Refrigerating Machine

"It has been remarked that an empirical formula which agreed with a series of experimental results, might give some indication of the direction in which a rational law should be sought. It has been alleged that the constant required in reducing the notched-bar tests must have the dimensions of work divided by volume. Now, Charpy and Thenard's bars were geometrically similar, and if the above statement is true, the work of rupture should be proportional to the cube of homologous dimensions, or to $a^{1.5}$. According to the tests, this does not seem to be the case." (*Engineering,* vol. 108, mp. 2802, September 12, 1919, pp. 329-320, *tA*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

A bill has recently been proposed in the United States Senate whereby jurisdiction is extended to the several courts of the United States sitting in admiralty, to hear and adjudge suits for damages brought by the owner of any vessel or cargo for loss, damage or injury to property, due to the fault of any vessel owned or operated by the United States or by a corporation in which the United States is the controlling stockholder. These courts are to enter a decree in a proper case against the United States for the amount of loss, damage or injury, together with interest at four per cent and costs.

MECHANICAL ENGINEERING
THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Published Monthly by the Society at
29 West Thirty-ninth Street, New York

As already announced to the readers of Mechanical Engineering, the printers' strike in New York has closed all the union printing plants of the city, the daily newspapers excepted, and has resulted in a complete tieup of the printing industry in this, the largest publishing center of the country. In this emergency Mechanical Engineering is being printed temporarily in another city, but will not arrange for permanent publication outside of New York unless a situation develops not yet anticipated.

As the most practical method of handling its publication, the "Society Affairs" material for November, usually contained in Section Two of Mechanical Engineering, was printed separately in a third place and mailed to the entire A.S.M.E. membership and to the subscription list early in the month, in order to give prompt service to those interested in the Employment Bulletin and in Society announcements. Following this the Technical Section is now issued at as early a date as could be arranged, and, although curtailed somewhat in extent and variety of contents, brings to its readers a selection of the papers to be presented at the Annual Meeting of the A.S.M.E., together with the usual Engineering Survey, Engineering Index and miscellaneous matter.

Congratulations to Western Society of Engineers

The Western Society of Engineers, with headquarters at Chicago, has just completed a successful drive for membership, resulting in 2000 new members. One hundred and fifty workers were enlisted to put the drive across, divided into ten teams, each with a captain and nine solicitors. That there might be no duplication, each team was given a definite list of names to work upon. There was the greatest rivalry between teams and enthusiasm was manifest throughout the undertaking.

The Western Society was organized in 1869, and though mainly devoted to the interests of one section of the country, as designated by its name, it actually has a membership throughout the nation and in several foreign countries. The engineers of Chicago are fortunate in having so strong and long-established a body through which to coördinate their interests, and the society is to be warmly congratulated on this, its fiftieth anniversary.

Mid-West Sections Meeting of The American Society of Mechanical Engineers

An innovation in the development of the sections' activities of The American Society of Mechanical Engineers was carried out at Indianapolis on October 24 and 25 when the members of the Society gathered for a two days' session under the direction of eight sections of the Society. The Indianapolis Section handled all of the details for the social side of the program, and the seven other sections were invited to contribute papers to the professional program. This secured a wealth of papers on the two topics covered by the meeting, the first of which was devoted to Industrial Unrest and the other to Research.

Recognizing the importance of meetings of this kind in the development of the Society, the Council contributed by holding its October meeting at Indianapolis and participated in several features of the program.

At the opening session Friday afternoon, Dean Charles Russ Richards, of the University of Illinois, presided. W. C. Rogers, Manager of the Employers' Association of St. Louis, opened a discussion on Industrial Unrest, with an analysis of the causes and remedies for the existing conditions. Adequate wages for employees, adoption of measures for their health and for recreational facilities, and the Americanization of foreigners, among other points, were urged by Mr. Rogers.

A paper prepared by C. F. Scribner, consulting engineer of Chicago, was presented by Arthur L. Rice, Chairman of the Chicago Section. It urged that the piece-work system be placed in operation only after thorough investigation to determine a just scale and to insure that rates would not be revised without a change in the conditions forming the basis on which they were first established.

Results of the Americanization Program Carried Out by the Commonwealth Edison Company of Chicago was the title of a paper presented by A. D. Bailey, Assistant Chief Engineer of that Company, who discussed the Americanization of foreigners by means of primary education in our language and methods of government.

Dean J. A. Watkins, Director of the Department of Industrial Medicine of the University of Cincinnati, described the work undertaken in the study of industrial disease.

Intensive Manufacturing Methods, together with the Proper Training of Men toward Organization, was the text of an illustrated address by Prof. B. W. Benedict, Manager of the Shop Laboratories of the University of Illinois.

Following a banquet in the evening, Charles F. Coffin, President of the Indianapolis Chamber of Commerce, welcomed the visitors and Dean M. E. Cooley, President of The American Society of Mechanical Engineers, responded. After this an unique and interesting address was given by Dr. Willis A. Moore of Detroit, Mich., who is now devoting his time to addressing the workers in various manufacturing plants, inculcating a spirit of true Americanism, a desire for closer relationship between capital and labor and an understanding of the reasons why increased production is essential at the present time. Dr. Moore stripped off his coat and collar, actually, not figuratively, and made his talk a realistic reproduction of a noon-day shop meeting, such as he addresses from day to day.

The session on Research, at which Prof. Arthur M. Greene, Jr., presided, brought forth a number of excellent papers.

C. F. Hirshfield, Director of the Research Department of the Detroit Edison Company, opened the session with a statement of the Present Status of Research in the Industrial Life of the Country, and pointed out the necessity of the attention to the problems of finance, distribution and utilization of products, as one means of stabilizing industrial conditions.

The Administration of Industrial Research Affairs was presented by R. E. Carpenter, Director of the Research Department, Aluminum Castings Company of Cleveland.

L. G. Robinson, of Cincinnati, spoke on Coöperative Industrial Research and Dr. E. P. Hyde, Director of the Nela Park Laboratories, described the work done there.

A paper on the Fatigue of Metals Phenomena was read by Prof. H. F. Moore, of the University of Illinois, who had with him a reel, showing by motion pictures in detail the effect of stress of steel.

Dean C. H. Benjamin described the tractor testing plant at Purdue University and Mr. L. C. Nordmeyer read a paper on Research, prepared by W. G. Hessenbruch of St. Louis.

Dean J. R. Allen, Director of Research for the American Society of Heating and Ventilating Engineers, completed the program with a paper on Pure Science and Engineering Research.

At the completion of the professional portion of the program the members enjoyed an automobile trip to the Indianapolis Canoe Club for luncheon, going later to the Aviation Repair Depot and the speedway flying field, where exhibition flights were made.

Transactions of the A. S. M. E.

Volume 40 of the Transactions of The American Society of Mechanical Engineers has been issued to the membership. The volume comprises forty-four papers and discussions on a wide variety of mechanical engineering and industrial economic subjects; two reports by committees of the Society—one on the metric system and export trade and the other on the standardization of flanges and pipe fittings; and a comprehensive symposium on the economical use of fuel, occupying practically one-sixth of the book and forming a consensus of the experience of a large number of engineers, contributed in the interests of the national fuel-conservation program. A number of the industrial papers relate to problems brought to the fore by the exigencies of the war.

One group of papers deals with thread gages and with the work thereon of the British Engineering Standards Association, while another takes up problems involved in the employment of labor. Other subjects considered in the remaining papers are management, power-plant topics, aeronautics, weights and measures, foundry costs and accounting, factory construction, internal-combustion engines, refrigeration, mechanics, textiles, etc.

The preparation of the volume has been carefully supervised by the Publication Committee of the Society, and special pains have been taken in the selection, arrangement and indexing of the material to make it of the greatest possible reference value.

The American Air Race

During the month, as part of the experimental program carried on by the War Department, an air race was conducted between Mineola, Long Island, and San Francisco, the conditions of the race being that each of the fliers had to start from and get back to one of these terminal points. Only military fliers were permitted to participate, various machines, American and foreign, being used.

Although at this writing only fragmentary data are available, a few facts nevertheless stand out. Several fliers have completed the circuit either from Mineola to San Francisco and back, or from San Francisco to Mineola and back, which shows that machines can be built to stand a 7000-mile trip under comparatively unfavorable weather conditions.

Another lesson of the flight is the apparent unsuitability of the DeHaviland-4 machine for long-distance flying and its lack of safety. In several accidents pilots were killed under conditions which indicated that had the accident occurred in a different machine, such as, for example, the DeHaviland-9, the pilots might have escaped with only minor injuries.

The most important and, to those who are familiar with the conditions of aviation service in this country, by no means unexpected lesson of the flight lies in its showing once more the high average of the human material in the service. The flight took place under more than usually unfavorable weather conditions. The qualities of the machines were well-known. There were no great prizes offered, and the men flew and took great and well-recognized risks, simply as part of the day's work. The large number of men who volunteered for the race showed a quite exceptional average of skill under very adverse conditions.

There is no question but that the American army possesses as fine human material for the upbuilding of its flying branch as could be desired, and it only needs that the mechanical equipment of the service be brought to the same standard.

The Engineering Index for 1919

Although the annual volume of the Engineering Index has heretofor been based upon the classified system, it has long been the opinion of many who use the index that a strictly alphabetical arrangement would greatly enhance the value of the volume. Accordingly the items which form the 1919 Engineering Index will be alphabetically arranged, with liberal cross-references provided.

The 1919 Index, published by the American Society of Mechanical Engineers, will be a volume of approximately 500 pages and will contain over 12,000 references to engineering literature of the current year. These references have been selected from over 1100 periodicals which are regularly received by the library of the United Engineering Societies, and which represent the leading literature of the engineering profession both in this country and abroad.

On account of the difficulties in the printing industry, no definite announcement can as yet be made concerning the date of publication, but it is hoped that the book will make its appearance early in the coming year, and as soon as possible further details will be announced.

Dedication of Pittsburgh Station Bureau of Mines

The new buildings of the Pittsburgh Station, U. S. Bureau of Mines, were formally dedicated on September 29 and 30, and October 1, under the auspices of the U. S. Government, the State of Pennsylvania and the city of Pittsburgh, the Chamber of Commerce coöperating.

The station at Pittsburgh, with its spacious buildings, its museum, and its many laboratories and offices, is the largest of the eleven experiment stations of the Bureau distributed throughout the country, and is of particular interest to mechanical engineers because of its fuel laboratory, constituting as it does one of the two Government laboratories for the investigation of mechanical engineering problems, the other one being the Naval Experiment Station at Annapolis. This, of course, is excluding the specialized work of the Government in aircraft and in connection with the physical laboratories at the Bureau of Standards.

While the Bureau of Mines is engaged primarily in mining problems, and particularly those relating to mine safety, a large and important part of its work is concerned with the problem of obtaining greater efficiency in the burning of coal. The Bureau has been the pioneer in combustion experiments in the United States and has issued many reports on this subject familiar to engineers.

The fuel laboratory at Pittsburgh is splendidly equipped and more apparatus of commercial size will be added in the near future. Extended experiments in the transmission of heat through boiler tubes and furnace walls are under way, and it is here that the research work lately instituted by the American Society of Heating and Ventilating Engineers is to be conducted with respect to systems of heating, radiation constants, air standards based on humidity, etc.

At the dedication of the Pittsburgh buildings there were opening exercises at which Governor Sproul of Pennsylvania was the principal speaker; a reception by Dr. Manning, Director of the Bureau of Mines, and Mrs. Manning; a pageant glorifying the mining industry; and a dinner given by the Chamber of Commerce. During the three days of the celebration demonstrations were made of coal-dust explosions and there were mine-rescue and first-aid contests by teams from different states.

TECHNICAL PAPERS TO BE PRESENTED AT THE A. S. M. E. ANNUAL MEETING

IN this and the last number have been printed extended abstracts of several of the papers to be presented at the coming Annual Meeting of the A.S.M.E., and there are given below very brief summaries of a larger list of these papers than it has been possible to incorporate in these two last numbers of MECHANICAL ENGINEERING. These papers are available in pamphlet form for distribution to the members of the Society in advance of the meeting, which occurs December 2 to 5. Members wishing copies should notify the Secretary of the particular papers desired and pamplets will be forwarded promptly.

COMMON ERRORS IN DESIGNING AND MACHINING BEARINGS, by Christopher H. Bierbaum. In this paper the author discusses such matters as oil grooves and their proper distribution, the disadvantages of tight-fitting bushings, proper methods of finishing brasses to provide for expansion when running, and proper methods of clamping bearings while they are being machined. He also shows by means of photomicrographs of finished surfaces the importance of using sharp tools with the proper rake in order that the crystalline structure of the surface material of the bearing may not be so crushed and compacted that it will fail to function as a normal bearing alloy.

TURBO-COMPRESSOR CALCULATIONS, by Allen H. Blaisdell. A paper dealing at length with the thermodynamic and pneumatic principles involved in the operation of a turbo-compressor, and including in its treatment a study of the nature of compression, and the layout of a compression diagram, the theory of fluid flow, essentials of impeller and diffuser design, and considerations regarding power consumption and efficiency.

THE HVID ENGINE AND ITS RELATION TO THE FUEL PROBLEM, by E. B. Blakely. This paper describes a type of engine, the Hvid, which it is claimed has all the advantages and none of the disadvantages of the so-called Diesel type, and which is being produced in units as small as 1½ hp. It can be started cold. It has no complicated air-compressor systems and is said to be so economical that it can compete with gasoline engines of the same size. The author outlines the operation of the engine, describing in detail the suction, compression, power, and exhaust strokes, and presenting a series of indicator cards. Fuel consumption is shown by means of a series of curves obtained as the results of tests performed. The paper concludes with a discussion of the heat balance and torque characteristics of the engine. It is pointed out that there are certain characteristics of the engine which ought to attract internal-combustion engineers to its study to the end, perhaps, of perfecting it and thus assisting in solving some of our fuel problems.

EMERGENCY FLEET CORPORATION WATER-TUBE BOILER FOR WOOD SHIPS, by F. W. Dean and Henry Kreisinger. This paper describes tests upon the standardized water-tube marine boiler designed by the United States Shipping Board, Emergency Fleet Corporation. Of the 1352 ordered, the first 706 were alike. The other 646 were ordered with slight changes including the use of four passes instead of three passes embodied in the original lot. In view of the large number of boilers needed, the scarcity of steel and the desire to secure competitive prices, the water-tube type was adopted instead of the Scotch marine type. This made it possible to have the boilers constructed in inland shops throughout the country and effected a reduction in the weight of steel of more than 9,000,000 lb. for the total order. The boilers had a grate area of 65.54 sq. ft., heating surface of 2500 sq. ft. and a commercial hp. of 135 on the basis of the marine rating of 6 lb. of water to a sq. ft. of heating surface per hour. Under test the three-pass type showed at first an efficiency of 69 per cent which was later raised to about 73 per cent, based upon combustible, by certain changes which were effected. The four-pass type exceeded 74 per cent on two tests. These results were obtained when the boilers were hand-fired. Subsequently an investigation was made by Mr. Henry Kreisinger of the Bureau of Mines of the mixture of air and combustible in the furnace and of the temperature of the gases, details of which are given in the text together with tables showing the complete results of the evaporative tests.

FLOW OF WATER THROUGH CONDENSER TUBES, by William L. De-Banfre and Milton C. Stuart. This paper is the result of a series of tests which were conducted at the United States Naval Engineering Experiment Station at Annapolis, Md., to determine the friction loss of water flowing through ⅝-in. standard condenser tubes of No. 18 gage. The investigations covered variable velocities, water temperatures, and tube length, as well as the effect of both fresh and salt water. The computations were made in such a manner that the various losses could be separated and the results have been expressed in a general formula.

WAGE PAYMENT, by A. L. DeLeeuw. A paper which discusses the various items entering into the present relations between employer and employee. The author first calls attention to the fact that some of the terms which are most commonly used are not clearly understood. Among these are "capital," "labor," "right to organize," "collective bargaining," and "wage." He accordingly discusses each, and then takes up the subject of the various systems of payment in existence at the present time. Taking the aims of the organized labor to be: (1) proper share of the proceeds of labor, (2) reasonable working conditions and working hours, (3) right to organize, and (4) collective bargaining, the author believes that these aims could all be accomplished without strife if collective bargaining were put into actual practice instead of being a mere catch word. In conclusion he states that in his opinion the real cause of the current unrest lies in the fact that our present wage system is not based on knowledge and justice, but only on guess work and on the fear that the one of the parties concerned may "do" the other.

SLOW-SPEED AND OTHER TESTS OF KINGSBURY THRUST BEARINGS, by H. A. S. Howarth. This paper presents operating and experimental data which show the wide range of application of the Kingsbury thrust bearings. The author describes typical installations of bearings which have been in successful operation since 1911. The Kingsbury thrust bearings have been applied to vertical and horizontal hydroelectric units, to horizontal steam turbines and to centrifugal pumps, and to determine some of the service conditions, a series of slow-speed tests were made, details of which the author presents in his paper. The results of these tests indicate that the lower the speed at which the bearing is run continuously, the better the conditions of bearing surfaces. Speeds as low as 0.38 r.p.m. have thus far been employed, using, however, only a light oil.

A PERFECTED HIGH-PRESSURE ROTARY COMPRESSOR, by Chester B. Lord. A paper giving particulars of an improved rotary compressor of the eccentric-rotor and telescopic-blade type, in which leakage, friction, and packing troubles have been overcome to such an extent that a volumetric efficiency of 92 per cent at seven compressions (100 lb. per sq. in.) is said to be commercially obtainable. This compressor, it is stated, will handle gas, air or liquid, or all three, without adjustment or alteration, and a single-stage machine will compress to a pressure of 500 lb. per sq. in.; further, it is possible to compress to 1000 lb. in three stages with the three units on the same shaft.

MODERN ELECTRIC-FURNACE PRACTICE AS RELATED TO FOUNDRIES IN PARTICULAR, by W. E. Moore. In this paper the author, after first giving particulars regarding the operation of acid and basic furnaces, enumerates the superior properties of electric steel, and the advantages of the electric furnace over the open-hearth method. Crucible and converter processes are next briefly mentioned, the author pointing out the superior characteristics of the acid type of furnace for foundry work. To set forth the marked economy of the electric furnace, comparative operating costs of producing liquid steel both by the converter and the electric-furnace process are given, and the paper concludes with notes on the use of the electric furnace in malleable-iron foundries and on the selection of the most suitable type of furnace for a given installation.

SCIENTIFIC DEVELOPMENT OF THE STEAM LOCOMOTIVE, by John E. Muhlfeld. Although marked progress has been made in the development of the steam locomotive and the results have been in many respects exceedingly effective, they have, nevertheless, been largely confined to assisting in improving sustained boiler capacity and increased thermal efficiency. There is, therefore, still considerable opportunity for further improvement, and this paper is a discussion of the various factors incidental to the design and construction of locomotives. Such matters as purification of boiler feedwater, use of various grades and types of fuel, heat losses, steam generation and superheating, steam distribution and utilization, and wasted heat are accordingly considered. The author also discusses acceleration and deceleration of a locomotive, and the power required for accessories such as air-brakes, signals, train lighting, heating, ventilating, etc.

AN INVESTIGATION OF STRAINS IN THE ROLLING OF METAL, by Alfred Musso. This paper is a discussion of one of the most important problems incidental to rolling-mill operation. In such mills, while raw stock is being transformed, a certain amount of material is wasted, and to determine the factors involved in this waste, the author asks and answers this question: "What is the most convenient length and width of the piece of metal to be rolled in order to produce a finished article of certain definite dimensions so that the waste of material may be reduced to a minimum?" The answer, which forms the body of the paper, is based on data secured as a result of actual investigation.

A NEW TYPE OF HYDRAULIC-TURBINE RUNNER, by Forrest Nagler. This paper is in the nature of a preliminary announcement describing the development of a new type of water-wheel runner, which it is ex-

pected will largely supplant the well-known mixed-flow reaction type. The first part of the paper is devoted to an explanation of the term "characteristic speed," which, while in the nature of a repetition of much more extensive articles previously written, is nevertheless thought to be desirable because of its peculiar adaptability to water-wheel analysis. A brief history of water-wheel development is next presented, which indicates that for nearly one hundred years characteristic speeds were gradually increased from 20 to 100, whereas the new form of runner reaches characteristic speeds averaging 150. The paper concludes with a short statement of the advantages and field of application of the new type of runner.

Appraisal and Valuation Methods, by David H. Ray. The author holds that appraisal and valuation are essentially engineering functions, and that it is the duty of the engineer to develop, guide and control the method and procedure employed. He pointed out that the variables affecting values depend on labor, material and an aleatory factor to cover the general risk of the business, with particular reference to marketing. Charts, curves and tabulations are given to show the change in these values during the period of the war, and terms used in appraisal work are defined. The author also directs attention to the desirability of giving a value to a machine as a unit, of the grouping of similar tools, and of the use of symbols in the form of numbers and letters in tagging the materials to be appraised.

Kerosene as a Fuel for High-Speed Engines, by Lawrence F. Seaton. Despite the fact that considerable work has been done toward the use of kerosene as a fuel for internal-combustion engines, there still remain many unsolved problems. To study these the author accordingly made a series of tests on a high-speed, heavy-duty-type of engine, using kerosene as a fuel, and these tests form the basis of his paper. The apparatus used and the manner of conducting the tests are described in detail, and as a result of his work the author states that in his opinion a kerosene engine would be successful if designed so that the piston displacement were higher than that commonly used, if the intake passages were larger and shorter, and if the incoming gases were heated to a temperature considerably above that of the boiling point of kerosene.

Oil Pipe Lines, by S. A. Sulentic. This paper compares the cost of pipe-line transportation of oil with that of rail and canal. It also points out the advantages of the oil engine as a means of economically transporting oil for a long distance through pipes, and derives formulæ by means of which one may calculate the pressure, net horsepower, and brake horsepower necessary to transmit any quantity of oil through a pipe of known diameter.

The Thermal Conductivity of Insulating and Other Materials, by T. S. Taylor. Although numerous experimenters have been interested in making thermal-conductivity measurements, but very few data are available for such materials as are used in the construction of electrical machinery. To further investigate this field, the author accordingly conducted a series of tests based upon two methods, both of which he explains in detail. The results obtained are tabulated for such materials as fish paper, fuller board, cambric, mica tape, various kinds of woods, asbestos, plate glass, sheet steel, wool felt, etc.

The Lubrication of Ball Bearings, by H. R. Trotter. Ball-bearing lubrication is a subject of which little is known, and this is chiefly due to the fact that there is no accepted method of determining the lubricating value of an oil or grease. As a step toward the development of a satisfactory method the author has devised an instrument for such a purpose, a brief description of which is given in his paper. The operating characteristics of a ball bearing as related to the problem of lubrication are also discussed and the specifications for a satisfactory oil are given. The use of grease and graphite as a lubricant is also briefly considered and the paper concludes with a suggested procedure for the analysis of lime-soap greases.

Thread Forms for Worms and Hobs, by B. F. Waterman. The use of worm gearing is steadily increasing and accompanying it, perhaps its cause, is a corresponding increase in efficiency and durability. This is doubtless the result of a better understanding of both the theoretical and mechanical problems involved, some of which the author points out in his paper. The author also suggests methods for bringing about a uniform and satisfactory practice in worm gearing.

Air Pumps for Condensing Equipment, by Frank R. Wheeler. This paper is devoted to a consideration of past and current practice in air-pump design and selection. After presenting a classification of air pumps the author proceeds to briefly describe the features of each type, stating their limitations and respective advantages and disadvantages. Special attention is given to the steam-jet ejector type of pump, whose advantages are stated to be: extreme simplicity, reliability and flexibility, stability, minimum space and weight, low steam consumption and high efficiency; and furthermore that it requires no maintenance or attention. The author concludes his paper by taking up the matter of selecting an air pump of proper size and capacity for a given condenser installation, accompanying his discussion with illustrative calculations and charts.

Octaval Notation and the Measurement of Binary Inch Fractions, by Alfred Watkins. This paper is an argument for the adoption of a system for measuring the binary inch fractions. At present there are two systems; one which divides the unit into halves, quarters and eighths, etc., and the other which makes use of a decimal notation. The author proposes to replace these by an octaval notation in which eight is to be used as the radix. He accordingly first presents the method of constructing such a notation, this being followed by a description of various types of rules, calipers and micrometers based upon it. It is not to be inferred, however, that the author proposes the substitution of octavals for decimals in all branches of engineering work, but he does advocate their use to denote the British binary inch fractions in the workshop and on workshop measuring instruments.

Motor-Transport Vehicles for the United States Army, by John Younger. This paper contains a discussion of the types of vehicle best adapted to various military needs. Motor-transport vehicles have been classified by the United States Army under ten broad heads, ranging from the small 250-lb. motorcycle to the 5-ton truck. The classification has been found to be a most satisfactory one, and the ultimate ideal, of course, is to standardize the single type of vehicle for each class. With that point in view the author discusses the various vehicles used, giving in connection therewith numerous photographs as illustrative of American design and construction. Tables and characteristic torque curves are appended to the paper, and these afford a comparison of the specifications of both commercial and specially designed Government trucks and vehicles.

OCTAVAL NOTATION IN SHOP MEASUREMENTS

(*Continued from page 871*)

Simplifications in Measuring "Limits"

The fact that all the standard binary fractions are expressed in the first two places of octavals, and that all the limit allowances and tolerances come in the next (3d and 4th) octaval places gives a new and unexpected value to octaval notation. The workman sets his standard size on two scales of the calipers or micrometers, and the plus or minus allowance on two different scales. No pencil or mental calculation of adding or deducting is required. Another happy fact which makes the provision of limit tables for octavals very easy, is that the third place in octavals ($_{0}001$) is $\frac{1}{512}$, and half this ($_{0}0004$) is $\frac{1}{1024}$, which is so near the much-used "thou" of the mechanic (within 2½ per cent of it) that it can safely be substituted for it in all the limit tables.

In conclusion, it should be stated that this paper is not a proposal for the substitution of octavals for decimals in all branches of engineering. It advocates their use to denote the British binary inch fractions in the workshop and on workshop precision instruments. Any use beyond this, and there are many, is for future experience. A maker adopting these in workshop practice need not bring them into his catalog until their simple logical structure is better known.

A PERFECTED HIGH PRESSURE ROTARY COMPRESSOR

(*Continued from page 878*)

The compressor may be built either vertical or horizontal and in the small sizes up to 5 cu. ft. it is air-cooled. Between this and the 15-cu. ft. size it is partly water-cooled. In the 20-cu. ft. size and above it is completely jacketed.

The advantages of the rotary compressor, all of which have been demonstrated commercially, are as follows:

1. Small weight per unit of capacity, about $\frac{1}{15}$ of that for reciprocating machines
2. Small amount of floor space required, about $\frac{1}{20}$ of that for reciprocating machines
3. Small initial cost of installation
4. Most economical drive known employed, either electric motor or steam turbine direct-connected
5. Small amount of headroom required. The machine is usually about the same size as the motor required to drive it
6. Simplicity of construction and hence small cost for adjustment or repair
7. Self-lubricating, since the entire machine operates in a bath of oil.

A MASTERPIECE OF STEEL CARVING

At a meeting of the New York Section on October 9, 1919, preceding the address of the evening, Mr. George J. Foran exhibited what he considered to be the finest modern specimens of steel carving. Mr. Foran added interest to his exhibition by his brief historical analysis of the causes which brought the art of wrought-metal work to the highest state of perfection during the golden age of Nuremberg, namely, its vital importance to the ruling classes and the insistent demand and commensurate remuneration for armor of maximum combined efficiency and beauty.

This, with the added honors bestowed upon the most successful artisians, inspired successive generations of artistic craftsmen to devote their entire life, thought, and energy to the development and perfection of the essential arts of heat treatment, hardening processes, etching, fretting, enameling, damascening, embossing, and sculptural work. Many of these arts became practically lost when the demand for this highly specialized craft ceased with the passing of armor upon the gradual practical development of firearms during the fifteenth century.

At this time Nuremberg reaped a well-earned reward for its long-continued encouragement and protection of the arts and crafts by becoming, in addition to one of the great marts of the commercial world, the center from which all great religious, scholarly and artistic movements of Germany emanated — for the reason that most of the important German scholars, artists and craftsmen had gradually been drawn to Nuremberg. These men, led by such master craftsmen as Peter Vischer, Adam Kraft and Vist Stoss, under the inspiration and example of the scholar-mathematician and artist, Albrecht Dürer, the father of German painting, turned their talents to commercial lines with great success.

The "Forest Smithy," rather inadequately reproduced in the accompanying illustration, in its subject, period, conception, perspective and execution is a perfect specimen of the old Nuremberg school. It depicts the moment when a knight, riding through a forest, discovers some trouble with his armor, and having tied his charger at the edge of the wood, is engaged in testing and bending the blade of a sword which the old smith is showing him while his assistants inside are busy at work. The smithy is the characteristic one of the Middle Ages, built upon the rough hillside in the forest to be near the charcoal supply; piles of mud and stone will be seen upon the roof to keep it from blowing off. On the road up to the castle will be seen a journeyman smith asking a village maiden the way to the smithy, which she is pointing out. The amount of undercutting and perfection of detail work can only be realized upon close inspection.

The "Forest Smithy," Carved from 2-in. x 12-in. Stock, Mild Steel, 18⅝-in. Long, by Frank L. Koralewsky of Boston. Weight in the Rough 127 Lb., Finished 30 Lb.

This beautiful carving was produced by Mr. Frank L. Koralewsky, of Boston, who served his apprenticeship in Germany with a firm of old-established artsmiths who adhered strictly to the best traditions of their art. After his masterpiece had been accepted and he was created a journeyman, Mr. Koralewsky spent several years traveling and working in different sections of Germany to become familiar with every branch of his art and to study the exhibited work of the early masters. He came to the United States in 1896 and settled in Boston. His work received immediate recognition and his gates will be found at Harvard, Yale and Princeton Universities, his screens at the Cathedral of St. John the Divine in New York, and fine specimens of his work in locks, handles, hinges, irons, etc., in the large public and private estates throughout the country. He received the gold medal and grand prize at the Panama Exposition for his carved wrought-iron lock illustrating the old fairy tale of "Snow White and the Seven Dwarfs."

Mr. Foran also exhibited a watch carved by Mr. Koralewsky in most wonderful detail and several smaller pieces of his work. Mr. Koralewsky executes this carved work in his spare time purely from his love of the art and always with the hope that by its exhibition other workers may be similarly inspired and the standard of the craft thus raised.

These specimens were loaned by Mr. Koralewsky to Mr. Foran for the purpose of exhibition at the different works of the Worthington Pump and Machinery Corporation. The result was most satisfactory in the way of deeply interesting the various workmen and furnishing them an outside interest for their spare time in reading the histories of the development and successes of the great craftsmen and studying the possibilities of the material upon which they work ordinarily in a purely perfunctory way.

THE JAMES WATT CENTENARY

At the James Watt Centenary Commemoration exercises held in Birmingham, England, from September 16 to 18, there was present a notable gathering of engineers and scientists to pay tribute to this remarkable man. The Society was fortunate in being represented by three of its members, J. Wilfred Harris, H. F. L. Orcutt and J. Sanford Riley.

The program arranged by the committee was a most comprehensive one and it would be difficult to attempt to tell of the many events. Three, however, will long be remembered by those who took part in the exercises—the service at the parish church of Handsworth where James Watt was buried, the chapel of which contains the famous Chantrey sculpture of the great engineer; the visit to the garret workshop of Watt, and the inspection of one of his early engines which was put under steam for the occasion. This was the Ocker Hill engine which was built in 1776 and erected at Smethwick for pumping operations in connection with the Birmingham Canal.

The main purpose of the commemoration, however, was the raising of a fund for an international memorial. It is hoped that this will take the form of a James Watt Chair of Engineering at the University of Birmingham for the promotion of research into the fundamental principles underlying the production of power and the study of the conservation of the natural sources of energy. It is also hoped to erect a James Watt Memorial Building to serve as a museum for collecting together samples of the work of James Watt and his contemporaries, Boulton and Murdock, illustrating this interesting epoch in the history of engineering. The building would also serve as a meeting place and library for scientific and technical societies and be a center from which engineers could coöperate in spreading scientific knowledge.

In a little pamphlet issued for this occasion there appears a very interesting sketch of the career of James Watt written by Prof. F. W. Burstall of the University of Birmingham, an abstract of which follows:

The name of Watt is familiar on both sides of the Atlantic and as a hundred years have now elapsed since his death, it is possible to estimate at its true value the influence which his genius had upon the modern world.

The popular idea that Watt invented the steam engine is not correct as the Newcomen engine had been in regular use for more than a century before his discovery. Watt's work lay in the improving of an imperfect and wasteful machine, which could be employed only where fuel was cheap, into the powerful and economical steam engine with which we are all familiar. In the evolution of our modern life the steam engine has had perhaps a greater effect than any other single influence and in the development of the steam engine James Watt stands out as the great pioneer.

Watt started life as an instrument maker and was so employed by the University of Glasgow where he was led into the study of the steam engine in repairing a model of the Newcomen engine. In his experiments he learned how wasteful was the Newcomen in fuel consumption and thereupon started his study of heat properties in which he received valuable aid from the well-known Dr. Black. Watt was not long in seeing that the great defect in the Newcomen engine lay in the ejection of the condensing water into the cylinder, which led to his discovery of the separate condenser with which his name will be associated for all time.

As is usual with inventors, the years immediately following his discovery were years of trial and disappointment. Success came when the partnership was formed with Matthew Boulton, a well-known manufacturer of small metal goods in Birmingham and the founder of the famous Soho Works. He was a man of great enterprise and dauntless courage and his belief in Watt's genius never wavered throughout their connection of a quarter of a century. One other man had no small share in Watt's success and this was William Murdock who worked throughout his life at the Soho Works. His invention of gas lighting, his introduction of compressed air for power distribution and his experiments in mechanically propelled vehicles, carried out in Cornwall as early as 1785, all go to prove him a man of remarkable power.

Watt's first engines were principally used for pumping in Cornwall, where the deepening of the mines made an economical source of power essential. The first rotating engines were not produced until nearly ten years after Watt had settled in Birmingham. It was Watt's intention to use the common crank for the purpose of the conversion of reciprocating into rotary motion but in this he was forestalled by the idea's being stolen and patented, so he contented himself with the sun-and-planet motion for effecting the same purpose. The rotative engine at the Albion Flour Mills in London and another at Whitehead's Brewery, also in London, marked the beginning of the use of steam power for industrial purposes.

The use of the independent valves for the admission and exhaust of steam, the slide valve, the governor, the indicator, all took their rise in the fertile brain of James Watt, and when he left the steam engine in 1800 it possessed practically all the features with which we are today familiar.

From the year 1800 until his death in 1819 Watt withdrew entirely from business and spent his time in scientific and mechanical pursuits. In his house at Heathville Hall, near Birmingham, there is preserved intact Watt's workshop, with all his tools in good condition and practically untouched since the time when they fell from the hand of Watt himself.

In character Watt was a man of retiring and modest disposition, who made no endeavor to push himself in the public life. His last letters show his kindly disposition, in the advice which he was always ready to give to those younger than himself. All contemporary accounts of his later life speak of him with a respect almost amounting to veneration.

It would seem only fitting that a permanent memorial should be raised to the trio of pioneers who have done so much by their discoveries to advance the material happiness and prosperity of the human race. Such a memorial should be one likely to be of service to future generations, and it should make its home in the city where these three men spent their manhood, rested in their old age, where so many relics of their work are preserved and where lies all that is mortal of Watt, Boulton and Murdock.

A Plea for the Enfranchisement of Junior Members

To the Editor:

Under the provisions of the Constitution of the A.S.M.E., adopted 34 years ago, Junior members of our Society are not allowed to hold office or even to vote. The Government permits all men, and in some states all women, not only to vote, but to hold office immediately on coming of age. Our religious and social organizations are, if anything, even more liberal in this respect. Among scientific and technical societies I find the engineers are the only ones which make this age distinction. As soon as doctors or lawyers or architects are admitted to practice they are given the right to vote and hold office in their respective professional organizations. Will it be alleged that our Juniors, who in most cases have completed stiff courses in high-grade engineering schools, are less qualified to bear a responsible part in professional activities? As I pointed out in the February issue, "This class of members will always be in a hopeless minority." A Junior who joins our Society on coming of age and who later becomes eligible for full membership, spends eleven years without a vote!

Would we not be better off for having the young man's point of view? Do we not need the young man's capacity for dreaming dreams and seeing visions? When it was a matter of recruiting regiments for service in France, it was these 21-30-year olds we wanted. Have they not earned the right to full companionship in the Republic? Perhaps some one who thinks otherwise will tell us why.

Morris Llewellyn Cooke.

Philadelphia, Pa.

COMMON ERRORS IN MACHINING OF BEARINGS

(Continued from page 880)

tion which proved to be the sole cause for the very unsatisfactory performance which this wheel gave in service. Fig. 6 shows a magnification of part of the edge *b* of Fig. 3, the inner edge or surface of this wheel from which it is centered accurately to within a thousandth of an inch upon its spider. This surface had been tooled in a horizontal boring mill with a single cut, the tool set so as to produce a smooth finished surface. The cutting of this surface, however, was done with a tool that was sharp and had sufficient rake, showing that it is an easy matter to cut a bronze surface satisfactorily without distorting the natural orientation of its crystalline structure.

NEWS OF THE ENGINEERING SOCIETIES

Reports of Meetings of Engineering Society of Western Massachusetts, National Safety Congress, International Railway Association, and American Foundrymen's Association

Engineering Society of Western Massachusetts

The Engineering Society of Western Massachusetts met at Pittsfield on October 14, the afternoon being spent in inspecting the Pittsfield Works of the General Electric Company. After the trip through the works a dinner was held, at which there were present one hundred and twenty-three members. The principal speakers were C. C. Chesney, general manager of the Pittsfield Works; G. Faccioli, chief engineer of the Pittsfield Works; Charles H. Wright, Republican Candidate for District Attorney; Calvin W. Rice, Secretary of American Society of Mechanical Engineers; and S. W. Ashe. Mr. Faccioli spoke very interestingly regarding the problems connected with high-voltage installations. Mr. Ashe in his remarks dealt with Americanization problems at the Pittsfield Works.

National Safety Congress

The Eighth Annual Safety Congress, held in Cleveland, October 1 to 4, by the National Safety Council, was divided into sections representing the automotive, cement, chemical, structural, metal, mining, woodworking, rubber, packing, paper and pulp, and textile industries, and special sections relating to steam and electric railroads, women in industry, employees' representation, Americanization, health service, public safety, public utilities, and marine and navigation. The papers read at the sessions of the metals sections included: Accident Prevention in a Malleable Iron Foundry, by H. L. Church, Rockford, Ill.; Personal Element in a Safety Program for the Foundry, by H. F. Grantland, Marion, Ind.; New Ways to Put Safety Across in a Steel Plant, by H. P. Hoyne, Canton, O.; Humanizing a Steel Plant, by Philip Stremmel, Granite City, Ill.; and Practical Demonstration of Welding and Cutting, by J. Schleicher, Baltimore, Md. A complete collection of commercial and non-commercial safeguard appliances and devices was exhibited in connection with the congress. There were seventy booths, in which were shown types of safety equipment for every industry.

International Railway Association

The International Railway Congress Association, the foundations for which were laid at the congress convoked at Brussels in 1885 by the Belgian Government for the purpose of celebrating the fiftieth anniversary of its railways, has just been reconstituted under the title of International Railway Association. The Association published, up to 1914, a monthly bulletin containing, besides original articles upon all questions relating particularly to the technique, working and organization of railways, reproductions of the most interesting articles appearing in the railway reviews of the world, and detailed reviews of works dealing with railway affairs. At the closing sitting of the eighth session, held in Berne in 1910, it was decided that the ninth session should take place in Berlin in 1915, and the preparations for this session were far advanced in 1914 when Germany declared war and began the invasion of Belgium. Naturally the invasion of the country, and the measures taken by the occupying powers, resulted in the paralysis of activity on the part of the Association for nearly five years, but after the return of the Belgium Government, the Association was placed under sequestration, in pursuance of the Belgian law of November 10, 1918, owing to the fact that a portion of its assets belonged to the subjects of enemy nations. The sequestrator having ordered the dissolution and liquidation of the society, the railway administrations, members of the Association, belonging to thirty-five countries in and outside Europe, decided to transfer their property to an association established upon exactly the same bases as before, and entitled the International Railway Association.

American Society of Safety Engineers

At a special meeting held in the Engineering Societies Building, New York, on September 26, the American Society of Safety Engineers adopted a new constitution defining more specifically its scope in the technical engineering field and reorganizing its activities so as to include the adoption and application of safety-engineering standards, the maintenance of a library devoted to the particular requirements of safety engineering, and helpful coöperation with official and other safety organizations. The coöperation of the Society with the Bureau of Standards and The American Society of Mechanical Engineers was discussed, as well as the formulation of national safety codes on elevators, head and eye protection, and lumber and woodworking machinery.

Association of Iron and Steel Electrical Engineers

The thirteenth annual convention of the Iron and Steel Electrical Engineers was held in St. Louis, Mo., September 23 to 26. D. M. Petty, retiring president, outlined the progress made by the Association in the establishing of new sections at various cities and emphasized particularly the advantage of holding section meetings, which, he said, further the interest of the steel and iron industry by bringing together the men who are striving with the problems of increasing production, lowering costs and improving the quality of the plant product.

Of special importance were the reports of the safety and educational committees. Walter Greenwood, of the Carnegie Steel Company, Youngstown, Ohio, submitted the report of the safety committee, which comprised safety rules for the government of employees working on electrical equipment. In the report of the educational committee, presented by A. B. Holcomb, of the Standard Tin Plate Company, Canonsburg, Pa., the necessity of training electrical employees of foreign birth was strongly emphasized. Discussion of the reports of these committees brought out the suggestion that safety should be considered before tonnage in all cases, and that it is more practicable to teach men what to do than what not to do.

The report of the electric-furnace committee of the Association outlined the present status of electrical furnaces in the steel industry. The discussion brought out the insufficiency of the available technical literature on electric-furnace reactions. Concerning furnace-lining thicknesses, the opinion was expressed that too thin a lining wasted heat, while an abnormally thick lining limited the capacity of the furnace. The careful training of the operator was considered to be of paramount necessity for securing the successful operation of any electric furnace. On the question of the shape, it was stated that the furnace body should be of such shape as to give equal heat at every point.

Calvert Townley, President of the American Institute of Electrical Engineers, presented an interesting historical sketch of the growth and development of electrical power as applied to the iron and steel industry. He pointed out that coöperation between

the various electrical societies was necessary in deriving the greatest benefits.

Much attention was attracted by an exhibition in which thirty-four manufacturers displayed electrical equipment.

American Foundrymen's Association

Remarkable advances in the design, development, and manufacture of metal-working and foundry equipment and in the solution of problems involved in casting practice and plant operation, were evidenced in the technical sessions and exhibition of the twenty-fourth annual convention of the American Foundrymen's Association, which was held in Philadelphia from September 29 to October 3 concurrently with the annual meeting of the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers. A significant feature of the convention was the attendance of more than a score of visitors from England, France, Norway, Japan, India, and Australia.

A paper on The Application of Powdered Coal to Malleable Annealing Furnaces, presented by Charles Longenecker, of the Bonnot Co., Pittsburgh, contained a description of the plant of the Pressed Steel Car Co., formerly the Pennsylvania Malleable Co., where powdered coal is being successfully employed for operating annealing furnaces. The figures quoted showed that the cost of operating one furnace ranges from $8400 a month with fuel oil to $2625 a month with powdered coal. That steel is being melted with 450 to 600 lb. of powdered coal per ton of charge and that 15 malleable foundries using powdered coal for annealing have a fuel ratio of from 500 to 700 lb. of coal per ton of castings was stated by A. J. Grindle, of the Combustion Economy Corporation, Chicago, who discussed the question of Powdered Coal for the Small Foundry.

Statements of costs covering the operation during four months of a 20-ton acid open-hearth furnace and a 6-ton basic electric furnace were compared and discussed by E. H. Ballard, of the General Electric Co., West Lynn, Mass. Mr. Ballard's figures showed that the cost of making electric steel is comparable with that of the open-hearth product. A. W. Merrick of the General Electric Co., Schenectady, N. Y., in the Refining of Cupola Malleable Iron in the Electric Furnace, presented the results of experiments on the duplex process of melting malleable cast iron, using a cupola and electric furnace. Special attention was paid to the effect of the electric furnace in reducing sulphur and to the influence of manganese. In one experiment the material contained 0.20 per cent sulphur before charging in the electric furnace; 15 minutes later a sample showed that the sulphur had been reduced to 0.057 per cent. Mr. Merrick offered several conclusions, among which was the statement that by the duplex process of melting malleable cast iron, using a cupola and electric furnace, it is possible to make iron of any carbon and silicon desired by adding the proper amounts of steel and ferrosilicon to the bath.

A special session was held to discuss the problem of industrial relations. The authors of four papers advocated systematic training for foundry apprentices, journeymen, and foremen along lines which will familiarize them with the economic conditions that play an important part in determining the administrative policies of the employers. The slogan "multiply yourself through your foreman," introduced by one of the speakers, impressed manufacturers as being a pertinent suggestion to remedy present conditions.

The exhibits of molding machines, sand-blasting equipment, and metal- and wood-working machinery furnished ample proof that engineers have taken full advantage of the cessation of hostilities to engage in experimental work and to further the development of labor-saving machines. Among the noteworthy machines displayed by the manufacturers of molding equipment was a device for producing tractor transmission housings entirely in green sand. Other new equipment included a combination split-pattern machine display, a jarring stripping-plate machine, an agricultural tractor, a 16-in. jolt roll-over machine fitted with a pattern and operated as a molding machine, and a combination jolt split-pattern molding machine equipped with an automatic slow-starting pattern-draft cylinder operated by oil and controlled by a knee valve.

American Institute of Mining and Metallurgical Engineers

The one hundred and twentieth meeting of the American Institute of Mining and Metallurgical Engineers was held at Chicago from September 22 to 26, inclusive. Exceedingly comprehensive and valuable papers were prepared for the twelve technical sessions, in which the subjects discussed were: Iron and Steel; Sulphur Coals; Pyrometry; Non-Ferrous Metallography; Non-Ferrous Metallurgy; Coal and Gas; Mine Taxation; Mining and Local Resources; Geology; Milling; Oil; and Industrial Organization. It will be of interest to call attention to some of the papers presented, especially at the iron and steel session.

A report of the work being done at the United States Bureau of Standards for the purpose of determining the gases in steel and the deoxidation of steel, was submitted by J. R. Cain, Chief of the Section of Chemical Metallurgy. The aim has been to examine critically some of the simpler methods in order to remedy any defects, to make them more rapid, and to form some idea of the metallurgical significance of the results obtained by them. The final object of the work, which is not altogether complete, is to devise a few simple methods which it is hoped will be useful to the steel manufacturer in controlling his deoxidation processes.

Erosion Tests of Rifle Barrels were described by Major A. E. Bellis, Ordnance Department. Three barrel blanks were prepared from the same bar of steel and treated differently. The first barrel was heat-treated by quenching from 1500 deg. fahr. and drawing for two hours at 1200 deg. fahr.; the second barrel was rolled at 1350 deg. fahr.; and the third barrel was rolled at 1200 deg. fahr. The three barrels were submitted to a 13,000-round firing test with measurements for accuracy and erosion. The accuracy was measured by firing ten rounds on each two targets at 500 yd. with muzzle rest; the tests were made after each 2000 rounds from 4000 to 10,000 and then every 1000 to 13,000; the firing was at the rate of 10 to 20 rounds per minute per rifle, cooling the rifles with water after each 100 rounds. The relative erosion was shown by the increase of diameter of the lands at the muzzle, which was 0.0018 in., 0.0020 in. and 0.0029 in. for the three barrels, respectively. After the tests the three barrels were sawn lengthwise and the appearances of the sections examined. It was concluded that the homogeneous structure of a heat-treated barrel offers the best resistance to erosion.

The results of an experimental study of the Effect of Time and Low Temperature on Physical Properties of Medium-Carbon Steel were presented by G. A. Reinhardt, metallurgist, and H. L. Cutler, assistant metallurgist, The Youngstown Sheet & Tube Co. In the first series of tests, four cores were drilled from each of six untreated blooms. Two cores from each bloom after being machined were rested for two days at room temperature, and then they were tested; the two duplicate cores after being machined were rested for two days on top of a Hoskins hairpin-type electric furnace where the temperature was kept at about 120 deg. cent. A second series of tests was also made in identically the same manner except that the test pieces were given a rest of four days before being tested. These two series of tests showed that a light increase in temperature resulted in a great increase of the possible elongation and reduction of area of the specimen, and also with the increased length of rest at the temperature of the top of the furnace. The increase in tensile strength was greater in the case of the two days' rest than in the case of the four days' rest.

Other interesting papers presented at the iron and steel session were: Blast Furnace Refractories, by Raymond M. Howe; Effervescing Steel, by Henry D. Hibbard; Aircraft Steels, by Albert Sauveur; Manufacture of Steel Rails, by Robert W. Hunt; Cooling Properties of Technical Quenching Liquids, by N. B. Pilling and T. D. Lynch; Differential Crystallization in Cast-Steel Runner, by Francis B. Foley; Manufacture and Properties of Light-Wall Structural Tubing, by H. J. French; Oxygen in Cast Iron and Its Applications, by Wilford L. Stork; Graphitization of White Cast Iron upon Annealing, by Paul D. Merica and L. J. Gurevich; Experimental Data Obtained on Charpy Impact Machine, by F. C. Langenberg.

ENGINEERING COUNCIL

Engineering Council[1] is an Organization of National Technical Societies of America, Created to Consider Matters of Common Concern to Engineers, as Well as Those of Public Welfare in Which the Profession is Interested

Engineering Council Joins Chamber of Commerce

WORD has been received by Engineering Council that the organization has been elected to membership in the Chamber of Commerce of the United States. In joining this great association of trade and commercial organizations, Engineering Council adds its strength to organized business and gives its members an opportunity to register their views with the central body in the consideration of national questions that affect business. Engineering Council represents five great national societies of professional engineers,— the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Society for Testing Materials. These societies have an aggregate membership of 41,000.

Engineering Council has appointed as National Councilor to represent it in the National Chamber, Mr. Harold W. Buck, of Viele, Blackwell & Buck, Consulting Engineers, New York City, and past-president of the American Institute of Electrical Engineers, and as alternate Mr. Irving E. Moultrop, of the Edison Electric Illuminating Company, Boston, Mass., member of The American Society of Mechanical Engineers and American Institute of Electrical Engineers.

The Chamber of Commerce of the United States was formed in 1912 as a means of bringing together all of the industrial and business elements of the country. How well it has succeeded is shown in a recent statement that the membership of the Chamber now consists of more than 1100 organizations in every state of the Union, in the outlying possessions and of all the principal American chambers of commerce abroad.

One of the chief aims of the National Chamber is to obtain the best thought on national questions that concern business. This is done through a system of referenda on which the more than half a million individual members of the organizations comprising the Chamber are entitled to vote through their associations. The opinion of business, thus obtained, is transmitted to Congress and to public officials and is given to the public.

The National Chamber will be able to render assistance to Engineering Council in many ways. It will receive weekly a general bulletin containing the latest and most authentic news of what is transpiring at Washington. There is also a special legislative bulletin issued weekly while Congress is in session following the progress of all legislation concerning business. Special bulletins are issued also as occasion arises. Members of the National Chamber also have the privilege of using all the facilities of the Chamber's offices in Washington when information is desired. This applies to every division of business, since the Chamber's organization is made up so that each general division of business has in Washington a special bureau to care for its particular needs.

Engineering Council Holds Important Meeting

On October 16, in the rooms of The American Society of Civil Engineers in the Engineering Societies Building, New York, Engineering Council held an all-day session, at which many matters of interest and importance were considered. Chief among these were reports of the Committee on Classification and Compensation of Engineers, the National Service Committee and the Committee on Curricula of Engineering Schools. Space will not permit, however, of an extended discussion of these and other reports, and for the present the brief abstract of the minutes of the meeting presented below must suffice.

The report of the Committee on Curricula of Engineering Schools, however, deserves special mention. Dr. Alexander C. Humphreys, President of Stevens Institute of Technology, is chairman, and while the committee is not prepared as yet to recommend a six-year course for colleges of engineering, it nevertheless called attention in its report to the fact that both Columbia University and the Massachusetts Institute of Technology are now conducting six-year courses in engineering in addition to their regular four-year course. The problem is also being studied and experimented with by other universities. The committee, however, does endorse the proposition to extend and enlarge the facilities for vocational training throughout the United States, and particularly in the great industrial centers. The committee also goes on record as favoring universal military training.

Employment Bureau reported 17,000 interviews, 4800 men registered, more than 1000 placed and total expenditure $10,600, in past 10 months; 60 to 70 men call daily.

National Service Committee active in connection with National budget legislation, Congressional Commission on Reclassification of Salaries, mileage for former engineer officers, Interstate Commerce Commission and International Joint Commission vacancies, Industrial Conference, census classification of engineers, U. S. Topographical Mapping and Department of Public Works. Washington office used increasingly by engineers and Government.

Chamber of Commerce has admitted Council to membership. H. W. Buck appointed National Councilor and Delegate, and I. E. Moultrop alternate.

National Department of Public Works: petition to Chamber of Commerce was voted by Engineering Council asking referendum on bill for Department of Public Works.

License Committee, at five-day session in Chicago, October 13 to 17, revised draft of typical law for registration of engineers.

Classification and Compensation of Engineers: progress in collecting and digesting data on Federal, Railroad, State and Municipal engineers. Final report on Federal service this month. Increases granted railroad engineers below $2500.

Fuel Conservation Committee recommended support of legislation for investigating super-power generation and distribution in Boston-Washington district; so voted.

Joint Conference Report of Development Committees was discussed and letters sent to Founder Societies endorsing general plan for a national engineering council.

Financial Statement: total resources, $50,393; expended, 9 months, $32,651, including $10,601 for Employment Bureau and $17,038 for Washington office.

Tentative Budget 1920: $60,000 needed for all purposes. Appropriations of Founder Societies must be supplemented by contributions from individuals.

Appeal for Funds to be made at once to engineers throughout the country.

Water Conservation Committee reported twenty-seven correspondents appointed in as many States, and much useful information collected.

Curricula of Engineering Schools: Committee reported on six-year course.

Reconstruction Commission, New York: Advisory Committee's recommendations sent to governors of all States and many civic bodies in New York.

Patents Committee: three bills, based on report of committees of National Research Council and Engineering Council, now before Congress.

Jurisdiction Awards in Building Industry: Board held first meeting in Washington August 11. Report by Council's representative, R. P. Miller.

Types of Government Contracts: important committee appointed.

Payment for Estimating: three delegates appointed to meet Associated General Contractors and American Institute of Architects, in Chicago.

National Budget: four delegates sent on invitation of committee of House of Representatives discussed budget legislation.

[1] Officers of Engineering Council: J. Parke Channing, *Chairman*, Alfred D. Flinn, *Secretary*; Engineering Societies Building, 29 West 39th Street, New York.

NATIONAL SERVICE COMMITTEE

Contributed by the Washington Office[1]

Engineering Legislation in Congress

Although Congress is chiefly engaged with problems relating to the Peace Treaty and the industrial unrest throughout the country, there have, nevertheless, been presented to it numerous bills and measures dealing particularly with engineering subjects. These bills deal with such matters as war minerals relief, soldiers' land settlement, tariff, water power, etc. Most of them are now being considered by the various committees of Congress and brief abstracts of them are herewith presented.

United States Reclamation Work

An appropriation of $250,000,000 for the purpose of carrying on and completing irrigation projects, which have been begun or estimated for and for the investigation and completion of such new projects as may be deemed feasible and desirable to undertake, is proposed in recent bills. According to the Director of United States Reclamation Service, it will cost $112,134,000 to complete projects that have been started. A total of 1,552,555 acres will be susceptible of irrigation, and the total ultimate irrigable area will be 2,948,161 acres.

Another important bill relating to irrigation work has had the special attention of the House. It proposes to allow water supply for reclamation projects to be used for miscellaneous purposes. Under the existing law, much inconvenience and trouble has been caused, owing to the fact that water for reclamation projects could not be used for domestic purposes, for railway engines and the miscellaneous needs of communities. This bill is expected to shortly receive consideration in the House.

War Minerals Relief

Legislation proposing to liberalize the War Minerals Relief Act is now before the Committee on Mines and Mining of the House. This Committee is considering House Joint Resolution No. 170, which brings out the fact that war minerals claims in excess of $15,000,000 had been filed but that a considerable portion of the claims are being denied because of the Attorney-General's interpretation of the Act. The resolution states that it was the intention of Congress in passing the War Minerals Relief Act "that all producers of the minerals mentioned should be repaid such sums as they are in equity and good faith entitled." The Attorney-General's opinion is that the request or demand must have been made on the claimant direct. The resolution provides that all claimants "who in response to any personal, written or published request or demand from any of the Government agencies mentioned in said Act in good faith expended money in producing or preparing to produce any of the ores or minerals named therein . . . and have heretofore filed their claims within the time and in the manner prescribed in said Act" are to be reimbursed for the net losses incurred. Another important feature of the resolution is that in the event that the appropriation is not sufficient to liquidate all claims allowed that a pro rata share of the appropriation is to be awarded to the claimants. Fifty per cent of the amount of any adjudicated claim is to be paid immediately.

Soldier Settlement Bill

The Mondell Soldier Settlement Bill, which is now before the House, is again coming actively to the front and determined efforts are being made to have it passed. Great differences of opinion have developed and the entire discussion on the soldier settlement plan seems now to be around the Mondell bill. Those who favor the bill point out the fact that it is the continuation of the historic policy of opening the way for the veterans of war to settle on the land. In the absence of public lands suitable for farming the acquisition of land in private ownership is necessary. It is argued that the bill comprises good business policy because tracts of poor land will be cleared, graded and irrigated. This is to be done by the soldiers, thus affording an opportunity to accumulate the amount of money required for the first payment on such property as may be alloted to them. Limited sums of money to be loaned for construction of permanent improvements to give a fair margin of security and at the rate of 4 per cent interest is held to be a reasonable income to the Government. Colonization of soldier settlers is necessary to proper Government supervision and to the securing of maximum economy and efficiency. Some action of this kind of legislation is apparently forced because of different schemes which have been suggested to either compensate veterans of the world war or to give them other opportunities.

Tariff Bill

When the House passed the magnesite tariff bill, it added one more to the jam of tariff bills awaiting action of the Senate Committee on Finance. As passed the bill provides a duty of one-half a cent per pound on magnesite ore; three-quarters of a cent on calcined dead-burned and grain magnesite, and three-quarters of a cent per pound and 10 per cent ad valorem. These rates represent a considerable reduction from the tariff proposed by the House Ways and Means Committee of three-quarters of a cent on ore, one and one-half cents on calcined dead-burned and grain magnesite and a duty of 25 per cent ad valorem on magnesite brick. The duties imposed are claimed to be high enough to prohibit imports of magnesite, and the increased rate would add only three and three-quarters cents per ton to the price of finished steel.

The question of a strong protective tariff on graphite is now before the House. The original writing of this bill provides a duty of two cents per pound on all imported amphorous graphites; a duty of three cents per pound on crystalline, lump and chipped graphite; and a duty of six cents on all large sizes of crystalline graphite. The first provision affects graphite produced in Mexico and Korea; the second provision affects the importation of the better grade of Ceylon graphite, while the last provision affects Madagascar and Canadian flake. The bill if enacted will practically exclude the importation of Canadian graphite and Madagascar flake.

The delay in considering the tariff bills before the Senate committee is due to the fact that it opposes "piece-meal" tariff legislation as it is conducted by the House, and they do not regard the matter of general revision of tariff with enthusiasm until such time as world conditions are in a more stable state. Many are of the opinion that the enactment of a general anti-dumping bill would protect American interests until it is possible to form a better idea of international trade relationships.

The United States Tariff Commission in reporting to the Committee on Ways and Means pointed out the fact that it would be unfair to group all scientific instruments together and place a blanket duty on them. And this, they say, is just an example of the plan to adapt a general tariff. Investigations further show that, in many cases, superior articles are now produced in the states to those formerly imported.

Machine Tools for Technical Institutions

Recently, the House passed a bill authorizing the Secretary of War to sell to schools, universities and colleges surplus machine tools which could be used for educational purposes. The educational institutions were to be charged 10 per cent of the original cost of these tools.

The Senate Committee on Military Affairs has now reported another bill authorizing the Secretary of War to transfer permanently to the Federal Board for Vocational Education, about $250,000 worth of this equipment. Surplus machine tools are to be loaned to the board, which, in turn, distribute them to schools and colleges throughout the country. This bill proposes to place

[1] Washington Office in charge of M. O. Leighton, *Chairman*, National Service Committee, McLachlen Building, 10th and G Streets.

the title to these machines in the hands of the Vocational Board, which is to report to Congress annually as to the disposition and use of the tools.

Water Power Bills

Engineering Council through its Water Conservation Committee is making determined efforts to assist in passing a bill (H.R. 3184) which will give the country good water-power legislation. The interest shown by requests for exact information on this bill indicates that the active interest and support required will be given by engineers. It is hoped that opposition to the bill, led by Wisconsin senators, will be broken through the influence of Wisconsin engineers.

The bill as reported to the Senate contains several important changes in the text of the bill passed by the House but these are not fundamental changes, and it is contemplated that the House will concur. The Senate Committee has explained and clarified the definitions of "reservations," "navigable waters" and "costs." A proportionate license fee not exceeding twenty-five cents per horsepower is proposed, which is to defray costs of the administration of the act. Fair rentals are to be charged for Government dams and other Government property on water-power sites. The House bill gave the Commission unlimited power to fix annual charges, whereas the Senate amendment limits this blanket power as indicated above. A change was made to provide that in case the United States does not exercise the right to take over the works, the license tendered shall be "on reasonable terms" and "which is accepted" by the original or the new licensee. That provision was thought necessary to make it certain that capital would invest under the law. A provision for severance damages was stricken out by the sub-committee and was restored by the full committee, so that it now appears in the bill.

Delay faces the action on this bill because past efforts to have immediate consideration indicate that it must await the disposal of the Peace Treaty before it comes up for consideration on the Senate floor. In reporting the bill to the Senate calendar, Senator Jones of Washington, chairman of the Committee on Commerce, pointed out its advantages as: "a saving of coal and a lower price for that used; a saving of oil, and a lower price for that consumed; more efficient transportation, and lower cost of service; the development of new industries; the building up of new communities; the creation of new property values, subject to taxation for the support and maintenance of local and state governments; and added employment for labor and increased markets for agricultural products," and urged that "we should pass legislation which will lead private capital and enterprise to develop these resources under such regulations as will give consumers good service and cheap power or the Government itself should proceed to make this development." This bill proceeds on the theory of private development with ultimate public ownership possible. While some of the fundamental provisions of this measure do not meet the approval of the members of the committee, we deem it wise to accept them in view of the legislative situation, rather than incur the result of no legislation on this important subject.

Budget Legislation

Through the National Service Committee of Engineering Council arrangements were made for the Public Affairs Committee and other representatives of Engineering Council to appear before the Select Committee on the Budget on October 1. Mr. Charles Whiting Baker, chairman of Council's Public Affairs Committee, gave reasons for the general desire among engineers for the adoption of a budget system, and pointed out the importance of such a system in Government work of an engineering nature. Mr. N. P. Lewis, Chief Engineer, Board of Estimate and Apportionment, New York City, explained the budget system as used in New York, showing that under existing conditions it would practically be impossible for New York to get along under any other system. Director and Chief Engineer of United States Reclamation Service, Mr. A. P. Davis, pointed out the necessity of the proper segregation of Government bureaus before an effective budget system can be adopted, and as a correct example of segregation, cited the plan proposed in the Jones-Reavis bill, whereby all related bureaus having engineering activities would be placed in the same department. Such a plan would simplify and make possible the efficient use of the budget system and of lump sums appropriation where responsible department heads could be obtained. Mr. W. R. Warner of the Warner-Swasey Company, Cleveland, pointed out the great advantages that had accrued to private engineering operations through the use of the budget system. It was pointed out during the hearing that engineering work was particularly hampered by the present system of appropriation. The lump sum or "continuing contract" method was held to be necessary in many cases. Illustrations of the success of the plan are the Panama Canal, levee work being done on the Mississippi River and the large reclamation projects.

There are obviously three phases of budget legislation: (1) formation of budget, (2) action on budget by Congress, and (3) supervision and control of the execution of budget. A new bill has been introduced and reported to the House calendar which aims to cover the first and third phases, while the second phase is to be cared for by House legislation which proposes a much larger appropriation committee to care for the budget in Congress. The main bill provides executive responsibility for the budget with Congressional authority to raise or lower it. The President, assisted by the Bureau of the Budget, is to prepare the estimates, which are submitted to him by the several executive departments, and no other officer is to submit estimates to Congress unless by special request. Provisions are made for an alternate budget in which estimates are to be made in the same form as they appear in current appropriation laws. The bill provides an independent establishment known as Accounting Department, because it is deemed necessary that Congress should have a check on expenditures under the direction of comptroller general and assistants, which would not be effective if the comptroller was appointed by the President. In reporting this bill, the chairman of the Select Committee on the Budget has explained that the bill is not intended to be the last word in budgetary legislation but is intended to correct weaknesses and to be a step in the right direction which will very probably have to be extended and further improved .

Engineers in the 1920 United States Census

As a result of Engineering Council's request to the Director of the Census, the National Service Committee has been successful in effecting a reclassification of engineers so that all technical engineers will be listed as such, separately and distinctly from the non-technical engineers. Thus, the next census will bring on enumeration of all technical engineers together as one unit under the main headings of Civil, Mechanical, Electrical, and Mining. Architects will also be enumerated separately.

This will enable the engineering profession, the Government or any other interested organization or person to know exactly how many technical men there are in the United States and in each State. Under separate headings the enumeration will also include non-technical engineers (stationary engineers, locomotive drivers and other engine-men); but there will be no group heading for the latter, and in order to get the totals of non-technical engineers (enginemen) all of the various grades of this classification would have to be sorted out and added.

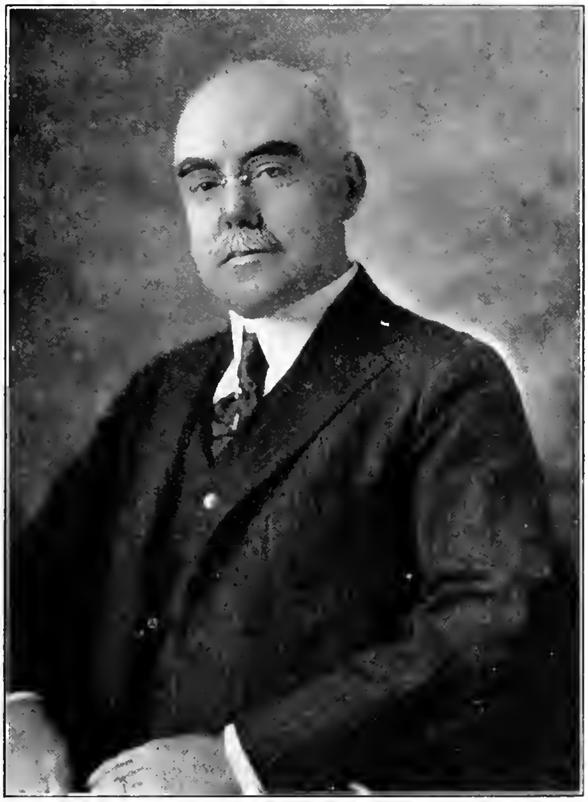
There are of course many practitioners of engineering who do nor ordinarily classify themselves under any one of the four headings given above and others there are whose practice extends into more than one field. More numerous headings or more complex classification is impracticable in the work of the Census Bureau. It is believed that every professional engineer can, with very little violence to the facts, place himself in one of the broad classes adopted for the 1920 census: Civil, Mechanical, Electrical, Mining. With the general coöperation of all engineers along these lines a much better enumeration should result than in any preceding census.

NECROLOGY

CHARLES EDWARD LORD

Charles Edward Lord, general patent attorney and manager of the patent department of the International Harvester Company, Chicago, died suddenly on September 25, as the result of injuries received in an accident at the Deering Works the evening before.

Mr. Lord was born in Somerville, Mass., on October 31, 1875, attended the public and high schools at Somerville, and was graduated from the Massachusetts Institute of Technology with the degree of B.S. in 1898. For a year he was employed in the inspection department of the American Telephone and Telegraph Company, with headquarters at Philadelphia. He then returned to the Massachusetts Institute of Technology as instructor for a short time, and later became assistant examiner in the United States Patent Office, Washington, D. C.



Charles E. Lord

In 1902 he entered the employ of the General Electric Company as assistant attorney in the patent department, which position he resigned in 1904 to take charge of the patent departments of the Bullock Electric Manufacturing Company and the Allis-Chalmers Company, spending four years at Cincinnati and four years at Milwaukee in this work. During part of this period he was president of the Bullock Electric Company.

He studied law at the Georgetown University Law School, Washington, D. C., was admitted to the bar in Ohio, Wisconsin and Illinois and to practice in the federal courts and in the Supreme Court of the United States.

Mr. Lord was associate editor of the Encyclopedia of Engineering and wrote several textbooks for this publication when it was getting under way. He was a lecturer on patent law at Marquette University, and during the days of the War was a member of the War Committee of the Technical Societies of Chicago. For two years and until recently he was chairman of the committee on patents of the National Implement and Vehicle Association.

During 1918 he served as chairman of the Chicago Section of our Society and at the time of his death was a member of the Committee on Aims and Organization, in the work of which he took a keen and active interest. He was also interested in the pioneer movement inaugurated by the Western Society of Engineers, in Chicago, for a strong and all-embracing local engineering society in that city.

His ability as an inventor, though not widely known, is evidenced by a record of nearly forty United States patents.

Mr. Lord was a fellow of the American Institute of Electrical Engineers, a member of the Society of Automotive Engineers, the Engineers' Club of Chicago, the American Patent Law Association, the University Club of Washington, D. C., and several other technical and social organizations. He became a member of our Society in 1909. [F.F.F.]

The following resolution was adopted by the executive committee of the Chicago Section:

> Whereas: Our fellow-member and former chairman of the Chicago Section, A.S.M.E., Mr. Charles E. Lord, who has served devotedly and who has sacrificed much in the interests of the mechanical engineers of the country, the Society and Section, has unfortunately been taken from us in the midst of a useful and active career; be it
>
> *Resolved*, By the Executive Committee of the Chicago Section that we record our deep regret at the loss of our friend and fellow-engineer. That we wish to express our appreciation of his high qualities, his interest in his profession, and the untiring zeal with which he has labored for its advancement and of its members, his great ability and high attainments. Be it further
>
> *Resolved*, That we express to his family and his associates in business our appreciation of his worth and our sincere sympathy with them in their loss.
>
> Executive Committee, Chicago Section,
> Arthur L. Rice, *Chairman*,
> G. R. Brandon, *Secretary*.

A similar resolution was passed by the Committee on Aims and Organization upon the receipt of the news of Mr. Lord's death.

JAMES WEBSTER CULLEN

James W. Cullen, First Lieutenant, Signal Corps, United States Army, died suddenly on June 28, 1919, shortly after his return from service overseas. Lieutenant Cullen was born on March 15, 1888, in Edgewater, a suburb of Chicago. He was educated in the schools both of that city and Hamilton, Ohio, later attending the Miami and Ohio State Universities. He was formerly connected with the Niles Tool Works, the Cullen & Vaughan Construction Co. and the Midvale Steel Company, having charge of the Pittsburgh sales office of the latter concern. He resigned from the sales department of the Elwell-Parker Company to enter the service, serving both in France and Italy.

Lieutenant Cullen was a member of the Chamber of Commerce of Pittsburgh and of several clubs and fraternal organizations. He became an associate-member of the Society in 1916.

FRANK J. LOGAN

Frank J. Logan, who, until his retirement in 1914, was vice-president and treasurer of the Logan Iron Works, Brooklyn, died on April 10, 1919. Mr. Logan was born on September 25, 1855, in Brooklyn, N. Y. He was educated in the public schools of the city and later attended the Flushing Institute and Cooper Union. He started work with his father in the Logan Iron Works. At the time of his father's death, in 1879, Mr. Logan entered the firm and continued with them until his retirement, May 1, 1914.

Mr. Logan belonged to a number of social clubs and business organizations. He became a member of the Society in 1894.

LOUIS MOHR

Louis Mohr, president and consulting engineer of John Mohr & Sons, Chicago, died on August 24, 1919. Mr. Mohr was born on September 27, 1858, in Chicago and was educated in the schools of that city prior to his entering the University of Illinois, where he completed in three years a four-year course in mechanical engineering. He was connected for short periods thereafter with the North Chicago Rolling Mills and the Old Excelsior Iron Works. In 1882 he associated himself with his father and brothers in the firm of John Mohr & Sons as consulting engineer. About ten years later he assumed the duties of secretary of the firm and from 1917 to the time of his death held the office of president.

Mr. Mohr was a member of the American Society of Naval Engineers, the American Institute of Mining Engineers, the Society of Western Engineers and a large number of other societies and clubs. He became a member of our Society in 1886.

LLOYD CECIL REYNOLDS

Lloyd C. Reynolds was born in Atglen, Pa., on November 20, 1893. He received his early education in the local schools and later entered Drexel Institute, taking the mechanical-engineering course, from which he was graduated in 1913. He was associated from 1913 to 1916 with the Overland Motor Company, Philadelphia, the Chambersburg Engineering Company, Chambersburg, Pa., and the Remington Arms Company, Eddystone, Pa. From July 1916, to the time of his death, January 6, 1919, Mr. Reynolds was employed as assistant engineer in the steam-engineering department of the Midvale Steel & Ordnance Co., Coatesville, Pa.

Mr. Reynolds was a member of the Drexel Club of Engineers. He became a junior member of the Society in 1917.

JAMES R. FLETCHER

James R. Fletcher, factory manager of the P. & F. Corbin Co., manufacturers of hardware, New Britain, Conn., died at his home in that city on September 13, 1919. Mr. Fletcher was born on February 21, 1867, in Jersey City, N. J., where he was educated and learned the trade of machinist. He served his apprenticeship with the New Haven Clock Company in tool making and die sinking. He was formerly associated with the American Cash Register Company, the National Cash Register Company, Sargent & Co., the New Britain Hardware Company, of which he was in charge for seven years, and the Yale & Towne Manufacturing Co., of which he was assistant superintendent.

J. R. FLETCHER

In 1906 Mr. Fletcher became associated with the P. & F. Corbin Co. as manufacturing expert to assist the general superintendent. Later he was made factory manager, a position created to give him the wider range warranted by his exceptional ability.

He was a member of a number of fraternal organizations. He became a member of the Society in 1906.

HUGH M. WILSON

Hugh M. Wilson, who, until his resignation in January 1917 was for six years first vice-president of the McGraw Publishing Company, died suddenly on September 19, at his home in Stockbridge, Mass. Mr. Wilson was born in June 1866, in Jacksonville, Ill. He was a graduate of the Illinois College. His first journalistic work was as a reporter for the daily press of the Middle-West. He was subsequently connected in varying capacities, including secretary, business manager, editor and president with the *Mississippi Valley Lumberman*, the *Northwestern Railroader*, the *Railway Age*, and the *Electric Railway Review*. After a year with the Barney & Smith Car Co., Dayton, Ohio, as vice-president in charge of sales, Mr. Wilson joined the McGraw Publishing Company.

Mr. Wilson became an associate of the Society in 1913.

RICHARD HAMMOND

Richard Hammond, former president of the Lake Erie Boiler Works and the Lake Erie Engineering Works, died on October 9, 1919. Mr. Hammond was born on January 27, 1849, in Thurles, Tipperary County, Ireland, and received his early education there in the parochial schools, coming to this country at the age of thirteen. He served his apprenticeship in the boiler-making trade in Troy, N. Y. In 1872 he moved to Titusville, Pa., and several years later bought out his partner's interests in an oil-well boiler and manufacturing business.

In 1880 he went to Buffalo and established the Lake Erie Boiler Works which soon obtained an unusual reputation for the manufacture of heavy marine boilers. In 1890 he organized the Lake Erie Engineering Works, the shops of which were equipped with the most modern tools especially designed and constructed according to Mr. Hammond's own specifications by the Niles Tool Works. He continued at the head of both concerns until 1917 when he retired from active business life.

Mr. Hammond was a member of the Engineer's Club of New York. He became a member of the Society in 1890 and devoted a great deal of his time and practical boiler-manufacturing experience to the Boiler Code Committee of the Society of which he was a member.

CYRUS T. RAYNER

Cyrus T. Rayner was born in New York City on January 28, 1879. He was educated in Southern schools and was graduated from Tulane University in 1902 with the degree of M. E. He spent one year in graduate work when he became connected with the Mississippi River Commission as junior engineer in charge of local surveys. From 1911 to 1912 he was associated with C. T. Rayner & Sons, consulting engineers. In 1912 he became first assistant engineer on the New Orleans Levee Board and four years later was made chief engineer, which position he was holding at the time of his death, January 19, 1919.

Mr. Rayner became a member of the Society in 1916.

OIL PIPE LINES

(*Continued from page 883*)

$$\text{Net hp.} = 17 \times \text{thousands of bbl. per day} \times P/1000$$
$$\text{B.hp.} = 20 \times \text{thousands of bbl. per day} \times P/1000$$

Since the horsepower varies directly as PQ and P varies directly as Q^2, it follows that hp. varies directly as Q^3.

Another relation of value in making rapid pipe-line calculations is the ratio between the diameter D and length L with the discharge Q and the pressure P remaining constant. From the friction formula [2], it will be seen that P varies directly as v^2L/D. Assuming P constant, L varies directly as D/v^2. For the same discharge, Formula [3], that is with Q constant, v varies directly as $1/D^2$. Therefore v^2 would vary directly as $1/D^4$. Substituting this value for v^2 above, it is seen that L varies directly as $D/(1/D^4)$, or in other words, L varies directly as D^5. This means that for the same discharge and pressure, i. e., the same friction, the length of the line would vary directly as the fifth power of the diameter.

Taking 6 in. as unity the fifth powers of several different diameters are as follows:

D =	6	8	10	12
D^5 =	1.0	4.2	12.8	32

An example will show how easily these relations are utilized. Let a proposed pipe line be made up as follows:

2 —	6-in. lines,	8 miles long	(Y-branch)
1 —	6-in. line,	6 miles long	
1 —	8-in. line,	10 miles long	
1 —	12-in. line,	12 miles long	

With the particular oil to be transported the pressure per mile when pumping 10,000 bbl. a day through a 6-in. line will be assumed as 20 lb. per mile. What, now, will be the pressure for 17,000 bbl. per day through above line and what will be the net hp. and b.hp. required?

Since P varies as Q^2, the pressure for 17,000 bbl. will be $\left[\frac{17{,}000}{10{,}000}\right]^2$ or 2.89 times the pressure for 10,000 bbl. The pressure in the line would then be 2.89×20 or 57.8 lb. per mile.

Inasmuch as the velocity is halved when using two 6-in. lines for the 8-mile section, each line carrying an equal amount of oil, the equivalent length of 6-in. line for each branch would be only two miles, the length varying directly as the square of the velocity. The length of 6-in. line equivalent to the 8-in. pipe would be 10 miles divided by the ratio of the fifth powers of the diameters 6 in. and 8 in. or $10/4.2 = 2.38$ miles. In a like manner the length of 6-in. line equivalent to the 12 miles of 12-in. pipe would be $12/32$ or 0.37 miles. In other words, the equivalent length of 6-in. pipe in the line under consideration would total 12.75 miles. Under a pressure on the line of 57.8 lb. per mile, the total pressure on the line would be 12.75×57.8 or 737 lb.

Making use of the simple formula for hp. already derived we have

$$\text{Net Horsepower} = 17 \times \frac{17{,}000}{1000} \times \frac{737}{1000} = 213$$

$$\text{Brake Horsepower} = 20 \times \frac{17{,}000}{1000} \times \frac{737}{1000} = 250$$

No doubt many other useful relations could be derived for the purpose of expediting pipe-line calculations, but those which have been presented are among the most useful.

THE ENGINEERING INDEX

(Reg. U. S. Pat. Off.)

Published Monthly by The American Society of Mechanical Engineers

The Engineering Index was Founded in 1884 by the Association of Engineering Societies; Published from 1895 to 1919 by The Engineering Magazine Company; and Acquired January 1919 by The American Society of Mechanical Engineers

THE following pages form a descriptive Index to articles on engineering and related subjects in current periodicals. In its preparation the Society's engineering staff regularly examines all of the technical journals and society publications received by the Engineering Societies Library, which form one of the greatest and most complete collections of scientific periodicals in the world, comprising upward of 1100 distinct publications in some ten languages. Cross-references are freely introduced in the Index, and in all cases where the titles of articles are not sufficiently descriptive, explanatory sentences are appended. The main abbreviations used in the items are given at the bottom of this page.

Mechanical Engineering

AIR MACHINERY

Air-Operated Tools

The Use of Compressed Air in Modern Industry, A. W. Swan. Can. Machy., vol. 22, no. 10, Sept. 4, 1919, pp. 253-255, 8 figs. Study on use of air-operated tools in mining, contracting, foundry, shipbuilding and machine shop.

Centrifugal Compressors

Centrifugal Compressors (Das allgemeine Verhalten der Kreiselverdichter), Gustav Fluegel. Zeitschrift des Vereins Deutscher Ingenieure, vol. 63, no. 20, May 17, 1919, pp. 455-460, 5 figs. Basic characteristics of centrifugal compressors both with casing that has no cooling device and with cooled casing. Also translated in Mech. Eng., vol. 41, no. 10, Oct. 1919, pp. 795-799 and p. 858, 5 figs.

Pickling Machine

Compressed Air Operated Pickling Machine. Blast Furnace & Steel Plant, vol. 7, no. 9, Sept. 1919, pp. 442-443, 3 figs. Installation of Mesta pickling machine at Consolidated Expanded Metal Co. utilizes compressed air to avoid installing high-pressure boilers.

Wind Motor

A Six-Foot Experimental Wind Motor, C. Blazdell. Model Engr. & Elecn., vol. 41, no. 955, Aug. 14, 1919, pp. 145-151, 7 figs. Constructed by writer with intention of utilizing power to drive small dynamos. (To be continued.)

CORROSION

Pipe Corrosion

Tests on Deoxidation of Hot Water During the Past Year, F. N. Speller. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 25, no. 2, April 1919, pp. 141-144. Irene Kaufmann Settlement pipe-corrosion tests conducted at Pittsburgh Testing Laboratory.

Selective Corrosion

Selective Corrosion (Die selektiven Korrosionen), F. v. Wurstemberger. Schweizerische Bauzeitung, vol. 74, no. 8, Aug. 23, 1919, pp. 91-94. Causes of development and means for its prevention.

FOUNDRIES

Alloy Castings

Making Alloy Castings at Cramp's. Foundry, vol. 47, no. 331, Sept. 15, 1919, pp. 641-646, 10 figs. With reference to tests made of metals used and finished products in brass, bronze and alloy foundry.

Bronze Foundry

Bronze Founding (La fonderie de bronze), Alex. Legrand. Fonderie Moderne, vol. 12, no. 3, March 1919, pp. 62-65, 1 fig. Description of a crucible furnace. Suggested remedies against separation of elements in copper-tin alloys.

Castings

Casting to be Based on the Principles of Physics (In Japanese), Kotaro Honda. Jl. Soc. Mech. Engrs., Tokyo, Japan, vol. 22, no. 58, July 1919.

Centrifugal Casting

Notes on Permanent Moulds and Centrifugal Castings, J. E. Hurst. Foundry Trade Jl., vol. 21, no. 212, Aug. 1919, pp. 558-562 and discussion pp. 562-563, 4 figs. Treats principally of overcoming cracking and distortion of cast-iron dies. Paper presented before Conference of British Foundrymen's Assn.

Condenser Castings

Making and Casting Cylindrical Condensers — II, III, Ben Shaw. Mech. World, vol. 66, no. 1702 and 1704, Aug. 15 and 29, 1919, pp. 78 and 103-104, 5 figs. Aug. 15: Preparing boards so that they can be swept in sections. Aug. 29: Preparation of loam pattern for head.

Core Box

Core Box Construction — I, Joseph Horner. Foundry Trade Jl., vol. 21, no. 212, Aug. 1919, pp. 568-572, 18 figs. Illustrating various types of construction.

Crucibles

The Manufacture and Handling of Crucibles, Jonathan Bartley. Metal Indus., vol. 17, no. 9, Sept. 1919, pp. 414-416, 3 figs. Causes of their failure in metal-melting practice.

Duplexing Process

New Duplexing Process is Invented, H. E. Diller. Foundry, vol. 47, no. 331, Sept. 15, 1919, pp. 662-665, 9 figs. High-carbon steel is melted in electric furnace and transferred to converter to be finished. Good grade of metal said to be obtained at low cost in this way.

Dust

How to Reduce Dust in Foundries (Die Mittel zur Verminderung des Staubes in Giessereien). Metall-Technik, vol. 45, nos. 19/20, May 17, 1919, pp. 73-74. Describes types suited for various conditons.

Electric Steel Foundry

Experiences in Electric Steel Foundry. Elec. World, vol. 74, no. 12, Sept. 20, 1919, pp. 630-634, 3 figs. Data on steel-furnace performance, together with results obtained with electric core baking.

Electrically-Melted Steel Castings, John A. Holden. Foundry Trade Jl., vol. 21, no. 212, Aug. 1919, pp. 584-585. Illustrating with photomicrographs coarse structure of badly annealed slowly-cooled casting, and of same steel completely annealed and cooled in current of air.

Foundry Management

Hoosier Foundry Seeks Difficulties, D. M. Avey. Foundry, vol. 47, no. 328, Aug 1, 1919, pp. 505-509, 9 figs. Iron Trade Rev., vol. 65, no. 11, Sept. 11, 1919, pp. 701-705, 9 figs. How Electric Steel Co. of Indiana conducts study of processes for which casting is intended and the properties desired in part to be made before production is attempted.

A Study of Improved Methods in an Iron Foundry, C. S. Myers. Foundry Trade Jl., vol. 21, no. 212, Aug. 1919, pp. 578-580. Movement study, training and instance in which organization material, combined with specially devised system of payment are said to have effected considerable increase of output with reduced hours of work.

Improved Methods in a Foundry. Metal Industry, vol. 15, no. 9, Aug. 29, 1919, pp. 161-162. Quoting instance in which movement study, training and organization of material, combined with specially devised system of payment, it is said, effected considerable increase of output with reduced hours of work.

Production Cost and Profit Control in Non-Ferrous Foundries, Walter Glenn Scott. Metal Indus., vol. 17, no. 9, Sept. 1919, pp. 417-420, 1 fig. Method for keeping in touch with cost of a product at any stage of its manufacture.

Making Foundry More Attractive, F. H. Bell. Can. Machy., vol. 22, no. 5, July 31, 1919, pp. 98-100, 7 figs. Emphasizes that better and more wholesome shop and working conditions would do much to make foundry a more attractive place in which to work.

Metal Molds

Using Metal Denseners and Molds, E. H. Broughall. Foundry, vol. 47, No. 328, Aug. 1, 1919, pp. 514-518, 7 figs. Sponginess in connecting sections between thin and thick casting parts, it is stated, may be remedied by metal denseners properly used. Permanent metal molds are recommended. From paper presented before Birmingham branch of British Foundrymen's Assn. and Staffordshire Iron & Steel Inst.

Model Foundry

Government Builds Model Foundry. Foundry, vol. 47, no. 331, Sept. 15, 1919, pp. 651-653, 7 figs. For making gray-iron and steel castings for the Navy. Plant represents investment of $1,500,000 in building alone.

Molding Machines

Pointers on Molding Car Couplers. Foundry, vol. 47, no. 328, Aug. 1, 1919, pp. 499-504, 11 figs. How molding machines are rigged. System for handling molds.

Special Rig for Continuous Foundry. Foundry, vol. 47, no. 331, Sept. 15, 1919, pp. 654-658, 8 figs. Four machines make molds with green-sand cores for tractor transmission housings; floor space saved by pouring as soon as molds are finished and shaking out while hot.

Molding Sand

A Comparison of British and American Moulding-Sand Practice, P. G. H. Boswell. Foundry

NOTE. — The abbreviations used in indexing are as follows.
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
New York (N. Y.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State Names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
Ventilating (Vent.)
Western (West.)

Trade Jl., vol. 21, no. 212, Aug 1919, pp. 552-556 and discussion pp. 556-557. Including table giving advantages and disadvantages of artificial and natural bonds in molding sands. Paper presented at Conference of British Foundrymen's Assn.

Pattern Plates

Pattern Plates for the Production of Light Castings, H. Sherburn. Foundry Trade Jl., vol. 21, no. 212, Aug. 1919, pp. 564-566 and discussion 566-567. Advises that range of uses of boxes to be operated be kept down to lowest possible figure. Paper read before Conference of British Foundrymen's Assn

Patterns

Cylinder Patterns—I, Jos. A. Shelly. Machy. (N. Y.), vol. 26, no. 1, Sept. 1919, pp. 67-70, 9 figs. Methods of laying out and constructing patterns and core boxes for pump cylinders.

Making the Pattern for a Four-Bladed Propeller, J. A. McEwan. Can. Foundryman, vol. 10, no. 9, Sept. 1919, pp. 250-251, 9 figs. Illustrating manner of proceeding.

Pouring Device

Labor is Saved by Pouring Device. Foundry, vol. 47, no. 328, Aug. 1, 1919, pp 519-520, 3 figs. Iron Trade Rev., vol. 65, no. 10, Sept. 4, 1919, pp. 637-638, 2 figs. Device consists of cylindrical ladle mounted on trunnions in such a way that iron may be discharged through nozzles which become submerged when ladle is rotated.

Shrinkage

Shrinking of Castings (Du retrait des pièces à la fonte), J. Duponchelle. Fonderie Moderne, vol. 12, no. 3, March 1919, pp. 50-54, 6 figs. Table is presented giving shrinking in length, in surface and in volume of various metals and alloys used in foundries.

Thin Metal Sections

How Water Shut-Off Boxes are Made. Foundry, vol. 47, no. 328, Aug. 1, 1919, pp. 494-498, 6 figs. Rigging required by reason of thin metal sections.

Turbine, Water Wheel

Moulding and Casting a Turbine Water Wheel, F. H. Bell. Can. Foundryman, vol. 10, no. 9, Sept. 1919, pp. 242-243. Noting order in which different parts are placed when ramming up mold.

FUELS AND FIRING

Alcohol

Alcohol as Fuel. South African Eng., vol. 30, no. 7, July 1919, pp. 119-120. South Africa as a possible exporter.

Blue-Water Gas

Blue Water Gas as a Metallurgical Fuel, A. E. Blake. Blast Furnace & Steel Plant, vol. 7, no. 9, Sept. 1919, pp. 443-444. Approximate cost of twin blue water-gas sets with daily capacity of 25,000,000 cu. ft. Cost of blue water-gas *vs.* producer gas per million B.t.u.

Fuel Conservation

Fuel Economy in Manufacturing Works—1, Charles F. Wade. Eng. & Indus. Management, vol. 2, no. 8, Aug. 21, 1919, pp. 235-236, 1 fig. General outline of causes which contribute to inefficiency.

Fuel Oil, Coal Competition

The Competition of Fuel Oil with Coal. Coal Trade Jl., vol. 50, no. 37, Sept 10, 1919, pp. 1109-1111. Analyses of threatened competition of fuel oil with coal.

Furnace Refuse

Loss Due to Carbon in Furnace Refuse, C. H. Perry. Power, vol. 50, no 13, Sept 23, 1919, pp. 700-702, 2 figs. Alignment chart for computing loss in question

Gaseous Fuel

The Utilization of Gaseous Fuel in Commercial Practice, F. W. Ewworth. Gas World, vol. 71, no. 1827, July 26, 1919, pp. 65-67, 7 figs. Including calculated diagrams giving percentage of total heat contained in final product at various temperatures. Paper presented to Soc. of British Gas Industries.

Gasoline-Kerosene Mixtures

The Flash and Burning Points of Gasoline-Kerosene Mixtures, James T. Robson and James B. Withrow. Chem. & Metallurgical Eng., vol. 21, no. 5, Sept. 1, 1919, pp. 244-252, 7 figs. Effect of gasoline content on flash and burning points of kerosene; Foster closed cup and Cleveland type open-cup methods compared; flash and burning points of kerosene mixed with "low-test" gasoline, "high test" gasoline and "petroleum ether."

Illinois Coal

Bureau Tests Illinois Coal, R. S. McBride and I. V. Brumbaugh. Gas Rec., vol. 16, no. 4, Aug. 27, 1919, pp. 17-20, 3 figs. Bureau of Standards experimental tests of Orient coal to investigate influence of temperature on quality of coke produced.

Kerosene

See Gasoline-Kerosene Mixtures.

Kilns

Abnormal Draft Conditions in Porcelain Kilns as the Cause of Various Defects in Burning (Anormale Zugverhaltnisse bei Porzellanbrennöfen als Ursache verschiedener Brennfehler), Otto Wilhelm. Sprechsaal, vol. 18, no. 16, Apr. 17, 1919, pp. 115-117. According to writer, the chemical constitution of gases is of minor importance, but special care must be taken that combustion in firebox is complete, so that products of incomplete combustion, such as hydrocarbons, etc., do not reach the kiln and there precipitate on wares of lower temperature.

Oil Fuel for Ships

Oil Fuel for Ships. Times Eng. Sup., no. 538, Aug. 1919, p. 249. Comparison with coal.

Pulverized Coal

The Use of Pulverized Coal, William H. Odell. Steam, vol. 23, no. 3, Sept. 1919, pp. 63-65, 8 figs. Raymond system of pulverizing coal and air separation. (To be continued.)

The Use of Pulverized Coal—III. Engineer, vol. 128, no. 3316, July 18, 1919, pp. 50-53, 15 figs. Illustrating its aplications to metallurgy.

Pulverized Coal in Boiler and Furnace. Iron Age, vol. 104, no. 11, Sept. 11, 1919, pp. 709-710. Comparison with producer gas as fuel for open-hearth furnaces.

FURNACES

Heat-Treating Furnaces

Heating Furnaces and Annealing Furnaces—IX, W. Trinks. Blast Furnace & Steel Plant, vol. 7, no. 9, Sept. 1919, pp. 423-427, 7 figs. Charts for computing boiler horsepower available from waste heat of furnace.

Heat-Treatment Furnaces at the Sheffield-Simplex Motor Works, Limited. Iron & Coal Trades Rev., vol. 99, no. 2688, Sept. 5, 1919, p. 299, 3 figs. Producers are fired with gas coke. Consumption is said to be 5 cwt. per 24 hr. for a pair of the small or one of larger furnaces.

Kiln, Multiple-Stack

Multiple Stack Kiln Solves Burning Problems, N. Hermes. Brick & Clay Rec., vol. 55, no. 3, July 29, 1919, pp. 214-215, 5 figs. Type recommended for burning of high-grade ware.

Oil Furnace

Economy in Industrial Fuel Oil Furnaces, Max Sklovsky. Am. Mach., vol. 51, no. 11, Sept. 11, 1919, pp. 495-500, 13 figs. Results of experiments undertaken to determine best method of obtaining high furnace efficiencies.

GAGES

Certification of Gages

Certification of Gages at Bureau of Standards, H. L. van Keuren. Mech. Eng., vol. 41, no. 10, Oct 1919, pp. 801-802, 2 figs. Outline of more important pieces of apparatus used for gage inspection.

Gage Limits

Gage Limits in Interchangeable Manufacture, E. C. Peck. Mech. Eng., vol. 41, no. 10, Oct. 1919, pp. 803-805, and 858. Writer discusses merits of English and metric systems and suggests that a 10-in. meter would be a most desirable unit; he also gives explanation of terms allowance and tolerance and outlines method for using gages in strict interchangeable quantity production.

GAS ENGINEERING

Gas as Fuel

Gas as a Substitute for Petrol and Petroleum Products. Jl. Roy. Soc. Arts, vol. 67, no. 3484, Aug. 29, 1919, pp. 639-641. Report of Inter-Departmental Committee appointed by British Government to study possibilities of employment of gas in substitution for gasoline and petroleum products as source of power, especially in motor vehicles.

Gasometers

Study of Large Gasometers (Etude des grands gazomètres), L. Schaffner. Memoires et compte rendu des travaux de la Société des Ingénieurs Civils de France, vol. 72, no. 4, 5 and 6, April-June 1919, pp. 238-277, 24 figs. Design, formulæ and calculations.

Ovens

Kalamazoo Gas Oven Plant, Walter V. Turner. Gas. Rec., vol. 16, no. 4, Aug. 27, 1919, pp. 11-14, 7 figs. Mechanical equipment in installation of 15 horizontal slot ovens.

Power Plants, Gas-Works

Gas-Works Power Plants, H. C. Widlake. Gas Jl., vol. 147, no. 2934, Aug. 5, 1919, pp. 286-287. Concerning advisability of carrying out alterations which involve scrapping of an existing power motor in favor of an electric motor.

Purification

The "Backward Rotation" System of Purification. Gas Jl., vol. 147, no. 2935, Aug. 12, 1919, pp. 339-342, 1 fig. Ammonia losses in direct process of sulphate making.

Safety Lamps

Height of Gas in Safety Lamp, C. M. Young. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 152, Aug. 1919, pp. 1207-1211, 2 figs. Experiments to correlate change of temperature of source of ignition with change of height of cap produced.

Stafford Gas Works

The Stafford Gas Works equipped for new Demands. Gas Jl., vol. 147, no. 2936 and 2937, Aug. 19 and 26, 1919, pp. 387-389 and 443-445, 10 figs. Large scheme effecting change in plant and processes. Among new features are vertical retort-house, MacLaurin centrifugal washers, neutral-process ammonia plant, gas holder and tank holding 1,000,000 cu. ft.

Standards

Cheaper Gas by Revising Present Standards. Contract Rec., vol. 33, no. 37, Sept. 10, 1919, pp. 859-860. Use of lignite fuels and relaxation from present high calorific value recommended as means for decreasing cost of production.

HANDLING OF MATERIALS

Ash-Handling Equipment

Mechanical Sand- and Ash-Handling Plant of the Austrian State Railroad at Wörgl (Die mechanische Besandungs-und Ascheabfuhranlage im Heizhause Wörgl der d.-ö. Staatsbahnen). Zeitschr. des oesterr. Ingenieur-u. Architekten-Vereines, vol. 71, no. 17, Apr. 25, 1919, pp. 159-161, 9 figs. Locomotive shed is also equipped with electrically operated coal-loading device.

Chute, Spiral

Speed Up Production by Systematic Handling, J. H Moore. Can. Machy., vol. 22, no. 10, Sept. 4, 1919, pp. 250-252, 5 figs. Illustrating operation of spiral chute between floors.

Coal Handling

Transport and Handling of Coal—II, John H Anderson. Tran. Inst. Marine Engrs., vol. 31, no. 244, July 1919, pp. 131-218 and discussion pp. 218-229, 89 figs. Methods employed in Great Britain for handling of coal in bulk.

Handling Machinery

Machinery to Help Solve the Problem of High Wages, Labor Shortage and Shorter Hours Demand, Zenas W. Carter. Manufacturers Rec., vol. 76, no. 11, Sept. 11, 1919, pp. 103-106, 6 figs. Illustrating material-handling machinery.

Jeffery Equipment

Transferring Your Product Efficiency, J. H. Moore. Can. Machy., vol. 22, no. 11, Sept. 11, 1919, pp. 277-278, 5 figs. Illustrating uses of Jeffrey equipment.

Shop Transportation

Shop Transportation, J. H Moore. Can. Machy., vol. 22, no 5, July 31, 1919, pp. 122-131, 21 figs. Handling of materials as one of chief factors in efficient shop operation.

Small Shop

The Handling of Material in the Small Shop. Can Machy., vol. 22, no. 5, July 31, 1919, pp 110-111, 2 figs. It is asid that solution to handling problem is often very simple matter if thought out seriously.

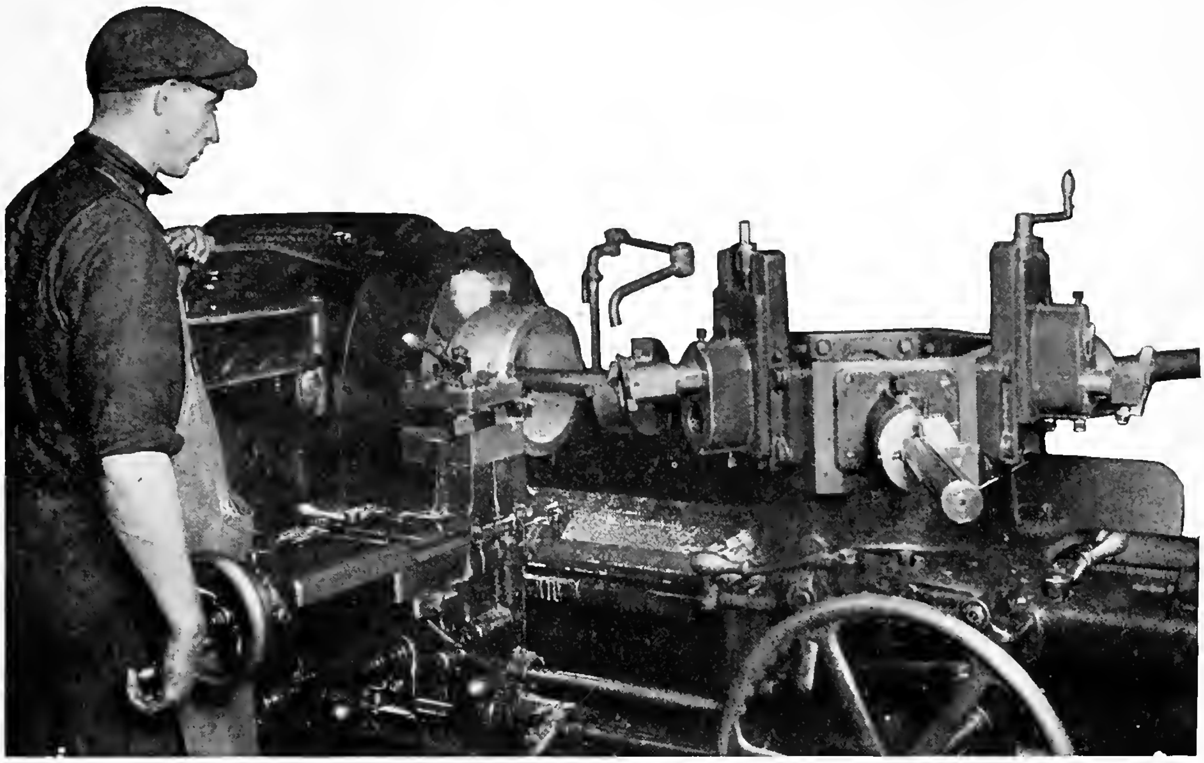
HEAT-TREATING

Case-Hardening

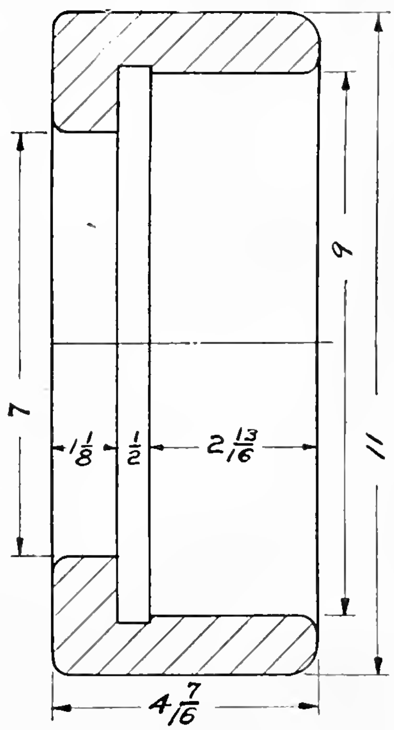
Practical Talks on Casehardening, Theodore G. Selleck. Jl. Am. Steel Treaters Soc., vol. 1, no. 10, Sept. 1919, pp. 325-335, 7 figs. Including suggested rules for heat treatment.

High-Speed Steel

American Practice for Hardening High Speed Steel. Proc. Steel Treating Research Soc., vol. 2, no. 6, 1919, pp. 34-36 and (discussion) pp. 36-42 and 45. Methods of treating alloys which



Breaks Another Time Record



The Hahn Manufacturing Company, a jobbing machine shop in Cleveland, reduced production time one-half on this drop forged Clutch Ring when the work was transferred from an engine lathe to a

No. 3-A Universal Hollow Hexagon Turret Lathe

Because of the flexibility of the tool equipment of the No. 3-A, the jobbing shop finds it adaptable for finishing small lots of different pieces as well as long runs of the same piece. Then the time saved by operating both square and hexagon turrets simultaneously, and the wide range of feeds and speeds for all classes of work makes the Universal Hollow Hex the machine for the jobber.

No. 4 Universal, 1½" x 10",	**16" Swing**
No. 2-A Universal, 2½" or 3¼" x 29",	**16½" Swing**
No. 3-A Universal, 3½" or 4½" x 44",	**21½" Swing**

THE WARNER & SWASEY COMPANY

CLEVELAND, OHIO, U. S. A.

TURRET LATHES—TURRET SCREW MACHINES—BRASS WORKING MACHINE TOOLS

NEW YORK Office—Singer Bldg. **Boston Office**—Oliver Bldg. **Buffalo Office**—Iroquois Bldg
Detroit Office—Ford Bldg. **Chicago Office and Show Room**—618-622 Washington Blvd.

FOREIGN AGENTS: Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. Allied Machinery Company, Paris, Turin, Barcelona, Zurich and Brussels. Stokvis & Zonen, Rotterdam. Wilhelm Sonesson Company, Malmo, Copenhagen, Gotenburg and Stockholm. Yamatake & Co., Tokio. Benson Brothers, Sydney and Melbourne. A. Asher Smith, Sydney. A. R. Williams Machinery Co., Ltd., Toronto, St. John, Winnipeg and Vancouver. Williams & Wilson, Ltd., Montreal

conform to generally accepted views relative to composition giving maximum cutting efficiency.

High-Speed Steel—Its Metallography and Heat-Treatment, G. J. Horvitz. Jl. Am. Steel Treaters Soc., vol. 1, no. 10, Sept. 1919, pp. 342-348, 13 figs. Illustrating with photomicrographs microstructure of metal at various stages in heat treatment process.

Rail Material

Heat Treatment as Applied to Railway Materials, C. R. Bronson. Jl. Am. Steel Treaters Soc. vol. 1, no. 10, Sept. 1919 pp. 336-341. Sound steel seen as fundamental basis for successful heat treatment. Process for heat treatment of rail steel by air cooling method described.

HEATING AND VENTILATION

Battleship

Report of Committee to Co-Operate with U. S. Navy Dept.—I. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 25, no. 3, July 1919, pp. 301-322, 4 figs. Investigations in regard to heating, ventilating and humidifying battleships and submarines.

Heating Installation

Heating and Ventilating Systems at the U. S. Government's Smokeless Powder Plant at Nitro, W. Va., G. W. Hubbard. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 25, no. 3, July 1919, pp. 287-293. Steam for manufacturing processes and for heating buildings throughout manufacturing department taken directly from high-pressure mains run above ground in wooden bents.

Plumbing Regulations

Recent Amendments to the New York City Plumbing Regulations Discussed, Albert L. Webster. Am. Architect, vol. 116, no. 2281, Sept. 10, 1919, pp. 361-365, 4 figs. Amendments permit restricted use of approved anti-siphon traps. Writer discusses relative merits of vented-bend trap and anti-siphon trap.

Radiation, Computations

Standard Rules for Computing Required Radiation. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 25, no. 3, July 1919, pp. 323-328. Report of Rules and Regulations Committee of Nat. District Heating Assn.

Schoolrooms

Heating and Ventilating the Standard School House, J. D. Cassell. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 25, no. 3, July 1919, pp. 261-266. Features of various systems. Writer advocates use of synthetic air chart for determining percentage of perfect ventilation, as originated by Dr. E. Vernon Hill, Chief of Ventilation Division of Chicago Dept. of Health.

Sprinkler System for Hot-Water Heating

Utilization of Automatic Sprinkler System for Hot-Water Heating, A. W. Moulder. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 25, no. 3, July 1919, pp. 273-280, 9 figs. Sketch showing typical combination installation.

Ventilation

A Comparative Study of Natural and Mechanical Ventilation for School Rooms, F. Gardner Legg and W. F. Walker. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 25, no. 3, July 1919, pp. 243-252, 8 figs. Investigations of Sanitary Bur. of Detroit Dept. of Health. Object was to determine what qualities must be present in class rooms so that physical well-being, comfort and mental alacrity of pupils may be at as high a standard as possible.

Classroom Ventilation, Konrad Meier. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 25, no. 3, July 1919, pp. 253-260. Discussion of data presented in Bul. no. 68 Reprint series, Dept. of Health of City of New York.

HOISTING AND CONVEYING

Belt Conveyors

Belt Loading and Carrying System, at Cement Mill Quarry, W. A. Scott. Belting, vol. 15, no. 5, Sept. 5, 1919, pp. 15-17, 5 figs. Inclined conveyors with combined capacity of 240 tons of material per hour.

Possibilities of Steel Belt Conveyor. Iron & Coal Trades Rev., vol. 99, no. 2687, Aug. 29, 1919, pp. 261, 3 figs. As competitor with rubber and fabric belts.

Bin Elevators

Special Features in Some Eastern Sand and Gravel Plants. Rock Products, vol. 22, no. 18, Aug. 30, 1919, pp. 18-20, 5 figs. Bin elevators avoid use of elevated bins; pan conveyor takes place of standard belt; skip hoists.

Conveyors, Gravity

The Economical Employment of Gravity Conveyors, J. Edward Schipper. Automotive Industries, vol. 41, no. 10, Sept. 4, 1919, pp. 467-472, 7 figs. Economy of system claimed because it is said not to involve further expense or worry after being installed.

Cranes

A New 250-ton Hammerhead Crane. Shipbuilder, vol. 21, no. 108, Aug. 1919, pp. 64-67, 2 figs. Constructed in connection with building of the "Vaterland." It differs from existing cranes in that jib carrying load is adjustable vertically through a certain angle to permit lowering loads on to deck of vessel. From Zeitschrift des Vereines Deutscher Ingenieure.

French Firm Constructs Reinforced Concrete Crane. Contract Rec., vol. 33, no. 35, Aug. 27, 1919, pp. 818-819, 1 fig. Crane has capacity of 6600 lb. and span of 32.8 ft. Rolling gear is removable and so attached that it can be adjusted to take care of any warping of crane. Translated from Génie Civil.

Semi-Portable Dock Cranes at Boston Army Base Wharf. Eng. News-Rec., vol. 83, No. 11, Sept. 11, 1919, pp. 516-517, 2 figs. Four hoists with 4-ton maximum capacity travel on tracks outside of wharf shed and load vessels in dock.

Electric Hoisting Machinery

Development of Electric Hoisting Machinery (Die Entwicklung des elektrischen Fördermaschinen-Antriebs), Schweizerische Bauzeitung vol. 74, no. 8, Aug. 23, 1919, pp. 95-97, 8 figs. Diagrams of machines with various types of drums.

Handling Coal and Ashes with Electric Hoists, James Monroe, Power Plant Eng., vol. 23, no. 18, Sept. 15, 1919, pp. 801-804, 9 figs. Illustrating types of systems and apparatus used in medium-sized plants.

Hoisting Rigs

Removing and Replacing Ceiling Motor Armatures, T. H. Fenner. Power House, vol. 12, no. 12, Aug. 5, 1919, pp. 347-348, 3 figs. Heavy rigging designed to handle heavy armatures with minimum of labor and time.

Skip Hoists

Induction Motor Drive for Skip Hoists, F. R. Burt. Elec. Jl., vol. 16, no. 9, Sept. 1919, pp. 381-382, 4 figs. Scheme showing relative positions of equipment and manner in which material is handled; also graphic records of load and speed with buckets empty and when hoisting full bucket.

Winding Drum

Bi-Conical Winding Drum at a Belgian Colliery, A. Bertiaux. Colliery Guardian, vol. 118, no. 3060, Aug. 22, 1919, p. 490, 3 figs. Driven by double-cylinder horizontal engine with cranks set at 90 deg. Translated from Annales des Mines de Belgique.

HYDRAULIC MACHINERY

Discharge Coefficients of Sharp-Edged Orifices

Experimental Determination of Discharge Coefficients of Sharp-Edged Orifices for Water and Sodium Chloride Brine and Discussion of Their Relationship (Die experimentelle Bestimmung der Ausflusskoeffizienten von Poncelet-Oeffnungen für Wasser und Kochsalzsole und Erörterung des inneren Zusammenhanges der Koefficienten), Adolf Schneider. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no. 213, 1919, 66 pp., 48 figs. Description of apparatus, measurements and test results. Coefficients are given for different heights, temperatures and concentrations.

Gate Closure, Pressure Rise

Pressure Rise Caused by Gradual Gate Closure, Norman R. Gibson. Can. Engr., vol. 37, no. 11, Sept. 11, 1919, pp. 295-299, 7 figs. Derivation of formulæ which include friction. (Concluded.)

Generator, 32,000 Kva.

A 32,500-Kva. Waterwheel Generator, R. B. Williamson. Elec. World, vol. 74, no. 9, Aug. 30, 1919, pp. 456-458, 4 figs. One of three units under way for Niagara Falls. Generator and wheel casing are rigidly connected. Weight, 300 tons.

Governors for Water Turbines

Seewer Universal Governor for High-Head Pelton Turbines [Le régulateur universel système Seewer pour turbines hydrauliques à haute chute (Pelton)], A. Strickler. Bulletin Technique de la Suisse Romande, vol. 45, no. 17, Aug. 23, 1919, pp. 169-171, 3 figs. Regulation effected by changing form of jet by means of movable guiding elements within admission nozzle. (Continuation of serial.)

McClure Hydroelectric Plant

The McClure Hydro-Electric Plant. Eng. & Min. Jl., vol. 108, no. 11, Sept. 13, 1919, pp. 457-460, 4 figs. Water flows through 13,600 ft. of 7-ft. pipe under 420-ft. head.

INTERNAL-COMBUSTION ENGINES

Air Cooling

Air-Cooling for Automobiles. Autocar, vol. 43, no. 1244, Aug. 23, 1919, pp. 271-272, 6 figs. Some details of cylinder design in relation to causes and prevention of overheating troubles.

Akroyd Cycle Engines

Akroyd Engine Cycles, Herbert Akroyd Stuart. Gas Engine, vol. 21, no. 9, Sept. 1919, pp. 275-281, 16 figs. Concerning origin of pure air compression with automatic ignition in crude-oil engines. Writer offers arguments in substantiation of his contention that the term "semi-Diesel" is a misnomer.

Benzol

The Use of Benzol and Benzol Mixtures as Motor Fuel, I. C. Mackie. Can. Chemical Jl., vol. 3, no. 9, Sept. 1919, pp. 295-297. Results of analytical work undertaken to determine effect of various settings of carburetor needle valve and also effect of surrounding temperature both by gasoline and benzol products.

Carburetors

Mathematical Study of the Operation of Constant-Level Spray Carburetors (Étude Mathématique de fonctionnement des carburateurs à giclage et à niveau constant), Génie Civil, vol. 75, no. 7, Aug. 16, 1919, pp. 148-152, 5 figs. Conditions for their automatic operation. (Concluded.)

The Asmo Carburettor. Autocar, vol. 43, no. 1244, Aug. 23, 1919 pp. 280, 1 fig. Instrument creates automatically its own vacuum feed.

Diesel Engines

Official Report on First Shipping Board Diesel Engine. Motorship, vol. 4, no. 9, Sept. 1919, pp. 34-35, 1 fig. Thirty-day non-stop full-power test of McIntosh and Seymour 750-b.hp. marine engine.

Winton Diesel Oil Engine. Power, vol. 50, no. 12, Sept. 16, 1919, pp. 453-455, 5 figs. Details of type built for stationary service for direct connection to generators, pumps, etc.

The Diesel Engine in the Southwest, B. V. E. Nordberg. Eng. & Min. Jl., vol. 108, no. 12, Sept. 20, 1919, pp. 497-500, 3 figs. Economy of power secured from this source compared with that from steam.

Diesel Engines in Mine Power-Plants, C. Legrand. Min. & Sci. Press, vol. 119, no. 11, Sept. 13, 1919, pp. 369-372, 2 figs. Reports that two vertical two-cycle engines, each with five cylinders and rated at 1250 b.hp. at sea-level have given satisfactory service at mines situated at elevation of 5950 ft. above sea level.

The White Diesel Heavy Oil Engine. Shipbuilding & Shipping Rec., vol. 14, no. 10, Sept. 4, 1919, pp. 263-265, 3 figs. Details of construction and results of tests.

Doxford Oil Engine

The Doxford Oil Engine. Engineer, vol. 128, no. 3316, July 18, 1919, pp. 64-65, 1 fig. How principle of engine has been transformed to make engine a hot-bulb engine instead of a Diesel.

Fuel Mixtures

The Possibilities of New Fuel Mixtures for Internal-Combustion Engines, E. Humboldt. Power, vol. 50, no. 11, Sept. 9, 1919, pp. 418-420. Concerning production of cheap and cleaner substitute for gasoline by mixing with engine distillate a small amount of ether and alcohol.

See also Benzol.

Heavy-Oil Engines

Official Test Report De La Vergne Heavy-Oil Marine Engine. Motorship, vol. 4, no. 10, Oct. 1919, pp. 26-27, 6 figs. Consumption of lubricating oil, heat balance and temperature in crankcase in 14-day test. (Concluded.)

Hot-Plate Engines

See Kromhout Engine.

Kromhout Engine

A Dutch Marine Oil-Engine. Motorship, vol. 4, no. 10, Oct. 1919, pp. 40-41, 5 figs. Kromhout hot-plate ignition two-cycle-type engine.

Turbine, Sanders

The Sanders Pressure Turbine. Autocar, vol. 43, no. 1245, Aug. 30, 1919, pp. 317-320, 9 figs. Model of a new form of petrol engine without reciprocating parts, capable of running at 4,000 r.p.m. and receiving 40,000 power impulses per minute.

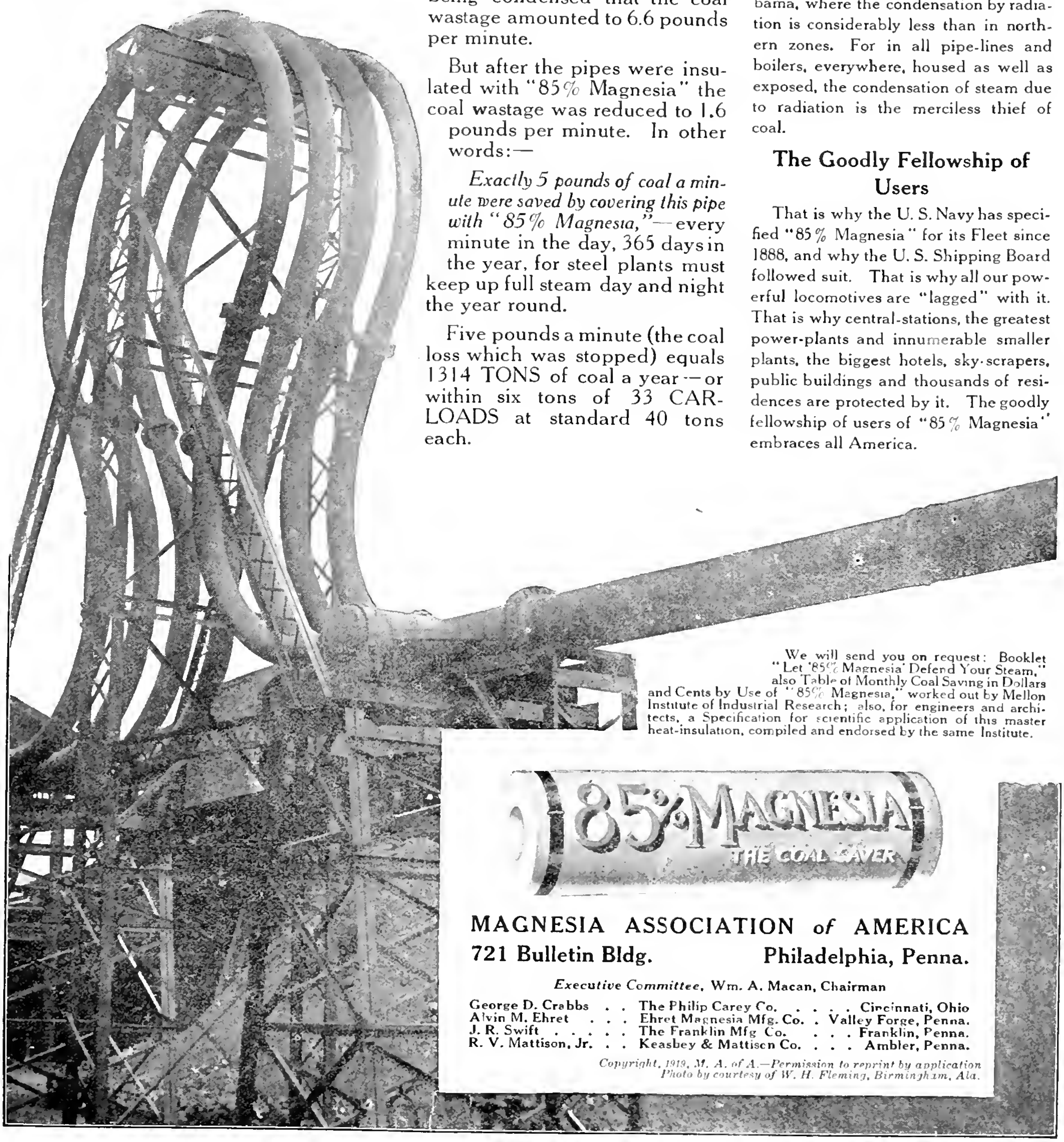
Valves, Exhaust, Pitting

What Causes Pitting of Exhaust Valves? Automotive Industries, vol. 41, no. 10, Sept. 4,

How $1,500 invested in "85% Magnesia" saved 33 carloads of coal a year—

THIS striking picture shows the lofty steam expansion bend of the great outdoor steam pipe-line of the gulf States Steel Company plant at Alabama City, Alabama.

The line is 750 feet long and 22 inches diameter. It carries 150 lbs. of steam. It is insulated with "85% Magnesia" pipe-covering.



On that coal-saving insulation hangs a vitally interesting story.

Before and After

This plant started operations before the "85% Magnesia" coverings were put on. While the pipes were bare, careful tests showed that so much steam was being condensed that the coal wastage amounted to 6.6 pounds per minute.

But after the pipes were insulated with "85% Magnesia" the coal wastage was reduced to 1.6 pounds per minute. In other words:—

Exactly 5 pounds of coal a minute were saved by covering this pipe with "85% Magnesia,"—every minute in the day, 365 days in the year, for steel plants must keep up full steam day and night the year round.

Five pounds a minute (the coal loss which was stopped) equals 1314 TONS of coal a year—or within six tons of 33 CARLOADS at standard 40 tons each.

Or, in Dollars—with coal at only $5.00 a ton, this saving amounts to no less than $6,570 a year in coal, while the outlay for installation was *less than* $1,500.

Arrest the Invisible Thief of Coal

That was under the hot sun of Alabama, where the condensation by radiation is considerably less than in northern zones. For in all pipe-lines and boilers, everywhere, housed as well as exposed, the condensation of steam due to radiation is the merciless thief of coal.

The Goodly Fellowship of Users

That is why the U. S. Navy has specified "85% Magnesia" for its Fleet since 1888, and why the U. S. Shipping Board followed suit. That is why all our powerful locomotives are "lagged" with it. That is why central-stations, the greatest power-plants and innumerable smaller plants, the biggest hotels, sky-scrapers, public buildings and thousands of residences are protected by it. The goodly fellowship of users of "85% Magnesia" embraces all America.

We will send you on request: Booklet "Let '85% Magnesia' Defend Your Steam," also Table of Monthly Coal Saving in Dollars and Cents by Use of "85% Magnesia," worked out by Mellon Institute of Industrial Research; also, for engineers and architects, a Specification for scientific application of this master heat-insulation, compiled and endorsed by the same Institute.

85% MAGNESIA
THE COAL SAVER

MAGNESIA ASSOCIATION *of* AMERICA
721 Bulletin Bldg. Philadelphia, Penna.

Executive Committee, Wm. A. Macan, Chairman

George D. Crabbs	The Philip Carey Co.	Cincinnati, Ohio
Alvin M. Ehret	Ehret Magnesia Mfg. Co.	Valley Forge, Penna.
J. R. Swift	The Franklin Mfg Co.	Franklin, Penna.
R. V. Mattison, Jr.	Keasbey & Mattison Co.	Ambler, Penna.

Photo by courtesy of W. H. Fleming, Birmingham, Ala.

1919, pp. 476-477. From investigation undertaken in connection with development of Rolls-Royce air-craft engines. Translated from La Technique Automobile et Aérienne.

LUBRICATION

Ball Bearings

The Lubrication of Ball-Bearings, H. R. Trotter. Mech. Eng., vol. 41, no. 10, Oct. 1919, pp. 811-815, 5 figs. Instrument designed by writer for obtaining data regarding lubricants consists of revolving element driven by small motor and stationary element similar to block used in a Michell or Kingsbury bearing with suitable means of obtaining readings of inclination angle of block to revolving element.

Cutting Lubricants

Cutting Lubricants for Machine Tools, Reginald Trautschold. Machy. (N. Y.), vol. 26, no. 1, Sept. 1919, pp. 45-47. Table indicating suggested uses of lard oil compounds, soda waters and soluble oils for different machining operations and metals.

Principles

Lubrication Principles, Robert June. Brick & Clay Rec., vol. 55, no. 7, Sept. 23, 1919, pp. 588-591, 2 figs. Writer contends that through a knowledge of how to save power, power-plant operator may save, many times over each year, cost of lubricants; he also considers accurate knowledge of lubricants as vitally important.

MACHINE ELEMENTS AND DESIGN

Bearings, Marine Thrust

Marine Thrust Bearings. Motorship, vol. 4, no. 10, Oct. 1919, pp. 28-30, 6 figs. Phenomena of film lubrication in pivoted-segments type. Paper read before Instn. Naval Architects.

Bearing, Michell Journal

The Michell Journal Bearing. Engineer, vol. 128, no 3322, Aug. 29, 1919, pp. 202-204, 10 figs. Adaptation of principle of bearing which has been employed for thrust blocks of marine engines of more than 10,000,000 hp. to journal bearings.

Bearings, Roller

Roller Bearing Types and Applications—II. Raw Material, vol. 1, no. 6, Aug. 1919, pp. 304-308, 16 figs. Construction features of principal makes.

Cams

Cam Design and Construction, Franklin de R. Furman. Am. Mach., vol. 51, no. 12, Sept. 18, 1919, pp. 569-574, 10 figs. Miscellaneous types, minimum sizes and non-interference. (Continuation of serial.)

Gears, Rawhide

The Strength of Rawhide Gears. Machy. (Lond.), vol. 14, no. 358, Aug. 7, 1919, pp. 559-560, 1 fig. Chart empirically devised and said to give same results as Lewis formula with correction for speed introduced by Carl G. Barth.

Gears, Reduction

A War Time Lesson on Reduction Gears. Automotive Industries, vol. 41, no. 11, Sept. 11, 1919, pp. 516-522, 15 figs. From investigations conducted at McCook Field, Dayton, Ohio, it is shown that in considering special gearing, such as propeller reductions, usual limitations of standard pitches and angles of obliquity can be departed from to advantage.

Shafting

Theory and Practice in Shafting, Robert S. Lewis. Belting, vol. 15, no. 5, Sept. 5, 1919, pp. 27-31, 4 figs. Development formula for calculating weight.

Special Machine Design

Principles of Special Machine Design. Machy. (Lond.), vol. 14, no. 360, Aug. 21, 1919, pp 616-617. Analysis of functions of special machines and important points to be observed in their design.

MACHINE SHOP

Drives

Machine-Tool Drives: Motors and Controllers, H. W. Tice. Jl. Engrs. Club Philadelphia, vol. 36, no. 171, Feb. 1919, pp. 47-51, 5 figs. Relative merits of a.c. and d.c. motors for planer drives; d.c. performance curves; a.c. performance curves.

Fitting-Shop Practice

Machine and Fitting Shop Practice, Fred Horner. Mech. World, vol. 66, no. 1703, Aug. 22, 1919, p. 86, 3 figs. Chucks in which separate pads or segments are set in place to form gripping jaws. (Continuation of serial.)

Foundations, Machinery

Making Templets for Machinery Foundations, Bruce Page. Power House, vol. 12, no. 12, Aug. 5, 1919, pp. 325-329, 14 figs. Says that templet drawings should be made for all except the simplest foundations and that drawings should be furnished the man who is to build the templet.

Lathe Operations

Machining Operations on Cast Iron Cylinders, Richard Vosbrink. Metal Trades, vol. 10, no. 9, Sept. 1919, pp. 406-408, 3 figs. Includes diagrammatic sketch of lathe operations.

Milling

Production Milling on Automatic Machines—I, Edward K. Hammond. Machy. (N. Y.), vol. 26, no. 1, Sept. 1919, pp. 48-55, 14 figs. Describes practice in milling of duplicate parts.

Monel Metal

Working Monel Metal, Hugh R. Williams. Am. Mach., vol. 51, no. 11, Sept. 11, 1919, pp. 509-511, 3 figs. Curves showing influence of temperature on tensile strength and on torsional strength of metal rods.

Optical Methods of Comparison

Some Optical Aids for the Engineer—I, Arthur C. Banfield. Machy. (Lond.), vol. 14, no. 360, Aug. 21, 1919, pp. 613-615, 9 figs. Points out advantages in adopting optical methods for comparison and for other purposes.

Shaft Straightening

Straightening Shaft of 45,000-Kw. Turbine, E. E. Clock. Power, vol. 50, no. 10, Sept. 2, 1919, pp. 377-378, 1 fig. Shaft was straightened by heat-treatment method.

Taylor's "Cutting Metals"

Supplement to Frederick W. Taylor's "On the Art of Cutting Metals"—I, Carl G. Barth. Indus. Management, vol. 58, no. 3, Sept. 1919, pp. 169-175, 1 fig. Reviews historical study of work and outlines engineering subjects that are to be treated in subsequent installments.

Thread, Milling

Milling Threads, W. G. Dunkley. Machy. (Lond.), vol. 14, no. 360, Aug. 21, 1919, pp. 631-634, 7 figs. Determination of true form of thread on inclined section.

MACHINERY, METAL-WORKING

Boring Machine

Horizontal Boring Machine. Engineer, vol. 128, no. 3320, Aug. 15, 1919, pp. 162-163, 2 figs. Special feature noted is controlling gear which is said to permit manipulation of machine in such a way that operator can have complete control without moving from one position.

Dividing Attachment

Dividing Attachment for 3½-in. and 4-in. Drummond Lathe, C. Young. Model Engr. & Elecn., vol. 41, no. 953, July 31, 1919, pp. 104-107, 8 figs. Attachment fits on lathe mandrel in place of gear used for screw-cutting, fork engaging with one of studs in extra quadrant and used for carrying intermediate gears.

Edging Rolls

Using Edging Rolls in Breakdown Emergency, W. S. Standiford. Can. Machy., vol. 22, no. 11, Sept. 11, 1919, pp. 271-273, 2 figs. Illustrating set of edging rolls for edging small flat bars on guide mill.

Lathes

Le Blond Multi-Cut Semi-Automatic Lathes. Am. Mach., vol. 51, no. 12, Sept. 18, 1919, pp. 545-550, 10 figs. Specially valuable feature is said to be multiple use of simple lathe tools for more or less complicated jobs of facing or turning.

Sliding-Head Drop-Rail Lathe. Iron Age, vol. 104, no. 11, Sept. 11, 1919, pp. 720-722, 4 figs. Designed to give extra capacity without employing more than one spindle.

Planers

Heavy Machine Equipment at Panama, R. D. Gatewood. Am Mach., vol. 51, no. 10, Sept. 4, 1919, pp. 463-465, 4 figs. Notably planing machine which handles works 96 in. high by 132 in. wide by 24 ft. long.

Saw, Metal

Vertical Metal Saw. Engineer, vol. 128, no. 3320, Aug. 15, 1919, p. 162, 4 figs. Of heavy and powerful construction, outstanding features being angular disposition of saw frame and high speed.

MACHINERY, SPECIAL

Breaker, Coal

Rebuilding the Loree Breaker, W. S. Hutchinson. Coal Age, vol. 16, no. 9, Aug. 28, 1919, pp. 352-354, 6 figs. How coal breaker having capacity of 6000 tons per day was erected in 130 days.

Dredges

Floating Dredge at Western Indiana Gravel Plant, Terre Haute, Ind. Rock Products, vol. 22, no. 17, Aug. 16, 1919, pp. 20-22, 8 figs. Used to remove gravel to depth of 40 ft. below water level.

Grinding Machine

Designing a Special Machine, F. E. Johnson. Machy. (N. Y.), vol. 26, no. 1, Sept. 1919, pp. 56-59, 6 figs. Illustrating method of procedure by reference to developing special duplex grinding machine as example.

Lathe and Drill Fixtures

Quantity Production by the American Coin Register Company. Metal Trades, vol. 10, no. 9, Sept. 1919, pp. 398-400, 9 figs. Lathe and drill fixtures used.

Milling-Machine Attachment

Some Labor-Saving Devices That Have Been Developed in the Moore Shops. Metal Trades, vol. 10, no. 9, Sept. 1919, pp. 394-396, 8 figs. Such as attachment for Le Blond milling machine, which is used in making ⅝-in. cut around corners of oil tight hatch frame.

Mine Cars

The Quantity Manufacture of Mine Cars. Metal Trades, vol. 10, no. 9, Sept. 1919, pp. 403-404, 4 figs. Special tools developed for manufacturing Matteson car.

Scales

Tapered-Floor Track Scales, Canadian Pacific Railway. Ry. Rev., vol. 65, no. 10, Sept. 6, 1919, pp. 336-338, 7 figs. Rails are elevated and floor sloped to shed water crosswise.

Screen, Mitchell Vibrating

Description of the Mitchell Vibrating Screen. Salt Lake Min. Rev., vol. 21, no. 11, Sept. 15, 1919, pp. 28-30, 4 figs. Screen cloth is agitated at rate of 3600 vibrations per min. and strikes material with an impact of from 500 to 1000 lb. The motor-actuated vibration is applied continuously to screening area by means of rigid arms or plates, fastened to ends of vibrator casing below.

Trench Machinery

Trench Machinery, A. E. Collins. Surveyor, vol. 56, no. 1436, July 25, 1919, pp. 55-59, 6 figs. Directs attention to machinery applicable to sewer and similar trenches.

MATERIALS OF CONSTRUCTION AND TESTING OF MATERIALS

Anchor, Cast Steel

Investigation of the Failure of a Cast-Steel Anchor. Iron Age, vol. 104, no. 12, Sept. 18, 1919, pp. 773-774, 4 figs. How hard interior sections were caused by use of charcoal on the riser in a German foundry. From Stahl und Eisen.

Fatigue

The Fatigue of Nickel and Iron Wires When Subjected to the Influence of Transverse Alternating Magnetic Fields, William Brown. Scientific Proc. Roy. Dublin Soc., vol. 15, no. 17, Jan 1917, pp. 163-170, 3 figs. Including also experiments on subsidence of torsional oscillations in wire carrying electric current.

Impact Machines

Experimental Data Obtained on Charpy Impact Machine, F. C. Langenberg. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 152, Aug. 1919, pp. 1471-1499, 21 figs. Results of experiments said to have indicated that material with lower elastic limit, lower tensile strength, slightly higher ductility and lower Brinell hardness has much higher shock strength, as determined by Charpy notched-bar specimen, either tensile or transverse.

Mahogany

Mahogany, and the Recognition of Some of the Different Kinds by Their Microscopic Characteristics, Henry H. Dixon. Scientific Proc. Roy. Dublin Soc., vol. 15, no. 34, Dec. 1918, pp. 431-486, 138 figs. on 23 supplement plates. Examination covered 40 species of trees which yield mahogany.

Metal Testing

New Processes of Mechanical Testing of Metals (Nouveaux procédés d'essais mécaniques des métaux), Charles Frémont. Comptes ren-

dus des séances de l'Académie des Sciences, vol. 169, no. 5, Aug. 4, 1919, pp. 228-231, 5 figs. Tension, compression and impact portable testing machines.

Notched Bar Tests

Impact Tests of Notched Bars (Sur les essais de flexion par choc de barreaux entaillés). A. Cornu-Thénard. Comptes rendus des séances de l'Académie des Sciences, vol. 169, no. 6, Aug. 11, 1919, pp. 272-275. It is concluded from tests that it is advisable to give notch (1) sufficiently small diameter, maximum recommended being 2 mm. for a 10 x 10 mm. bar, and (2) sufficiently large depth, one-half depth of bar being suggested as advisable practice.

See also Impact Machines.

Sheets, Galvanized-Steel

Galvanised Steel Sheets. Iron & Coal Trades Rev., vol. 99, no. 2688, Sept. 5, 1919, pp. 289-290, 7 figs. Object of investigation was to study from a physical, chemical, microscopic and mechanical point of view the composition and finish of steel sheets and practice connected with their manufacture.

Testing of Materials

The Testing of Materials, Walter Rosenhain. Automotive Industries, vol. 41, no. 11, Sept. 11, 1919, pp. 508-510. Writer, who is connected with Nat. Physical Laboratory in Teddington, England, makes plea for simple tests of materials and for statement of results in definite, certain and understandable terms.

Tile, Drain, Shale

An Investigation of Tests of Iowa Shale Drain Tile, W. J. Schlick. Iowa State College of Agriculture & Mech. Arts, Bul. 49, Eng. Experiment Station, vol. 16, no. 43, Mar. 27, 1919, pp. 5-55, 16 figs. Scope of investigations covered studies of methods and results of making sodium sulphate tests of pieces from tested drain tile as accelerated tests of resistance to freezing and thawing; methods and results of making artificial freezing ano thawing tests; effects of natural freezings and thawings upon whole tile; rate of absorption and necessary time of immersion in making absorption tests by immersion.

Tubes, Boiler, Testing

The Commercial Testing of Railway Materials, T. H. Sanders. Mech. World, vol. 66, no. 1703, Aug. 22, 1919, pp. 92-93. Testing of tubes for locomotive boilers. (Concluded.) Paper read before Junior Inst. of Engrs.

MECHANICAL PROCESSES

Drill-Chuck Manufacture

Manufacturing a Drill Chuck, Fred R. Daniels. Machy. (Lond.), vol. 14, no. 358, Aug. 7, 1919, pp. 553-557, 11 figs. Methods and fixtures developed in manufacture of "Ettco" drill chuck made by Eastern Tube & Tool Co., Brooklyn, N. Y.

Interchangeable Manufacture

Machine Design in Interchangeable Manufacturing Practice, Earle Buckingham. Machy. (N. Y.), vol. 26, no. 1, Sept. 1919, pp. 8-11, 1 fig. Function of machine design in promoting economical manufacture on interchangeable basis.

Locks

The Cylinder Lock—I, Ellsworth Sheldon. Am. Mach., vol. 51, no. 10, Sept. 4, 1919, 3 figs. Features of construction.

Painting and Upholstery

Finishing Bodies for Automobiles, C. A. Marston. Indus. Management, vol. 58, no. 3, Sept. 1919, pp. 207-211, 10 figs. Organizing operations of painting and upholstering.

Roller-Chain Manufacture

Making Roller Chain—I. Machy. (Lond.), vol. 14, no. 361, Aug. 28, 1919, pp. 645-649, 8 figs. Special machines and fixtures developed in America for making sprocket chain.

Sprocket-Chain Manufacture

Making Diamond Sprocket Chain—II, Edward K. Hammond. Machy. (N. Y.), vol. 26, no. 1, Sept. 1919, pp. 25-28, 11 figs. Steps in process of assembling. (Concluded.)

Upholstery

See Painting and Upholstery.

MECHANICS

Cams

Technical Study of Mechanisms Operated by Cams (Étude rationnelle des méchanismes commandés par cames), Octave Lepersonne. Revue Universelle des Mines et de la Métallurgie, vol. 2, no. 1, Mar.-Apr. 1919, pp. 433-500, 10 figs. Criticism of Prof. Hartmann's theory as presented in issues of Sept. 30 and Oct. 7, 1905, of Zeitschrift des Verein Deutscher Ingenieure; construction of profile necessary to assure permanent contact between parts of mechanism, with special reference to requirements for operation of valves in internal-combustion engines. (To be continued.)

Deflection of Beams and Rigid Frames

Deflection of Continuous Beams and Rigid Frames, F. E. Richart. Eng. News-Rec., vol. 83, no. 12, Sept. 18, 1919, pp. 564-565, 3 figs. Formulæ for computing maximum deflection in case of symmetrical loading and its application value in case of unsymmetrical loading.

Engine Columns Design

The Design of Engine Columns—II, W. K. Wilson. Mech. World, vol. 66, no. 1704, Aug. 29, 1919, p. 102, 3 figs. Side-thrust curves for case of oil engine. (Continuation of serial.)

Moments, Combined Bending and Twisting

Combined Bending and Twisting Moments, Victor M. Summa. Machy. (N. Y.), vol. 26, no. 1, Sept. 1919, pp. 41-42, 5 figs. Application of Rankine's formula to types of levers or cranks which are keyed or otherwise attached to shafts.

Stresses, Material, Equations

The Equations for Material Stresses, and their formal solution, R. F. Gwyther. Lond., Edinburgh & Dublin Phil. Mag., vol. 38, no. 224, Aug. 1919, pp. 235-240. Equations based on "Doctrine of Material Stresses" contained in June Phil. Mag., vol. 35, p. 490, 1918, and the solution of these equations in cartesian coordinates.

Struts

On the Stability of Long Struts of Variable Section, Akimasa Ono. Memoirs of the Coll. of Eng., Kyushu Imp. University, Fukuoka, Japan, vol. 1, no. 5, 1919, pp. 395-406, 4 figs. Formula for critical load developed from assumption that moment of inertia varies as *n*th power of distance of section from free end.

MEASUREMENTS AND MEASURING APPARATUS

Balls for Gage Checking

Use of Balls in Measuring, G. C. Haneman. Machy. (Lond.), vol. 14, no. 358, Aug. 7, 1919, pp. 561-562, 2 figs. Illustrating methods of using finished balls for checking gage measurements.

Conductivity of Metals, Thermal

An Apparatus for Determining the Thermal Conductivity of Metals, Gordon B. Wilkes. Chem. & Metallurgical Eng., vol. 21, no. 5, Sept. 1, 1919, pp. 241-243, 1 fig. Consists essentially of a heater, guard ring, two continuous flow calorimeters, and three thermocouples used in measuring temperature of different parts of specimen.

Dynamometers

Calculating Power Requirements for Small Machinery. Machy. (Lond.), vol. 14, no. 361, Aug. 28, 1919, pp. 662-663, 2 figs. Suggested form of indirect-reading dynamometer.

Gages

See Measurements and Measuring Apparatus (Balls for Gage Checking).

Heat Meter

A New Compensated Heatmeter, Charles P. Frey. Chem. Engr., vol. 27, no. 9, Sept. 1919, pp. 215-218, 6 figs. Effect of line and thermocouple resistance eliminated by means of simple operation. Developed at Bureau of Standards.

A New Compensated Heatmeter, Charles P. Frey. Chem. & Metallurgical Eng., vol. 21, no. 5, Sept. 1, 1919, pp. 259-261, 7 figs. Fundamental principle of Harrison-Foote invention explained.

Indicators

Using Indicator on Internal Combustion Engines, Ralph Miller. Power, vol. 50, no. 11, Sept. 9, 1919, pp. 422-423, 2 figs. Cards taken from 23 x 24 in. four-stroke-cycle oil engines running at 150 r.p.m.

Pyrometers

Teaching Pyrometry, O. L. Kowalke. Bul. Am. Inst. Min. & Metallurgical Engrs., no 152, Aug. 1919, pp. 1425-1427. Suggests introducing exercise that will bring out limitations and sources of error in pyrometer employed.

Optical and Radiation Pyrometry, Paul D. Foote and C. O. Fairchild. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 152, Aug. 1919, pp. 1389-1455, 16 figs. General theory, diagrammatic sketches of various types used both in optical pyrometry and in radiation pyrometry, method of using each, and advantages and disadvantages of radiation pyrometry.

Thermo-Electric Pyrometer for Metallurgical Purposes. Metal Industry, vol. 15, no. 9, Aug. 29, 1919, pp. 171 and 173, 2 figs. Indicating methods of maintaining cold junction at constant temperature.

Resistance Thermometry for Industrial Use, Charles P. Frey. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 152, Aug. 1919, pp. 1437-1441, 2 figs. Construction and operation of commercial resistance thermometer.

Tin: An Ideal Pyrometric Substance, E. F. Northrup. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 152, Aug. 1919, pp. 1443-1444. Particularly because of increase of given volume in resistivity with increase in temperature and decrease of given volume in density with increase in temperature.

Thermocouple Installation in Annealing Kilns for Optical Glass, E. D. Williamson and H. S. Roberts. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 152, Aug. 1919, pp. 1445-1453, 3 figs. Essential features of system of temperature control evolved at plant at Pittsburgh Plate Glass Co.

Pyrometer Shortcomings in Glass-House Practice, W. M. Clark and Charles D. Spencer. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 152, Aug. 1919, pp. 1455-1458. Shortcomings due, it is claimed, to lack of standardization of utilitarian type.

Pyrometry and Steel Manufacture, A. H. Miller. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 152, Aug. 1919, pp. 1501-1510. Method considered as best adapted for measuring bath temperature is that of sighting optical pyrometer either on surface of spoonful of metal drawn from furnace or stream poured from spoon. In forge practice best method of measuring temperature is considered to be that of focusing optical pyrometer directly on article to be forged while it is in its heating furnace.

Temperature Indicating and Controlling Systems—III, Franklin D. Jones. Machy. (N. Y.), vol. 26, no. 1, Sept. 1919, pp. 12-17, 9 figs. Location and protection of thermocouples; prevention of errors in pyrometer readings; apparatus for determining hardening temperatures. (Concluded.)

Scales

Trustworthiness of the Balance Over Long Periods of Time, George Dean. Jl. Chem. Soc., vol. 115-116, no. 681, July 1919, pp. 826-828. Variation of 1.6 mg. detected and attributed to gradual shifting of central knife edge.

Speed Indicators

Electric Speed Indicators, Victor H. Todd. Power, vol. 50, no. 11, Sept. 9, 1919, pp. 421-422, 6 figs. Principle of operation, construction features, method of gearing and application.

See also Tachometers.

The Waltham Speedometer. Autocar, vol. 43, no. 1245, Aug. 30, 1919, p. 333, 4 figs. New instrument for which greater accuracy is claimed and which is operated by air pressure.

Spherometer

A Spherometer of Precision, J. Guild. Sci. Am. Supp., vol. 88, no. 2281, Sept. 20, 1919, pp. 184-185, 3 figs. Designed with a view to obtain greater accuracy in determination of exact point of contact of micrometer leg with surface of lens or flat under examination than is usually obtained with spherometers of existing patterns. Paper read before Optical Soc.

Tachometers

The Van Sicklen Chronometric Tachometer, Frank J. Feely. Aviation, vol. 7, no. 3, Sept. 1, 1919, pp. 137-138, 5 figs. Instrument has dial uniformly graduated from zero to 2500 r.p.m. for complete rotation of pointer, and, like other similar chronometric tachometers, its calibration is controlled by time of its watch unit.

See also Speed Indicators.

Temperature Scales

See Pressure and Temperature Scales.

Thermocouples

See Pyrometers.

Thermometers

See Pyrometers.

Variance of Measuring Instruments

Variance of Measuring Instruments and Its Relation to Accuracy and Sensitivity, Frederick J. Schlink. Bul. Bur. of Standards, vol. 14, no. 4, July 12, 1919, pp. 741-764, 7 figs. With

The apprentice says:

"Almost the first tool I ever heard of was a Starrett 'mike.' Somebody pinched Dad's out of his jumper pocket and the fuss he made showed he thought it was *some* tool, even if he had had it close on twenty years.

"When I got into the shop myself, I noticed the toolmakers and everybody who had 'fussy' jobs preferred Starrett Tools.

"There's something about 'em that the fellows like. Yeh! They're accurate and they're convenient, but I guess the fact that the men who make 'em are pretty good mechanics themselves, has something to do with it.

"What? Sure I'm getting me a set of Starrett Tools — I need 'em every day. Yes, I got me one of those seventy-five cent Starrett Apprentice Books, too. It saves me asking the foreman a question every five minutes. Now, when I want to know how to do something, I can look in the book and study it out myself."

Starrett Tools

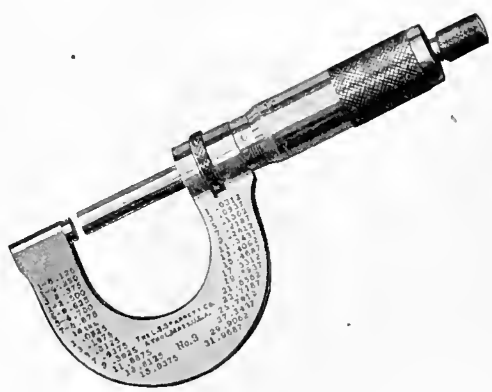
The L. S. Starrett Company

THE WORLD'S GREATEST TOOLMAKERS

Manufacturers of Hack Saws Unexcelled

ATHOL, MASS.

For thirty-nine years Starrett Tools have measured the accuracy of the world's work. Catalogue No. 21 "LD" free upon request.



reference to calibration curves of typical instruments, which are presented to show character of hysteresis loops and nature and amount of various errors as actually determined.

Visibility Measurement

The Low Visibility Phase of Protective Coloration, Loyd A. Jones. Jl. Franklin Inst., vol. 188, no. 3, Sept. 1919, pp. 363-387, 7 figs. Theory upon which measurement and specification of visibility is based; description of instrument to measure visibility. (To be concluded.)

MOTOR-CAR ENGINEERING

Axles

Unusual Types of Axles on the German War Trucks—V, Arthur J. Slade. Automotive Industries, vol. 41, no. 10, Sept. 4, 1919, pp. 457-461, 17 figs. Front axles about equally divided between Elliot and reserve Elliot type. No roller bearings are used. From observations made of trucks handed over to A. E. F.

Berliet

The Berliet Three Tonner. Motor Traction, vol. 29, no. 755, Aug. 20, 1919, pp. 157-158, 6 figs. Lower part of crankcase base chamber made detachable. Engine has bore of 110 mm., stroke of 140 mm., capacity of 1330 cc. per cylinder, and is designed for speeds not exceeding 1250 to 1500 r.p.m.; rated at 22 hp.

Busses

London's New Motor Busses. Motor Traction, vol. 29, no. 756, Aug. 27, 1919, pp. 182-183, 6 figs. Designed with a view to reduce weight, in order to comply with police regulations, though carrying twelve additional passengers.

Connecting Rods

Connecting-Rods for Motor Trucks and Passenger Cars, Fred H. Colvin. Am. Mach., vol. 51, no. 10, Sept. 4, 1919, pp. 467-470, 10 figs. Methods of machining, noting especially how concentration of machines eliminates handling of material and fixtures which reduce loss of cutting time.

Garages

Practical Suggestions for the Construction, Equipment and Operation of Automobile Garages (Praktische Vorschläge für den Bau, die Einrichtung und den Betrieb von Automobil-Garagen), Albert Neuburger. Automobil-Rundschau, vol. 18, nos. 7/8, Apr. 1919, pp. 60-70. Heating, illumination and ventilation. (To be continued.)

Impact on Road

Motor-Truck Impact on Roads Five Times Dead Load. Eng. News-Rec., vol. 83, no. 12, Sept. 18, 1919, pp. 573-575, 3 figs. Experiments of Bureau of Public Roads said to indicate that force is dependent on speed, power and condition of truck.

Impact Tests of Truck

Effect of Impact of Trucks, E. B. Smith and J. T. Pauls. Mun. Jl. & Public Works, vol. 47, no. 11, Sept. 13, 1919, pp. 162-164, 3 figs. Tests being made by Bur. of Public Roads indicate that there is general tendency of increased impact with higher speeds although relation between speed and impact is not constant; also general increase of impact with increase of height of drop.

Plows

Tractor Ploughing Machine of Unique Design, J. H. Rogers. Can. Machy., vol. 21, no. 11, Sept. 18, 1919, pp. 293-296, 9 figs. Particular advantage claimed is that a plurality of plows can be carried by tractor, entire mechanism of machine being operated by tractor motor located on front end of framework.

Springing Device

A New Springing Device, W. Gordon Aston. Autocar, vol. 43, no. 1234, Aug. 16, 1919, pp. 244-245, 1 fig. Shocks met through variable leverage toggles by coil springs.

Springs, Auxiliary

Supplemental Springs for Metal Tired German Trucks, Arthur J. Slade. Automotive Industries, vol. 41, no. 9, Aug. 28, 1919, pp. 409-412, 14 figs. Made necessary on account of substitution of steel for rubber tires.

Tractors

Automotive Manufacturers Developing French Tractors, W. F. Bradley. Automotive Industries, vol. 41, no. 11, Sept. 11, 1919, pp. 526-529, 5 figs. Influence of war tank design in new tractors developed recently for France.

Wheels

Wheels for Power Vehicles (Das Kraftwagenrad), K. Bilau. Automobil-Rundschau, vol. 18, no. 7/8, Apr. 1919, pp. 71-74, 3 figs. Strength, light weight and resistance to various temperatures are some of their requirements.

PIPE

Wood-Stave Pipe

Kipawa Co.'s Pulp Mill and Power Development. Can. Engr., vol. 37, no. 12, Sept. 18, 1919, pp. 305-310, 16 figs. Noting details of wood-stave power pipe line 8 ft. in diameter.

Diagram for Computing Band Spacing for Wood-Stave Pipe, Willis T. Batcheller. Eng. News-Rec., vol. 83, no. 10, Sept. 4, 1919, p. 472, 1 fig. For pipe 1 to 20 ft. in diameter, under heads of from 10 to 200 ft. and for band diameters of $\frac{3}{8}$ to $1\frac{1}{4}$ in.

POWER GENERATION

Chesapeake and Ohio Power Plant

Chesapeake and Ohio Power Plant, C. L. Humphreys. Nat Engr., vol. 23, no 9, Sept. 1919, pp. 423-425, 3 figs. Plant supplies steam, air and electric power for general repair shops employing about 2500 men.

Gas Works Power Plant

Gas Works Power Plants, H. C. Widlake. Gas Jl., vol. 147, no. 2935, Aug. 12, 1919, pp. 336-338, 3 figs. Economical aspect of substituting steam engine for electric motor in gas works.

Government Ownership

Government Ownership of Water Powers and Electrochemical Industry, F. A. J. FitzGerald. Gen. Meeting Am. Electrochem. Soc., Paper no. 24, Sept. 23-26, 1919, pp. 305-317 and (discussion) pp. 317-328. Arguments advanced by advocates of government ownership are judged to be a priori and not based on actual experience. Examples of governmental activities in fields which can be undertaken by private enterprise are considered as offering evidence strongly against public ownership in such cases.

Interconnecting Systems

Developing Hydroelectric Power Sites. Power Plant Eng., vol. 23, no. 18, Sept. 15, 1919, pp. 806-808, 2 figs. Advantages of interconnecting systems.

United States

Growing Demand for Industrial Power, L. W. Alwyn-Schmidt. Power Plant Eng., vol. 23, no. 17, Sept. 1, 1919, pp. 774-776, 2 figs. Statistical data gathered in U. S. and their economical significance.

Power Systems of the North Central States, Chester H. Jones. Chem. & Metallurgical Eng., vol. 21, no. 6, Sept. 15, 1919, pp. 342-347, 9 figs. Statistics of present development and estimated figures of possible utilization.

POWER PLANTS

Boiler Rooms

Boiler-Room Economy in Small Plants, M. B. Watson. Elec. News, vol. 28, no. 17, Sept. 1, 1919, pp. 27-28. Suggestions in regard to making systematic records. (To be concluded.)

Coal and Wood Furnaces Under Stirling Boilers. Power, vol. 50, no. 11, Sept. 9, 1919, pp. 414-417, 5 figs. Boiler plant where it is said, \$25,000 saving in coal per year is effected.

Coal Handling

Equipment for Handling Coal and Ashes in Power Plants, Robert June. Elec. Rev., vol. 75, no. 12, Sept. 20, 1919, pp. 481-483, 3 figs. Influence of methods upon plant operation; classification of mechanical methods of handling coal and ashes; power calculations.

Condenser Tubes

Life of Brass Condenser Tubes, Guy D. Bengough and O. F. Hudson. Sci. Am. Supp., vol. 88, no. 2274, Aug. 2, 1919, pp. 75-77. Results of study of actions of certain metals in distilled and sea water, and possible protective measures. Summary of report to Inst. of Metals.

Edgewater Power House

Edgewater Power House in Operation. Power Plant Eng., vol. 23, no. 17, Sept. 1, 1919, pp. 753-760, 11 figs. Source of energy supply for North Central Ohio. Coal- and water-handling systems and method of reclaiming heat losses described as interesting installation features.

Exhaust Steam, Utilization of

Conservation of Coal by Saving Exhaust Steam in the Textile Industries, William B. Hoyt. Jl. Am. Soc. Heat. and Vent. Engrs., vol. 25, no. 2, Apr. 1919, pp. 119-122. Recommendations for effecting conservation in felt mills, woolen mills and knitting mills.

Firing

Saving Coal in Power Plants. Universal Engr., vol. 29, no. 6, June 1919, pp. 32-37, 1 fig. Chief losses in boiler plant operation are said to be due to (1) dirty boiler, (2) leaky setting, (3) poor firing.

Oil Burners

Influence of Load Pressures of Oil and Atomizing Steam in Oil Burners, C. R. Weymouth. Jl. Electricity, vol. 43, no. 5, Sept. 1, 1919, pp. 218-220, 7 figs. Charts showing results of test data in relationship of oil and steam pressures, which results in greatest boiler efficiency.

Records

Boiler- and Engine-Room Record Sheets, P. R. Duffey. Power, vol. 50, no. 12, Sept. 16, 1919, pp. 461-463, 3 figs. Illustrating various forms which are said to have been found serviceable in actual operation.

Stacks

Experiments on Stack Performance, Julian C. Smallwood. Power, vol. 50, no. 12, Sept. 16, 1919, pp. 464-467, 2 figs. Comparison of experimentally determined temperatures, velocities and pressures with values assumed and results calculated in design.

Stand-By Operation

Converting a Steam Plant to Stand-by Operation, L. M. Klauber Power Plant Eng., vol. 23, no. 18, Sept. 15, 1919, pp. 815-817, 2 figs. Enumeration of problems encountered following tie-in with transmission service. From paper read before Pac. Coast Section, Nat. Elec. Light Assn.

Superheated Steam

Industrial Uses of Superheated Steam, Alexander Bradley. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 25, no. 2, Apr. 1919, pp. 123-132, 6 figs. Including results of comparative tests conducted by Engineering Dept. of Standard Oil Co. on oil pumping engines with saturated and superheated steam.

Vacuum

Vacuum—II, Roger Taylor. Power Plant Eng., vol. 23, no. 18, Sept. 15, 1919, pp. 809-812, 6 figs. Advantages of low pressure; controlling conditions.

PRODUCER GAS

Ammonia in Producer Gas

Ammonia in Producer Gas, F. K. Ovitz. Chem. & Metallurgical Eng., vol. 21, no. 5, Sept. 1, 1919, pp. 253-255. Tests made at factory of Hazel-Atlas Glass Co., Washington, Pa., to determine amount of ammonia in gas from producers of Smith type.

Producer-Gas Engines

The Gorham Producer Gas Engine. Pac. Mar. Rev., vol. 16, no. 9, Sept. 1919, pp. 149-152, 4 figs. Arranged for running in either direction, reversal being accomplished by use of compressed air furnished by compressor mounted on and forming part of engine.

Smith Producer Plant

Producer Gas Traction. Gas and Oil Power, vol. 14, no. 168, Sept. 4, 1919, pp. 178-180, 5 figs. Description of the Smith producer plant.

PUMPS

Control

Automatic Pump Control, B. N. Everett, Power, vol. 50, no. 13, Sept. 23, 1919, pp. 496-499, 14 figs. Illustrating arrangements of automatic pump-control apparatus for motor- and belt-driven power pumps, of both plunger and centrifugal types.

Quarry Service

Pumps in Quarry Service—I. Stone, vol. 40, no. 7, July 1919, pp. 311-313. General requirements in American quarries.

Turbine Pump, Electric

Economical Pumping by New Application of Electric Turbine Pump, H. Hughes. Iron & Coal Trades Rev., vol. 99, no. 2685, Aug. 15, 1919, pp. 210-211, 4 figs. Installation at Nantgarw colliery which is 860 yd. deep, for pumping 10,000 gal. of water per hour.

Vacuum Pumps

A Volumetric Efficiency Test of a Vacuum Pump, George S. Tayman. Mech. Eng., vol. 41, no. 10, Oct. 1919, pp. 823-824. Pump tested was Laidlaw-Dunn-Gordon duplex dry-vacuum pump, size 18 in. by 12 in., when operating under different intake and discharge pressures.

Weir, Turbo-Feed Pump

The Weir Turbo-Feed Pump. Iron & Coal Trades Rev., vol. 99, no. 2685, Aug. 15, 1919, p. 203, 4 figs. Of impulse type with one pressure and several velocity stages.

REFRACTORIES

Haydite

Prominent Clay Men Organize to Make New Building Material. Brick & Clay Rec., vol. 55, no. 6, Sept. 9, 1919, pp. 484-487, 2 figs. Historical account of development and outline of physical properties of "Haydite."

REFRIGERATION

Boyle Curve

See Refrigerating Machinery.

Code, Refrigerating

Proposed Refrigerating Code. Power Plant Eng., vol. 23, no. 18, Sept. 15, 1919, pp. 825-827, 2 figs. As outlined for municipal and State regulations for refrigeration machines and plants. Approved by Council of Am. Soc. Refrig. Engrs.

Dehydration

Dehydration in Absorption Machines. John E. Starr. Refrig. World, vol. 54, no. 9, Sept. 1919, pp. 11-12. Suggests keeping gas between the dehydration and condenser at temperature 8 or 10 deg. above temperature corresponding to pressure actually existing in condenser.

Food Storage

Cold Storage of Food—I and II, Ingrar Jorgensen and Walter Stiles. Sci. Am. Supp., vol. 88, nos. 2279 and 2281, Sept. 6 and 20, 1919, pp. 150-151 and 178 and 192. Sept. 6: Technical considerations involved in developing appropriate types. Sept. 20: Concerning physical changes in meat preserved by cold storage. (From Science Progress, London.)

Packing Houses

Refrigerating Troubles in a Packing House Plant. J. C. Moran. Power, vol. 50, no. 12, Sept. 16, 1919, pp. 459-461, 2 figs. Remedying troubles due to inadequate cooling coil surface.

Refrigerating Machines

The Compression Refrigerating Machine, Gardner T. Voorhees. Ice & Refrigeration, vol. 57, no. 3, Sept. 1919, pp. 93-95, 1 fig. Construction and significance of Boyle Curve. (Continuation of serial.)

See also Testing.

Refrigerating Plants

Getting a Refrigerating Plant Out of a Critical Situation. J. C. Moran. Power, vol. 50, no. 11, Sept. 9, 1919, pp. 429-430, 1 fig. Additional capacity secured by connecting individual branches to each of three ammonia compressors from top of main line instead of bottom.

Testing

Rules for Testing Compression Refrigerating Plants (Regeln für Leistungsversuche an Kompressions-Kühlanlagen). Karl Fehrmann. Zeitschrift für die gesamte Kälte-Industrie, vol. 26, no. 4, Apr. 1919, pp. 25-28. Testing efficiency of evaporator; power consumption of condenser; water consumption of liquefier; power consumption of pumps, agitator, etc.

RESEARCH

Chemical Research

Research and Application. Wm. H. Nichols. Science, vol. 50, no. 1288, Sept. 5, 1919, pp. 217-224. Illustrating by survey of chemical progress how research work has furthered scientific development. Also notes on appreciation of its importance by associations and organizations, principally Am. Federation of Labor. Paper read before Am. Chem. Soc.

Universities

The New Opportunity in Science. R. A. Millikan. Science, vol. 50, no. 1291, Sept. 26, 1919, pp. 285-297. Argues that universities cannot possibly fulfill their function of selecting and developing scientific men of outstanding ability unless they create within themselves the atmosphere of scientific research.

STANDARDS AND STANDARDIZATION

Economies

Industrial Viewpoint on Standardization. E. E. George. Elec. World, vol. 74, no. 12, Sept. 20, 1919, pp. 635-636. Instances emphasizing economies resulting from fixing standards.

Engineering Standards Committee

Engineering Standards Committee Proposes New Constitution. Eng. News-Rec., vol. 83, no. 12, Sept. 18, 1919, pp. 575-576. New draft provides for taking in other societies on equal basis and association plan for outside financing dropped.

Glassware Laboratory

Report of the Committee on the Standardization of Laboratory Glassware. Jl. Soc. Chem. Indus., vol. 38, no. 15, Aug. 15, 1919, pp. 280R-285R, 2 figs. Metric dimensions and capacities of accepted standards for cylindrical beakers, flasks, funnels, drying towers and graduated operators.

Pyrometer Standardization

Metals for Pyrometer Standardization, Charles W. Waidner and George K. Burgess. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 152, Aug. 1919, pp. 1511-1512. Summary of work done by Bureau of Standards, with table giving values of freezing points and purity of standard pyrometric metals.

Standard Determination

Standardisation. J. Fearn. Managing Engr., vol. 6, no. 4, Aug. 1919, pp. 83-86 and discussion pp. 86-90. Necessity of conducting research work for determining standards.

Steel Standards

Foreign Steel Standards Compared to Ours —I, F. F. Macintosh. Blast Furnace & Steel Plant, vol. 7, no. 9, Sept. 1919, pp. 432-434. Although American practice is said to outstrip foreign competition in tonnage and cost, higher quality is considered as predominant characteristic of European steel.

STEAM ENGINEERING

Bleeder Turbines

The Bleeder Turbine, Josef Y. Dahlstrand. Power Plant Eng., vol. 23, no. 17, Sept. 1, 1919, pp. 762-768, 13 figs. Its use, design and construction.

Boilers

An Improved Steam Boiler. Am. Marine Eng., vol. 14, no. 9, Sept. 1919, pp. 20-21, 3 figs. Primary object of invention is to obtain maximum steaming capacity for given area of grate surface, water passages being so arranged that proper circulation of water is insured and liberation of steam facilitated.

Boilers, Cleaning

How Much Fuel Does a Clean Boiler Save? W. F. Schaphorst. Blast Furnace & Steel Plant, vol. 7, no. 9, Sept. 1919, pp. 456-457, 1 fig. Chart for determining fuel saved by clean boilers.

Boiler Fittings

Fittings for Steam Boilers—I, Edward Ingham. Colliery Guardian, vol. 118, no. 3060, Aug. 22, 1919, p. 489. Concerning arrangement of safety valves on large boilers.

Boiler Plugs, Fusible

Tin Fusible Boiler-plug Manufacture and Testing, L. J. Gurevich and J. S. Hromatko. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 152, Aug. 1919, pp. 1351-1360, 5 figs. From tests at Bureau of Standards, precautions to be taken in manufacture of fusible plugs are recommended, notably that pig tin should be at least 99.7 per cent pure, containing not more than 0.1 per cent lead, or 0.1 per cent zinc, which are requirements of Steamboat Inspection Service.

Boilers, Low-Pressure

Code for Testing Low Pressure Heating Boilers. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 25, no. 2, Apr. 1919, pp. 212-214, and (discussion) pp. 215-218. Revision of form accepted by Soc. of Heat. & Vent. Engrs. in Jan. 1918.

Cracking of Cast-Iron Sectional Hot-Water Boilers, Charles R. Honlball. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 25, no. 2, Apr. 1919, pp. 133-140. Results of investigations claimed to point out that to avoid cracking it is necessary to provide for easy and equable working, avoidance of air locks or steam formation, continuous circulation and avoidance of deposit.

Boilers, Superheated-Steam

Boiler for Compound Superheater Engines, Midland Railway. Ry. Engr., vol. 40, no. 476, Sept. 1919, pp. 186-190, 13 figs. Constructed for working pressure of 225 lb. per sq. in., but safety valves for compound engines are adjusted to blow off at 190 lb. per sq. in.; firebox of Belpaire type with inclined grate.

Boilers, Water-Tube

The Cross Drum Type Heine Water Tube Boiler. Mar. Eng. & Can. Merchant Service Guild Rev., vol. 9, no. 8, Aug. 1919, pp. 271-273, 3 figs. Particularly as fitted in ships of United States Emergency Fleet.

Turbines

Low-Pressure Turbines in Forge Shops, H. V. Schoepflin. Power, vol. 50, no. 12, Sept. 16, 1919, pp. 450-453, 6 figs. Economy of utilizing exhaust steam from hammers instead of wasting it to atmosphere. Details of apparatus required and problems to be considered in application.

Refinements in Turbine Design, A. G. Christie. Power, vol. 50, no. 10, Sept. 2, 1919, pp. 362-364, 4 figs. Article deals with forms of throats and mouths of nozzles, polished surfaces for diaphragms and thickness of blade edges.

Steam Turbines and Gears for Marine Service. Power, vol. 50, no. 11, Sept. 9, 1919, pp. 424-426, 4 figs. Greater speed for given weight of power plant, less operating expense, greater reliability, saving in fuel and greater efficiencies claimed as principal advantage of turbine drive with reduction gear for ship propulsion.

Valves, Drop

Notes on Drop Valves for Steam Engines, H. W. Morley. Sci. Am. Supp., vol. 88, no. 2280, Sept. 13, 1919, pp. 164-165, 4 figs. Results of experience with slow-speed land engines discussed in their significance to designing other types.

THERMODYNAMICS

Heat Interchangers

Heat Interchangers (Echangeurs de chaleur), G. Bastien. Mémoires et compte rendu des travaux de la Société des Ingénieurs Civils de France, vol. 72, no. 4, 5 & 6, Apr.-June 1919, pp. 183-237, 3 figs. Theoretical analysis of phenomena taking place in heat interchangers operating by contact of two fluids with separating medium.

Latent-Heat Formulæ

Latent Heat and Surface Energy—I, D. L. Hammick. Lond., Edinburgh & Dublin Phil. Mag., vol. 38, no. 224, Aug. 1919, pp. 240-245. Expression connecting internal latent heat and surface energy, and discussion of its agreement with available data.

WELDING

Aluminum

New Method for Soldering Aluminum (Ein neues Verfahren zum Löten von Aluminum). Autogene Metallbearbeitung, vol. 12, no. 4, Apr. 1919, pp. 57-62, 12 figs. Method employs "Foramus" solder, which is made in bars 4, 7 and 10 mm. thick and can be used for soldering sheets, pipes, aluminum with copper; material is also made in a special quality with low melting point for repairing delicate aluminum parts.

Boiler Welding

Standard Boiler Welding. Welding Engr., vol. 4, no. 9, Sept. 1919, pp. 21-25, 27 figs. Oxy-acetylene and electric welding on the Kansas City Southern Railroad.

The A. C. System of Arc Welding. Engineer, vol. 128, no. 3322, Aug. 29, 1919, pp. 213-214, 4 figs. With exposition of advantages claimed for this system.

Jigs

Welding Jigs and How to Overcome Distortion, C. S. Milne. Can. Machy., vol. 22, no. 9, Aug. 28, 1919, pp. 228-229, 2 figs. Illustrating welding fracture in rim of cast iron gear wheel to transmit 240 hp. (Concluded.) Paper read before British Acetylene & Welding Assn.

Oxy-Acetylene Welding

The Judgment of the Oxy-Acetylene Process, Alfred S. Kinsey. Can. Machy., vol. 22, no. 11, Sept. 11, 1919, pp. 280-281. Sees process as engineering success and fine commercial asset.

Oxy-Hydrogen Gas Welding

Oxy-Hydrogen Gas — Its Uses at the J. I. Case Threshing Machine Company, Manufacturers of Tractors and Farm Implements, Charles Kandel. Am. Gas Eng. Jl., vol. 111, no. 11, Sept. 13, 1919, pp. 219-222, 5 figs. Purity of gases produced insures maximum efficiency for cutting and welding parts of Case farm-implement products.

Weld Production

Some Interesting Welds (Einige interessante Schweissarbeiten). Autogene Metallbearbeitung, vol. 22, no. 7/8, Apr. 1919, pp. 31-32, 6 figs. High-pressure distributor; cooling aggregate; pressure cylinder; tank car for high-pressure gases.

Repairing Engine Cylinders by Autogenous Welding (Ueber die Ausbesserung schadhafter Motorzylinder mittels der autogenen Schweissung). Autogene Metallbearbeitung, vol. 22, no. 7/8, Apr. 1919, pp. 27-30, 2 figs. Preventing hard seams and dripping of iron from welds. (To be continued.)

Wrought-Iron Welding

Welding Wrought Iron and Steel, H. L. Unland. Elec. Ry. Jl., vol. 54, no. 12, Sept. 20, 1919, pp. 581-582. Suggestions in regard to practical procedure.

Your Responsibility

You, as an Engineer, have the opportunity of playing an important part in the solution of present industrial conditions.

The crying need of this country and the world is for Increased Production. More things per capita must be produced if prices are to come down and conditions return to a normal basis. And this in the face of the demands of labor for shorter hours.

There is one solution and only one—IMPROVED MACHINERY. And here lies your opportunity and responsibility.

It is up to every Engineer to redesign, refine and improve the machinery for which he is responsible. He should study and utilize the best and most modern tendencies in design to assure the desired result—increased production from the machines.

Durable Hyatt Roller Bearings are a logical part of all Improved Machinery—Machinery designed for Maximum Production. Their use makes machinery dependable, insures continuous operation and eliminates shutdowns for repairs. Hyatt Roller Bearings keep a machine at its job—production.

As an Engineer, you are responsible for the design of this Improved Machinery. You should carefully investigate the increased production made possible by the use of Hyatt Roller Bearings.

Send for our latest engineering data covering the class of machinery in which you are interested.

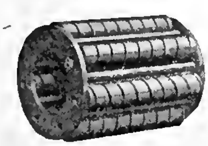
Hyatt Roller Bearing Company

INDUSTRIAL BEARINGS DIVISION

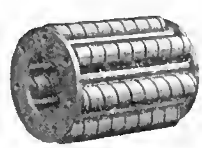
Metropolitan Tower, New York City

MOTOR BEARINGS DIVISION
DETROIT, MICHIGAN

TRACTOR BEARINGS DIVISION
CHICAGO, ILLINOIS



Manufacturers of Bearings for Mine Cars, Ore Cars, Steel Mill Cars, Roller Tables, Trolleys, Cranes, Hoists, Machine Tools, Line Shafts, Countershafts, Concrete Machinery, Textile Machinery, Conveyors, Lift Trucks, Industrial Trucks, Railway Service Cars, Storage Battery Locomotives, etc.



WOOD

Laminated Wood

Reducing Shrinkage and Swelling in Laminated Wood Construction, J. S. Mathewson. Aviation, vol. 7, no. 3, Sept. 1, 1919, p. 140. Remarks based on experimental research conducted at U. S. Forest Products Laboratory.

Organization and Management

ACCOUNTING

Accounting Methods

Importance of Proper Accounting in the Maintenance of Way Department in General, I. A. May. Street Ry. Bul., vol. 19, no. 9, Sept. 1919, pp. 329-335, 5 figs. Details as to reports, time slips, data cards, etc., used by The Connecticut Co., New Haven, Conn.

Appraisals

Practice in Making Electric Utility Appraisals, Charles W. McKay. Elec. Rev., vol. 75, no. 11, Sept. 13, 1919, pp. 428-433. Discussion of value of unit costs and necessity for care in their preparation.

Unit Costs for Use in Public Utility Appraisals, R. L. Baldwin. Eng. News-Rec., vol. 83, no. 11, Sept. 11, 1919, pp. 514-516, 1 fig. Method at present employed by many commissions described as combination of "reproduction cost with unit prices based upon average prices," and "actual cost from records."

Classification of Expenses

Protection of Owners on Cost-Plus Contracts, F. A. Wells. Can. Engr., vol. 37, no. 13, Sept. 25, 1919, pp. 323-326, 4 figs. Practical use of Dewey Decimal System in keeping books on the job; classification of plant expense and field overhead.

Cost Accounting

Uniform Cost Accounting in Shipbuilding—II, J. L. Jacobs. Int. Mar. Eng., vol. 24, no. 9, Sept. 1919, pp. 638-640. Plan adopted by Atlantic Coast Shipbuilders' Assn. for uniform method of cost accounting in steel shipbuilding.

A Cost System for Shipyards—III, Creighton Churchill. Int. Mar. Eng., vol. 24, no. 9, Sept. 1919, pp. 641-642. 1 fig. How the system is operated; practical application in the case of a hull under construction or under contract.

Costing

Costing in Relation to Scientific Management, J. H. Boyd. Elecn., vol. 83, no. 2152, Aug. 2 1919, pp. 171-172. Results obtained at various works.

The Necessity of Knowing Manufacturing Costs, Roland H. Zinn. Am. Industries, vol. 20, no. 2, Sept. 1919, pp. 20-21. Points out that unless exact cost of each department is known, waste of materials, inefficient help, or careless supervision in buying will not be reported.

The Philosophy of Costs, C. E. Knoeppel. Indus. Management, vol. 58, no. 3, Sept. 1919, pp. 179-183. Importance of determining hourly performance of labor illustrated by various instances in which efficiency was increased by recording it regularly, notably experience of one company in which efficiency in one department increased production 60 per cent by displaying graphically from day to day actual hourly production against predetermined hourly production.

Do You Know Exactly What Your Product Costs? Can. Machy., vol. 22, no. 5, July 31, 1919, pp. 101-106, 5 figs. Illustrating instances showing how planning costs worked out; comparison chart for engines built during 1917-1918.

Cost Factors

Summarizing All Cost Factors, M. H. Potter. Iron Trade Rev., vol. 65, no. 10, Sept. 4, 1919, pp. 630-631, 6 figs. Suggested method for determining basis for fixing of selling price.

Inventories

Inventorying Materials and Supplies, B. J. Yungbluth. Elec. Ry. Jl., vol. 54, no. 11, Sept. 13, 1919, pp. 518-520, 2 figs. How Pittsburgh Railways Co. inventoried in two days, at cost of $239.85, 8613 different kinds of materials valued at $916,317, without special help of overtime of employees.

EDUCATION

Army Trade Tests

The Army Trade Tests, William T. Bawden. Dept. of Interior Bur. of Education, Circular no. 4, Apr. 1919, 28 pp., 8 figs. Report of a conference of specialists in industrial education, called by the U. S. Commissioner of Education.

Factory School

The Factory School as an Americanizing Force, T. A. Levy. Am. Industries, vol. 20, no. 2, Sept. 1919, pp. 23-24. From address at Americanization Congress under auspices of Assn. Industries of Mass.

Training Factory Help

Possibilities in Training Factory Help, James F. Johnson. Indus. Management, vol. 58, no. 3, Sept. 1919, pp. 221-224, 2 figs. Proposed as remedy for labor shortage.

EXPORT

British Machine Tool and Metal Industries

British Machine Tool and Metal Industries, Alexander Luchars. Machy. (N.Y.), vol. 26, no. 1, Sept. 1919, pp. 19-24. Report of U. S. Trade Commissioner to Great Britain and Continental Europe appointed by U. S. Dept. of Commerce, for purpose of studing conditions affecting sale and use of American machine tools and accessories in European market. Also in Am. Mach., vol. 51, no. 10, Sept 4, 1919, pp. 478-480.

Cement

International Trade in Cement. Cement, Mill & Quarry, vol. 15, no. 5, Sept. 5, 1919, pp. 19-23. Statistics of imports into other countries. Export opportunities for American producers. Third article.

China

China as Market for Railway Materials, Frank Rhea. Ry. Rev., vol. 65, nos. 9 and 11, Aug. 30 and Sept. 13, 1919, pp. 289-294 and 371-376, 23 figs. From Far-Eastern Markets for Railway Materials, Equipment and Supplies, Special Agents' Series no 180, published by Dept. of Commerce, Bureau of Foreign and Domestic Commerce. Operating methods; track materials and maintenance; general characteristics of rolling stock.

East Indies, Dutch

Dutch East Indies Offer Many Construction Opportunities, J. W. Evans. Eng. News-Rec., vol. 83, no. 11, Sept. 11, 1919, pp. 497-498. Developments now under way or in prospect in Sumatra and Java include port works, railroads and waterpower.

Signaling Apparatus

Opportunities for American Signaling in Far East, Frank Rhea, Ry. Age, vol. 67, no. 12, Sept. 19, 1919, pp. 557-558. Urges that American firms must recognize differences in operating methods to compete successfully.

FACTORY MANAGEMENT

Bar Steel, Identification

Identification of Bar Steel. Machy. (N. Y.), vol. 26, no. 1, Sept. 1919, pp. 36-38. Method employed by Rockford Drilling Machine Co., which consists in painting streaks of different colors laterally and transversely on side of bars.

Construction Work, Chart for

A Useful Progress Chart for Construction Work. Power Plant Eng., vol. 23, no. 17, Sept. 1, 1919, p. 769, 1 fig. Employed during construction of Edgewater power station for determining percentage of work already done on any particular job as well as percentage of work remaining unfinished, and estimated length of time required to complete work.

Controlling Production

A System for Controlling Production, Robert H. Wadsworth. Am. Mach., vol. 51, no. 10, Sept. 4, 1919, pp. 451-455, 12 figs. Forms used are illustrated and their functions discussed.

Drawing Office

Drawing Office and Workshop Organization, N. Gerard Smith. Eng. & Indus. Management, vol. 2, no. 9, Aug. 28, 1919, pp. 259-263, 11 figs. Concerning filing of technical data and routine for tool supply.

Employment Department

Adjusting the Employment Department to the Rest of the Plant, Dwight T. Farnham. Indus. Management, vol. 58, no. 3, Sept. 1919, pp. 201-205, 3 figs. Suggested standard-practice instructions for employment determined.

Follow-up Plants for Production

Keeping Production on Schedule, S. P. Keator. Factory, vol. 23, no. 3, Sept. 1919, pp. 510-511, 6 figs. Suggested follow-up plan for small plants

Foremen

The Foreman in Relation to Workshop Organization, A. Robert Stelling. Eng. & Indus. Management, vol. 2, no. 10, Sept. 4, 1919, pp. 294-295. Comparison of American and English practice in management of workshops.

Foundry

See Production Methods.

Industrial Relationships

Industrial Relationship, Bass Smith. Am. Mach., vol. 51, no. 10, Sept. 4, 1919, pp. 471-472. Qualifications of industrial management.

Industrial Welfare, Edgar L. Collis. Eng. & Indus. Management, vol. 2, no. 10, Sept. 4, 1919, pp. 309-311. Welfare is considered as "an inevitable development of modern industry, necessary to enable it to do its duty by its employees," and it is pointed out that welfare work "must cover outside activities, such as recreation, transport and housing questions."

Inspection, Electrical

Organizing Electrical Inspection and Maintenance, C. A. Cowdery. Elec. World, vol. 74, no. 12, Sept. 20, 1919, pp. 645-649, 4 figs. Method carried out in one of large industrial plants in New England while factory was employed on war work exclusively and operated 24 hr. daily excepting Sundays.

Machine-Tool Plant

Organization and Management of a Machine Tool Plant—III. Machy. (Lond.), vol. 14, no. 358, Aug. 7, 1919, pp. 565-569, 9 figs. Manufacturing departments and systems recommended for medium-size machine-tool-manufacturing plant making a single line of machines.

Motor-Transport Business

Starting in the Motor Transport Business. Motor Traction, vol. 29, no. 758, Sept. 10, 1919, pp. 219-222. What it costs and what it brings in.

Motion Analysis

Graphic Methods of Analysing Motions. Eng. & Indus. Management, vol. 2, no. 8, Aug. 21, 1919, pp. 229-232, 2 figs. Charts illustrating simultaneous cycle motion of lowering pig iron upon a railway truck and action of workman in leaving his work.

Planning

The Production Planning System of the Heald Machine Company—II, W. S. Pratt. Am. Mach., vol. 51, no. 11, Sept. 11, 1919, pp. 501-508, 11 figs. Planning board and method of following work.

A Planning Department System in Use in a Machine Shop, John H. Black. Indus. Management, vol. 58, no. 3, Sept. 1919, pp. 225-229, 2 figs. Viewpoint around which planning department is said to be built is necessity of knowing at all times "what is still needed" and how to make up actual or impending shortage.

Planning the Industrial Plant—IV, Hugh M. Wharton. Indus. Management, vol. 58, no. 3, Sept. 1919, pp. 237-241, 5 figs. Material handling, fire protection, toilets and lavatories, power transmission, heating, ventilation and illumination. (Concluded.)

Production Methods

Continuous Movement in the Essex Production Line, J. Edward Schipper. Automotive Industries, vol. 41, no. 9, Aug. 28, 1919, pp. 416-421, 10 figs. partly on supplement plate. Engine, chassis, and body treated as separate units until delivered complete at final assembly line.

Increased Output with Reduced Hours of Work, Chas S. Myers. Eng. & Indus. Management, vol. 2, no. 8, Aug. 21, 1919, pp. 227-229. Study of improved methods in an iron foundry.

Installing Management Methods in the Woodworking Industry, Carle M. Bigelow. Indus. Management, vol. 58, no. 3, Sept. 1919, pp. 185-195, 24 figs. Preparing orders, determining upon stock and material, laying out progress of work, making out production orders, preparing standard instructions, using control board, handling job cards and inspection records and computing labor efficiency, are described and illustrated by drawings and forms.

Machinery Versus Trained Brains, Lazarovich-Hrebelianovich. Indus. Management, vol. 58, no. 3, Sept. 1919, pp. 198-200. War experience of company which after losing its trained workers failed to increase its production efficiency even after having spent $200,000 in important machinery for use of new employees.

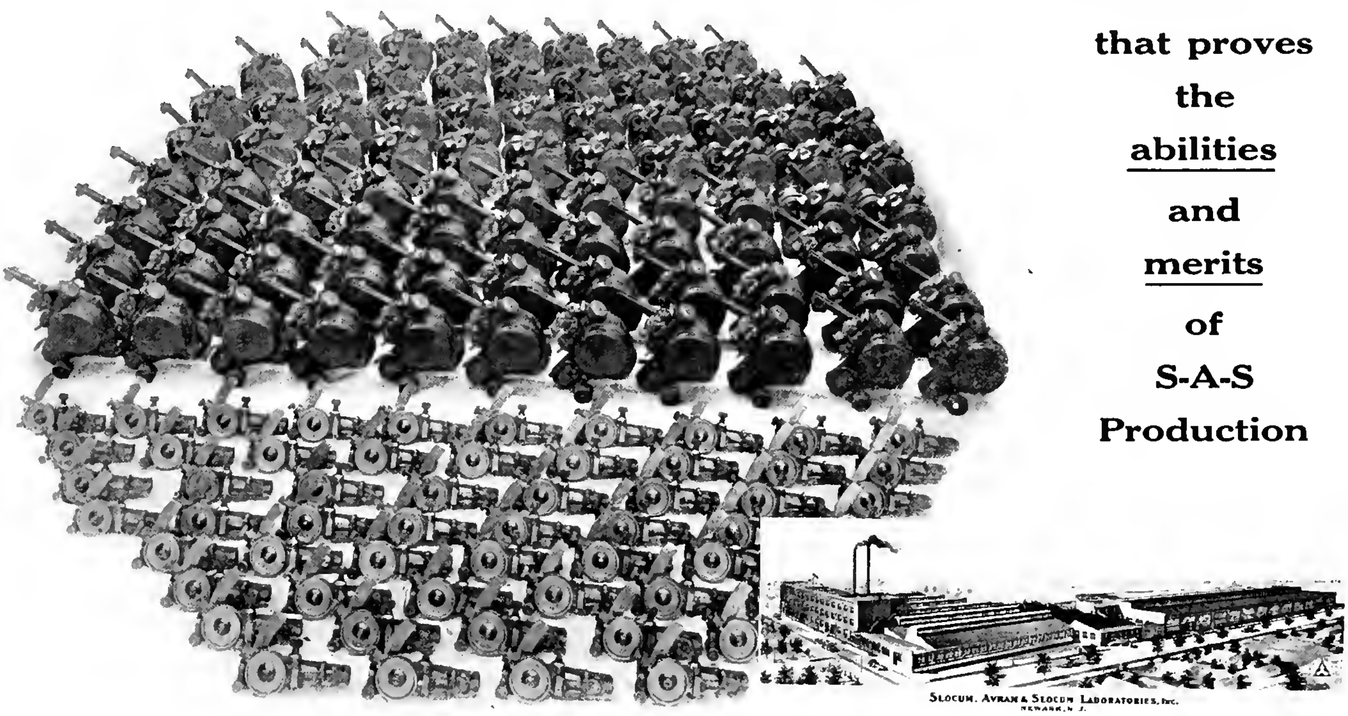
Factory Management in Garment Trades, Mack Gordon. Indus. Management, vol. 58, no. 3, Sept. 1919, pp. 230-235, 4 figs. Advising acceptance of democratic principle in training and follow-up functions.

Need of Personal Responsibility in Industry, Harry Tipper. Automotive Industries, vol. 41,

Production Work

As you want it — and when you want it

One Week's Work—



that proves the abilities and merits of S-A-S Production

The above illustration shows one week's production in the S-A-S Shops for the U. S. Government—83 Schneider sights and 60 4.7 range quadrants—an achievement in the quantity production field for accuracy and delivery.

This is only one of many examples of S-A-S performance that demonstrates S-A-S Leadership in the quantity production field. War-time necessity for accuracy and speed has developed our shops to a high point of efficiency and insures accurate, rapid and economical production for you now.

When you give the S-A-S Laboratories your Production Work

—you eliminate loss of profits through troublesome production
—you strengthen your abilities to meet competition
—you build an enviable reputation for quality

Superior workmanship—careful attention to details—a continuous record for satisfactory delivery and the development of S-A-S Service from year to year to keep S-A-S Production Leadership over all others has won the confidence of many leading organizations.

Let us be of service to you—let us solve your production difficulties and problems—write today.

This is the eighth of a series of advertisements telling about our plant, our methods and the work we are doing—another view of our production shops in the next issue.

SLOCUM, AVRAM & SLOCUM LABORATORIES, Inc.

Production Plant: NEWARK, N.J. *New York Office*: Woolworth Bldg., N.Y.

Special Machinery QUANTITY PRODUCTION Jigs, Fixtures and Gages

SLOCUM-AVRAM-SLOCUM MANAGEMENT

no. 11, Sept. 11, 1919, pp. 534-535. Points out that employer can do much to solve his labor troubles if he will educate his workers as to their part of whole and himself realizes responsibility to workers.

Getting Ready for the Shop Emergency. Can Machy., vol. 22, no. 5, July 31, 1919, pp. 118-121, 6 figs. States that every well appointed plant must have the means to deal quickly and efficiently with any mishap that may be encountered. How outfits are made up; accident prevention.

Maintenance of Management, Frank B. Gilbreth. Eng. & Indus. Management, vol. 2, no 10, Sept. 4, 1919, pp. 296-298, 1 fig. Proposed form for standing orders.

Sceintfic Management IV, Henry Atkinson. Eng. & Indus Management, vol 2, no. 10, Sept. 4, 1919, pp. 300-301 Points out that in order to establish successfully scientific management in any plant, "it is essential to take the broad view of industry and its relation to the general welfare," without any spirit of trying to "see if there is anything in it."

The Application of Industrial Efficiency, Charles E. Bedaux. Eng & Contracting, vol. 52, no. 11 Sept. 10, 1919, pp. 311-312. Its importance to meet European competition.

Engineering Organization and Routine, George L. McCain Automotive Industries, vol. 41, no. 12, Sept 18, 1919, pp 562-567, 9 figs Suggested system for keeping all concerned in touch with all of the work and developments at all times

Eliminating the Stop Watch from Industry, C. E. Knoeppel. Iron Age, vol. 104, no 12, Sept. 18, 1919, pp. 766-767. Production rates, determined by conferences with workers, and efficient management as essentials.

Production Records

Planning and Controlling Production, Ivan R. DeArmond Macy. (Lond.), vol. 26, no. 1, Sept. 26, 1919, pp. 617-619. Records used by R K LeBlond Machine Tool Co., by means of which information concerning progress of work, stock on hand or required, and location of job at any time may be quickly determined.

Purchasing

Organization for Purchasing and Stores, Henry B. Spencer. Ry. Age, vol. 67, no. 13, Sept. 26, 1919, pp. 617-619. Supervision by executive officer of purchasing, selling, storing, handling, protecting and disbursing.

Restaurants

Installing and Operating an Industrial Cafeteria, E F. Ross. Iron Trade Rev., vol. 65, no. 11, Sept 11, 1919, pp. 691-694, 6 figs. Information regarding equipment required, method of operating, system of financing and cost of Installing a modern lunch room for employees.

Shop Layout

Efficiency in Industrial Planning Illustrated in a New Forge Shop Am. Architect, vol. 116, no. 2279, Aug. 27, 1919, pp. 283-287, 6 figs. Illustrating general character of buildings in plant of Central Forge Co., Detroit, Mich., and open space provided on all sides by use of rolling doors, also diagrams showing arrangment of equipment.

Shop Papers

The Shop Paper as an Aid to Morale, Peter F. O'Shea. Factory, vol. 23, no. 3, Sept. 1919, pp. 518-522, 10 figs Experience of writer as editor of factory house organ of Greenfield Tap and Die Corporation.

Make the House Organ a Human Interest Organ with a Punch, Robert E. Park. Automotive Industries, vol. 41, no. 12, Sept. 18, 1919 pp 572-574. Survey of editorial policies followed by various plant journals.

Tool Repairs

Getting Quick Action on Small Tool Repairs, T. F. W. Meyer Factory, vol. 23, no. 3, Sept. 1919, pp. 504-506, 2 figs. Method where tag itself is work order.

Woodworking Industry

See Production Methods.

INSPECTION

Bureau of Standards, Optical Apparatus

Optical Projection Applied to Inspection, H. C Bean Inspector, vol. 1, no. 4, Sept 15, 1919, pp 25-30, 7 figs. Description of apparatus developed and used by Bur of Standards.

LABOR

Bonus System

Bonus System for Boiler Room Employees, Robert June. Power House, vol. 12, no 13, Aug. 20, 1919, pp. 356-357, 2 figs. Its effect upon economy in operation. From answers received by writer to circular letter he sent to various chief engineers of power plants in Canada.

Bonus Systems for Chemical Works, Norman Swindin. Chem. Age, vol. 1, no. 9, Aug. 16, 1919, pp. 240-243, 4 figs. Account of research carried on in large chemical works in regard to application of Rowan system.

Employment System

Placing the Right Man in the Right Job—I, W. D. Stearns, Machy. (N. Y.), vol. 26, no. 1, Sept. 1919, pp 30-33. Outline of methods used by Westinghouse Elec. & Mfg. Co., East Pittsburgh.

Health of Man

How to Keep the Human Machine in Working Order, Thomas Darlington. Eng. & Contracting, vol. 52, no. 12, Sept 17, 1919, pp. 331-332. Noting relation of efficiencies to health.

Labor Unrest

Effect of Labor Unrest on Output and Cost. Eng. & Indus. Management, vol. 2, no. 8, Aug. 21, 1919, p. 250. Report submitted by German Industry and Trade Conference to Nat. Assn., outlining result of inquiry as to direct and indirect effects of revolution on conditions of labor and consequently on production and exchange of goods.

One-Man-One-Job System

Fallacy of the One-Man-One-Job System in Industy, Harry Tipper. Automotive Industries, vol 41, no. 12, Sept. 18, 1919, pp. 580-581. Monotony of system argued as drawback against its effectiveness

Profit Sharing

Profit-Sharing and Ownership Fred Mills. Eng & Indus. Management, vol. 2, no 8, Aug. 21, 1919, pp. 237-239 Memorandum n labor unrest laid by writer before British Coal Commission.

Shop Committees

Labor and the Shop Committee, William Leavitt Stoddard, Indus Management, vol. 58, no. 3, Sept. 1919, pp. 217-220. Organized labor's position.

Recognizing the Human Side of Industry, A B. Kennedy. Can. Machy., vol. 22, no. 5, July 31, 1919, pp. 92-96, 6 figs. Industrial council and cafeteria among features adopted.

Steel Industry

The Iron and Steel Situation. Manufacturers Rec., vol. 76, no. 11, Sept. 11, 1919, pp. 107-108. Labor question as it affects iron and steel situation.

Wage Systems

The Piece Work Pay System, J A. A. Beaudin. Gas Rec., vol. 16, no. 4, Aug. 27, 1919, pp 37-38. How it works in Montreal Light, Heat & Power Co as applied to meter readers, billers, delivery men and collectors. Paper read before Can. Gas Assn.

Welfare

Industrial Welfare, Edgar L. Collis. Eng. & Ind. Management, vol. 2, nos. 8 and 9, Aug. 21 and 28, 1919, pp. 246-249 and 266-268, 1 fig. Aug. 21: Welfare in relation to industrial birth, life and death. Aug. 28: Deals with organization of welfare, and refers particularly to a scheme of welfare supervision for boys.

Women

Women's Work in Engineering and Shipbuilding During the War, Lady Parsons. Trans. North-East Coast Instn. Engrs. & Shipbuilders, vol. 35, no 6, Aug. 1919, pp. 227-234. Summary of technical work of skilled nature.

Report on the Metabolism of Female Munition Workers, M. Greenwood, C. Hodson and A. E. Tebb. Proc. Roy. Soc., vol. 91, no. B635, Aug. 6, 1919, pp. 62-82. Following conclusions are arrived at from experimental tests and measurements: For light training and forging about 100 cal. per sq. m. of body surface per hr. are needed; for tool setting, heavy turning, stamping, finishing copper bands and shell hoisting, about 125 cal. per sq. m. per hr.; for gaging, walking and carrying, about 160 cal. per sq m. per hr.; and for laboring, cleaning and drying, about 180 cal. per sq. m. per hr.

A Preliminary Study of the Energy Expenditure and Food Requirements of Women Workers, O. Rosenheim. Proc. Roy Soc., vol 91, no B635, Aug. 6, 1919, pp. 44-61, 1 fig. As results of experiments in which it was intended to measure actual energy expenditure of average woman worker during 24 hr., it is quoted that an average of 2400-2800 cal. may be assumed as a standard for women the corresponding figure for men being 3000-3500 cal.

LEGAL

Infection Liability

The Liability of Infections, Chesla C Sherlock. Chem. & Metallurgical Eng., vol. 21, no. 5, Sept. 1, 1919, pp. 252-253. Court interpretations of problems brought by workmen's compensation acts.

Resale Price Fixing

The Fixing of Resale Prices—I, Chesla C. Sherlock. Am. Mach., vol. 51, no. 11, Sept. 11, 1919, pp. 521-522. Legal aspect of question.

LIGHTING

Daylight Measurements

Some Practical Daylight Measurements in Modern Factory Buildings, Emile G. Perrot and Frank C. Vogan. Tran. Illum. Eng. Soc., vol. 14, no. 6, Aug. 30, 1919, pp. 257-277, 10 figs. Photometric readings taken in several buildings.

Industrial Lighting

What Better Industrial Lighting Can Do to Stimulate Production, F. H. Bernhard Elec. Rev., vol. 75, no. 10, Sept. 6, 1919, pp. 381-384, 2 figs. Based on records of increased production due to efficient lighting at time of war.

The Science of Efficient Shop Illumination, A. W. Swan. Can. Machy., vol. 22, no 5, July 31, 1919, p 97, 1 fig. Subject of shop lighting considered as a very vital one, for without proper illumination workmen cannot be expected to produce results either from quality or quantity standpoint.

How Better Industrial Lighting Can Improve Working Conditions, F. H. Bernhard. Elec. Rev., vol. 75, no. 12, Sept. 20, 1919, pp. 469-472, 3 figs. Because, it is said, it adds to welfare of employees and reduces labor turnover and labor disputes.

Shipyards

Shipyard Lighting, H. A. Horner. Tran. Illum. Eng. Soc., vol. 14, no. 6, Aug. 30, 1919, pp. 278-282 and discussion pp. 282-285. Notes deficiency in present methods and suggests improvement.

Shops

See Industrial Lighting.

Windows

What It Pays to Know About Factory Lighting—VII, C. E. Clewell. Factory, vol. 23, no. 3, Sept. 1919, pp. 496-499, 5 figs. Concerning location of windows and selection of sash and glazing.

RECONSTRUCTION

Alsace

Textile Industries of Alsace (Les industries textiles de l'Alsace), Alfred Renouard, Bulletin de la Société d'Encouragement pour l'Industrie Nationale, vol. 131, no. 4, July and Aug. 1919, pp. 32-63. History of their development and remarks on their present economic significance.

France

Present Position and the Future of French Industry (La situation et l'avenir de l'industrie française), Ch. Vallet, Industrie electrique, vol. 28, no. 652, Aug. 25, 1919, pp. 301-302. Economical situation in coal industry. (Concluded.)

Germany

Germany's Industrial Position, Richard D. Zucker. Jl. Indus. & Eng. Chem., vol. 11, no. 8, Aug. 1, 1919, pp. 777-780. From before the war to the present time. Compiled from writer's personal observations.

War-Time Activities of Dye Plants in Germany. Chem. & Metallurgical Eng., vol. 21, no. 5, Sept. 1, 1919, pp. 224-225. From report of British mission appointed to visit enemy chemical factories in occupied zone, introduced at Dyestuffs Hearings before House Committee on Ways and Means.

The German Machine-Tool Industry During and After the War. Am. Mach., vol. 51, no. 11, Sept. 11, 1919, pp. 537-539. Writer sees "German national front of business" broken and believes in eventual internationalization of German industry.

Machine-Tool Trade

Conditions in the Machine Tool Trade, Machy. (N. Y.), vol. 26, no. 1, Sept. 1919, pp. 75-76, 1 fig. Containing Government price fixing chart for determining selling price of standard machine tools.

Plant Conversion to Peace Work

Adapting Munitions Plant to Peace-Time Work. Elec. World, vol. 74, no. 12, Sept. 20, 1919, pp. 620-626, 9 figs. Particularly in reference to method employed of making distribution system more flexible.

Trans-Missouri Region

Industrial Development in the Trans-Missouri Region, P. F. Walker. Mech. Eng., vol. 41, no. 10, Oct. 1919, pp. 821-823. Statistical figures relative to agricultural and mineral products, accomplishments in manufacturing and transportation and freight adjustments.

SAFETY ENGINEERING

Accident Statistics

Accident Statistics of German Reinforced-Concrete Construction for 1911 to 1918 (Unfallstatistik des Deutschen Ausschusses für Eisenbeton 1911 bis 1918), W. Petry. Beton u. Eisen, vol. 18, no. 7 and 8, May 5, 1919, pp. 73-76. Compiled by German Committee on Reinforced-Concrete Construction, appointed by Secretary of Public Works.

Boiler Explosion

The Boiler Explosion at Mobile, Ala. Locomotive. Hartford Steam Boiler Inspection & Insurance Co., vol. 32, No. 6, April 1919, pp. 162-165, 2 figs. Suggested explanation for explosion of two water-tube boilers, one Heine and one Stirling.

Dust Explosions

Dust and Dust Explosions (Straub und Straubexplosionen). Rauch u. Straub, vol. 9, no. 7, Apr. 1919, pp. 53-54. Considers ventilation and sprinkler system used in German mines since 1898 to be the best means to prevent explosions.

Cause and Prevention of Dust Explosions. Contract Rec., vol. 33, no. 37, Sept. 10, 1919, pp. 858-859. Recommendations made by Ontario Fire Prevention League.

Fires, Mine

Mine Fires, and the Inert Gas Method by Which They May be Extinguished, Joseph J. Walsh. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 25, no. 3, July 1919, pp. 329-331, 1 fig. Arrangement consists of ordinary boiler furnace; gases produced by combustion are conducted through cooling tubes, immersed in water, and then forced into mine. Gases used are carbon dioxide and nitrogen.

Fire Protection

Fire Protection for Oil Tanks. Eng. & Min. Jl., vol. 108, no. 9, Aug. 30, 1919, pp. 350-351, 3 figs. Method for extinguishing fires by using bubbles containing carbonic-acid gas to form blanket covering on surface.

Fire Protection for Schools. H. W. Forster. Construction, vol. 9, no. 1, July 1919, pp. 11-21. Importance of providing for it and essential features to secure it. From Nat. Fire Protection Assn. Quarterly.

Water Departments and Private Fire Lines, Dow R. Gwinn. Can. Engr., vol. 37, no. 13, Sept. 25, 1919, pp. 335-337. Proper regulation governing private fire-protection lines; contamination of water supply suggestions for compensations.

Industrial Safety

Industrial Safety—H. C. W. Price. Power Plant Eng., vol. 23, no. 17, Sept. 1, 1919, pp. 784-785. Suggestions in regard to plant conditions, arrangement, order and lighting in and around industrial plants.

Steam Prime Movers

Methods of Guarding Engines and Turbines. Power House, vol. 12, no. 12, Aug. 5, 1919, pp. 330-333, 4 figs. Different forms of safety apparatus as applied to governor, flywheels and rotors.

SALVAGE

Goodrich Rubber Company

Salvage and Reclamation Department of The B. F. Goodrich Rubber Company, George W. Sherman. Indus. Management, vol. 58, no. 3, Sept. 1919, pp. 176-178, 4 figs. Deals particularly with organization features of department.

Liberty Engine Materials

Application of Liberty Engine Materials to the Automotive Industry, Harold F. Wood. Am. Mach., vol. 51, no. 12, Sept. 18, 1919, pp. 557-562. Author states reasons for use of certain materials and certain treatments for each part and gives recommendations for their application to problems of automotive industry.

TRANSPORTATION

Automobile Factory Transportation System

Automobile Factory Transportation Systems, Edward K. Hammond. Machy. (N. Y.), vol. 26, no. 1, Sept. 1919, pp. 1-7, 11 figs. Types of equipment used for transporting raw materials and parts of product through plant of Willys-Overland Co. in Toledo, Ohio.

Motor Trucks at Marine Freight Terminals

Motor Trucks and the Problem of Efficient Marine Freight Terminal Operation—II, III, Merrill C. Horine. Int. Marine Eng., vol. 24, nos. 9 and 10, Sept. and Oct. 1919, pp. 632-627 and 696-703, 15 figs. Sept.: Comparison of horse dray with motor carriers; also discussion of value of store-door delivery. Oct.: Emphasizes that weak link of our transportation facilities as applied to overseas commerce is not in railroads or ocean carriers, but in methods and facilities employed for handling freight at marine terminals.

Truck Routing

Routing Trucks by Capacity. Commercial Vehicle, vol. 21, no. 3, Sept. 1, 1919, pp. 99-101, 2 figs. Brooklyn soap manufacturer claims to obtain greatest truck efficiency by this method.

Trucks, Electric

Use of Industrial Electric Trucks and Tractors in Warehouses, Bernard J. Dillon. Elec. Rev., vol. 75, no. 9, Aug. 30, 1919, pp. 345-348, 5 figs. Application of such equipment to handling problems of warehouses and storage places of all types.

Trucks, Garaging

How the American Railway Express Co. Secures Greater Service from Its Motor Trucks. Eng. & Contracting, vol. 52, no. 12, Sept. 17, 1919, pp. 340-341. Features of garaging and maintaining 3313 motor vehicles.

VARIA

Chicago District

Industrial Resources of the Chicago District, H. B. Pulsifer, Procter Thomson and Ernest Edgar Thum. Chem. & Metallurgical Eng., vol. 21, no. 6, Sept. 15, 1919, pp. 310-319, 7 figs. Metallurgically, Chicago is described as ranking second only to Pittsburgh as producing center, while in non ferrous operations refining and alloying are represented extensively. Statistics are quoted to show that in Lake County, Ind., and Cook County, Ill., value of stone, lime, sand and gravel, clay products, mineral paint, pigments, cement, coke and steel reached $300,000,000 market in 1917.

Indiana

Natural and Industrial Resources of Indiana, W. N. Logan and F. O. Anderegg. Chem. & Metallurgical Eng., vol. 21, no. 6, Sept. 15, 1919, pp. 320-325, 5 figs. Noting specially research work being done in chemical plants.

Michigan

Natural and Industrial Resources of Michigan, R. A. Smith and W. L. Badger. Chem. & Metallurgical Eng., vol. 21, no. 6, Sept. 15, 1919, pp. 326-334, 2 figs. Leading products include iron, copper, salt, alkalis, halogens, lime, gypsum, cement, abrasives, silica, sugar, paper, dyes and organic chemicals.

Wisconsin

Natural and Industrial Resources of Wisconsin, W. O. Hotchkiss, O. L. Kowalke and A. M. Plumb. Chem. & Metallurgical Eng., vol. 21, no. 6, Sept. 15, 1919, pp. 335-341, 11 figs. Raw-material resources consist of zinc ores, iron ores, granite and mineral waters. Leather and paper industries among most important of state on bases of value of product and number of men employed.

World Trade

The Economics and World Markets. Raw Material, vol. 1, no. 6, Aug. 1919, pp. 282-289, 9 figs. Reviews status of producing centers of the world, traces shipping routes, outlines smelting conditions and indicates present tendencies of market.

Electrical Engineering

ELECTROCHEMISTRY

Polarization

The Polarisation of a Leclanché Cell, Felix E. Hackett and R. J. Feely. Scientific Proc. Roy. Dublin Soc., vol. 15, no. 26, March 1918, pp. 279-288, 4 figs. Recovery of cell from polarization divided into two sections: initial stage of rapid recovery in which about 90 per cent of polarization disappears in about ten minutes; followed by slow return extending over several hours to initial value of e.m.f.

Potential of Aluminum

The Effect of Amalgamation upon the Single Potential of Aluminum, Louis Kahlenberg and John A. Montgomery. General Meeting of the Am. Electrochem. Soc., paper no. 7, Sept. 23-26, 1919, pp. 45-46, 5 figs. Measuring single potential of aluminum in 1/3 molar solution of aluminum chloride at room temperature, by means of calomel electrode, writers claimed to have obtained much higher values with amalgamated than with unamalgamated aluminum, due to removal of coat of resistant oxide by mercury.

ELECTRODEPOSITION

Gold and Silver

Electrodeposition of Gold and Silver from Cyanide Solutions, S. B. Christy. Dept. Interior, Bur. Mines, Bul. 150, 1919, 171 pp., 44 figs. Bases on writer's experiments made in laboratories of University of Cal., extending over period of 20 years. Results are expressed in diagrammatic form by curves showing relation between simultaneous variables.

Lead Plating

Lead Plating from Fluoborate Solutions, W. Blum, F. J. Liscomb, Zalia Jencks and W. E. Bailey. General Meeting of the Am. Electrochem. Soc., paper no. 11, Sept. 23-26, 1919, pp. 101-122, 12 figs., partly on six supp. plates. From experiments it is concluded that by increasing concentration of lead it is possible to use higher current densities than those ordinarily used without causing treeing of deposits. A range of conditions is recommended as guide for commercial work.

Platers' Solutions

Standardisation of Platers' Solutions in Individual Plants, Charles H. Proctor. Metal Industry, vol. 15, no. 7, Aug. 15, 1919, pp. 122-124. As means of increasing efficiency.

Structure of Electrodeposited Metals

Factors Governing the Structure of Electro-Deposited Metals, William Blum. General Meeting of the Am. Electrochem. Soc., paper no. 8, Sept. 23-26, 1919, pp. 57-76, 19 figs., partly on ten supp. plates. Experiments said to have shown that Bancroft's "axioms of electroplating" are applicable over wide range of conditions and with variety of metals. It is therefore suggested that they may serve as valuable guide in plating research and in practical plating operations.

ELECTROPHYSICS

Armature Reaction

Reactions of the Armature of an Alternator (Sur la réaction d'induit des alternateurs), E. Brylinski. Comptes Rendus des Séances de l'Académie des Sciences, vol. 169, no. 4, July 28, 1919, pp. 174-177. As influenced by magnetic hysteresis.

The Solution of Circuit Problems. Mathematical Methods of Investigation Resulting from the Application of Fourier's Integral, Thorton C. Fry. Phys. Rev., vol. 14, no. 2, Aug. 1919, pp. 115-136, 6 figs. Expansion of fundamental integral for current in any network in circuit theory effected in Bessel's series and also by (1) using Heaviside-Carson expansion, and (2) using Taylor's series.

Notes on Electric and Magnetic Field Constants and Their Expression in Terms of Bessel Functions and Elliptic Integrals, A. Gray. Lond., Edinburgh, & Dublin Phil Mag., vol. 38, no. 224, Aug. 1919, pp. 201-214, 4 figs. Four cases—(1) Potential produced at any point in a thin disk of matter of uniform surface density; (2) potential produced and component magnetic field intensities at any point in a circular doublet-disk of uniform strength per unit area; (3) potential and field intensities of uniform right circular cylinder; and (4) potential and field intensity of right cylindrical array of equal doublet-disks.

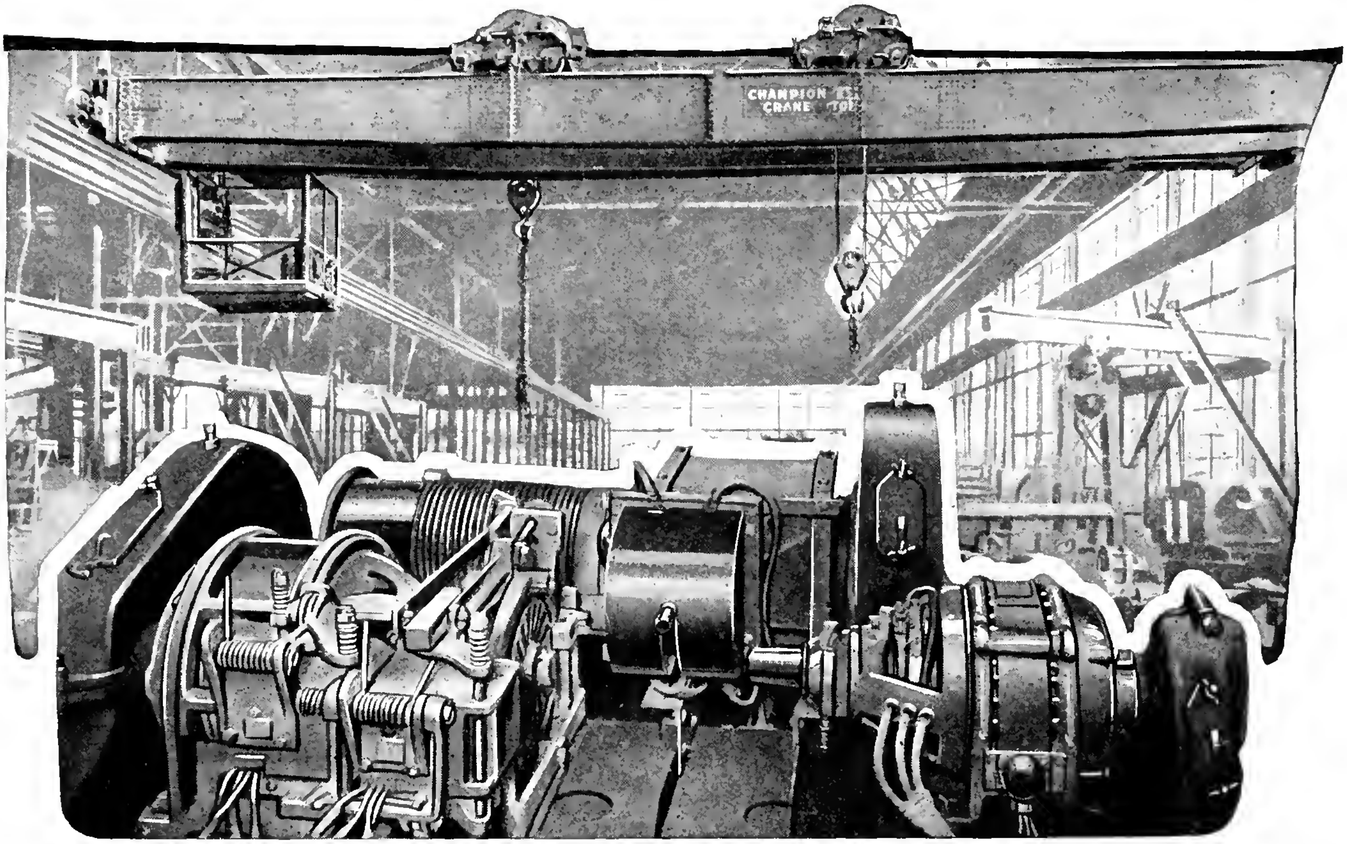
A Report on Electromagnetic Induction, S. J. Barnett. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 10, Oct. 1919, pp. 1151-1169. Historical sketch of fundamental results obtained from days of Faraday to present time in studying electromotive forces ordinarily referred to domain of electromagnetic induction, together with treatment of unipolar induction in both open and closed circuits.

Additions to the Formulas for the Calculation of Mutual and Self Inductance, Frederick W. Grover. Bul. Bur. of Standards, vol. 14, no. 4, July 12, 1919, pp. 537-570. Supplementing collection of formulæ given in Scientific Paper No. 169.

Interference

Interference of Power Circuits with Telephone Circuits, E. Parry. New Zealand Jl. Sci. & Technology, vol. 11, no. 4-5, July 1919, pp. 308-314, 4 figs. Attempt to coördinate result of experience for calculating beforehand

The wonderful achievements of America's shipbuilding industry were greatly facilitated by electric power equipment.



Lower at Constant Speed and Without Friction

AN alternating current motor-driven hoist can be made to lower many varieties of loads at any desired speed—if equipped with a solenoid load brake. Friction wear is eliminated, except at creeping speeds or when stopping.

Loads of from 0 to 125% load are lowered at less than 50% speed. Heavy loads are lowered with regenerative braking at not over 150% normal speed, and power returned to source of supply.

Light hook can be lowered at normal speed.

Motor can be jogged 1/20 of a revolution of the armature, which is impossible with any other type of AC or DC Control.

Send for full information given in Reprint X386, Second Edition, entitled "Speed Control of Induction Motors on Cranes and Hoists by Means of Solenoid Load Brakes and Multiple Magnet Brakes."

General Electric Company

General Office Schenectady, N.Y.

Effects resulting from any given relative disposition of circuits and from any given method of work.

Leakage

Studies on Doubly Interlinked Leakage (Beitrag zur doppeltverketteten Streuung), F. Punga. Archy f. Elektrotechnik, vol 7, no. 11 12, May 5, 1919, pp. 337-379, 53 figs. Vectorial derivation of differential leakage for any desired number of grooves and any desired position of rotor. Cases where zig-zag leakage and double interlinked leakage are synonymous, as in motors with squirrel-cage rotor and motors with an uneven number of grooves in the stator and rotor and in those with slip-ring rotor.

Magnetic Field, Molecular

The Molecular Magnetic Field (El campo magnético molecular), Richard Gans. Contribucion al estudio de las ciencias fisicas y matematicas, Universidad Nacional de la Plata, vol. 11, no. 36, July 1918, pp. 209-222, 2 figs. Technical derivation of following theorem: At absolute zero all directions of molecular magnetic field may be considered, with respect to determination of magnetism curve, as equally probable.

Reactance Coils

Some New Formulas for Reactance Coils, H. B. Dwight. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 9, Sept. 1919, pp. 1039-1060, 7 figs. Formulæ are derived for mutual inductance of coils with parallel axes, repulsion of coils with parallel axes and self-inductance of long cylindrical coils.

Thermoelectricity

Thermoelectric Power and Resistance of Bismuth in a Magnetic Field (Potere thermoelettrico e resistenza del bismuto nel campo magnetico), M. La Rosa. Il Nuovo Cimento, vol. 18, no. 7, July 1919, pp. 26-38, 1 fig. Experimental. Effect of producing Peltier, Thomson, and Hall phenomena in magnetic field.

Vacuum Tube

The Vacuum Tube as a Generator of Alternating Current Power, John H. Morecroft and H. Trap Friis. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 10, Oct. 1919, pp. 1193-1221, 35 figs. Deals with operation of tube when separately excited and efficiency of tube as generator. Analysis of forms and phases of voltages and currents in different parts of circuit as well as oscillograms showing action of tube under various conditions are given.

FURNACES

Design

The Design of Electric Furnaces, R. C. Gosrow. Chem. & Metallurgical Eng., vol. 21, no. 5, Sept. 1, 1919, pp. 235-241. Consideration of the elements of size and other details in relation to operation and recovery of metal, with special reference to production of ferromanganese.

GENERATING STATIONS

Cost of Electric Supply

The Cost of Electric Supply, William Woodhouse. Elec. Times, vol. 56, no. 1454, Aug. 28, 1919, pp. 159-160, 1 fig. Relationship between cost, load factor and demand.

High-Tension Service

Delivery of High-Tension Service to Large Consumers, Rawson Collier. Elec. Rev., vol. 75, no. 10, Sept 6, 1919, pp. 392-396, 3 figs. General considerations involved: relation of cost to station capacity and revenue; choice of equipment; metering.

Gatun Hydroelectric Station

Development of Gatun Hydroelectric Station. Jl. Electricity, vol. 43, no. 5, Sept 1, 1919, pp. 198-201, 5 figs. Details of recent improvements in power plant which furnishes power for operation of canal.

Rectification

Advantages and Disadvantages of the Various Systems of Rectifying High-Tension Alternating Current (Advantages et inconvénients des divers systèms de transformation de courant alternatif à haute tension en courant continu), F. Sarrat. Association des Ingéieurs Electriciens Sortis de l'Instiut Electrotechnique Montefiore, vol. 1, nos. 3, 4, 5, 6, 7, March, April, May, June, July, 1919, pp. 161-236, 29 figs. Figures compiled from various power stations in reference to efficiency, cost, maintenance expense, power factor, etc., of various systems, for presentation to Congrès International de Tramways et de Chemin de fer d'intértêt local, which was to be held at Budapest in Sept. 1914.

Unit Analysis

Unit Analyses of Industrial Power Business. Elec. World, vol. 74, no. 12, Sept. 20, 1919, pp. 627-629. Records of Massachusetts central stations quoted as proof that desirable revenue is consistent with moderate average yield per kw hr.

GENERATORS AND MOTORS

Balancing Rotors

Balancing and Alignment of the Alternator Rotor, C. Sylvester. Elec. Rev., vol. 85, no. 2179, Aug. 29, 1919, pp. 260-261, 3 figs. Illustrating method for adjusting balance weights on turbo-alternator rotor.

Control Gear for D.C. Motors

Control Gear for Direct Current Motors, C. W. Stubbings. Electricity, vol. 31, no. 1504, Sept. 5, 1919, pp. 553-554. Recently constructed switch of the liquid type was so arranged that closing short-circuiting switch for starting resistance automatically opened valve which caused tank immediately to empty.

Dynamo, D.C.

Direct Current Dynamo for Constant Current at variable speed (Gelijkstroomdynamo voor constanten stroom bij veranderlijk aantal omwentelingen), J. Botermans. Ingenieur, vol. 34, no. 33, Aug. 16, 1919, pp. 603-605, 2 figs. This dynamo differs from other constructions in that its field is influenced by currents which circulate in a number of short circuited bars.

See also Motors, D.C., Large.

Motors, D.C., Large

The Operation of Large Direct-Current Motors Without Starting Resistances, W. Linke. Elecn., vol. 83, no. 2152, Aug. 28, 1919, pp. 170-171. Account of Trettin's conclusions arrived at from mathematical investigations and of tests performed by writer. From Elektrotechnische Zeitschrift.

See also Control Gear.

IGNITION APPARATUS

Spark-plug Terminals

Deterioration of Nickel Spark-Plug Terminals in Service, Henry S. Rawdon and A. I. Krynitzky. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 152, Aug. 1919, pp. 1323-1350, 21 figs. Investigation at Bureau of Standards represented as having shown that service deterioration of nickel spark-plug terminals is due to embrittlement of wire by formation of system of intercrystalline network and definite transverse cracks.

Two-Spark Ignition

A Two-Spark Generator Battery Type Ignition. Automotive Industries, vol. 41, no. 11, Sept. 11, 1919, pp. 511-512, 7 figs. Equipment consists of double ignition distributor, two ignition coils and combination lighting and ignition switch.

LIGHTING AND LAMP MANUFACTURE

Arc, Luminous Vapors in

Luminous Vapors Produced in the Arc, with Applications to the Study of Spectral Series and Their Origin (Vapeurs lumineuses distillées de l'arc, avec applications à l'étude des séries spectrales et leur origine), R. J. Strutt. Radium, vol. 11, no. 7, May 1919, pp. 200-204, 4 figs. Brilliant effects similar to those obtained with mercury arc are reported to have been produced with other metals.

Photometry

On the Photometric Measurement of Searchlights (Ueber das Photometrieren von Scheinwerfern), Gehlhoff. Zeitschrift f. Beleuchtungswesen, Heizungs- und Lüftungstechnik, vol. 25, no. 7 8, Apr. 1919, pp. 35-41, 12 figs. Claims that in order to eliminate absorption it is necessary to photometer two sufficiently different distances.

Searchlights

Metal Mirrors for Searchlights, R. B. Hussey. Gen. Elec. Rev., vol. 22, no. 9, Sept. 1919, pp. 652-655, 6 figs. Processes used in production of 60-in. mirrors. (The issue is devoted mainly to the subject of searchlights.)

Standardized Industrial Lighting Systems

Standardized Industrial Lighting Systems.—II, H. L. Cornelison. Elec. World, vol. 74, no. 9, Aug. 30, 1919, pp. 459-461, 5 figs. Engineering plans of Austin Co., Chicago, for conduit, wiring, panel and fixture arrangements for providing layouts in standard buildings.

MEASUREMENTS AND TESTS

Conductivity Constant

Simple Method for Ascertaining the Conductivity Constant in Alternating-Current Measurements (Einfache Verfahren zur Ermittlung der Leitungskonstanten aus Wechselstrommessungen), H. Jordan. Telegraphen- u. Fernsprech-Technik, vol. 8, no. 2, May 1919, pp. 17-22, 5 figs. Approximating formulæ for low and high values of Bl.

Electrometer

A Sensitive Modification of the Quadrant Electrometer: Its Theory and Use, A. H. Compton and K. T. Compton. Phys. Rev., vol. 14, no. 2, Aug. 1919, pp. 85-98, 3 figs. Introduction of tilted needle and movable quadrants in design. Advantages claimed are high sensitivity independent of deflection and quick adjustment of sensitivity through great range. It is claimed that by using a small needle 4.5 mm. in radius with a slight tilt, sensitivity as high as 60,000 mm. per volt were obtained.

Electroscope, Gold-leaf

A Method of Measuring the Capacity of Gold-leaf Electroscopes, A. T. Mukerjee. Lond., Edinburgh, and Dublin Phil. Mag., vol. 38, no. 224, Aug. 1919, pp. 245-256, 1 fig. Using standardized or (Gerdien) sliding condenser, absolute capacity of quadrant system, including specially designed connector, is first determined by method of mixtures; gold-leaf system is then charged to known voltage, adjusted so that when charge is shared with quadrant system final potential is not far from one volt; as capacity of quadrant system can be varied by sliding condenser, capacity of electroscope can be measured at different voltages.

Galvanometers

Needle Galvanometers with Recording Mechanism (Galvanomètres inscripteurs à fer mobile), Henri Abraham and Eugène Bloch. Comptes Rendus des Séances de l'Académie des Sciences, vol. 169, no. 4, July 28, 1919, pp. 171-174. Built for military radiotelegraphy and geographic service of French army.

Meters, Current

Sensitive Alternating Current Meters (Appareils sensibles pour les mesures en courants alternatifs), H. Abraham, E. Bloch and L. Bloch. Comptes rendus des séances de l'Académie des Sciences, vol. 169, no. 2, July 15, 1919, pp. 59-62. Amplifying direct-reading voltmeter.

Potentiometer, High-Frequency Measurements

Alternating-Current Planevector Potentiometer Measurements at Telephonic Frequencies, A. E. Kennelly and Edy Velander. Proc. Am. Philosophical Soc., vol. 58, no. 2, 1919, pp. 97-132, 16 figs. Principle of potentiometer is the same as that described by Prof. Larsen in 1910, (Elek. Zeitschrift, Oct. 13, 1910, vol. 31, pp. 1039-1041; also The Electrical World, vol. 56, Nov. 3, 1910, pp. 1085-1088.) Present form was worked out in Mass. Inst. Technology Laboratories through thesis studies of A. E. Hanson in "The Design and Construction of an Alternating-Current Potentiometer," Sept. 1918.

Voltmeter, Synchronizing

An Improved Voltmeter for Synchronising Purposes, G. Keinath. Elecn., vol. 83, no. 2153, Aug. 22, 1919, p. 198, 1 fig. Employing resistance, having high temperature coefficient in series with voltmeter. From Elektrotechnische Zeitschrift, No. 46, 1918.

MATERIALS OF CONSTRUCTION

Contact Material

Contacts and Contact Material, H. von Fleischbein. Elecn., vol. 83, no. 2154, Aug. 29, 1919, pp. 220-221, 3 figs. Results obtained with tungsten contacts on relays. Translated from Elektrotechnische Zeitschrift.

Fiber

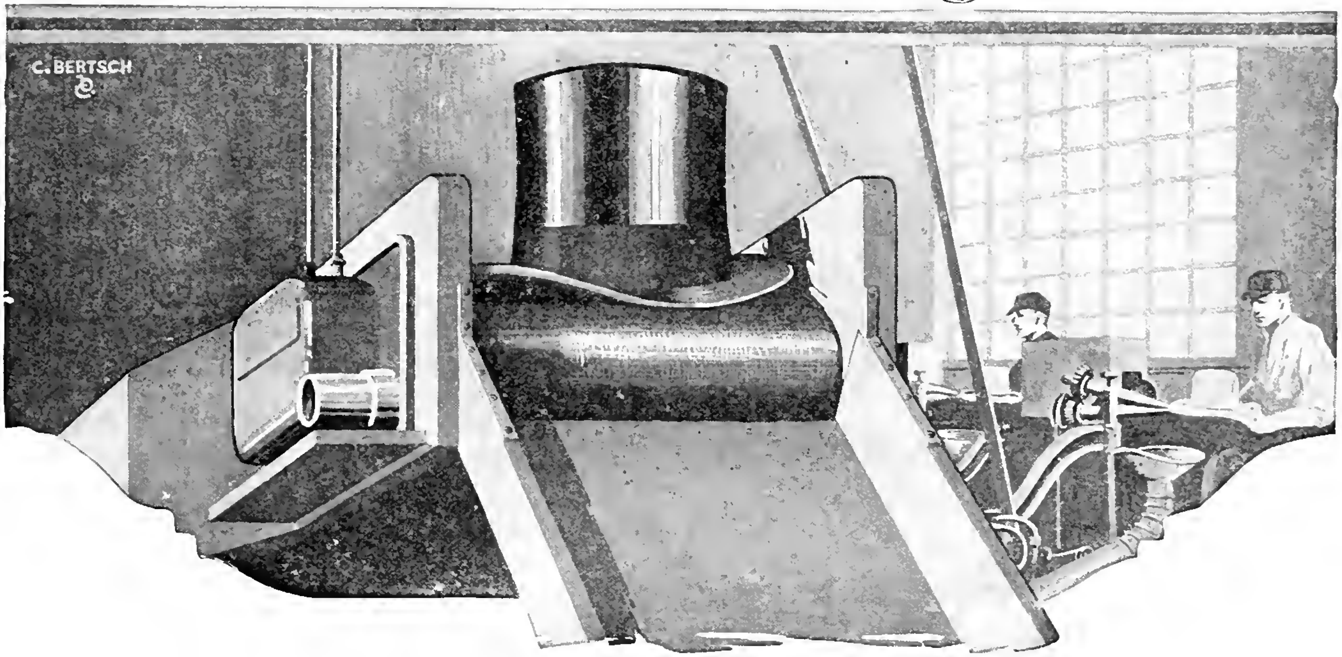
The Absorption of Water by Vulcanized Fiber and Erinoid on Exposure to Moist Air, and the Consequent Change of Electrical Resistance, R. G. Allen. Scientific Proc. Roy. Dublin Soc., vol. 15, no. 32, Oct. 1918, pp 405-414. Vulcanized fiber found to be much more hygroscopic than erinoid. After being thoroughly dried and then exposed to moist air, electrical resistance of both, specially fiber, observed to decrease rapidly as time of exposure continued.

Insulators

The Porosity of Porcelain, with Special Reference to High-Pressure Insulators for Electric Transmission Lines, C. C. Farr. New Zealand Jl. Sci. & Technology, vol. 11, nos. 4 & 5, July 1919, pp. 302-307, 1 fig. Experiment claimed to have shown that density and porosity have little or no connection with each other.

Cracking or Pin Type Corner Porcelain Insulators, S. L. Foster. Jl. Electricity, vol. 43, no. 5, Sept. 1, 1919, pp. 213-215. How problem was solved by painting with shellack by United Railroads of San Francisco.

Lamson Conveyors



Stetson Hats Go through Factory on a Lamson Conveying System

The hat factories of the John B. Stetson Company are among the largest and most complete in the world, and they are equipped with a Lamson System of Mechanical Messengers and Conveyors.

Throughout four six-story buildings the Mechanical Messengers carry orders, memoranda, and other papers, the Conveyors and Chutes carry materials, unfinished and finished hats, and packing cases and boxes.

This Lamson installation saves its cost every year. It is in constant operation during working hours, handling many tons of material. It does work formerly done by hand and does it far better. It occupies no valuable floor space, running overhead out of the way.

Practically every factory can make profitable use of Lamson Conveyors. They are as varied as industry itself—Lamson Systems carry automobile bodies in one plant, olive bottles in another, flour in a third. They don't get tired or quit; they don't make mistakes; they save space—and the space saving alone is sometimes enough to pay for the conveyors. They reserve human labor for work that requires mind rather than mere muscle. They place the thing wanted where it is wanted, just when it is wanted.

The Lamson-equipped factory can operate at full speed all the time with no congestion in the packing and shipping departments. Plants using Lamson Systems have learned a new meaning of the word "capacity."

The Lamson Book on Conveying shows what Lamson Systems do, how they simplify production and packing, how they save. A copy will be sent on request, or our representative will call and discuss your problem with you.

The Lamson Company

100 BOYLSTON ST., BOSTON, MASS.

Branches and Service Stations

Boston	100 Boylston St.	Detroit	97 Woodward Ave.	Chicago	6 No. Michigan Ave.	Dallas	905½ Elm St.
New York	15 West 44th St.	Cleveland	2063 East 4th St.	Omaha	15th and Dodge Sts.	Seattle	215 Stewart St.
Philadelphia	1200 Walnut St.	Cincinnati	119 East 5th St.	Minneapolis	320 Tribune Annex	Washington, D. C.	426 Colorado Bldg.
Pittsburgh	319 Third Ave.	Indianapolis	Cor. Washington and Illinois	San Francisco	617 Mission St.	Atlanta	30 Moore Bldg.
Baltimore	Equitable Building	Los Angeles	221 San Fernando Bldg.	St. Louis	709 Pine St.	Montreal,	Jones & Glassco, Reg'd., St. Nicholas Bldg.
Rochester	194 Main St. East	Toronto	136 Simcoe St.	Vancouver, B.C.	603 Hastings St.		

Additional Service Stations

Denver, 1622 Arapahoe St. New Orleans, 124 St. Charles St. Albany, 22 So. Pearl St. Buffalo, 194 Main St. Kansas City, 200 New Ridge Bldg.

LAMSON SERVICE

The Electrical Resistance of Porcelain at Different Temperatures. R. G. Allen. Scientific Proc. Roy. Dublin Soc., vol. 15, no. 27, June 1918, pp. 289-309, 6 figs. Tests of several samples in various forms at different temperatures ranging from 80 to 300 deg. cent. Relation of Rasch and Hinrichsen between insulation resistance and absolute temperature found to remain approximately true.

The Insulating Properties of Erinoid. R. G. Allen. Scientific Proc. Roy. Dublin Soc., vol. 15, no. 29, Aug. 1918, pp. 331-358, 6 figs. Experimental. Erinoid found to be good insulator of fairly constant insulation resistance. Of various varieties of erinoid, red was found to be most absorbent of water and generally of lowest resistance.

See also Fiber.

Porcelain

See Insulators.

POWER APPLICATIONS

Heating

Industrial Applications of Electric Heating (Les applications du chauffage électrique dans l'industrie). F. Rutgers. Génie Civil, vol. 75, no. 9, Aug. 30, 1919, pp. 189-194, 18 figs. Illustrating electrically heated boilers, air-heating apparatus, electric radiators and electric furnaces.

Lighters

An Electrically Equipped Lighter, William H. Easton. Pac. Mar. Rev., vol. 16, no. 9, Sept. 1919, pp. 130-131, 6 figs. Penn. R.R. lighter equipped with electrically operated winches.

Motor Selection

The Use of Electrical Power in Industrial Works, G. W. Stubbings. Eng. & Indus. Management, vol. 2, no. 9, Aug. 28, 1919, pp. 264-265, 2 figs. Writer suggests types of electrical motors suitable for different classes of work.

STANDARDS

French Rules, Electric Material

French Rules for Standardizing Electric Material (Règles françaises d'unification du matériel électrique). Electricien, vol. 49, no. 1235, Aug. 31, 1919, pp. 73-75. Regulations for rating and classifying electric machines adopted by Commission Permanente de Standardisation.

STORAGE BATTERIES

Theory of Lead Storage Battery (Sur la théorie de l'accumulateur au plomb). Paul Bary. Revue générale de l'Electricité, vol. 6, no. 7, Aug. 16, 1919, pp. 195-199. Taking into account electrolysis of lead sulphate dissolved in electrolyte.

TELEGRAPHY AND TELEPHONY

Amplifiers

Recording Amplifiers Used in Wireless Telegraphy (Application des amplificateurs à l'inscription mécanique des signaux de télégraphie sans fil). Henri Abraham and Eugène Bloch. Comptes rendus séances de l'Académie des Sciences, vol. 169, no. 6, Aug. 11, 1919, pp. 282-285. Essays and field work of French Military radiotelegraphy quoted as evidence that lamp amplifiers permit direct reception of signals without any mechanical relays being used.

Antennæ

See Interference Elimination.

The Natural Constants of Wireless Antennæ. A. Meissner. Wireless Age, vol. 7, no. 78, Sept. 1919, pp. 320-323, 6 figs. Empirical formulæ for determining natural wave-length of various form of aerials. Translated from Physikalische Zeitschrift, March 15, 1919.

Artom Receiver

Artom's Visual Receiver for Directive Wireless Telegraphy. Wireless Age, vol. 6, no. 11, Aug. 1919, pp. 21-22, 3 figs. Built in form of d'Arsonval galvanometer. Movable coil is traversed by rectified high-frequency currents fed by directive aerials.

Automatic Switchboards

The Operator versus the Automatic. H. C. Townsend. Telephone Engr., vol. 22, no. 3, Sept. 1919, pp. 98-100. Examples in which manual switchboard is said to cope better with traffic.

Automatic Telephony

Meter and Coin Devices for Automatic. Arthur Bessey Smith. Telephone Engr., vol. 22, no. 3, Sept. 1919, pp. 101-105, 9 figs. Illustrating method of operation. Paper read before Automatic Tel. Engrs'. Conference.

Conduits, Telephone

Conduit Construction in Telephone Cable Tunnels. Eng. World, vol. 15, no. 6, Sept. 15, 1919, pp. 33-35, 6 figs. Construction methods employed.

Direction Finding

Theory and Practical Attainments in the Design and Use of Radio Direction Finding Apparatus Using Closed Coil Antennas, A. S. Blatterman. Jl. Franklin Inst., vol. 188, no. 3, Sept. 1919, pp. 289-362, 69 figs. Summary of investigation carried out in U. S. Signal Corps Radio Laboratories.

Infra-Red Radiation, Radiotelegraphy

Radiotelegraphy by Infra-Red Radiations (Radiotélégraphie par rayonnement infrarouge). J. Herbert-Stevens and A. Larigaldie. Comptes rendus des séances de l'Académie des Sciences, vol. 169, no. 3, July 21, 1919, pp. 136-137. Experiments said to have given satisfactory results of distance up to 12 miles. Transmitter was arc projector, luminous rays of which were observed through suitable screen; receiver was thermoelectric couple placed at focus of parabolic mirror.

Oscillations

Electrical Oscillations in Antennas and Inductance Coils, John M. Miller. Bul. Bur. of Standards, vol. 14, no. 4, July 12, 1919, pp. 677-696, 8 figs. Application of antenna to theory of circuits having uniformly distributed electrical characteristics such as cables, telephone lines, and transmission lines.

Thermophones or Hot-Wire Receivers. Elecn., vol. 83, no. 2155, Sept. 5, 1919, p. 242, 1 fig. Technical note on relationship between watts in wire and diameter of wire. Hot-wire receiver is not considered to be sufficiently developed to be ready to replace electromagnetic receiver for all branches of telephony, but it is said that it has already filled conditions which electromagnetic failed to do.

Telephone Repeaters

Telephonic Repeaters, A. B. Hart. Instn. Post Office Elec. Engrs., no. 75, Nov. 22, 1918, 46 pp., 10 figs. Review of conditions which have led to evolution of telephonic repeater as at present used in post-office service, together with data offered as being of assistance in constructing estimates for telephonic repeater equipments, and suggestions in regard to changes in design, construction and maintenance of telephone lines that writer believes must be introduced if full advantage is to be taken of telephonic repeaters.

Thermophones

See Receiving Sets.

Transatlantic Communication

Transatlantic Radio Communication, E. F. W. Alexanderson. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 10, Oct. 1919, pp. 1077-1093, 15 figs. Account of operation of present transatlantic stations and description of radio transmitting system at New Brunswick, N. J., which comprises special means for generating, modulating and radiating continuous wave energy. Article contains also account of multiple-antenna system of radiation.

Transmission

Principles of Radio Transmission and Reception with Antenna and Coil Aerials, J. H. Dellinger. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 10, Oct. 1919, pp. 1095-1150, 17 figs. Mathematical study of coil aerial as direction finder, interference preventer, reducer of strays and submarine aerial. Experiments are quoted which verify conclusions reached and formulæ are presented for designing aerial for any radio station.

TRANSFORMERS, CONVERTERS, FREQUENCY CHANGERS

Air-Blast Transformers

Maintenance of Air-Blast Transformers. Elec. Ry. Jl., vol. 54, no. 9, Aug. 30, 1919, pp. 424-426, 4 figs. Practice of United Railways of St. Louis where 63 air-blast transformers are kept in continuous service, noting special cover designed to prevent fires.

Booster Transformers

Principles of Booster Transformers, C. M. Jansky. Elec. Rev., vol. 75, no. 9, Aug. 30, 1919, pp. 341-344, 8 figs. Formulæ for finding percentage of boosting and cooking of single phase and poly-phase transformers under different conditions.

Furnace Transformers

Transformers and Connections to Electric Furnaces, J. F. Peters. Elec. Jl., vol. 16, no. 9, Sept. 1919, pp. 397-399, 7 figs. Concerning requirements of leads for large furnaces requiring over 10,000 amperes, especially at 60 cycles.

Large Transformers

Large Power Transformers, A. G. Ellis and J. L. Thompson. Elecn., vol. 83, no. 2155, Sept. 5, 1919, pp. 253-255, 3 figs. Writers refer to progress toward increased size of modern stations, generating units and transformers, and tendencies to higher pressures. Limiting sizes of transformers as effected by handling and cooling are discussed, and prices per kilovolt-ampere in relation to output, voltage and cooling are presented. (To be continued.) From paper presented before Instn. Elec. Engrs.

TRANSMISSION, DISTRIBUTION, CONTROL

Centralization

Centralization of Electrical Energy (Etat actuel des principaux transports d'énergie électrique). Pierre Moutier. Electricien, vol. 49, no. 1235, Aug. 31, 1919, pp. 76-80, 1 fig. Recent progress and consideration of future developments.

Condensers

Synchronous Condensers in High-Tension System, J. W. Andree. Elec. World, vol. 74, no. 11, Sept. 13, 1919, pp. 564-567, 5 figs. 52,500 kva. of synchronous condenser capacity is used for extensive high-tension system of Southern California Co. Functions of condensers discussed. How equipment is operated for maximum economy.

Insulators

Locating Defective Transmission-Line Insulators, T. F. Johnson, Jr. Elec. World, vol. 74, no. 11, Sept. 13, 1919, pp. 568-572, 5 figs. Details of "Buzz-stick" method that can be used on live high-voltage lines to detect faulty insulators of suspension or pin type, together with construction and use of special tools required.

Interconnection

California 220,000-Volt—1100 Mile—1,500,000 Kw. Transmission Bus. R. W. Sorensen, H. H. Cox and G. E. Armstrong. Proc. Am. Inst. Elec. Engrs., vol. 38, no. 9, Sept. 1919, pp. 1027-1038, 5 figs. Jl. Electricity, vol. 43, no. 5, Sept. 1, 1919, pp. 202-205, 4 figs. Scheme for interconnection of all California power plants.

Layout, Transmission Line

Laying Out a Power Transmission Line, Charles R. Harte. Elec. Ry. Jl., vol. 54, no. 12, Sept. 20, 1919, pp. 561-564, 3 figs. Concerning selection of route, clearances and pole and tower spacing with regard to maintenance as well as construction costs.

Power-Factor Correction

Power-Factor Correction by Use of the Static Condenser, O. C. Roff. Elec. Rev., vol. 75, no. 11, Sept. 13 1919, pp. 423-427, 8 figs. Characteristics of static condenser installations. Causes of low power factor. Operating costs and purchase price. Paper read before Penn. Elec. Assn.

Substations

Railway Converter Substations—III. C. F. Lloyd. Power House, vol. 12, no. 12, Aug. 5, 1919, pp. 334-337, 4 figs. Information concerning class of equipment to be used and its arrangement in substation building.

The Substations of Electro-Chemical Industries (in Japanese), S. Fukuda. Denki Gakkwai Zasshi, no. 373, Aug. 10, 1919.

The Nisqually Substation at Tacoma, Washington. Jl. Electricity, vol. 43, no. 6, Sept. 15, 1919, pp. 257-258, 3 figs. Description of equipment and operation.

Switches

Automatic Isolation of Faults on High-Tension A. C. System. Iron & Coal Trades Rev., vol. 99, no. 2687, Aug. 29, 1919, pp. 266-267, 10 figs. Particulars of various types of protection gear for tripping switches automatically.

Transmission Circuits

Electrical Characteristics of Transmission Circuits—III, Wm. Nesbit. Elec. Jl., vol. 16, no. 9, Sept. 1919, pp. 385-396, 11 figs. Tables for determining approximate size of conductor corresponding to given I_2R transmission loss for any ordinary voltage or distance.

WIRING

Mine Wiring

Modern Mine-Wiring Practice, Terrell Croft. Coal Age, vol. 16, no. 12, Sept. 18, 1919, pp. 480-485, 21 figs. Particulars of methods and appliances employed at various plants.

Civil Engineering

BRIDGES

Arch Testing

Description of a Machine to Test the Actual Horizontal Thrust of Model Arches, Edward Waller Stoney. Indian Eng., vol. 66, no. 3, July 19, 1919, pp. 38-39, 2 figs. Machine constructed to scale of one twelfth for 10 ft. span, bricks being made of teakwood, two forms, plain and grooved, being used.

Approach Fill

Concrete Ties Hold Together Walls of Bridge-Approach Fill. Eng. News-Rec., vol. 83, no. 11, Sept. 11, 1919, pp. 522-523, 2 figs. Showing details of reinforced-concrete tie rods between retaining walls of bridge-approach fill.

Construction

New Railroad Bridge at Schwanden, Switzerland (Neue Linthbrucke der S. B. B. in Schwanden). Schweizerische Bauzeitung, vol. 74, no. 7, Aug. 16, 1919, pp. 80-84, 14 figs. Air temperature curves; details of construction.

Design

Economic Span Lengths for Simple-truss Bridges, J. A. L. Waddel. Ry. Age, vol. 67, no. 13, Sept. 26, 1919, pp. 635-636. Showing fallacy of old criterion of equal superstructure and substructure costs.

Floors

Highway Bridge Floor Replaced after Corrosion. Eng. News-Rec., vol. 83, no. 12, Sept. 18, 1919, pp. 562-564, 2 figs. Noting special details adopted to protect new steel-concrete covering for tops of transverse floor beams, complete encasement of steel at abutments and over piers.

Hydraulic Resistance of Bridge

A Problem on the Hydraulic Resistance of a Bridge over the Chemung River at Elmira, N. Y., S. C. George, and E. W. Rettger. Cornell Civil Engr., vol. 27, no. 4, May 1919, pp. 119-126, 1 fig. Maximum flow in river near Lake Street bridge was found to be about 118,000 cu. ft. per sec.; special reference is made to Collingwood report on flood of 1889.

Rebuilding

Method of Rebuilding the Genesee River Bridge, Lehigh Valley R.R., Eng. & Contracting, vol. 52, no. 9, Aug. 27, 1919, pp. 249-251, 4 figs. Bridge originally built for 126-ton heavy-grade engine was brought up to capacity of Cooper's E 60 loading, which is present standard used on Lehigh Valley R.R. main-line bridges.

Reconstruction and Reinforcement of Iron Bridges of the Gotthard Railroad between Erstfeld and Bellinzona (Ueber den Umbau und die Verstäkung der eisernen Brücken auf der Bergstrecke Erstfeld-Bellinzona der Gotthardlinie), A. Buhler. Schweizerische Bauzeitung, vol. 74, no. 6, Aug. 9, 1919, pp. 61-66, 11 figs. Reconstruction necessary to enable bridges to carry load of new electric locomotives. (To be continued.)

Swing Bridge

Temporary Swing Bridge Over the Suez Canal. Engineer, vol. 128, no. 3321, Aug. 22, 1919, pp. 174-176, 3 figs. There are six separate spans, all of different length, total length of structure being 537 ft.; four of the spans are fixed and two are capable of being swung. Translated from Génie Civil.

BUILDING AND CONSTRUCTION

Air Pressure

Design of Structures Subjected to Passive Earth Presssue (Etude de quelques Constructions sollicitées par la Pression passive des Terres), Keiichi Hayashi. Memoirs of the Coll. of Eng., Kyushu Imp. University, Fukuoka, Japan, vol. 1, no. 5, 1919, pp. 333-394, 41 figs. By passive thrust is understood resistance offered by bank of earth to lateral displacement of wall subjected to external horizontal forces. Theory of stresses is developed in such cases as a reinforced-concrete repair-dock, members bridges, etc., where passive thrust of earth occurs.

Arches

Reinforced-Concrete Arches in Construction of Ships and Hangars for Dirigible Balloons (Les voûtes en béton armé dans la couverture des bâtiments. Le hangar de Montebourg pour ballon dirigeable). Génie Civil, vol. 75, no. 10, Sept. 6, 1919, pp. 213-224, 32 figs. Design formulæ and calculations.

Code, Building, Scotland

National Building Code Adopted in Scotland Uses Quantity Surveying Methods. Contract Rec., vol. 33, no. 38, Sept. 17, 1919, pp. 878-883. Contracts are standardized by requiring all schedules for building works to adhere to same conditions.

Dams

Reinforced-Concrete Dam at Gideabacka, Sweden (Le barrage en béton armé de Gideabacka, Suède). Génie Civil, vol. 75, no. 11, Sept. 13, 1919, pp. 249-251, 14 figs. Noting especially precautions to provide against pressure of ice masses and against contraction of masonry in excessively cold weather.

Construction Features of Grand River Roller Crest Dam. Eng. & Contracting, vol. 52, no. 11, Sept. 10, 1919, pp. 289-921, 10 figs. Dam is steel roller crest surmounting concrete weir with sluiceway and canal intake with capacity of 1425 cu. ft. per sec. at one end.

Foundation, Tremied

Finishing a Tremied Foundation Under Air Pressure. Contracting, vol. 9, no. 4, Aug. 15, 1919, pp. 91-92, 3 figs. Pneumatic chambers formed in mass concrete made leaky bottom of cofferdam accessible.

Housing

Government Housing at Home and Abroad, Wm. E. Shannon. Am. Industries, vol. 20, no. 2, Sept. 1919, pp. 25-27. American types of houses considered as more practical, comfortable and more healthful to live in than European, although latter are said to have a higher architectural standard.

Steel Corporation's Alabama Developments. Iron Age, vol. 104, no. 10, Sept. 4, 1919, pp. 627-631, 12 figs. Building of homes for employees.

Reservoirs

See Roofs.

Roofs

Calculation of Wind Pressure on Arched Roofs, F. Grau. Eng. & Contracting, vol. 52, no. 9, Aug. 27, 1919, pp. 253-254, 5 figs. Method of determining forces and moments produced in parabolic fixed arches. Translated from Génie Civil, May 31.

Groined Arches or Flat Roof for Concrete Reservoirs. Eng. News-Rec., vol. 83, No. 12, Sept. 18, 1919, pp. 566-568. Opinions of various engineers and builders as to relative economy and safety, based on experience with both types through a number of years.

Snowslide Protection

Viaduct Protected from Snowslides by Concrete Walls, E. E. Adams. Eng. News-Rec., vol. 83, no. 10, Sept. 4, 1919, pp. 470-471, 3 figs. Bases of shore bents encased in concrete to prevent recurrence of accidents due to snowslides.

Standards

Establishing Standards in Construction, A B. Segur. Eng. & Contracting, vol. 52, no. 9, Aug. 27, 1919, pp. 242-244, 2 figs. Associated Gen. Contractors of Am., vol. 1, no. 2, Aug. 1919, pp. 9-12, 2 figs. Diagrams showing possibility of shipping labor between local industries. From report prepared for Committee on Methods of Assoc. General Contractors of America. Also abstracted in Contract Rec., vol. 33, no. 37, Sept. 10, 1919, pp. 854-857, 2 figs.

Steel Construction

The Standard Unit System of Steel Construction, R. R. Reid. Contract Rec., vol. 33, no. 37, Sept. 10, 1919, pp. 862-863, 2 figs. Development in England.

Stucco Work

Making a Success of Stucco Work. Building Age, vol. 41, no. 9, Sept. 1919, pp. 284-285, 2 figs. Framing and methods of application that prevent cracks, as recommended in extracts from Committee Report of Am. Concrete Inst.

Tanks

Tank Construction—XXXI, Ernest G. Beck. Mech. World, vol. 66, no. 1703, Aug. 22, 1919, pp. 91-92, 5 figs. Design of supports, stays, and connections for side wall of rectangular tanks. (Continuation of serial.)

Underpining

Underpinning a 6-Story Iron, Glass and Brick Wall. Contracting, vol. 9, no. 4, Aug. 15, 1919, pp. 107-108, 1 fig. Also Contract Rec., vol. 33, no. 37, Sept. 10, 1919, pp. 864-865. Work done in strengthening and extending footings so as to increase their strength and reliability without disturbing them or impairing their stability during operation.

Wind Pressure

See Roofs.

Wind Pressure on Cylindrical Structures in Practice, R. Fleming. Eng. News-Rec., vol. 83, no. 11, Sept. 11, 1919, pp. 499-502. Methods applicable to various problems of structural designer in dealing with chimneys, stacks and standpipes.

CEMENT AND CONCRETE

Bonding

Bonding New Cement Mortar and Concrete to Old in Tests, W. E. Rosengarten. Public Roads, vol. 2, no. 14, June 1919, pp. 26-34, 4 figs. Results of tests carried out in engineering research laboratory of Bureau of Public Roads.

Cracks

The Significance of Cracks in Reinforced Concrete Construction, H. Stanley Harris. Surveyor, vol. 56, no. 1439, Aug. 15, 1919 pp. 103-104. Can. Engr., vol. 37, no. 13, Sept. 25, 1919, pp. 333-334. States that cracks are generally due to contraction of concrete in setting, to expansion and contraction caused by temperature changes in concrete; to too early removal of forms; to overloading of structure and to settlement of supports. From Proc. of Roy. Victorian Inst. Architects.

Diagrams, Reinforced Concrete

Calculating Diagrams for Reinforced Concrete, James Williamson. Engineer, vol. 128, no. 3320, Aug. 15, 1919, pp. 149-151, 6 figs. on supp. plates. Two types—one combination of logarithmic alignment chart with ordinary logarithmic graph and adaptable to slabs, beams, shear members, pillars, etc., and the other applicable to cases of doubly reinforced beams and rectangular sections under combined stresses, for which ordinary formulæ do not admit of direct solution.

Mixers

Better Concrete—the Problem and Its Solution, Nathan C. Johnson. Jl. Engrs. Club, Philadelphia, vol. 36, no. 178, Sept. 1919, pp. 333-341, 16 figs. With microscopic motion-picture studies as basis, type of mixer is developed in which it is claimed reaction between cement and water is promoted with greater production of useful "glue."

Reinforcements

Proof that Iron Used in Reinforced Concrete is Rustproof (Ein Nachweis für die Rostsicherheit des Eisens bei Eisenbeton), E. Probst. Armierter Beton, vol. 12, no. 5, May, 1919, pp. 105-107, 3 figs. Cites as example slabs made 33 years ago by Dyckeroff & Widman, and which were stored in the open most of the time; based on his examination of these slabs writer furthermore concludes that a depth of 1.5 cm. is sufficient to prevent iron from rusting.

Vibration

Effect of Vibration, Jigging and Pressure on Concrete, Duff A. Abrams. Eng. & Contracting, vol. 52, no. 13, Sept. 24, 1919, pp. 352-354, 7 figs. Concrete, vol. 15, no. 3, Sept. 1919, pp. 107-111, 7 figs. Effect of vibration produced by electric motor on strength of concrete; effect of consistency on strength of jigged concrete.

EARTHWORK, ROCK EXCAVATION, ETC.

Backfilling

Backfilling Tunnel with Concrete. Concrete, vol. 15, no. 3, Sept. 1919, pp. 130-131, 2 figs. Employed in connection with construction of Winnipeg aqueduct, which is 97 miles long.

Breakwaters

Building Toronto's Western Breakwater. Contract Rec., vol. 33, no. 35, Aug. 27, 1919, pp. 807-809, 4 figs. Large concrete blocks and rock fill, keyed together with mass concrete, form structure. Dredge converted for handling blocks.

Canals

Progress of Queenston-Chippawa Power Canal. Can. Engr., vol. 37, no. 9, Aug. 28, 1919, pp. 249-256, 33 figs. Loading 8500 cu. yd. on cars in 20 hours with one shovel.

Conduits

Winnipeg Circular Concrete Conduit. Contracting, vol. 9, no. 5, Sept. 1, 1919, pp. 127-128, 7 figs. Reinforced pipes 87 to 108 in. in diameter, built with steel forms set on invert in open trench.

AN AMERICAN ACHIEVEMENT

WHEN the emergency was greatest and tracing cloth was more than ever needed urgently, it was then that this only American-made tracing cloth transferred the standard of excellence to the native product.

It was proven on the drafting boards of America's largest industries to be a product of quality unsurpassed by any other. Now that imported cloth may be readily secured, have these concerns changed back to it? Our sales sheets say no!

National Tracing Cloth provides a uniform drafting surface that will endure continual wear and tear of handling, that can be scraped and rubbed, yet gives good prints, one that has a smooth, even texture and a wonderful transparency. It is backed by the guarantee that any sheet or roll which is not free from blemish will be replaced free of expense to you.

If you have been seeking an *ideal* drafting medium—here it is. A sample sheet will immediately be sent to you. Test it thoroughly. Send for it today.

A Product of the

NATIONAL TRACING CLOTH CO.

SAYLESVILLE, RHODE ISLAND

National Tracing Paper National Blueprint Cloth

National White Pencil Cloth

National

TRACING CLOTH

107-2

Demolition

Safety Measures in Demolition of Buildings Contract Rec., vol. 33, no. 39, Sept. 24, 1919, pp. 895-897, 1 fig. Suggested precautions to observe when tearing down old structures; protection of eyes; securing of beams before cutting; removal of material.

Excavation, Labor

Piece Work versus Day Labor in Hand Excavation. Everett N. Bryan. Eng. & Contracting, vol. 52, no. 12, Sept. 17, 1919, pp. 319-320. Instance illustrating advantage of piece work over day rate.

Excavator Work, Measurement of

Scottish Mode of Measurement for Preparation of Schedules of Quantities. Contract Rec., vol. 33, no. 39, Sept. 24, 1919, pp. 903-907 Standardized methods which are applied to measurement of excavator and mason work in Scottish Nat. Building Code.

Shovels, Steam

Methods of Moving Steam Shovels, J. R. Sherman. Eng. & Contracting, vol. 52, no. 12, Sept. 17, 1919, p. 318, 4 figs. Methods employed in connection with excavation of material for large earth dam for Braden Copper Co., Chile, S. A.

HARBORS

Peru

Plans for Harbor Improvements in Peru (Plannen voor verbetering van Peruaansche havens), G. J. van den Broek. Ingenieur, vol. 34, no. 35, Aug. 30, 1919, pp. 638-646, 12 figs. Mollendo, Callao, Camana and Matarani. Paper read before Department of Building and Waterways, Holland.

HYDRAULIC ENGINEERING

Flood Hazard

Widened Channel Reduces Flood Hazard at Columbus. Eng. News-Rec., vol. 83, no. 11, Sept. 11, 1919, pp. 512-513, 2 figs. Fixtures of spillway levee.

Scouring of Drainage Channels

Board Mattress for Preventing Scour in Drainage Channel, B. F. Burns. Eng. & Contracting, vol. 52, no 11, Sept. 10, 1919, p. 299, 4 figs. Plan, section and details.

Siphon Spillway

Dam and Tunnel Construction by the Marin Water District. Eng. & Contracting, vol. 52, no. 11, Sept. 10, 1919, p. 302, 2 figs. For providing daily draft of 15,000,000 gal. Siphon spillway of dam is designed to discharge 4,000 cu. ft. per sec.

MATERIALS OF CONSTRUCTION

Wood

"Compression" Wood and Failure of Factory Roof-Beam, G. E. Heck. Eng. News-Rec., vol. 83, no. 11, Sept. 11, 1919, pp. 508-509, 4 figs. Instance in which cause of sagging in roof was found to be yellow-pine beam with wood of peculiar, abnormal growth and wide annual rings.

MUNICIPAL ENGINEERING

City Planning

City Planning for Portland. Mun. Jl. & Public Works, vol. 47, no. 9, Aug. 30, 1919, pp. 133-134. Arguments for narrower roadways in minor streets. (Concluded.)

Street Cleaning

Street Cleaning and Refuse Collection in Newark. Mun Jl. & Public Works, vol. 47, no. 12, Sept. 20, 1919, pp. 180-182, 3 figs. Appliances, methods and organization in a large manufacturing and commercial city. (To be concluded.)

RECLAMATION AND IRRIGATION

Linsay-Strathmore Irrigatio District

Operation Methods and Results on the Linsay-Strathmore Irrigation District, E. Court Eaton. Eng. News-Rec., vol. 83, no. 20, Sept. 4, 1919, pp. 474-478. Well tests and reconstruction; operation results of well and main pumping plants; water hammer in wood pipe lines; repairs to steel pipes; gravity and pressure consumers' meters.

Rio Grande Irrigation Project

Drainage Works of the Rio Grande Irrigation Project, J. L. Burkholder. Eng. News-Rec., vol. 83, no. 12, Sept. 18, 1919, pp. 543-549, 4 figs. Elements of design, methods of ditch construction with dragline excavators on caterpillar tractors and details of cost.

ROADS AND PAVEMENTS

Bituminous Pavements

Some Practical Points to Observe in the Construction of Bituminous Pavements, R. Keith Compton. Mun. & County Eng., vol. 57, no. 3, Sept. 1919, pp. 105-107. Specifications; inspection of hot material; brick gutters; rate of rolling.

Bituminous Road Materials

Ultra-Microscopic Examination of Disperse Colloids Present in Bituminous Road Materials, E. C. E. Lord. Jl. Agricultural Research, vol. 17, no. 4, July 15, 1919, pp. 167-176, 3 figs. partly on supplement plates. Investigation undertaken principally to develop method for counting colloidal particles in bituminous solutions.

Classification

Street Classification as an Aid to Pavement Design, James W. Routh. Mun. Jl. & Public Works, vol. 47, no. 10, Sept. 6, 1919, pp. 148-149. Relation between character and density of traffic and thickness of foundation. Opinions of several prominent municipal engineers.

The Classification of Highways, Henry G. Shirley. Good Roads, vol. 18, no. 13, Sept. 24, 1919, pp. 149-151, 2 figs. Advantages of improved roads; description of several classes and estimates of costs of improvement.

Cracking

Does Rich Concrete in Roads Crack More Than Lean? Eng. News-Rec., vol. 83, no. 11, Sept. 11, 1919, pp. 518-520. Replies received from various engineers to questionnaire sent out to them by Eng. News-Rec. Answers show that there is no well-developed foundation for statement that there is greater tendency to crack in richer mixes of concrete.

Fresh Concrete Pavement, Protection of

Methods of Protecting Concrete Pavements Laid in Warm Weather. Eng. & Contracting, vol. 52, no. 10, Sept. 3, 1919, pp. 266-267, 2 figs. Suggested design for light frame to hold canvas over newly placed concrete pavement.

Granite-Block Pavement

Quick Work in Laying Granite Block Pavement, Clarence D. Pollock. Mun. Jl. & Public Works, vol. 47, no. 9, Aug. 30, 1919, pp. 128-130, 3 figs. Composition of working gangs and methods employed in paving half mile of Seventh Avenue, New York. Paving was done in 40 working days; street crossing were closed to traffic three days only.

Experience with Granite Block Pavements in New Orleans, La., John C. Bartley. Mun. & County Eng., vol. 57, no. 3, Sept. 1919, pp. 112-115. Old Belgian block pavements; salvaging old granite blocks.

Macadam Roads

Construction of Twelve-Mile Macadam Road is Largely a Haulage Problem. Contract Rec., vol. 33, no. 37, Sept. 10, 1919, pp. 849-850, 3 figs. Caledonia-Jarvis highway in Haldimand County, Ont., built in two sections; wagons used on one, motor trucks on the other.

Recommended Procedure in the Construction of New Macadam Roads, M. D. Ross. Mun & County Eng., vol. 57, no. 3, Sept. 1919, pp. 116-118. Characteristics of properly constructed road; equipment used on construction; preparing subgrade.

Mississippi Valley State Highway Department

Recommended Practice of Mississippi Valley State Highway Departments for Concrete Road Construction. Can. Engr., vol. 37, no. 9, Aug. 28, 1919, pp. 260-262. As adopted at conference of Miss. Valley Assn. of State Highway Depts.

Overhaul Computation

Simple Method of Computing Overhaul. Eng. & Contracting, vol. 52, no. 10, Sept. 3, 1919, p. 273, 1 fig. Employed by Minnesota State Highway Commission.

Suggestions for Contractors on Concrete Road Construction, Clyde E. Learned. Public Roads, vol. 2, no. 14, June, 1919, pp. 15-17. Concerning overhauling, proportion of subgrade, hauling materials and laying pipe line.

Road Machinery

Road Machinery, A. H. Blanchard. Better Roads & Streets, vol. 9, no. 5, June 1919, pp. 187-189 and 214. Factors determining selection of equipment for construction and maintenance of highways.

Pneumatic Tools for Breaking up Pavement, Walter P. Burn. Elec. Ry. Jl., vol. 54, no. 12, Sept. 20, 1919, pp. 583-584, 7 figs. How by using special points a tie tamping machine was used for cutting ashphalt, toothing out paving blocks and breaking up pavement.

Resurfacing

Resurfacing Old Macadam and Gravel Roadways with Special Reference to Adaptability of Old Roadbeds as Foundation for Hot-Mix Bituminous Surfaces, Hugh W. Skidmore. Mun. & County Eng., vol. 57, no. 3, Sept. 1919, pp. 99-105, 12 figs. General requirements of pavement foundations; suitability of broken stone, stone and gravel macadam pavements as foundations for permanent types of surfaces; thickness of base; edging for highway pavements.

Standard Details

Standard Details of Pennsylvania State Highway Department for minor Features of State Roads. Eng. & Contracting, vol. 52, no. 10, Sept. 3, 1919, p. 264, 8 figs. Underdrains, plain and grouted rubble gutter, plain cement concrete gutter, concrete curbing, stone curbing.

Survey Instructions

Instructions of Arizona State Highway Department for Guidance of its Engineers. Eng. & Contracting, vol. 52, no. 10, Sept. 3, 1919, pp. 271-273. Instructions to engineers on reconnaissance surveys.

SANITARY ENGINEERING

Garbage Utilization

Profit in Garbage-Fed Hogs, E. C. W. Schubel. Am. City, City Edition, vol. 21, no. 3, Sept. 1919, pp. 217-220, 3 figs. Experience of Lansing, Mich.

Refuse Collection

The Trend in Municipal Refuse Collection and Disposal—Estimating Costs, Rudolph Hering. Mun. & County Eng., vol. 57, no. 3, Sept. 1919, pp. 107-109. The Cobwell system; garbage disposal by feeding; incineration.

Sewage Disposed

The Utilization of Sewage Sludge in Birmingham, England. Am. City, City Edition, vol. 21, no. 3, Sept. 1919, pp. 213-215, 4 figs. Shallow tanks and thorough digestion furnish sludge without odor, with possibility of organic fertilizer.

Sewage-Disposal Difficulties at Madison, Wisconsin. Eng. News-Rec., vol. 83, no. 11, Sept. 11, 1919, pp. 510-511, 1 fig. Improving sludge handling by hoppers and new pipe connections for flat-bottom tanks.

Sewage Treatment

Electrolytic Sewage Treatment. Mun. Jl. & Public Works, vol. 47, nos. 9 and 10, Aug. 30 and Sept. 6, 1919, pp. 131-132 and 151-152. Investigation of Easton plant by committee of Franklin Inst. Chemical and bacterial effect of treatment. Cost of treatment.

SURVEYING

Reconnaissance Mapping

Quick Method of Reconnaissance Mapping, M. L. Fuller. Economic Geology, vol. 14, no. 5, Aug. 1919, pp. 411-423. Method involves among other features taking of compass bearings to nearest 5 deg. and direct plotting of courses by standard coördinates while in motion.

Resurvey, Railway

Curve Chart for Railway Resurvey, J. G. Wetherell. Eng. News-Rec., vol. 83, no. 11, Sept. 11, 1919, p. 506, 1 fig Chart shows degree of curve having given angle and external.

WATER SUPPLY

Filters

High-Capacity, Self-Cleaning Filters for Purifying Water. Contract Rec., vol. 33, no. 37, Sept. 10, 1919, p. 857. Arrangement used at waterworks on Desrumaux system, in France. Translated from Génie Civil.

Purification Effected in Toronto's Water Supply by Slow Sand Filtration, N. J. Howard. Contract Rec., vol. 33, no. 38, Sept. 17, 1919, pp. 871-875. Also tests of 10,000 samples during 1918 said to show reductions of 99.7, 99.1 and 99.0 per cent in b. coli, total bacteria and excremental bacteria respectively.

Municipal Water-Works

Management of Municipal Water-Works, W. M. Rich. Am. City, City Edition, vol. 21, no. 3, Sept. 1919, pp. 209-212. Introduction of budget system, metering and water-waste surveys said to have increased economy of operation of Sault Ste. Marie water works.

San Francisco

San Francisco's Auxiliary System, Fred M. Hyde. Fire & Water Eng., vol. 66, no. 10, Sept. 3, 1919, pp. 497-499 and p. 503, 6 figs. One high-pressure hydrant claimed to give more water than three fire engines.

Storage of Water

Development and Storage of Water for Electrical Purposes, J. W. Mearles. Engineer, vol. 128, no 3321, Aug. 22, 1919, pp. 186-189, 7 figs. Conditions requisite for water power; classification according to head. Paper read before Instn. Elec. Engrs.

Water Works and Fire Insurance

Relation Between Water Works Improvements and Fire Insurance Rates, Kelsey L. Walling. Contract Rec., vol. 33, no. 36, Sept. 3, 1919, pp. 834-835. Suggestions in regard to reducing fire rates with improvements to water works.

WATERWAYS

Meanders

See River Beds.

River Beds

River Beds and Meanders, Colonel Hoc. Sci. Am. Supp., vol. 88, no. 2278, Aug. 30, 1919, pp. 134-135, 8 figs. Mechanical analysis of forces at work suggests to writer that meanders result from "buckling." Translated from Génie Civil, Paris

Mining Engineering

BASE MATERIALS

Gravel

See Sand.

Gypsum

Progress of the Gypsum Industry, Curtis F. Columbia Cement, Mill & Quarry, vol. 15, no. 5, Sept. 5, 1919, pp. 13-16, 3 figs. Prospecting, quarrying and mining, and growth of production.

Magnesite

The Magnesite Industry. U. S. Tariff Commission, Washington. 1919 23 pp. Prepared for use of Committee on Ways and Means, House of Representatives.

Magnesite: Its Geology, Products and Their Uses, C. D. Dolman. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 152, Aug. 1919, pp. 1193-1202, 2 figs. Notes on magnesite industry in Washington and its possibilities. With abundant water-power available on Spokane, Pen d'Oreille and Kettle Rivers and with raw materials, such as clays, waste wood and magnesite in large quantities close at hand, writer sees great opportunities for building up important and revolutionizing industries in Northwest.

Sand

Nature, Origin and Properties of Sand Rock Products, vol. 22, no. 17, Aug. 16, 1919, pp. 23-25, 1 fig. Classification of sand. Physical properties. Second article

Stone

The Commercial Sizes of Crushed Stone Aggregates, F. H Jackson. Public Roads, vol. 2, no. 14, June 1919, pp 25-40. Survey of present practice in states of Ohio, Kentucky, Tennessee, North Carolina and Georgia.

COAL AND COKE

Carbonization

Carbonization of Coal, W. S. Kirkpatrick. Engr World, vol. 15, no. 5, Sept. 1, 1919, pp. 39-41. Carbonization of lignite suggested as means of great economic waste.

Coke Ovens, By-Product

Temperatures in By-Product Coke Oven Practice, R. S McBride and W A. Selwig Gas Age, vol. 44, no. 6, Sept. 15, 1919, pp. 235-237, 5 figs Accounts of tests made by chemists of U S. Bureau of Standards and U S. Bureau of Mines at Koppers plant at St. Paul.

Coke Plants

New Coke Plant of La Belle Iron Works. Iron Age, vol 104, no. 11, Sept 11, 1919, pp 699-701, 1 fig. Plant has two batteries, each of 47 standard Koppers 12½ ton ovens, and is planned to permit duplication

Coking

Coking of Illinois Coal in Koppers Type Oven, R. S McBride Gas Age, vol. 44, no 5, Sept. 1, 1919, pp. 197-201, 2 figs Operating test at St. Paul plant of Minnesota By Product Coke Co. conducted jointly by Nat. Bureau of Standards and Bureau of Mines.

Oxidation of Coal

The Oxidation of Coal, Frederick Vincent Tideswell and Richard Vernon Wheeler. Jl. Chem. Soc., vol. 115-116, no. 681, July 1919, pp. 895-902, 2 figs. Preliminary account of investigation on relative tendencies to spontaneous ignition of the several distinct portions into which a banded bituminous coal can be separated.

Pennsylvania

Low-Sulfur Coal in Pennsylvania, H. M and T. M Chance. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 152, Aug. 1919, pp. 1459-1468. Description of deposits.

Tipples

Avoidable Degradation of Coal, Benedict Shubart. Coal Age, vol. 16, no. 10, Sept. 4, 1919, pp. 401-403, 3 figs. In tipple design, gravity is seen as convenient force to utilize, but careful control is advised.

COPPER

Concentrate, Nodulizing

Nodulizing Copper Concentrate, Oscar Lachmund. Can. Min. Inst. Bul., no. 89, Sept. 1919, pp. 950-954. Comparative study of value of briquetting, sintering and nodulizing as methods of putting concentrate in proper physical condition for blast-furnace practice.

Heath-Mining District, Idaho

The I.X.L. Copper Prospect, Robert N. Bell. Eng. & Min. Jl., vol. 108, no. 10, Sept. 6, 1919, pp. 400-402, 4 figs. Property in Heath Mining District, in Adams County, Idaho, described as a possible "porphyry copper" deposit, though evidence of zone surface oxidation is lacking.

EXPLOSIVES

Blasting

Advantages of Electrical Blasting, J. B. Stoneking. Cement, Mill & Quarry, vol 15, no. 5, Sept 5, 1919, pp. 35-37, 5 figs. For igniting blasting powder and detonating dynamite, electrical method is considered superior to others in spite of higher initial cost.

Blasting with Liquid Air in Potash Mines (Das Schiessen mit flüssiger Luft im Kalibergbau), Gropp. Kali, vol. 13, no. 6, Mar. 15, 1919, pp. 95, 6 figs. Technical and economical experience gained at Wintershall and Sachsen-Weimar mines. (Continued from no. 2.)

GEOLOGY AND MINES

Amber

Amber and Its Origin, George F. Black. Am. Mineralogist, vol. 4, no. 8, Aug. 1919, pp 97-99. Geological formation. (Continuation of serial.)

IRON

Minnesota

Minnesota State-Owned Iron Mines. Eng. & Min. Jl., vol. 108, no. 10, Sept. 6, 1919, pp. 388-389, 1 fig. Administration of commonwealth lands, leased to operators on royalty basis, with minimum yearly shipments specified, vested in state auditor and organized mines department. Official report pronounces system a success.

LEAD, ZINC, TIN

Lead Smeltery

A New South Wales Lead Smeltery. Eng. & Min Jl., vol. 108, no. 10, Sept. 6, 1919. pp. 394-395, 1 fig. Cockle Creek silver-lead works of the Sulphide Corporation, Ltd., treat complex ores by roasting and blast-furnace smelting, followed by refining of base bullion.

Zinc Ores

Zinc Ore. U. S. Tariff Commission, Washington. 1919. 46 pp. Prepared for use of Committee on Ways and Means, House of Representatives.

The Wisconsin Zinc District, W. F. Boericke and T. H. Garnett. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 152, Aug 1919, pp. 1213-1235, 5 figs. Possibilities of field estimated from records of past production which is quoted as having increased from 1900 tons in 1904 to over 250,000 tons in 1917.

MAJOR INDUSTRIAL MATERIALS

Manganese

Manganese Ore. U. S Tariff Commission, Washington, 1919, 28 pp. Prepared for use of Committee on Ways and Means, House of Representatives.

Pyrites

Pyrites and Sulphur Industry. U. S. Tariff Commission, Washington. 1919. 31 pp. Prepared for use of Committee on Ways and Means, House of Representatives.

MINES AND MINING

Apex Law

New Angles to the Apex Law, John A. Shelton Bul. Am. Inst. Min. & Metallurgical Engrs., no. 152, Aug. 1919, pp. 1417-1423, 1 fig. Importance of stability of titles in furthering prosperity of community.

Crushing

Crushing Practice, New Cornelis Copper Co., W. L. Dumoulin. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 152, Aug. 1919, pp. 1203-1206. Two crushing plants: Primary plant which consists of one no. 24 Gates, style K, gyratory crusher, followed by four Gates no. 8, style K, gyratory crushers; and secondary plant which consists of four units of 48-in. Symons vertical-shaft disk crushers, each unit consisting of three crushers, one coarse Symons and two fine Symons.

Sinking the "H" Shaft at the Pabst Mine, A. J. Wagner. Eng. & Min. Jl., vol. 108, no. 12, Sept. 20, 1919, pp. 513-515, 5 figs. Sequence of operations and arrangement of equipment specially noted as factors which are said to have contributed to obtaining high drilling efficiency and low maintenance cost.

Laws

See Apex Law.

Milling

Mill Operations at United Eastern During 1917 and 1918, Wheeler O. North. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 152, Aug. 1919 pp. 1171-1191, 7 figs. Notable features quoted are absence of filters and use of short peb mills loaded with steel balls for fine grinding.

Mining Methods

Geology and Mining Methods at Pilares Mine, W. Rogers Wade, Alfred Wandtke and Pilares de Nacozari. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 152, Aug. 1919, pp. 1143-1169, 14 figs. Mine is of pyrite-chalcopyrite type occurring in latite and andesite breccias of early Tertiary age.

Stoping

Economy of Machine Stoping, S. A. Min. & Eng Jl., vol. 28, no. 1454, Aug. 9, 1919, pp. 639 Figures relative to operations on narrow tin lode.

Timbering

The Preservation of Mine Timber, N. T. Williams. Trans. Instn. Min. Engrs., vol. 57, no 3, July 1919, pp. 125-133, 4 figs partly on supp. plate. Survey of various methods of treatment.

MINOR INDUSTRIAL MATERIALS

Tungsten-Bearing Ores

Tungsten-Bearing Ores. U. S. Tariff Commission, Washington, 1919. 47 pp Prepared for use of Committee on Ways and Means, House of Representatives.

Wulfenite

Notes on the Metallurgy of Wulfenite, J. P. Bonardi. Chem. & Metallurgical Eng., vol. 21, no. 6, Sept. 15, 1919, pp. 364-369. Source and importance of wulfenite; description of its metallurgical treatment, acid leach, alkaline leach and fusion methods; comparison of these methods; costs of treatment; tabulated results.

OIL AND GAS

Alsace

Oil in Alsace (Le pétrole d'Alsace), Aime Witz. Revue générale de l'Electricité, vol. 6, no. 8, Aug. 23, 1919, pp. 244-250, 1 fig. Survey of various deposits indicating quality of oil found in each; also economical study of their exploitation.

PRECIOUS MINERALS

Alaska

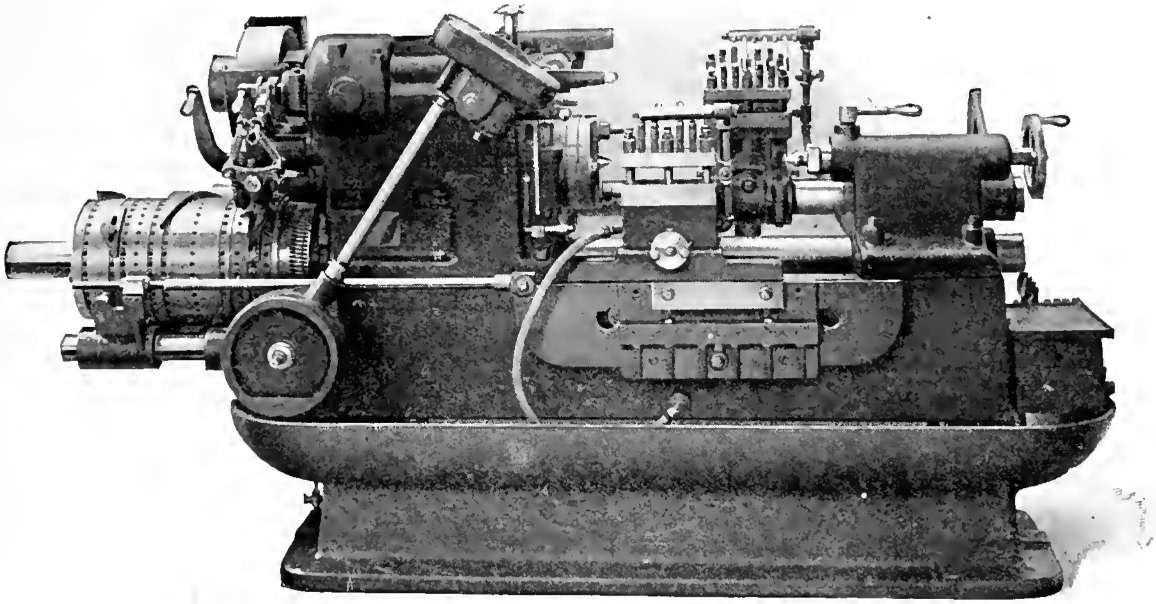
Mining in Chistochina Basin, Prince William Sound Region, and Kenai Peninsula, Alaska, Theodore Chapin and Bertrand L. Johnson. Dept. of Interior, U. S. Geological Survey, Bulletin 692 C, 1919, pp. 137-176, 3 figs. Including notes on geology of platinum-bearing auriferous gravels.

See also Platinum.

Platinum

Geology of Platinum Deposits—I and II, W. L. Uglow. Eng. & Min Jl., vol 108, nos. 9 and 10, Aug. 30 and Sept 6, 1919, pp. 352-355 and 390-393 Aug 30: Formations and occurrences. Sept. 6: Occurrences in association with other minerals; production of various districts.

The Fay Automatic Lathe



An automatic machine for simultaneous turning, facing and shouldering cuts on bar stock and centered forgings, such as pinion shafts, steering knuckles, cam shafts, etc.

An automatic machine for second operations on work held on centered arbors, such as spur and bevel gear blanks, hubs, pulleys, etc.

Designed with strength and driving power to carry all the tools, speed, and feed the work will stand under balanced cuts.

Jones & Lamson Machine Company

SPRINGFIELD, VERMONT, U. S. A.

109 Queen Victoria Street, London, E. C

France, Spain and Belgium: F. Auberty & Co., 91 Rue de Maubeuge, Paris
Holland: Spliethoff, Beeuwkes & Co., Rotterdam

SEE OUR DATA IN 1919 A.S.M.E. CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT

TRANSPORTATION

Cables, Stresses

Stresses in Mine Cables (Sur les efforts dans les cables), M. E. Dessalles. Annales des Mines de Belgique, vol. 20, no. 3, 1919, pp. 1079-1087, 4 figs. Result of experiments to determine coefficient of elasticity and velocity of propagation of stress suddenly applied.

Haulage, Underground

Efficiency in Underground Haulage, C. E. Bowron. Coal Age, vol. 16, no. 9, Aug. 28, 1919, pp. 360-361. Suggests making some one responsible for each operation or for each department.

Metallurgy

ALUMINUM

Alloys

Constitution and Metallography of Aluminum and Its Light Alloys with Copper and with Magnesium, P. D. Merica, R. G. Waltenberg and J. R. Freeman, Jr. Dept. of Commerce, Scientific Papers of Bur. of Standards, no. 337, Aug. 16, 1919, pp. 105-119, 28 figs. partly on eight supp. plates. Temperature-solubilty curves of $CuAl_2$ and Mg_4Al in aluminum determined by method of annealing and microscopic examination. Aluminum said to dissolve about 4 2 per cent copper as $CuAl^2$ at 525 deg. cent. and about 12.5 per cent magnesium as Mg_4Al at 450 deg. cent.

Aluminum Alloys (Quelques Alliages divers d'Aluminum), J. Escard. Metaux, Alliages et Machines, no. 7-8, July-Aug. 1919, pp. 1-4. Alloys used for making machine parts which are subjected to continuous friction. (Concluded.)

Aluminum, Aluminum Alloys and Their Strengths (Betrachtungen über Aluminum, Aluminiumlegierungen und der en Festigkeit), Hugo Rieger. Giesserei-Zeitung, vol. 16, no. 10, May 15, 1919, pp. 151-153. Results of tests made by German Imperial Navy Office. Composition of various alloys. (Concluded.)

Studies of Technical Aluminum Alloys (Studien über techoische Aluminiumlegierungen), E. H. Schulz. Metall und Erz, vol. 7, no. 5, March 8, 1919, pp. 91-101, 30 figs. Aluminum alloys, partly annealed and partly cold-worked were tested as to their strength and resistance to corrosion; these alloys contained besides small quantities of manganese and magnesium either 7 per cent zinc or copper up to 4 per cent.

BLAST FURNACES

Air Preheating

Conditions Required for Obtaining Favorable Results in Preheating of Air in Blast Furnaces (Die thermischen, baulichen und betrieblichen Bedingungen für einen günstigen Wirkungsgrad der Winderhitzung bei Hochöfen), Hugo Bansen. Stahl u. Eisen, vol. 39, no. 19, May 8, 1919, pp. 493-497, 5 figs. Amount of air and temperature of air; heating area; size of heater, radiation losses and their dependence on amount of exhaust and its velocity. (To be continued.)

Electric Furnace Developments for Metals. Metal Indus., vol. 17, no. 9, Sept. 1919, pp. 424-427, 6 figs. Crucible in which heat is produced directly in crucible wall.

Electric Furnaces, Testing

Commercial Testing of Metallurgical Electric Furnaces, H. M. St. John. Chem. & Metallurgical Eng., vol. 21, no. 6, Sept. 15, 1919, pp. 377-392, 5 figs. Interpretation of collected data, summarizing results, conclusions as to suitability, reliability, production, cost of operation and maintenance and other considerations.

Gas Washers

Increasing Wet Gas Washer Efficiency, George B. Cramp. Blast Furnace & Steel Plant, vol. 7, no. 9, Sept. 1919, pp. 430-432. Suggests use of corrugated sheets for baffles in blast-furnace gas washer to more thoroughly clean gas and to increase available cleaning surface.

FLOTATION

Colloids

Notes on Troubles from Colloids in Flotation. Eng. & Min. Jl., vol. 108, no. 12, Sept. 20, 1919, pp. 510-512. Survey of opinions of flotation experimenters, particularly in regard to whether physical or chemical qualities of primary slime are responsible for its action on flotation.

FURNACES

Application of Electrical Energy to the Melting of Metals, H. A. Greaves. Elecn., vol. 83, no. 2155, Sept. 5, 1919, pp. 256-257, 5 figs. Method said to enable three-phase or two-phase current to be applied to a furnace with unequal resistance in one of phases and still maintain a balanced load as regards both power and power factor on primary phase. From paper read before Instn. Elec. Engrs.

Operating Brass-Making Induction Furnaces, R. N. Blakeslee, Jr. Elec. World, vol. 74, no. 12, Sept. 20, 1919, pp. 642-644, 4 figs. Experience dealing with problems of furnace lining, charging, mixing of zinc and removal of zinc oxide deposit.

IRON AND STEEL

Carbon-Free Alloys

Electric Production of Carbon-Free Alloys, E. F. Northrup. Chem. & Metallurgical Eng., vol. 21, no. 5, Sept. 1, 1919, pp. 258-259, 2 figs. Scheme of furnace.

Cast Iron

Cast Iron under Heat Influences, E. Adamson. Iron & Coal Trades Rev., vol. 99, no. 2686, Aug. 22, 1919, pp. 239-240, 2 figs. Experiments made by writer and other investigators studied to determine influence of temperature on molecular structure of cast iron.

Composition

The Effect of Certain Elements on the Properties of Steel, N. J. Gerbert. Jl. Am. Steel Treaters Soc., vol. 1, no. 10, Sept. 1919, pp. 349-359. Shows by means of examples how to proceed in order to obtain a steel complying with specific requirements from a carbon steel containing a known percentage of carbon.

Ferrite Crystallization

Inclusions and Ferrite Crystallization in Steel, Edward G. Mahin. Jl. Indus. & Eng. Chem., vol. 11, no. 8, Aug. 1, 1919, pp. 739-745, 33 figs. Technical study and experimental research lead to following conclusions: (1) Recurrence of ferrite ghosts after repeated thermal treatment is due largely to phosphorus banding, and (2) that even after phosphorus distribution has been made uniform, repeated heating followed by slow cooling still leaves inclusions surrounded by ferrite.

Fractures

On the Inter-crystalline Fracture of Metals under Prolonged Application of Stress (Preliminary Paper), Walter Rosenhain and Sydney L. Archbutt. Proc. Roy. Soc., vol. 96, no. A674, Aug. 1, 1919, pp. 56-68, 8 figs. partly on three supp. plates. As result of observations theory is put forward that constituent crystals of metal are held together by amorphus intercrystalline cement, which in some metals is sufficiently mobile to yield to tendency of any applied stress to produce flow.

High-Speed Steel

British Practice in High-Speed Steel. Iron Age, vol. 104, no. 11, Sept. 11, 1919, pp. 702-707, 8 figs. Investigation of forging operations of cogging, rolling, etc. It is believed that, for an efficient forging, temperatures must be used which are appreciably higher than those generally accepted as correct.

Impurities

Reducing Non-Metallic Impurities in Steel, L. B. Lindemuth. Blast Furnace & Steel Plant, vol. 7, no. 9, Sept. 1919, pp. 445-447. Selection of runner bricks, temperature control and rate of pouring considered as essential. First-quality bricks for ladle lining.

Inclusions

See Ferrite Crystallization.

Lime

The Uses of Lime in Ore Dressing and Metallurgy, Paul T. Bruhl. Rock Products, vol. 22, no. 16, Aug. 16, 1919, pp. 33-35. Noting limited impurities.

Sheet Manufacture

Features of the Iron and Steel Sheet Industry—II. Raw Material, vol. 1, no. 6, Aug. 1919, pp. 290-297, 10 figs. Commercial varieties of sheets and qualities imparted to them by different processes.

MICROPHOTOGRAPHY

Aluminum Ingot

Metallography of Aluminum Ingot, Robert J. Anderson. Chem. & Metallurgical Eng., vol. 21, no. 5, Sept. 1, 1919, pp. 229-234, 32 figs. Study of microstructure, with notes on influence of quality of ingot on resultant castings and a tentative explanation of differential etching. Extract from forthcoming publication of Bur. of Mines.

Steel, Galvanized

Metallographical Study of Galvanized Steel (in Japanese), Y. Taji. Jl. Soc. Naval Architects, vol. 24, Apr. 1919.

NON-FERROUS ALLOYS

Brass

Thermal Expansion of Alpha and of Beta Brass between 0 and 600 deg. Cent. in Relation to the Mechanical Properties of Heterogeneous Brasses of the Muntz Metal Type, P. D. Merica and L. W. Schad. Bul. Bur. of Standards, vol. 14, no. 4, July 12, 1919, pp 571-590, 15 figs. Measurements showing difference in thermal expansion of alpha and of beta brass of compositions which normally are in equilibrium in such alloys as Muntz metal, naval brass, etc.

Lead Alloys

Lead-Sodium-Mercury and Lead-Sodium Tin Alloys (Ueber Blei-Natrium-Quecksilber- und Blei- Natrium-Zinn-Legierungen), J. Goebel. Zeitschrift des Vereins deutscher Ingenieure, vol. 63, no. 19, May 10, 1919, pp. 424-430, 32 figs. Constitution, hardness, flexibility.

Zinc Alloys

Study of Copper-Aluminum-Zinc Alloys with High Percentage of Zinc (Studie über die hockzinkhaltigen Kupfer-Aluminium-Zink-Legierungen), E. H. Schulz and M. Waehlert. Metall und Erz, vol. 7, no. 8, Apr. 22, 1919, pp. 170-176, 38 figs. partly on supp. plate. Thermic and metallographic tests: Zn-Cu and Zn-Al systems; surface of melting diagram. (To be concluded.)

Aeronautics

AIRCRAFT

Balloons, Observation

Observation Balloons (L'aérostation d'observation), M. Georges. Aéronautique, vol. 1, no. 3, Aug. 1919, pp. 105-111, 11 figs. Their origin and development, notably during the war.

Electrostatic Effects

Electrostatic Effects on Airships, Gordon S. Fulcher. Aviation, vol. 7, no. 4, Sept. 15, 1919, pp. 174-176. Results of experiments conducted at Princeton University and in wind tunnel at Navy Yard, Washington, to determine safety precaution in design, construction and operation of airships necessary because of electrostatic effects.

Mooring Gear

See Landing Gear.

Naval Airships

Naval Airships (L'aérostation maritime), Génie Civil, vol. 75, no. 7, Aug. 16, 1919, pp. 141-147, 7 figs. Types of the French and Italian navies.

United States

Airship Engineering Progress in the United States, J. C. Hunsaker. Aviation, vol. 7, no. 3, Sept. 1, 1919, pp. 123-128, 9 figs. Suspension systems and valve construction; features of C class. (Concluded.)

United States Navy

The U. S. Navy B-Class Dirigible. Aerial Age, vol. 10, no. 1, Sept. 15, 1919, p. 19, 3 figs. Sketch showing arrangement of parts.

Vickers

"Milestones" (Airships). Vickers. Flight, vol. 11, no. 34, Aug. 21, 1919, pp. 1121-1130, 20 figs. British Admiralty types developed from 1913 to 1918.

Wiring, Stresses

Tensions in Transverse Wiring of a Rigid Airship Due to Deflated Gas Bag, E. H. Lewitt. Aeronautics, vol. 17, no. 302, July 31, 1919, pp. 121-123, 3 figs. Deflation diagram of circular shape having axial wire passing through center.

APPLICATIONS

Commercial Flying

Commercial and Pleasure Flying, Claude Graham-White. Aeronautical Jl., vol. 23, no. 101, May 1919, pp. 231-256, 13 figs. Considerations in regard to safety, reliability, and commercial value of flying together with illustrations of various models developed for carrying passengers.

AUXILIARY SERVICE

Parachutes

Aviation Parachutes (Les parachutes d'aviation), L. P. Frantzen. Aérophile, vol. 27, no. 13-14, July 1-15, 1919, pp. 211-217, 8 figs. Particulars of various types developed in U. S., England and France. (To be continued.)

DESIGN

Some Points in Aeroplane Design, F. S. Barnwell. Aeronautical Jl., vol 23, no. 102, June 1919, pp. 301-325, 10 figs. Concerning form of aerofoil section, optimum position for main spars of aerofoil and question of economic position of points of support.

Ceiling

Formulæ for Practical Calculation of Ceiling of Aircraft (Näherungsformeln zur praktischen Berechnung der Hohenleistung von Flugzeugen), P. Jaray. Zeitschr. f. Flugtechnik und Motorluftschiffahrt, vol. 10, no. 7/8, Apr. 26, 1919, pp. 73-82, 5 figs. Tables and curves showing altitude and velocity calculations.

Linear Flight

Notes on Flying (Indications sur le problème de l'avion), M. Devillers. Aéronautique, vol. 1, no. 2, July 1919, pp. 22-28, 3 figs. Technical study of linear flight; experiments to determine efficiencies of various problems differing in ratio of pitch to diameter. (To be continued.)

Performance Formulæ

Predicting the Performance of an Airplane, V. E. Clark. Aviation, vol. 7, no. 4, Sept. 15, 1919, pp 168-174, 16 figs. Curves for estimating absolute ceiling, climb and maximum and minimum horizontal speeds at any working altitude.

DYNAMICS

High-Speed Aerodynamic Phenomena

Studies in High-Speed Aerodynamic Phenomena, F. W. Caldwell and E. N Fales. Automotive Industries, vol. 41, no. 9, Aug. 28, 1919, pp. 422-426, 13 figs. Comment on workings of army high-speed wind tunnel at McCook Field, Dayton, Ohio.

ENGINES

Rotary Engines

German Type of Double Rotary Aircraft Engine. Automotive Industries, vol. 41, no. 11, Sept. 11, 1919, pp. 514-515, 1 fig. Siemens & Halske Power plant which appeared in single-seater scout plane near end of war. Cylinders and crankshaft rotate in opposite directions.

Supercharging

How to Get Maximum Efficiency of Supercharged Motors Giving Constant Power at all Altitudes (Emploi des moteurs suralimentés à puissance constante à toutes les altitudes). Aéronautique, vol. 1, no 2, July 1919, pp. 17-22. It is recommended that calculation of speed propeller be run at various altitudes.

Vibration

Airplane Engine Vibration, Glenn D. Angle. Aviation, vol. 7, no. 3, Sept. 1, 1919, pp. 118-122, 6 figs. Technical study of its causes and manner of preventing it.

MATERIALS OF CONSTRUCTION

Fabric and Dope

Fabric and Dope, with Special Reference to Deterioration of Strength and Tautness, F. W. Aston. Aeronautical Jl., vol. 23, no. 101, May 1919, pp. 213-230, 10 figs. Sunlight is claimed to be only serious deteriorating agent; a curve is given showing change in rate of strength throughout year, effect being very great in summer and practically negligible in winter.

Plywood

Tests on Thin Plywood as a Substitute for Linen in Aeroplane Construction, Armin Elmendorf. Aerial Age, vol. 9, no. 24, Sept. 1, 1919, pp. 1135-1136 and p. 1147, 4 figs. At Forest Products Laboratories of U. S. Forest Service, Madison, Wis.

Wood

Selecting Wood for Airplanes, Arthur Koehler. Sci. Am. Supp., vol. 88, no. 2279, Sept. 6, 1919, pp. 148-149, 5 figs. Discussion of considerations necessary in selecting materials and the effects of some hidden defects.

See also Plywood.

Splintering of Airplane Woods, G. E. Heck. Sci. Am. Supp., vol. 88, no. 2274, Aug. 2, 1919, pp. 68-69, 4 figs. Tests of different airplane woods to determine relative splintering under rifle fire, conducted at U. S. Forest Products Laboratory, Madison, Wis.

Treatment, Seasoning and Working of Spruce for Airplanes (Manutention, magasinage et entretien des bois de sapin pour aéroplanes). Génie Civil, vol. 75, no. 11, Sept. 13, 1919, pp. 251-253, 2 figs. Account of processes followed and of experiments performed to determine physical properties of various samples.

METEOROLOGY

Atmosphere Sounding

Sounding of Very High Regions of Atmosphere with Long-Range Artillery (Sondage de la très haute atmosphère par l'artillerie à longue portée), A. de la Baume-Pluvinel. Aérophile, vol. 27, no. 13-14, July 1-15, 1919, pp. 209-210. Concerning requirements which must be possessed by shells capable of being sent to height in neighborhood of 50 miles.

Clouds, Measurement of Water

Measurement of Water in Clouds, L. F. Richardson. Proc. Roy. Soc., vol. 96, no. A674, Aug. 1, 1919, pp. 19-31, 3 figs. How to measure diminution by clouds of difference of brightness at edge of sun's disk by special photometer.

Stirring, Atmospheric, Measurements of

Atmospheric Stirring Measured by Precipitation, Lewis F. Richardson. Proc. Roy. Soc., vol. 96, no. A674, Aug. 1, 1919, pp. 9-18. Equation for diffusion is investigated in general case in which atmospheric distance and degree of turbulence must both be regarded as varying with height.

United States Army

Some Scientific Aspects of the Meteorological Work of the United States Army, Robert A. Millikan. Proc. Am. Philosophical Soc., vol. 58, no. 2, 1919, pp. 133-149, 8 figs. Scientific interest seems to center about (1) extension of knowledge of law of motion of pilot balloons, (2) procurement of data and development of methods for preparation of artillery range tables, (3) development of long-range propaganda balloons, and (4) charting of upper air in United States and overseas in aid of aviation.

Wind Velocity at High Altitudes in Clear Weather (Sur la vitesse du vent dans la haute atmosphère par temps clair), Ch. Maurain. Comptes rendus des séances de l'Académie des Sciences, vol. 169, no. 2, July 15, 1919, pp. 79-82, 1 fig. Measurements taken from balloons at altitudes exceeding 32,800 ft

PRODUCTION

Standardization

Standardization in Aircraft Construction (Normung im Luftfahrzeugbau). Zeitschr. f. Flugtechnik und Motorluftschiffahrt, vol. 10, no. 5-6, Mar. 29, 1919, pp. 45-61. Standards for bolts, screws, cables, sheets, tubes, etc.

PLANES

B. A. T.

The B. A. T. Four-Seater Biplane. Aerial Age, vol. 9, no. 26, Sept. 8, 1919, pp. 1172-1174, 7 figs. Biplane designed either for passenger work or for carrying mail. From Flight.

German Giant Aircraft

Development of Giant Aircraft Construction in Germany during the War (Die Entwicklung des deutschen Riesenflugzeugbaues während des Krieges), A Baumann. Zeitschr. des Vereins deutscher Ingenieure, vol. 63, no. 22, May 31, 1919, pp. 497-504, 10 figs. Description of C, G, R, and Lenz types.

See also Hydroaeroplanes, German.

Hydroaeroplanes, German

Development of German Hydroaeroplane Construction (Die Entwicklung des deutschen Seeflugzeuges), Werner v. Langsdorff. Schiffbau, vol. 20, no. 16, May 28, 1919, pp. 423-427, 10 figs. Description of AEG, Ago, Albatros, Friedrichshafen and other types.

Lawson

The "Lawson" Aerial Transport. Flight, vol. 11, no. 37, Sept. 11, 1919, pp. 1220-1222, 6 figs. Power is supplied by two Liberty engines of 400 hp. each. Overall length is 47 ft. 7 in., overall height 14 ft.; speed is 100 m.p.h.

Nieuport

British Nieuport Aeroplanes. Aeronautics, vol. 17, no. 301, July 24, 1919, pp. 94-95, 6 figs. Economy claimed in manufacture by use of rectangular section struts, streamlining being effected by means of fabric fairing.

Westland

The Westland Limousine. Aeronautics, vol. 17, no. 303, Aug. 7, 1919, p. 133, 1 fig. Flight, vol. 11, no. 35, Aug. 28, 1919, pp 1145-1148, 6 figs. Four-seater commercial biplane; length 28 ft. 6 in., wing span 38 ft. 2 in.; speed at 10,000 ft. 91 miles; fitted with 275-hp. Rolls-Royce Falcon engine.

RESEARCH

Stanford University

The Stanford University Aerodynamic Laboratory, E. J. Baughman. Aviation, vol. 7, no. 4, Sept. 15, 1919, pp. 183-184, 4 figs. With reference particularly to wind tunnel.

Licensing of Engineers

The Licensing of Aeronautical Engineers and the Inspection of Aircraft, G. Edward Barnhart. Aviation, vol. 7, no. 3, Sept. 1, 1919, pp. 128-129. Suggestions in regard to licensing, making inspection reports, and maintaining logbooks.

Marine Engineering

AUXILIARY MACHINERY

Gyrostabilizer

On Gyrostabilizer for Ships (In Japanese), N. Watanabe. Jl. Soc. Naval Architects, vol. 24, Apr. 1919.

SHIPS

Air Flow Over Rear Deck

Air flow Over Rear Deck of Battleship Pennsylvania, A. F. Zahm. Jl. Franklin Inst., vol. 188, no. 3, Sept. 1919, pp. 389-397, 11 figs. Tests made with navy model of battleship Pennsylvania, both in natural condition and with shelving deck placed above rear part, in 8-ft. x 8-ft. wind tunnel, to determine aerodynamical and structural conditions suitable for landing light airplanes upon afterdeck of full-scale ship.

Barges

Designs Modern Inland Barges. Mar. Rev., vol. 49, no. 10, Oct. 1919, pp. 461-463, 6 figs., partly on supp. plate. Details of various types of barges and towboats.

Canal Vessels

See River and Canal Vessels.

Cargo Steamers

See Freight Steamship.

Chinese-Built Steamers

The Chinese-Built Passenger and Cargo Steamers "Mylie" and "Gweneth." Shipbuilder, vol. 21, no. 109, Sept. 1919, pp. 135-138, 2 figs. Principal dimensions are: length overall, 261 ft.; length between perpendiculars, 250 ft.; breadth molded, 40 ft.; depth molded, 40 ft.; dead weight loaded, 3000 tons.

Composite Ships

Ballin Composite Ships of 4,400 Tons D W. Mar. Eng., vol. 24, no. 10, Oct. 1919, pp. 680-684, 11 figs., partly on supp. plates. Outstanding feature of hull is steel topside construction in combination with double diagonal planking under fore-and-aft course of heavier outside planking.

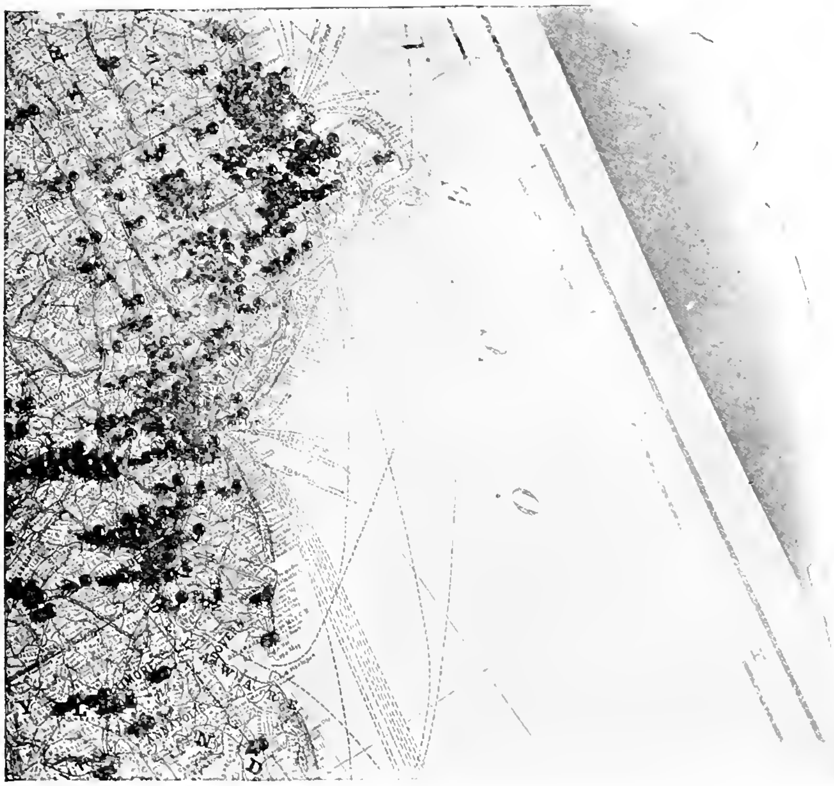
Concrete Ships

Reinforced-Concrete Barges and the Navigation on the Seine During Hostilities (Les chalands en ciment armé et la navigation sur la Seine pendant les hostilités), Ch. Lavaud. Mémoires et compte rendu des travaux de la Société des Ingénieurs Civils de France, vol. 72, no. 4, 5 & 6, Apr.-June 1919, pp. 163-178. From technical considerations as well as statistics of operation it is concluded that industrial value of reinforced-concrete barges has been sufficiently established

Precast Members Used for British Concrete Barges. Eng. News-Rec., vol. 83, no. 11, Sept. 11, 1919, pp. 507-508, 7 figs. Details of members of precasting concrete bridges of 1,000 tons capacity.

The Resistance of Ships (in Japanese), N. Yokota. Jl. Soc. Naval Architects, vol. 24, Apr. 1919

Resistance Tests of Keels Used in Mercantile Vessels (Essais de résistance des carènes appliqués à des navires de commerce), Ch. Doyere. Bulletin Technique du Bureau Veritas, vol. 1, nos. 2 and 3, July-Aug. 1919, pp. 19-24 and pp. 35-43, 19 figs. Precautions to be taken and reservations to be introduced in interpreting experiments conducted with models. Tests at Grenelle basin discussed and interpreted.



That Feeling of Security

called confidence should be the final factor in the selection of power plant equipment. To sign a contract without it would be to admit you were taking a chance.

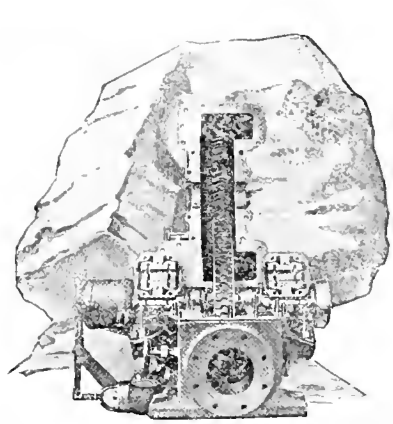
The pins in the map indicate towns or cities in which there are from one to two hundred Terrys each and, although this is a densely populated part of the country, less than one-tenth of all the Terrys are installed here. Yet, if the Terrys in Massachusetts alone were evenly spaced over the State, you couldn't get more than a mile away from one. Because of this vast number of Terry installations, it is obvious that a man who specifies

THE TERRY TURBINE

for Generator, Blower or Pumping units knows that he is not taking a chance. He is following the good judgment of thousands of engineers who know by experience what Terry service means. There is a sphinx-like stolidity behind equipment used so extensively which brings that feeling of security to the man who specifies Terry

Select your equipment with confidence.

Specify Terry



T-657

The Terry Steam Turbine Co.

Terry Square, Hartford, Conn.

Design

Center of Gravity in Ship Construction (Schwerpunktslagen), Wilhelm Schmidt. Schiffbau, vol. 20, no. 15, May 14, 1919, pp. 389-393, 6 figs. Describes simple method for determining center of gravity of area, outlines of which correspond to parabola of *n*th degree.

See also Air Flow.

New Data on Ship Stresses. Eng. News-Rec., vol. 83, no. 12, Sept. 18, 1919, pp. 550-553, 10 figs. Results of strainograph measurements on ships at sea and during launching. Strainograph registers changes in gage length by drawing curve on moving strip of paper.

Extensometer, Recording

A Recording Extensometer and the Measured Stresses in a Concrete Hull, Franklin R. McMillan. Eng. & Contracting, vol. 52, no. 13, Sept. 24, 1919, pp. 360-362, 10 figs. Strainograph used for measuring stresses in vessel during launching and under actual conditions of service. From paper presented at annual meeting of Am. Concrete Inst.

Italian Geared Turbine Cargo Steamers, C. E. Spinnler. Pac. Mar. Rev., vol. 16, no. 9, Sept. 1919, pp. 77-82, 13 figs. Details of Franco Tosi turbine installation on 8000-ton cargo steamers.

Skinner & Eddy's 10,400-Ton Freighters. Pac. Mar. Rev., vol. 16, no. 9, Sept. 1919, pp. 97-98, 3 figs., partly on supp. plate. Length overall, 439 ft. 9½ in.; breadth molded, 55 ft.; depth molded to shelter deck, 36 ft.; designed load draft, 26 ft. 6 in.

Freight Steamships

A Modern Steel Freight Steamship, D. D. Thomas. Int. Mar. Eng., vol. 24, no. 9, Sept. 1919, pp. 592-600, 20 figs. partly on two supp. plates. Factors determining size of vessel and type of propelling machinery; details of 8800-deadweight-ton turbine driven ship.

River and Canal Vessels

Large Program of River and Canal Vessel Construction Now Under Way. Mar. Eng., vol. 24, no. 10, Oct. 1919, pp. 671-678, 10 figs. Types under construction for Railroad Administration for New York barge canal, Mississippi and Warrior River.

Rolling of Ships

Experiments on the Rolling of Ships (In Japanese), K. Suyeniro. Jl. Soc. Naval Architects, vol. 24, Apr. 1919.

Rudders, "Kitchen," Reversible

Proposed Method of Maneuvering Vessels. Motorship, vol. 4, no. 10, Oct. 1919, p. 42, 14 figs. Describes the "Kitchen" reversible rudder, consisting of two curved deflectors formed of parts of circular cylinder, partly enclosing propeller; by suitable mechanism deflectors are made to turn together in same direction or equally in opposite directions.

Trawler and Drifter Combined

A Combined Trawler and Drifter. Shipbuilding & Shipping Rec., vol. 14, no. 9, Aug. 28, 1919, pp. 237-239, 7 figs. Principal dimensions are: Length between perpendiculars, 85 ft.; breadth, 19 ft.; depth, molded, 10 ft. 3 in.

Drifters and Trawlers. Mar. Eng., vol. 24, no. 10, Oct. 1919, pp. 665-669, 6 figs. British drifters, for Canadian company, built of wood with length of 84 ft. and breadth of 19¼ ft.

TERMINALS

Drydock, Floating

Twenty-Thousand-Ton Floating Dry Dock. Mar. Eng., vol. 24, no. 10, Oct. 1919, pp. 661-665, 7 figs. Put in operation by Bethlehem Shipbuilding Corporation. Dock is of pontoon type, making use of individual wooden pontoons and continuous side wings of steel.

Seattle

World's Largest Pier for Seattle, G. F. Nicholson. Freight Handling & Terminal Eng., vol. 5, no. 8, Aug. 1919, pp. 2911-2912. Length, 2560 ft.; width, 365 ft. Type of construction and mechanical handling equipment.

YARDS

Barge Repairs

Repairing in Four Weeks a 500-Ton Reinforced Concrete Barge, Which Fell, When Being Launched, from a Height of 6 ft. (Réparation en quatre semaines d'un bateau en ciment armé de 500 tonnes, tombé, au lancement, d'une hauteur de 6 pieds), Ch. Lavaud. Mémoires et compte rendu des travaux de la Société des Ingénieurs Civils de France, vol. 72, no. 4, 5 & 6, Apr.-June 1919, pp. 179-182. Rigidity of reinforced-concrete construction evidenced by fact that straight lines of vessel in question were not deformed.

Bethlehem

Ocean-Going Tugs Built at the Moore Plant of the Bethlehem Shipbuilding Corporation, Ltd. Int. Mar. Eng., vol. 24, no. 9, Sept. 1919, pp. 587-591, 6 figs. Tugs are 150 ft. long overall, 141 ft. 3½ in. between perpendiculars, 27 ft. 6 in. molded beam, and 16 ft. 8 in. molded depth at lowest point of sheer.

Clyde

Development of a Clyde Shipyard. Shipbuilding & Shipping Rec., vol. 14, no. 8, Aug. 21, 1919, pp. 209-211, 3 figs. Plans involving laying out of six building berths, four to accommodate vessels of about 650 ft. in length, and two for ships over 750 ft. long.

Kiel

Second 40,000-Ton Floating Dock at the Kiel Imperial Ship Yards (Zweites 40,000 Tonnen-Schwimmdock der Reichswerft in Kiel), B. Meyer. Schiffbau, vol. 20, no. 17, June 11, 1919, pp. 451-458, 13 figs., partly on supp. plate. Total length of dock is 220 m., length of each pontoon, 36 m.; width, 47 m.; lifting time for maximum load, 2 hours; lowering time, 1 hour.

Malcolm Pneumatic Tools

A New Adjunct to Pneumatic and Electric Hand-Tools in Shipbuilding. Shipbuilder, vol 21, no. 108, Aug. 1919, pp. 77-78, 2 figs. Malcolm arrangement for suspension of pneumatic or other portable tools when being used on perpendicular surfaces.

Mobile

Great Shipbuilding Plant at Mobile. Subsidiary of United States Steel Corporation. Manufacturers Rec., vol. 76, no. 10, Sept. 4, 1919, pp. 115-120, 13 figs. Noting type of town building for white and colored employees.

Roumanian Shipyards

The German-Roumanian Shipyards at Giurgiu (Der deutsch-rumänische Werftbau Giurgiu), E. Foerster. Zeitschr. ds. Vereins deutscher Ingenieure, vol. 63, no. 23 and 24, June 7 & 14, 1919, pp. 525-531 and 557-561, 39 figs. Details as to economical and technical aspects, size and design of yards; housing of workmen.

Staten Island Shipyard

Staten Island Shipyard Greatly Enlarged to Meet Demands for War Work. Int. Mar. Eng., vol. 24, no. 9, Sept. 1919, pp. 608-617, 17 figs. Addition to concrete ways, 400 ft. by 60 ft. to care for construction of ships of 10,000 tons displacement. Arrangement of space beneath ways for rivet storage. Pneumatic-tool storage. Riggers loft and offices for foreman quoted as unique feature.

William Gray & Co. Shipyard

The War Shipyard of Messrs. William Gray & Co. (1918), Ltd. Shipbuilder, vol. 21, no. 108, Aug. 1919, pp. 79-94, 21 figs., partly on supp. plates. Consists of four building berths, each capable of accommodating a vessel of about 440 ft. long, with necessary shops and fitting-out quay.

VARIA

Crankshaft Repairs at Sea

An Extension Repair Job at Sea, H. W. Schreck. Motorship, vol. 4, no. 9, Sept. 1919, p. 42, 4 figs. Temporary repair of crankshaft in single-screw motorship "Lidvard" (formerly "Pangan") now belonging to Norwegian Government. Translated from Skibsbygning.

Fueling at Sea

Fueling at Sea, H. C. Dinger. U. S. Naval Inst. Proc., vol. 45, no. 199, Sept. 1919, pp. 1607-1612, 4 figs. Instructions prepared on occasion of oiling destroyers at sea. Destroyers were taken in tow abreast by collier and maintained in that position while oiling.

Navigation

Selection of Terrestrial Points of Reference in Coastal Navigation (Sul punto rilevato) A. lachino. Rivista Marittima, vol. 52, no. 7, July 31, 1919, pp. 7-27, 11 figs. Concerning probable error resulting from relative position of points selected and ratio of their distances to ship.

Towing Experiments

New Formula for Towing Experiments (Eine neue Formel für Schleppversuche), Bruckhoff. Schiffbau, vol. 20, no. 16, May 28, 1919, pp. 419-423. Developed by writer, who thinks that although the opinion may be expressed that by the new formula effective hp. values are apparently too small, it is exactly the small "effective power" between the eff. hp. calculated by this formula and the i.hp. which will help to solve the problem of actual efficiency of propeller.

Physics Cellular Structure

Cellular Solidification (Solidification cellulaire), M. C. Dauzère. Annales de Physique, vol. 12, July-Aug. 1919, pp. 5-106, 57 figs., partly on 12 supp. plates. Study of cellular structure in inanimate solids and determination of conditions under which it takes place during solidification.

Ionization

Ionization by Collision (Contribution à l'étude de l'ionisation par choc), M. Blanu. Radium, vol. 11, no. 7, May 1919, pp. 195-197, 4 figs. Experiments in air and water vapor.

Luminescence

Electrolytic Luminescence of Certain Metallic Anodes (Phénomènes de luminescence électrolytique présentés par certaines anodes métalliques) James Lavaux. Comptes Rendus des Séances de l'Académie des Sciences, vol. 169, no. 4, July 28, 1919, pp. 180-182. Anodic polarization of aluminum, magnesium, zinc and bismuth.

Railroad Engineering

CONSTRUCTION

Track Elevation

Elevation of Tracks at Aurora, W. T. Christine. Engr. World, vol. 15, no. 5, Sept. 1, 1919, pp. 17-21, 11 figs. Plans and details of construction.

Train-Shed Raising

Raising a Large Train Shed under Traffic. Ry. Age., vol. 67, no. 13, Sept. 26, 1919, pp. 609-612, 8 figs. Lackawanna lifts entire structure at Hoboken to overcome settlement and restore original clearance.

ELECTRIC RAILROADS

Freight Traffic

Mineral and Goods Traffic Electrically Operated, Theodore Stevens. Electrical Rev., vol. 85, no. 2178, Aug. 22, 1919, pp. 249-251. Comparison between British steam locomotive mineral railway and American electrified mineral railway. (To be continued.)

Locomotives

Electric Freight Locomotive of the Pennsylvania Railroad designed for Use on Heavy Grades. Ry. & Locomotive Eng., vol. 32, no. 9, Sept. 1919, pp. 260-261, 1 fig. One of interesting features is jackshaft gear which is so constructed and rim so connected to center by springs, that the whole power is transmitted through them, while design is such that up to an exertion of 25 per cent of its horsepower gear acts practically as a solid gear.

See also Regenerative Brakes.

New Electric Locomotives for the Hydro-Electric Power Commission, F. A. Gary. Elec. Traction, vol. 15, no. 9, Sept. 1919, pp. 563-567, 2 figs. Description of six new 100,000-lb. electric locomotives being built for use on Niagara Construction Railway.

Regenerative Brakes

Trial Trips of Alternating Current Locomotive with Electric Regenerative Brakes (Versuchsfahrten einer Wechselstromlokomotive mit elektrischer Nutzbremsung), Hans Behn-Eschenburg. Schweizerische Bauzeitung, vol. 74, no. 7, Aug. 16, 1919, pp. 84-89, 5 figs. partly on supp. plate. Refers to article published in latter part of 1918 in Schweiz. Bauzeitung concerning new regenerative brake for a. c. locomotives. Present article supplements former and gives data in regard to practical tests, curves, wiring diagram of motor, etc.

Three-Wire System

Continuous Current Overhead Systems for Suburban Railway Electrification, E. Goolding. Tramway & Ry. World, vol. 46, no. 8, Aug. 14, 1919, pp. 72-74, 3 figs. Three-wire system using low-pressure continuous-current machines in series.

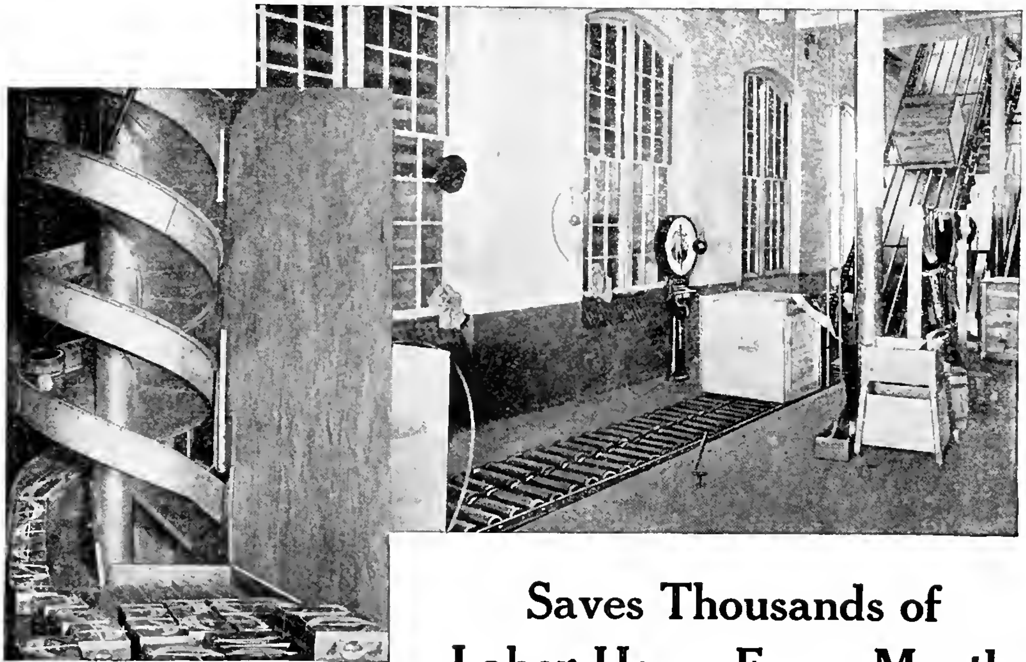
West Penn System

The West Penn System. Elec. Traction, vol. 15, no. 9, Sept. 1919, pp. 531-542, 14 figs. Vast system of electric railways, light and power companies serving territory of 2500 square miles

ELECTRIFICATION

Switches

Railroad Electrification Facts and Factors, A. J. Manson. Ry. Elec. Engr., vol. 10, no. 9, Sept. 1919, pp. 311-314, 7 figs. Details of controlling apparatus and construction of electro-pneumatic unit switches.



Saves Thousands of Labor Hours Every Month

Thousands of tons in scores of factories are now *rolled* along from operation to operation on Mathews Gravity Roller Conveyers. Thousands of dollars of labor expense and thousands of labor hours are saved to these manufacturers every month. Rolling by gravity is far cheaper and far easier and far more dependable than any system of conveying by means of expensive man power.

Fifteen years devoted to designing and constructing gravity conveying equipment enables us to effect really surprising economies in your handling costs. No matter where you want your product moved in your plant, we have a dependable Mathews unit adapted to get that product where you want it, quickly, easily, on time, and without *labor cost* for moving it there.

Mathews Roller Conveyers are made in units of various standard lengths. The entire construction is designed to give great strength without excessive weight. Therefore the units can be quickly set up and taken down wherever desired as well as erected for permanent use in one location.

Send for further valuable information.

MATHEWS GRAVITY CARRIER COMPANY
136 Tenth Street, Ellwood City, Pa.

Branch Factories: **Port Hope, Ontario—London, England**

MATHEWS
SPEED ECONOMY
GRAVITY ROLLER CONVEYER

LABOR

Track Labor

Improving Efficiency of Track Labor. Ry. Rev., vol. 65, no. 12, Sept. 20, 1919, pp. 409-412. Urges construction of good, clean, commodious, comfortable and sanitary quarters for track laborers as means for improving their working efficiency. Paper read before Roadmasters & Maintenance of Way Assn.

LOCOMOTIVE

British Locomotives

The Metamorphosis of the Locomotive, H. Holcroft. Engineer, vol. 128, no. 3320, Aug. 15, 1919, pp. 153-154, 1 fig. Recent innovations to British locomotive design, such as use of three high-pressure cylinders, and carrying circular smokeboxes in saddles. Fourth article.

Locomotives

Carbonization in Valve Chambers and Cylinders of Superheated Steam Locomotives; Its Cause, Effect on Lubrication and Maintenance, and Proper Measures to Overcome it. F. P. Roesch. Can. Ry. & Mar. World, no. 259, Sept. 1919, pp. 475-477, 1 figs. Study based on analyses of deposits of foreign matter which collect in valve chambers, passages, etc.

Feedwater Heaters

A New Departure in Locomotive Feedwater Heaters. Ry. Age, vol. 67, no. 10, Sept. 5, 1919, pp. 475-476, 3 figs. Combined feed-pump and feedwater heater of open type, capable of handling 60,000 lb. of feedwater per hour.

Preheating of Feedwater in Locomotives (Vorwarmung des Speisewassers bei Lokomotiven). H. Igel. Zeitschrift für Dampfkessel u. Maschinenbetrieb, vol. 42, no. 18, May 2, 1919, pp. 130-133, 18 figs. Rieger preheater; flat-shaped preheater for locomotives produced by Atlas Works, Bremen; types constructed by Schichau and Vulcan Works; Knorr one-chamber type.

Powdered Fuel Equipment

A Pulverized Fuel Equipment for Locomotives. Ry. Age, vol. 67, no. 11, Sept. 12, 1919, pp. 519-520, 3 figs. Consists of fuel tank on tender, fuel-feeding apparatus, special arrangement of combustion chamber, slag or ash pans and smokebox.

MAINTENANCE

Bunk Cars

Some New Ideas in Bunk Car Facilities, H. F. Haag. Ry. Maintenance Engr., vol. 15, no. 9, Sept. 1919, pp. 305-307, 3 figs. Portable quarters provided for small gangs.

Upkeep of Railways

The "Upkeep" of the Railways Under Federal Control. Eng. News-Rec., vol. 83, no. 10, Sept. 4, 1919, pp. 457-459. Analysis of conditions of railway properties now as compared with Jan. 1, 1918, when they were taken over by U. S. Government.

Tank Cars

The Tank Car Maintenance Problem, Paul Bateman. Mech. Eng., vol. 41, no. 10, Oct. 1919, pp. 817-819, 3 figs. Concerning particularly repairing of friction draft gear

OPERATION AND MANAGEMENT

Explosives, Transportation of

The Safe Movement of Explosives, D. J. O'Dea. Ry. Mech. Engr., vol. 93, no. 9, Sept. 1919, pp. 533-537. Duties of car inspectors and repairers in respect to shipments of explosives and inflammables.

Freight Handling

Freight Handling at Brooklyn Army Base. Eng. News-Rec., vol. 83, no. 12, Sept. 18, 1919, pp. 555-560, 5 figs. Principles and prospective methods which controlled design of huge terminal intended to care for army overseas business at port of New York.

Logarithmic Charts

The Logarithmic Chart in the Analysis of Railroad Operations, F. J. Deesen. Ry. Age, vol. 67, no. 12, Sept. 19, 1919, pp. 570-571, 6 figs. Illustrating uses of logarithmic chart.

PUBLIC REGULATION

Good Will

Acquiring Good Will. Elec. Traction, vol. 15, no. 9, Sept. 1919, pp. 548-552, 14 figs. Springfield (Ohio) railways begin all over after granting of new franchise and are said to have succeeded in giving real service that is highly appreciated by public.

Japan

Railway Nationalization in Japan. Ry. Engr., vol. 40, no. 476, Sept. 1919, pp. 196-199. Account of operation under state management from 1907-1917.

Municipal Ownership

Elements of the Cost of Service. Replacements. Valuation and Rate of Return, Mortimer E. Cooley. Aera, vol. 8, no. 1, Aug. 1919, pp. 15-18. Arguments against municipal ownership of street railways.

The Advantages of Municipal Ownership and Operation of Street Railways, Glenn E. Hoover. Elec. Traction, vol. 15, no. 9, Sept. 1919, pp. 544-545. Enumerates advantages accruing from municipal ownership and points out that to his knowledge, no city ever reverted from municipal ownership of street railways to private ownership.

Track Supports

Concrete for Railway Track Support. Contract Rec., vol. 33, no. 36, Sept. 3, 1919, pp. 827-831, 2 figs. Four years' experience claimed to show lower maintenance though higher first cost.

Concrete Railway Track Supports. Engr. World, vol. 15, no. 5, Sept. 1, 1919, pp. 25-28, 9 figs. Illustrating various types in operation and suggested designs. Paper read before Am. Concrete Inst.

Turntables

Recent Examples of Turntable Design. Ry. Maintenance Engr., vol. 15, no. 9, Sept. 1919, pp. 312-314, 6 figs. Two designs illustrated, one with disk-bearing center built by N. Y. Central, and one of continuous girder design built by Penna. R. R.

RAILS

Selection

Selection of Rails for Electric Railway Service, R. C. Cram. Elec. Ry. Jl., vol. 54, no. 12, Sept. 20, 1919, pp. 556-559, 6 figs. Duty required and track-maintenance details as factors in determining proper form for a rail. For determining weight of rail rule developed by Baldwin Locomotive Works is recommended.

ROLLING STOCK

All-Metal Cars

Multiple Unit Equipment for English Railway. Ry. Age, vol. 67, no. 13, Sept. 26, 1919, pp. 625-628, 4 figs. Description of all-metal cars offers opportunity for interesting comparison with similar American rolling stock.

Box Cars

Box Cars Built by C. M. & St. P. Ry. Mech. Engr., vol. 93, no. 9, Sept. 1919, pp. 529-531, 5 figs. Underframe has steel center sill and wooden side sills; wooden-frame body with steel ends.

Cabooses

United States Standard Caboose Cars. Ry. Rev., vol. 65, no. 11, Sept. 13, 1919, pp. 379-380, 6 figs. Designs prepared for both steel and composite construction by Railroad Administration's Equipment Standards Committee.

Grain Elevators, Portable

Portable Pneumatic Grain Elevator, George F. Zimmer. Eng. World, vol. 15, no. 6, Sept. 15, 1919, pp. 36-38, 8 figs. Mounted upon railway rolling stock. Front end is supported on 8-wheel bogie, and rear pair of wheels being of ordinary type, while center pair can be coupled to engine so that truck can travel on its own power at rate of 5 miles per hour.

Lighting

New Developments in Car Lighting Save Money, E. Wanamaker. Ry. Age, vol. 67, no. 12, Sept. 19, 1919, pp. 567-569. Historical review of progress made from 1825 to present time, with notes on recent investigations. From paper read before Western Ry. Club.

Mail-Cars

Specifications for Steel Full Mail Cars for Canadian Railway Mail Service. Can. Ry. & Mar. World, no. 259, Sept. 1919, p. 472, 1 fig. Approved by Board of Railway Commissioners.

SAFETY AND SIGNALING SYSTEMS

Block-Signal Working Model

Southern Pacific Builds Instruction Car. Ry. Signal Engr., vol. 12, no. 9, Sept. 1919, pp. 309-311, 3 figs. Automatic block signal working model installed with other apparatus for presenting operating problems.

Blue Lights, New York Subways

Blue Lights and Their Significance in the New York Subways, Edward A. Poor. Elec. Ry. Jl., vol. 54, no 12, Sept. 20, 1919, pp. 579-581, 6 figs. Emergency precautions that have been taken to provide for the cutting off of power, the turning in of alarms and the automatic changing over to an emergency source of power for lighting.

Inspectors

Power-Saving Instruments a Long-Standing Success in Great Britain and Ireland. Elec. Ry. Jl., vol. 54, no. 11, Sept. 13, 1919, pp. 521-526, 6 figs. Value of follow-up recognized by maintaining motorman's inspector as permanent official.

Lightning Protection, Telegraph and Telephone

Telegraph and Telephone Lightning Protection Ry. Signal Engr., vol 12, no. 9, Sept. 1919, pp. 317-319, 18 figs. Purpose, scope and requirements briefly outlined with rules for applying protector principles.

Signalmen's Car

Improved Outfit Cars Produce Good Results, H. F. Haag. Ry. Signal Engr., vol. 12, no. 9, Sept. 1919, pp. 302-304, 4 figs. Layout of four-car outfit designed by Kansas City Southern for use of signalmen.

Train-Control System

Test of Automatic Train Control System. Ry. Signal Engr., vol. 12, no. 9, Sept. 1919, pp. 312-316, 8 figs. Magnetic-inductive type installed on Western Pacific and Southern Pacific in California.

SHOPS

Cylinders, Welding

Welding Locomotive Cylinders, J. B. Tynan. Ry. Mech. Engr., vol. 93, no. 9, Sept. 1919, p. 540, 2 figs. Cylinder casting having large section of barrel broken off repaired by gas welding.

Electrical Equipment

Electrical Equipment of B. & O. Glenwood Shops. Ry. Elec. Engr., vol. 10, no. 9, Sept. 1919, pp. 297-304, 16 figs. With special reference to facilities for lighting, power and electric arc welding.

Round-House Design

Modern Tendencies in Round-House Design, Exum M. Haas. Ry. Mech. Engr., vol. 93, no. 9, Sept. 1919, pp. 521-522. Modern types divided into three classes—brick wall, wood frame and roof; reinforced-concrete frame and roof; and combination of steel frame and reinforced-concrete structure. From paper presented before Western Soc. of Engrs.

Tie-Treating Plant

Pennsylvania Has Novel Treating Plant. Ry. Maintenance Engr., vol. 15, no. 9, Sept. 1919, pp. 315-317, 4 figs. Portable tie-treating plant.

Wood-Preserving Plant, Portable

A Complete Wood Preserving Plant Mounted on Cars. Ry. Age, vol. 67, no. 10, Sept. 5, 1919, pp. 453-455, 4 figs. Portable equipment used by Penn. R. R.

STREET RAILWAYS

Cincinnati

Cost of Service in Cincinnati, W. C. Culkins. Elec. Traction, vol. 15, no. 9, Sept. 1919, pp. 570-572, 2 figs. Service-at-cost franchise adopted for solving street-railroad problem.

Coupling Mechanism, Automatic

Automatic Coupling Mechanism for Tramways (Autocoupleur pour tramways). Bulletin Technique de la Suisse Romande, vol. 45, no. 17, Aug. 23, 1919, pp. 171-174, 5 figs. Projecting bar operates mechanism which drops weight and engages vertical rod in hole of bar. There are two similar mechanisms, one in each tramway.

Dundee

Dundee Municipal Tramways. Tramway & Ry. World, vol. 46, no. 12, Sept. 11, 1919, pp. 131-135, 8 figs. Progressive system with prospects of extensive development.

Economic Future

Economic Future of Transportation Utilities. Elec. Ry. Jl., vol. 54, no. 11, Sept. 13, 1919, pp. 529-531. Symposium presented at Western Society of Engineers' meeting.

Electric Railway Situation

The Electric Railway Situation of the United States Summarized. Aera ,vol. 8, no. 1, Aug. 1919, pp. 8-11. Facts which have been brought out before U. S. Federal Elec. Ry. Commission appointed by the President to investigate urban transportation and its needs.

The Drive of Efficiency *The Drive of Durability*

MORSE CHAINS

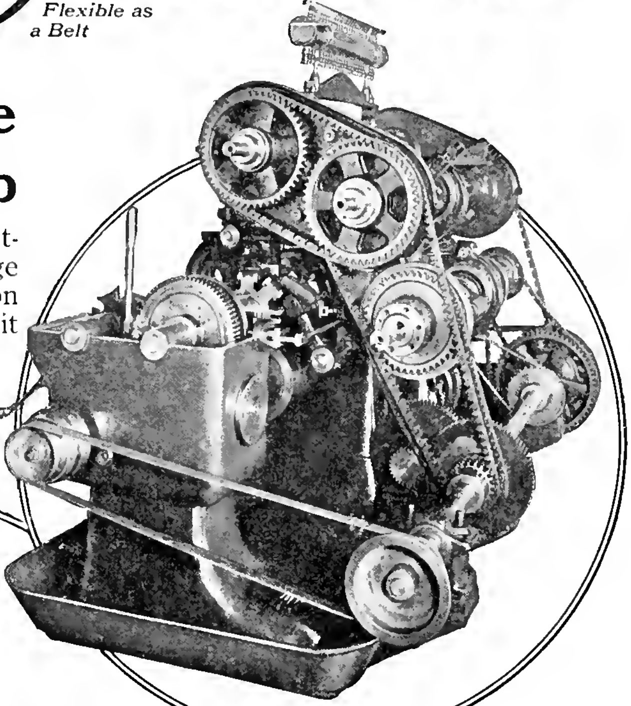
THE MORSE "ROCKER JOINT"

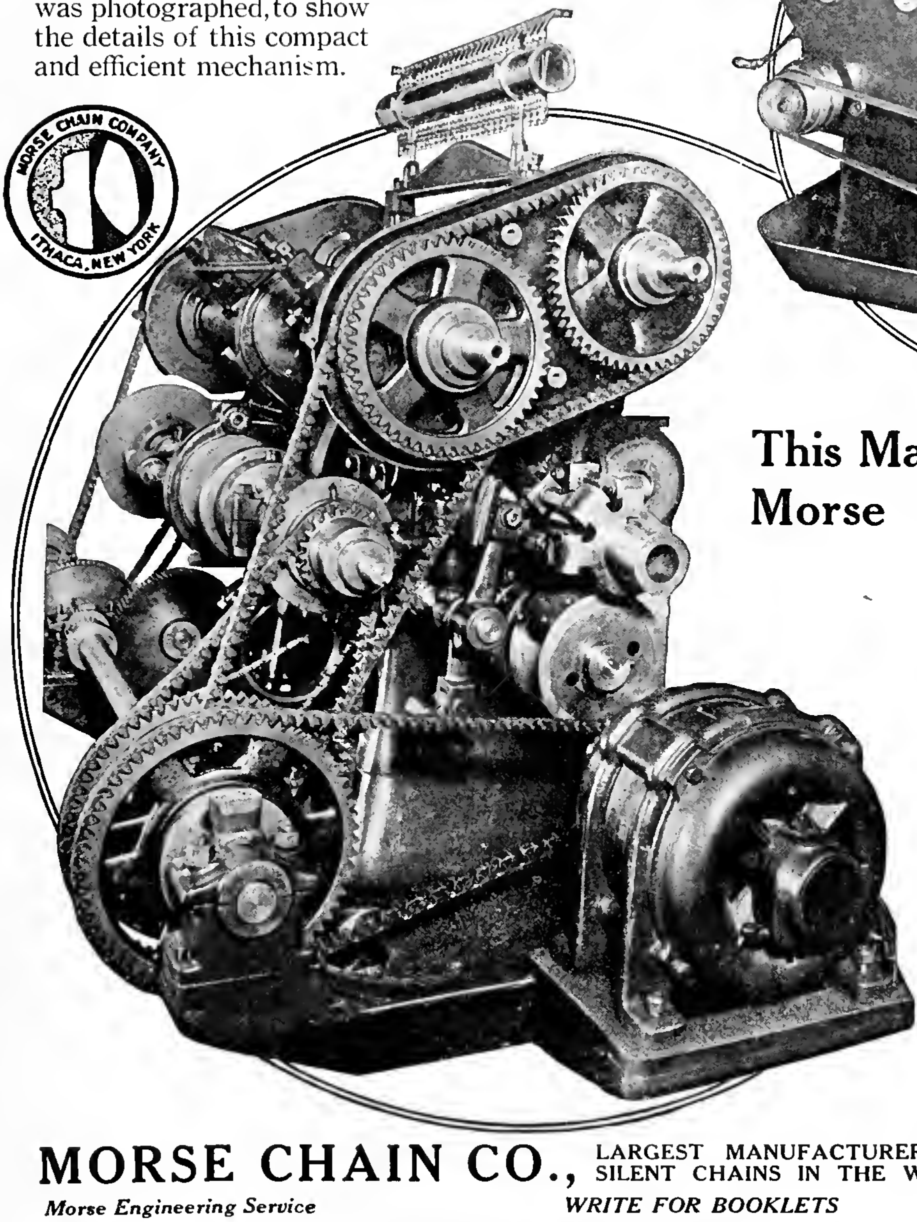
Positive as Gears *Flexible as a Belt*

Longer Life

For Economy in Space and Economy in Upkeep

This automatic hub boring machine, built by the Blomquist-Eck Machine Co., of Cleveland, Ohio, shows to advantage the application of Morse Silent Chain to speed reduction in small power drives. All guards were removed before it was photographed, to show the details of this compact and efficient mechanism.





MORSE CHAIN COMPANY ITHACA, NEW YORK

This Machine is Driven with Morse Chain Throughout

Seven Morse Silent Chains—.9″ pitch, 1″ face—transmit power from a 10 H. P. motor to and through this mechanism.

In some cases they eliminate intermediate gears; in others, bevel gears, shafts, brackets and other units which take up more space and deteriorate more rapidly.

This machine has given five years of complete satisfaction to its owners and is good for many more. The patent "Rocker Joint" reduces wear to a minimum. Easy to take up wear, when necessary. Consult us when planning important drives—large or small.

MORSE CHAIN CO., LARGEST MANUFACTURERS OF SILENT CHAINS IN THE WORLD **ITHACA, N. Y.**

Morse Engineering Service — *WRITE FOR BOOKLETS* — *Assistance Without Obligotion*

1920 Vest Pocket Memo. and Diary. Give Firm Name, Position

Address Nearest Office

BOSTON, MASS.	141 Milk Street	SAN FRANCISCO, CAL.	Monadnock Bldg.
CHICAGO, ILL.	Merchants L. & T. Bldg.	ATLANTA, GA., Candler Bldg	Earl F. Scott, M. E.
CLEVELAND, OHIO	Engineers Bldg.	CANADA	Jones & Glasco, Regis'd
DETROIT, MICH.	1003 Woodward Ave.	MONTREAL, St. Nicholas Bldg	Toronto, Traders' Bank Bldg.
GREENSBORO, N. C.	805 Ashboro Street	KANSAS CITY, MO., Long Bldg.	Morse Engineering Co.
NEW YORK CITY	50 Church St.	MINNEAPOLIS, MINN., 413 3rd St., S.	Strong-Scott Mfg. Co.
PITTSBURGH, PA	Westinghouse Bldg.	ST. LOUIS, MO., Chemical Bldg.	Morse Engineering Co.

"Morse" is the Guarantee Always Behind the Efficiency, Durability and Service

Fare Collection

The Collection of Odd Street Railway Fares, R. T. Sullivan. Elec. Ry. Jl., vol. 54, no. 13, Sept. 27, 1919, pp. 653-656, 4 figs. Illustrating how design of car facilitates collection.

Fare Systems

Zone Fares in Springfield. Elec. Ry. Jl., vol. 54, no. 13, Sept. 27, 1919, pp. 628-636, 12 figs. Based on central city zone with outer zone belts and two reduced-rate tickets to points in first outside zone.

Zone System in Portland. Elec. Ry. Jl., vol. 54, no. 13, Sept. 27, 1919, pp. 621-627, 11 figs. System in Portland, Me., comprises slightly more than 100 miles of track, the population served approximating 100,000 except during summer months when it is increased to 175,000.

The Net Result of the 5-Cent Fare. James R. Bibbins. Elec. Ry. Jl., vol. 54, no. 12, Sept. 20, 1919, pp. 570-571, 1 fig. Instance of large company in which 5-cent fare is said to have produced instability. Paper presented at Western Soc. of Engrs.

Zone Fares Have Been Found Satisfactory in Milwaukee. Elec. Ry. Jl., vol. 54, no. 13, Sept. 27, 1919, pp. 613-620, 11 figs. Present system has been in existence since January 18, 1914.

Discussion of Fare Systems. Elec. Ry. Jl., vol. 54, no. 13, Sept. 27, 1919, pp. 610-612. Present fare systems classified and compared. Fundamentals of scientific system outlined.

Speeds

Advantages of Higher Schedule Speeds, John A. Beeler. Elec. Ry. Jl., vol. 54, no. 13, Sept. 27, 1919, pp. 657-660. Claimed to be of benefit to both the company and the public.

TERMINALS

East St. Louis

Terminal Improvements in East St. Louis. Ry. Rev., vol. 65, no. 12, Sept. 20, 1919, pp. 405-407, 7 figs. Arrangement to route traffic along water front instead of through to junction points.

Markham Yards

Markham Yards of Illinois Central. W. T. Christine. Eng. World, vol. 15, no. 6, Sept. 15, 1919, pp. 25-28, 8 figs. For classifying freight, making up trains composed of various commodities and for various industries and destinations to bring freight so classified into Chicago for distribution and to handle outbound freight in an equal manner.

General Science

CHEMISTRY

Air

New Forms of Instruments for Showing the Presence and Amount of Combustible Gas in the Air, E. R. Weaver and E. E. Weibel. Dept. Commerce, Scientific Papers of Bur. of Standards, no. 334, June 23, 1919, 90 pp., 21 figs. Description of devices developed by Bur. of Standards, principles upon which they operate, results of tests showing their accuracy and reliability, and discussion of their application.

Ammonia Oxidation

Analytical Method for Determining Efficiency of Ammonia Oxidation. D. P. Gaillard. Jl. Indus. & Eng. Chem., vol. 11, no. 8, Aug. 1, 1919, pp. 745-747, 1 fig. "Bulb" method of analysis.

Analysis

The Use of Freezing-Point Determinations in Quantitative Analysis, Charles Edward Fawsitt. Jl. Chem. Soc., vol. 115-116, no. 681, July 1919, pp. 801-808. Method of estimating ingredient in substance by finding freezing-point depression of substance in ingredient as solvent and also in some other solvent is found to be applicable only by special cases where it is possible to experiment previously with samples of substance somewhat similar to the one under investigation.

See also Air, Ammonia, Battery Acid, Foods, Gas Mixtures, Lead, Magnesium, Marbles, Ocean Currents, Ores and Alloys.

Battery Acid

Determination of Iron in Battery Acid by the Ferricthiocyanate Color, Ernest Nyman. Can. Chemical Jl., vol. 3, no. 9, Sept. 1919, pp. 298-300. As to rapidity and accuracy, method was found to compare favorably to both gravimetric and volumetric permanganate methods.

Catalysis

Some Problems in Contact Catalysis. Wilder D. Bancroft. Gen. Meeting Am. Electrochem. Soc., Paper no. 6, Sept. 23-26, 1919, pp. 41-43. Concerning reaction of phosgene with water.

On the Oxidation of Phenols by Gaseous Oxygen and the Catalytic Effect of Metals. F. W. Skirrow. Can. Chemical Jl., vol. 3, no. 9, Sept. 1919, pp. 292-294, 1 fig. Account of experiments.

Carbon Activation

The Activation of Carbon, N. K. Chaney. General Meeting of the Am. Electrochem. Soc., paper no. 13, Sept. 23-26, 1919, pp. 157-166. Discussion of general theory of nature of active carbon and its relations to generally occurring forms of carbon.

Chemical Affinity

Chemical Affinity and Atomic Valence, G. Ciamician and M. Padoa. Sci. Am. Supp., vol. 88, no. 2279, Sept. 6, 1919, pp. 154-155. Relation between chemical and thermal energy and modern views of constitution of atom. Translated from Jour. de Chim. Physique (Geneva).

Coagulation

Heat of Coagulation (Ueber Flockungswärme). H. R. Kruyt and Jac. van der Spek. Kolloid-Zeitschrift, vol. 24, no. 5, May 1919, pp. 145-155, 2 figs. Discussion of Berthelot, Thomsen, Wiedemann and Ludeking, Graham and other methods.

Colloids

Colloidal Chemical Studies of Kongo Ruby (Kolloidchemische Studien am Kongorubin), Wolfgang Ostwald. Kolloidchemische Beihefte, vol. 10, no. 6-12, 1919, pp. 179-288, 3 figs. Study on the theory of indicators and the theory of color changes in organic matter.

Enamel Ware

Acid Test on Enamel Ware, W. D. Collins. Jl. Indus. & Eng. Chem., vol. 11, no. 8, Aug. 1, 1919, pp. 757-759. Account of acid tests made on sixty-one samples of enamel ware from twenty-six different manufacturers.

Foods

The Estimation of Sulphates in a Concentrated Electrolyte and the Determination of Sulphur in Foods, Vernon K. Krieble and Autrey W. Mangum. Jl. Am. Chem. Soc., vol. 41, no. 9, Sept. 1919, pp. 1317-1328. Laboratory study of oxidation of foods by sodium peroxide and precipitation of sulphate as barium sulphate in solutions containing large amounts of sodium chloride.

Gas Mixtures

Industrial Analysis of Gas Mixtures by the Refractometric Method. Chem. & Metallurgical Eng., vol. 21, no. 6, Sept. 15, 1919, pp. 392-393, 7 figs. How to use Lord Rayleigh's interferometer and how to interpret measurements effected with it. Translated from Chimie et Industrie, June 1919.

Glucinium

Glucinium, J. S. Negru. Chem. & Metallurgical Eng., vol. 21, no. 6, Sept. 15, 1919, pp. 353-359, 1 fig. Historical account of discovery, uses, treatments of glucinium minerals for glucina, and method of effecting chemical and electrochemical separation of glucinium.

Iron Penetration of Hydrogen

The Penetration of Iron by Hydrogen, T. S. Fuller. General Meeting of the Am. Electrochem. Soc., paper no. 9, Sept. 23-26, 1919, pp. 77-93, 4 figs. Results of experiments showing effect of various conditions on penetration of iron by nascent hydrogen at temperatures from 20° to 100° cent. It was found that velocity of hydrogen penetration is greater for a unit immersed without electrical connections in 1 per cent sulphuric acid than four units electrolyzed as cathode in like solution with current densities up to one half an ampere.

Lead

Titrimetric Determination of Antimony in Slag Lead (Über die titrimetrische Bestimmung des Antimons im Hartblei), A. Wogrinz and R. Gohring. Das Metall, no. 9, May 10, 1919, pp. 117-118. Description and results of tests; analysis of weight; titration.

Magnesium

The Alkalimetric Determination of Small Amounts of Magnesium, P. L. Hibbard. Jl. Indus. & Eng. Chem., vol. 11, no. 8, Aug. 1, 1919, pp. 753-754. Suggests changes in Bruckmiller's method for determining magnesium by titration of ammonium magnesium phosphate.

Marbles

Physical and Chemical Tests on the Commercial Marbles of the United States, D. W. Kessler. Techn. Papers Bur. Stand., no. 123, July 15, 1919, 54 pp., 8 figs. Chemical analyses made on 42 samples for purpose of classification and determination of harmful elements. Volume resistivity determinations made on a number of samples to determine their relative value for electrical insulators and the variation of this value under different conditions of moisture. Carbonic-acid tests also included.

Ocean Currents

Detecting Ocean Currents by Observing Their Hydrogen-Ion Concentration. Alfred Goldsborough Mayor. Proc. Am. Philosophical Soc., vol. 58, no. 2, 1919, pp. 150-160, 1 fig. Observations are said to have established that easterly moving water in Tropical Pacific is commonly less alkaline than that of general region in which it occurs. Having this and similar established conditions writer suggests detection of currents by testing sea water with a few drops of red dye thymolsulphonephthalein.

Ores and Alloys

A Rapid Method for Determining Nickel and Cobalt in Ores and Alloys.—III, W. R. Schoeller and A. R. Powell. Analyst, vol. 44, no. 521, Aug. 1919, pp. 275-280. Application of iodide process to certain ores and alloys.

Phenol Oxidation

See Catalysis.

Piezochemistry

Piezochemical Studies; experimental test of Braun's Law—XV (Piezochemische Studien Experimentelle Prüfung des Braunschen Gesetzes), Ernst Cohen and A. L. Th. Moesveld. Zeitschrift für physikalische Chemie, vol. 93, no. 4, 1919, pp. 385-515, 8 figs. Investigations included determination of temperature coefficient of solubility, pressure coefficient of solubility, hypothetical change of volume and hypothetical temperature of solubility.

PHYSICS

Acoustics

Detection of Submarine by Sound Waves (Etude des ondes acoustiques, la propagation des ondes vibratoires et l'ecoute sous-marine), H. Brille. Génie Civil, vol. 75, nos. 8 & 9, Aug. 23 & 30, 1919, pp. 171-175, and 194-199, 15 figs. Technical study of physical questions involved in transmission of sound waves through different media with special reference to submarine detection. (Continuation of serial.)

Velocity of Sound in Sea Water. (Sur une mesure de la vitesse de propagation des ondes sonores dans l'eau de mer.), M. Marti. Comptes rendus des séances de l'Académie des Sciences, vol. 169, no. 6, Aug. 11, 1919, pp. 281-282. Measurement effected by the French Naval Hydrographic Service at Cherbourg. Value obtained was 1503.5 m. per sec. at temperature of 14.5 deg. cent.

The Speed of Sound Pulses in Pipes, Arthur L. Foley. Phys. Rev., vol. 14, no. 2, Aug. 1919, pp. 143-151, 3 figs. Measured by photographic method modified so as to obtain instantaneous photograph of sound pulse part of which had come through a tube while another part had come through free air.

Sound Emitter and Sound Receiver—II (Schallgeber und Schallempfänger), W. Hahnemann and H. Hecht. Physikalische Zeitschrift, vol. 20, no. 11, June 1, 1919, pp 245-251, 2 figs. Discusses use of electro-mechanical transformer as receiver.

Emulsions

Investigations Concerning Oil-Water Emulsion, Alex. W. McCoy, H. R. Shidel and E. A. Trager. Bul. Am. Inst Min. & Metallurgical Engrs., no. 152, Aug. 1919, pp. 1513-1537, 24 figs. Laboratory experiments conducted to determine compositions and properties of emulsified oil lead to conclusions that permanent B. S. is emulsion of very small water bubbles in oil having diameter generally less than 0.5 mm. Behavior of emulsion on heating is suggested as basis for division into two groups—(1) when water separates from oil rapidly with small amount of heating, and (2) when water can be removed by distillation.

Microphones

See Acoustics.

Theoretical Basis for the Construction of Microphones (Theoretische Grundlagen zur Konstruction zweckmassiger Mikrophone), Ph. Broemser. Telegraphen - u. Fernsprech - Technik, vol. 8, no. 1, Apr. 15, 1919, pp. 6-8. Formulæ given for number of vibrations and sensitivity show that it is possible to increase number of vibrations without reducing thereby sensitivity.

Slow-Speed Tests of Kingsbury Thrust Bearings

By H. A. S. Howarth,[1] Pittsburgh, Pa.

This paper presents operating and experimental data which show the wide range of application of the Kingsbury thrust bearing, and the author gives particulars of typical installations which have been in successful operation since 1911. These bearings have been applied to vertical and horizontal hydroelectric units as well as to horizontal steam turbines and centrifugal pumps, and to determine some of the service conditions, a series of slow-speed tests was recently made on a bearing having a total area of 76 sq. in. on its four shoes and a load of 10,000 lb. Details of these tests are given, and the results obtained indicate that the lower the speed at which the bearing is run continuously, the better the conditions of the bearing surfaces. Speeds as low as 0.38 r.p.m. have thus far been employed, using, however, only a light oil.

The Kingsbury thrust bearing in its simplest form consists of one or more pivoted segments or shoes against which the thrust collar presses as it rotates. The bearing faces are copiously supplied with oil so that perfect film lubrication takes place with its resulting low friction coefficient. This bearing was invented many years ago by Albert Kingsbury, of Pittsburgh, but it met with so much conservatism on the part of engineers and manufacturers that it was slow to be taken up. The author of this paper believes there are many engineers wrestling with thrust problems who will welcome data on the wide range of usefulness of this pivoted-segment type of thrust bearing. Whether the load be great or small, or the speed be high or low, it can be applied successfully. It is the object of this paper to present operating and experimental data to show the wide range of its application to date.

A Kingsbury thrust bearing was applied to a Morgan mill in 1911 to take the bevel-pinion thrust on the horizontal drive shaft. Its characteristics are as follows: load, 66,000 lb.; 70 r.p.m.; unit thrust load, 100 lb. per sq. in.; mean surface speed, 8.4 ft. per sec. The collar is of air-furnace iron and the pivoted shoes are babbitt-faced. It runs in machine oil. The heat of friction is dissipated by its connection with an oil-circulating system, but the bearing will lubricate itself automatically from an oil reservoir in its housing if the central-station system gets out of order. This bearing has been in successful operation ever since 1911, none of its parts has ever been replaced and today it is in first-class condition.

The next application of the bearing was in a plate-glass grinding and polishing machine in 1911. This bearing, of the vertical type, was placed below the lower end of the spindle. It was designed to carry a load of 160,000 lb. at 35 r.p.m. with a unit thrust of 980 lb. per sq. in. Its mean surface speed is 2.1 ft. per sec. On account of the high unit pressure and slow speed the collar was made of chilled iron and the shoes of bronze, and the oil used was very heavy. Its service requires alternate runs of two to three hours and stops of about one hour. A conservative estimate of the starts and stops of this machine to date is 15,000. This bearing is still in service and none of its parts has ever been replaced.

Following the above applications the Kingsbury thrust bearing began to be applied to vertical and horizontal hydroelectric units, to horizontal steam turbines and centrifugal pumps. During the war its use in these fields was greatly extended and it began to be employed to take propeller thrust. When our country entered the war the demand for turbine-driven ships advanced with a bound, which caused a similar increase in the demand for Kingsbury thrust bearings both for the turbines and for taking the propeller thrust.

The development of the Kingsbury thrust bearing has now reached such a stage that it is being used in steam turbines to take the whole steam thrust, no dummies whatever being required. One turbine thus equipped runs at 3600 r.p.m., the mean surface speed in the thrust bearing being 155 ft. per sec. This is the highest speed attained thus far, but there is no reason to believe it cannot be greatly exceeded. High surface speed is not always accompanied by high angular velocity. Tests are now being made that show the bearings will operate successfully at 15,000 r.p.m.

For *constant* low-speed operation the best operating example is the plate-glass-machine bearing described above, whose mean surface speed is 2.1 ft. per sec. Much lower speeds occur when the machine slows down to a stop. A mean operating surface speed of 2.1 ft. per sec. is not low for a heavy oil, however, even with a unit load of 1000 lb. per sq. in.

Hydroelectric units ordinarily run on light engine oils and the film thicknesses are, therefore, much less at any speed and load than would be the case if heavy oils were used. They have to start and stop under practically full thrust load, consequently that service may be considered as the most severe for thrust bearings. When one of these units slows down it passes gradually through the whole range of speeds from normal to the very low speed at which the oil film breaks in the thrust bearing. All this time the friction coefficient, and hence the torque required to turn the rotor, is reducing. When the film breaks the friction coefficient increases and the rotor is brought to rest.

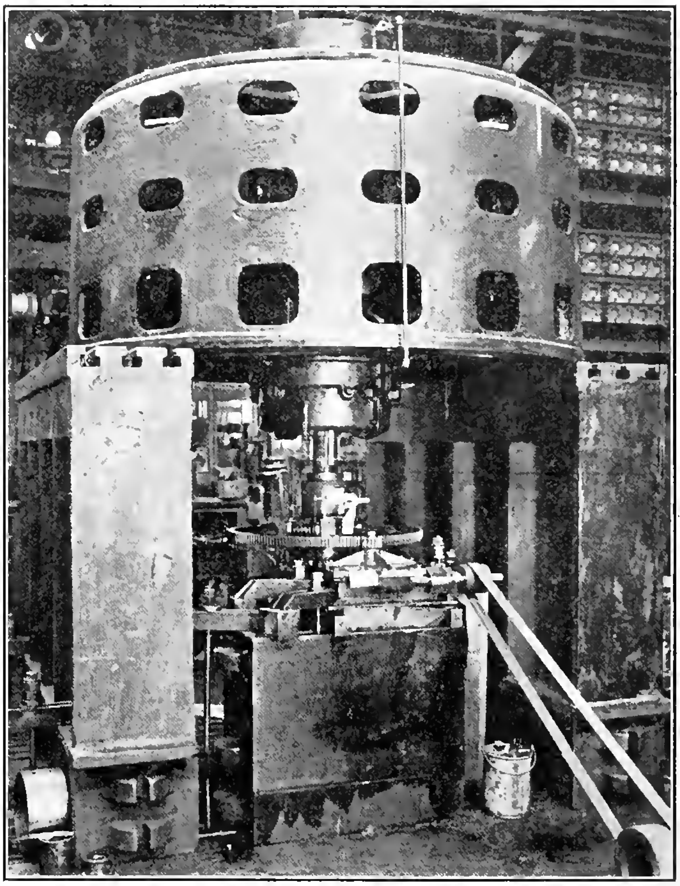


Fig. 1 View of Machine Employed in Testing Thrust Bearings at Slow Speeds

Consideration of these severe service conditions suggests the following questions: At what surface speed does the film break? What happens to the bearing if it continues to turn after the film breaks? Does the film break suddenly? These questions are of great importance. The slow-speed tests described later were made for the express purpose of answering them. An effort will be made

[1] Gen. Mgr. and Ch. Eng., Albert Kingsbury, Eng. Mem. Am. Soc. M. E.

Presented at the Annual Meeting, December 2 to 5, 1919, of The American Society of Mechanical Engineers. The paper is here printed in abstract form. Copies of the complete paper may be obtained at a nominal price. All papers are subject to revision.

to cover the field between film lubrication and so-called metallic friction.

It is known that, in a given bearing carrying a known load, the film thickness at a given speed is greater for a heavy oil than for a light one. Hence a heavy oil will sustain a given load at a lower speed than will a light oil. It may be assumed that the oil film breaks when it gets so thin that the high spots begin to rub. If the bearing surfaces are poorly fitted the film will break at a

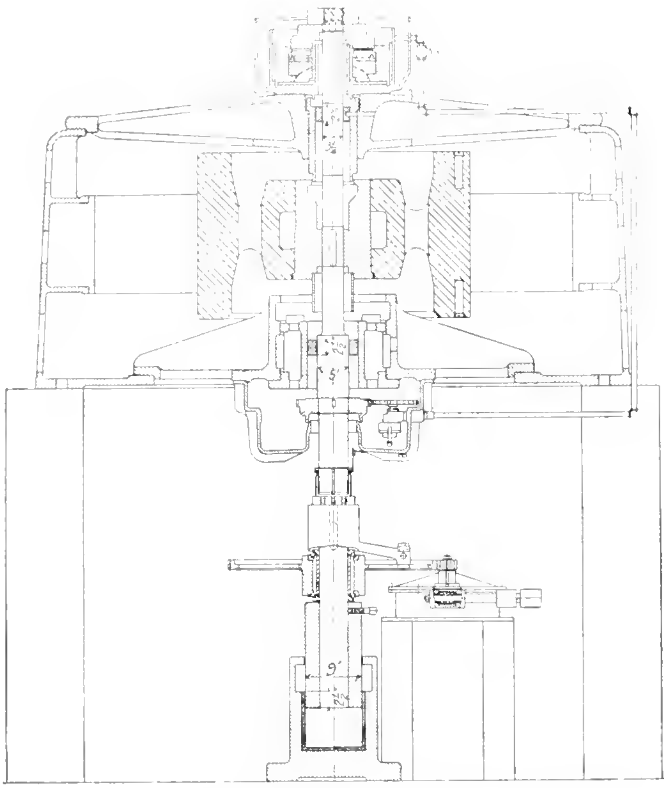


FIG. 2 VERTICAL SECTION OF THRUST-BEARING TESTING MACHINE SHOWN IN FIG. 1

higher speed than otherwise. When it is said that high spots rub on each other it is not meant that the metals come into contact with no oil between them. If the high spots are wet with oil, oil will persist in remaining between them. The local pressure may be enough to cause the softer of the two spots to be "ironed off" or crowded back out of the way. If the high spots are not of great magnitude the local heating will not be sufficient to make trouble and as soon as the high spots rub they will pass and cool. The softer high spot will recede on cooling and may even fall below the general surface. If the harder surface be perfectly flat it might iron off the soft high spots and make the soft face also flat. If the harder face is not perfectly flat the softer face will gradually conform to it as far as possible.

The machine used for the slow-speed tests to be described is shown in Figs. 1 to 4, inclusive. Power from a variable-speed motor is belted and geared down so as to produce constantly any desired low speed at the driving gear A which is mounted on ball bearings around the rotor shaft B, Fig. 3. A hub C is keyed to the shaft as shown in Fig. 4. It has arms D and E while the gear arm has a lug F. Between lug F and arm D are mounted two compression springs in a holder that is so arranged as not to bind when the springs are compressed. Angular movement between the hub and gear, by means of a suitable linkage, causes a corresponding axial motion of the ring-shaped indicator G that surrounds the shaft as Fig. 3. A fixed scale H is fastened to the machine frame. This can be graduated so that torque can be read directly. Since the load is constant the friction coefficient can be read directly on the scale if desired.

It will be noted in the section shown in Fig. 4 that two sprin[illegible] are used, a light one and a heavy one. When the driving [illegible] started its arm lug F moves and begins to compress the springs. The light one compresses first and then the heavy one also comes into action. When the compression of both becomes great enough, rotation begins and the springs expand as the coefficient of friction reduces from its starting values to its running value. The coefficient of running friction is so very low for a continuous film that the light spring will be compressed but little.

The following action was noted when the tests were begun: If the speed of rotation of the driving gear was not high enough to keep the shaft going fast enough to maintain a perfect film in the thrust bearing the high spots would rub and the coefficient increase, causing the shaft to stop turning. Then as the stiff spring compressed, the driving torque would become great enough to start the shaft turning again. Once the starting resistance was overcome

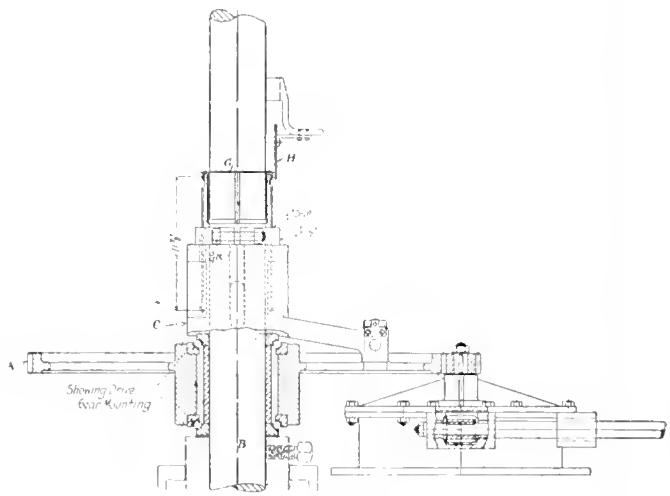


FIG. 3 DETAILS OF DRIVE-GEAR MOUNTING OF TESTING MACHINE SHOWN IN FIG. 2

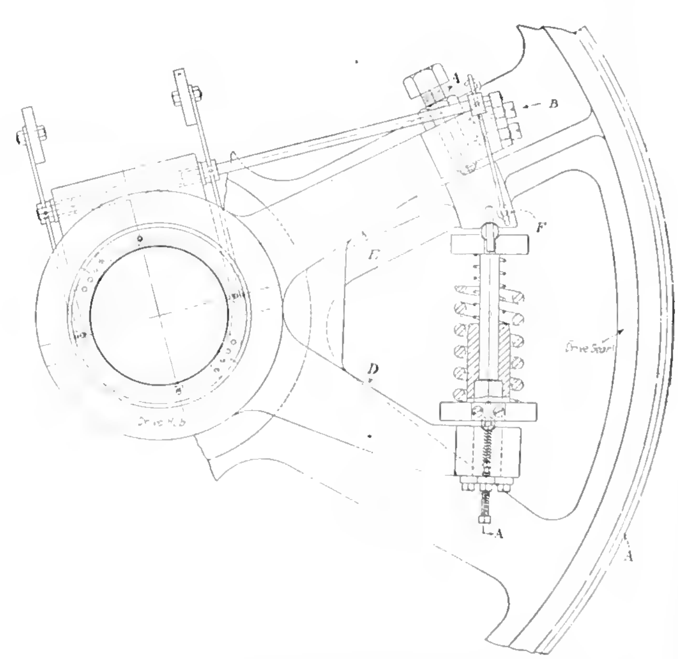


FIG. 4 PORTION OF DRIVE GEAR, SHOWING METHOD OF MOUNTING THE COMPRESSION SPRINGS

t[illegible] [illegible]ld be accelerated by the expansion of the stiff spring [illegible] up sufficiently to be driven by the light spring. [illegible] [illegible]ar would not be turning fast enough to keep [illegible] [illegible]ould then slow down till the film broke [illegible] would take place about every two seconds. [illegible] 10,000 lb. The thrust bearing has four shoes of

the form shown in Fig. 5, their total area being 76 sq. in. Hence the initial tests were run with a unit pressure of (10,000/76 =) 132 lb. per sq in., the intention being to decrease the area later to 38 sq. in. by taking out two shoes; then still more by reducing the total area of the remaining shoes to 19.53 sq. in., 13.33 sq. in., 10 sq. in., and finally to 5 sq. in.

Before making the tests the thrust bearing, which is shown in section by Fig. 6, was carefully inspected. The face of the cast-iron collar was in excellent condition, i.e., smooth and flat. The babbitt-faced shoes were then fitted to the collar face under load. This fitting process developed some interesting features. Not knowing at how low a speed the machine would run and have a perfect film, it was assumed that the high spots would rub at 2.8 r.p.m. The machine was run at this speed for 30 min. The friction was so high that the load came on the heavy spring. The shoes were then removed and the high spots scraped down slightly. The shoes were then put back and the bearing run at 2.9 r.p.m. for 15 min. They were then removed and scraped again, and run at 3 r.p.m. After the starting friction was overcome the load was carried on the light spring and the speed kept constant for 45 min. The spring compression gradually reduced from 9/16 to 3/8 in., showing that the friction was decreasing rapidly. This indicated that such high spots as interfered with each other at this speed were gradually being rubbed down. The results of this first test are plotted in Fig. 7. The shoes were inspected after this run and found to be in excellent condition.

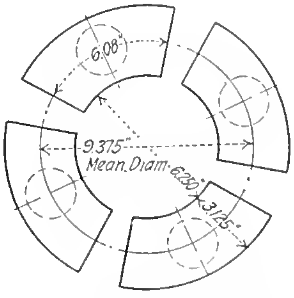
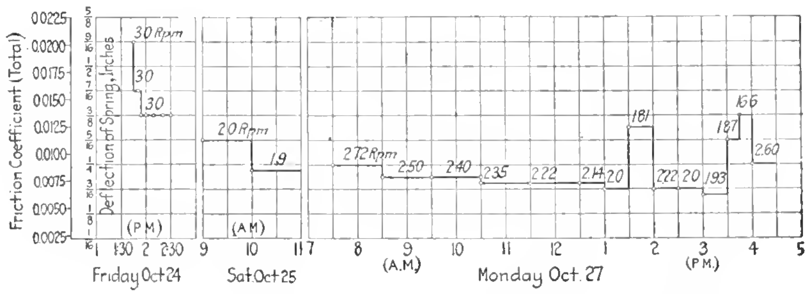


Fig. 5 Arrangement of Shoes in the Thrust Bearing Tested



Figs. 7 to 9 Results of Tests of Thrust Bearing

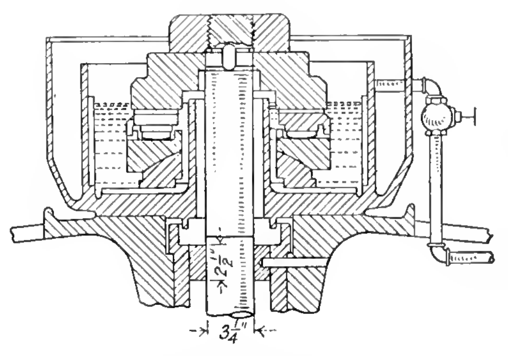
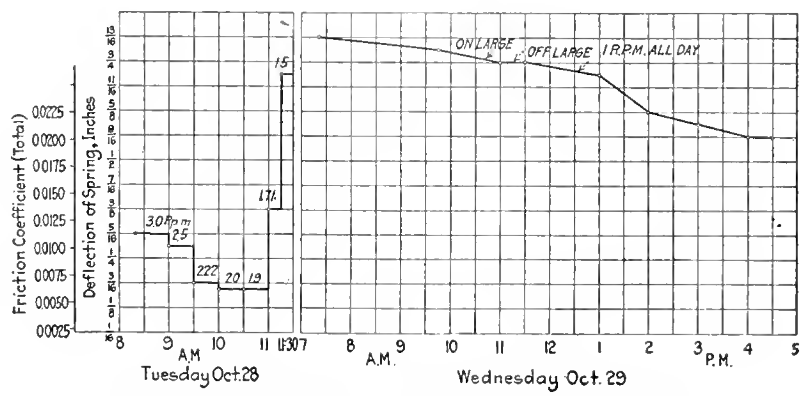


Fig. 6 Section through Thrust Bearing Employed in the Tests



Figs. 10 and 11 Results of Tests of Thrust Bearing

The next test was run on Saturday, October 25, beginning with 2.86 r.p.m. The speed was then reduced to 2 r.p.m. (see Fig. 8) and the spring compression decreased to 5/16 in. It was expected that the compression would decrease with the speed so long as a good film was maintained. The machine was then run for an hour at 1.9 r.p.m., and the light-spring compression was 15/64 in., showing that the friction coefficient still continued to reduce. This run had to be stopped on account of quitting time.

Tests were continued on Monday, October 27, starting with 2.72 r.p.m. (see Fig. 9). The first run showed that the friction decreased until the speed was 2 r.p.m. When an attempt was made to run at 1.81 r.p.m., the friction increased considerably — about 100 per cent. It will be noted that with a speed as low as 1.66 r.p.m. the light spring still carried the load easily.

The results of Tuesday's tests correspond very closely with the previous ones (see Fig. 10). The speed was lowered at intervals until it reached 1.9 r.p.m., the friction coefficient likewise decreasing. When an attempt was made to run at 1.71 r.p.m., the spring compression increased more than 100 per cent. At 1.5 r.p.m. it increased to almost double its value at 1.71 r.p.m.

After the run on Tuesday the thrust bearing was inspected. It was found to be in excellent condition, the shoe faces having apparently worked in so as to be a much better fit to the collar. In view of this improvement it was decided to see what would happen if the machine were run constantly at 1 r.p.m. (see Fig. 11). At the beginning of the run the heavy spring was slightly compressed. At the end of four hours the load was beginning to be carried by the light spring alone. At the end of another four hours the compression of the light spring had reduced considerably, finally reaching 9/16 in. This compression remained constant for 30 min. As there was an evident improvement in the bearing surfaces, shown by the gradual reduction of the friction coefficient, it was decided to run the next day at various speeds and see whether the coefficient would reduce with the speed to a lower point than before.

On Thursday the machine was started up and run for 15-min. intervals at each speed beginning with 2.25 r.p.m. The minimum friction was obtained at 2 r.p.m. The coefficient remained constant, however, until the speed reached 1.71 r.p.m. It increased appreciably when the speed was reduced to 1.66 r.p.m. and continued to increase, though slowly, until the speed reached 1.5 r.p.m. The friction then remained constant until the speed was reduced to 1.39 r.p.m. At this point the machine was shut down.

It is evident from the foregoing that by running continuously at 1 r.p.m. the bearing surfaces improved so that the friction coefficients at speeds slightly above 1 r.p.m were less than they otherwise would have been.

(Continued on page 968)

The Hvid Engine and the Fuel Problem

By E. B. Blakely,[1] Chicago, Ill.

This paper describes a type of engine, the Hvid, which it is claimed has all the advantages and none of the disadvantages of the so-called Diesel type, and which is being produced in units as small as 1½ hp. It can be started cold, has no complicated air-compressor systems, and is so economical that it can compete with gasoline engines of the same size. The author outlines the operation of the engine, describing in detail the suction, compression, power and exhaust strokes and presenting a series of indicator cards. Fuel consumption is shown by means of curves obtained as the results of tests performed. The paper concludes with a discussion of the heat balance and torque characteristics of the engine.

It has been estimated that there are in use now in this country, burning gasoline, nearly 4,000,000 automobiles, 250,000 trucks, 500,000 motor boats, 75,000 tractors and 750,000 farm engines. Is it any wonder, therefore, that the demand for gasoline has increased?

The visible supply of crude oil is naturally diminishing and since the oil is becoming heavier all the time, the percentage of gasoline yield, now averaging 15 per cent, is lessening.

The supply of gasoline may be increased slightly by making use of the cracking processes, which would necessitate an increased cost of production, and also by blending high-test casing-head gasoline with kerosene, a process bound to be short-lived because our gas wells are rapidly giving out. It may also be conserved by increasing the thermal efficiency of the engines and by adapting them to burn kerosene and mixtures of gasoline and kerosene. The relief gained, however, would be but temporary at best. We are having trouble enough now in burning properly the present-day gasoline without trying to burn all sorts of mixtures which at the least would necessitate constant changing of carbureting adjustments and methods.

Much has been written and said during the past two or three years on the subject of using kerosene as fuel in conventional gasoline engines of both the slow- and high-speed types, and while undoubtedly much has been learned concerning the characteristics of kerosene under certain conditions, the burning of kerosene in gasoline engines, so far as the writer knows, has not been accomplished with complete success up to the present time. By complete success the writer means starting the engine on kerosene in atmospheric temperatures approximating 0 deg. fahr. and below (for these must be reckoned with) without preliminary heating of any sort and burning the kerosene so as to eliminate troublesome carbonization and complicated and unsightly apparatus, and obtain high economy.

In attempting to burn kerosene in modified gasoline engines we are confronted by the following basic difficulties: Kerosene and gasoline are chemically widely different substances, having nothing in common but the base from which they are derived. Their initial boiling points are wide apart, that of commercial gasoline being about 100 deg. fahr., while that of kerosene is about 330 deg. fahr. Their boiling ranges are also totally different, that of gasoline being 340 deg. fahr., while that of kerosene is about 200 deg. fahr. Gasoline-air mixtures will ignite spontaneously at approximately 680 deg. fahr. while similar mixtures of kerosene and air self-ignite at approximately 575 deg. fahr. Mixtures of gasoline and air form a permanent fixed gas, but mixtures of kerosene and air do not. Under these conditions a jet carburetor designed for vaporizing gasoline cannot be expected to vaporize kerosene. The best it can do is to atomize it.

In order to vaporize, as well as to prevent precipitation or condensation of the atomized kerosene in the combustion chamber it is necessary to heat the charge, and since the power output of the engine depends upon the amount of oxygen taken in and burned during each cycle, it is clear that the more the charge is heated the less oxygen we can get into the cylinder and the less power we can obtain. This forces us to a compromise between two conflicting conditions, the maintenance of the incoming charge at the lowest possible temperature which will vaporize the kerosene and the prevention of precipitation in the combustion chamber. This compromise might be satisfactorily effected in the case of an engine running at a constant speed and load, but in the case of an engine running at varying speeds and loads it is a very different compromise to make, because as the power demands on the engine vary, so must the total amount of heat added to the charge vary.

In order to obtain maximum power from any internal-combustion engine, regardless of the kind of fuel used, we must have maximum mean effective pressure, and since mean effective pressure depends largely upon compression pressure, we must use the highest compression pressure possible. This brings us again to a conflicting pair of conditions, because in order to prevent so-called preignition with its attendant disagreeable and harmful pounding, when burning kerosene, we are forced to use a relatively low compression pressure which lowers the mean effective pressure and also the power output.

In this connection may also be mentioned the so-called preignition knock which occurs when using too high a compression pressure with kerosene. This knock is not caused by preignition, as is generally supposed, but by small detonations after ignition has occurred and the piston has started downward. These detonations are due to the fact that kerosene is of a very complex chemical make-up and that after ignition has started the conditions are most favorable to cracking it. Under these conditions the kerosene breaks down into simpler combinations, some of which are highly detonating, others less so, and these compounds set one another off successively, according to their stability, but so rapidly as to produce a single knock.

Many engineers believe that if the problem of utilizing kerosene for fuel in these engines now burning gasoline could be solved, the whole fuel problem would be solved. It undoubtedly would help the situation immeasurably, but the true economic solution of the fuel problem lies not in trying to adapt some particular fraction of the distillation of crude oil to the engine, but in adapting the engine to the available fuel, whether it be crude oil just as it comes out of the ground, or some by-product of its distillation.

There have been numerous engines built in the last ten years, capable of running consistently on the various crude and fuel oils, as for instance the Diesel and so-called semi-Diesel engines, hot-bulb and surface-ignition engines. These, however, have been used mainly in marine work and in relatively large units. It is out of the question to consider making Diesel engines of much less than 100 hp. per cylinder, because of the complicated fuel-injecting mechanism and the high cost of production. The other types have the disadvantage of requiring external preheating before they can be started, and the torches used for this purpose are a source of constant danger. Electric preheating has been tried, but with little success.

Advantages of the Hvid Engine

Th[illegible] an engine, however, which has all the advantages of th[illegible]tioned types and none of the disadvantages. This [illegible]. It can be started cold on any liquid fuel which [illegible]gh a pipe. It has no complicated air-compressor [illegible]njecting the fuel, no hot bulbs or torches and runs with [illegible]nomy on a par with the Diesel engine. The Hvid engine [illegible] and is being produced in units as small as 1½ hp., and so

[1] Sears, Roebuck and Company

Presented at the Annual Meeting, December 2 to 5, 1919, of The Amer[illegible] Society of Mechanical Engineers. The paper is here printed in ab[illegible] form. Copies of the complete paper may be obtained at a nominal pric[illegible] All papers are subject to revision.

economically as to be able to compete with gasoline engines of the same size. Briefly enumerated, its chief advantages are:

a Mechanical simplicity
b Low fuel consumption at all loads
c Ability to start and run on any oil which will flow
d Low water-jacket losses
e No lubricating difficulties
f Constant compression
g Remarkable torque characteristics
h Absence of all electrical devices, hot bulbs and torches for ignition purposes
i Absence of all carbureting mechanism
j No carbon troubles.

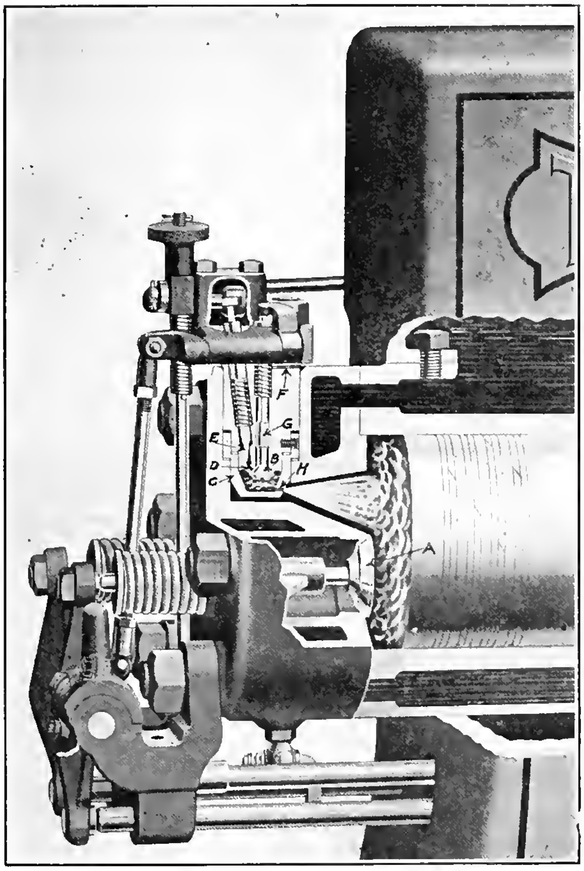


Fig. 1 Cutaway Section of 8-hp. Hvid-type Farm Engine

The Hvid engine is of conventional four-cycle type, embodying the usual inlet and exhaust valves, timed to open and close as in any four-cycle engine. The compression pressure is carried to between 425 and 475 lb. per sq. in., which heats the compressed air to between 900 and 1000 deg. fahr. In the cylinder head there is a fuel-admission valve terminating in a small steel cup by means of which a preliminary explosion is made to force the fuel into the combustion space. Referring to Fig. 1, the Hvid cycle is as follows:

Suction Stroke. During the suction stroke pure air is admitted to the cylinder through intake valve *A*. Fuel valve *B* is opened in synchronism with intake valve *A* and some fuel flows into cup *C* out of hole *D* which is uncovered by the opening of valve *B* (the fuel enters cup *C* partly by gravity and partly by inhalation). The amount of fuel admitted is controlled by the metering pin *E*, which in turn is controlled by the governor. At the same time that the fuel is being inhaled into the cup, a small amount of fresh air is also drawn through auxiliary air hole *F*, down past a fluted guide *G* into the cup *C*. At the end of the suction stroke, fuel valve *B* and air-intake valve *A* close, valve *B* sealing the fuel-admission hole *D*.

Compression Stroke. During this stroke all valves are closed and the air admitted to the cylinder on the suction stroke is compressed to about 420 lb. per sq. in., which raises its temperature to between 900 and 1000 deg. fahr. In other words, there is now a mass of highly heated air under high pressure in the combustion chamber and this rushes into cup *C* through small holes *H* near its bottom until the pressure in the cup is practically equal to the pressure in the combustion chamber. The conditions in the cup are now most favorable to "cracking" the oil, and as the oil cracks the lighter and more volatile components are detonated by the high temperature and the resultant high pressure within the cup forces the rest of the oil out into the air in the cylinder. The amount of fuel consumed in the cup per cycle is infinitesimal because there is only a very small amount of air present in the cup to support combustion.

Power Stroke. As the fuel in an atomized and vaporous state comes into contact with the heated air in the combustion space, very rapid combustion takes place and the pressure arising from it drives the piston.

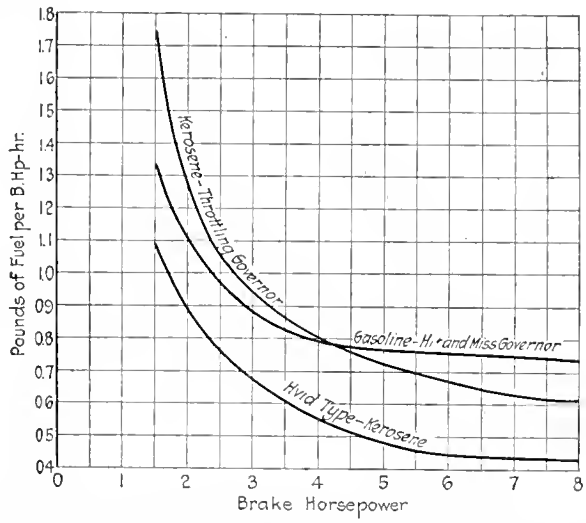


Fig. 2 Comparative Fuel-Consumption Curves of $5\frac{3}{4} \times 9$-in. Farm-Type Engines Operating on Different Principles

Exhaust Stroke. As in any four-cycle engine, the exhaust valve opens and the products of combustion are forced out by the piston.

Fuel Consumption

The fuel consumption of small Hvid-type engines is very good, being in general on a par with Diesel engines of large size. If

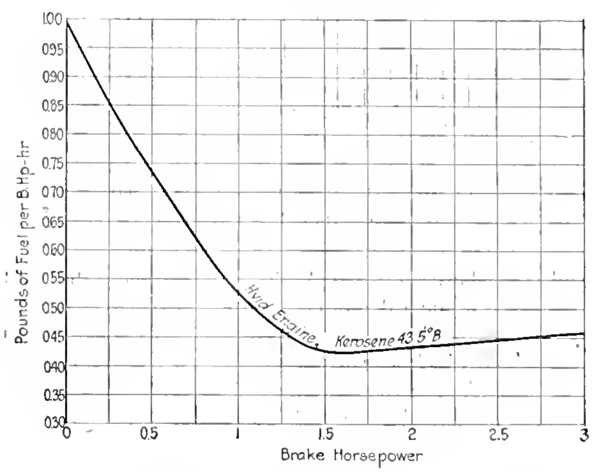


Fig. 3 Fuel-Consumption Curve of a $3 \times 4\frac{1}{2}$-in. Hvid Engine

Diesel engines could be economically constructed in units as small as Hvid engines can, it is doubtful whether they would compare at all favorably in thermal efficiency with the small Hvid units on account of the mechanical inefficiency of the air compressors

necessary to inject the fuel. In the comparative fuel-consumption curves shown in Fig. 2 the fuel economy of the Hvid engine as compared with two other types of the same size stands out very plainly, particularly at the lower fractional loads. The engine used in each case was $5\frac{3}{4}$ in. by 9 in., running 450 r.p.m., rated hp., 8.

The fuel-consumption curve of the small 3-in. by $4\frac{1}{2}$-in. Hvid engine shown in Fig. 3 is particularly interesting because this engine, running at 1100 r.p.m. normally, is the first relatively high-speed engine of this type built. Owing to the high speed, it was natural to suppose that trouble would be encountered with the time element necessary for the introduction of fuel into and ejection out of the cup; but it was found that this little engine could be run at speeds as high as 1500 r.p.m. without any apparent interference with the perfect operation of the Hvid principle.

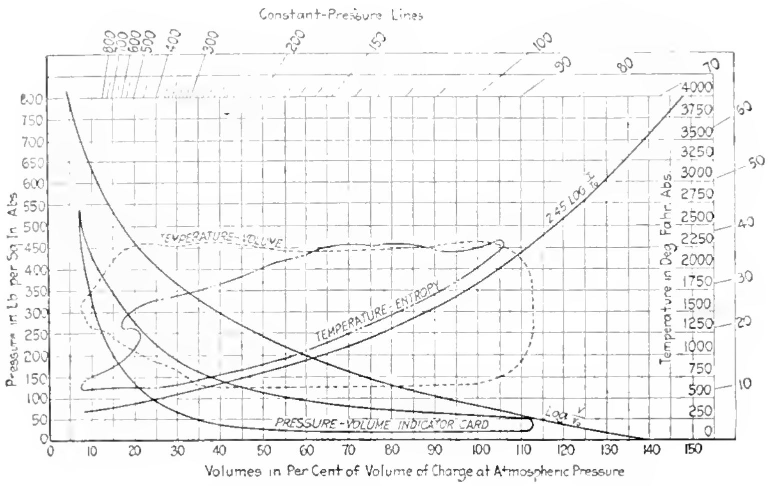


FIG. 4 VOLUME-TEMPERATURE DIAGRAM FOR A $5\frac{3}{4} \times$ 9-IN. SINGLE-CYLINDER HVID KEROSENE ENGINE

Entropy Diagram. The entropy diagram, shown in Fig. 4, was plotted from a pressure-volume indicator card taken from a $5\frac{3}{4}$-in. by 9-in. single-cylinder Hvid-type engine running at 450 r.p.m. and using kerosene as fuel. This diagram is submitted because it shows the general temperature characteristics, which are quite different from those in an explosive gasoline engine. It is interesting to note the low maximum temperatures, 2300 deg. fahr. abs., as compared with the maximum temperatures for gasoline engines, which frequently run as high as 3000 to 3500 deg. fahr. abs., and also, the sustained temperature in the Hvid engine throughout the working or expansion stroke. At first glance it might be argued that this sustained temperature would be harmful because of undue heat losses to the water jackets, but since the water-jacket losses are low and the thermal efficiency of th engine is remarkably good, the writer believes that combusti the Hvid engines takes place in the form of zone burning and the cylinder walls are more or less insulated from the high temperatures of combustion by a layer of air which is not burnt until near the end of the stroke.

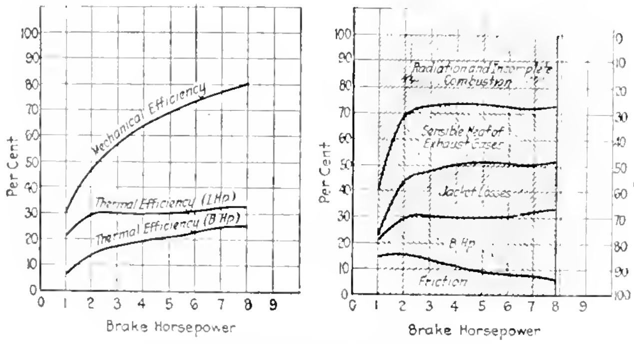


FIG. 5 HEAT BALANCE AND EFFICIENCY CURVES FOR $5\frac{3}{4} \times$ 9-IN. SINGLE-CYLINDER HVID ENGINE

Heat Balance. This test gives the mechanical efficiency and the thermal efficiency for both brake and indicated horsepower. The test was made upon a $5\frac{3}{4}$-in. by 9-in. single-cylinder Hvid engine which was flexibly connected to a Sprague electric cradle dynamometer by means of two "Spicer" universal joints. The engine was operated under various loads and speeds with various adjustments of fuel supply, compression and cup design. The final setting was made with a compression of 390 lb. per sq. in.

Test runs, curves for which are shown in Fig. 5, were conducted at various loads from a maximum to about one-eighth of maximum load, and readings were taken to determine the following:

1 Friction horsepower (electric dynamometer method)
2 Brake horsepower (torque and speed)
3 Jacket-water loss
4 Sensible heating in the exhaust (calorimeter method)
5 Loss due to radiation and incomplete combustion (by difference)
6 Fuel consumption (lb. per hour).

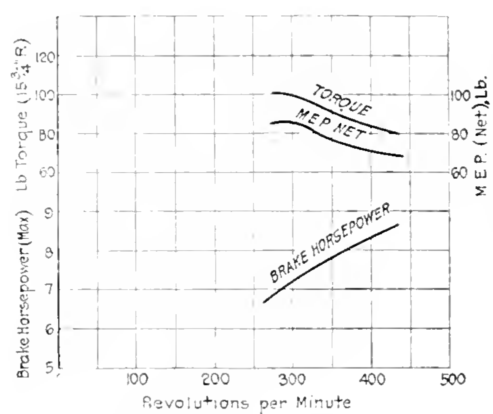


FIG. 6 BRAKE-HORSEPOWER AND TORQUE CURVES FOR A $5\frac{3}{4} \times$ 9-IN. SINGLE-CYLINDER HVID ENGINE

Items 1 and 2 are determined directly from dynamometer reading; items 3 and 4 are calculated from observed temperatures and weights; item 5 is determined by difference; and item 6 is obtained from direct measurements. The heat value of the fuel expressed in B.t.u. per lb. of kerosene is calculated from the following accepted formula: B.t.u. = 18,440 × 40 (deg. Baumé — 10) = 19,740 for the quality of fuel used in the test runs.

Torque. In Fig. 6 are shown some of the torque characteristics of the Hvid engine. When a gasoline engine of conventional design is overloaded so that the speed drops beyond a certain point its torque drops rapidly, because a certain velocity of air must be maintained through the carburetor to pick up and vaporize the fuel and carry it into the cylinder, but in a Hvid engine, since the introduction of fuel into the cup and into the cylinder is not dependent upon the velocity of the air taken in, as the speed drops, due to overload, more fuel is admitted than at normal speed, because the time element for the introduction of fuel is lengthened and the engine consequently shows remarkable "hanging on" characteristics.

Under these conditions it is very wasteful of fuel without a doubt, but there are certain conditions where this "bull dog" characteristi is desirable, even though it may be at the expense of fuel eco

on, the writer would say that while the Hvid engine s reached its ultimate state of development, it ssesses a number of wonderful characteristics which ract many internal-combustion engineers by the possi they hold out of helping to solve some of our fuel problems.

A New Type of Hydraulic-Turbine Runner

By FORREST NAGLER,[1] MILWAUKEE, WIS.

This paper is in the nature of a preliminary announcement describing the development of a new type of water-wheel runner which, on account of its greater speed and lower cost, is expected to largely supplant the well-known mixed-flow reaction (Francis) types of runners under low-head conditions. In order to provide a simple criterion of progress, but particularly to afford a more ready means of contrasting previous practice with the development described, the first part of the paper is devoted to an explanation of the term "characteristic speed" and its applications. This explanation, while in the nature of a repetition of much more extensive articles previously written, is thought to be desirable by reason of its peculiar adaptability to water-wheel analysis, and because it is not in as common use among engineers in general as it might be. A brief history of water-wheel development is likewise given, based on a consideration of characteristic speeds attained by successive types and during different periods of development. This history is brought up to date and includes the origin and development of the new type of runner. Finally a brief statement of the advantages and field of application of the new type is given, showing that by its use it is possible to build satisfactory machinery for heads down to one-half those previously found to be the limit, and for present head limits to go to over double the capacity of units previously used.

THE history of water-wheel development is practically covered by the developments of the last twenty or thirty years. This means that it has gone hand in hand with electrical development, which alone has made possible the utilization of large capacity units and high speeds. In the matter of speed, electrical-generator development has permitted of higher limits of r.p.m. than water-wheel designers have been able to reach under low- or medium-head and large-capacity conditions. On this account and because the limit of efficiency has long been so nearly reached, the greatest endeavors of runner designers have been directed toward increasing speed, and, as has been the case more or less with all lines of design, loyalty to precedent has largely interfered with any radical departures that might make for most rapid progress.

To permit of comparison between any two runners, or between the runners of any two periods of time, some common ground is necessary, some characteristic that can be expressed preferably in a single figure. Such a figure is available in what will be hereafter designated as *characteristic speed*. Because of its peculiar value in water-power work, though at the risk of repetition of more extensive articles already written, the original meaning and use of this term will be outlined briefly and explained by example.

To compare two water-wheel runners operating under different heads, developing different horsepowers, and running at different speeds, the first step would logically be to compute their power and speed performance under the same head. To do so, however, would leave varying horsepower, speed, and diameter, and so the second step would be one of the following:

A Recompute and compare their powers on the basis of their being so changed in dimensions as to have the same speed

B Recompute and compare their speeds on the basis of the same power.

Either method would give a positive indication of character expressed by a single figure. Basis *A* would give a *characteristic power* which serves to give the desired absolute basis of comparison, though on an exaggerated scale. This basis is used by Professor Zowski in *Engineering Record* of December 26, 1914, and as that article presents the most recently published data on high-speed runner development, comparisons given in the following paragraphs will be made on the same basis, making use of the same scales.

In general practice the speed comparison or *B* basis is made, and to make universal comparison possible the common head basis is taken as 1 ft. and the common power basis as 1 hp. Professor Zowski used a common speed of 50 r.p.m. in place of unity as that value is about the average unit speed of runners built for the Holyoke test and hence incurs the least recomputation or readjustment of mental conception as to size. The speed in r.p.m. resulting from such recomputation is the characteristic speed and is the characteristic which is used generally in hydraulic-turbine practice. This characteristic may be defined as follows:

> The characteristic speed of a runner is the speed in r.p.m which a model of that runner would have if operated under a head of 1 ft., this model to be reduced proportionally in all dimensions from the original until it will develop 1 hp. under 1 ft. head.

As an illustration of the universal application of the basis of comparison, Table 1 is given, which contains examples from actual installations; even figures, however, being used througbout. The final figure in each column is a direct indication of the character of the runner and comparison of these figures shows the relative speeds of the various types under any given condition of head and power. The universal application of this characteristic speed is evidenced by the fact that by its means the performance of any extremes of type may be compared. For example, an overshot wheel is shown to have about one-tenth the speed of the Fourneyron wheel, which was one of the types that superseded it. Similarly, modern wheels may attain from three to eight times the speed of the Fourneyron, and for that reason they have in turn displaced it.

TABLE 1 COMPARISON OF OLD- AND MODERN-TYPE HYDRAULIC TURBINES

Item	Old Types		Modern Types			
	Overshot Wheel	Fourneyron (Tremont) (Turbine)	Nagler: High Speed Low Head	Usual Mixed-Flow or Francis: Medium Speed	Usual Mixed-Flow or Francis: Low Speed Dbl. Run	Impulse (Pelton): Twin
Head in feet	14	14	14	200	400	2,000
Horsepower, total	50	180	500	40,000	20,000	20,000
Runner horsepower	50	180	500	40,000	10,000	10,000
Speed, r.p.m.	10	53	200	150	360	375
Runner diam., in.	144	40	72	130	72	96
Unit horsepower	0.95	3.44	9 55	14.14	1.25	0.11
Unit speed, r.p.m.	2.67	14.16	53.50	10.61	18	8.39
Characteristic diam., in.	148[1]	21.50	23.30	34 70	64.60	290
Characteristic speed, r p.m.	2 66	26.30	165	40	20	2.78

[1] Physically an impossibility under 1 ft. head as the diameter of an overshot wheel is fixed by the head and not by power or speed. Similarly the value of column 6, while not so positively a physical impossibility, is practically so.

To obtain the corresponding figure or characteristic speed in the metric system multiply by 4.46, which allows for the slight difference in metric horsepower and for head expressed in meters rather than in feet.

The last three columns of Table 1 are indicative of the field which exists for medium- or low-speed runners. They cover head conditions where mechanical features of strength, or hydraulic conditions governing wear, limit the desirability of attaining high speed. For example, for the conditions of column 4, higher speed is readily obtainable from the runner end and is very desirable from the standpoint of generator design. The medium-speed type of runner is used from considerations of life and strength of the runner, both of which would be decreased at higher speed according to the present state of the art. Similarly, the conditions of columns 5 and 6 are best met by low-speed types, the limiting feature

[1] Allis-Chalmers Manufacturing Company, Mem.Am.Soc.M.E.

Presented at the Annual Meeting, New York, December 2 to 5, 1919, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. The paper is here printed in abstract form. Copies of the complete paper may be obtained at a nominal price. All papers are subject to revision.

being generator speed, although runner design would readily permit higher limits. Hereafter in this paper comments on application will be confined to the high-speed, low-head type of runner, primarily applicable to heads under 100 ft.

Historical

Historically, the progress in hydraulic-turbine building may be excellently illustrated by noting the increases in characteristic speed that have been effected. The earliest types of water wheels were the current wheels of the flat-paddle type, used for irrigation, of which there are records antedating the Christian era.[1] These developed into the various forms of overshot, undershot, and breast wheels prevalent during the first half of the nineteenth century, very infrequently reaching a capacity of 100 hp. Their characteristic speed varied up to a maximum of possibly 3, and, as a consequence of their application to such small heads, their r.p.m. was very low, averaging probably under 20.

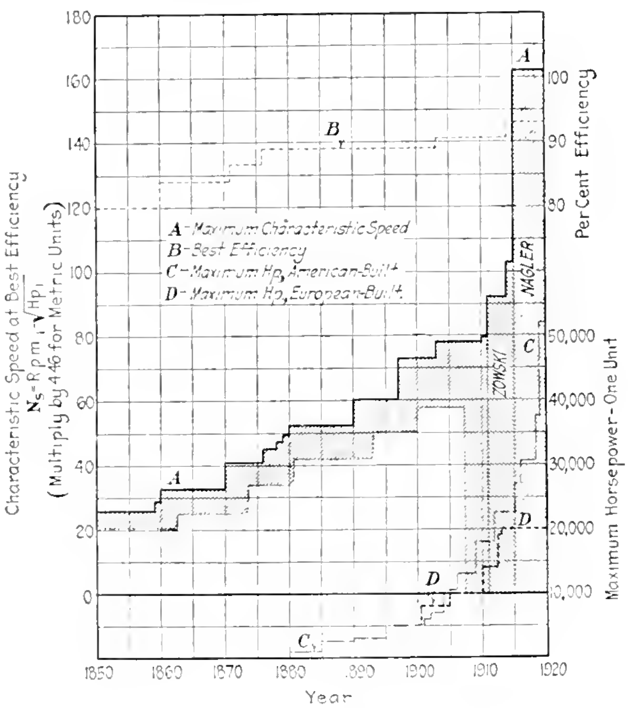


FIG. 1 GRAPHICAL REPRESENTATION OF THE DEVELOPMENT OF THE HYDRAULIC TURBINE

Lack of necessity for capacities beyond what could be absorbed by a millstone or saw and crudeness in power-transmitting machinery held capacities and speeds down to low limits. These limits began to be raised about 1825 and the turbine types of water wheel soon displaced their cumbersome predecessors. From about 1825 to 1840 two Frenchmen, Fourneyron and Jonval, developed two general types which were the forerunners of the turbine as it is known today. These are respectively the radial (outward)-flow and axial-flow types, and are still known by the names of their originators, both of whom, according to records, had exceptional knowledge of hydraulics. These types of wheels were developed both in Europe and America with efficiencies exceeding 80 per cent, but demands for speed and capacity were such as to limit specific speeds to between 20 and 40 and capacities to considerably under 1000 hp.

The next radical step is found in our present form of mixed-flow turbine, which resulted from successively increasing the capacity of the radial-inward-flow type of turbine until the buckets or vanes received the water radially and discharged it axially. This is the type of runner used for low-head work up to the present time, it being designated originally under various trade names such as Hercules, Sampson, Success, New American, and by the names of various designers. More generally it has been known as the reaction or Francis type, though strictly the latter name may not be applied to the mixed-flow runner as appropriately as to the pure radial-inward-flow type which Francis brought to a high state of perfection around 1870.

The mixed-flow runner which has been used in developing probably well over 90 per cent of all the water power produced in the world from medium to low heads has had most of its development and reached its highest state of perfection in America. This statement is based on the fact that record performances in size, efficiency, capacity, and head of hydraulic turbines have been made and held in America throughout the greater part of the period covering modern turbine development.

Fig. 1 has been prepared to illustrate graphically the history of hydraulic-turbine development as outlined above. These curves embody the most authentic data available and, while there may be particular points not entered or not enveloped by the lines shown, their form would be affected to a negligible extent by their inclusion. Curve *B* illustrates the extent to which practical limits of efficiency have been reached. That most rapid progress has dated from the nineties is very strikingly brought out by curve *A* of characteristic speed and curve *C* of turbine capacity. Both of these criteria of improvement go hand in hand with electrical development. Curve *A* further indicates that characteristic speed was advancing by only moderate amounts, although its improvement had been steady for a considerable period. It is this curve which points out the radical nature of the increases effected by the new type of runner forming the subject-matter of this article, its characteristic speed exceeding previous records by over 50 per cent at the outset. The increases made by Zowski in 1911 and in 1914 when characteristic speeds of approximately 90 and 102, respectively, were attained, were the subject of the most widespread comment among engineers and were the basis of great advance in the design of low-head, direct-connected units.

Since the speed of a runner is directly proportional to its characteristic speed, inspection of Curve *A* will indicate that under any given conditions this new type of runner will permit of speeds over 50 per cent in excess of those possible heretofore. The effect of such an increase will be instantly apparent to any one who is familiar with the extensive efforts made to increase electrical gen-

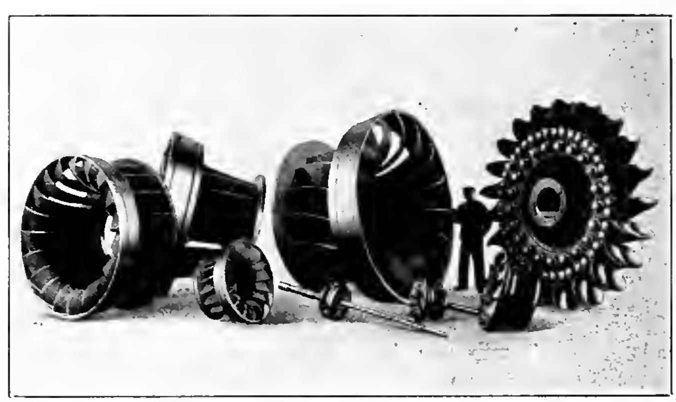


FIG. 2 TYPICAL GROUP OF MODERN MIXED-FLOW, REACTION (FRANCIS) RUNNERS CONTRASTED TO IMPULSE-TYPE WHEEL SHOWN ON THE RIGHT

These two types are the basis of practically all hydraulic-turbine development since about 1900, with the exception of the type of runner forming the subject-matter of the paper. Characteristic speeds are about 3 for the impulse wheel and from 25 to 95 for the reaction wheels.

erator s[illegible] hydroelectric plants by means of belts, gears, the multip[illegible] of twin, quadruplex, and even octuplex turbines, etc. [illegible] complication, loss of power, and departure from [illegible]ch devices are fundamental disadvantages that on[illegible] ll correct and this elimination has heretofore been [illegible]e sacrifice of speed. The generator builder [illegible]ys for the unit and the plant to house it are [illegible] most concerned, the former with design diffi- [illegible] latter [illegible]th increased cost, and both with lower efficiency. [illegible] at Keokuk is a striking illustration of this feature, direct [illegible]ion and large capacity being obtained only by using speeds

---

[1] Roman and Chinese particularly.

between 50 and 60 revolutions per minute as contrasted to the 90 or 100 readily obtainable with the new type of development.

Development of the New Runner Type

In 1907 and 1908 the author was connected with some rather extensive field work, comprising erecting, experimentally improving and testing of some large-size axial-flow or screw pumps. This work concentrated all attention on a single type of hydraulic impeller for over a year, and it was only natural that impressions then formed should greatly influence his trend of thought in later work, which has been exclusively along hydraulic-turbine lines. At any event the effect was such that the accepted form of reaction (Francis) runner, illustrated typically in Fig. 2, then and still the basis of practically all low-head turbine design, seemed unnecessarily complicated and without logical justification from any hydraulic or mechanical standpoint. These ideas crystallized in 1913 when definite application of the axial-flow principle was shown as giving inherently less wetted surface, simpler passages and greater mechanical strength than the corresponding reaction runner having radial inlet and axial discharge.

To bring out the comparison most effectively the initial drawings showed the axial-flow runner sketched in on the outline of the reaction runner, using the same runner band and showing the additional advantage of being able to use either the usual radial inlet guide case or the straight axial case. Most, but not all, of subsequent commercial applications have been along the former lines, but, undoubtedly, the still greater simplicity effected by the latter, especially in horizontal settings, will bring it into prominence. Models were made with the least possible delay and theories checked

Fig. 3 One of the First Commercial Applications of the New "Suction" Type of Runner Designed in 1916[1]

[1] Two units were constructed for a rating of 100 hp., 8 ft. head, 225 r.p.m. At the left is shown a high-head Francis wheel having about one-eighth the characteristic speed of the new type of runner, the characteristic speed of the former being about 20.

out practically with actual runners. New lines of improvement naturally became evident during trials, but the original profiles were left fundamentally intact, with the result that the form of turbine runner shown in Fig. 3 was developed. Inspection of this figure reveals the fact that the entire design is based on a straight radial blade, which offers the absolute minimum of wetted surface and of bending moment on the root of the blade. It is by reason of these two fundamental advantages emphasized by the simplicity and inexpensiveness of the design that the author believes the new type of runner will supersede the mixed-flow or Francis type. Runners of practically the axial-flow type, but roughly conical in profile, may possess certain desirable features of strength or form of passage, but the measure of their advantage is largely indicated by the nearness with which they are found to approach the flat form.

Commercial installations of any considerable size were naturally approached with the greatest care, as it was difficult to anticipate what effects there might be due to the critical state of water resulting from the high velocities used. The initial small plants designed in 1916 operated without any difficulties with regulation such as might have been expected, nor did commercial operation show any noticeable difference from previous types.

Tests on models were verified by Holyoke tests in 1917, the initial design being used partly for commercial reasons and partly for historical purposes. Only one design of blade was tested, although two runners, one having three and the other four blades, were also given runs. A typical set of results of these initial tests will be found in Table 2 of the complete paper, and although they do not equal in efficiency later tests obtained on improved runners, the figures were nevertheless used in plotting some of the curves in Figs. 4 and 5. Comparisons are confined to speed and capacity

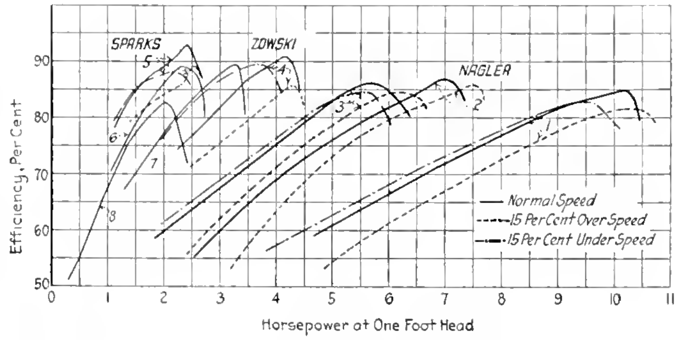


Fig. 4 Power-Efficiency Curves for Wheels Having a Normal Speed of 50 r.p.m.

for the purpose of this description and previous best results are accordingly also plotted in Figs. 4 and 5. The basis of these curves is taken directly from Professor Zowski's comparisons in *Engineering Record* of December 26, 1914, and it should be noted that they are plotted to show comparative powers on the basis of constant speed as outlined previously herein, although a common basis of 50 r.p.m rather than unity is used. This power basis exaggerates the comparison considerably over the characteristic-speed basis, but is retained to permit of direct reproduction of curves showing results typical of the state of runner development prior to the author's work.

Fig. 5 is a reproduction of the "equal efficiency" diagram of the December 26, 1914, *Engineering Record* article. The scale has been extended to permit of showing the relative location of the new point of best efficiency and the great flexibility inherent in the new form of runner. The diagram of runner No. 3 is shown at the right on repeated abscissæ in order to avoid too much overlap of diagram and consequent confusion. The ordinates remain the same. The shape of the "efficiency hills" is somewhat different from that of the mixed-flow runner, although perhaps not as much so as might be expected from the great difference in runner forms. That the guide cases (gates) were of the same design for both forms may be somewhat responsible for the runner not showing greater diversity in characteristics.

Fig. 5 presents an excellent basis for showing the contrasting speed characteristics of runners. Obviously their having been recomputed to 50 r.p.m. causes all the highest efficiency areas to lie on the same vertical line. This simplifies comparison in that the horizontal width of the equal-efficiency areas indicates flexibility of the runner or its ability to maintain good efficiency under varying speed or head, the latter being the variation encountered in commercial application. The position of the highest efficiency area on the vertical ordinate indicates whether it is of a high-capacity or low-capacity type or similarly whether it is a high- or low-speed runner. Its suitability for low-head work is determined largely by its vertical position.

Commercial Advantages

Up to date seventeen commercial runners of this type, varying from 80 to nearly 1000 hp. in capacity, have been built or are building for a total of nine plants. Nine of these have been tested out thoroughly in place with an actual showing of characteristic speeds often over 200 (in the metric system 900) under abnormal low-head conditions when synchronous speed was maintained during high water.

Numerous and sometimes unexpected advantages have been found to result from the simple and open form of runner. For example, a runner may be taken out and another substituted for

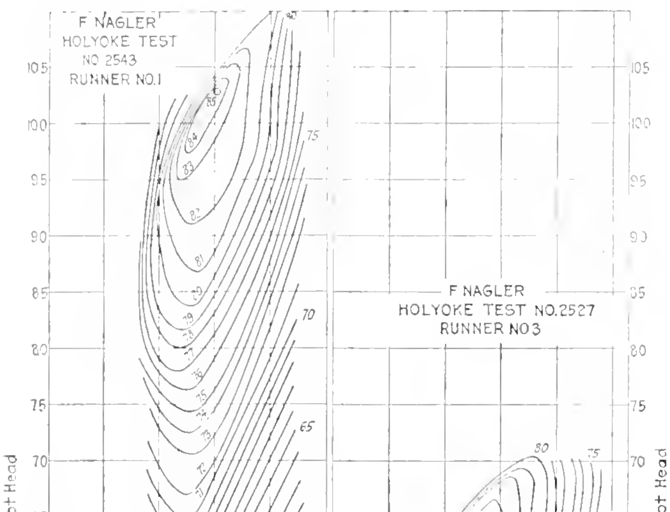


Fig. 5 Comparison of the Zowski and Nagler Tests

capacity variation under flood conditions or for test purposes without removing any other turbine parts except two or three guide vanes. In two plants this was made use of to install a high-capacity runner for obtaining more power during flood periods. Likewise these higher-capacity runners were made by using the original core boxes, which means that blade angles were unchanged, the result being accomplished simply by using a different number.

The greatest mechanical advantage arises from the fact that the runner cannot clog up with sticks, blocks, leaves, or other debris, a feature which the author's experience with the average low-head installation would indicate should result in several per cent more power the year around.

The primary advantages which were anticipated and which have proven out in practice are as follows:

a Lower generator cost due to an increased speed of 50 per cent and over above previous practice. This saving varies from 15 to 35 per cent of the generator cost, depending on its size and speed

b Lower turbine cost due to simpler runner. This averages around 10 per cent, the runner being about one-third the weight of the corresponding mixed-flow type and much easier to build, either solid or with separate blades

c Smaller generator diameter, which in turn means a smaller power house

d Higher generator efficiency due to better design possible with the higher speed. This is seldom less than 2 per cent gain and may conservatively be stated to vary from $1\frac{1}{2}$ to 3 per cent

e Greater turbine flexibility, which permits the plant to give more power under flood conditions when the head is greatly reduced. This runner has an overspeed of about 100 per cent as contrasted to perhaps 60 to 75 per cent for previous types. This means that its efficiency and consequently its power will not become zero until the head has been reduced to about one-quarter normal as contrasted to four-tenths or one-third normal for reaction types. This advantage lies not solely at the extreme limit of minimum head, but at all abnormal heads or speeds, as the efficiency is less affected than with the other types. (See Fig. 4, showing abnormal-speed curves.)

At the present time efficiencies equaling the records of reaction (Francis) wheels have not been reached, but they are being approached rapidly and with the inherent advantage of better generator efficiency, equivalent combined results for the unit are only a matter of short time. Fundamentally the axial-flow runner should give greater efficiency than the mixed-flow purely from considerations of wetted surface and hydraulic friction, to say nothing of the simpler form permitting of greater accuracy of construction and more correct design.

Type of Runner

As to the nature of this new type of runner, it may be said that from direction of flow it is undoubtedly a pure Jonval type, although his runner consisted of a narrow row of blades on the periphery of a comparatively large disk, and his characteristic speeds seldom exceeded 20 or 30 as contrasted to the present 100 to 200. Furthermore the Jonval type was a pure reaction wheel, which infers jets issuing from orifices or channels, these being noticeably lacking in the runners of Fig. 3.

Professor Baudisch in some of his mathematical studies on the design of high-speed axial-flow runners has introduced a type name which translated literally is "suction jet," the conclusions from his calculations being that in order to produce extraordinarily high characteristic speed it is essential to run into certain underpressure conditions such as result when velocities greater than $\sqrt{2gH}$ are produced in the throat of a diffusing nozzle discharging under a head of H feet. The term "suction turbine" impresses the writer as being quite appropriate, but from another reason which may be outlined as follows: Underpressure is not essential to high characteristic speed, though it may frequently occur. The primary essential to high characteristic speed (125 to 200) is a reduction of hydraulic friction and harmful centrifugal forces. Neglecting friction and possibly blade thickness, there are no mathematical or hydraulic laws that will prevent doubling or quadrupling any particular characteristic speed by simply flattening the blade angles. A direct analogy to this is the well-known illustration of relative velocities evidenced in the sail of an ice boat. The practical effect of so doing with a given profile is to lengthen the blade so that the friction on the increased wetted surface reduces efficiency and speed or results in constriction of passage. In the author's design these effects are counteracted by cutting out blades, the effect of which is not manifested in the reduction of power that might be expected. On the contrary the discharge is increased *without* reduction of efficiency.

Investigation of thrust and power shows that the force on each

blade exceeds the product of blade area and the total apparent head, which can only mean that in such cases there is less than atmospheric pressure on the back side of the blade aside from that due to draft head. This is strictly analogous to the distribution of the total force on the wings of an airplane, less than half of which is pressure from below, the remainder being suction on the upper surface. As such suction action is in evidence primarily with these high speeds, the author believes the term "suction" to be peculiarly applicable to this form of turbine runner.

It may be of interest to engineers who have studied runners to note the high coefficients obtained with this type of design. At normal speed the runner has a peripheral coefficient ranging as high at 2.00 as contrasted to the usual 80 to 85 per cent. Similarly at runaway speed the peripheral coefficient is around 4.00 or a speed four times as fast as the full spouting velocity ($\sqrt{2gH}$) of the driving water. At Holyoke it was very unexpectedly necessary to remove the brake pulley in order to safely measure runaway speed. This high limit is quite at variance with the usual trend of decreasing runaway speed as the characteristic speed increases. The lowest-speed runners or the impulse type have the high overspeed of about 100 per cent, a result which reaction (Francis) runners approach less and less closely as their characteristic speed increases from 10 to 100.

It is difficult in practice to secure these high characteristic speeds

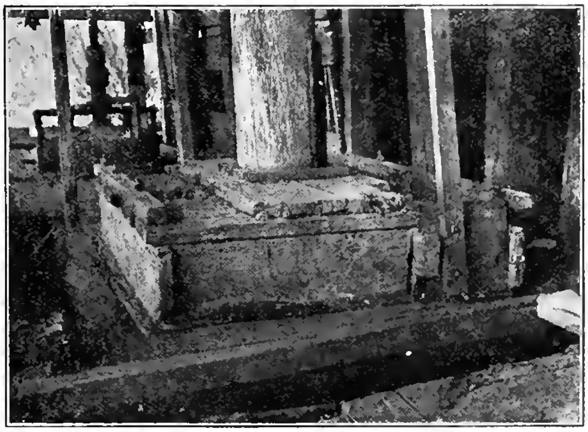


Fig. 6 An Early Type of Turbine

without correspondingly high velocities of the water at the runner discharge. Such high exit velocities running from $0.50 \times \sqrt{2gH}$ up to $0.80 \sqrt{2gH}$ would incur tremendous efficiency losses were no draft tube or diffuser used. On low heads and large capacities a long, straight tube is usually uncommercial on account of the excessive excavation involved and some form of a radial-outward-flow type is practically necessary. White's "Hydraucone Regainer" is the most perfect commercial solution of this diffuser problem yet found for general conditions, and practically all of the installations using the author's runner have been furnished with this hydraucone built either of steel or concrete.

Conclusions

In conclusion it is probably well to outline a few of the possibilities resulting from the development of this runner. In pointing these out it is realized fully that such features as the limit of application to higher heads and possibilities of pitting can only be determined by practice.

In low-head plants where all large power is to be developed it is desirable to use units as large as are feasible. Practical limits, however, are set by generator speed and by size of parts which may cause difficulties in manufacturing, transportation, or in placing these out it is realized fully that such features as the limit of limit is raised by the new design in that for any given generator speed more than double the power can be developed per unit than with the mixed-flow types of reaction wheel.

More general though equally significant illustrations of the extent to which the new type of runner may increase possibilities of hydroelectric development are afforded by the consideration of the following: With any given limit of minimum generator speed and for any given power, the new type of runner will permit turbines to operate under heads one-half as high as those required by the mixed-flow (Francis) runners of prior practice. Similarly, for large powers such units can be developed with low runner cost and without transportation difficulties. As an illustration, this design is the basis of some contemplated units of 800 hp. each under 9 ft.

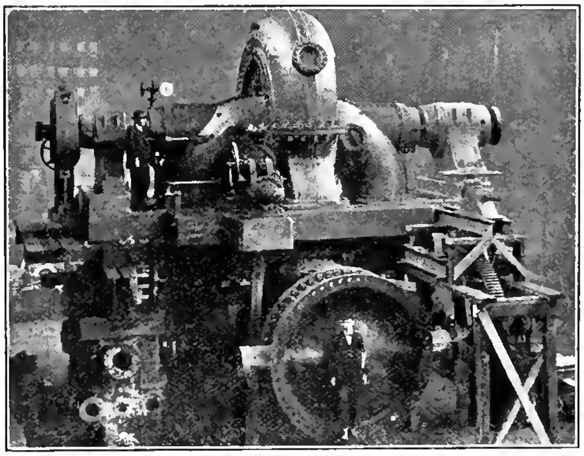


Fig. 7 A 25,000-Hp. Double-Discharge Type of Steel Spiral-Cased Francis Turbine Operating Under a Head of 485 Ft.

head at 90 r.p.m., a design which, it may be said, incidentally eliminates all gates on the turbine and effects all regulation from gates which form part of the power house on the discharge side of the turbine.

Probably the most novel application is to horizontal plants where it is necessary to replace old turbines but desirable to retain the electrical equipment. This has been done practically, a single high-speed runner replacing an old quadruple turbine and giving the same speed and more power with the same head.

Applying an axial-flow guide case with two 45-deg. bends in the draft tube gives as simple flow as possible with any arrangement and contrasts very favorably with the four 90-deg. bends given to the water with a radial-guide-case setting of a horizontal unit. This arrangement and, when floods are prevalent, the single vertical setting using a hydraucone regainer are probably the most advantageous forms of hydraulic-turbine settings that can be devised.

To a generation of engineers whose practical connection with water power has been based almost exclusively on the use of one type of turbine the author's statements as to the short period of time covering real progress may seem somewhat overdrawn. However, one need only look back a comparatively short time to perceive that modern water wheels are young compared to other forms of prime movers. This was never brought to the author's attention more forcefully than by consideration of the views shown in Figs. 6 and 7. The former is reproduced from a photograph presented to the author by William G. Fargo, of Jackson, Mich., and shows a single vertical open-flume turbine having about an 18-in. *wooden* shaft, which was squared at its lower end to receive the four flat paddles forming the runner. Water was admitted through crude "rabbit trap" gates diagonally opposite each other. This wheel was in operation under about 9 ft. head driving a millstone up to a very few years ago, less than fifteen if memory serves correctly. Fig. 7 shows one of the most extreme types using a mixed-flow reaction or Francis runner. This turbine, if not actually in operation at the same time as that shown in Fig. 6, missed being so by but a very few years. That two such extremes so nearly overlap in period of time is the best evidence the author can offer to the effect that the field of hydraulic-turbine design still offers tremendous opportunities for improvement.

Air Pumps for Condensing Equipment

By FRANK R. WHEELER,[1] CHICAGO, ILL.

This paper is devoted to a consideration of past and current practice in air-pump design and selection. After presenting a classification of air pumps the author proceeds to describe briefly the features of each type, stating their limitations and respective advantages and disadvantages. Special attention is given to the steam-jet ejector type of pump, whose advantages are stated to be: extreme simplicity, reliability and flexibility, stability, minimum space and weight, low steam consumption and high efficiency; and furthermore that it requires no maintenance or attention. The author concludes his paper by discussing the selection of an air pump of proper size and capacity for a given condenser installation, and accompanying this discussion are illustrative calculations with references to charts.

THE past few years have brought about decided changes in three component parts of a steam power plant: (*a*) The steam turbine has replaced prime movers of the reciprocating type; (*b*) mechanical stokers of fuel have increased boiler efficiency and ratings; (*c*) improved condensing equipment is now used which will maintain vacua of 29.5 in. referred to a 30-in. barometer under operating conditions and with proper water temperatures. The improvement in condensing equipment is primarily due to the better designs of air pumps adopted and to the radical changes and innovations that have been introduced since 1914, and the following review, dealing with past and current practice in air-pump design and selection, is submitted in the hope that it will prove of interest.

Air pumps may be classified as follows:

- Displacement
  - Wet-vacuum pumps, handling liquid and vapor
    - Simple, 3-valve decks
    - Edwards
    - Rotrex
    - Mullan
  - Dry-vacuum pumps
    - Simple
    - Two-stage
- Impulse
  - Rotary
    - Leblanc
    - A.E.G.
    - Roturbo
    - Thyssen
    - Weir
  - Ejectors
    - Water
      - Koerting
      - Kinetic
      - Müller
      - Radojet
    - Steam
      - Evacter
      - Leblanc
      - Briguet
      - Occluder

As most of these types are well known to engineers, but little attention will be given to the older designs.

Displacement Pumps

Wet-Vacuum Pumps. "Wet"-air pumps have proven their merit for more purposes and duties than is often realized, and are still excellent pumps for units up to 1500 kw. For larger units, however, it is necessary that the rotative speed be reduced, in which event they become both cumbersome and expensive and take up a large amount of space. The volumetric efficiency of these pumps varies from 60 per cent at 3 in. partial air pressure to 18 per cent at 0.5 in. partial air pressure, and since they handle both the water of condensation and vapors, at high vacuum the partial air pressure soon becomes very low unless the condensate is refrigerated by flooding the lower banks of tubes in a surface condenser.

Dry-Vacuum Pumps. The next development was the separating of the handling of condensate and vapors, introducing what is commonly known as the "dry-air" pump. Wet-vacuum pumps of the type previously described were first used with a small quantity of water admitted for sealing purposes, a separate pump being provided to remove the condensate. Later the dry-vacuum pump made with small clearances and handling air only appeared, and this type has the same general advantages as the "wet" pumps, but with better volumetric efficiencies. With improvements like flash ports, introduced by Wellner, to momentarily connect the clearance space at the end of the compression stroke with the vacuum side of the piston, both suction and discharge valves being closed, and using two-stage pumps with double and single cylinders, this type has held its own in the demands for high vacuum and increased sizes. And, except for its complications, the number of moving parts, maintenance, size, space requirements, etc., its use cannot be criticized.

The increase in the size of turbines coming into general use, however, together with the continuous demand for higher vacuum, called for dry air pumps of cumbersome size and excessive cost, and the solution of this problem seemed to point to an ejector air pump of some form, using water as the motive fluid.

Hydraulic-Entrainment Air Pumps

In 1862, Christian Schiels, of Oldham, England, invented a hydraulic-entrainment air pump which expelled the air from a condenser by combining or entraining it with hurling water in its passage through a fan or centrifugal pump. The necessary water pressure was provided by means of a high-speed rotary device and this, together with the relatively small space required and ability to maintain a high vacuum, offered such desirable features that, when the demand had exceeded the limitations of the dry-air pump, development came very rapidly. These pumps took two general forms: In one the air is entrained in the same chamber containing the rotating element. In the other the entrainment or compression of the air is performed in a part of the apparatus entirely separate from that producing the pressure of the hurling or entraining water. These pumps follow the simple ejector principle, using single or multiple jets of water, discharging into a combining cone or diffuser and entraining the air due to the high velocity of the water jets. Under favorable conditions this type will be found satisfactory, its limitations being the amount of water that must be pumped and the necessity of keeping the nozzles thoroughly clean; for the pump must have water, and as it has very definite limitations in its air-handling capacity, it becomes very unstable when called upon to handle air in excess of the designed quantity.

These water ejectors are occasionally used in series with some form of a steam jet which acts as a booster, and they usually take their water supply from a small centrifugal pump connected in parallel with the circulating system.

The hydraulic-entrainment type of pump has given complete satisfaction in performing the function demanded of an air pump, i.e., removing air and vapors from the condensing chamber and maintaining as low pressure as is consistent with circulating-water temperatures. But against the many advantages and satisfactory performances must be balanced the disadvantages. Hydraulic air pumps, using water as their working medium, are subject to erosion, and on account of the necessarily small passages, or sharp edges of vanes, presented to the water, must have clear, clean water or the falling off in capacity and efficiency is very rapid. In

[1] Dist. Mgr. C. H. Wheeler Mfg. Co.

Presented at the Annual Meeting, New York, December 1919, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. The paper is here printed in abstract form. Copies of the complete paper may be obtained at a nominal price. All papers are subject to revision.

most cases these essential requirements necessitate a tank for the hurling water, screens, and incidental attention thereto. And on account of the simplicity of the apparatus when compared with the rotary dry-vacuum pump, the admitted high power consumption has been accepted as a necessary evil and provision made to equalize the heat balance by providing electric drive for other auxiliaries.

Steam-Jet Ejector Air Pumps

The ejector principle is an old one, the use of steam as a medium and applied as a vacuum pump having been patented in England in 1868, but for high-vacuum service the ejector pump has not been in general commercial use in this country until the last three years. It is now, however, a definite engineering and commercial success, one manufacturer having actually delivered ejector pumps to serve over 4,000,000 hp. of prime movers.

Before outlining the development of the ejector air pump, the reason for its adoption may be considered by reviewing the advantages claimed for it, namely,

a Extreme simplicity
b No maintenance or attention
c Reliability and flexibility
d Stability
e Minimum space and weight
f Low-steam consumption, high efficiency.

The first advantage enumerated, while the most important, may be passed over as obvious. The second advantage results from the fact that there are no moving parts to wear out; and, because there are no moving parts to oil or adjust, the only attention required is that of opening and closing the valves controlling the pump.

The third advantage claimed is one that will carry the most weight with engineers in charge of power production, because with them continuity of service is of first importance. As is well known and shown later, the air leakage varies greatly and provision must be made for leakages largely in excess of those expected with good operation. With other types of air pumps than those being considered, particularly rotary dry-vacuum pumps, it is usual to provide a pump large enough for maximum requirements and operate at reduced speed or displacement. This has the serious objection of making the entire unit dependent on a single-air pump operating inefficiently. With ejector-type pumps, on account of their small size, weight and space requirements (no foundations being required), the total estimated air-removal capacity can be provided by two or more units, one or more of which can be operated as required, thereby providing maximum efficiency and insurance against shutdown. And the size of units can be so selected that one only is sufficient with a tight condensing system. Another desirable feature is that the necessity of using a second pump is an indication that unusual air leaks exist, and a third advantage is the maximum steam economy resulting from only as many pumps being used as are actually required. The adoption of ejector air pumps by the navies of the United States and France, and the United States Emergency Fleet Corporation supports this claim.

The fifth claim is clearly demonstrated by the following comparative figures for weight and floor space required by three types of pumps for use with a 7500-kw. surface condenser:

Type of pipe	Floor Space	Weight, lb.
Rotary dry vacuum	10 ft. × 22 ft.	31 000
Hydraulic	5 ft. × 10 ft.	6,300
Ejector	1 ft. × 1 ft.	450

As a general rule, for plants of ordinary size (excluding units of 20,000 kw. and over, where better results are obtainable) it may be said that with ejectors without intercondensers less than 1 per cent of the total steam consumption is required for surface condensers, and from 2½ to 3 per cent for jet condensers; for intercondenser ejectors the percentages are approximately one-half these values.

One of the early developments of the ejector using steam jets in series for high vacuum was by Leblanc for his refrigeration system. He was able to obtain an absolute pressure of 0.05 in. Hg, and later applied his design to air pumps for condensers with marked success. The general design is shown in Fig. 1.

This ejector has a single nozzle in the first stage which entrains the air and compresses it in the diffuser, from which it is discharged into a mixing chamber where it comes in contact with the steam from a large number of nozzles of the second stage, the steam and air from the first stage being entrained and compressed to atmospheric or discharge pressure in the second diffuser.

It is well known that ordinary single-stage ejectors work best and are most stable when the compression ratio is approximately one to seven, and it is for this reason that two stages are always employed in steam-ejector air pumps. The ratios of compression in the two stages should be kept as nearly equal as possible, although for maximum economy over varying loads it is found in practice that the best results will be obtained by making the ratio

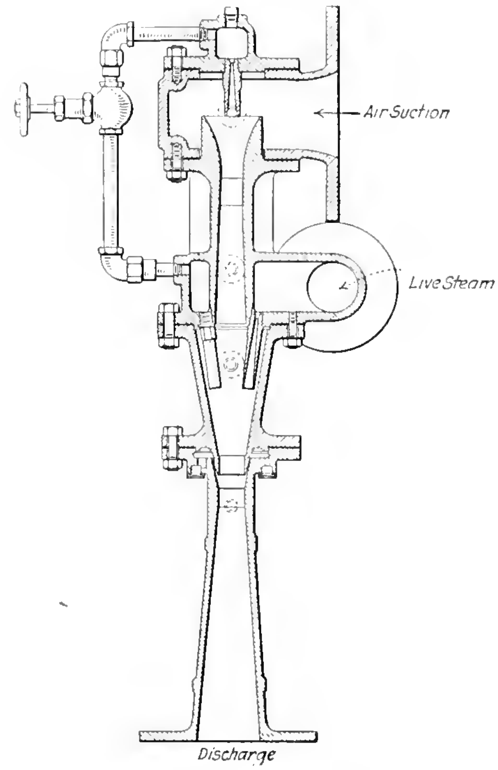


Fig. 1 Sectional View of Leblanc Ejector

of compression in the first stage equal to or greater than that in the second stage.

As has been mentioned before, hydraulic air pumps operate almost entirely by use of the kinetic energy of the motive fluid. The entrained water vapor, carried over with the air, condenses on coming in contact with the water and uncondensable vapors are entrained, either between sheets of, or with small globules, of water and compressed by kinetic energy in the diffuser.

The action in a steam ejector is somewhat different, where there is a fluid to be compressed, moving at a very low velocity, which must be acted upon by steam issuing from nozzles at velocities varying from about 3000 to 3500 ft. per sec. It is quite evident, then, that the operating steam must entrain the air by friction, and also that a maximum entraining surface of the operating steam is of prime importance.

This means that either a number of small cylindrical nozzles must be used, or some special form of nozzle be substituted to give a greater superficial area per unit of steam used. This is of most importance in the second stage, where 70 per cent or more of the steam is used, and may be accomplished in any one of three ways. The first method, that of using a large number of small

nozzles, is objectionable, on account of the difficulty of obtaining effective entrainment with the nozzles in the center of the group. And where the nozzles are placed concentrically or surrounding the first stage diffuser, only half of the exposed steam area is effective.

In the second method a concentric steam nozzle is employed. This nozzle is sensitive to pressure fluctuations and exposes only a small portion of its superficial steam area to contact with the air.

In the third method, using a single steam nozzle in which an adjustable nozzle point spreads out the jet and causes it to flow radially as a thin sheet of steam, the air is entrained on both sides of the sheet and compressed in a radial diffuser surrounding the nozzle. This is the general form of the Radojet air pump illustrated in Fig. 2.

Referring to Fig. 2, steam is admitted from the boiler to the strainer cage A, a part being passed through the pipe B and strainer S to the first-stage nozzle chamber C. The steam expands in the nozzles D and passes across the suction chamber E at a velocity of approximately 3000 ft. per sec., entrains the air and the vapors from the condenser and compresses them in the diffuser F to a higher absolute pressure. The mixture of steam and entrained vapors passes into a double passage G so arranged as to come into contact with both sides of the sheet of steam, and issues radially from the second-stage nozzle. Steam is simultaneously delivered through strainer S_1 and nozzle throat H to contact with the nozzle point J, which spreads the steam radially into a thin sheet of steam issuing at a high velocity and passing across the mixing chamber G, entraining the commingled air and steam (or the air only, where an intercondenser is used) and carrying them into the annular diffuser K, where the mixture is compressed to atmospheric or discharge pressure and then discharged through the volute and opening L.

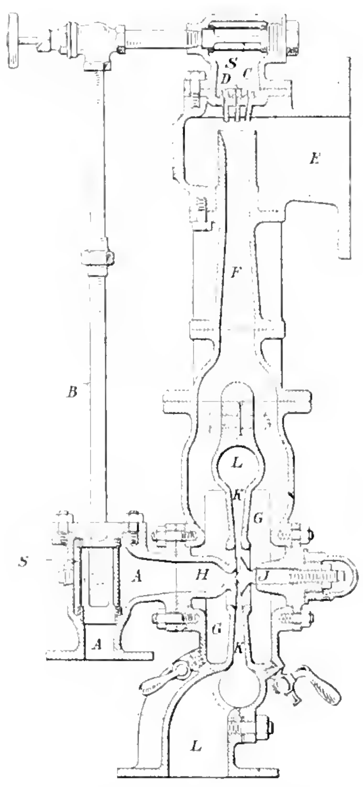


FIG. 2 SECTIONAL VIEW OF RADOJET AIR PUMP

From 70 to 90 per cent of the total steam used passes through the second-stage nozzle. The thin sheet of steam issuing radially from the adjustable nozzle point J, by having both sides of the sheet in contact with the air to be entrained, exposes the maximum surface possible for entrainment and secures for this design the highest efficiency and economy. The nozzle point J being adjustable, permits of varying the cross-section of the nozzle passage and changing the expansion ratio of the steam. This is a factory adjustment and made to secure the maximum efficiency of each individual pump. The first-stage nozzles and both diffusers are made of bronze and the second-stage "Radojet" of special steel. The parts described show absolutely no wear or erosive effect in service.

Ejectors with and without intercondensers are now made by practically all of the condenser companies.

SELECTION OF AIR-PUMP CAPACITIES AND SIZES

The selection of air-pump capacities and sizes has always been shrouded with considerable mystery and the methods to employ should be given more publicity. Air is admitted to the condensing chamber in three ways:

a From leaks in the system, under vacuum

b From entrained air in the boiler feedwater carried over with the steam, and

c From entrained air in the injection water (in jet or barometric condensers only).

The size of air pumps to use with surface condensers, where only *a* and *b* in the preceding paragraph apply, will be considered first. The early air pumps were of the wet type, and textbooks and handbooks of not many years ago gave a rule that the displacement of the air pump should be a function of the low-pressure cylinder displacement. And on this basis, or on the proportions of a successful installation, most air-pump sizes were then selected. Later a rule making the displacement a function of the volume of condensed steam was very generally used and proved to be very satisfactory. This called for ratios of swept displacement of the air-pump cylinder to the volume of condensate of:

20: 1 for 26 in. vacuum	40: 1 for 28 in. vacuum
30: 1 for 27 in. vacuum	53: 1 for 29 in. vacuum

For rotary dry-vacuum pumps of good design the ratio of displacement to volume of condensate for 28 in. vacuum seldom exceeds 35 to 1.

The introduction of ejector pumps using water or steam required that some other method of selection be used. And the adoption of ejector- and entrainment-type air pumps and the general use of large units also called for a more accurate method of selection of sizes. For a number of years experiments and investigations have been made on the effect of air leakage on vacuum heat transfer, etc., all of which have indicated that the presence of only a small amount of air has a very detrimental effect. The relative coefficient of heat transfer as referred to steam was shown by Josse[1] to be 1 to 700. This caused the large operators to introduce periodic tests of their condensers for air leakage, which was accomplished by discharging the rotary dry-vacuum pump into a gasometer.

These periodic tests showed some unexpected results: That a 30,000-kw. unit need not necessarily have a greater air leakage than a 20,000-kw. unit, and that it was possible to keep air leakage to extremely low quantities, dependent on (*a*) the care exercised in installing the condensing equipment and (*b*) on the care in operation, or rather the willingness of the operating engineer to go after small leaks. That a system can be made practically airtight can be demonstrated by shutting down the air pump while the unit is under load, Fig. 3 showing results as reported on a 10,000-kw. unit at the Boston Elevated Station. Here a drop of only 0.30 in. Hg in 30 min. indicates that there was very little entrained air in the steam and practically no air leakage.

The purchaser of a condensing equipment insists that the manufacturer guarantee the vacuum, but with this inquiry, in which he specifies the amount of steam to be condensed, water temperature, etc., he neglects to state how much air he intends shall be allowed to leak into the system. And the writer contends that this is almost as important a factor as the quantity of steam. For this reason the condenser manufacturer is compelled to do a great deal of "educated guessing." We know that with the ordinary system,

[1] *Engineering* (London), vol. 85, 1908.

using open feedwater heaters, the amount of air mechanically entrained in the feedwater is reduced to 1 per cent or less. Orrok[1] showed reductions of entrained air from 4.325 per cent in raw water to 0.9319 per cent in the heater. The air quantity from this source is in direct proportion to the quantity of steam condensed. Leakage through glands, joints, connections, and the materials of which the condenser and the low-pressure stages of the turbines are made, is a function of its size and tightness. Assuming the same care in manufacture and makeup, then size also is a function of quantity of steam condensed and we may assume total air leakage as a factor of the quantity of steam condensed.

In arriving at our figures there are some very uncertain factors to be taken into consideration: Shall we assume the best operation possible, weekly tests for leaks, etc., or the operation of a shiftless attendant satisfied with a spring gage? Inasmuch as the manufacturer is interested in the prosperity of his customer, he assumes the former, and to be sure of his own guarantee, provides for the latter. It is generally known that under good operative conditions the speed of a rotative dry vacuum pump can be cut to one-half its rating, and that there are other times when the full capacity is needed. It is therefore excellent practice to supply air pumps of capacity in excess of the anticipated requirements.

Calculation of Dry-Air Leakage in Surface-Condensing Equipment

Based on a *tight system and first-class operation,* the amount of *dry*-air leakage to be expected with surface-condensing equipment is shown in Fig. 4. It should be noted that this is dry air and is less than the capacity to be provided by the air pump, because, in passing through the condenser this air becomes saturated and the air pump must remove with the air an amount of water vapor dependent on the pressure and temperature of the mixture.

It will also be noted that the air-leakage curves in the figure are indicated in pounds of air per hour. This is done because a pound of air is a definite thing — a cubic foot of air must be specified as to temperature and pressure to have a definite meaning. To those accustomed to thinking in terms of cubic feet the approximate

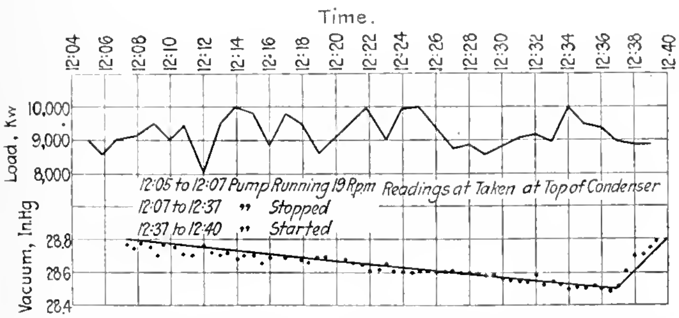


Fig. 3 Curves Showing Effect of Shutting Down the Air Pump While Unit is Under Load
(10,000 kw. unit at Boston Elevated Station)

relation of 4.5 lb. of air per hour to 1 cu. ft. of air per min. at 70 deg. fahr. and atmospheric pressure, will be of some assistance.

According to Dalton's Law, the total pressure in the condenser is the sum of the partial vapor pressure, corresponding to the temperature of the mixture, as taken from the steam tables, and the partial air pressure due to the air or other gas present in the condenser. The volume of the air is directly proportional to its absolute temperature and inversely proportional to its pressure; therefore, if the mixture of air and water vapor in a condenser is cooled, the total pressure, or vacuum, remaining the same, the vapor pressure is reduced and the partial air pressure increased, with corresponding changes in volume.

For example, 1 lb. of a mixture of air and water vapor at 80 deg. fahr, and 2 in. absolute pressure, as extracted from a condenser, would be composed of 0.595 lb. of air and 0.405 lb. of water vapor. Let this mixture be taken from a colder part of the condenser so that its temperature is reduced to 70 deg. fahr., and the relative weights will be changed to 0.724 lb. of air and 0.276 lb. of water vapor; or, to do the same effective work an air pump with a displacement only 0.595/0.724 or, approximately, four-fifths as large would be required. The problem may also be considered as the determination of the total weight of saturated mixture that must be removed from a condenser to extract 1 lb. of dry air, and Fig. 5 has accordingly been plotted to show the weight of water vapor that must be removed from a chamber containing saturated air and vapor to remove 1 lb. of dry air at different temperatures and pressures. These factors must be used in conjunction with Fig. 4.

For example, assume a 10,000-kw. surface condenser condensing

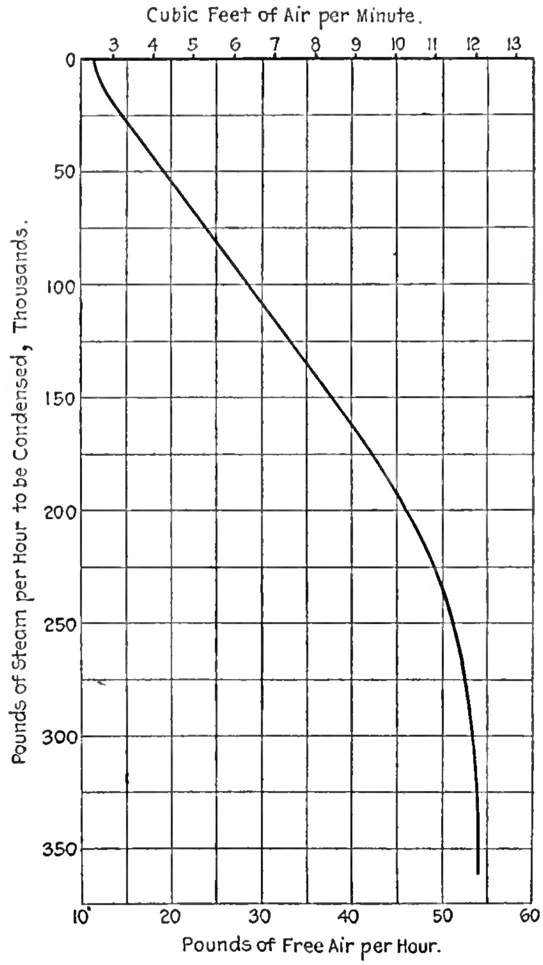


Fig. 4 Estimated Quantity of Air to be Removed from Surface Condenser with Tight System and Good Operation

140,000 lb. of steam per hour, with circulating water temperatures of 60 deg. in and 74 deg. out, a vacuum of 1.5 in. abs. being maintained.

From Fig. 4 it is seen that the expected dry-air leakage with a *tight system and with good operation* is 36 lb. per hour. Under these conditions and with good design the temperature of the mixture going into the air pump should not exceed a mean of the circulating-water temperatures, or 67 deg. with a vacuum of 1.5 in. abs., as Fig. 5 shows that in order to remove 1 lb. of air it is necessary to remove 0.5 lb. of water vapor. Therefore, the air pump must have a capacity of 1.5 x 36 or 54 lb. per hour of a mixture of air and vapor at a pressure of 1.5 in. abs. to take care of a leakage of 36 lb. of dry air. Now this capacity is selected on the assumption of *a tight system* and good operation, and does not provide for emergencies. The usual way to provide for emergencies, unusual operating conditions and excessive air leaks is to select a larger

[1] Trans.Am.Soc.M.E., 1912.

pump and operate at reduced capacities, but the better way by far is to select two pumps of minimum size as indicated from capacity curves. There are several good reasons for this: A spare pump is provided as an insurance against shutdown; maximum economy of power is obtained; and the necessity of the use of both pumps is an automatic indication of excessive air leakage. The steam ejector being so small and not requiring foundations, lends itself most admirably to this selection and can be used in two or as many more units as are desirable, to provide for fractional loads and maximum economy.

Selection of Air Pumps for Jet and Barometric Condensers

In selecting an air pump for a jet or barometric condenser, capacity must also be provided for the entrained air and gases which enter with the injection water and immediately expand to the pressure being maintained in the condenser. Here we have a very uncertain item, for cold water will hold more air than hot water, and water flowing over leaves and decayed vegetable matter absorbs CO_2. The air content will be different in the water of a spray pond or a still lake, or of a slow-moving river or a mountain stream, and will vary under ordinary conditions from 1 to 5 per cent by volume. The quantity of air admitted into the condensing system with the injection water is greatly in excess of that entering with the steam and air leaks, and a considerable quantity of air

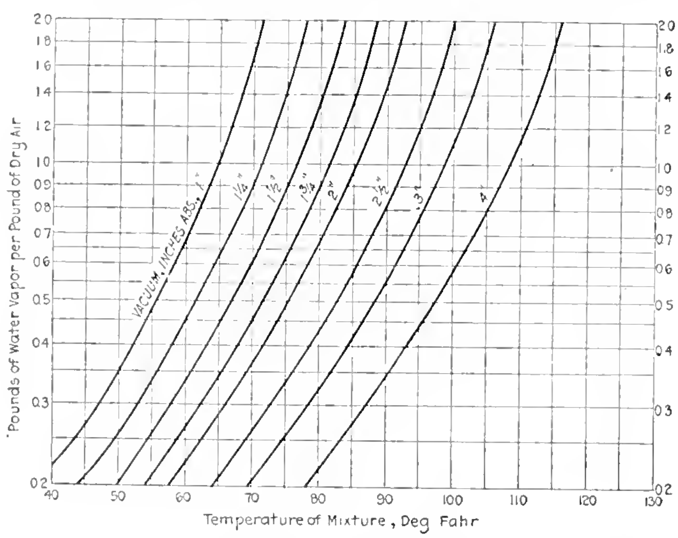


Fig. 5 Chart Showing Weight of Water Vapor That Must Be Removed from a Chamber Containing Wet Air and Vapor to Remove One Pound of Dry Air at Different Temperatures and Pressures

passes out of the system through the water-removal pump or down the tail pipe by entrainment. This latter quantity is sometimes as large as 40 per cent of the total and seldom less that 20 per cent. It is therefore assumed that the air admitted with steam and by leaks in the system passes off with the injection water, and air-pump capacity is provided only for the air entering with the injection water. Taking all these variations into consideration, *dry-air-removal* capacity for either a low-level jet or barometric condenser should be provided as shown in Fig. 6, using as before the factors from Fig. 5.

In this case it is advisable to select two or more pumps so that the total capacity is that obtained from the curve. The ejector pump lends itself to the best advantage in this selection and provides flexibility and economy when the air entrained in the injection water is not as great as anticipated.

To illustrate the selection of an air pump for a low-level jet condenser, assume a 7500-kw. unit condensing 110,000 lb. of steam per hour and maintaining a pressure of 2 in. abs. when supplied with 9000 gal. of injection water per min. at 70 deg. fahr. Fig. 6 shows that we can expect to remove 12 x 9 or 108 lb. of air per hour from the condenser. Assuming the mixture going to the air pump has a temperature of 75 deg., it is seen from Fig. 5 that with this temperature and a pressure of 2 in. abs., it is necessary to remove 0.49 lb. of water vapor in order to remove 1 lb. of air. Therefore, the air pump must have a displacement of 1.49 x 108, or approximately 160 lb. of mixture per hour at 2 in. abs. To provide this capacity in a single unit would require inefficient operation at partial loads, or when the air leakage and content in injection water is not as great as provided for. To use two or more units is also better practice, as then the entire equipment is not dependent on a single air pump.

Most steam-ejector air pumps have their nozzles designed for a fixed initial and back pressure, a pressure-regulating valve being installed in the steam supply line to automatically take care of boiler fluctuations. The maximum back pressure usually specified is 0.5 lb. gage, but this may be increased to a maximum of 3 lb. by increasing the initial steam pressure at some sacrifice in steam economy. Ordinarily, steam-ejector air pumps should be exhausted under water into a surge or feed tank so that the entire heat in the

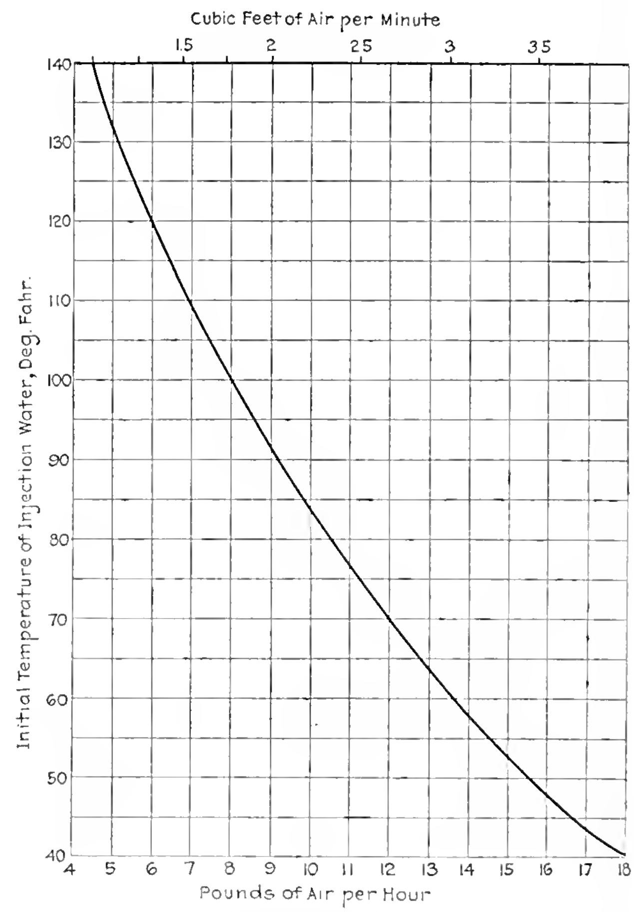


Fig. 6 Estimated Quantity of Air to be Removed from Jet or Barometric Condenser per 1000 Gal. per Min. of Injection Water

steam and air can be utilized, and the entrained air passed off through a vent. The exhaust can be into an open feedwater heater without detrimental effect, provided the heater is thoroughly vented, and also can be piped to any reasonable distance, provided pipe sizes are so selected as not to produce excessive back pressure. If the exhaust discharge is above the air-pump exhaust opening a manometer trap should be provided at the lowest point of the exhaust line, and of such length as to balance the predetermined back pressure. And a check valve should always be installed in the exhaust line from each ejector.

There is nothing to get out of order, to oil, or adjust about this type of pump, and if the screens and nozzles are inspected and cleaned occasionally the owner of a condenser equipped with steam air ejectors can be excused for exclaiming, "Why didn't some one think of this before?"

Appraisal and Valuation Methods

By DAVID H. RAY,[1] PASADENA, CAL.

This paper brings out the need of the engineer's entering the appraisal field in the full capacity which his training and experience warrant. He is likely to be more familiar with the cost and value of materials, machines and structures than the lawyer or accountant, who in the past have been the only ones considered competent to direct this work.

The author shows how the variables affecting values depend on labor, material and an aleatory factor to cover the general risk of the business, with particular reference to marketing. He also defines the terms used in appraisal work and points out the desirability of giving a value to a machine as a unit, of the grouping of similar tools, and of the use of symbols in the form of numbers and letters in tagging the materials to be appraised.

THAT appraisal and valuation work is fundamentally a matter of fair dealing and that, granted experienced technical ability and honest intent, a sensible method or procedure would produce rapid and accurate results, has long been the belief of the writer. This opinion was put to the test in recent work for the United States Government and the judgment confirmed that the difficulties of appraisal work are largely matters of honesty of purpose and of method, or, as the British call it, "procedure."

Method is born of time and consistent effort, and proven method slowly builds precedent into procedure. As in many other lines of effort, we may properly review, for a moment, European experience.

Britain, with her far-flung commercial and industrial interests, has developed methods which by custom and usage have arisen to the dignity of semi-legal and legalized procedure. The English and Scottish Law has come to provide for the certification of qualified appraisers and valuators. While the employment of such appraisers and valuators is not compulsory, a settlement out of court being entirely legal, yet should the matter come to court, the license, charter or qualification of the appraiser or valuator immediately comes into question. A qualified person may carry out appraisals or valuations without a license, but cannot enforce payment for services in the absence of private contract.

British Methods of Appraisal

The larger private appraisals of industrial plants are usually handled by firms of "chartered accountants," while the "compulsory appraisals," on complaint of a rate payer, are provided for by statutory law and by the appointment of an "official appraiser." Boards of trade have jurisdiction in matters of rates and tolls and follow the statutory procedure sanctioned by the British Parliament.

In effect, British procedure under the guidance of the lawyers and accountants has somewhat limited appraisal work to men of recognized integrity and of technical experience in values, defined the method and channel of action, and by usage and customs fixed to some extent the fees for such services. The British, therefore, have a class of professional appraisers, valuers or valuators; in America this function has, in considerable part, fallen to the lot of the engineer.

The engineer is likely to be more familiar with materials, machines, and structures and their cost and value than the lawyer or accountant, but is usually less accustomed to function in a systematic channel of procedure or to be interested in the reasons therefor. Commercial and business practice rather expects and requires this formality, with the result that the engineer usually finds himself serving subordinate to a lawyer or accountant. It is believed that this is neither necessary nor beneficial, and that an engineer might without professional detriment act in the full capacity.

The British system is rather weighted down with technicalities of a legal and an accounting character which are detrimental to rapid and equitable settlements. This appears to be due to the overpredominance of the lawyer and accountant in the development of the British procedure. Had the British engineering societies taken this matter in hand, as there is now the opportunity for the American national engineering societies to do, a simpler, more direct, rapid, and equitable type of procedure might, through custom, have come into use.

Accounting versus Engineering Methods in Appraisal Work

An illustration of the functioning of the legal type of mind and the accountant type of mind in appraisal work is shown in the photograph reproduced in Fig. 1, which pictures an appraisal in which nothing loose escaped being tagged. A spare screw the size of an anise seed was put in an envelope and two tags filled out in detail and attached; it was then inventoried and appraised by two men and listed and carried forward as a separate item. In the case of a set of ten small stamping or numbering punches in a wooden box, a tag was made out for each number and one for the box. Every one of the three dozen clamps shown on top of the shelf at the right of Fig. 1 had its own individual tag and appraisal valuation, signed and certified to by the initials of two men. Every jot and tittle of the law was carried out. Thirty thousand tags were printed to appraise this one plant and were but half enough.

Fig. 1 Complex Method of Inventorying, Where an Individual Tag is Placed on Every Article

In this plant every machine was stripped to the casting, chucks, spindles, collets, tool rests, and holders being taken off the lathes and tool centers, dividing heads and table equipment removed from the milling machines; in fact, all operative parts were taken off, collected, put in groups of a kind in another building, checked and listed. That it was neither possible readily to put this machinery back into production nor to show a prospective purchaser the available parts of the machines or their condition, made no difference; accounting was vindicated and sense sacrificed to system.

Neither of these methods would have been suggested or chosen by an engineer engaged to determine value. No engineer would spend fifty times the cost of a screw in tagging it, nor make out

[1] U. S. Appraisal Officer, N. Y. Dist. A.S.A.P., 1918-1919; member representing U. S. A. on various boards of appraisal; member of the Faculty of Throop College of Technology.

Presented at the Annual Meeting, December 2 to 5, 1919, of The American Society of Mechanical Engineers. The paper is here printed in abstract form. Copies of the complete paper may be obtained at a nominal price. All papers are subject to revision.

thirty-six tags for three dozen identical simple tools in the same condition of wear. Nor would he think of making a collection of all the similar parts in a machine shop, for his sense of value would tell him a machine must be considered as a unit, as a going functioning entity for operation or for sale. It is true that parts are interchangeable, but when adjustments must be made to thousandths of an inch, a considerable loss of time and expense is involved in an indiscriminate shuffle of similar parts.

The topic of appraisal and valuation methods is particularly opportune because of the considerable amount of appraisal and valuation work in connection with the settlement of war contracts and because of the expected growth of American commercial and industrial interests abroad; and the present study of appraisal and valuation methods is offered as a contribution to the subject, with the conviction that valuation is essentially an engineering function, and that it is the duty of the engineer to develop, guide and control method and procedure.

Classification of Appraisals

Procedure and reports must necessarily depend in part on the purpose of the valuation. Appraisals may be classified as follows:

Private Appraisals and Valuations in connection with
- *a* Sale, Rent, Mortgage or Bond Issue
- *b* Absorption or Business Combination
- *c* Reorganization
- *d* Liquidation, Insolvency, Letters Testamentary
- *e* Insurance, Private Damage Claims.

Public Appraisals and Valuations in connection with
- *a* Taxation — federal, state, local; Custom Duties
- *b* Condemnation Procedures, Public Damage Claims
- *c* Regulation of Rates, Charges, Tolls
- *d* Public-Ownership Negotiations
- *e* Alien Property
- *f* Mobilization and Demobilization of War Industry
- *g* Material Disposal.

The method of studying and valuing assets commonly calls for a broad division into
- *a* Tangible or physical, such as real estate, structures, appurtenances, equipment and tools
- *b* Intangible or non-physical, such as organization-effectiveness, experienced management, good-will, franchises, patents, etc.[1]

With so many elements, each with possibilities of variation, it should be realized at once that value is by no means a constant quantity but is, in the nature of the case, fluid and variable.

Determination of Value

Whatever the purpose of an appraisal, the writer would emphasize this fluidity of values, and more especially the continuity of values. One of the chief difficulties of appraisers, appraisal boards and commissions is that they do not keep on the path of value — they stray off, get lost in a fog of terms. They then try to locate themselves by assuming an unreal hypothetical "base," a "rate base" or "taxing base," "return base," "capitalization base," etc. Such a "base" in value is an illusion and a snare. In the nature of the case, base connotes permanence, an absolute fixed reference point. Value as the function of numerous variables is continually changing. The correct method is to follow the changes by studying their cause and reason.

The road of value might be said to begin with cost and end with price. It flows along, up or down, broadening or narrowing perhaps, but it is continuous. The mathematical ideal for tracing any flowing value is Newton's method of fluxions or formulæ of flow. It is not proposed to develop by the calculus an exact formula for fluctuating value, but it is desired to emphasize that the variations in value are continual and are best considered in relation to the causes of which they are a function. As a general method, therefore, the value at any time between cost and selling price may be determined, and is best determined for practical purposes by percentage allowances and adjustments for changing conditions.

Value flows from (actual) cost to (fair selling) price and is a function of numerous variables. It is believed that if the principal economic variables are allowed and adjusted for by percentages, value can be traced and determined at any point desired with reasonable accuracy and a fair market value close'y approximated.

The line of flow of value may be pictured graphically as the compound of a number of variables. The three main variables, labor, material and an aleatory factor which covers the general risks of the business with particular reference to marketing, may be plotted separately and then compounded. A composite of these indicates the normal value of an article. The interest return on capital is commonly expected and admitted to be a constant and not a variable factor.

Normal or natural value is therefore determined by cost of production to a considerable extent. Beginning with the simplest case of value, an article composed of a labor and a material element has a value of the actual cost of the material and the actual cost of the labor including overhead, combined with the aleatory element of market conditions as indicated graphically in Fig. 2. The first two lines indicate the tangible or physical value. The aleatory variable combined with these gives an indication of value in exchange or market value. The heavier line drawn normal or perpendicular to the fluctuations of the latter gives the line of "normal" or "*fair* market value."

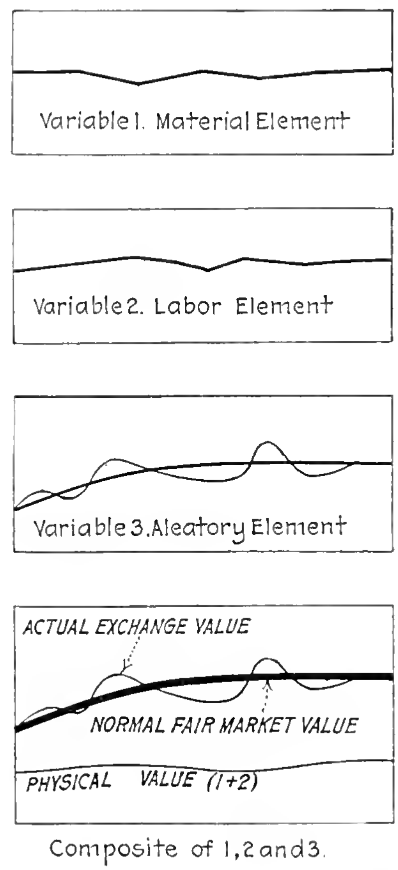


Fig. 2 Lines of Flow in Value of an Article

Commodity Values

Normal values of freely produced commodities tend to be equal to their expenses of production. Any price which yields a greater or less return is unstable. The law of supply and demand operates to oscillate value above or below normal. But as price is a function of quantity demand, the departures from normal are usually not excessive. Other things remaining constant, the quantity demanded increases as price falls, and conversely, the quantity demanded

[1] Development and promotion expenses, advertising early losses in establishing the business as a going concern, are properly allowed for under this heading.

decreases as price rises. "Demand Schedules," i.e., lists of quantities called for and corresponding prices, are usually available for various commodities. "Supply Schedules" give the response to range of price by indicating offerings at various prices. Variation of quantity demand rests ultimately on the principle of marginal utility. The equilibrium between supply and demand schedules, when reduced to graphs, will be indicated by the intersection of the demand and supply curves. Potential supply affects demand-price value nearly as much as actual supply.

While values of constituent labor and material do fluctuate, the changes are usually slow, late and easily discounted. The element or factor varying the most widely is the aleatory element. However, even this does not depart on the average very largely from a normal value. A line of flow of value over any period would then run about as shown in Fig. 3 for the composite for these three major elements.

Industrial-plant Values

Passing now from a simple commodity to an industrial plant, a similar flow of values from actual cost to selling price holds. That the line is by no means straight is the commonplace of commercial experience. Value goes up or down, oscillating sensitively with broad economic opportunity or depression. The law of supply and demand governs. Naturally utility is a big factor, which is not the case in commodity appraisals. Prospects, the law of diminishing return and that of increasing return are elements in the aleatory factor.

A line of flow of value for an industrial plant is the combination of physical value and aleatory value. If the plant is liquidating, the value is practically all in the physical or tangible value. There is little difficulty in determining physical value as it is largely a matter of honesty of purpose and assiduity.

The Aleatory Element

The determination of the aleatory element is difficult because it is composed of many variables which change from day to day, such as the quality of management, experience, ability, skill of the organization, labor conditions, the general demand and supply of raw material and the demand and for supply of the product. The obvious thing to do is to study and fix the major variable elements by careful investigation, comparison, and study, form a judgment, and value and appraise accordingly.

Manifestly the skill and ability of business men and managers should be directed to holding steady the aleatory elements if they take their responsibility honestly and seriously, but the scandal of business is the advantage taken of such opportunity by corporation officers to advance private interests and their own fortunes.

This is one of the factors that has brought on regulation by public-service or public-utility boards. Speculative fortunes, misnamed "profits," have been unfairly acquired by monopoly or jobbery. It has been proposed and attempted to prevent this and enforce fair dealing by a mechanical fixing of rates, wages and salaries. The result, however, has been that life and enthusiasm were crushed out of management and a legitimate element of going-concern value, in ignorance or in vindictiveness, was destroyed. Naturally, the uniform complaint of such regulation is that it "hits value." The *reductio ad absurdum* of regulation would be to fix all the economic variables which wou'd bring value to a fixed base, a condition of stagnation. The essence of the public service or utility difficulty is not so much a question of valuation as it is of ethical responsibility and criminal prosecution of evil corporate activities.

A true appraisal of the aleatory element in an undertaking of any size is bound to be what is known mathematically as an instantaneous value, a value for the ability and integrity of the men involved and the conditions of the moment. Character, fair dealing, trend of supply and demand, etc., can be allowed for as business assets, but they are in the nature of the case speculative and the value is as instantaneous as a stock quotation. Price as the ultimate test of value proves this by its variations and fluctuations.

A stock quotation is a price estimation of a share in a concern under the pressure of supply and demand for the share. It does not indicate, except vaguely, the value of the whole, but may, if full information is available, give the trend of the estimation of the speculative variable. A comparative range of stock quotations is useful but not conclusive.

In connection with the appraisal of war industrial plants which in many cases were going out of business or liquidating, leaving for appraisal merely the physical value and a small speculative opportunity, this matter was thrown into sharp relief. The importance of the elements of organization, management, supply and demand for raw material and products as factors in market value were strikingly evident. At least 50 per cent of the value of a producing concern is in these elements and value will rise or fall as they vary.

Problems of Demobilization of War Industrial Plants

On the signing of the armistice on November 11, 1918, our country faced two big problems:

a The demobilization of the war personnel

b The demobilization of the war material, or the demobilization of the war industrial plants.

In connection with the demobilization and readjustment of war industrial plants to peace service, the writer, as District Appraisal Officer, Finance Division, Bureau of Aircraft Production, New York District, faced the problem of obtaining rapidly appraisal

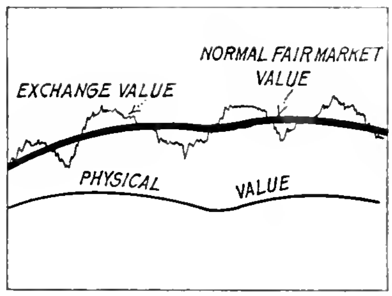


Fig. 3 Lines of Flow in Value of a Plant

valuations for a great mass of war utilities varying all the way from isolated lots of chemicals, coal, textiles or containers to entire industrial plants.

The industrial plants were in some cases "taken over"; in others they had been built entirely *de novo* for war service; while in still other cases they were assembled out of heterogeneous existing buildings, adapted or enlarged to meet the emergency. While some of the latter were entirely completed and went into production, the armistice found some but three-fourths done and which had never gone into production at all. The problem presented itself, therefore, of determining equitable valuations rapidly for the settlement of claims and the restoration of the industrial life of the country to peace channels promptly and without economic shock.

A considerable force of appraisal engineers or appraisal experts was assembled and organized for this special work and a number of engineers were at once assigned to collect, tabulate, and systematize all available data and statistics on prices and wages, and finally to bring the data down to readily usable shape in the form of tabulations, charts and graphs.

This was done for the various materials, such as chemicals, metals, textiles, paints, coal, etc. Also for the usual structural materials of engineering and for machinery. As an exhibit of method, several such charts or graphs for building materials and wages are given in the complete paper. Such information indicating the current variation in values is the first requisite in the equipment of an appraisal office.

At the same time an endeavor was made to gage the future and forecast prices by a study of the trend of the markets and the

economic factors affecting them. No sudden decided general slump in prices or wages was observed in the first six months after the armistice; probably for the reason that demobilization was in general carefully and judiciously managed and also because the normal production in many lines of activity had been interrupted or suspended and was below the demand.

With reference to statistics as a basis for valuation, the general run of unchecked statistics are probably not of great reliability. Indeed, all statistics not tested or checked back to the daily market quotations for material, and to daily wage rates or payrolls for labor, should be used with caution. This applies with equal force to Government statistics. The imprimatur of a Government seal lends often a fictitious importance which may or may not be sustained by checking against hard facts. The empire that depended most on statistics during the war in formulating policies in vital matters, time and time again found its painstakingly classified "reports" unreliable and came to one foolish decision after another. The changing personnel of bureaus subject to politics is

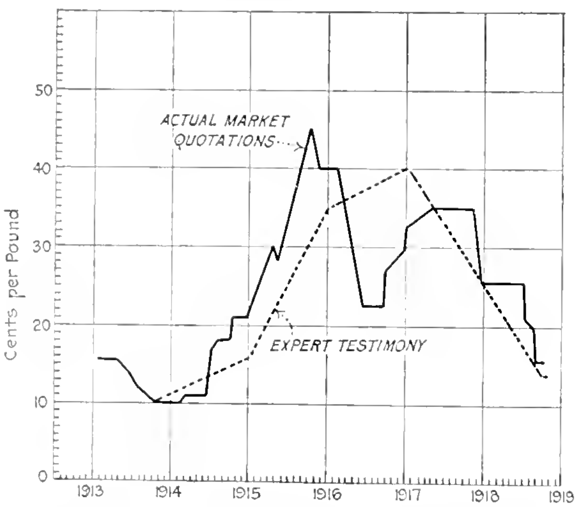


FIG. 4 CHART SHOWING COMPARISON BETWEEN MARKET QUOTATIONS AND EXPERT TESTIMONY ON PAST PRICES OF AN IMPORTANT WAR CHEMICAL

more than likely to be casual and careless in work steadily calling for the highest accuracy and faithfulness to fact.

IMPORTANCE OF DAILY MARKET QUOTATIONS

As for expert testimony on past prices, the experience of the writer in checking such testimony given before a Government appraisal board on which he represented the United States, against the actual daily market prices of a certain indispensable and important war chemical, is shown in Fig. 4. When the facts of market value are a matter of daily record at first hand, it is well to have recourse to them rather than to expert testimony.

Curves and graphs, however, must be plotted and used with sense, for daily market values tend to indicate the extremes of prices, much as a differential thermometer indicates extremes of temperature. It is manifestly inaccurate to judge the temperature of a day by the extremes indicated for a moment by a differential thermometer at, say 1 a.m. and 2 p.m. The limit of variation is defined, and division and allocation will give an accurate average value.

With reference to method of determining fundamental values, therefore, recourse should be had to actual daily market quotations and payrolls rather than to testimony, compilations or unchecked statistics. The facts should be obtained in each instance, and obtained at first hand.

DEFINITIONS OF APPRAISAL TERMS

The terms commonly used in appraisal work should be defined explicitly for the sake of uniformity and clearness in both field operations and in office reports. A memorandum of definitions developed by the writer and used for such purpose in U. S. Government work is given below.

MEMORANDUM FOR APPRAISAL EXPERTS BY DISTRICT APPRAISAL OFFICER

1 An appraisal is a valuation by an authorized person, of definite date. It is a mature, studied judgment, not merely an opinion.

2 A valuation is an estimation of worth, the act of setting a price after mature consideration.

3 Price is the money equivalent for which an article can be exchanged in a current market.

4 Appraisal is therefore the estimation of money equivalent or exchange value in the current market made by an authorized person at a definite time and place.

5 It is only valuation in exchange, and *not utility*, which is, in general, of interest to the appraiser.

6 Careful distinction must be drawn between cost and present value; cost is essentially a past price or value, market value is related to present price.

7 There is no constant uniform relation between a past cost price and a present value price, but the first is useful in arriving at a fair, reasonable estimation of the second, and should be obtained as a basis of departure.

8 In general, an investment should at all times remain unimpaired and this is provided for in larger matters by "amortization," i. e., by an allowance against the gradual dying of a tool, equipment or entire plant, or capital.

9 Amortization is provision for the recovery or the conservation of capital. The principle of the conservation of capital is in the public interest. It is to the effect that the cost of a tool or plant is a proper charge on production pro rata, that a workman or working concern should not use up its tools without an allowance to recover or replace them, and indeed cannot do so, survive and serve.

10 Physical depreciation is the decrease in worth, due to wear, tear, and use. It is the percentage *used* up.

11 Physical amortization is the percentage of value extinguished or "charged off" by reason of decrease in effectiveness, or serviceability for production. It is the shrinkage of value by reason of age or passage of time.

12 Appreciation is increase in value due to economic causes.

13 Scrap value is the value as old material or the fair market price after deducting the cost of removal — perhaps 10 per cent of cost.

14 Salvage valuation in contradistinction to scrap value means the value below which an item will not be depreciated as a going, functioning article or machine — perhaps 25 per cent of original or reproduction cost.

15 In making a valuation of an industrial property account may properly be taken of:

- *a* Original actual costs and year of purchase
- *b* Probable remaining life or usefulness, item by item
- *c* Obsolescence and percentage of inserviceability for efficient production
- *d* Present average market price and conditions
- *e* Any annual write-off made in accounting.

These to be used as a basis of an appraisal, i. e., an estimation of money equivalent at going prices in the current market, singly, and finally as an entity at a definite time and place.

16 A "Fair Value" is that which fair and reasonable men would say ought to be attached to a property under all the circumstances of a particular case; it is an estimation of what under all the facts and circumstances of the case is a just and equitable amount.

17 Fair Market Value is an estimation of the reasonable value obtainable by a prudent, solvent seller from a prudent, willing buyer, both under the necessity of making an exchange in a reasonably brief period of time. It is not immediate-forced-sale or auction-sacrifice-sale value.

18 Fair Market Value is for all practical purposes the actual cost less the physical depreciation or *used-up* percentage, less the physical amortization or a *shrinkage* percentage of decrease in effectiveness for service, with an adjustment to transfer this value to market value.

19 Physical Value: Actual cost less physical depreciation less physical amortization. Fair Market Value: Actual cost less physical depreciation less physical amortization, with an adjustment to present market conditions; or

20 P.V. = A.C. - P.D. - P.Am.
F.M.V. = A.C. - P.D. - P.Am. - M.Adj.

21 Fundamental Diagram (Normal) (Fig. 5)

22 Fundamental Diagram (War) (Fig. 6)

As the basis of any appraisal of physical assets for any one of the twelve kinds of appraisals mentioned in an earlier paragraph, a listing or inventory is necessary. In the appraisal of small lots

of supplies the process is simple. Accuracy in enumeration and in giving a brief identification description is what is required.

PERCENTAGE METHOD OF PLANT APPRAISAL

In the case of the appraisal of an entire plant, however, some systematic method must be devised and strictly adhered to. In general, the plan of attack will be to divide the inventory work into sections as follows:

a Buildings and appurtenances
b Raw materials and supplies or stock
c Goods in process
d Finished products.

Sections *b*, *c* and *d* as a rule call for a straight commercial inventory or stock taking and present no unusual difficulties. Any convenient system of listing and checking that prevents duplication or omission will serve. Section *a*, however, which usually comprises a large percentage of the value, calls for the best skill of the engineer, and is therefore usually handled under sub-classes or symbols. A scheme of symbols and sub-classes that was found serviceable in War Department work is given in the complete paper.

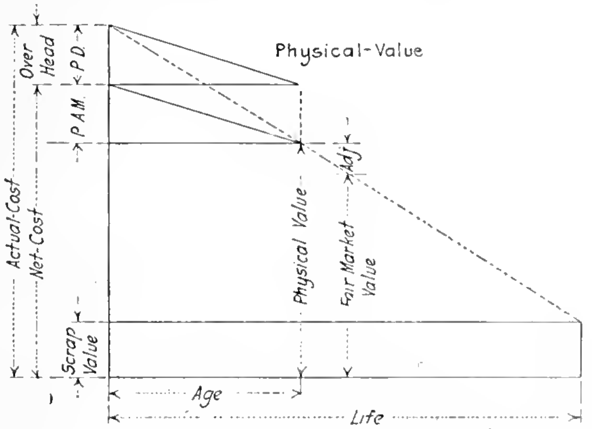


FIG. 5 FUNDAMENTAL DIAGRAM (NORMAL)

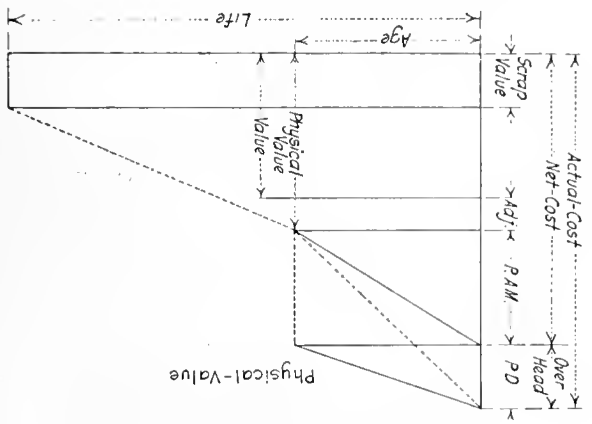


FIG. 6 FUNDAMENTAL DIAGRAM (WAR)

When a plant is to be liquidated and sold either by item or as a unit, it is sometimes desirable in inventorying to leave a numbered tag of identification on the article and to take a carbon copy for listing by symbol on the appraisal sheets. Any permanent identification number stamped on the article or machine should be given as a check in the disposal of the material.

The value of any item as a separate, isolated article may well be different from that for the article considered as a part of an entire functioning plant. Therefore appraisal values set upon tags at the time of tagging must, after being listed by symbol, be reviewed both as a check and as an adjustment to the department or plant as a unit. Judgment and experience must be the guide in these matters.

As a check upon this and as a means of very rapid approximate appraisal, a set of sheets adapted to the formula 20 given in the preceding memorandum were devised with six columns, namely,

1 Physical Depreciation
2 Physical Amortization
3 The Sum of 1 and 2, or the Write-Off
4 The Balance of Value
5 The Market Adjustment
6 The Fair Market Value.

The arrangement of one of these sheets is shown in the complete paper.

If either the approximate cost of the segregation under the symbol or its percentage of the total cost is known, it is then possible by allocation to determine a value and an estimated fair market value for an entire department, or for an entire plant. It should be remembered that an appraisal is not as a rule an outright sale or settlement, but is an estimation and calculation, or a judgment, as a basis for action.

The sub-divisions under the symbols will be numerous and the individual items almost infinite in number; therefore handling an appraisal by itemizing and appraising each individual article, item by item, is long, tedious, and expensive.

The entire matter can, however, be handled on a percentage basis quite rapidly if actual costs are known or determined. If the percentage of physical depreciation by group or even by article is carefully determined and fixed, and the group or article given its proper relative "weight" or approximate percentage-cost importance, it is possible quickly to integrate article physical-depreciation by allocation to group physical-depreciation, and then integrate to sub-symbol and finally to find a value for physical depreciation by symbol and finally for the entire plant.

By this method it is believed that the small errors average, or balance out, disappearing in the successive integrations much as second differentials do in calculus.

ADVANTAGE OF THE PERCENTAGE METHOD

As depreciation and amortization are after all a matter of ratio or percentage, the dollar sign need not appear anywhere in the process of appraisal except at the beginning in the determination of relative weight and at the end in determining fair market value in money.

An additional advantage is believed to be that this method concentrates attention on relativity of value rather than on actual prices, mention of which leads to endless detail discussion and lost motion, and distracts attention from the end to be achieved. The only way in which the ultimate object and purpose can be kept constantly in view is by using weighted percentages and integrating. Experience indicated that the effect of discussing individual money prices was to differentiate rather than to integrate valuation.

Column 5 need not be carried out for each symbol, as it is more than likely that the adjustment for the speculative factor will be practically uniform for an entire symbol, or even for an entire plant. This adjustment percentage must be carefully studied so as to allow for any variable factors favorable or unfavorable, which appreciably affect or enter into value. They should be determined separately by comparison with all available data and given their proper weight in the final integration.

As a check on the more laborious detailed method of appraisal by itemized priced inventory, or as a rapid appraisal where time is a vital factor, it is believed that this method has the advantage of constantly viewing the process as a whole; also the additional advantage that the errors due to its approximations are averaged out by integration and are less than the inevitable errors in the close, near-sighted, detail-price appraisal. Therefore it is not only more expeditious but also more accurate.

The flexibility under rapidly changing markets is apparent. By this method an appraisal by percentage of a large war plant was finished and reported on in ten days. An appraisal on the individual item tag system had been going on for months, with no prospect of its being completed in a year or being in any close connection with prevailing prices at the time of completion of the appraisal, in spite of the amount of time and money expended upon it.

In this percentage method the basis on which the percentage is to be taken must be most carefully checked and determined. The advantages of actual cost, taken in this method as the basis, are believed to be as follows: Actual cost is (1) a past value; it is (2) a definite, absolute figure; it can be (3) closely approximated even if not a matter of record; it can be (4) more accurately determined by reference to records of past material quotations, wages, and payrolls than any other possible "base"; it is (5) logical to adjust this past value to present value, and (6) in doing so the trend of value is necessarily brought under consideration. In connection with war contracts, whether fixed-sum of cost-plus, the actual cost was usually available.

Table 1 shows an allocation of physical depreciation by symbol

TABLE 1 TYPICAL TABULATION OF ALLOCATION BY SYMBOL OF PHYSICAL DEPRECIATION

Symbol	Percentage of Total Actual Cost. (P)	Depreciation by Symbol. (D)	$P \times D$
1	(Laud constant value	by contract)	.....
2	62.97	10 25	646.0
3	7.74	19.83	153.0
4	1.81	13.00	23.6
5	3 56	10 00	35.6
6	4.59	15.00	69.0
7	0.11	40.00	4.4
8	1.52	24.70	37.0
9	2.84	20.00	57 0
10	5 99	20.50	123.0
11	0.19	12.00	2.2
12	2.18	13.60	30.0
13	0.22	25.00	6.2
14	2.20	16.00	35.2
15	(Drawings)	0	.....
16	0.18	90.00	16.2
17	3.78	58.80	222.0
18	0.12	80.00	9.6
		(Average = 14.70)	1470.0

built up from integration of the sub-symbols. In an exactly similar manner the physical amortization can be tabulated and determined.

Divisions of the Speculative Factor

Exact agreement by an appraisal board, without arbitration, has been achieved on physical valuation by this percentage method. The speculative factor is the one on which differences largely occur, but the method has the advantage of concentrating and confining discussion to that topic. This factor may be considered broadly under two headings:

a Going-concern speculative factor
b Liquidation speculative factor.

Under heading *a* the elements contributing value are:

1 Effectiveness of organization
2 Experienced management
3 Good-will, sound advertised reputation
4 Standard product, standard service
5 Patents, franchises, etc.
6 Sound business policy; financial (credit) strength and connection.

These intangibles must be rated by their past and prospective performances, by comparison with similar cases, and judgment taken. In a sense they represent common-stock capital, as against the preferred-stock capital of the physical values, and must be judged by results achieved or reasonably to be expected. In the nature of the case they are speculative and not subject to exact definition. The test is neither so-called "efficiency" nor even production. It is the maintenance and prospective improvement of an evenly balanced, healthy, profitable business life.

A rating or appraisal of this element calls for the most intelligent and careful conservative study of the main elements listed above, and an honest judgment on them individually, and finally as a whole. The capitalizing of these elements on the basis of dividend returns or profit is not a proper procedure, unless it is clearly indicated as a common stock capital or marked clearly as an instantaneous valuation of the conditions of the date which is given. The Supreme Court of Maine has gone on record to the effect that "the capitalization of income even at reasonable rates cannot be adopted as a sufficient or satisfactory test of value."

The Prevention of Value Fluctuation

The necessity of the hour is a balance wheel to business that will decrease the speculative element and prevent wide or violent fluctuations of value. During the past two years there has been a world-wide advance in prices. This is due rather to a fall in the value of gold, or money, rather than to a simultaneous rise in the value of everything else. One very practical suggestion to steady business is the plan of Prof. Irving Fisher, of Yale, for stabilizing the dollar in purchasing power. He says: "With each change in the purchasing power of money (in other words, with each change in the price level) some people lose what properly belongs to them and others gain what does not properly belong to them. Our sense of 'social justice' is offended." These fluctuations cheat the small savings-bank depositor as well as the wealthier bondholder, conduce to social unrest, distrust, and discontent, and produce industrial instability and crises. In a word, they make fair dealing in the conduct of business difficult for those of good intent, and enable those who study values as a pure speculation or gamble to profit without production.

Even the conservative must unwillingly, even unconsciously, become involved when our unit of measuring values shifts 50 per cent in a few years and constantly varies. To capita'ize income to a rate base under these circumstances is unreasonable, unfair, and unjust.

The remedy of legal regulation or restriction aggravates matters by working against effectiveness of organization and against good management by removing the incentive. Price and rate fixing are less important than value and dollar fixing. The former seem in practice to operate on some minds to decrease the importance or even eliminate necessity of good-will. Indeed, the statement has been made in a court of law that under monopoly there is no "good-will." Government control and regulation are a species of monopoly and do not foster good-will. A decline in good-will results in a lower appraisal valuation.

Patents and franchises (if not in perpetuity) have a value which is limited by the life of the patent and the circumstances. These matters are speculative and must be appraised accordingly. They are best considered as individual elements, given their proper weighted importance and integrated as physical value can be integrated.

The Final Value

The combination of the integration of physical value and integration of speculative values gives a final value which should check against capitalized interest or dividend return in the light of all the circumstances of the case. In this way a value may be obtained which is a real basis for production profits and dividends, which will also justify unusual dividends on the basis of efficient organization and management. Let it be said that there should be no objection or complaint against large dividends or profits if large and efficient service has been rendered. The sooner this idea is accepted, the better for every one.

With reference to the procedure in the appraisals for various purposes classified earlier in the paper, the general methods indicated will naturally be varied in detail and emphasis laid according to the special requirements, and the report will stress and elaborate circumstances accordingly. Supply and demand schedules would naturally be of importance in an appraisal for absorption or combination, but of little moment in a matter of liquidation. In material disposal they would be vital, but in a taxation appraisal of much less moment; the exigencies of the case will vary the methods and procedure outlined in the paper.

There will shortly be under the American flag 1731 oil-burning steamers, nearly 10,000,000 deadweight tons. Fuel stations are being established so that these ships may make a world circuit without fueling at other than American-owned stations.

Investigation of Strains in Rolling of Metal

By ALFRED MUSSO,[1] NEW YORK, N. Y.

This paper is a discussion of one of the most important problems incidental to rolling-mill operation. In such mills, while raw stock is being transformed, a certain amount of material is wasted, and to determine the factors involved in this waste, the author asks and answers this question: "What is the most convenient length and width of the piece of metal to be rolled in order to produce a finished article of certain definite dimensions so that the waste of material may be reduced to a minimum?" The answer, which forms the body of the paper, is based on data secured as a result of actual investigation.

When a piece of metal is put through the rolls in a rolling mill, its linear dimensions are strained and the whole piece itself is deformed; in other words, the thickness of the piece becomes smaller while its length and width are increased. These strains are the effect of the pressure which the rolls exert on the piece, and as introductory to our specific subject we will first consider the behavior of a piece of metal under compression.

Let $ABCD$ (Fig. 1) be the cross-section of a piece of metal as subjected to the pressures P and P_1 normal to the faces shown in cross-section as AB and CD. When the compression is carried beyond the elastic limit of the material, the two faces AB and CD

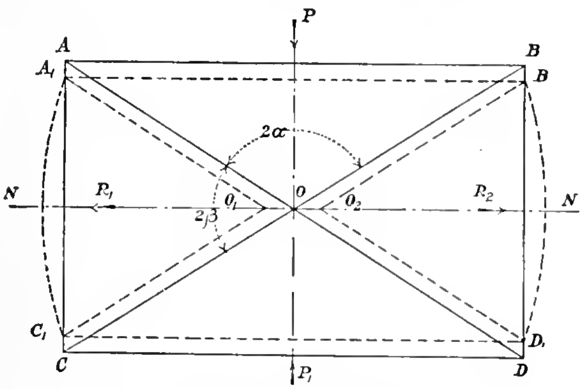


Fig. 1 Cross-Section of a Piece of Metal Subjected to Pressures P and P_1

will come closer together as shown by the dotted lines A_1B_1 and C_1D_1, while the two sides faces AC and BD will bulge outward as shown by the dotted curved lines A_1C_1 and B_1D_1, and if the forces P and P_1 are still increased the piece will ultimately fail by shearing along its diagonals.

The ultimate behavior of the failing piece is influenced by the structure of the metal itself. In fact, experience shows that ductile metals possessing a homogeneous structure, such as copper, aluminum, etc., will become plastic and flatten down to a disk, while fibrous metals, such as steel, wrought iron, etc., where strength across the grain is much lower than with the grain, are not susceptible of any plastic state at all and will ultimately fail by splitting sideways. As it is beyond our present scope, however, to discuss this subject of the failure of metals under compression, it is sufficient for our purpose to regard the piece as shown by Fig. 1 as divided into six pyramids having as a common vertex its pressure center O, and as bases its six faces.

It is obvious that while the compressive forces P and P_1 are tending to telescope into each other along the pressure line PP_1 of the upper and the lower pyramids, the other four pyramids will be pushed outside by the expulsive forces R_1 and R_2 consequently set up by the aforesaid pressures P and P_1. The value of the expulsive forces evidently depends on the two angles AOB and AOC, ordinarily known as *pressure angle* and *expulsion angle*, respectively. We will now apply the foregoing considerations to the rolling-mill process, and begin our investigation of the effects of the roll pressure at any point of the surface of the piece being rolled.

Let Fig. 2 represent a cross-section of a rolling mill through the rolls. NN_1 is the piece of metal going through the rolls C and C_1. Inasmuch as the pressure is exerted radially we may consider it at any point, say at A, which is the initial point of the contact arc AMB. The pressure P may be resolved into two components, one normal to the piece and the other parallel to its surface, as follows:

$$n = P \cos b, \text{ normal component}$$
$$m = P \sin b, \text{ parallel component}$$

where b = angle ACB, known as the *approach angle*. The direc-

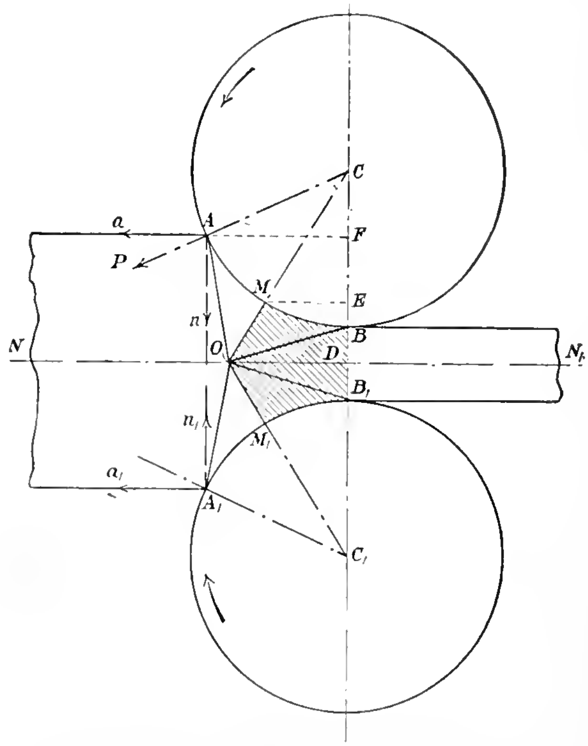


Fig. 2 Cross-Section of a Rolling Mill through the Rolls and Piece of Metal Being Rolled

tions of the components clearly show that while n is the force which actually compresses the piece, m is the component of the pressure which hinders the piece from entering the rolls, and unless n is larger than m, the rolls will not grip the piece.

The useful limit of b is easily found from the relation $n > m$, from which $b <$ 45 deg. The actual value of b for metals is given by $\tan b = c$, the coefficient of friction between roll and piece, but for metals $c = 0.577$ (approx.), therefore $b = \tan^{-1} 0.577 =$ 30 deg., which, according to actual practice, is the maximum value of the approach angle for which the rolls will grip the piece.

Let us now deal with the effect of the pressure on the whole arc of contact AB. We may consider the pressure as applied to the middle point M and the whole piece represented in cross-section by ABB_1A_1 will be divided into pressure pyramids with a common vertex at O. In accordance with previous remarks concerning the behavior of a piece under compression, we deduce that the part of the piece bounded by the contact arcs and shown shaded in the figure is pushed outward by the rolls in the direction of the pass, consequently it is the one we must consider in looking for the elonga-

[1] Gen. Mgr., The Coast Coaling & Engrg. Co. Assoc.-Mem.Am.Soc.M.E.

Presented at the Annual Meeting, December 2 to 5, 1919, of The American Society of Mechanical Engineers. The paper is here printed in abstract form. Copies of the complete paper may be obtained at a nominal price. All papers are subject to revision.

tion of the piece. Obviously, when the piece has gone through the rolls, the shaded area $OMBB_1M_1$ will have been transformed into a rectangle, its height being equal to the pass and its base longer than the average base of the original expelled part.

Determination of Elongation. In the complete paper an expression is derived for the shaded area $OMBB_1M_1$, which, as previously noted, must be equal to the area of a rectangle of height b and base of length l, where p = pass (BB_1). The value of l is given by the equation:

$$l = \frac{1}{p}\left(\frac{(2r+p)^2(t-p)}{8r \sin b} - \frac{3.14r^2}{360} b\right) \quad [1]$$

and the value of the average base l_0 of the shaded area by

$$l_0 = \tfrac{1}{2}\left(\frac{(2r+p)\,(t-p)}{4\,r \sin\, b} + r \sin \frac{b}{2}\right) \quad [2]$$

in which r is the radius of the roll and t the original thickness of the piece (AA_1).

The elongation e of the piece will evidently be $l - l_0$, and referring e thus found to the total length of the piece gripped by the rolls, we will have the elongation per unit length e_1. Also, the total length of the piece gripped by the rolls is (Fig. 2) $AF = r \sin b$, whence the percentage elongation e_2 will be

$$e_2 = \frac{100\,e}{r \sin b} \quad [3]$$

Equation [3], besides showing the elongation obtained by rolling a piece of metal, furnishes also other valuable information, namely, a check on the safety of the rolling operation, by comparing the e_2 with the tensile-strength test of the material in question. In the event that the value of e_2 is too large for safely straining the piece, or should it happen to be too conservative, it will always be possible to readjust the pass of the rolling mill to suit, because e is a function of b.

In order to find the side spread (s) of the piece caused by the roll pressure, we will refer to Fig. 3, which is a longitudinal cross-section through the rolls. Let CC' and C_1C_1 be the axes of the rolls, $AA_1 = t$ the original thickness of the piece and $BB_1 = p$ the pass. In this case, since the expulsion angles AOA_1 are equal for both sides of the piece, the total spread will be twice the spread of one side.

By reasoning the same as in the case of Fig. 1, we can easily see the amount of side spread is given by the shaded areas, namely, AOA_1 and B_1O_1B. In this case the shaded area is given by the difference of the areas of the triangles AOA_1 and BO_1B_1, which depend upon the value of the pressure angle a because angle $DAO = a/2$. In the complete paper it is shown that

$$\frac{a}{2} = \tan^{-1}\left[\frac{(r+\frac{p}{2})\tan\frac{b}{2}}{\frac{p}{2}}\right] - \frac{b}{2} \quad [4]$$

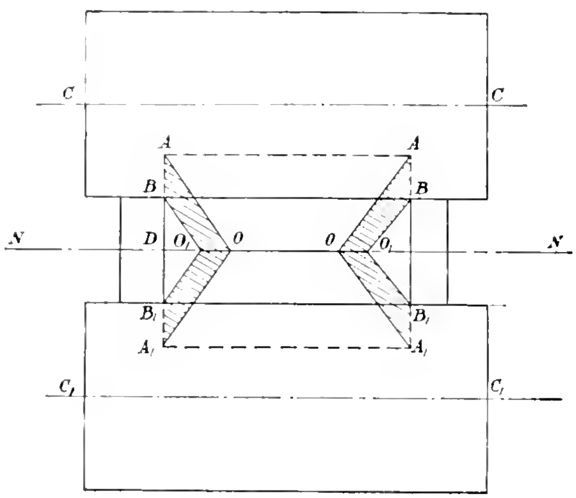


Fig. 3 Longitudinal Cross-Section of a Rolling Mill through the Rolls

It should be noted that the pressure angle is also a function of the approach angle b, and once the value of the pressure angle has been calculated it is easy to find (Fig. 3) the area of the shaded portion, which divided by the pass will give the amount of the side spread at each side of the piece, namely,

$$s = \frac{(t^2 - p^2)}{p} \tan \frac{a}{2} \quad [5]$$

If w is the width of the piece, the total spread per unit of width will be $2s_1 = 2s/w$, and the percentage spread

$$2s_2 = \frac{200\,s}{w} \quad [6]$$

Equation [6] shows that the side spread is independent of the width of the piece, but it depends entirely on the values of the original thickness t and the pass p.

In conclusion the author wishes to present a practical application of the foregoing formulæ by solving the following problem: In the cold-rolling operation a strip of 0.20 per cent carbon steel is put through a 10-in. mill. The strip before rolling is 2 in. wide and 0.065 in. thick. The pass is 0.050 in. Find the percentage elongation and side spread.

The first step is to find the approach angle. The fundamental equation of a rolling mill is

$$t = p + 2r\ (1 - \cos\ b)$$

Substituting and solving, it is found that b = 3 deg. 8 min.. Also, from the above data and Equation [4], $a/2$ = 78 deg. 7 min.

We can now dispose our data as follows:

Roll radius, $r = 5$ in.
Original thickness, $t = 0.065$ in.
Pass, $p = 0.050$ in.
Width of strip, $w = 2$ in.
Approach, b = 3 deg. 8 min. = 3.133 deg.
$\sin b = 0.05466$
$\cos b = 0.9985$
$\sin \frac{b}{2} = 0.02734$
$\tan \frac{a}{2} = 4.75219$

The elongation, using Equations [1], [2] and [3] is found to be 0.06275 in., or in percentage, $e_2 = \frac{6.275}{5 \times 0.05466} = 24.6$ per cent of the original length of the piece gripped by the rolls.

The side spread on either side, from Equation [5] is $s = 0.164$ in., and the percentage spread from Equation [6] is 16.4 per cent.

The result thus obtained evidently shows that the percentage spread is inversely proportional to w, the width of the piece. Now, because of the fact that in rolling-mill practice we are interested only in obtaining the highest possible value of the elongation e, the best economic operative conditions will be furthered by using a strip as wide as possible consistent with the dimensions of the rolls, the power of the mill and above all the degree of uniformity desired in the thickness of the finished strip.

Wage Payment

By A. L. DeLEEUW,[1] NEW YORK, N. Y.

This paper discusses the various items entering into the present relations between employer and employee. The author first calls attention to some of the terms which are most commonly used but of which there is no clear understanding of their meaning. Among these are "capital, labor, right to organize, collective bargaining and wage." He discusses each of these and then takes up the subject of the various systems of payment in existence at the present time. These are straight wages, piece-work system, various systems of bonus payment, premium payment, and combinations of these systems. In conclusion he states that in his opinion the real cause of the present-day unrest lies in the fact that the wage system now in use is not based on knowledge and justice, but only on guesswork and on the fear felt by both employer and employee that the one may "do" the other.

UNREST among the laboring classes has taken on such proportions and is so widespread that it is timely to discuss the various items which enter into the present relations between employer and employee. Many times one or both parties in the conflict try to befuddle the third party, the general public, by statements which are misleading or which are couched in such words as will hide that which is not true. It is well recognized that where two parties have a difference of opinion the first step should be to find some common ground from which to start, and that then the second step should be to define clearly and precisely the chief terms which enter into the controversy. We read practically every day about war between "capital" and "labor," about the demand of the laboring man for the "right to organize," and of his right to insist on "collective bargaining," and yet these three terms, which are perhaps used in every controversy that comes up, are not only not defined but they are actually misleading in themselves.

If war between capital and labor means anything at all, it must mean war between capitalists and laboring men. Capital is the result of past labor used progressively. Without capital, civilization is unthinkable. Capital is the tool with which the laboring man works. There can no more be war between labor and capital than between the laboring man and his tools. There are a large number of people who actually believe and act upon the idea that capital must be destroyed in order to give the laboring man his own. The fault lies with the capitalists or to the present system of control of capital, not with *capital itself*.

In late years the control of capital has been more and more centralized, or, in other words, in the hands of fewer individuals. And though it is well recognized that this condition has its advantages in many ways, yet the dangers to which such centralized control may well lead have caused it to be regarded with suspicion and enmity. Capital being the tool with which labor must work, it is but natural that labor should look with suspicion on an attempt to corner the tool supply. For this reason we may naturally expect that labor will insist upon a better control of their tools, namely, capital.

It has been pointed out many times recently that there are really three parties, not considering the general public, which have a right to be heard in this controversy, namely, capital, labor and management. It seems to the author that this merely leads to complication without any compensating features. Management and labor are both labor, but of different kinds. If at times they clash, it is not due to unavoidable conditions, but merely to defects in one or the other.

Another term quite familiar to all of us is the "right to organize." The writer does not believe that there is an appreciable percentage of employers who would deny their employees the right to organize; for instance, for a baseball team, or a brass band, or sick benefits. On the other hand, nobody would blame the employers for denying their employees the right to organize for the purpose of burning down the plant, or sabotage in the shops, or blowing up the works of his competitors — however beneficial this might be to him in a business way, or for many other purposes. It follows, then, that the "right to organize" must be further defined or at least limited in its scope before we can judge as to the real right of the employee to organize. If the purpose for which the employee wishes to organize is legal and proper, the third party, the general public, will naturally concede this right, and quite as naturally inquire as to whether the employer has really denied this right to his employee.

The facts in most cases where this right to organize has been brought to the foreground, are these: A labor organization, acting within its rights, succeeds in gathering into its union part of the employees of a certain establishment. The employer, fearing that this activity may lead to a strike, attempts to keep the other employees from joining the union; in other words, he tries to organize them with him, instead of with the union. He also acts within his rights and cannot be said to have denied his employees the right to organize. It is doubtful whether in late years there have been many cases where the employer has denied the employee the right to join the union, even if he was not in favor if it. When undesirable conditions or relations existed between employer and employee, or perhaps when union activities led to a strike, it was quite customary to make a demand on the part of the men for the right to organize, — yet this right had seldom been denied; but, put in this way, the general public would get the impression that all kinds of organizations of the employee are taboo. What is really meant by the "right to organize" is that the employer shall give, not to *his men*, but to *some labor union*, the right to come into his shop and organize his men into a union; which is very different from the idea which the expression "the right to organize" conveys.

Another term which is misleading, even more so than those mentioned before, is "collective bargaining." In collective bargaining it is supposed that some or all of the employees have delegated the right to bargain for them to some attorney or business agent. In practically all cases this business agent is their union, and this union is, according to the term used, supposed to bargain with the employer. As a matter of fact, however, there is no bargaining, and, under the present conditions, there can be no bargaining. There have been cases where the men were entitled to all they asked for, and possibly more; there have been cases where the men were not entitled to as much as they asked for, but the method of bargaining has never been employed, and, in the writer's opinion, *could not* have been employed, to settle the differences, because the essential feature of bargaining, which is a process of readjustment of the value of the object of barter in the minds of the two parties concerned, is lacking. The issue has been brought to a conclusion by strikes, or threats of strikes, which is no more a method of bargaining than when a man points a gun at his debtor in order to collect a bill.

In order that there shall be true bargaining, there must be an object to be sold, an object to be given in barter therefor, and an attempt of buyer and seller to modify each other's conception as to the value of what they are offering. In offering labor and demanding money we have no measure nor can we estimate its value by personal observation, as we can in purchasing a house, except after the labor is done, which is long after the so-called bargaining took place, long after the price was set. It is true that labor is sold by the hour, but the hour is a measure of time, not of labor.

At the present time labor is not sold by measure, but a workman sells his time. *This inability to strike a bargain because the value of the product to be sold is entirely unknown, is, in the writer's*

[1] Consulting Engineer. Mem.Am.Soc.M.E.

Presented at the Annual Meeting, December 2 to 5, 1919, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. The paper is here printed in abstract form. Copies of the complete paper may be obtained at a nominal price. All papers are subject to revision.

opinion, one of the greatest difficulties to be overcome before there can be an equitable adjustment of the differences between employer and employee. The fact that labor is sold by the hour is equally unjust to both parties. Sometimes the employer suffers, sometimes the employee. In all cases it is a source of curtailment of production, and this leads at once to a discussion of wage system.

"Wage" is defined as remuneration for work done, and also as remuneration for time given. The second definition seems to be defective. In the first place, when money is paid for time given, it is called "salary." In the second place, and this objection is more serious, time alone is not bought or paid for. There are many occupations in which the employee must wait until something turns up for him to do, and then he is supposed to do it. Besides time and labor there enters into such cases the requirement of physical presence.

There are cases where, practically speaking, time alone is sold. Such is the case, for instance, with a stationary watchman. Even in such an extreme case something more than time is paid for: the man's watchfulness and faithfulness. In other cases time and labor are paid for: for instance, with a machinist's helper, or a blacksmith's helper. In still other cases time and skill are paid for: for instance, the man running a large planer or boring mill. The writer cannot think of any case where wages or salary are paid for time alone.

In the great majority of cases it is labor that is wanted, or rather the results of labor, and not time. The great problem is to find a measure for this labor, in order to obtain an equitable way of paying for it. In even the simplest operations of labor there are so many factors which modify the result that it is difficult to establish a unit of measurement. In some of the more complex work it has been possible to subdivide the operations to such an extent as to set a fixed time for a given operation. But even in the very simple operations some factors enter which will cause trouble at times — trouble with the machine, breakages, replacement of tools, and the like.

In a large portion of work there is a combination of time, physical presence, labor, skill, knowledge, judgment, and probably other factors which are hard to define, such as reliability, steadiness, enthusiasm, loyalty, ambition, and whatnot. To make up a formula which would embody all these elements and from which a man's value could be calculated is, of course, impossible. The impossibility of a mathematical solution shows the necessity for the development of a compromise system.

There are various systems of payment in existence at the present day — there are straight wages, piece-work system, various systems of bonus payment, premium payment, and combinations of these systems.

The wage system considers nothing but time and physical presence. A man is selected for a certain task because he or some one else claims that he is fit for that task. If his work is satisfactory he is retained; if not, he is dismissed. Both employer and employee have made a guess. The employee knows exactly what he will get, and guesses at what he will have to deliver. The employer knows exactly what he must deliver, and guesses at what he will get.

With the piece-work system the employer knows exactly what he will get for his money, but the employee makes a guess as to how much he can reasonably do; he has no control over the conditions which will enable him to do, or prevent him from doing, as much as he is expected to.

There are various kinds of bonus systems. The employee may earn his regular wages and get a bonus at stated intervals if his work exceeds the expectations of his employer; or he may be working under the task-and-bonus plan, in which case there is less guessing and more of an attempt at a definite bargain. If the employer is in earnest with such a system, and sees to it that it is possible for the employee to fulfill his task, then this system approaches quite closely to true bargaining.

The premium system is an attempt at gaining the interest of the employee by making him invent improvements in the method of working and sharing the profits with him; but unless the time originally set was carefully studied, and unless all conditions of machinery, tools, existing knowledge, and so on, remain unchanged, this system also will lead to controversies and injustices.

To sum up, the pure wage system is no bargaining in any sense of the word; the piece-work system is only bargaining if employer and employee have reached an agreement, and if there is some mechanism by which this agreement can be changed as soon as conditions change; the pure bonus system is nothing else but a wage system with a kind of profit-sharing plan; the task-and-bonus system, if properly worked out, and if accompanied by complete instructions to the employee, is a perfect bargain, but must be constantly revised as conditions change. However, this system carries with it the necessary mechanism to effect these changes.

Labor unions are fighting organizations, the army with which the laboring man fights the employer. If fighting has given them, if not all, at least a large portion of what they desired, it is but natural that they should consider war the best means of reaching their ends. The unions, so far, have not offered any constructive suggestion, and this cannot be expected from a fighting organization. Furthermore, it is to the personal interest of union leaders to hold to this system. It may be taken for granted that there have been, and are, many unselfish union leaders, but this does not offset the general tendency of the system to perpetuate itself as a fighting organization.

Another reason why the attempt of the employer to put labor on a contract basis has not been well received by the labor unions, lies in the historical fact that on account of occasional scarcity of work it became one of the principles of the union to take measure to insure that whatever work was available should be sufficient to keep the union men in employment. The three chief means used to accomplish this were: first, to prevent anybody but union men from working at the trade; second, to limit the number of apprentices, or in general, newcomers in the union; third, to limit the output per man. The second item has not been strictly adhered to, because it was found that by limiting the number of men in the union the number of men outside the union was increased, thus decreasing the relative fighting strength of the union. The first item has been strictly adhered to, but has often been denied by the union, probably for the purpose of satisfying public opinion. The third item is still generally adhered to, but is mostly camouflaged.

Taking the aims of organized labor to be:

1 Proper share of the proceeds of labor
2 Reasonable working conditions and working hours
3 Right to organize
4 Collective bargaining,

the writer believes that these aims could all be accomplished without strife if the last item, collective bargaining, were put into actual practice instead of being a mere catchword.

If employers and employees together would put as the first item in their catechism the truth that the world must produce more in order to have more, if employer and employee together would try to find an equitable way of estimating the value of work done, if both would subscribe to the truth that no permanent gain can be made by wearing out a man's capacity for work nor by allowing him to work less than he should for the good of the world at large, if then employers and employees together would organize a Bureau of Research for defining the conditions under which various classes of work should take place, and if, finally, an attempt were made by both employers and employees to classify men according to their natural or acquired ability, there would be very little reason left why a union should be a fighting organization.

Up to the present time the unions have acted entirely through their business agents, who sometimes had, and more often had not, a clear idea of the problems involved in the trade they represented. Whatever knowledge they might have had was not permitted to come to the foreground. It seems to the writer that the time has come for the unions to take the first step along the lines of considering union activities as a legitimate business, and legitimate business cannot shut its eyes to facts, however disagreeable to contemplate they may be. It is his belief that the crux of the solution lies in the establishment of a proper wage system, and that in order to establish such a system the engineer must come to the assistance of labor in order to find standards of value for work done. Though it is not likely that there will ever be a time when

(Continued on page 976)

COMBUSTION OF HEAVIER FUELS IN CONSTANT-VOLUME-TYPE AND SUPERINDUCTION-TYPE ENGINES

By LEON CAMMEN,[1] NEW YORK, N. Y.

Well-recognized liquid-fuel conditions make it imperative to prepare for the demand for engines capable of running on fuel heavier than gasoline, such as paraffin gas oil and similar products. The cardinal element governing the design of such engines is the rate of combustion of the fuel-air mixture, and since oil-air mixtures have a much lower basic rate of combustion than gasoline, conditions have to be created in the cylinder which will accelerate the combustion. One method of doing this, suggested in the paper, is by the use of superinduction, and an installation is described showing its application, and formulae for power output are deduced. The design of kerosene engines and the carburation of kerosene and similar fuels are discussed in some detail.

THE demand for gasoline is so great that it becomes imperative to look for other fuel supplies, either heavier oils of petroleum base or such fuels as gasoline, benzol, etc. The present paper considers mainly the combustion of kerosene and still heavier fuels in engines of the constant-volume type, that is, engines such as are at present used in motor cars, tractors and aeroplanes.

The conventional motor-car or aeroplane engine of today has reached such a state of development when operating on gasoline or equivalent easily vaporizable fuels that only small improvements may be expected from a further refinement of design. In fact, it is doubtful if the time devoted to its perfection would be well spent in view of the fact that what the world needs mainly today is not a better gasoline engine but an engine that will work better on a fuel costing about one-half to one-third what gasoline costs or is likely to cost in a couple of years.

The first effort to meet this situation was made in the direction of adapting the conventional engine to the use of kerosene, which proved, however, to be a much more difficult proposition than was expected at the start.

Two methods, singly or in various combinations, have been resorted to by designers of kerosene engines in order to make it possible to burn that fuel. The first and most obvious method has been to preheat the fuel, but this apparently leads to the break-up of the higher hydrocarbons present in kerosene and the evolution of free hydrogen and possibly formation of acetylene or acetylides. The presence of free hydrogen leads, however, to a very high acceleration of the rate of combustion of the mixture and creates the phenomenon generally known under the name of "kerosene knock."

The other way in which the solution of the problem of burning kerosene has been attempted has been by means of the extremely fine atomization of the fuel. There have been two considerations underlying this idea.

The first was to burn kerosene with air, not as a mixture of gases but somewhat in the same manner in which explosions of coal and grain dust take place; that is, converting the kerosene into such a fine "powder" or fog as to insure a very intimate contact between it and the air. The other consideration was the desire to vaporize the kerosene at a point far below its end point of distillation. If the kerosene is very finely broken up and heated to about 225 deg. the vapor tension between the extremely small drops and air is sufficient to vaporize the fuel.

Tests made by the present writer, however, have indicated that to secure this result the atomization of the kerosene must be very fine indeed, a condition not easily secured because of the high average viscosity of kerosene and the greater toughness of the surface skin. It proved possible to vaporize kerosene in conventional carburetors by using a large number (300 and more) of extremely small jets (1/8 in. deep and shaped as a semicircle 0.003 to 0.004 in. in diameter). Later tests have brought out a rather interesting fact, namely, that this arrangement of a large number of very small jets which gave good results on kerosene proved to be very poor for use with gasoline.

But even atomizing kerosene finely at the nozzle of the carburetor seems to be only half the battle and a number of other conditions must be satisfied before it is possible to obtain successful results.

The first question is that of delivering the atomized mixture to the engine cylinder which employs proper manifolding not only outside of the cylinder block casting but inside of it as well. Since a kerosene-air mixture carries the fuel largely in a state of a fog or very fine drops, any bends, loci of turbulence or cold places are apt to cause condensation of the kerosene.

In other words, kerosene-engine manifolds have to represent the nearest possible approach to a straight-line flow with the minimum of changes of direction and have to be designed from end to end with an eye to some relation like the Fanning formula. To take care of these conditions a design has been evolved, or rather adapted, in which the carburetor sits right at the cylinder head, the manifold is cast into the cylinder head and the mixture flows in an absolutely straight line from the mixing chamber of the carburetor to the valves; the only abrupt turn being at the valves, where the temperature conditions are such that condensation need not be feared.

Furthermore, the temperature in the manifold should be strictly controlled, it being desired to bring the kerosene-air mixture to a temperature of approximately 225 deg. without, however, exceeding it, and also without using an exhaust-gas heater which would involve a large frictional resistance to the flow of the mixture with attendant condensation. Because of this the entire work of preheating the kerosene-air mixture was thrown on the manifold itself by placing the manifold in the cylinder head, which latter has no jacket, while the walls of the cylinder are liquid-cooled. The head, therefore, is cooled partly by radiation and partly by the flow of gases through the manifold, and it has been found that with kerosene as fuel and an outlet-jacket-liquid temperature of about 210 deg. fahr. the temperature of the head is in the neighborhood of 350 deg. fahr., which is just that required to raise the temperature of the mixture flowing to about 225 deg. fahr. This resulted in a good mixture being delivered in good shape to the cylinder, and all that remained to be done was to burn it there properly, a problem easier stated than solved.

A large number of tests by the writer, confirmed by similar tests made by the Office of the Director of Military Aeronautics, War Department, have shown that the amount of crankcase dilution is directly related to the temperature of the engine and is much greater in a cold engine than in a warm one. Also, numerous tests have shown that in order to properly burn kerosene the cylinder-wall temperature has to be under good control and somewhat higher than for gasoline engines; the main reason for this being that, other things being equal, the rate of combustion of kerosene-air mixtures is considerably lower than that of gasoline-air mixtures, which may be expressed otherwise by saying that the *basic* rate of combustion of kerosene-air mixtures is lower than that of gasoline-air mixtures.

In fact, it would appear that the entire design of an engine should be built around the rate of combustion of the fuel-air mixture used in driving the engine. This factor was of course unconsciously taken into consideration by the early designers of gasoline engines, but the proportions derived from their practice have been, still unconsciously in the vast majority of cases, applied to kerosene engines. It becomes therefore of prime importance to determine by what factors the rate of combustion in an engine

[1] Associate Editor, MECHANICAL ENGINEERING.

Presented at the Annual Meeting of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York, December 2 to 5, 1919. The paper is here printed in abstract form and copies of the complete paper may be obtained at a nominal price. All papers are subject to revision.

cylinder is governed, apart from the physical properties of the explosive mixture itself. The most important factor governing the rate of combustion in the cylinder of an internal-combustion engine is the temperature of the mixture, and because of this it becomes important to determine what affects the temperature of the mixture in the cylinder of an engine of the constant-volume type during the course of combustion.

In the first place, of course, the temperature of the mixture is materially affected by the temperature of the cylinder walls, which means temperature of the cooling fluid.

The next factor affecting the rate of combustion of the mixture is the compression available, which means, however, a good deal more than the "compression ratio," which is often alone taken into consideration.

The compression ratio, as such, determines only the upper limit of compression, that is, the compression pressure at maximum filling of the cylinder; but at partly open throttle there is a partial filling of the cylinder and a different final compression pressure. Hence a different final temperature of the charge. In other words, the final compression pressure depends not only on the compression ratio but also on the volumetric efficiency of the engine during the given cycle.

Therefore, if a kerosene-air mixture ignites well at, say, 500 deg. fahr. and if this temperature is produced by the compression in a given engine at maximum filling of the cylinder, at full throttle, at half throttle or half filling the compression pressure will be roughly one-half and the temperature of the mixture will be lower in accordance with well-known laws. But if combustion in a kerosene-air mixture proceeds at a certain suitable rate when this mixture is at an initial temperature of 500 deg., a much lower rate of combustion will be maintained when the temperature is, say, 375 deg., and the point may be, and actually is, reached when explosive combustion does not take place at all.

In common parlance this is described by saying that the engine "lacks flexibility" or "does not idle well."

This trouble is fundamental and does not depend on the design of a carburetor. There are only two ways to overcome it. One is by varying the temperature of the induced charge, making it colder at full throttle and warming it up at low throttle, which is, however, only a crude solution of the problem and does not meet all conditions that are encountered. Another method of meeting the same conditions would be to use a variable-stroke engine of such a construction that the full stroke is used in connection with wide-open throttle and a reduced stroke when the throttle is partly closed. It is very doubtful whether such an engine can be built with a mechanically operable piston, but its equivalent may be obtained in a somewhat roundabout way by using one of the variations of the superinduction principle. Thus, a design of engine is shown where the bottom of the cylinder is covered with a cushion of either air or inert gas when the engine is operating at low throttle.

Further consideration of the subject, especially with regard to fuels used heavier than kerosene, such as paraffin gas oil, having also lower rates of combustion, indicates, however, that compression pressure determines not so much the actual rate of combustion of the charge as the initiation of the combustion, while the actual rate of combustion at each instant depends on the expansion pressure obtaining at the preceding instant during the process of combustion. But the expansion pressure may be raised by ramming into the cylinder a greater charge than it will take when supplied with air at atmospheric pressure, which brings us to a point where we may consider what is known as a "superinduced" engine.

To sum up what has been said above, it may be stated that because of the low basic rates of combustion of the lower grades of fuel (from kerosene down to paraffin gas oil) it is hardly possible that the conventional motor may be made to handle them with the same flexibility as it does gasoline, and if lower grades of fuel are to be burned in our automotive engines these latter will have to undergo a much more thorough change in design than a makeshift adaptation, namely, a change that will bring about a high rate of combustion in a charge consisting of a fuel having a low basic rate of combustion. This condition can be accomplished by superinduction, and so far no other means have been indicated to produce the same result.

It may be stated in this connection that work which stops at enabling us to burn only kerosene will not relieve the present serious fuel situation for any appreciable length of time, because the supplies of kerosene cannot be easily increased to an extent sufficient to meet the demands of the automotive industries. Furthermore, the difference between the cost of gasoline and that of kerosene is not large now and would become still smaller if a large demand were created for kerosene. On the other hand, such fuels as paraffin gas oil with a heat content of about 140,000 B.t.u. per gal. sell for about 6.5 cents per gal. as compared with 23 cents for a gallon of gasoline having a heat content of about 125,000 B.t.u. per gal. It is therefore to these cheaper and far more plentiful fuels that we must look for a relief of the impending fuel shortage.

Briefly, superinduction may be defined as a method of operating an engine of the constant-volume type so that the pressure in the cylinder at the beginning of compression is higher than the atmospheric pressure.

The complete paper, after giving a brief account of the work done in this direction, describes an unconventional type of engine with two carburetors. The main carburetor feeding a conveniently located inlet valve is supplied with atmospheric air. The auxiliary carburetor feeding an inlet valve located at the bottom of the cylinder and uncovered by the piston at the end of the induction stroke is supplied with air delivered at a pressure of, say, 30 lb. abs. The operation is as follows: The main inlet valve opens as in conventional engines, but when the filling of the cylinder from the main inlet valve has been very nearly completed and a pressure of about 12 lb. abs. prevails, the auxiliary valve opens and the charge delivered therefrom raises the pressure at the beginning of the compression stroke to a value in the neighborhood, say, of 25 lb. abs.

In order to produce a balanced operation of the auxiliary carburetor the same pressure (i.e., 30 lb. abs.) is maintained in the carburetor inlet, the carburetor float chamber and the fuel tank, two fuel tanks being used — one for gasoline for the main carburetor and another for the auxiliary carburetor.

Furthermore, since there is a greater difference of pressure between the float chamber and the inlet manifold in the auxiliary carburetor than would have been in a conventional carburetor, a better atomization of the fuel is secured which makes it possible to use oils heavier than kerosene, such as, for example, paraffin gas oil. Moreover, while the compression pressure is roughly the same as in the conventional engine, the expansion pressure is a good deal higher, which makes it possible to secure a higher rate of combustion with paraffin gas oil as compared with what it would have been with conventional expansion pressures.

As regards the process of ignition, the top layer of the charge, which is mainly a gasoline-air mixture, is ignited first and by its combustion brings about conditions which permit an explosive combustion of the paraffin gas oil-air mixture, thus securing practically the same flexibility with the new fuel as with straight gasoline in conventional-type engines.

In the original article formulæ are given for computing the power output of superinduction engines of the type described, from which it appears that a four-cylinder 3.5 x 5 engine running at 1800 r.p.m. is capable of delivering 78.6 hp. as compared with 32.5 hp. for an engine of the conventional type. This means that the superinduction engine not only consumes a cheaper and more plentiful fuel, but that it is far more powerful than the conventional engines.

The basic idea of the paper is that the high-speed, high-efficiency fuel-oil engine that will take the place of the present extremely efficient gasoline engine such as is used in all our automotive equipment, has to be designed with a far clearer understanding of the processes of combustion than is evidenced by the engine of today. In other words, the good fuel-oil engine of tomorrow will have to be first and last a better engine intrinsically than anything we have today.

E. F. C. Water-Tube Boiler for Wood Ships

By F. W. DEAN,[1] BOSTON, MASS., and HENRY KREISINGER,[2] PITTSBURGH, PA.

The following paper describes and reports tests upon the standardized water-tube marine boiler designed by the United States Shipping Board, Emergency Fleet Corporation. In view of the large number of boilers needed (1352 ordered), the scarcity of steel and the desire to secure competitive prices, the water-tube type was adopted instead of the Scotch marine type, making it possible to have the boilers constructed in inland shops throughout the country, and effecting a reduction in the weight of steel of more than 9,000,000 lb. for the total order. The boilers had a grate area of 65.54 sq. ft., heating surface of 2500 sq. ft. and a commercial horsepower of 435 on the basis of the marine rating of 6 lb. of water to a square foot of heating surface per hour. Part 2 of the paper gives details of an investigation made by Mr. Henry Kreisinger of the Bureau of Mines on the mixtures of air and combustible in the boiler furnaces and of the temperature of the gases.

PART 1 DESCRIPTION OF BOILER AND RESULTS OF EVAPORATIVE TESTS

By F. W. Dean

In 1917 the Emergency Fleet Corporation embarked upon a program of building a great fleet of wood ships for the purpose of quickly meeting a great emergency. Wood was selected, not only for accelerating delivery, but for reducing the demand for steel which was needed for steel merchant and naval vessels.

At first it was intended to build 1000 wood ships of 3500 tons deadweight capacity each, and each ship would require two boilers containing about 2500 sq. ft. of heating surface each. The problem of securing 2000 good-sized boilers was a serious one and naturally caused careful consideration of the relative merits of water-tube and Scotch boilers. The natural inclination was to use Scotch boilers, but the boiler-making capacity of the country on the sea coast, or on waters tributary thereto, was insufficient to produce them in a reasonable time, to say nothing of the capacity of the mills of the country to produce the steel and steel plates required if Scotch boilers were used.

It was decided to use water-tube boilers, as the weight of steel in one of these boilers, with casing, is 41,200 lb., while for the equivalent Scotch boiler it is 110,000 lb. The saving of steel for the 1352 boilers finally ordered was thus more than 9,000,000 lb.

Furthermore, the adoption of the water-tube type rendered most of the boiler shops of the country available at such inland places as Battle Creek, Mich., Chattanooga, Tenn., and Allentown, Pa. All told, they were built by 19 different contractors.

Still further the competition coming from the adoption of the water-tube type, taking into consideration prices asked by some of the regular makers of marine water-tube boilers, resulted in a saving which is estimated to have been about $7,000,000 for the requirements of the program. While the Emergency Fleet Corporation has been accused of extravagance, credit for this piece of economy should be given to it, and this is due to the engineering department.

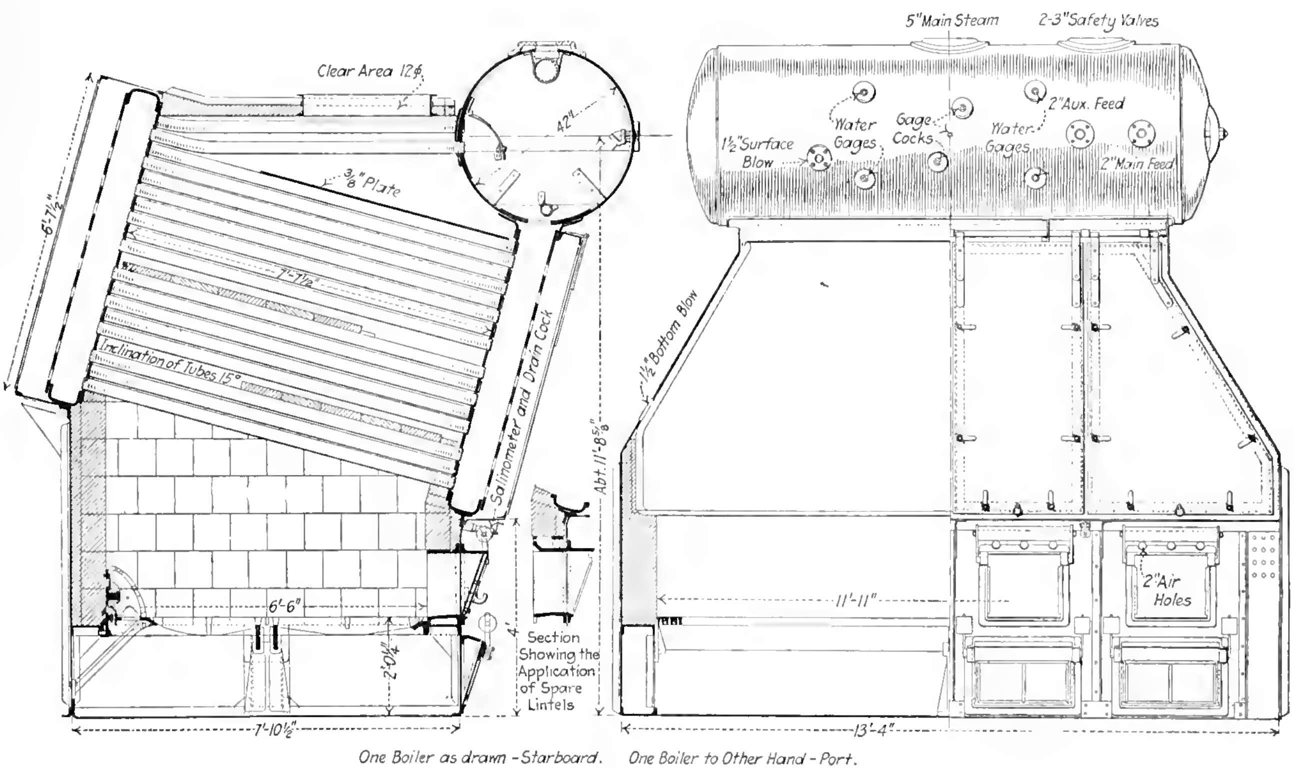


Fig. 1 Three-Pass Standard Water-Tube Marine Boiler for Wood Ships

A great advantage of the design made by the Emergency Fleet Corporation came from the fact that all of the boilers for the wood ships using the first 706 boilers were alike and differed only slightly from the later orders of 646 which were all alike. The differences in the design came from changing the number of baffles from three to four and in using Key handhole caps instead of plugs with copper ferrules.

[1] U. S. Shipping Board, Emergency Fleet Corporation, Philadelphia. Mem.Am.Soc.M.E.

[2] Engineer, U. S. Bureau of Mines. Mem.Am.Soc.M.E.

Presented at the Annual Meeting, New York, December 1919, of The American Society of Mechanical Engineers. The paper is here printed in abstract form. Copies of the complete paper may be obtained at a nominal price. All papers are subject to revision.

Description of the Boiler

The boiler as first designed is shown in Fig. 1, and as later modified in Fig. 2. It consists of two headers, each composed of two plates, known as tube and handhole plates, connected at the edges by channel-shaped pieces, the two headers being connected by tubes which furnish most of the heating surface and form means of fastening the headers together. The front header is surmounted by a steam drum which is riveted to both the drum and header. Holes in the bottom of the drum within the limits of the saddle furnish the means of connecting the interior of the drum and header, and two rows of so-called circulating tubes connect the upper part of the back header with the drum and serve to conduct the steam to it.

The header plates are stayed together by means of hollow iron staybolts, the holes being $^3/_4$ in. in diameter. The handholes in the first 706 boilers were closed by means of tapered plugs surrounded by thin copper ferrules. The plugs had a threaded shank secured by a yoke and nut as is usual for handhole plates. It was soon recognized, however, that the Key cap is better and the 646 boilers afterward ordered were provided with them.

The drum was made with the longitudinal joint where the circulating tubes enter, there being here an inside and an outside strap. The tubes pass through the shell and both straps, but the holes in the shell are larger than the tubes and the expanding occurs only in the straps. The drum is reinforced at the bottom by means of an inside strap in order to make up for the plate section cut away by the holes already referred to.

The tubes are seamless hot-rolled steel. The baffles are of the longitudinal type, of which the first boiler tested had three, forming three passes as shown in Fig. 1. After some testing it was decided that it was best to place the lowest baffle on the lowest row of tubes in order to render the second and third rows of tubes more active as heating surface. In the first design these tubes did little good except such portions of them as extended across the first pass. When this change was being made it was seen that there was room for four passes and accordingly four baffles were inserted. This rendered the boiler somewhat more efficient, especially at the higher powers, and made the efficiency curve flatter than in the case of three passes.

In the three-pass boiler the upper baffle was of steel plate and the others of tiles, but in the four-pass boiler the two upper baffles were of steel and the indications are that the others might be of steel if the tubes were sufficiently near together to touch the baffles on both sides and thus conduct the heat from them into the water. In the four-pass boiler tested the baffle next to the lowest was made of steel, and although it merely rested on the tubes it stood the service. The outer end of the lowest baffle of this boiler was made of steel and although it was in contact with tubes on the bottom only it stood the service fairly well. Experience with steel baffles in a Foster boiler tested at Burlington, Iowa, showed that they stood so well that they were adopted in all positions in this boiler. By using steel baffles in the four-pass boiler, 34 more tubes can be put in. The four-pass boiler is shown in Fig. 2.

In the drum of the standard boiler there is the usual deflector plate which prevents the steam, as it comes through the circulating tubes, from passing across the drum and compels it to pass to the ends. This deflector was removed for a time and no difference in the behavior of the boiler could be observed except that the water as it appeared in the glasses was livelier. In a seaway other advantages might appear.

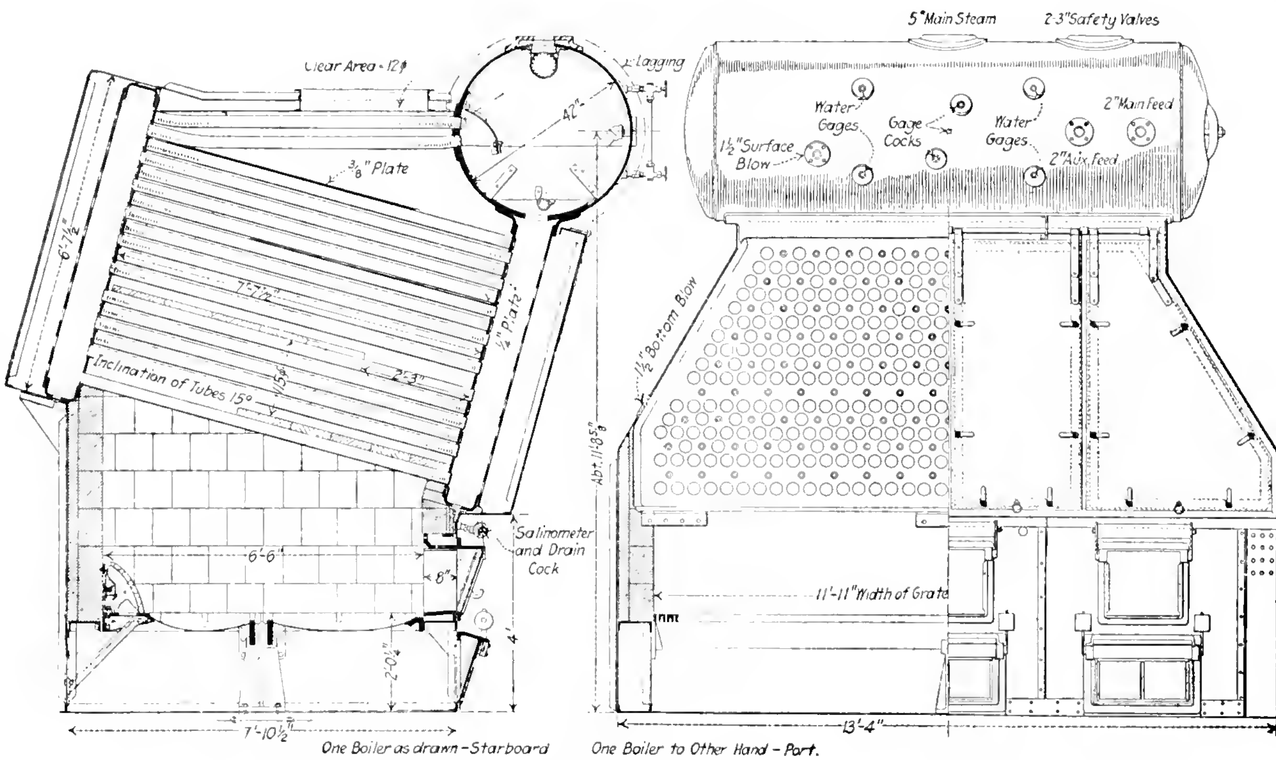


Fig. 2 Four-Pass Standard Water-Tube Marine Boiler for Wood Ships

In the top of the drum a perforated drypipe is used having eighty-eight $^3/_8$-in. holes. This is a rather small area and it proved to have an important effect in separating moisture from the steam. This was determined by testing the boiler both with and without the drypipe. The reduction in the pressure of the steam in passing from the drum to the steam nozzle was determined by a mercury manometer. At ordinary rates of working the loss in pressure amounted to little, but when forcing it amounted occasionally for short periods to six or eight inches of mercury.

The casing of the boiler is built up of steel plates joined together by external and internal shapes secured to a channel frame at the bottom which rests on the keelson of the ship. At the front there are two vertical channels acting as columns which are secured to the channels and bolted to tees riveted to the bottom of the header. The rear header of the boiler rests on a shelf formed in the casing, and the casing is a close fit around the rear header. The front columns form the only rigid connection to the channel base, and the boiler is free to slide in the rear part of the casing. The channel base is bolted to the bottom of the ship and the casing holds the boiler firmly in place and is amply able to prevent rolling or pitching at sea or in a collision, all of which has been proved by

experience, including the latter, even without rolling or collision braces.

The front and back of the casing have sheet-iron doors covering the headers, and the space between the headers and doors is sufficiently great to accommodate soot blowers. These blowers, which are found to be of great importance, blow through the hollow staybolts.

The boilers are equipped with bottom and surface blows, a duplex safety valve, two water glasses, a set of three gage cocks, main and auxiliary feeds, a salinometer cock, a basket of zinc plates and an internal perforated feedpipe.

In the three-pass boiler there are four fire doors and four ash-pit doors, but in the four-pass boiler there are three of each. These doors are of the in-swinging type. Above each door there is a hollow perforated lintel with air freely entering through holes in the casing and on the sides of the doors there are perforated jambs with air supplies from the outside. All of these air openings are not only useful in protecting the parts from burning, but promote economy, for it is found that none too much air enters the furnace through them.

The grates are of the fixed type of double bars in two lengths, and have ½-in. air and ½-in. iron spaces.

Across the back end of the furnace there is a cast-iron bridge wall with narrow air spaces which saved nearly 2 per cent of coal, perceptibly diminished smoke, improved the gas analyses, saved the back brickwork and reduced the time and labor of cleaning the fires nearly 50 per cent.

Dimensions of Boiler

The following are the leading dimensions of the boiler:

Width of casing at floor level	13 ft. 4 in.
Length of casing at floor level	7 ft. 10½ in.
Height of center of drum above floor	11 ft. 8⅝ in.
Thickness of header plates	11/16 in.
Width of water spaces of headers	8 in.
Outside diameter of tubes	3 in.
Exposed length of tubes between headers	7 ft. 7½ in.
Number of tubes between headers	388
Number of tubes between rear header and drum	21
Inside diameter of drum	42 in.
Thickness of drum plates	⅝ in.
Width of furnace	12 ft.
Depth of furnace	6½ ft.
Height of furnace at center	3 ft. 8 in.
Firing doors	15 in. by 18 in.
Width of grate	11 ft. 11 in.
Depth of grate without bridge wall	6 ft. 6 in.
Depth of grate with bridge wall	5 ft. 8 in.
Grate area without bridge wall	77½ sq. ft.
Grate area with bridge wall	67½ sq. ft.
Heating surface, fire sides	2518 sq. ft.
Thickness of brick lining	8½ in.

The Evaporative Tests

In the beginning it was decided to use Georges Creek Cumberland coal from the Big View vein on all tests in order to have a standard coal of good and uniform quality, low volatile content, and high-fusing clinker.

It was also decided to make tests with fixed grates, shaking grates, firebox without a bridge wall, with the iron bridge wall already mentioned, a brick bridge wall covering the same area as the other, and several kinds of oil burners, using Mexican oil. Mexican oil was selected because that is the oil that will be used chiefly in future.

The three-pass boiler was erected with the baffles in the positions and of the lengths in the original drawing, but the first test showed that they were not sufficiently long. Several of the earlier tests were made with the grate of the full size, that is to say, without the iron or the brick bridge wall. By the addition of the iron bridge wall, admitting air around the fire doors, lengthening and otherwise changing the baffles, and studying the method of firing, the efficiency of the three-pass boiler was raised from about 60 per cent to about 71 per cent based upon dry coal, and to about 73 per cent based upon combustible. The efficiency of the four-pass boiler was about 72½ per cent based on dry coal, and based upon combustible exceeded 74 per cent on two tests. These tests were made when firing by hand, but when using the "Type E" stoker higher efficiencies were obtained.

TABLE 1 RESULTS OF TESTS OF FOUR-PASS BOILER EQUIPPED WITH TWO-TYPE "E" UNDERFEED STOKERS

1	Date, 1919	April 8	April 9	April 13	April 12
2	Duration, hr.	24	24	22	24
	Dimensions and Proportions				
3	Grate area, sq. ft.	77.50	77.50	77.50	77.50
4	Heating surface, sq. ft.	2500	2500	2500	2500
5	Ratio grate area to heating surface	32.26	32.26	32.26	32.26
	Average Pressures				
6	Gage pressure, lb.	199 00	199.00	197.00	198.40
7	Atmospheric pressure, lb.	14.51	14.51	14 50	14.44
8	Absolute pressure, lb.	213.51	213 51	211.50	212.84
9	Draft between damper and boiler, in.	0.35	0.85	1.40	1.43
	Average Temperatures				
10	External air, deg. fahr.	47	53	50	44
11	Fire room, deg. fahr.	61	68	63	62
12	Feed water, deg. fahr.	66	67	66	63.40
13	Escaping gases, deg. fahr.	535	591	618	659
	Fuel				
14	Moist coal consumed per hour, lb.	1189	1614	2000	2392
15	Moisture in coal, per cent	2 92	2.82	3 35	4.14
16	Dry coal consumed per hour, lb.	1155	1568	1933	2293
17	Dry refuse per hour, lb.	126	160	184	214
18	Dry refuse in per cent	10.90	10.20	9.50	9 30
19	Combustible consumed per hour, lb.	1029	1408	1749	2079
	Quality of Steam				
20	Moisture in steam, per cent	0.75	0.75	0.85	1.02
	Heat Value of Coal and Efficiency				
21	Heat value of one pound of dry coal, B.t.u.	14040	14342	14234	14404
22	Efficiency of boiler based on dry coal, per cent	79.20	75.00	72.50	71.40
23	Efficiency of boiler based on combustible, per cent	80.20	76.50	72.90	72.50
	Water				
24	Water supplied to boiler per hour, lb.	11124	14588	17253	20390
25	Dry steam generated per hour, lb.	11041	14479	17106	20182
26	Factor of evaporation	1.20	1.20	1.20	1.204
27	Equivalent evaporation from and at 212 deg. per hour, lb.	13249	17375	20527	24299
	Evaporative Performance				
28	Water evaporated per pound of dry coal, lb.	9.55	9.23	8.87	8 80
29	Equivalent from and at 212 deg., lb.	11 47	11.08	10.62	10.60
30	Water evaporated per pound of combustible, lb.	10.85	10.21	9.80	9 66
31	Equivalent from and at 212 deg., lb.	12.90	12.34	11.70	11.68
	Rate of Combustion				
32	Dry coal burned per sq. ft. grate per hour, lb.	14.90	20.23	23.80	29.60
33	Dry coal burned per sq. ft. heating surface per hr., lb.	0.46	0.62	0.77	0.92
	Rate of Evaporation				
34	Water evap. from and at 212 deg. per sq. ft. h. s. per hr., lb.	5.30	6.95	8.21	9.72
35	Water evap. from and at 212 deg. per sq. ft. grate per hr., lb.	170.90	234.20	264.00	313.60
	Power of Boiler				
36	Commercial horse power for land use, hp.	384	504	595	704
37	Excess above commercial rating of 250 hp., per cent	54	102	138	182
38	Marine rating in water evap. per hr. from and at 212 deg., lb.	15000	15000	15000	15000
39	Equiv. commercial hp. of marine rating, hp.	435	435	435	435
40	Excess above or below marine rating, per cent	12 below	16 above	37 above	62 above

Results of Tests

In the complete paper four tables are given which show the general results of the tests of the three-pass and four-pass boilers under all of the conditions, both with hand and stoker firing. Those for the four-pass boiler with stoker firing are given below in Table 1. No results with oil firing are given because those tests are now in process.

While it was intended to test the boiler at the marine rating in general, which is to evaporate 6 lb. of water per sq. ft. of heating surface per hr., other rates were used, especially with the four-pass boiler. In the test of Dec. 18, 1918, the four-pass

boiler (hand-fired) was worked at 131 per cent of marine rating and 229 per cent of land rating. Even at this high rate the efficiency was about 71 per cent, and but little below that of lower rates. With the stokers the boiler was operated at 162 per cent of marine rating and 282 per cent of land rating. At this rate the evaporation was 9.72 lb. per sq. ft. of heating surface per hr. from and at 212 deg., and the efficiency was 72.3 per cent based upon combustible. Based upon the total area of grate for hand firing the coal consumption was at the rate of 29.6 lb. per sq. ft. of grate per hr. The coal consumption per sq. ft. of heating surface per hr. on this test was 0.92 lb. The test of April 8 (Table 1), shows a very high efficiency, but this is open to suspicion because the heat balance did not work out quite properly, due, it is thought, to an error in the coal weight of one hour. All of the tests given in Table 1, were of 24 hr. duration each, excepting that of April 13, which was for 22 hr.

The conclusion arrived at is that the boiler is of excellent efficiency, and that the four-pass boiler is well adapted to overloads. This is due to its having four passes. The only defect of the four-pass boiler is, as might be expected, that there is considerable absorption of draft in the passes, and the greatest loss was in the third pass from the bottom. The third baffle was lowered one tube, but the great loss continued, and it was then restored to its former position.

Among the experiments tried with this boiler were those to determine whether the number of circulating tubes and the number of holes in the bottom of the drum connecting its water space to that of the front header were excessive. Half of them, together and separately, were closed, but no effect could be observed. The conclusion was that an unnecessary number of such tubes and openings are used in this type of boiler, and by reducing them the drum will be made a safer structure.

The quality of the steam was most satisfactory when the water was carried at a proper level and it was necessary to carry it near the top of the glass before the limit of a throttling calorimeter was reached. The quality of the steam is given in all of the tables.

PART 2 PRELIMINARY TESTS

By Henry Kreisinger

This part of the paper presents some of the results of special investigations conducted by the Fuel Section of the Bureau of Mines in connection with the tests of the three-pass and four-pass marine boilers shown in Figs. 1 and 2. Outline diagrams illustrating the methods of testing these boilers are given in Figs. 3 and 4. The special investigations consisted of the study of combustion in the furnaces and the temperature of gases as they flow through the boiler. This study was carried on by the analysis of samples of furnace gases collected at various points in the setting.

Fig. 3 is a diagram of the three-pass boiler as originally designed. After the first few tests the baffles were extended, making smaller the gas passages between the ends of the baffles and the water legs. Other changes were also made as the investigation indicated the need for them. The points at which gas samples were collected are indicated by the small circles designated by the capital letters A, A', B, C, D, E, F, G, H, and I.

Admission of Air Over Fuel Bed

During the first six tests a large amount of combustible gas passed out of the furnace and either burned at the base of the stack, causing high flue-gas temperature, or escaped unburned. It was apparent, therefore, that more air had to be admitted over the fuel bed and better means provided for mixing it with the combustible. Admission of air through the holes in the fire being undesirable because the size of holes cannot be controlled, a number of ½-in. holes were accordingly made in each firing door; the small opening in the first baffle at I was closed and the baffle extended, making the gas passage between the end of baffle and the rear water leg 36 in. This had the effect of causing the air admitted through the firing door to flow farther to the rear of the furnace and thus facilitate better mixing with the combustible gases.

In addition to these changes, Wager's bridge wall was installed to supply additional air to the rear part of the furnace. See Fig. 4. The bridge wall consists of a large number of cast-iron bars

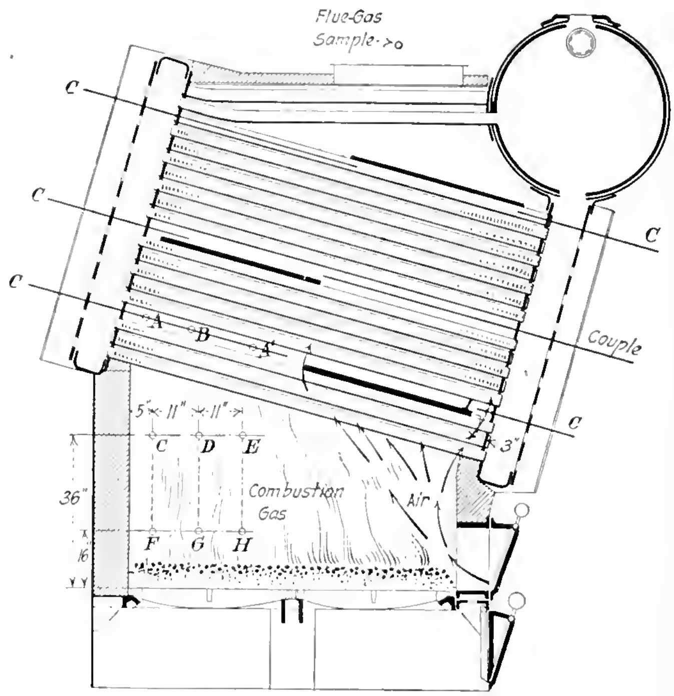


Fig. 3 Diagram Showing Method Used in Testing Three-Pass Type of Boiler

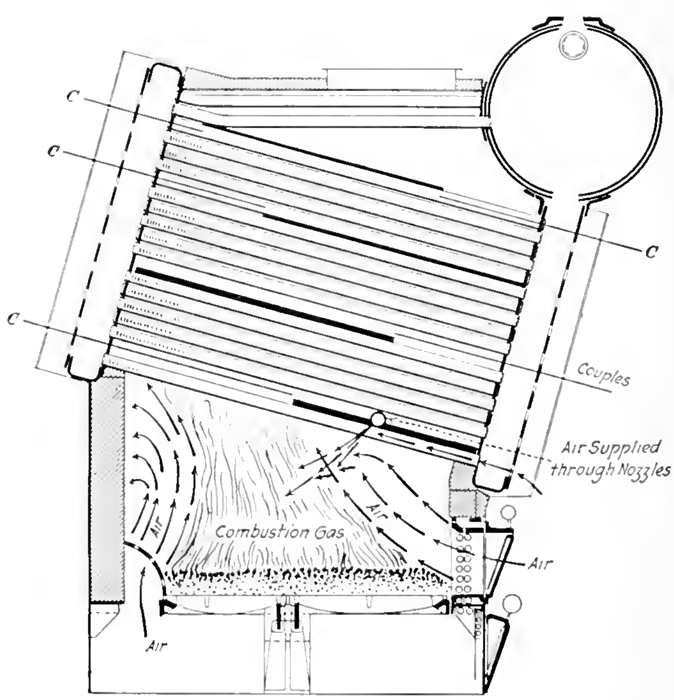


Fig. 4 Diagram Showing Four-Pass Type of Boiler With Facilities for Introducing Air Over Fuel Bed

placed against the rear wall of the furnace, and forms a structure similar to a plain grate. The air passes into the furnace through narrow slots between the bars, and is regulated by the thickness of the fuel bed near the bridge wall. The thicker the fuel bed the greater is the area of the air spaces covered with coal, and the

smaller is the quantity of air flowing into the furnace. The air enters in a large number of thin streams.

With the air admitted through the firing door and through the bridge wall, the combustible gases rising from the fuel bed are squeezed between two streams of air coming in from two different directions and the mixing is greatly aided. The direction of the streams of air admitted over the fuel bed under these conditions is indicated in Fig. 4. The total area for admission of air over fuel bed was about 160 sq. in., or approximately 2 per cent of the grate area.

Mixing of Air and Combustible by Different Methods of Admitting Air over Fuel Bed

In order to determine the effect on the mixing and combustion of various methods of admitting air over the fuel bed, a set of six gas samples was taken in the furnace and two in the gas passage between the rear water leg and the end of the first baffle. The points at which these samples were taken are indicated in Fig. 3 by the small circles designated by the capital letters A to H. The analyses of these gas samples are shown graphically in Fig. 5.

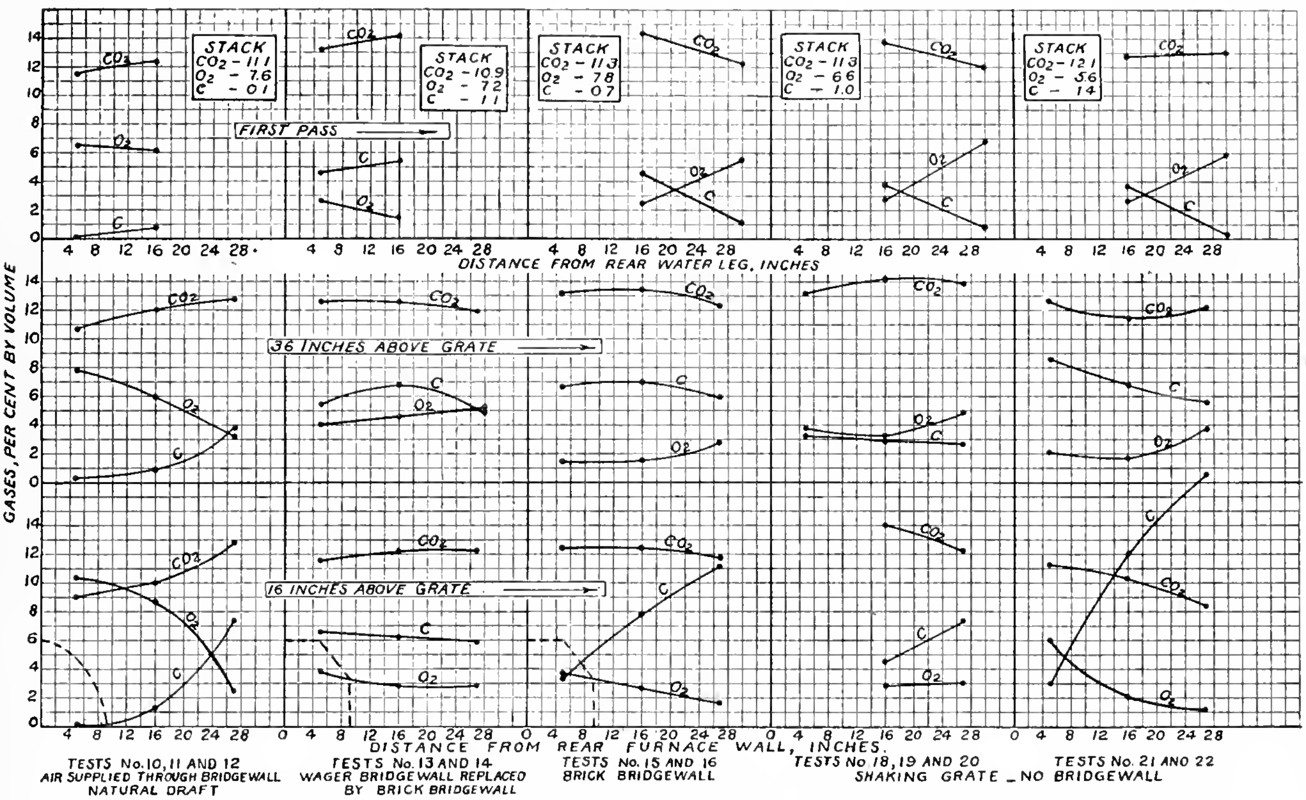


Fig. 5 Composition of Gases in Furnace with Various Methods of Introducing Air Over Fuel Bed and the Effectiveness of Mixing. Three-Pass Water-Tube Boiler

Analyses of Gas Samples Shown by Diagrams in Fig. 5

Fig. 5 shows five groups of tests, each group being represented by one of the five vertical charts. The furnace conditions under which each group of tests was made are indicated by the label at the foot of each chart. Each of the three large squares in each vertical chart gives the samples taken at one elevation above the grate, e. g., the lowest square gives the analyses of samples taken 16 in. above the grate.

The abscissæ of the lower two squares give the distance of sampling from the rear of the furnace wall; and those of the highest square give the distance of the point of sampling from the rear water leg. The ordinates give the percentage of the gases. The points giving the percentage of each gas at one elevation above the grate are connected by a smooth curve, principally to make the chart clearer. The analysis of the flue gases collected at the same time at the base of the stack is given in the small tables in the top squares. The location where the stack gases were taken is also indicated in Fig. 3.

The first group of tests gives the analysis of the furnace gases when the air over fuel bed was admitted through the firing door and through Wager's bridge wall. The chart is intended to show how the air admitted through the bridge wall mixes with the gases and affects combustion. The sample taken 16 in. above the grate and 5 in. from the rear wall shows practically no combustible gas, over 10 per cent of free oxygen, and about 9 per cent CO_2. The sample taken 27 in. from the rear wall shows about 7½ per cent of combustible, only 2½ per cent of oxygen, and nearly 13 per cent of CO_2. Apparently at this level the oxygen admitted through the bridge wall did not have a chance to penetrate far enough toward the center of the furnace to help in the combustion. The sample taken 36 in. above the grate and 5 in. from the rear wall shows less than 8 per cent of oxygen, a trace of combustible gas, and nearly 11 per cent CO_2. At this elevation above the grate the sample taken 27 in. from the rear wall shows less than 4 per cent combustible gas, about 3 per cent of oxygen, and nearly 13 per cent of CO_2. Comparison of the analyses of samples taken at these two elevations indicates that the air admitted through the bridge wall, in rising about 2 ft., has penetrated to a considerable depth into the stream of combustible gases rising from the fuel bed.

In the first pass the composition of the gases in the first 16 in. from the rear wall is nearly uniform, showing that the air admitted through the bridge wall mixed well with the combustible gases and did not pass out of the furnace in a separate stream. The stack gases showed, at the same time, 11.1 per cent CO_2 and only 0.1 per cent combustible, indicating a good combustion.

The second and third vertical charts give the analyses of gases of two groups of tests made with Wager's bridge wall replaced by a brick wall of similar shape, but having no provision for air admission. The shape of this brick bridge wall is shown by the dotted lines in the lower left-hand corners of the lowest squares. In both of these groups of tests the percentage of oxygen in the

samples taken in the furnace is low, and the percentage of combustible gases is high, clearly indicating the lack of sufficient air supply. The stack gases of these two groups of tests contain a considerable amount of combustible, although the percentage of free oxygen is about the same as it was in the groups of tests made with Wager's bridge wall. Although the air found its way into the furnace it was not introduced close enough to the fuel bed to bring the combustion nearly to completion before the gases left the furnace. In the second group of tests the gases passed out of the furnace still containing about 5 per cent of combustible, and in the third group they contained 3 per cent of combustible gas. It should be noted, however, that in the third group of tests the samples collected in the first pass were taken farther away from the rear wall, and their analyses show the presence of the air admitted through the firing doors, the sample taken 30 inches from the rear water leg showing more free oxygen than the sample taken only 16 in. from it.

The tests of the fourth and fifth group were made with a shaking grate and no bridge wall of any description. The samples taken 16 in. above the grate indicate that a small quantity of air passed into the furnace close to the rear wall, but it was not sufficient to have much effect on the combustion. The percentage of combustible remained high even when the gases reached the first pass. In these two groups of tests the samples taken in the first pass 30 in. from the rear water leg show the effect of the air admitted through the firing door. The stack samples show over one per cent of combustible gas and lower oxygen than either of the three previous groups. The lack of proper admission of air over fuel bed is clearly indicated in these last two groups of tests. The advantage of air admission through Wager's bridge wall was clearly demonstrated and it was therefore used on all subsequent tests with hand-fired furnaces.

Effect on Combustion of Different Methods of Admitting Air Over Fuel Bed

In a similar way the effect on combustion of various methods of admitting air over the fuel bed was shown by means of tests made on the four-pass standard boiler of Fig. 4. The samples were taken similarly to those on the test with the three-pass boiler, the points at which they were taken being indicated by the abscissæ and the label in each square.

The first group of tests was made with the air supplied over the fuel bed, through the firing door, and through Wager's bridge wall. Sixteen inches above the grate the admission of air through the bridge wall was apparent only in the sample taken 5 in. from the rear wall. Samples taken 36 in. above the grate and in the first pass indicated fairly uniform distribution of the air but an insufficient quantity of it. Apparently during these tests the fuel bed near the bridge wall was carried too thick. Had a thinner fuel bed been carried the combustible in the first pass would have been much lower.

The second group of tests was made with the air over fuel bed being supplied with natural draft, through Wager's bridge wall, and through the firing doors, and in addition to this also under pressure of 2 in. of water through 17 half-inch nozzles from a $3\frac{1}{2}$-in. pipe placed between the first and second rows of tubes, as indicated in Fig. 4. The object of the air forced in through these nozzles was to force the air supplied through the firing door into the center of the stream of combustible gas rising from the fuel bed and cause intimate mixing. The action of these nozzles is shown in Fig. 4. The samples collected in the first pass showed fairly uniform mixture and lower percentage of combustible than was obtained when the air was admitted only through the bridge wall and through the firing door. However, the amount of combustible was a little too high, indicating that not quite enough air was admitted.

The third group of tests was made with air admitted through the firing door, and with natural draft and air admitted through Wager's bridge wall under a pressure of $\frac{3}{8}$ in. of water. In this case the air admitted through the bridge wall tended to flow in a separate stream close to the rear wall without penetrating very deep into the stream of combustible gas. The analysis of the samples taken in the first pass showed that the excess of air decreases as the distance from the rear water leg increases. On the whole, the admission of air through the bridge wall under pressure proved to be undesirable in this type of furnace. The tests represented by the second group showed conditions most favorable to complete combustion. However, the installation of the nozzles entails undesirable complications in boiler plants of ships. The conditions represented by the first group recommend themselves by their simplicity and effectiveness when attention is given to the proper thickness of fuel bed next to the bridge wall.

Temperature Measurements

The temperatures were measured with thermocouples inserted into the setting through the hollow staybolts and moved across the gas passages, as indicated by the straight lines labeled "couples," or C, in Figs. 3 and 4. The temperatures were measured across the spaces between the ends of the baffles and the water legs.

[The complete paper concludes with a discussion of charts showing the temperature measurements at various distances from the front and rear water legs of both the three-pass and four-pass boilers, the former first with short baffles and then with long baffles, the latter with long baffles. A figure is also given which shows the average temperature drop of the gases along their path of travel through the four-pass boiler. — EDITOR.]

Government Insurance for Ex-Service Men

A series of decisions issued by the Director of the Bureau of War Risk Insurance with the approval of the Secretary of the Treasury providing for more liberal conditions of reinstatement of lapsed or canceled insurance, should prove of interest to all ex-service men. The provisions of Treasury Decision No. 47, allowing eighteen months from the date of discharge for reinstatement upon payment of only two months' premiums on the amount of insurance to be reinstated, are still retained, but that decision is liberalized by a new provision that men out of the service are permitted to reinstate by merely paying the two months' premiums without making a statement as to health at any time within three calendar months following the month of discharge. After the three months following the date of discharge have elapsed, a statement from the applicant to the effect that he is in as good health as at the date of discharge or at the expiration of the grace period, whichever is the later date, will be required together with a written application for reinstatement and the tender of two months' premiums on the amount of insurance he wishes to reinstate.

In order to give all former service men whose insurance has lapsed or been canceled, a fair chance to reinstate their insurance, including men who have been out of the service eighteen months or more, and who are therefore barred from reinstatement under the former ruling, a special blanket ruling is made which allows all ex-service men to reinstate their insurance before December 31, 1919, provided that each applicant is in as good health as at date of discharge or at expiration of the grace period, whichever is the later date, and so states in his application. Of course it is necessary that he tender the two months' premiums on the amount of insurance he wishes to reinstate.

Service men who reinstated their insurance by payment of all back premiums prior to July 25, 1919, when the decision requiring payment of only two months' premiums went into effect, upon written application to the Bureau may have any premiums paid in excess of two applied toward the payment of future premiums. For example, if after a policy had elapsed for six months, a man reinstated and paid six months' premiums instead of two, he may secure credit for four months' premiums. The provisions for reinstatement do not, however, protect a man until he actually reinstates. If he waits he may not be in as good health as he was at the time of discharge and consequently may not be able to secure reinstatement.

Flow of Water Through Condenser Tubes

By WILLIAM L. DE BAUFRE,[1] LINCOLN, NEB., AND MILTON C. STUART,[2] ANNAPOLIS, MD.

In this paper the authors give particulars regarding an extended series of tests recently conducted at the United States Naval Engineering Experiment Station at Annapolis, Md., to determine the friction loss of water flowing through ⅝-in. No. 18 gage standard condenser tubes. The investigations covered variable velocities, water temperatures, and tube length, as well as the effect of both fresh and salt water. The results obtained are presented in tabular form and from them a general formula has been derived which gives the total drop in pressure due to entrance and exit losses and to frictional resistance within the tube.

THERE was conducted recently at the U. S. Naval Engineering Experiment Station, Annapo'is, Md., an investigation upon the friction loss of water flowing through ⅝-in. standard condenser tubes of No. 18 gage, 0.522 in. in internal diameter. The principal variables were velocity and temperature of water, and tube length. The investigation also covered the variation in friction loss with clean tubes and tubes as received, and the effect of fresh and salt water. The computations were made in such a manner that losses at the tube ends and along the tube could be separated, the results being expressed in a general formula.

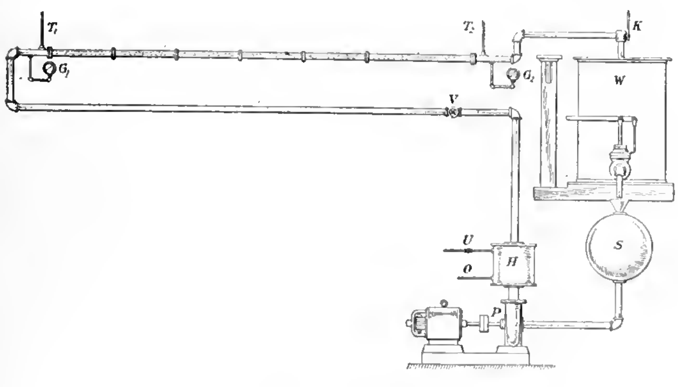


Fig. 1 Diagram of Test Apparatus

A number of sections of 3-in. iron pipe were assembled with flanges as indicated in Fig. 1. A corresponding number of lengths of ⅝-in. condenser tubing were obtained, and two brass blank flanges prepared to serve as tube sheets. These tube sheets could be inserted between any two pairs of flanges, thus enabling tube lengths of approximately 5, 8, 11, 14, 17, and 20 ft. to be tes'ed. The tubes were held in place by ordinary screwed glands in the tube sheets, and packed with cotton held between two fiber washers as shown in Fig. 2. They were supported by sheet-iron disks between the intermediate pairs of flanges.

Referring to Fig. 1, water from the storage tanks S was pumped by the motor-driven centrifugal pump P through the heater H to the condenser tube indicated by the dotted lines. From the condenser tube the water was discharged into the two tanks W, where it was weighed before being discharged into the storage tank S below. The centrifugal pump P ran at constant speed, the rate of flow of water being regulated by valve V. The temperature of the water as indicated on thermometers T_1 and T_2 was regulated by the valve U admitting steam to the heater H. The condensed steam was discharged through O into a trap not shown. Gages G_1 and G_2 served to measure the pressures before and after the tube.

[1] Professor, Department of Mechanical Engineering, University of Nebraska. Mem.Am.Soc.M.E.

[2] Mechanical Engineer, U. S. Naval Engineering Experiment Station. Mem.Am.Soc.M.E.

Presented at the Annual Meeting, December 2 to 5, 1919, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. The paper is here printed in abstract form. Copies of the complete paper may be obtained at a nominal price. All papers are subject to revision.

With each tube length a number of runs were made with distilled water at temperatures of 85, 100, 130, 160, and 190 deg. fahr. and with rates of flow up to about 7500 lb. per hr. corresponding to

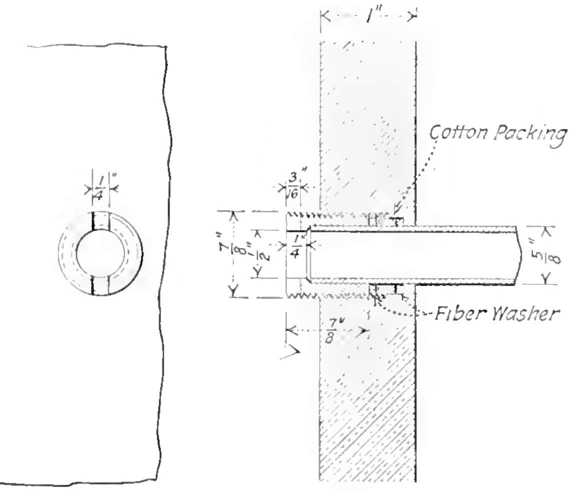


Fig. 2 Method of Securing Condenser Tube in Tube Sheet

a velocity of about 22 ft. per sec. A few runs were first made with the tube in the condition as received and at 100 deg. fahr. The tube was then cleaned by pushing through it a small rag which had been soaked in kerosene. After cleaning, the complete set of runs, numbering in all 337, was made and the results obtained are given in Table 1 of the complete paper. In order to check the constancy of the results from day to day, a certain pressure drop and rate of flow were selected as a standard at each temperature.

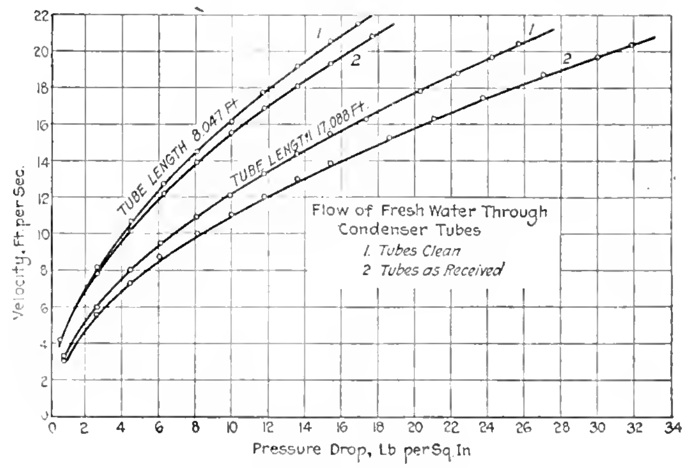


Fig. 3 Curves Showing the Effect of Cleaning Tubes

and the run under these conditions was repeated when starting up in the morning and just before shutting down at night.

After completing the runs with distilled water, which began with the longest tube and ended with the shortest one, the longest tube was again installed in order to make runs with salt water and compare the results with the data obtained for fresh water. A few runs were repeated with fresh water and then duplicated with salt water at both 70 and 100 deg. fahr. The salt water was prepared by adding to the fresh water one thirty-second of its weight of salt, in order to approximate the normal density of sea water

For the several tube lengths it was decided to use entirely different tubes rather than to take one long tube and cut off parts to obtain the shorter tubes. The results therefore include the variations that are liable to occur with commercial tubes of this size and gage.

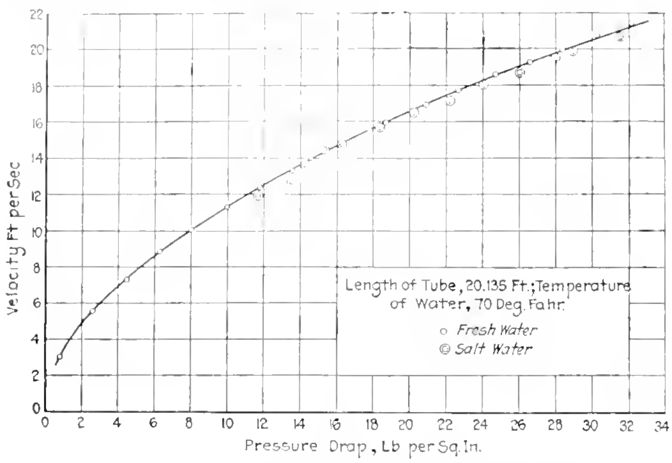


FIG. 4 CURVES SHOWING A COMPARISON OF THE EFFECTS OF SALT AND FRESH WATER FLOWING THROUGH CONDENSER TUBES

The effect of cleaning the tubes is shown in the curves of Fig. 3. and similar curves for four other tube lengths are given in the complete paper. As received from the manufacturers condenser tubes apparently offer a resistance to the flow of water 10 to 20 per cent greater than after cleaning them. A more thorough cleaning would probably have still further reduced the frictional resistance. To approximate actual condenser conditions it was deemed advisable

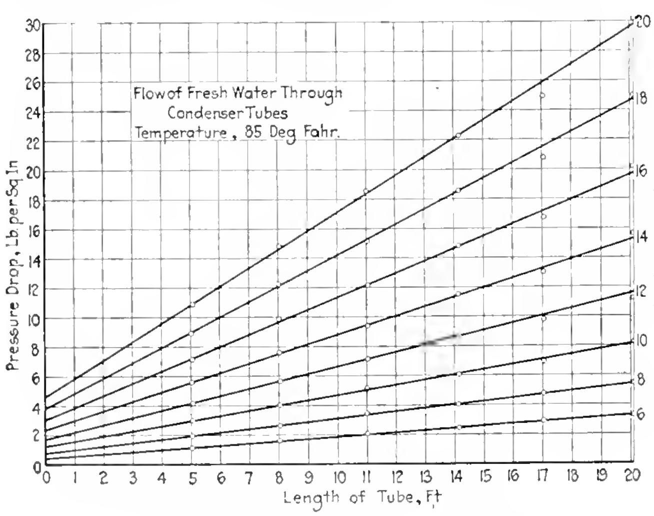


FIG. 5 CURVES SHOWING THE RELATION OF PRESSURE DROP TO TUBE LENGTH WITH WATER AT 85 DEG. FAHR.

to add about 20 per cent to the tabulated results obtained with cleaned tubes.

The curves of Fig. 4 show that the resistance with salt water having a salinity of one-thirty-second, equivalent to that of sea water, was practically the same as with fresh water. Consequently no further corrections are necessary to apply the results obtained in this investigation to condenser conditions on board ship.

In order to separate the loss of head at entrance and exit from the frictional resistance through the tubes, there were plotted in Figs. 5 to 7, inclusive, the pressure drop versus the tube length for various velocities. The points plotted in these figures were not taken directly from Table 1, but from faired curves (not included in this paper) of all runs made. By prolonging the straight lines for each velocity back to zero tube length, there was obtained the loss of head, or pressure drop, at entrance and exit.

The total drop in pressure of water flowing through a condenser tube may be expressed by the formula —

$$P = P_1 + P_2$$
$$= K_1 V^n + K_2 L V^m$$

where

P = total drop in lb. per sq. in.
P_1 = drop in lb. per sq. in. due to entrance and exit losses
P_2 = drop in lb. per sq. in. due to frictional resistance within the tube
n = velocity exponent for entrance and exit losses
m = velocity exponent for frictional resistance within the tube
L = tube length in ft.
K_1 = factor for entrance and exit losses, and
K_2 = factor for frictional resistance.

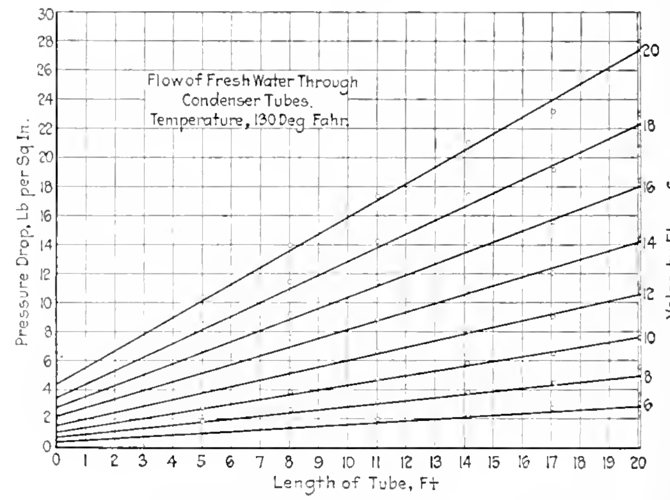


FIG. 6 CURVES SHOWING THE RELATION OF PRESSURE DROP TO TUBE LENGTH WITH WATER AT 130 DEG. FAHR.

Theoretically, the entrance and exit losses should vary as the square of the velocity. This is confirmed experimentally by the curves plotted in Figs. 8 to 10, inclusive, from the pressure drops in Figs. 5 to 7, corresponding to zero tube length. The velocity

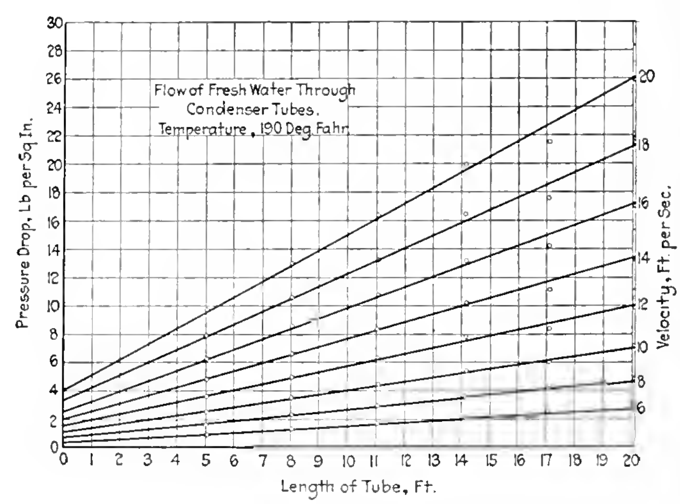


FIG. 7 CURVES SHOWING THE RELATION OF PRESSURE DROP TO TUBE LENGTH WITH WATER AT 190 DEG. FAHR.

exponent for the frictional resistance within the tube should lie between 1 and 2. The curves in Figs. 8 to 10 for the loss per foot of tube length were obtained by plotting the slopes of the straight lines drawn in Figs. 5 to 7. The exponent in all cases was found to be 1.83.

The following values of K_1 and K_2 were taken from the curves of Figs. 8 to 10, inclusive, as well as from two other figures in the complete paper for temperatures of 100 deg. and 160 deg.

Temperature, deg. fahr.	K_1	K_2
85	0.0123	0.0052
100	0.0111	0.0051
130	0.0107	0.0048
160	0.0101	0.0047
190	0.0097	0.0046

These values are plotted in Fig. 11.

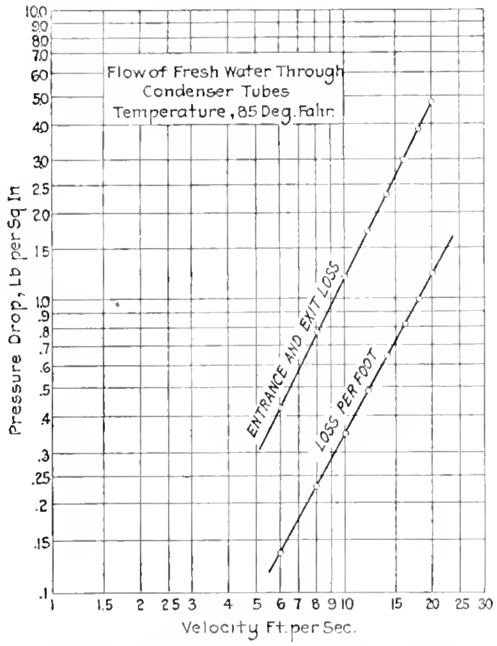


FIG. 8 LOGARITHMIC PLOTTING OF PRESSURE DROP VERSUS VELOCITY FOR A WATER TEMPERATURE OF 85 DEG. FAHR.

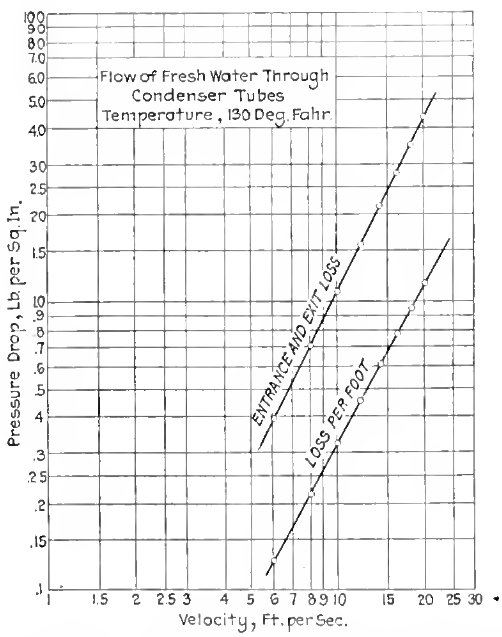


FIG. 9 LOGARITHMIC PLOTTING OF PRESSURE DROP VERSUS VELOCITY FOR A WATER TEMPERATURE OF 130 DEG. FAHR.

For clean condenser tubes, standard $\frac{5}{8}$ in. outside diameter, No. 18 gage 0.0345 in. thick, and for an average water temperature of 90 deg. fahr., we may write

$$P = 0.0118\ V^2 + 0.0051\ LV^{1.83}$$

where P is the total loss in pounds per square inch; V is the velocity in feet per second; and L is the tube length in feet. With very dirty tubes the entrance and exit losses would undoubtedly be unchanged, but the loss per foot would be greater. Assuming the latter to be increased 20 per cent for condenser tubes in the ordinary condition, for standard $\frac{5}{8}$-in. diameter tubes No. 18 gage we may write —

$$P = 0.0118\ V^2 + 0.0061\ LV^{1.83}$$

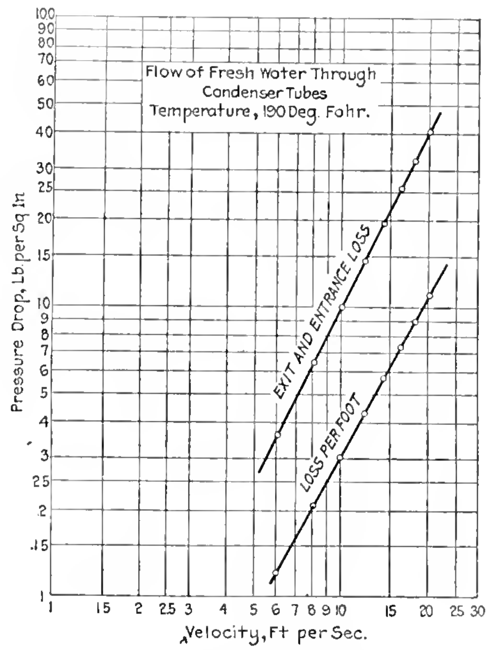


FIG. 10 LOGARITHMIC PLOTTING OF PRESSURE DROP VERSUS VELOCITY FOR A WATER TEMPERATURE OF 190 DEG. FAHR.

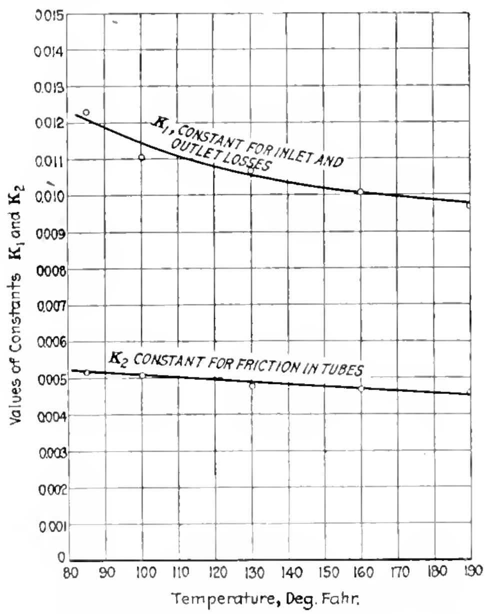


FIG. 11 CURVES SHOWING THE RELATION OF CONSTANTS TO THE TEMPERATURE OF WATER

Expressing the resistance in feet head of water, we have

$$H = 0.0274\ V^2 + 0.0141\ LV^{1.83}.$$

Pamphlets of instructions to enumerators for the fourteenth census have been sent to the 80,000 people engaged in this work. These instructions cover a special classification of technical engineers so that the returns will permit of their accurate enumeration. Special agents under the immediate direction of the Washington Census Bureau officials are in charge of the census of mines, quarries, forestry and manufactures.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A. S. M. E.

Research Problems

The attention of readers of MECHANICAL ENGINEERING is directed to two research problems proposed by the Bureau of Ordnance of the United States Navy. These problems are of a research nature in machine design, and the satisfactory solution of them would be of value for naval use.

Bibliography

The attention of the members of the Society is called to the Book Review Index published by the Carnegie Library of Pittsburgh, and also to the bibliographies which are published by the Library. The Director of the Library has consented to furnish the Research Committee with information regarding the work of the Library, and the Committee plans to transmit this information to the members through MECHANICAL ENGINEERING.

Correction

Referring to *Apparatus and Instruments A14-19* on page 890 of the November issue of MECHANICAL ENGINEERING, the Bulletin from the Bureau of Standards stated that the change in gages after a few months was from 2 to 6 one-thousandths of an inch. This should have been from 2 to 6 hundred-thousandths of an inch.

A — RESEARCH RESULTS

The purpose of this section of Engineering Research is to state the origin of research information which has been completed, to give a résumé of research results with formulæ or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigator do not warrant a paper.

Cement and Other Building Materials A11-19 Effects of Cal and Calcium Chloride on the Strength of Concrete. Calcium chloride is more effective than cal as an accelerator of the hardening of concrete. The effect varies with the concentration of the accelerator, the cement and the conditions of storage. There is some difference in the action of these during two or three days. The strength of treated concrete is invariably higher than that of the untreated. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Cement and Other Building Materials A12-19 Cement Drain Tiles and Alkali Soils. The Bureau of Standards, in continuing its work on cement drain tile and alkali soils, has found that there has been little change in the concrete blocks buried in alkali soil which were last inspected in 1916. Tiles which were then in good condition are in the same condition, and the same is true for the concrete blocks. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Electric Power A5-19 Corrosion of Cables. An investigation by the Bureau of Standards regarding the corrosion of power cables in St. Louis has shown that the corrosion was caused by electrolysis which occurred several years ago during the first few months after the cables were installed. The investigation has resulted in no saving to the company, but has demonstrated the importance of prompt attention to possible electrolysis. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Fire Protection A1-19 Gases Produced from Smoldering Fires in Small Chambers. A number of smoldering fires were built in the gas chamber of the Pittsburgh Station of the Bureau of Mines to show that it was possible to build up a concentration of 1 per cent of carbon monoxide in four hours. A quick smoldering fire or smoke seldom contains more than 1 per cent of carbon monoxide. Army gas masks remove irritating tar particles but do not remove the carbon monoxide. Bureau of Mines, Washington, D. C. Address Van H. Manning, Director.

Heat A3-19 Vapor Pressure of Lead Chloride. A complete table of vapor pressures and report on the investigation by L. E. Duschak and E. D. Eastman of the Bureau of Mines Station at Berkeley, Cal., is being printed. Bureau of Mines, Washington, D. C. Address Van H. Manning, Director.

Lubricants A1-19 Blending of Viscosity. The Bureau of Standards has prepared a diagram which corresponds with formulæ and experiments for the purpose of obtaining a certain viscosity from two oils of known viscosity. The viscosities are expressed in seconds as determined by the Saybolt viscosimeter. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Properties of Engineering Materials A6-19 Specific Gravity of Wood The Forest Products Laboratory has issued No. B-14 of its Technical Notes relating to the method of determining the specific gravity of timber by selecting chips from a boring or from a representative specimen of the wood. A specimen should not contain more than 25 cu. in. Forest Products Laboratory, Madison, Wis. Address C. P. Winslow, Director.

Wood Products A10-19 Waste Liquid Sulphur Dioxide from Smelters for the Manufacture of Sulphite Acid. The Forest Products Laboratory suggests the use of liquid sulphur dioxide from the stack gases of smelters for the manufacture of sulphite acid. When the freight charges on shipment permit this, it is advisable to utilize the waste gases. Forest Products Laboratory, Madison, Wis. Address C. P. Winslow, Director.

Wood Products A11-19 Moisture Resistance Tests for Coatings. In testing the water resistance of coated material it was found that for a 17-day exposure a humid atmosphere of 95 to 100 per cent humidity gave equal absorption with that obtained by immersing the specimen in water. Forest Products Laboratory, Madison, Wis Address C. P. Winslow, Director.

B—RESEARCH IN PROGRESS

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Cement and Other Building Materials B12-19 Reinforced-Concrete Floor Slabs. The Bureau of Standards has started an investigation on large flat slabs used in the floors of a new building for a manufacturing plant in Ohio. The slab is reinforced in the two-way system of reinforcement with hollow tile at certain intervals. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Fire Prevention B1-19 Gases Produced from Carbon-Tetrachloride Fire Extinguishers. At the Pittsburgh Station of the Bureau of Mines an investigation is being made of the composition of gases from fire extinguishers using carbon tetrachloride together with the use of gas masks for protection against these vapors. Several men were recently overcome and subsequently died from inhaling such gases in a restricted place in a submarine. The investigation is under the direction of A. C. Fieldner and S. H. Katz. Bureau of Mines, Washington, D. C. Address Van H. Manning, Director.

Fuels, Gas, Tar and Coke B6-19 Economic Use of Fuels. The Bureau of Mines is investigating this subject at Pittsburgh under the direction of Henry Kreisinger. The work includes the use of fuels in steam boilers and furnaces, the use of powdered coal, the use of fuel in refining oils, the subject of heat transmission and the study of combustion in underfeed stokers. Bureau of Mines, Washington, D. C. Address Van H. Manning, Director.

Fuels, Gas, Tar and Coke B7-19 Solid Fuels. The Bureau of Mines is investigating the utilization of coals of the Northwest at the Station at Seattle under the direction of F. K. Ovitz. This work will include the use of powdered coal and the storage of coal. Bureau of Mines, Washington, D. C. Address Van H. Manning, Director

Fuels, Gas Tar and Coke B8-19 Lignite. Work is being conducted at the Station of the Bureau of Mines at Fairbanks, Alaska, by John A. Davis on the preparation of lignite for market, and the use of this under boilers. A survey is being made of the power requirements for the interior of Alaska. Bureau of Mines, Washington, D. C. Address Van H. Manning, Director.

Metallurgy and Metallography B14-19 Graphite for Crucible Use. The Bureau of Mines is studying the preparation of graphite for crucible use at the station at Salt Lake City under the direction of F. G. Moses. Bureau of Mines, Washington, D. C. Address Van H. Manning, Director.

Metallurgy and Metallography B15-19 Flotation. The Bureau of Mines is investigating flotation at the Station at Salt Lake City under O. C. Ralston and at the Station at Seattle under W. H. Coghill. At both of these stations flotation oils are being investigated. Bureau of Mines, Washington, D. C. Address Van H. Manning, Director.

Paints, Varnishes and Resins B1-19 Luminous Paint. The Bureau of Mines through R. B. Moore, S. H. Schlundt, S. C. Lind, J. E. Underwood and C. W. Davis is investigating the cause of luminosity in radium luminous paints, and the reasons for changes in luminosity after the radium and zinc sulphide are mixed together. Bureau of Mines, Washington, D. C. Address Van H. Manning, Director.

Wood Products B3-19 Deterioration of Paper in Storage. The Bureau of Standards is testing a large number of samples of paper. Samples were tested in 1909. The results of these tests are to be compared with the tests of today. The rosin content seems to have increased 20 per cent and the strength has decreased 27 per cent. These results may be due to the change in method of making the tests. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

C—Research Problems

The purpose of this section of Engineering Research is to bring together persons who desire coöperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring coöperation or aid will state problems for publication in this section.

Apparatus and Instruments C14-19 Contraction of Sylphons with Aging. The sylphon is a corrugated tube of thin metal used as a combined spring and air container in various hydrostatically operated mechanisms. It is made at present by the Fulton Company, of Knoxville, Tenn. At present the sylphons vary in their free length with aging while retaining the same elasticity. As a result they operate at a different pressure from that intended. They usually decrease in length. It is desired, if possible, to obtain an equivalent mechanical device not subject to this defect. The requirements are as follows:

The device to be entirely of metal

The device to resist corrosion and damp air especially at sea

To be easy to assemble

To be capable of test for precision of operation without change of quality

To permit a maximum contraction of 25 per cent in length without permanent set.

Bureau of Ordnance, U. S. Navy, Washington, D. C. Address Chief of Bureau, Rear-Admiral Ralph Earle.

Apparatus and Instruments C15-19 Clamp for Wire Rope. Certain Ordnance equipment requires that pure copper wire rope be clamped without the use of any other metal than copper to a fitting by which it can be shackled or hooked to other parts. This joint is subject to continual bending of small amount, due to water motion, and joints so far constructed show failures just outside the clamp employed, due to the fact that the clamping and the stress produced by bending is not well distributed. It is required to have a clamp to meet the following specifications:

To contain no other metal than copper.

To permit clamping wire rope between ¼ in. and ½ in. nominal diameter

To be easy of assembly

To resist in the best manner continual bending in any plane to an amount not exceeding 15 deg.

To have an ultimate tensile strength of not less than 50 per cent of the rope used.

Bureau of Ordnance, U. S. Navy, Washington, D. C. Address Chief of Bureau, Rear-Admiral Ralph Earle.

D—Research Equipment

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

University of Maine D1-19 Equipment of Mechanical Engineering Laboratory:;

Five 150-hp. h.r.t. boilers

One 10 x 30-in. Hamilton-Corliss engine with Alden dynamometer

One Ford automobile engine

One six-cylinder Pierce-Arrow automobile engine

One 8 x 10-in. Fairbanks-Morse gasoline engine

One 2-cycle Knox marine engine, two cylinders 4½ x 4½, kerosene carburetor

One 4 by 6-in. Dean double-acting triplex pump

One 6-in. weir with 2-in. venturi meter and weighing tanks

One 170-sq. ft. Worthington condenser

One 7-kw. G. E. turbo-generator

One Junker calorimeter

One Olsen oil-testing machine

One 60,000-lb. Riehlé testing machine

One 150,000-lb. Riehlé testing machine

One 14,400-inch-pound Swiss torsion machine

One 2000-lb. beam testing machine

One 5-in. No. 3 Sturtevant blower.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession and especially the members of the A.S.M.E. of bibliographies which have been prepared. These bibliographies have been prepared at the request of members, and where the bibliography is not extensive, this is done at the expense of the Society. For bibliographies of a general nature the Society is prepared to make extensive bibliographies at the expense of the Society on the approval of the Research Committee. After these bibliographies are prepared they are loaned to the person requesting them for a period of one month. Additional copies are prepared which are available for periods of two weeks to members of the A.S.M.E. or to others recommended by members of the A.S.M.E. These bibliographies are on file in the offices of the Society and are to be loaned on request. The bibliographies are prepared by the staff of the Library of the United Engineering Society, which is probably the largest engineering library in this country.

Fuels, Gas, Tar and Coke F6-19 By-Product Coking. A very complete bibliography on by-product coking theory and practice with discussion of by-products. A pamphlet of 40 pages. Price 5 cents. Address Director, Pittsburgh Carnegie Library, Pittsburgh, Pa.

Economics F4-19 Market Prices. A list of journals giving market prices listed under various industries. A six-page pamphlet published by the Pittsburgh Carnegie Library, Address Director, Pittsburgh Carnegie Library, Pittsburgh, Pa.

Mechanics, General F1-19 The Gyroscope. A bibliography of theory and application of the gyroscope to aeroplanes, monorail cars, marine navigation for stabilizing and compass. A bibliography of 23 pages published by the Pittsburgh Carnegie Library. Address Director, Pittsburgh Carnegie Library, Pittsburgh, Pa.

Paints, Varnishes and Resins F1-19 Lampblack. A bibliography of 8 pages giving books, magazine articles and patents relative to lampblack. Published by the Carnegie Library of Pittsburgh. Address Director, Carnegie Library of Pittsburgh, Pittsburgh, Pa

---

A unique educational project has been developed at Spartanburg, S. C., in connection with The Textile Industrial Institute of that place. Eighteen months ago it was decided to build a modern mill for instruction purposes if funds could be raised sufficient to carry through the undertaking. Generous subscriptions were secured of cash, materials and machinery, work was begun, and the main building is now nearly completed, of reinforced concrete, most modern in design and equipment. In fact it is said that in its appointments this will actually be the finest mill in the world.

Students will operate the mill. The superintendent, overseers, as well as all the operatives, will attend The Textile Institute and will manufacture a line of high-grade cotton cloth to be known as "Character Cloth" and sold direct to consumers by parcel post.

Every student in the mill will be given special training in the class room so that he will understand the theory of the process upon which he is engaged. It is also expected that he will be self-supporting by working every other week in the mill, for which he will receive pay sufficient to cover his expenses for two weeks. At first there will be two separate student organizations having a superintendent, corps of overseers, section hands, loom fixers and operatives. Later, as the work becomes organized, it may be possible to employ more than two shifts of students and thus run the plant at the highest possible teaching efficiency.

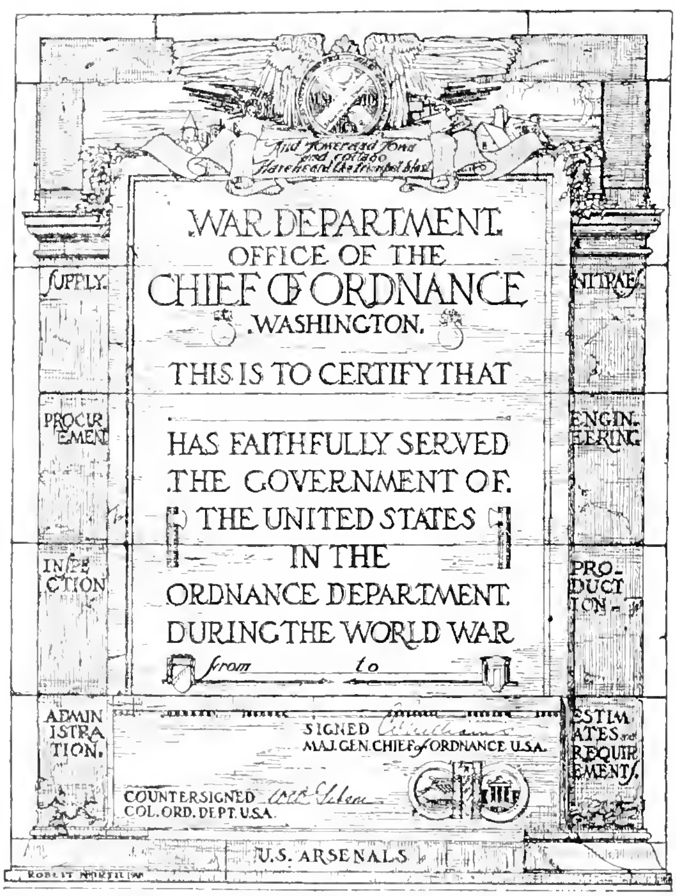
CORRESPONDENCE

Contributions to the Correspondence Departments of Mechanical Engineering by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in this journal, or brief articles of current interest to mechanical engineers.

Certificates for Engineers in War Service in the United States

To the Editor:

In the September 1919 issue of Mechanical Engineering, attention was called by Mr. Donald A. Hampson to the fact that one of the most highly-prized possessions of the returned soldier is his discharge paper. For many years the soldier who was at the front will exhibit this paper with pride and long after his friends have forgotten his record of war service his discharge will stand as evidence of the deeds which he performed. Mr. Hampson also suggested that as "it was the rounding up of the country's resources of engineering that was largely responsible for the



Certificate Issued by Ordnance Department, U. S. A., in Recognition of Home Service

'year earlier than expected' result," the Government provide "some tangible mark or document" in recognition of the service rendered during the war by those engineers engaged in work here in the United States.

Such a document is obtainable upon request, at least from the Ordnance Department, and possibly from the other branches as well. The writer served about five months at Frankford Arsenal Gage Department and was then sent to the Engineering Division at Washington for work on the standardization of gages, serving one year and eight months in all. He received a certificate on which was indicated the two departments mentioned. There may be other engineers desirous of this memento; if so, they should address their former personnel officer.

There was also a pin purchasable after three months' service, a bronze bar after six months, a red bar after a year, a red and a bronze bar after eighteen months, etc.

H. S. Kartsher.

Cleveland, Ohio.

[The Ordnance Department has issued a Procedure for Distribution of Certificates of Faithful Service which states, in part, that " a certificate of faithful service may be issued to each employee of the Ordnance Department during the war, on request, when separated from the Ordnance Department without prejudice on or after November 11, 1918," and that "any employee entitled to a certificate may, on request, have a certificate mailed to him or her bearing the dates showing the period of service in the Ordnance Department during the World War."—Editor.]

The Usual Misleading and the Correct Statement of Averages

To the Editor:

Ask anyone for a definition of an "average" and how to arrive at such average. Ninety out of a hundred will answer in accord with the Century Dictionary:

"Average: A sum or quantity intermediate to a number of different sums or quantities, obtained by adding them together and dividing the result by the number of quantities added; an arithmetical mean. Thus, if four persons lose respectively \$10, \$20, \$30 and \$40, the *average* loss of the four is \$25."

And this definition is correct so far as it goes, but it does not go far enough and therefore is frequently distinctly misleading. Yet the great majority of people and engineers who deal with averages are content with this incomplete definition and fail to realize how absolutely misleading it may be and frequently is. A few simple examples will make this clear:

I. What is the average of $2 + 3 + 4$?

The usual answer is $\dfrac{2+3+4}{3} = \dfrac{9}{3} = 3.$

II. And similarly the average of $1 + 3 + 5 = 3$.
III. And the average of $3 + 3 + 3 = 3$.
IV. Again the average of $2 + 2 + 5 = 3$.

Here are four different series all having the same apparent average of 3.

The error lies in the disregard of the amount by which the average differs from the original values. The true average should include that and for the four examples is:

I. 3 Plus or minus 1
II. 3 plus or minus 2
III. 3 plus or minus 0
IV. 3 plus 2 or minus 1

When the average is so expressed it is at once clear that in I. the terminal values of the series are 2 and 4, in II. are 1 and 5, in III. are 3 and 3, and in IV. are 2 and 5.

Certainly it is not a matter of indifference, but may be a matter of decided importance to know whether maximum and minimum values of a series differ much or little from one another.

The importance will be clear from the following illustration taken from the writer's experience in the domain of mechanical engineering.

Occasion arose casting doubt on the uniformity of the strength of balls of a well-known and highly-regarded make. On voicing that doubt to the manufacturer the writer was assured that carefully conducted tests on a considerable quantity of balls showed marked uniformity within a relatively few points.

A request for the log of these tests disclosed the explanation and showed that the claim was made in perfectly good faith, but was nevertheless made in error; the averages took into account only the first number or ordinary average, whereas the second or + and — number of the correct average had not been considered.

The log follows: Breaking loads of three series of balls of equal diameter are —

	a	*b*	*c*
	62,500	76,000	93,500
	68,000	84,500	63,000
	72,000	86,000	74,000
	94,000	91,000	69,000
	83,000	75,500	71,500
	379,500	413,000	371,000
Average	75,900	82,600	74,200

This log, when the usual averages only were considered, showed a not very serious difference.

But had the correct method of stating the averages been used, then these would have been shown as

$$a\ 75{,}900\ {}^{-\,13{,}400}_{+\,18{,}100} \qquad b\ 82{,}600\ {}^{-\,7{,}400}_{+\,8{,}400} \qquad c\ 74{,}200\ {}^{-\,11{,}200}_{+\,19{,}300}$$

These three complete averages are fully representative of the entire series of tests, while the incomplete or ordinary averages give no clue whatsoever as to the seriousness of divergencies from the average.

a The ordinary average or 75,900 gave no clue as to whether this was an average of 75,901 and 75,899 with a difference of only 1 point + or —, whereas the actual difference between the numbers of the series was much more important, amounting to 13,400 — and 18,100+.

It is thus clear that these full or complete averages do convey full information. Had these complete averages been used their use would, in all probability, have avoided the unintentional giving of misleading information.

This misleading use of the term average is so general that it invades even such standard works as our engineering pocketbooks.

Thus Suplee gives the compression in pounds per square inch of granite as averaging 15,000 lb. and for four different varieties gives 12,000, 15,000, 16,000 and 15,000 lb. The average of these four varieties is $14{,}500\ {}^{-\,2{,}500}_{+\,1{,}500}$.

Assuming that all granites lie between the limits of the four cited, the complete average stated gives safe data.

Suplee further gives the average for slate as 10,000 lb., but quotes no varieties; yet it is certain that some slates are stronger and some weaker than others. What is their safe value? The completion of the average by the second term of $\frac{-}{+}$ would give the necessary information.

Similarly it is certain that some steel castings have higher elastic limits than the 40,000 lb. per sq. in. that Suplee quotes as average; but how much less or how much more is left to the reader's imagination. A complete statement of the average would here again substitute definite information for guesswork.

These few examples taken at random prove the need of a more complete definition, which, following the Century, would be:

"Average is that quantity intermediate a number of different quantities obtained by adding together these quantities, dividing the result by the number of quantities that were added, supplemented by a statement of the quantities by which the result differs from the largest and the smallest of the quantities. Thus, if four persons lose respectively \$10, \$20, \$30 and \$60, the average loss is $\$30\ {}^{-\,\$20}_{+\,\$30}$."

Henry Hess.

Philadelphia, Pa.

Present-Day Problems Discussed by E. W. Rice, Jr.

In an address at the opening meeting in Schenectady of the recently organized Eastern New York Section of the A.S.M.E., Mr. E. W. Rice, Jr., president of the General Electric Company, urged engineers to give more attention to economic problems and emphasized the importance of increased production and simple living as a means of offsetting the difficulties of today. He said in part:

Engineers have been so busy increasing the productivity of man that they have not noticed that many people, who have profited thereby, have been equally busy in an effort to decrease the productiveness. Engineers are workers, not talkers, and have been inclined to ignore the talkers who were not workers.

This attitude was fairly safe as long as the talkers had no influence on the result. The situation has changed greatly during the last few years. Millions of producers were taken out of production to form armies and navies and to take care of their supply and maintenance. Besides the loss of the production of useful goods, there was, of course, added the tremendous destruction and wastes of war. In view of such a situation, what action should be taken by the engineer?

With his training and record, he would, of course, bend every energy to replace the destroyed goods and increase the output of the world's farms, factories and mines; he would improve the methods of transportation, not only to meet the current demands, but to make up for the losses of the last five years. This country and the whole world needs to produce greater quantities of every useful thing more than ever before in its history. Most people who think clearly and without passion and prejudice agree with the engineers on this subject, but there are others, unfortunately, who act as if they did not see the world's need, or seeing it, did not care. They demand shorter hours, although this means loss of production, and they strike, thus actually stopping production altogether for a time to enforce their demands for lessened production.

What would you think of an engineer who deliberately designed machinery to produce fewer articles rather than more, who instead of trying to increase his usefulness and service to the world, made every effort to reduce the value of his contribution? I imagine that we would pity him and the verdict would be that he had lost his mind. Now it is difficult to believe that these masses of men, of which I speak, are all crazy or wicked, and therefore the problem to be solved is to find out what is the matter with them.

I suggest as possibly the most reasonable answer that they are ignorant of the fundamental economic facts and principles. They really do not know what they are doing. The essential principles of economics are not difficult to ascertain or to understand. I think we all wish to get at the truth. The problems of today are created by a lack of understanding and appreciation of the great principles of economics which are built upon the experience of men during the long evolution upward from savagery and barbarism.

I am anxious to see engineers devote more time to the study of economic facts and principles. I feel sure that if they approach this investigation in the same spirit and use the same methods that they employ in solving mechanical problems, they will arrive at a satisfactory solution.

The high cost of living is one of our basic present-day problems. The ultimate solution from the standpoint of an engineer would seem to be increased production so that the world may have an abundance of the things which are needed or desired. Until this increased production has been obtained and a bountiful supply of goods realized, it would seem to be our duty to restrict our desires and demands as much as possible and to make the same sacrifices which were so cheerfully made during the war. It has been suggested that the present high cost of living is aggravated and increased by the extravagance of the great majority of people — rich and poor.

The engineer will readily appreciate that if such extravagance is limited to a few, the effect on the high cost of living will be negligible, while if indulged in by many, it will be most serious.

ENGINEERING SURVEY

A Review of Progress and Attainment in Mechanical Engineering and Related Fields, as Gathered from Current Technical Periodicals and Other Sources

SUBJECTS OF THIS MONTH'S ABSTRACTS

AIR MACHINERY

Blowers for Aero Engines, W. G. Noack. Description of blowers built in Germany for use in supercharging aircraft engines at high altitudes.

The blowers are of the centrifugal type. Three or four stages are directly driven off the engine shaft, suitable provision being made to prevent torsional oscillation. The delivery is regulated by throttling the air intake of the blower. The carburetor has to be compensated for variations of air pressure in the usual manner. The speed of rotation is very high—10,000 to 11,000 r.p.m., and special steels are used for the rotors. The weight of a blower complete with fittings suitable for an engine 260 hp. and capable of reproducing ground-level conditions up to 15,000 ft. is 125 lb. The power consumed is about 25 hp. *(Flugsport,* Sept. 19, 1919, abstracted through *The Technical Review,* vol. 5, no. 48, Oct. 28, 1919, p. 82, *d)*

ENGINEERING MATERIALS (See Metallurgy and Ignition Apparatus)

HEAT TREATING

Copper Diffusion through Cast Iron, H. E. Diller. When a malleable-iron bar packed in copper oxide packing and annealed at 1000 deg. cent. was taken from the furnace it was found that the copper oxide was reduced to metallic copper, which latter was melted and penetrated into the iron. An average sample of

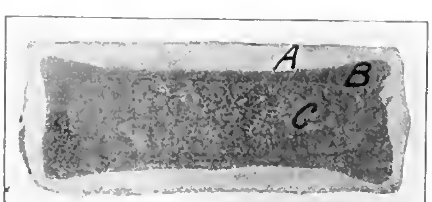


Fig. 1 Cross Section of Gray-Iron Bar Annealed in Copper Oxide Packing

the bar showed that the carbon had been reduced from 2.70 to 0.60 per cent and that there was 21.4 per cent copper.

The test showed for this bar a strength of 68,200 lb. per sq. in. and an elongation of 1 per cent in 2 in. The electrical conductivity of the metal was not materially increased by the presence of the copper.

In other tests the test pieces were packed in black copper oxide and heated to about 900 deg. cent. The results were different and a far smaller penetration of copper was observed.

With gray iron quite different results from those for malleable iron were obtained. This is illustrated in Fig. 1, which shows a cross-section of one of the bars. Three distinct areas can be seen. The area *A* contains all of the copper. There is a thin layer of copper on the outside and next to this the copper is very finely divided and is in the form of droplike areas surrounded by a

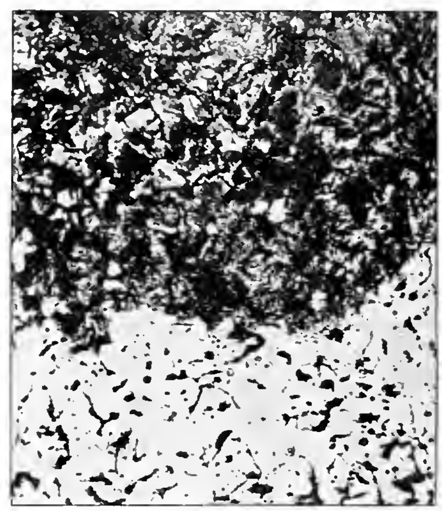


Fig. 2 Dividing Line Between *A* and *B*, Fig. 1

Fig. 3 Structure of *B* and *C*, Fig. 1

matrix of iron. This matrix has a peculiar structure and is more like steel than it is like gray iron. The line between *A* and *B*, Fig. 1, is shown in Fig. 2. The dark area is the portion containing the copper. The light portion in the same figure represents

the structure of the section marked *B* in Fig. 1. The same structure is seen in the upper section of Fig. 3, which is part of the dividing line between areas *B* and *C*. This structure is almost like the structure of malleable iron in its appearance under the microscope, but scattered through it can occasionally be seen flakes of graphite.

The center of the bar *C*, Fig. 1, has the structure of unchanged gray iron. This is shown in the lower section of Fig. 3. (*The Foundry*, vol. 47, no. 334, November 1, 1919, pp. 779-780, 6 figs., *e*)

HYDRAULIC ENGINEERING

Orifice Measurement of Water-Pipe Discharge

THE ORIFICE AS A MEANS OF MEASURING FLOW OF WATER THROUGH A PIPE, Raymond E. Davis and Harvey H. Jordan. The thin-plate orifice may be used with confidence for measuring the discharge of water through pipes. Like nearly all methods, it is subject to some limitations, although it helps to fill a growing need which has been partly filled by the pitometer and by the injection of chemicals. The pipe orifice is in effect a portable venturi meter, the disadvantage of the pipe orifice being the relatively large lost head caused by the obstruction of the orifice plate; however since the pipe orifice method is probably best adapted to temporary use the lost head may in general be unimportant. In a long pipe line also the lost head caused by the orifice would be relatively small. Cases in which the pipe orifice should be of particular value have already been suggested in the introduction.

Although all the deductions and conclusions given in this summary apply to the measurement of water, attention should be called to the fact that the pipe orifice is adapted to measuring the discharge of air, gas, and steam through pipes.

The following points are important as a guide to the proper use of the pipe orifice method of measuring the discharge of water through a pipe:

1 The two sections of the pipe between which change in pressure head may be most reliably determined are the section at which normal flow is discontinued and the stream begins to converge as it approaches the orifice, and the section of greatest contraction of the jet after it leaves the orifice. Regardless of the size of pipe, for all sizes of orifice which it is feasible to use, the distance from the plane of the orifice to the section of beginning of convergence may be taken as eight-tenths the pipe diameter, and the distance of the section of greatest contraction as four-tenths the pipe diameter.

2 The drop in pressure head between these two sections is greater than that to be found for any other two sections near the orifice.

3 Having given the measured difference between the pressure head at the section of beginning of convergence and the pressure head at the section of greatest contraction the discharge may be determined through the use of one of two equations given in the original paper. (In one of these equations there is used a coefficient of discharge which is a variable quantity.) It decreases as the size of pipe increases; it decreases slightly as the drop in pressure head increases; it has a minimum value for orifices having a diameter of one-third that of the pipe and increases as the diameter of the orifice becomes greater or becomes less than one-third the diameter of the pipe.

4 The lost head caused by any given orifice in the pipe in terms of the velocity in the pipe may be determined by an equation given in the original paper, and is always less than the drop in pressure head between the section of beginning of convergence and the section of greatest contraction, but approaches it in value as the ratio of the diameter of the pipe to the diameter of the orifice (D/d) increases.

5 Due to the fluctuations of the liquid in the gage tubes the systematic error of reading the gage increases as the ratio of the diameter of the pipe to that of the orifice decreases, but when that ratio (D/d) is 2 or greater the error may under normal conditions of flow be reduced to a negligible quantity by a proper manipulation of apparatus. As (D/d) becomes less than 2 the accidental error of reading the gage increases very rapidly, and also small errors in the measurement of the diameter of the pipe or the diameter of the orifice are likely to be the constant sources of an error of increasing magnitude in the computed discharge. The indications are that, for favorable conditions of flow and with care in installing the apparatus and in observing, discharge may be determined generally within 2 per cent when the diameter of the orifice is not in excess of two-thirds that of the pipe, but this size of orifice seems to be about the maximum that can be used except for approximate determinations of discharge. When the magnitude of the lost head is not the controlling factor in the choice of size of orifice, best results are likely to be obtained if the diameter of the orifice is not greater than one-half that of the pipe.

6 For orifices having a diameter greater than one-half that of the pipe the use of two opposite pressure openings at each section is important because of the probability of the orifice being somewhat eccentric with the pipe, unless greater care is taken in placing the orifice than will usually be found practicable. Systematic errors of observing may be greatly reduced by proper throttling.

7 The coefficient of discharge for bevel-edged orifices is a much more variable quantity and is materially greater than the coefficiency of discharge for thin square-edged orifices. The use of the bevel-edged orifice seems not to be practicable, except for approximate measurements when the orifice diameter is greater than two-thirds of the pipe diameter. (*The University of Illinois Bulletin*, vol. 16, no. 14, Dec. 2, 1919, 52 pp., 14 figs., 7 tables, ***tpA***)

HYDRAULIC MACHINERY

DETERMINATION OF ENERGY LOSSES IN CENTRIFUGAL MACHINERY ON THE BASIS OF THEIR CHARACTERISTIC CURVES, R. Muller, Dr. of Engrg. Data of an investigation having reference to centrifugal machinery in which a liquid or gaseous material of substantially constant density flows through one or more centrifugal wheels

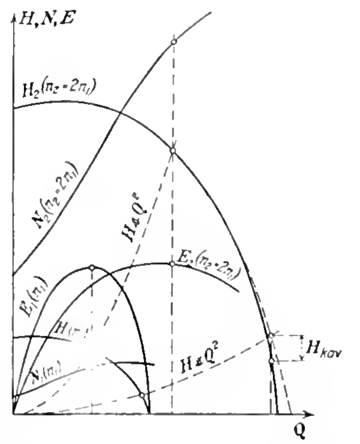


FIG. 4 CHARACTERISTIC CURVES OF A CENTRIFUGAL PUMP WITH CONSTANT SPEED OF ROTATION IN REVOLUTIONS n_1 AND $n_2 = 2n_1$

having full admission. The problem under consideration is to determine the energy losses occurring in the machinery, to separate them into their main components and to express their functional relation to known magnitudes by means of constant or variable coefficients. It is assumed that there are available constructional and blade drawings of the machine, data of tests and characteristic curves.

These characteristic curves are given for a centrifugal pump in Fig. 4 and show the output demand *N*, delivery head *H*, and efficiency *E* as a function of the amount of water *Q* delivered in one second at constant speed in revolutions *n* (or 2 *n*) of the pump wheel.

The article itself is of a mathematical character not suitable for abstracting under the present conditions of publication of the Journal. The whole calculation is based on the assumption that the known deviations of the actual flow through the turbine wheel as compared with what they should be in accordance with the Euler theory may be credited to secondary phenomena of flow within the wheel itself. As far as possible at the present time proper loss coefficients are used in the computation of the various components of the total loss, these loss coefficients being derived partly from the estimation of the characteristic curves and partly by direct experimentation. As regards these latter, references are given to technical literature where data as to their value may be found. (Beurteilung des Energieverlustes von Kreiselradmaschinen auf Grund ihrer Kennlinien, R. Mueller, *Zeitschrift des Vereines deutscher Ingenieure*, vol. 63, no. 26, June 28, 1919, pp. 601-607, 12 figs., *t*)

IGNITION APPARATUS

Nickel Spark-Plug Terminals Deteriorate through Excessive Local Heating

Deterioration of Nickel Spark-Plug Terminals in Service, Henry S. Rawdon and A. I. Krynitzky. The most commonly used material for terminals in spark plugs is commercial nickel wire containing about 97 per cent nickel, the remainder being manganese, cobalt, iron, copper and minor impurities. The peculiar type of deterioration that occurs in these nickel terminals during the service life of the spark plug was recently brought to the attention of the Bureau of Standards, the present paper giving the main results of the investigation.

It has been found that the deterioration of the central terminal was quite negligible compared to that of the side terminal or terminals. These latter wires had developed, in service, transverse cracks that in many cases were as sharp and definite as a knife cut. After a separation occurred the bridge widened by loss of material from ends of the fractured wires until a gap of as much as one centimeter often resulted. The fragments of the deteriorated wire terminals removed from the spark plugs were found on the whole to be rather ductile and stand several sharp right-angle bends before breaking. The extreme end portion immediately adjacent to the break, however, was brittle and broke readily when an attempt was made to bend it.

The examination of the central terminal showed that a change of the same character as occurred in side terminals had taken place in this one also, but to a far less extent.

The tests would indicate that variations in chemical composition such as occur in commercial nickel wire are not a determining factor in the deterioration of the wire in service. Terminals of nickel of relatively high purity were found to be attacked in the same manner as others of lower nickel content. Oxidation of the nickel does not appear as being of great importance in this connection, and the action of hot reducing gases, though somewhat greater than that of oxidizing, does not appear to be very great either.

It would appear that the main cause of embrittlement of the wire lies in the intense local heating by means of the electric spark, together with the sudden cooling, and that once the formation of transverse intercrystalline cracks has started the application of a relatively low stress to the hot wire is sufficient to fracture the wire. (*Bulletin of the American Institute of Mining and Metallurgical Engineers*, no. 152, August 1919, pp. 1323-1350, 21 figs., *e*)

INTERNAL-COMBUSTION ENGINEERING

British Improvements in Diesel Engines

British Stationary Diesel Engines of Today. Brief notes on various improvements introduced by British manufacturers in the last five or six years.

Mirrlees, Bickerton & Day have introduced in their engines a pilot jet of kerosene to form a flame for the ignition of a varying jet of tar oil, which enables this difficult form of fuel to be used successfully at all loads.

The same firm has recently introduced the air-blast controlling device shown in Fig. 5, the purpose of which is to control the pressure of the air blast to suit the varying loads in central-station work.

It has been recognized that the proper proportioning of the air to the load and hence to the amount of fuel used results in a smoother-running engine due to better combustion of the fuel owing to a reduction of the cooling effect of the incoming air.

In the device shown in Fig. 5 two pointers are fitted centrifugally on a dial calibrated in pounds per square inch of blast-air pressure ranging from the pressure suitable for no load up to that for full load, one pointer being operated by the blast-air pressure and the other by the main generator current passing through the solenoid *A*. The calibration of the gage is so adjusted that the latter finger points to the pressure which is suitable for the power being given by the engine instead of to the amperes being given by the generator, as would be the case if the gage were being used an as ammeter, which, in fact, it is. The two pointers are insulated from each other, but are provided with platinum contacts coupled to wires through which the circuit can be made through the relay *H*. Thus, if the generator pointer is separated from the

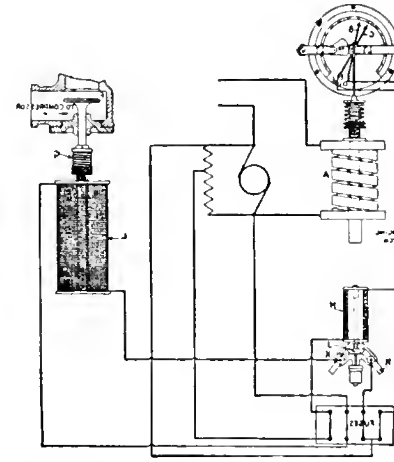


Fig. 5 Mirrlees Air-Blast Controlling Device

air-pressure pointer no current passes through the relay *H* and the core *J* falls and closes the circuit through the carbons *K* and so through the solenoid *L*, which opens the throttle valve *F* to the air compressor and increases the supply of air till the two pointers coincide. In actual practice when on a steady load the apparatus is constantly working and it has been found that the improved combustion so procured actually increases the life of the exhaust valve.

Hick, Hargreaves & Co. state that their valve rockers are now made of cast iron, not the ordinary cast iron of commerce, but something more of a malleable nature, and they give no trouble.

The same firm evolved the cylinder cover shown in Fig 6. Their belief was that one could not expect to get a rigid casting of unequal thickness to withstand the unequal temperature stresses to which this part is subjected. The utmost possible flexibility has therefore been aimed at and only the inlet- and exhaust-valve pocket walls are carried right through. This leaves a large space between the two pockets for water circulation. This space is not completely filled in by the fuel-valve pocket as is usual, and instead of a thick cast-iron ring a light steel tube is used. This tube is screwed into the bottom and a watertight joint is secured at the bottom by a series of sharp concentric serrations on the face of the lower shoulder, the top being riveted over. The air-starting valve pocket is formed in the same way. Then in order to obtain the full benefit of the passages so formed, internal combustion pipes are fitted (shown dotted in the drawing) which direct the water round the exhaust and fuel valve and make for thorough cooling of those parts.

In the engines of Willans & Robinson, Ltd., the fuel-pump suction valve is used as the medium for stopping the engine in the event of the failure of the water circulation.

From the article it would appear that a good deal of attention is paid by British Diesel engine manufacturers to the neat design of their air compressors. *(The Engineer,* vol. 128, no. 3328, Oct. 10, 1919, pp. 349-351, 6 figs., *d)*

Practical Brake-Horsepower Formula for Internal-Combustion Engines

A Practical Brake-Horsepower Formula for Internal-Combustion Engines, Herman Lemp. The author's formula has been derived from the old formula, $PLAN/33{,}000$, and is peculiarly convenient in that all its numerical coefficients have been combined into a single round number, 1,000,000. This formula is:

For a single-acting multi-cylinder engine of the four-stroke cycle type:

$$\frac{s \times d^2 \times n \times N \times MP}{1{,}000{,}000} = BHP \ldots\ldots [1]$$

To suit these conditions the special formula described above has been derived from the well-known horsepower formula: $PLan/33{,}000 = IHP$, which gives the indicated horsepower of a single-cylinder double-acting engine, in which P stands for the mean effective pressure in lb. per sq. in. of piston area (usually termed MEP), L for the length of piston stroke expressed in feet, a for the area of piston expressed in square inches, n for the number of strokes (2 × revolutions) per minute, and 33,000 for the ft-lb. per min. contained in one horsepower.

To adapt this formula to the brake horsepower of a multi-cylinder engine of the four-stroke cycle, single-acting type, the formula becomes:

$$\frac{PLan \times N \times M}{33{,}000 \times 2} = BHP$$

where M stands for mechanical efficiency, N stands for the number of pistons, and n for number of revolutions.

Since in a four-stroke cycle an active stroke occurs only every other revolution, the formula is divided by 2, or further expanded becomes:

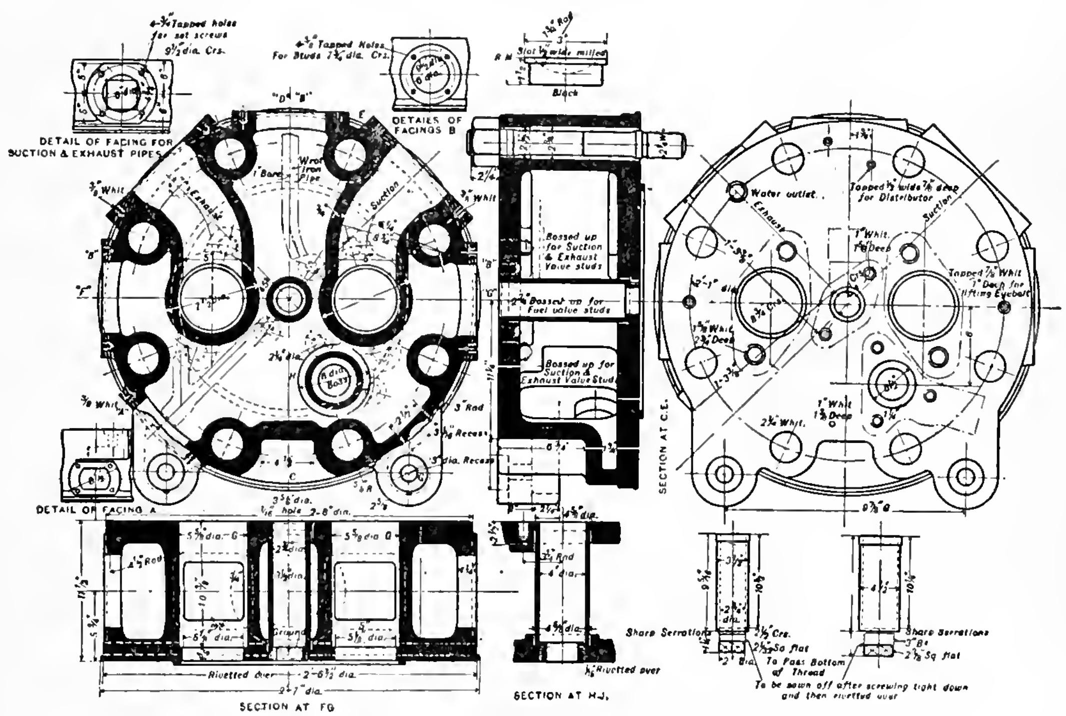


Fig. 6 Hick, Hargreaves & Co. Diesel-Engine Cylinder Cover

For a single-acting multi-cylinder engine of the two-stroke cycle type:

$$\frac{s \times d^2 \times 2 \times n \times N \times MP}{1{,}000{,}000} = BHP \ldots. [2]$$

in which s stands for stroke of piston in inches, d for diameter of piston in inches, n for number of revolutions per minute, N for number of pistons (not cylinders), MP for mean effective pressure (MEP) in lb. per sq. in. of piston area multiplied by mechanical efficiency.

For a double-acting engine [1] and [2] should be multiplied by 2.

The preponderant number of internal-combustion engines are single-acting, of multiple-cylinder type, and work on the four-stroke cycle. They are mostly used in automobiles, motor boats, airplanes, and stationary lighting sets, and are usually of a speed so high that the taking of indicator diagrams is not practical, while on the other hand the brake-horsepower outputs are easily ascertained by a cradle dynamometer, a Prony brake, or a plain electric generator whose efficiency curve is known. Furthermore, the stroke of such an engine is usually expressed in inches.

$$\frac{P \times \frac{s}{12} \times d^2 \frac{3.14}{4} \times n \times N \times M}{33{,}000 \times 2} = BHP$$

The formula may now be simplified by writing all constant factors together, followed by variables; thus we have:

$$\frac{3.14}{4 \times 12 \times 33{,}000 \times 2} \times s \times d^2 \times n \times N \times MP = BHP$$

The first part of the formula may now be solved and replaced by $\frac{1}{1{,}008{,}403}$, or for all practical purposes $\frac{1}{1{,}000{,}000}$, and we then have the final formula [1] shown at the head of this article, namely,

$$\frac{s \times d^2 \times n \times N \times MP}{1{,}000{,}000} = BHP \ldots\ldots\ldots\ldots [1]$$

The fact that the quotient of the constant factors $\frac{1}{1{,}008{,}403}$ when

replaced by $\frac{1}{1{,}000{,}000}$ produces an error of less than nine-tenths of one per cent had been discovered accidentally by the writer at the time this formula was developed, and it is this feature which renders the formula particularly useful.

We may now write the formula in the following form:

$$\frac{s \times d^2 \times n \times N}{1{,}000{,}000} = \frac{BHP}{MP}$$

showing that the relation between *BHP* and *MP* remains for any set of conditions.

The slide rule is extremely useful for solving either *BHP* or *MP*, by multiplying $s \times d^2 \times n \times N$ and setting 1 on scale *C* over the product, when by means of the rider either *MP* may be read off on scale *C* or *BHP* on scale *D*. This is best illustrated by a complete example:

A four-cylinder, four-stroke cycle engine of 5-in. bore, 6-in. stroke delivers at 600 r.p.m., 22.9 b.hp. What is its *MP?*

$$6 \times 5 \times 5 \times 600 \times 4 \times MP = 22.9\ BHP$$

Multiplying $6 \times 5 \times 5 \times 600 \times 4$ on the slide rule brings the rider to 36 on scale *D*, opposite which having placed 1 on scale *C*, one will find opposite 22.9 on scale *D* an *MP* of 63.6 on scale *C* (see Fig. 7).

This *MP* (accurately 64) is based on 80 *MEP*, with a mechanical efficiency of 80 per cent, which with a compression of 60 lb. is reasonable to expect in a normally designed engine.

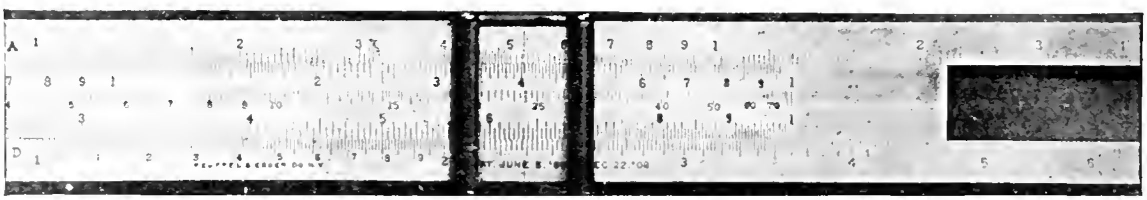


Fig. 7 Illustrating the Application to the Formula of a Concrete Case by Use of the Slide Rule

With slide rule set as above, the respective values of *MP* and *BHP* can be varied at will, since their relation remains constant.

The writer wishes to lay particular stress on the value of *MP* as a characteristic value whereby to compare engines. We find this value in recent works and technical papers expressed as *mean effective pressure per b.hp.* or *brake mean effective pressure.*

The writer has already recommended that *mean pressure* or its symbol *MP* should be adopted for this value and this figure is being used more frequently. A high *MP* is an indication that both the indicated horsepower for a given displacement is high and the internal friction is low, hence a large b.hp. is developed.

To illustrate: Diesel engines have a very high mean effective pressure owing to a high thermal efficiency, but the mechanical efficiency is relatively low as compared with automobile engines of the constant-volume type. For this reason the *MP* is only slightly larger than that of an engine of the constant-volume type. An *MP* of from 70 to 84 is the average.

On the other hand, we have quite a number of aviation engines of the constant volume type which have an *MP* as high as 100 and 105. This is due to the high thermal efficiency with a high mechanical efficiency. *(General Electric Review,* vol. 22, no. 10, October 1919, pp. 808-809, *pA)*

Changes in Engine Design Due to Poorer Grades of Fuel, P. J. Dasey. The author, who is research engineer for the Buda Company, claims that fuel changes are imposing serious handicaps on the production and use of the present types of combustion engines.

In one Detroit factory where records are kept of each carload of gasoline received, it was found that early in 1916 there was delivered in tank-car lots gasoline of which 92 per cent distilled over 300 deg. fahr. In 1917 one sample tested showed an end point of 327 deg. fahr., another 350 deg. fahr. and all the rest 400 deg. fahr. In 1918 the first sample tested showed an end point of 420 deg. fahr. In 1919 the end point gradually rose from 425 to 465 deg. fahr., and it seems to be understood that the present grade of fuel can last but a few months before it will have to stand another addition of kerosene in order that sufficient volume of fuel be produced to take care of the present automotive equipment.

It means that within a comparatively short time practically the only available fuel will be composed of what used to be gasoline and kerosene mixed. In other words, the distillation process will be carried on without a stop until all the light and heavy naphthas are wrought into one fuel and that fuel will have an end point of about 500 deg. fahr. or higher.

The use of the heavier fuel, however, is apt to cause crankcase dilution, a condition which is more serious in engines using lighter grades of lubricating oil (such as are commonly used in splash-feed engines) than in those of the pressure-feed types in which heavier oils can be used. (*Power Wagon*, no. 180, November 1919, p. 25. *p*)

MACHINE PARTS AND DESIGN

The Equation of the Involute, N. Finkelstein. The mathematics of an involute curve are of interest because they apply to the design of the involute form of gear tooth. The writer evolves simplified formula for finding the thickness of the tooth at any point from the base circle to the point of the tooth. The article is of a mathematical character not suitable for abstracting, notwithstanding its interest. *(American Machinist,* vol. 51, no. 15, October 9, 1919, pp. 693-694, 2 figs., *m)*

The Manufacture and Design of Tooth Gearing. A general paper of which the most interesting part is that referring to tooth pressures for lubricated gearing.

The following method of determining tooth pressure for spur and double helical reduction gearing is used by an Italian firm, Luigi Pomini, Castellanza, Milan. It has been found to give good results with spur gearing, and is being applied tentatively to double helical gearing:

P = load in lb. per in. of width of tooth
p = circular pitch in inches
v = velocity of pitch line in ft. per sec.
R = factor depending on the number of teeth in the pinion and the reduction ratio

$$P = Rp \times \frac{1480}{v + 32.8}$$

For cast-iron spur gears the value of *P* is taken as above; for steel spur gears 3 *P* is taken as load; for cast-iron double helical, 1.5*P* is taken and for steel double helical, 4.5*P*. Values of *R* are given in the following table and apply to enclosed lubricated gearing.

No. of Teeth in Pinion	Reduction Ratio							
	1 : 1	1 : 2	1 : 3	1 : 4	1 : 5	1 : 6	1 : 8	1 : 10
12	2.8	3.4	3.8	4.2	4.36	4 54	4.8	5.0
14	3.2	3 8	4.2	4.6	4.88	5.08	5.4	5.6
16	3.5	4.2	4.64	5.06	5.36	5.58	5.84	6.1
18	3.8	4 4	5.0	5.4	5 76	5 96	6 24	6 44
20	4.2	4.9	5.4	5.9	6.2	6.4	6.88	6.9
24	5.0	5.76	6.3	6.8	7.04	7 3	7.6	7.8
28	5.7	6.4	7.04	7.6	7.88	8.14	8.5	8.64
32	6.4	7.28	7.92	8 4	8.8	9.04	9.4	
36	7.2	8.1	8.76	9 24	9 6	9.88		
40	7.9	8.84	9.56	10.28	10.44			

These factors have been deduced from observations on the wear of lubricated teeth with circular pitches varying from ½ in. to 2½ in. They are valuable in determining tooth pressures for high-speed gearing where wear of the teeth is the determining factor.

In the discussion which followed, Bernard H. Brown called attention to the alleged lack of uniformity in the proportions of stub teeth adopted by different makers. He found that teeth cut to the dimensions given in the following table (40 deg. included angle) gave satisfaction in every way.

Pitch, diametral	Cutter pitch	Thickness of tooth on pitch line in.	Dedendum. in.	Addendum. in.	Whole depth. in.	Amount added to pitch diam. to obtain outside diam., in.
2 to 2½	2	0.7854	0 463	0.4000	0.863	0.8000
2½ to 3	2½	0.6283	0.3857	0.3333	0.719	0.6666
3 to 4	3	0.5236	0.289	0.2500	0.539	0.5000
3½ to 4½	3½	0.4488	0.257	0.2222	0.479	0.4444
4 to 5	4	0.3927	0.231	0.2000	0.441	0.4000
5 to 7	5	0.3142	0.165	0 1429	0 308	0.2858
6 to 8	6	0.2618	0 145	0.1250	0.270	0.2500
7 to 9	7	0.2244	0.129	0,1111	0.240	0.2222
8 to 10	8	0.1963	0 116	0.1000	0.216	0 2000
9 to 11	9	0.1745	0.105	0 0919	0.196	0.1818
10 to 12	10	0.1571	0 0955	0.0833	0.180	0.1666

(*Transactions of the North-East Coast Institution of Engineers and Shipbuilders,* vol. 35, pt. 3, May 1919, pp. 134 and 136, *gp*)

Wedge Bolt. Description of a device intended to take the place of the standard bolt. As shown in Fig. 8, it consists, first, of

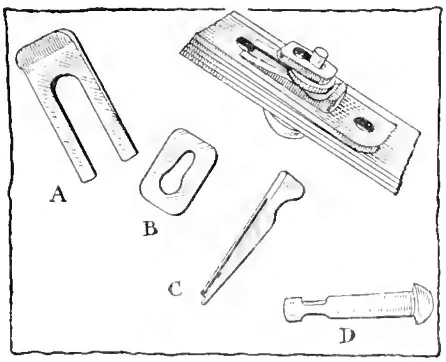


Fig. 8 Wedge Bolt

a wedge slotted through its length to accommodate the thickness of the bolt; next, of a washer with a hole resembling an ordinary keyhole; and, third, of the bolt or pin which is a plain unthreaded bolt with two shoulders or rather slots punched on opposite sides near its point.

The procedure on the job is as follows. While one workman passes the pin or bolt through the hole, another slips the keyhole washer over the pin. It is engaged in the slot, bears on the shoulder and then the wedge is placed between the washer and the bolt; the workman gives it a few raps with his hand hammer and is ready for the next.

The plates are then reamed if necessary, and the riveter follows to perform his particular task. As each wedge bolt is passed the riveter taps the wedge with his hammer and as the contrivance is released the holder-on at the other side of the plate takes out the pin and sticks another (hot one) through in its place. It is stated that at a plant in Portland a hull is being constructed with these wedge bolts without the use of a single threaded nut. (*Pacific Marine Review,* vol. 16, no. 11, November 1919, pp. 118, 1 fig., *d*)

MACHINE SHOP (See Machine Parts and Design)

MARINE ENGINEERING

Turbine-Gear Drive for Torpedo-Boat Destroyers, W. B Flanders. The design of propelling machinery for destroyers is an unusually difficult problem in view of the fact that a 1200-ton destroyer requires propelling machinery of a capacity equal to that put into a 30,000-ton battleship and that this machinery must be operated by a force of 30 to 40 men in the small boat as against 200 in the large boat.

The relatively greater power required by the destroyer is due to its higher speed. The power required increasing approximately as the fourth power of the speed and the two-thirds power of the displacement. As the propeller speed can be increased with the ship speed, the speed of the propelling machinery can also be

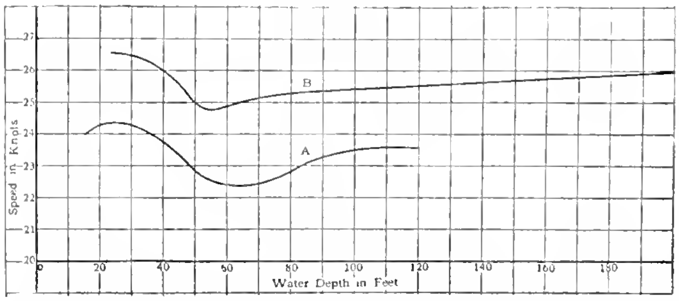


Fig. 9 Speed Curves of Destroyers in Various Depths of Water and with Constant Indicated Horsepower

increased, in addition to which the type of machinery must be of the simplest form possible consistent with reliability and economy.

Increased rotative speed means decreased size and weight of driving machinery. The use of reduction gears allows the main turbines to have higher speeds, which, in its turn, leads to decreased steam consumption with the resultant decrease in weight of fuel necessary for a given cruising radius. Furthermore, with the high-speed geared turbines a relatively large number of rows of blades or stages can be used at slower speeds, at which the boat chiefly operates, which tends to give good efficiency at these speeds.

The article gives brief information on the fuel economy of boats of the *Clemson* type compared with similar data of the U. S battleship *Tennessee.* It is of interest to note in this connection that in unofficial builders' trials on the *Clemson* at about 30 knots the machinery developed a shaft horsepower on slightly less than one pound of oil per hour, and that the boats reached a full speed ahead of 35 knots.

Interesting data are presented in reference to the influence of the depth of water in which a boat is moving on its speed. In general, the deeper the water up to at least one boat length, the faster the boat will go with the given propulsive power, but with long narrow boats of the torpedo or destroyer type there may be a shallow depth at which the boat speed will actually be higher than at any greater or lesser depth. This is shown in Fig. 9 made from trial data and has been confirmed in trials of the destroyers of the *Clemson* type. (*The Electric Journal,* vol. 16, no. 11, November 1919, pp. 474-476, 6 figs., *de*)

METALLURGY

Occlusion of Gases by Metals

The Occlusion of Gases by Metals. At the meeting of the Faraday Society, London, November 12, 1918, a general discussion took place on the occlusion of gases by metals.

The president, Sir Robert Hadfield, gave a brief historical account of the development of our knowledge of this subject and then proceeded to discuss the nature of occlusion of gases.

As showing the remarkable influence of gas upon such a metal as nickel, the following experiments were carried out by the speaker. Nickel wire was obtained of very high purity and malleable, the latter quality being shown by the fact that it was drawn into excellent wire free from all defects. This wire was heated three times in an oxidizing Bunsen flame reaching a temperature of about 1000 to 1100 deg. cent.; another specimen was also heated, but in a reducing flame of about 900 to 1000 deg. cent. Both specimens remained unchanged, but on heating the third time in an oxidizing flame over a dish of burning sulphur the wire became quite brittle and similar results occurred when heating to about 1000 deg. cent. over an open coke fire, this showing the penetrability of gases into this metal.

It was only after difficulties due to the presence of occluded gases had been overcome that it became possible to produce intricate steel castings; for example, hydraulic cylinders for cotton baling presses, the design of which is discussed in some detail by the writer.

Sir Robert Hadfield also touched in some detail on the subject of slag inclusion and critical forging temperatures, and appended to his address a bibliography on occluded gases covering 73 items.

Prof. Alfred W. Porter of University College, London, opened his discussion with some general remarks on occlusion of gases in metals, discussing, among other things, the occlusion of hydrogen in palladium.

A paper by Cosmo Johns was devoted to the consideration of the physical properties of metals as affected by their occluded gases. In particular, he objects to the use of the term "occlusion" to cover all the complex changes that must occur when various gases are absorbed by or become constituents between gases that were originally absorbed as such, and those formed as reaction products during cooling. The first might be called primary and the last-mentioned secondary.

There is evidence that under certain conditions iron above the critical range can absorb nitrogen and that the properties of iron and steel are seriously affected when such absorption takes place.

On the whole, the writer believes that under the term "occlusion of gases in metals" there have been included such widely differing phenomena as solution, the formation of definite compounds which may dissociate when the conditions are changed, and gaseous products formed as the result of reactions between non-gaseous substances in solution in the liquid metal which had undergone changes in concentration, and thus were no longer in equilibrium, during the consolidation of the metallic mass.

The gaseous constituents of the metals used for constructional purposes affect their properties more profoundly than is generally admitted

As all the metals used for industrial purposes contain gases as constituents, and as all the more complete physical investigations of the common metals have been made on specimens containing such gases, it follows that we have no knowledge of the properties which the pure metals or alloys would possess, if they could be produced, and such data as are available can only refer to metals or their alloys with an unknown quantity of gases as important constituents.

Capt. J. W. McBain discussed the theories of occlusion and the sorption of iodine by carbon. As regards the latter, in particular, it is claimed that adsorption may be accompanied by absorption, so that, in addition to rapid condensation on the surface, there may be a slow diffusion which goes on for long periods of time. This was shown in experiments on the sorption of iodine by carbon, extending over periods of many years. The writer gives the following summary of his views:

It is once more emphasized that sorption phenomena should not receive clear-cut designations as adsorption and absorption (solid solution), etc., until the experiments have adequately shown that the particular case is a pure type of only one of these factors, which are known in a number of cases to occur simultaneously.

Attention is drawn to Langmuir's hypothetical explanations of all these chemical phenomena, in which he has crystallized out views shared by a number of authors.

The long-continued diffusion following on rapid surface condensation involves in the case of animal carbon more than half of the total iodine sorbed.

Thomas Baker, in a paper on the gases occluded in steel, describes an investigation carried out with the view to determining the effect of occluded gases on the physical properties of steel and also to discovering the relation, if any exists, between the temperature of evolution of the gas and the critical points of the steel.

The results of all the experiments are collected in the following table.

Description	Weight of Steel in grms.	Volume of Gas per grm. of Steel in c. c.	Volume of Gas in c. c.	Average percentage composition				
				CO_2	H_2	CO	CH_4	N_2
Sound steel....	69.3	1.32	91.86	1.68	52.00	45.53	0.72	0.07
Sound steel reheated........	47.3	1.40	66.54	1.16	49.55	45.99	2.71	0.59
Steel with blowholes	63.2	0.66	42.10	0.88	54.56	42.36	1.73	0.47
Soft ingot.......	66.6	1.03	68.84	1.18	52.12	45.64	0.73	0.33
Bar from soft ingot...........	67.7	0.53	36.25	0.91	49.08	48.12	0.11	1.77

Thermal critical points of these steels occur at the following temperatures:

	A_{C1}	A_{C2}	A_{C3}	A_{r1}	A_{r2}	A_{r3}
Sound steel and steel with blowholes......	746 deg.	746 deg.	746 deg.	693 deg.	693 deg.	693 deg.
Soft steel ingot and bar	722 deg.	758 deg.	867 deg.	682 deg.	760 deg.	846 deg.

(*Transactions of the Faraday Society*, vol. 14, pt. 3, July 1919, pp. 173-231, *etA*)

MOTOR-CAR ENGINEERING (See Internal-Combustion Engineering)

POWER PLANTS

Influence of Air Leakage on Design and Operation of Surface Condensers

Calculation of Dimensions and Conditions of Operation of Surface Condensers with Air Leakage, K. Hoefer, Dr. of Engrg. An extensive, largely mathematical discussion of the influence of air leakage on the design and operation of surface condensers. An attempt is made to establish formulæ which will permit determining numerically the behavior of a condenser under various operative conditions, in particular the influence of air leakage on the available vacuum.

The presence of air in a condenser has as a consequence the fact that the temperature of steam is not all the time equal to the saturation temperature t_c of the steam corresponding to the condenser pressure p_c, but there occurs a fall of temperature with the fall of partial pressure due to falling off in the weight of steam through condensation.

The author states that there are ten factors affecting the degree of vacuum available, namely, (1) cooling air of the condenser, (2) amount of steam handled, (3) amount of cooling water, (4) temperature of cooling water, (5) weight of air leakage, (6) efficiency of air pump, (7) coefficient of heat transmission from steam to

cooling water, (8) coefficient of heat transmission from water of condensation to cooling water, (9) coefficient of heat transmission from air to cooling water and (10) design of condenser. The writer discusses all these points in succession, though not in the order given, and starts with point 10, which is "design of condenser."

In this connection he points out that while the construction of the condenser, the type employed, etc., materially affect the vacuum, these are factors which cannot be expressed numerically. Because of this, a certain amount of estimating based on the experience or judgment of the designer has to be used in applying the formulæ expressing the influence of the other factors to each individual condenser installation.

Coefficient of Heat Transmission from Steam to Cooling Water and from Water of Condensation to Cooling Water. He points out, in this connection, that these coefficients are materially affected by the velocity of flow of cooling water and, in addition to it, such other factors as diameter, length, material, wall thickness and character of surface of the condenser tubes; likewise, by the amount of turbulence in the flow of the water.

Of all these factors the author considers only the influence of the velocity of flow of cooling water when it is desirable to determine the amount of vacuum obtainable from a given condenser of given dimensions at different rates of flow of cooling water. In this case the velocity of flow of cooling water and hence the coefficient of heat transmission varies as the amount of cooling water flowing per unit of time, and the upper curve in Fig. 10 may be used as expressing average conditions. The lower curve on the same figure gives the coefficient of heat transmission from water of condensation to cooling water.

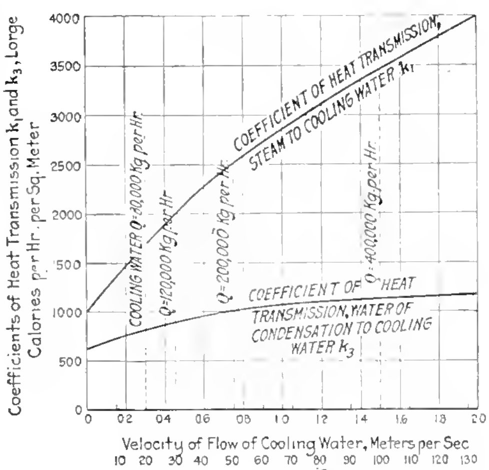


Fig. 10 Coefficients of Heat Transmission

It may be stated in this connection that the coefficient of heat transmission from steam to cooling water depends also on the steam pressure, as has been shown in a previous investigation of the author. The influence of steam pressure is however only slight and the coefficient of heat transmission has been shown in the tests carried out by the writer to rise only about 5 per cent when the steam pressure in the condenser increases from 0.1 to 0.2 atmos. abs.

Coefficient of Heat Transmission from Air to Cooling Water. In this connection, the writer uses an equation previously derived by Nusselt.

Further, the writer states that of the factors affecting the vacuum obtainable in a condenser, particular attention must be paid to air leakage. Since it is believed to be impossible to derive general formulæ which would cover this case, a numerical example is taken as the basis of consideration. It is assumed that we have a surface condenser 100 sq.m. (1076.4 sq. ft.) cooling area operating with cooling water having an inlet temperature of 15 deg. cent. (59 deg. fahr.) The condenser works in connection with the steam turbine operating on steam of 12 atmos. abs. pressure and 300 deg. cent. (572 deg. fahr.) superheat, or a heat content of 728.3 large calories per kg. (2882.9 B.t.u. per lb.) At full load of 800 hp. the turbine consumes 4000 kg. of steam (8818 lb.) per hour, if the consumption of the cooling water is 200,000 kg. (440,924 lb.) per hour or 50 times that of the steam and if there is no air leakage in the condenser. As will be shown later, to do this the condenser pressure must be 0.046 atmos. abs., which, together with the amount of steam used, the initial state of the steam and output, gives the effective efficiency of the turbine as 58 per cent. It is further assumed that the output of the turbine does not vary with varying vacuum in the condenser, but if, under these conditions, the condenser pressure rises above 0.046 atmos. abs. the steam consumption becomes greater than 4000 kg. per hour or vice versa. This assumption is more in correspondence with actual conditions than that of constant steam consumption. For the purpose of computing the steam consumption it is further assumed that the efficiency of the turbine does not vary, which is not exactly a fact, however. Fig. 11 gives the theoretical (adiabatic) heat difference, the usefully employed heat, and the steam con-

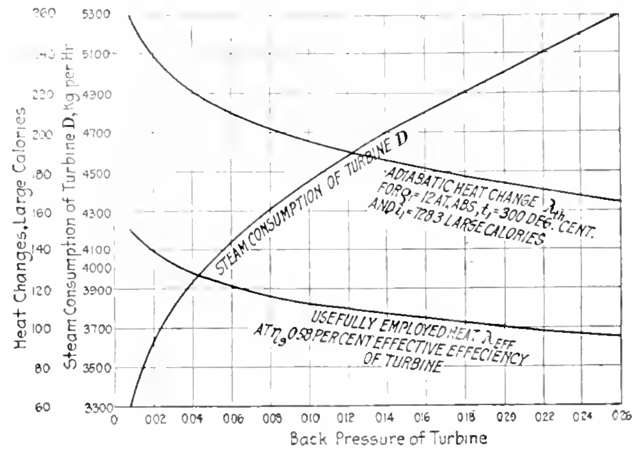


Fig. 11 Fall of Heat and Steam Consumption in a 800-Hp. Steam Turbine with Variable Condenser Pressure

sumption *D* of the turbine for various condenser pressures, the fall of pressure between the turbine and condenser being neglected.

Next are discussed the influence of dimensions and kind of air pumps used, influence of the cooling water and of the cooling area available, all of these being illustrated by curves. (Berechnung und Betriebsverhältnisse der Oberflächen-Kondensatoren unter Berücksichtigung der in den Kondensator eindringenden Luft, K. Hoefer. *Zeitschrift des Vereines deutscher Ingenieure*, vol. 63, nos. 27-28, July 5-12, 1919, pp. 629-635 and 650-653, 14 figs., *t*)

RAILROAD ENGINEERING

Gasoline Engines for Street-Railway Cars

Gasoline vs. Electric Motors, N. W. Storer, Mem.Am.Soc. M.E. Discussion of the respective merits of the two types of propulsion for street-railway service. The writer claims that while the gasoline motor is excellent for certain classes of service such as automobile and truck work, it is not suitable for street-railway cars.

The electric motor is almost ideally suited for street-railway service. Its speed-torque characteristics meet the requirements as the electric motor has the enormous starting torque of the overload capacity and flexible speed characteristics necessary to give the rapid acceleration and different speeds for street-railway service. In point of reliability it also stands very high and its cost of maintenance, depreciation and power are all relatively low.

The gasoline motor can make street cars run but its speed-torque characteristics are not well adapted for the work. Thus, it absorbs from 25 to 30 per cent of its normal amount of power when running idle. It has no starting torque and very little torque at low

speeds. Gear ratios help to balance this weakness, but at best the gasoline motor would give a very poor acceleration for a street car unless it were very much overmotored.

The reliability of the gasoline motor is also claimed to be less than that of the electric motor.

As regards costs, it is claimed that they would be higher for gasoline cars because the cost of maintaining the transmission on motor trucks and motor buses is very high. It is also claimed that the life of a gasoline motor is shorter than that of an electric motor.

It may be well to call attention, in this connection, to the fact that whenever the author speaks of motors for street-railway service he compares the electric motor with the aeroplane-type gasoline motor, which is, of course, the very last thing that could be thought of for applying in street-railway service. *(Aera, vol. 8, no. 3, October 1919, pp. 375-378, g)*

STEAM ENGINEERING (See also Power Plants)

TIN FUSIBLE BOILER PLUGS: MANUFACTURE AND TESTING, L. J. Gurevich and J. S. Hromatko. Data of an examination, at the Bureau of Standards, of tin fusible boiler plugs for the Steamboat Inspection Service and of the tests made subsequently.

The experimental results show that there are six primary causes for the rejection of fusible plugs which may be roughly divided into two classes. Under the first class, rejections are included due to mechanical defects of casing material. The second class includes rejections due to lack of purity of the tin filling. The impurities in the latter case may be those either present in the original tin or those introduced during the manufacture of the plug.

The following conclusions have been reached as to the precautions to be taken in the manufacture of fusible plugs:

1 The pig tin should be at least 99.7 per cent pure, containing not more than 0.1 per cent lead, or 0.1 per cent zinc, which are the requirements of the Steamboat Inspection Service.

2 The casing should be of bronze, an alloy the major constituents of which are copper and tin. Small amounts of zinc and lead increase the ease of casting and machining and are not objectionable if not present in greater amounts than in the following compositions:

	I	II
Copper	88	87
Tin	10	7
Zinc	2	5
Lead	..	1

3 The pot or crucible for melting the tin should not be used for melting other metals, thus doing away with the liability of contaminating the good tin when these are not thoroughly cleansed.

4 Casings should be tinned on the inside with the same grade of tin used for filling, but the tin left over from this process should not be added to the filling to be used. Zinc-chloride flux may be used although hydrochloric acid is preferred, though no flux need be used during the filling process.

5 The casing should be preheated to not above 250 to 275 deg. cent. (482 to 527 deg. fahr.) and tin should be poured at a temperature not above 275 to 300 deg. cent. (527 to 572 deg. fahr.). *(Bulletin of the American Institute of Mining and Metallurgical Engineers, no. 152, August 1919, pp. 1351-1360, epA)*

FLOW OF STEAM THROUGH PIPES, Bassett Jones. Formulæ for the flow of steam through pipes simplified in such a manner as to lend themselves to accurate computation.

The ultimate formula given is

$$W = 60\ Ac\ \sqrt{(pD\ L)} = m\ \sqrt{(pD\ L)}$$

where A is the area of the pipe in square feet, c a constant, p pressure drop in pounds per square inch, D mean density of steam in pounds per cubic foot, L equivalent length of straight pipe. The value of $m = 60\ Ac$ may be computed once for all for each pipe size.

Values of $\sqrt{(pD)}$ for various values of pD can be computed for various initial pressures and in the original article a table is given for same, so that the only computation not of plain first order multiplication necessary in any application of the above formula is the finding of the value of $\sqrt{L}$. In computing L the usual allowances must be made for fittings, valves, openings, etc.

The author gives several examples of the application of this formula. *(General Electric Review, vol. 22, no. 10, October 1919, pp. 805-807, 1 fig., p)*

STANDARDIZATION

STANDARDIZATION OF SPINDLE NOSES FOR MILLING MACHINES IN GREAT BRITAIN. Because of the large number of American milling machines in Great Britain the proposed standard noses are designed to apply for the time being, only to machines of British manufacture, although the adoption of a common standard for British and American manufactures is recognized as being highly desirable.

The design of spindle noses has changed considerably in recent years as a result of the heavier duty which has been performed by milling machines. Screwed spindle noses have been found to be faulty for heavy work and the tendency has been to adopt on new designs either parallel or taper fits, holding the cutter back by a draw bolt through the spindle, the torsion being taken by the clutch drive.

It is generally agreed that some form of clutch drive is necessary on a spindle nose for heavy milling and it has also been found necessary to harden the clutch to prevent distortion.

The illustration in Fig. 12 shows four suggested standard noses.

The article does not state to what extent standardization of spindle noses has proceeded in Great Britain. *(The Engineer. vol. 128, no. 3328, Oct. 10, 1919, p. 358, 1 fig., dg)*

THERMODYNAMICS

THEORY OF EQUILIBRIUM CONDITIONS IN SATURATED STEAM: UNDERCOOLED STEAM. In a series of articles by H. M. Martin (see MECHANICAL ENGINEERING, February 1919, p. 150) it was claimed that when wet steam is expanded through a turbine it never attains a condition of thermal equilibrium until the condenser is reached.

In the criticisms to which the above hypothesis has so far been subjected there appears to be a disposition to accept the view that supersaturation does persist down to the Wilson line, but there has seemed to be more hesitation in admitting that thermal equilibrium is not reëstablished at the Wilson line and maintained throughout the remainder of the expansion. There is, however, some direct evidence in favor of the view that the condition of supersaturation persists.

In the first place, Wilson found that when the expansion was prolonged beyond the Wilson line the number of droplets formed was enormously increased, showing that those already in existence ceased to act as effective centers for condensation once they had attained a certain size, and any further condensation had to take place on other nuclei, which is possibly only when the steam is undercooled by some tens of degrees.

Again, the exhaust temperature of a turbine as measured by a thermometer appears in normal working conditions to be invariably a little below that corresponding to the pressure. In this connection Allen's condenser experiments are mentioned to show that the discrepancy is due not to erroneous readings from the thermometer, but conditions surrounding the operation of the thermometer prevented from giving reliable indications.

Coming back to the question of droplet formation, it is stated that any change of state involves either an increase of pressure or the performance of external work that change takes place with difficulty. A "catalyst" is commonly necessary to make the change possible. In the case of supersaturated steam not merely has work to be done in forming the surface films of the droplets, but the ultimate effect of the change from the undercooled condition is an increase in the volume occupied. The presence of a "catalyst" is

thus doubly necessary, and this is for the most part provided by the Wilson nuclei which are molecules having a constitution H_4O_2, or perhaps H_6O_3, or even possibly H_8O_4. The existence of these combined molecules in steam is proved by a comparison of the theoretical and actual volumes occupied by unit weight of the steam.

From this it appears that there are a certain number of aggregated molecules in steam, the number of which depends on the temperature and pressure of the steam and is quite unaffected by turbulence. It is on these aggregated molecules that condensation occurs when the expansion is carried far enough.

As has been stated above, the presence of a catalyzer of some kind is necessary for condensation to occur. The condensation of thermal equilibrium is more stable than that of supersaturation, but to pass from the one state to the other involves the performance of work. The energy liberated on condensation is not instantaneously available to this end, as time is necessary for its conversion into the form of heat. The presence of a catalyzer makes it possible for the transformation to take place in two stages. In the first stage condensation occurs without development of heat and with the consequent contraction in volume. In the second stage the energy liberated on condensation is converted into heat and absorbed by the vapor which, therefore, increases in volume of pressure. It is probable that the transformation is, for the most part, completed within a very small fraction of a second.

From this point of view it would appear that when condensation occurs at the Wilson line there must be at least a temporary diminution of volume and this decrease of volume is considerably greater than it would be if the weight of steam at first condensed were only that requisite to the ultimate attainment of thermal equilibrium. The condensation comes down in the first instance as droplets which are smaller than those known to show the Brownian movements. They may thus be considered as equivalent to molecules of a very dense gas and will not therefore add to the frictional resistance experienced by the steam as it passes through the turbine. When, however, such droplets coalesce to form large droplets, the conditions are changed, and it appears quite conceivable that such large droplets may give rise to increased losses in nozzle and blading.

It would appear also that condensation of steam at the Wilson line is likely to be excessive and expansion beyond the Wilson line will begin accordingly with the volume not intermediate between the equilibrium volume and the volume corresponding to no condensation, but may actually be considerably smaller than the latter. How long such an excessive condensation persists is not known, but if it may be untrue for any appreciable time, as is possible, expansion beyond the Wilson line will proceed with an unusual volume smaller and final volume greater than was provisionally presumed in the theory as was exposed by H. M. Martin. (Editorial article in *Engineering*, vol. 108, no. 2806, Oct. 10, 1919, pp. 483-484, *tA*)

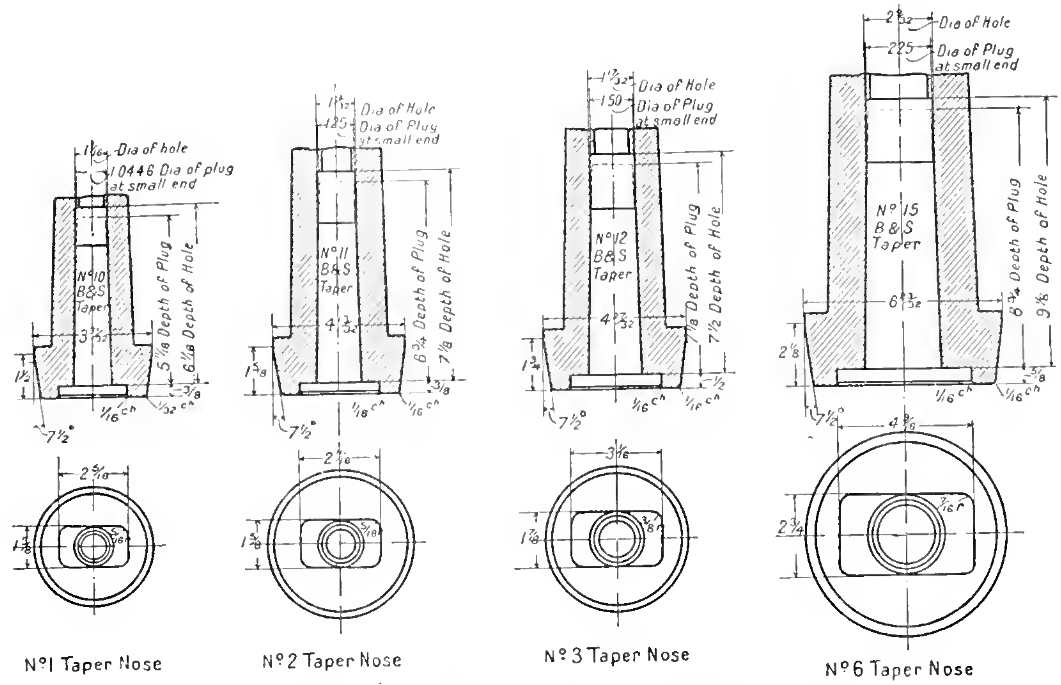


Fig. 12 Suggested Standard Noses for Milling-Machine Spindles

VARIA

Societies, Associations and Commissions Promulgating Specifications for Engineering Materials, K. D. Williams. Brief data as to the activities, organizations and publications are given in reference to the following:

(*a*) Steamboat-Inspection Service, Department of Commerce, Washington, D. C.

(*b*) Bureau of Standards, Washington, D. C.

(*c*) American Bureau of Shipping, 66 Beaver Street, New York, John W. Coutillion, Secretary and Treasurer.

(*d*) American Society for Testing Materials, C. L. Warwick, Assistant Secretary, University of Pennsylvania, Philadelphia, Pa.

(*e*) American Society of Mechanical Engineers, Calvin W. Rice, Secretary, 29 West 39th Street, New York, N. Y.

(*f*) Bureau of Explosives, Underwood Building, 30 Vesey Street, New York, N. Y., J. E. Fairbanks, Secretary and Treasurer.

(*g*) American Institute of Electrical Engineers, 33 West 39th Street, New York, N. Y., F. L. Hutchinson, Secretary.

(*h*) Master Car Builders' Association, 746 Transportation Building, Chicago, Ill., V. R. Hawthorne, Acting Secretary.

(*i*) American Railway Engineering Association, Room 1011, 910 Michigan Avenue, Chicago, Ill., E. H. Fritch, Secretary.

(*j*) American Institute of Weights and Measures, 20 Vesey Street, New York, N. Y., F. A. Halsey, Commr. and Secy.

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

MECHANICAL ENGINEERING

THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Published Monthly by the Society at
29 West Thirty-ninth Street, New York

M. E. Cooley, *President*

William H. Wiley, *Treasurer* Calvin W. Rice, *Secretary*

PUBLICATION COMMITTEE:

George A. Orrok, *Chairman* J. W. Roe
H. H. Esselstyn George J. Foran
Ralph E. Flanders

PUBLICATION STAFF:

Lester G. French, *Editor and Manager*

Leon Cammen, C. M. Sames, *Associate Editors*

W. E. Bullock, *Assistant Secretary Editor Society Affairs*

Frederick Lask, *Advertising Manager*

Walter B. Snow, *Circulation Manager*
136 Federal St., Boston

Yearly subscription $3.00, single copies 35 cents. Postage to Canada 50 cents additional; to foreign countries $1.00 additional.

Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

New York Printers' Strike Ended

Continuing in our efforts to publish as regularly as possible the successive numbers of Mechanical Engineering regardless of the printing strike in New York, which completely tied up the printing plants of that city for a period of more than six weeks, this Journal is again issued from a plant outside of the city under difficulties which inevitably attend such an undertaking. It is expected that copies will reach the membership during the latter part of December.

In all probability the January number will again be published in New York City by our regular printers, who have the facilities for rapid production and will thus be able to gain time, which we hope will permit the distribution of the January number at a relatively earlier date. The striking printers have, for the most part, returned to their old positions, and it is believed that the stability of the industry is now assured, although still subject to conferences which are to be held for adjustments with regard to wages and other matters.

A Successful Annual Meeting

The fortieth Annual Meeting of The American Society of Mechanical Engineers, held in New York, December 2 to 5, was the largest meeting in the history of the Society, having a registration of upwards of 2100. In its professional sessions, its social features and in the many committee meetings was evidence of a fine spirit and enthusiasm, a close bond between members of this great organization and a loyalty to the high principles and ideals of the engineering profession.

Although the meeting nominally opened on Tuesday, December 2, there were various committee meetings on Monday. On Tuesday evening, the night of the presidential address, Honorary Membership was conferred upon Charles de Freminville, consulting engineer, Creusot Works, France, and announcement was made of Honorary Membership to be conferred upon Auguste C. E. Rateau, of the Rateau, Battu and Smoot Company, France. At the Business Meeting interest centered in the reports of the Aims and Organization Committee and of the Joint Conference Committee of the Founder Societies, discussion of which was continued in the afternoon of that day. No less than ten professional sessions were held, one of which, the keynote session, comprised a series of strikingly important addresses on Industrial Unrest, before an audience which filled the auditorium of the Engineering Societies Building.

On Thursday evening was the annual lecture and reunion, with two addresses, one by Col. E. A. Deeds, of Dayton, Ohio, on The Future of Aviation, and one by Col. Thurman H. Bane, on the Present Development of the Military Airplane. After the lectures the audience assembled upon the fifth floor of the Engineering Societies Building and on the first floor where there were reunions for a social time.

Although this number of Mechanical Engineering will not reach its readers until well past the date of the meeting, it will be impossible to incorporate a further account of the meeting in this number, owing to the publication difficulties involved as a result of the printers' strike which has already been alluded to. It is expected that this report will appear in the January number.

Salaries of Engineers in Canada

A report dealing with the classification of engineering organizations and proposed qualifications and remuneration for engineering services, prepared by the Toronto Branch of the Engineering Institute of Canada, is published in the November issue of the journal of that society. *The salary schedule proposed by the committee is based on the pre-war cost of living and does not take into account the very great increase which has occurred during recent years.* Classifications are made for engineers employed in railway work, municipal work, industrial work, large public utilities, and public works.

Of greatest interest to mechanical engineers are the recommendations of the committee for engineers employed in industrial work, a summary of which follows:

Chief Engineer. A chief engineer in charge of research, mechanical, electrical, chemical or metallurgical work, should be a graduate from an engineering school recognized by the Institute, with from 10 to 15 years' experience in his special line, and should receive a salary from $3600 to $10,000, according to the size of the industrial works where he is employed, and the extent of his responsibility.

Assistant Chief Engineer. An assistant chief engineer in a large industry should preferably be a technical graduate with from 5 to 10 years' experience. His salary should be 75 per cent of the salary of the chief engineer, with a minimum of $3000. This recommendation applies also to the engineer in general charge of all outside construction.

Designing Engineer. The designing engineer having responsible charge of all design in any one of the branches of mechanical, electrical, structural, or heating and ventilating engineering, should preferably be a technical graduate with 5 years' practical experience in his special line, or, should be a high school graduate with 10 years' practical experience, and should have a good general knowledge of mathematics and the fundamental physical laws used in engineering. His salary should be 50 per cent of the salary of the chief engineer, with a minimum of $2700.

Estimating Engineer. The engineer in charge of estimating, figuring costs, etc., should preferably be a technical graduate with 3 years' practical experience in his special line, or, should be a high school graduate with 8 years' practical experience, and should have a good general knowledge of mathematics and the fundamental physical laws used in engineering. His salary should be 35 per cent of the salary of the chief engineer, with a minimum of $2400.

Testing Engineer. Same qualification and salary as for estimating engineer.

Resident Engineer on Construction. Same qualification and salary as for estimating engineer.

Designer, Assistant to Designing Engineer. The assistant designer to a designing engineer should preferably be a technical graduate with 2 years' practical experience, or should be a high

school graduate with 4 years' practical experience, and should have a good general knowledge of mathematics and the fundamental physical laws used in engineering. His salary should be $2400.

Chief Draftsman, responsible for all working drawings. To be qualified by training and experience for the special work required of him. (Salary not stated.)

Assistant Estimator. The assistant estimator to an estimating engineer should preferably be a technical graduate with 2 years' practical experience, or should be a high school graduate with 3 years' practical experience and should have a good general knowledge of mathematics and the fundamental physical laws used in engineering. His salary should be $2400.

Squad Boss. The squad boss, in charge of small squad of draftsmen, should be a high school graduate with 3 years' practical experience, including 1 year's experience as checker, and should have a good general knowledge of mathematics and the fundamental physical laws used in engineering. His salary should be $2100.

Chief Shop Inspector. The chief shop inspector, in charge of shop inspection, should preferably be a technical graduate with 1 year's experience, or should be a high school graduate with 3 years' experience as inspector, and should have a good general knowledge of mathematics and the fundamental physical laws used in engineering. His salary should be $2100.

Draftsman. A draftsman, making detailed working drawings, should preferably be a technical graduate or have 3 years' experience in drawing, tracing, etc. His salary should be $1800.

Engineers Honor Eugene Schneider of France

On Monday evening, November 24, the Four Founder Societies, upon the invitation of the Mining and Metallurgical Society of America, joined with that organization in a testimonial dinner at the Hotel Biltmore, held in honor of Charles Eugene Schneider, head of the famous Schneider-Creusot Steel Works of France. The dinner was the occasion for the presentation to Dr. Schneider of the gold medal of the Mining and Metallurgical Society of America, which is annually awarded for research work in metallurgy. Dr. Schneider is the first other than an American to be so honored.

H. H. Knox, the president of the Mining and Metallurgical Society of America, was toastmaster, and the speakers were Bradley Stoughton, secretary of the American Institute of Mining and Metallurgical Engineers; Dr. Henry M. Howe, professor emeritus of metallurgy at Columbia University; Charles M. Schwab; and Brigadier-General Manus McCloskey, U. S. A.

A closer understanding between this country and France was urged by Dr. Howe, as he declared that future conflict with Germany was "inevitable." "German treachery persists," he said, "and will persist to plague our descendants. German vices spring from the nature of the people and not from their form of government. The Germans are avowedly criminal. They avow criminal intent."

Dr. Howe also called attention to the magnitude of the Creusot works, where 250,000 men are employed, and he pointed out that this works had supplied three-fourths of the French artillery used in the war, and also had furnished Belgium and Serbia with guns. Engineers from Creusot, he said, had been sent to the United States when this nation declared war to help in organizing the American steel industry for war.

Mr. Schwab also paid high tribute to the French ironmaster, whom he has known for thirty years. Mr. Schwab declared that there is a greater problem ahead of the Allies than forging guns of war, and that is the forging of the guns of public opinion, and no man, he said, was better qualified to do this than Charles Eugene Schneider.

General McCloskey told of the use to which the guns manufactured by Mr. Schneider were put by the American troops at the front.

Earlier in the day Stevens Institute of Technology, at Hoboken, N. J., conferred the degree of Doctor of Engineering upon Mr. Schneider. Dr. Alexander Humphreys, president of Stevens, conferred the degree and Mr. Schneider responded by a brief address, in which he praised the work of American engineers in France and suggested that French and American universities exchange students as well as professors.

Pan-American Financial Congress

An indication that engineers are no longer confining themselves to their profession but are playing a larger part in public affairs is found in the confirmation of the appointments of C. B. Lord, Mem.Am.Soc.M.E., of the St. Louis Section of the Society, and Calvin W. Rice, Secretary of the A.S.M.E., to the Permanent Group Committee of the Pan-American Financial Congress. The Permanent Group Committees were established at the time of the first Pan-American Financial Conference, May 25-29, 1915, by Secretary McAdoo, with a view to assembling and studying material concerning the financial and commercial relations between the United States and the countries for which they were respectively appointed.

The second Pan-American Financial Conference will take place in Washington, January 12-17, 1920. Mr. Lord, serving on the committee of the Dominican Republic, and Mr. Rice, on that for Bolivia, will join with other appointees in conferring with the official delegations from the other American republics. The Committee will enter into executive session to study the problems submitted by the official delegations from the different countries and will submit for the consideration of the entire conference conclusions which will be based upon its examination of those problems.

American manufacturers of machinery and engineering and structural materials will be interested to learn of the Andhra Engineering Company of Cocanada, India, who are endeavoring to introduce American machinery and engineering materials into the Indian market and desire to get into communication with American machinery firms. The information came through a letter forwarded by Clinton H. Scovell, Mem. Am. Soc. M. E., of Scovell, Wellington and Company, of Boston.

International Electrotechnical Commission

The International Electrotechnical Commission which suspended its meetings during the war, recently held a conference in London, at which 18 countries were represented by 52 delegates. A Special Committee on the Rating of Electrical Machinery was appointed in order to push forward this work, which was regarded as of the highest importance to the electrical industry, more particularly to its export trade. Increasing attention is being given to the work of the International Electrotechnical Commission by the manufacturers of the world who are prepared to coöperate in the formulation of standards for the simplification of international commerce.

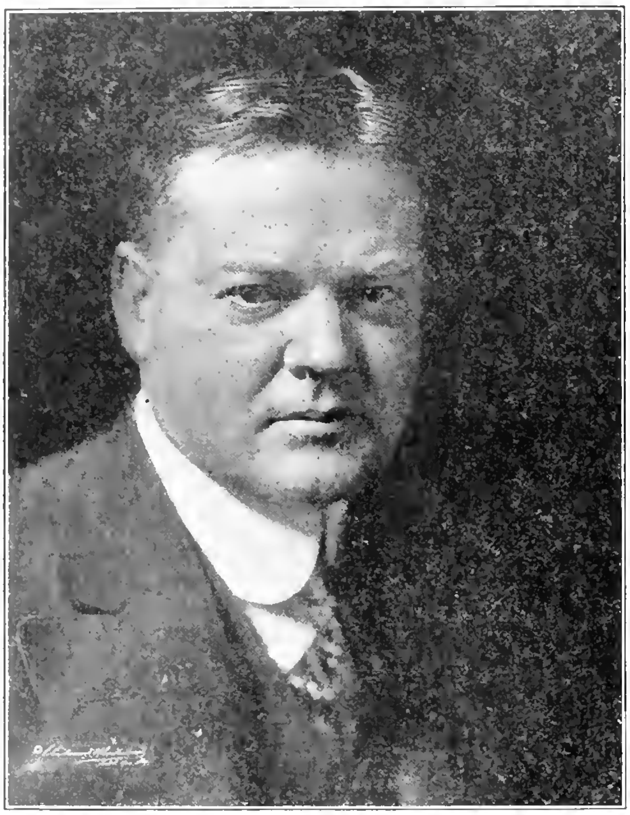
The Librarian of the Public Library of Sydney in New South Wales has written the Society of their desire to obtain regularly any trade catalogs published by members of the Society. The "Condensed Catalogs" and other trade catalogs already received from the United States have been very freely used and it is felt that other catalogs would also be of valuable aid in fostering trade relations between Australia and the United States.

The headquarters for Rhodes scholarships in the United States from now on will be at the Massachusetts Institute of Technology. Professor Frank Aydelotte of the Institute staff has been appointed Secretary to the Rhodes scholars throughout the United States. He will have leave of absence from the Institute for this academic year and will devote all his efforts toward the selection of men from American universities who are to be sent to Oxford College.

Herbert Hoover to Head Mining and Metallurgical Engineers

Herbert Hoover, the engineer who so ably typifies the modern definition of engineering as written on the wall of the Engineers' Library in New York, "Engineering, the art of organizing and directing men, and controlling forces and materials of nature for the benefit of the human race," is to be the next president of the American Institute of Mining and Metallurgical Engineers.

Mr. Hoover received his early training as a mining engineer at Stanford University, Cal. He first served with the United States Geological Survey, then went to West Australia and China, in mining activities. He took part in the defense of Tientsin during the Boxer disturbance in 1900. He was also engaged as consulting and managing engineer in metallurgical, mining and railway operations in Mexico, Russia, Africa and India. His work in London up to the beginning of the world war was notable in that he departed from the usual share-promotion schemes of the mining market, developing the properties in which he was interested purely on technical lines.



Herbert Hoover

When the war broke out in 1914, he gave up his management and directorships and began his service on various committees and commissions. The first of these was as chairman of the American Committee in London. He began his work the morning after England declared war on Germany, taking charge of the relief of American refugees.

In October 1914 he organized the Commission for the Relief of Belgium. Under his supervision millions of people were continually supplied with food, many of whom were entirely dependent upon this relief. Shortly after America entered the war, Mr. Hoover was summoned to Washington to take charge of the food situation here. The problem was a large one, as food demands from Europe were centered upon the United States. His organization of volunteer workers all over the country did much in making this work successful.

Mr. Hoover served as member of the War Trade Council since 1917, as director general of Allied Relief, director general of the American Relief Administration, chairman of American Economic Delegation at Paris, chairman of Food Section of Supreme Economic Council of Peace Conference, including supervision of transportation and communications of Eastern Europe, and later, as chairman of the Supreme Economic Council.

The work that Mr. Hoover has done in relief of the civilian population of Europe since the signing of the armistice has proved again his right to the title of "engineering economist." In this great task which he has performed so successfully, those characteristics coloring all his achievements have again been emphasized. His ability to get men to do things, to organize them and direct them in action, his knowledge of the right methods to follow and the psychological moment to act in order to secure the full measure of support and the greatest degree of success, may be largely attributed to his training as an engineer and make him worthy of the many honors accorded him and especially of this one, the presidency of the American Institute of Mining and Metallurgical Engineers.

SLOW-SPEED TESTS OF KINGSBURY THRUST BEARINGS

(Continued from page 917)

On Friday, October 31, the machine was run at 0.5 r.p.m. for $4\frac{1}{2}$ hours. The load was carried by the heavy spring throughout the run, but its compression gradually decreased. The machine was then run at various speeds, beginning with 3 r.p.m., to see if the bearing had been improved by its long run at 0.5 r.p.m. The bearing was to be maintained at each speed for 15 min. The friction force at low speeds was less than it had been in previous tests, but it remained constant from 2.85 to 2 r.p.m. It then slightly increased as the speed was further lowered, and remained constant from 1.87 to 1.66 r.p.m. From here on it gradually increased, but remained very low until the speed had been reduced to 1.01 r.p.m. At this low speed the friction coefficient was about one-third as great as the minimum value that had been obtained when the bearing had been run steadily for a whole day at 1 r.p.m.

On Saturday the test was begun at 1.5 r.p.m. and continued for 30 min. The coefficient was less than at same speed the previous day. This is explained by the assumption that the surfaces improved during the lower speed runs following that at 1.5 r.p.m. on Friday. At 1.25 r.p.m. the friction was still considerably less than the previous day. At 1.05 r.p.m. it was nearly as great as on Friday. At 0.88 r.p.m. it was increased about 75 per cent and continued to increase rapidly as the speed was lowered until 0.38 r.p.m. was reached. The motor was not belted to run slower than this, so that the run at this speed was continued. The friction coefficient at 0.38 r.p.m. gradually decreased as it had done at other speeds, indicating continued improvement in the bearing surfaces. The runs for Thursday, Friday and Saturday are plotted in Figs. 15, 16 and 17 of the complete paper.

No serious attempt has thus far been made to measure the starting friction. Some preliminary tests, however, have shown that it will vary with the length of time the bearing has been at rest.

The results of the tests already carried out indicate that the lower the speed at which the bearing is run continuously, the better the condition of the bearing surfaces. Speeds as low as 0.38 r.p.m. have thus far been employed and further tests will be made with yet lower speeds. Reference to the shoe areas mentioned in an earlier paragraph will show the range of pressures it is intended to employ. They will extend from the initial test of 132 lb. per sq. in. and a light oil to as high as 2000 lb. per sq. in. with a light and a heavy oil. The tests with the light oil will be continued as far as they lead to valuable results, then the tests will be run on heavy oil. When the tests are completed on the light oil, it will be easier to estimate how heavy an oil will be needed for continuing the tests. The author is gratified with the excellent showing made with a light oil, and is glad that he did not begin the tests with a heavy oil.

NEWS OF THE ENGINEERING SOCIETIES

Reports of Meetings of American Welding Society, American Paper and Pulp Association, Iron and Steel Institute, Illuminating Engineering Society, etc.

National Machine Tool Builders' Association

That business throughout the machine-tool industry has shown a steady gain since the beginning of the year, was the general consensus of opinion at the eighteenth annual convention of the National Machine Tool Builders' Association, held in New York on October 15 and 16. It was also brought out that, contrary to what was expected at the outset, the surplus equipment in the possession of the Government at the close of the war has not worked a material hardship upon the machine-tool industry, and that the remainder of this equipment yet to be disposed of ranges in value from \$25,000,000 to \$50,000,000. Of special interest was the report on the conditions of the machine-tool industry in Europe, presented by Alexander Luchars, president of The Industrial Press, who had returned recently from an extended trip of investigation overseas.

Association of Railway Electrical Engineers

The eleventh annual convention of the Association of Railway Electrical Engineers was held in Chicago on October 28 to 31. Among the committee reports presented there were three covering the various phases of electric-headlight operation and one on the subject of railroad electrification. The question of electric-headlight operation was of particular interest this year as the time is rapidly approaching when all locomotives must be equipped with high-power headlights to conform with the ruling of the Interstate Commerce Commission. The standards recommended by the Committee on Electric Headlights included those for generator baseplates, steam-pressure ranges, ball bearings, brush sizes and steam-pipe openings. The report of the Committee on Railroad Electrification contained a typical skeleton form for an electrification report, which was intended to serve as guide in procuring all data necessary to an intelligent and comprehensive conclusion and recommendation, together with a bibliography of articles and papers referring to steam-railroad electrification which have appeared in the American and foreign technical press during the years from 1908 to 1919.

American Welding Society

A meeting of the American Welding Society was held on October 24, at the Engineering Societies Building, New York, N. Y. The program comprised various addresses on the progress and development of the welding industry, and an account by Prof. Ralph G. Hudson of a series of investigations he conducted at the laboratories of the Massachusetts Institute of Technology, in which his efforts were mainly directed to the determination of the cause and nature of the transmission of metal from an electrode to a plate. According to the theory developed by Professor Hudson in consequence of his investigation, the function of the electric current is nothing more than that of furnishing heat in the form of the electric arc. The welding is accomplished by metal that is expelled from the electrode in the form of metallic vapor and minute liquid particles which are shot across to the plate opposite at the rate of some fifty a second. The force that propels these particles is the pressure that arises from the sudden formation of vapors and gases under the intense heat of the arc. Carbon monoxide is the gas mentioned, and the vapors are those of the lower-melting constituents of the electrode. The particles that strike fluid metal on the plate solidify with it; but those that strike solid metal either bounce off and are wasted, or adhere without fusion and are a cause of bad welding. One great advantage of maintaining a short arc, Professor Hudson observed, lies in the fact that it secures a better concentration of the projected particles within the fluid spot on the plate.

American Paper and Pulp Association

A committee report presented at the annual conference of the American Paper and Pulp Association, assembled in New York on November 14, contained a plan for the conservation of the United States forest capital, which, in the statement of the committee, is being used up faster than it is replaced. The suggestions proposed embraced:

1 A forest survey and land classification
2 A great enlargement of the public purchase of cutover lands for which ample precedent has been established in the East by both the Federal Government and by some of the states. The best interests of the country would seem ultimately to require at least twice the present area of public forests
3 A much more general extension of Federal coöperation with the states in fire prevention
4 The states should do much more than they now do in the way of fire control
5 The states, through the adoption of uniformly fair forest taxation laws, the establishment of forest nurseries, and the preparation of forest working plans, should offer every possible encouragement to the owner who wishes to grow timber on his land
6 Very properly the most immediate concern is the protection of the timber we already have, but wherever sufficient fire protection can be secured a large program of forest planting should be carried out.

In conclusion, the committee outlined methods of fire protection in the Northeastern States, and urged that immediate steps be taken to unite the professional foresters, the lumberland owners and the consumers of forest products upon a program of forest-fire protection and acquisition of cutover lands.

International Trade Conference

According to statements made by the trade representatives of the allied countries at the International Trade Conference, held in Atlantic City under the auspices of the Chamber of Commerce of the United States on September 30 to October 6, Europe will probably not require as much of American materials for its reconstruction period as it has been generally believed in the United States. Even before such requirements as the European nations may purchase in this country are finally provided, it will be necessary to find means of financing this business and extending credits over possibly a long period of years. Finance was concluded to be the crux of the entire international problem and the very thing upon which depends the reduction of the enormous trade balance piling up in favor of the United States. Great Britain, it was found, will not need much American assistance, except as this country can relieve her of some of the burdens of caring for the other European nations while Great Britain is engaged in settling her own problems. France, Italy, and Belgium need American aid and need it badly, but, as was emphasized by not only the visiting speakers, but by the American participants in the general program, this

assistance is not the kind required by weak, characterless nations, but by nations of strength and ability suffering from the ravages and privations caused by the war with Germany. Help will be given these countries, it was declared, — just how is not known, but help will be extended. This was made clear time and again in the addresses given by the business men of the United States.

American Iron and Steel Institute

The principle of the open shop as advocated by Judge Gary in the steel strike and before the industrial conference at Washington was enthusiastically indorsed by the American Iron and Steel Institute at its sixteenth general meeting, held in New York on October 24. Resolutions were formally adopted, in which the Institute recorded "its unqualified approval of Mr. Gary's firm stand against any infringement of the rights of the individual in labor or in business, rights fundamental to American industrial supremacy as well as to American liberty."

Recent applications of metal radiography were outlined by W. E. Ruder, research metallurgist of the General Electric Company, Schenectady, N. Y. He referred particularly to an experiment made in order to determine the thickness of the smallest air inclusion which could be distinguished radiographically. Two plates of steel were machined and ground to flat surfaces. In one of these a slot was cut to give a wedge of air of varying thickness. Each plate when finished was 5/8 in. thick. The two plates were then bolted together and radiographed at a 15-in. gap. In this manner it was found that a 0.021-in. air inclusion could be detected at 1 1/4 in. of steel and a 0.007-in. air inclusion in a total thickness of 5/8 in. of steel. This was, of course, under the most favorable conditions, when it was known beforehand that the inclusion existed and just where it was.

In a paper on Testing Steel by Magnetic Analysis, R. L. Sanford, associate physicist, United States Bureau of Standards, described a method for determining the degree of magnetic uniformity along the length of a specimen of substantially uniform cross-section, such as a rail. The test consists of surrounding the specimen with a magnetizing solenoid which is run along the specimen. A sensitive electrical instrument which is connected to a test coil carried with the solenoid indicates any change in magnetic permeability of the specimen as the coil moves along. The conclusions so far warranted are, according to Mr. Sanford, that a bar which is magnetically uniform along its length is also mechanically uniform, that a bar which is mechanically non-uniform along its length is also magnetically non-uniform and this non-uniformity will be surely indicated by the test; and finally that bars which are magnetically non-uniform may or may not be seriously defective from the mechanical point of view. The Bureau is conducting further investigations in coöperation with the ordnance department of the United States Army.

King Albert of Belgium attended the banquet as the guest of honor and gave a message of good-will and of appreciation of the American steel and iron industry. Another guest of distinction was M. Eugene Schneider, head of the Creusot works of France, and president of the Iron and Steel Institute.

Illuminating Engineering Society

The thirteenth annual convention of the Illuminating Engineering Society was held at Chicago, October 20 to 23. The report of the Committee on Progress expressed the hope that the reaction from the restricted lighting which war conditions compelled, either from the necessity of saving or conservation, would be in the direction of a demand for a higher standard of illumination, both indoors and out. "The results of higher illumination intensities in increasing factory production, as reported to this Society," continued the report of the committee, "are being recognized as evidence of the necessity for increasing the foot-candle values ordinarily considered satisfactory for this class of lighting. The Inspector of Factories in British Columbia has called attention to the desirability of better industrial lighting, and, that in many cases such as sawmills where electric generators are part of the equipment, the lighting is so inadequate that the inspector has had to be furnished with a lantern in order to see well enough to perform his duties." The records of improvement presented by the committee took up the progress made in the gas and electric fields in the development of fixtures for special illuminating purposes, industrial as well as scientific, standardization and the recent designs of powerful searchlights.

In a paper on Glare Measurements, Ward Harrison, Illuminating Engineer, National Lamp Works, Cleveland, Ohio, presented data showing the range of agreement in opinion among a number of observers as to the glare from bare lamps and other more diffuse light sources, in comparison with a reference source of variable intensity. The set-up consisted merely of a row of ten or twelve light sources of varying intensity, some bare lamps, some frosted lamps, and some lamps in globes or reflectors. All were lighted and the observer was asked to state which of the sources he deemed most objectionable from the standpoint of glare. The source named was then extinguished and he was requested to point out the most glaring of those which remained, and so on until but one was left burning. The unexpected feature of this investigation was that practically all of the observers asked to have the lamps turned out in precisely the same order; in fact, there were but three or four cases among fifteen observers where a difference of opinion existed as to the relative standing of any two light sources. Mr. Harrison concluded with a discussion of the practicability of making a rough classification of lighting installations into groups according to the sensation of glare as registered by a small instrument based on the method of comparison followed in his experiments.

Arthur H. Compton, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., described a photoelectric photometer. He noted the difficulties which heretofore have prevented the use of the photoelectric cells in routine photometry, and suggested the use of a thermionic amplifier to increase current readings, also a filter to reduce the proportion of blue light and render the indications proportional to the photometric value. With such equipment, lamps are compared by varying their distances to the cell, until the deflection of the galvanometer is the same as that given by the Standard lamp.

American Railway Bridge and Building Association

The American Railway Bridge and Building Association convened at Cleveland on October 21 to 23. Welcoming the association to the city, D. C. Moon, assistant to the federal manager of the New York Central at Cleveland, emphasized the necessity of exercising practical sense in applying the technical principles of engineering. "My personal observations and experience," he said in part, "led me long ago to feel that, as between the so-called practical 'horse sense' and the technical or book knowledge, I would select the man with the former qualifications for a majority of the jobs. One can buy books and technical knowledge, but he cannot buy brains. The purely technical man has usually proven a costly theorist, as many an employer has found out to his sorrow. But the practical man has moved along on safe lines and been the employer's benefactor. Strive to be a combination man in every sense, and with that you surely will be a success. Study formulæ and technique, for they must be used, but don't forget to keep your mind working on the practical side of every job."

Comparing the internal-combustion engine with the steam engine as source of power in a railroad plant, C. A. Lichty, of the purchasing department of the C. & N. W. Ry., said that while the cost of installation is about equal for either type in the small plants or may be even higher for the internal-combustion engine in installations of from 20 to 50 hp., nevertheless the oil engine is much more economical in the matter of attendance and operates more efficiently than the steam engine, and considerably less space

is required for the storing of the oil fuel than for the transportation and storage of coal. A wide difference of opinion developed in the discussion of Mr. Lichty's paper. E. A. Demars, of the Oregon Short Line, favored steam plants because they require less-experienced operators. He stated that he had found trouble in securing men sufficiently trained and experienced to operate and maintain gasoline engines. J. P. Wood, of the Pere Marquette Railway, stated that he had found gasoline engines to be more economical than steam for small stations. He employed section foremen to run engines at a number of minor points on that road and had found that they were able to do this work satisfactorily. In larger stations where standpipes are installed he favored steam plants, largely because of his practice of piping exhaust steam to the standpipe pits to prevent their freezing in extreme cold weather. C. R. Knowles, I.C. Ry., presented data showing the comparative costs of operating a gasoline station pumping 200,000 to 300,000 gal. of water per day — which was operated originally by steam and recently changed over to an oil engine—which showed a reduction in fuel cost of over $1000 per year under identical conditions. G. W. Andrews, of the Baltimore & Ohio, stated that there are a number of points on his road where gasoline plants are not practicable, as they are flooded at certain seasons of the year. He referred to one line of 100 miles on which there are five water stations which have been under water five times this year. He uses steam plants at these places in order that the stations can be operated even when under water. In general, he favored the use of gasoline engines for ordinary locations. Mr. Knowles and others pointed out the fact that oil-burning engines can be operated on lines subject to floods by placing the pumps in waterproof pits and locating the engines above the high-water level, this arrangement giving much higher efficiency than operating steam pumps under water.

The committee reports on painting metal railway structures and on the economical use and storage of fuel at railway pumping stations contained information of much interest and many valuable suggestions which can well be applied to similar practices outside of the railway industry.

Sir John Wolfe Wolfe-Barry

The accompanying portrait of Sir John Wolfe Wolfe-Barry was presented to the American Engineering Standards Committee by the British Engineering Standards Association, whose destinies he so ably guided through long years from its beginning in 1901 as a committee of nine. That committee inaugurated by Sir John has developed into the present Association which numbers some twelve or fourteen hundred members and over three hundred committees, covering all the branches of engineering and allied industries.

Sir John Wolfe Wolfe-Barry, K.C.B., F.R.S., was the doyen of the engineering profession of Great Britain. Past-president of many of the learned societies, he always took the greatest interest in the younger members of the profession and probably is more responsible than any other man for the status of engineering generally.

His father was the architect on the Houses of Parliament and the well-known Reform Club. He himself was more closely identified with transportation facilities than with any other branch of engineering and in this connection first place may be given to the railways in and around London. He was responsible for the work of carrying the South-Eastern Railway across the Thames into Charing Cross and Cannon Street Stations and also for the construction of Tower Bridge. For the latter work he studied and developed the bascult system for the opening span, determined, as the result of many experiments, the load which could be safely imposed upon London clay, and made careful observations on the subject of wind pressure. He was also chairman of the Arbitration Board which resulted in bringing about the Metropolitan Water Board of London.

Much of Sir John's time was devoted to dock construction and there are few ports in Great Britain or her colonies in which his influence as designing, executive, or consulting engineer has not been felt.

His death on January 22, 1918, ended a long and exceedingly active life. He contributed greatly to the commercial prosperity

Sir John Wolfe Wolfe-Barry

of the United Kingdom, advanced the science of engineering particularly in relation to transportation and helped to raise the profession to a higher status. Throughout his life, Sir. John showed a singleness of purpose in giving his time and experience for the general good of the community by serving on commissions and by utilizing every opportunity to inculcate principles whereby the natural wealth and physical energy of the nation might be economized.

Correction to Paper on Octaval Notation in Shop Measurements

In Mechanical Engineering for November there appeared on page 871 an illustration with the caption —"Fig. 2 Simple Vernier Calipers." The illustration showed, however, a simple calipers

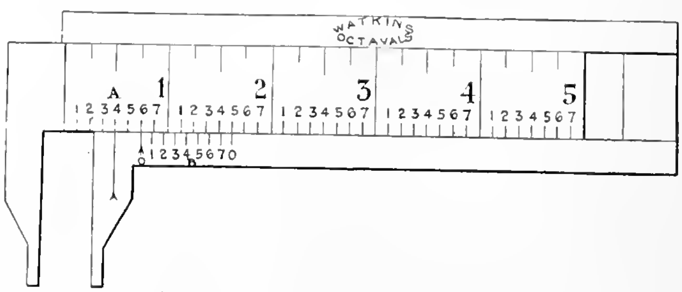


Fig. 2 Simple Vernier Calipers

to which reference was made in the complete paper, that appearing in the November issue being only an abstract. The correct figure is reproduced herewith.

ENGINEERING COUNCIL

Engineering Council[1] is an Organization of National Technical Societies of America, Created to Consider Matters of Common Concern to Engineers, as Well as Those of Public Welfare in Which the Profession is Interested

Classification and Compensation of Federal Engineers

Employed professional engineers have found themselves unprepared to meet the changes in economic conditions which have occurred during the last few years, but they are now endeavoring to bring about increases of compensation so as to sustain themselves according to previous standards of living and to adjust the hitherto inadequate salaries of positions to their responsibilities. To help correct these unfavorable conditions, Engineering Council organized, in April last, a Committee on Classification and Compensation of Engineers, of which Arthur S. Tuttle, Deputy Chief Engineer, Board of Estimate, New York City, is chairman.

The committee is divided into three sections — State and Municipal, Railroad, and Federal Government. The last-named of these, which is headed by John C. Hoyt as chairman, has just issued a preliminary report, which should receive the careful attention of every engineer so that the final report may serve as a basis for a rational system of classification and the establishment of adequate compensation for all branches of engineering.

Space prohibits more than a brief summary of the report, but it is the hope of the committee that many may see fit to offer their criticisms and suggestions, for it is highly important that every engineer interest himself actively in this subject, because the right solution of the problem is essential to the welfare of the individual and necessary in keeping the standards on a high plane.

Briefly the report indicates the lack of an adequate or consistent employment policy with respect to engineers and other technical employees in the Government service. This is shown by the following conditions, which are believed to be largely responsible for the unsatisfactory status of this class of Government employees:

1 Absence of any system of grading of positions.

2 Lack of uniformity in classes of positions and in their titles and duties.

3 Inequalities in compensation for positions of the same grade in different organization units.

4 Generally inadequate compensation for services rendered.

To the end that these conditions may be corrected and proper and equitable conditions of employment established for engineers, as well as for other Government employees, the following practices and principles are recommended:

1 Positions should be classified in accordance with the character of the duties to be performed and with the training and experience necessary for their performance, as indicated by a system of grading.

2 Within the salary limits fixed for each grade, there should be a system of advancement through the grade based upon experience gained in the position and upon proof of increase in the proficiency of the employee in performing the duties of the grade.

3 Promotions from grade to grade should depend upon the existence of a vacancy in the higher grade and proof that the employee is qualified to fill the vacancy.

4 The determination of adequate salary schedules should take into account and properly weigh the following basic considerations:

(a) The capital invested, both in money and in time, in obtaining the requisite fundamental training.

(b) The amount and character of experience and the degree of personal ability required.

(c) The relative value of the classes of work to be performed.

(d) The amount paid for work of a similar nature in private employment.

(e) The amount necessary to enable the employee to maintain a standard of living commensurate with the general standards of the community for positions carrying similar dignity and responsibility.

(f) The amount necessary to procure for and retain in the Government service a class of employees capable of conducting the business of the Government with an efficiency and a spirit of initiative equal to that of private business.

5 In the interest of an adequate social policy, no position likely to be occupied by individuals of an age to assume family responsibilities should fail to pay an amount sufficient to permit the maintenance of the average family in reasonable decency and comfort.

6 In the interest of the employees as a whole and of the proper conduct of the work of the Government, a system should be established by which employees who fail to maintain satisfactory standards of service should be removed, transferred, demoted, or retired as may be equitable in the circumstances.

Numerous tables and charts comparing salaries and grades of both past and present form an interesting and valuable part of the report, and one showing the tentative recommended salary schedule is reproduced below as Table 1.

TABLE 1 TENTATIVE RECOMMENDED SALARY SCHEDULE

Titles of Positions	Minimum Years of Service in Grade	Minimum Salary of Grade	Maximum Salary of Grade	Total Promotion between Grades
PROFESSIONAL GRADES				
1 Chief Engineer		8100	and up	
				2160
2 Engineer	4	5940	7860	
				1620
3 Senior Assistant Engineer	3	4320	5760	
				1620
4 Assistant Engineer	3	2700	4140	
				1080
5 Junior Assistant Engineer	2	1620	2580	
SUB-PROFESSIONAL GRADES				
6 Aid	3	1680	2400	
				600
7 Junior Aid	2	1080	1560	

NATIONAL SERVICE COMMITTEE

Contributed by the Washington Office[1]

Engineering Appropriations, 66th Congress

A number of items of vital importance to engineers were included in the first deficiency appropriation bill. They are as follows: $2,950,000 for the prevention of forest fires; $175,000 for industrial research, industrial safety standards and standardization of scientific instruments at the Bureau of Standards; $250,000 for repair of naval vessels. The following items were changed in conference: Alaskan Railroad appropriation was reduced from $17,000,000 to $6,000,000; Army Air Service appropriation of $15,000,000 was entirely eliminated and the appropriations providing for 33⅓ per cent increase of pay for draftsmen in the Navy Hydrographic Office and engineers in the Coast and Geodetic Survey Office were also eliminated.

The Alaskan Railroad appropriation was reduced because $6,000,000 is all that will be needed during the current fiscal year and the balance of the $17,000,000 required to complete the work will probably be taken care of in the next regular Sundry Civil bill.

[1] Officers of Engineering Council: J. Parke Channing, *Chairman*; Alfred D. Flinn, *Secretary*, Engineering Societies Building, 29 West 39th Street, New York.

[1] Washington Office in charge of M. O. Leighton, *Chairman*, National Service Committee, McLachlen Building, 10th and G Streets.

The appropriation for the Army Air Service was eliminated because it was contemplated that this service will be cared for in the future by a regular appropriation bill covering this special subject.

The total amount appropriated under the provisions of the first deficiency appropriation bill was $29,461,035.85. This is a reduction of almost 50 per cent from the bill which was originally passed by the Senate.

Mileage Pay for Engineers

After the National Service Committee of Engineering Council announced that it was prepared to look after the interests of engineer officers who were required to travel long distances to their first stations but were never paid for such travel, a large number of letters giving evidence in the case were received and used as evidence.

Arrangements were completed whereby a bill was drafted to care for the engineer officers who had lost heavily on this score. This measure was approved by the Adjutant General, Chief of Engineers and the Chairman of the Military Affairs Committee of the House, but has not been reported to the House calendar because of press of other business before the Military Affairs Committee.

Assistance to Civilian Aviators

Bills have recently been proposed in both Houses of Congress, authorizing the Secretary of War to sell at contract prices, plus 10 per cent, gasoline, oil, and aircraft supplies to civilians in charge of aircraft who land on or near aviation stations. He is to promulgate rules for the distribution of this coöperation, but with the special provision that the amount so sold is to be limited to the immediate needs of the aviator to enable him to get to the nearest point where supplies can be purchased.

This, together with the weather bulletins provided the Air Service through the Weather Bureau and the maps that are being prepared by the Government to assist aviators, should be a boon to civil aviation. These things show a distinct attitude on the part of the Government to assist aeronautical development as much as possible.

Road Building for 1920

A total of $633,000,000 is now in sight for road-building purposes during the year of 1920. The Bureau of Roads arrives at this estimated total expenditure as follows: brought forward from unfinished work, $165,000,000; available from state and county taxes and federal aid, $273,000,000; one-fifth state and county bond issues not before available, $50,000,000; one-third unexpended balance of state and county bond issues, previously available, $45,000,000; available from new bond issues to be voted on during the remainder of 1919 and early part of 1920, $100,000,000.

The United States Geological Survey will assist the Bureau of Roads by stimulating the production of road-building material if they can obtain the funds that will be required for this purpose. It has now become apparent that unless greatly increased production of road-building material is secured in the near future, full advantage of transportation facilities as well as the funds that are available cannot be had.

According to the records of the Bureau of Roads each month breaks the record of new roads started and completed under the extensive road-building campaign of the state and federal governments.

Chamber of Commerce to Erect New Building

The Chamber of Commerce of the United States is preparing to erect a building in Washington, D. C., to serve as the permanent national headquarters. This building will be a large and dignified structure, and is designed to commemorate the part taken by American business and industry in the Great War. The site selected for this building is at the corner of Connecticut Avenue and H Street, just across Lafayette Square from the White House, the State, War and Navy and other Government buildings. Of dignified classical architecture, the building will be five stories high, and is estimated to cost $2,500,000. Mr. Cass Gilbert, of New York, is the architect.

Engineers are interested because Engineering Council is a member of the National Chamber, and as such, has the privilege of using all the facilities of the Chamber's offices in Washington for the benefit of its member societies. The site for the new building has been purchased, and a campaign to raise the balance of the funds needed is soon to be made. Engineering Council bespeaks the coöperation with the Chamber of such engineers throughout the country as can help. Harry A. Wheeler, vice-president of the Union Trust Company, Chicago, Ill., is the chairman of the Committee on Financing Building.

National Research Council Reorganizes Its Division of Engineering

The Division of Engineering of the National Research Council has recently been organized, and Prof. Comfort A. Adams, Dean of the Harvard Engineering School and a past-president of the American Institute of Electrical Engineers, is now chairman. He replaces Dr. Henry M. Howe, who formerly headed the Division, Dr. Howe having been made Honorary Chairman. Mr. Galen H. Clevenger still retains the vice-chairmanship.

The work of the Division is progressing along many lines, perhaps the most important of which is the investigation of the fatigue phenomena of metals. An agreement has now been reached by the University of Illinois, the Engineering Foundation, and the National Research Council under the terms of which Engineering Foundation is to give $15,000 a year for two years to carry on this work and the University of Illinois is to contribute the use of its laboratories and the services of Professor Moore, the chairman of the Division's Committee on the Fatigue Phenomena in Metals. The work will be done under the direction of the Division of Engineering. A report as prepared by the committee, and which summarized the available facts and theories relating to fatigue failure, and discussed some of the unsolved problems, appeared in the September issue of Mechanical Engineering.

The relation of the Division of Engineering to other organizations engaged in research in the field of engineering is also receiving considerable study, to the end that the research work of the various societies and organizations may be properly coördinated. Eight national engineering societies are now represented in the Division, among them being The American Society of Mechanical Engineers, and in order to bring about a larger measure of coöperation other societies and organizations engaged in engineering research will shortly be invited to appoint representatives.

Research Work in Alloys

The Division of Industrial Research of the National Research Council is arranging for the formation of a coöperative association to plan and support fundamental reseaches in alloys. Although much valuable work has been done in this field by scattered investigators, there is no doubt but that a well-planned and coordinated effort under the general guidance of the National Research Council and composed of specialists representing both the manufacturers and the more extensive users of alloys can produce additional results of great importance. The success of other industries which have supported research on a coöperative plan, such as has been done by the National Canners' Association and the Malleable Iron Manufacturers, is evidence of this fact.

It is planned to create a special scientific staff composed of a Director and Assistant Director of Research and a group of scientific investigators and technical experts who will give their whole time to the work. To finance the organization each member of the coöperative association will pay $1000 a year, and all contributing members, who may be either alloy, manufacturing or using individuals, firms or companies, are to benefit alike by the results of the researches.

NECROLOGY

HENRY LAURENCE GANTT

Henry L. Gantt, an industrial engineer of national reputation and a former manager and vice-president of the Society, died suddenly on the evening of November 23 at his home in Montclair, N. J., of heart disease.

Mr. Gantt was born in Maryland in 1861. He received his B. A. degree from the Johns Hopkins University in 1880 and was graduated from the mechanical engineering course at Stevens Institute of Technology in 1884. In association with Frederick W. Taylor he helped to install modern methods of manufacture at the plant of the Midvale Steel Company and at other large industrial establishments. During the war, as production advisor to the Government, he developed a new and effective method for the rapid production of war materials.

Mr. Gantt was a member of the Society of Naval Architects and Marine Engineers, the American Geographic Society, the Engineers' Club and the Machinery Club. He became a member of our Society in 1888 and later held the office of manager (1908-1911) and that of vice-president (1913-1915).

A more extended account of Mr. Gantt's career will appear in the January issue of Mechanical Engineering.

WILLIAM FRANKLIN AUSTIN

William F. Austin, a member of the Society since 1905, died on July 12, 1919. Mr. Austin was born on October 2, 1864, in East Greenbush, N. Y. He received his early education in the public schools of Rensselaer and later supplemented this by a correspondence course in mechanical engineering. He served his apprenticeship with the Central Bridge Company, Buffalo, from 1882 to 1884, when he became connected with the Hilton Bridge Company, Albany, first as foreman of their drafting room and later of the erection department. In 1894, Mr. Austin became superintendent of the Albany plant of the American Bridge Company, and in 1905 superintendent of the Eddystone plant of the Belmont Iron Works, where he was located for about eight years, when illness compelled his giving up active business life.

WILLIAM FRAZIER CARPENTER

William F. Carpenter, vice-president of the Pittsburgh Testing Laboratory, died suddenly on October 10, 1919. Mr. Carpenter was born in 1857 in Staten Island, N. Y. He was graduated from Stevens Institute of Technology in 1876 and took his first position with the Ramapo Iron Works. From there he went to Pittsburgh and started the Kent Construction Company and later the Pittsburgh Testing Laboratory. For a number of years he was associated with the Westinghouse and Electric Manufacturing Company, holding very responsible positions. He was also connected with the St. Lawrence Power Company as vice-president and general manager and acted as consulting engineer for the Spokane and Inland Empire Railway Company. He then returned as vice-president to the Pittsburgh Testing Laboratory, which concern he himself had established many years before.

Mr. Carpenter (who, in 1918, had his name changed from Zimmerman) was one of the original members of the Engineers' Club of New York. He became a member of the Society in 1884.

JOHN ARTHUR HALL

John Arthur Hall, a member of the Society since 1916, died on October 1, 1919, of injuries received in an automobile accident. Mr. Hall was born in Pittsburgh, Pa., on September 16, 1877. He was graduated from Sheffield Scientific School, Yale University, in 1897, and after a year of graduate study became associated as chemist with the Carnegie Steel Company, Pittsburgh. From 1902 to 1915 he was connected with the Tennessee Coal, Iron and Railroad Company, as superintendent of the Alice Furnaces, with the Edison Portland Cement Company as chemical engineer and with the Ransome Concrete Machinery Company as superintendent in charge of production. More lately, Mr. Hall has been engaged in business under the firm name of the Hall Machine Company, general machinists.

WALTER W. KREISER

Walter W. Kreiser was born on July 23, 1892, in Jersey City, N. J. He was prepared for college at Stevens Preparatory School and then entered Stevens Institute of Technology, from which he was graduated in 1916 with the degree of M.E. He spent a year in chemical research work and then became connected with the mechanical engineering department of the Western Union Telegraph Company, New York. In September 1917 he became assistant engineer of tests in the Brooklyn Navy Yard. Here, while performing his regular duties in the mechanical laboratory, he was injured by falling into a manhole carelessly left open, and, after an eleven-months' illness, died on October 11, 1919.

Mr. Kreiser was a member of the American Chemical Society. He became a junior member of our Society in 1916.

FRED A. LARKIN

Fred A. Larkin was born in Mason, N. H., on December 2, 1850. He was educated in Massachusetts schools and gained his technical knowledge through special instruction. He served an apprenticeship in shop practice, and for three years served as engineer in charge of engines and boilers in manufactories.

He then became connected with the Allis-Chalmers Manufacturing Company, Milwaukee, representing them in New York. For a number of years he was connected with the General Electric Company, and for two years was with the Foundation Company, New York.

Mr. Larkin was a member of the Engineer's and also of the Republican Club. He became a member of the Society in 1888.

JULIAN H. PITKIN

Julian H. Pitkin, a son of Judge Stephen H. Pitkin, was born at Lewiston, Ill., on July 4, 1839. When a boy, the family moved to Hudson, Ohio, and here he attended the Western Reserve College of which his grandfather, the Rev. Caleb Pitkin, was one of the founders.

He learned the machinist's trade and took a special course at the Polytechnic College of Pennsylvania, working for a year in some of the best shops in the East for experience. For several years he was with Altman Miller & Co., Akron, Ohio, in charge of the tool department. He then became connected with C. Altman & Co., Canton, Ohio, in a similar capacity. In 1886 he was called to the During Harvester Company, Chicago, Ill. (now a part of the American Harvester Company), where he held the position of assistant general superintendent in charge of manufacture, later being transferred to the experimental department.

During all these years of service, in addition to his regular duties, he was engaged in the design and perfection of new machinery. His efforts in these lines were honored by medals from Paris and the St. Louis Expositions.

Shortly after his retirement from the Harvester Company, the engineering department of the Civil Service of Chicago offered him the position of counsellor regarding plans and construction of new city shops. For many months he made a close study and inspection of plans and work, which resulted in a municipal plant as efficient as that of the most highly organized private corporation.

Mr. Pitkin was a member of several clubs and fraternal organizations, among these being the G. A. R. He was formerly a member of the Society, joining in 1883. — J. S. L.

BARTON J. ROBINSON

Barton J. Robinson, manager and proprietor of B. J. Robinson's Machine Works, Vicksburg, died on October 4, 1919. Mr. Robinson was born in Claiborne County, Miss., on February 14, 1868. He received his early education in the New Orleans Schools, and served his apprenticeship as a machinist with the Shakespeare Iron Works, New Orleans, later attending night school to perfect himself in his chosen trade.

In 1896, after spending a number of years in machine-shop and railroad work, he started in business for himself under the firm name of B. J. Robinson's Machine Works, specializing in rebuilding saw-mill and cottonseed-oil mill machinery.

Mr. Robinson was prominent in fraternal circles and belonged to several local business organizations and clubs. He became an associate member of the Society in 1917.

RICHARD CHARLES VIET

Richard C. Viet, head of the marine department of the Standard Oil Company, New York, died on August 29, 1919. Mr. Viet was born in New York City on November 17, 1855. He was educated in the public schools of the city, and when comparatively young secured employment with the firm of Rockefeller, Andrews & Flagler, the predecessor of the Standard Oil Company, with which concern he remained for fifty-two years. He was advanced from one position to another, gradually acquiring a comprehensive grasp of the oil industry. In 1880 he was made chief of the lighterage department at the time when the Standard Oil Company had its beginning. For many years Mr. Viet was a director of the company and in 1911 he became secretary.

Mr. Viet was affiliated with various philanthropic institutions, among these being the old J. Hood Wright Memorial Hospital, the American Museum of Natural History, the Metropolitan Museum of Art and the New York Zoölogical Society. He was a member of a number of clubs and social organizations. He became a member of the Society in 1891.

LIBRARY NOTES AND BOOK REVIEWS

AIR NAVIGATION. Notes and Examples. By Capt. S. F. Card. Longmans, Green & Co., New York, 1919. Cloth, 6 x 9 in., 149 pp., illus., tables, map.

An elementary textbook of navigation for airplane pilots, which presents the methods and the course of instruction used in training the officers of the British flying service.

APPLIED MECHANICS. By Fuller and Johnson. Vol. II. Strength of Materials. First edition. John Wiley & Sons, Inc., New York, 1919. Cloth, 6 x 9 in., 556 pp., illus.

Volume I of this textbook, treating of statics and dynamics, appeared several years ago. The present volume, treating of the strength of materials, covers the fundamentals of this subject, as taught in the engineering departments of the Massachusetts Institute of Technology, in so far as they are required in the study of structural and machine design and in the ordinary problems of engineering practice.

AUTOMATIC SPRINKLER PROTECTION. By Gorham Dana. John Wiley & Sons, Inc., New York, 1919. Cloth, 5 x 9 in., 456 pp., illus.

The author of this volume has attempted to cover the subject in such a way that his book may serve as a textbook for students and also as a reference book for experienced engineers. Starting with a historical summary of the development of the art, he then describes the tests and characteristics of sprinklers, installation rules, layouts, valves, supervisory systems, etc. An appendix lists all types on which information is available and summarizes over six thousand tests of various sprinklers.

CHILTON TRACTOR INDEX. July 1919. Published semi-annually by the Chilton Co., Philadelphia. Paper, 7 x 10 in., 500 pp.

This volume is a directory of the American tractor industry, in which, the editors state, they have attempted to present all the information useful to the industry as a whole. It includes descriptions of power-farm machinery, illustrated descriptions and specifications of tractors and farm implements, and directories of those firms manufacturing implements, tractors, parts, and accessories.

CONCRETE-STEEL CONSTRUCTION. Part I. Buildings. A Treatise upon the Elementary Principles of Design and Execution of Reinforced Concrete Work in Buildings. By Henry T. Eddy and C. A. P. Turner. Second edition. C. A. P. Turner & Co., Minneapolis, 1919. Cloth, 6 x 9 in., 502 pp., illus., tables.

The authors of this volume believe that the fundamental principles underlying the theory of reinforced construction are not generally understood by engineers and the methods of computation of applied bending moments in common use are erroneous. Their book presents what they believe to be the correct analysis of the bending and twisting moments present in columns and flat slabs, a method founded upon the manner of distribution and of the vertical shears that transmit the leading to the supports.

THE CONDENSED CHEMICAL DICTIONARY. A reference volume for all requiring quick access to a large amount of essential data regarding chemicals and other substances used in manufacturing and laboratory work. Compiled and edited by the Editorial Staff of the Chemical Engineering Catalog. The Chemical Catalog Co., Inc., New York, 1919. Cloth, 6 x 9 in., 525 pp.

This volume has been prepared to meet the need for a concise summary of the properties of chemicals, which is felt by exporters, brokers, purchasing agents, manufacturers, and others who require quick access to information on chemical products.

The arrangement of the book is alphabetical and, while the compilers state that no attempt has been made to be exhaustive but merely to give the outstanding facts concerning the chemicals ordinarily met in commerce, approximately six thousand substances are included.

DYKE'S AUTOMOBILE AND GASOLINE ENGINE ENCYCLOPEDIA. By A. L. Dyke. Tenth edition. A. L. Dyke (copyright 1919), St. Louis. Cloth, 7 x 10 in., 940 pp., illus.

It is difficult to imagine any topic connected with the use or repair of automobiles which is not discussed in this comprehensive volume for repairmen and operators. Theoretical considerations are omitted, but an immense amount of practical information is supplied in concise, definite form, illustrated by numerous drawings and charts. In addition to passenger automobiles, the volume treats of trucks, tractors, motorcycles, and airplanes.

FOUNDRY PRACTICE. A Textbook for Molders, Students and Apprentices. By R. H. Palmer. Second edition. John Wiley & Sons, Inc., New York, 1919. Cloth, 6 x 8 in., 390 pp., illus., 40 tables.

This volume is intended primarily for purposes of instruction, rather than as a treatise for experienced foundrymen. The various types of molds are explained and illustrations of the different practices are given. Cupola and air-furnace practice, foundry equipment, methods of mending and cleaning castings are also discussed.

This edition has been enlarged by the inclusion of methods for casting and holding a number of additional articles, such as engine cylinders, propellers, lathe beds, and large kettles.

THE GASOLINE AUTOMOBILE. Prepared in the Extension Division of the University of Wisconsin by George W. Hobbs and Ben G. Elliott. Second edition, completely revised by Ben G. Elliott and Earl L. Consoliver. McGraw-Hill Book Co., Inc., N. Y. Cloth, 6 x 9 in., 483 pp., 1 pl.

Developments in automobile practice during the past four years have necessitated changes in this popular textbook. In addition to the necessary revision, the book has been rewritten and enlarged by the inclusion of several new chapters. In doing this the authors have provided a work on the fundamental principles of automobile design, construction, and operation for the instruction of those who drive, repair, sell, or otherwise have to do with motor cars.

IRON AND STEEL. A Treatise on the Smelting, Refining, and Mechanical Processes of the Iron and Steel Industry, including the Chemical and Physical Characteristics of Wrought Iron, Carbon, High-Speed and Alloy Steels, Cast Iron and Steel Castings, and the Application of these Materials in Machine and Tool Construction. By Erik Oberg and Franklin D. Jones. First edition. The Industrial Press, New York, 1918. Cloth, 6 x 9 in., 328 pp., illus.

This volume, the authors state, is not intended as a treatise for metallurgists and those engaged in the manufacture of iron and steel, but as a textbook for students in technical schools and those engaged in mechanical engineering and machine building. The book provides for these a broad general survey of the industry, with definite practical information on the various commercial grades and forms of iron and steel products, and the particular class of service for which each is suitable.

MARINE GAS ENGINES. Their Construction and Management. By Carl H. Clark. Second edition. D. van Nostrand Co., New York, 1919. Flexible cloth, 5 x 8 in., 136 pp., illus.

This volume is a small manual of convenient size, intended for those who desire a systematic presentation of the principles of operation and construction of the standard types of marine gas engines, from a practical rather than a theoretical point of view. The present edition has been revised to current practice, and material on oil and Diesel engines has been added.

Manufacturers' Instructors and Advisors. By Frederick Meron. Theo. Audel & Co., New York (copyright 1918). Cloth, 3 vols. and portfolio.

Contents: No. 1 — Layouts and equipments for factories, 228 pages and portfolio of 34 plates. No. 2 — Common-sense working methods in factories, 161 pages. No. 3 — The human element in organizations, 351 pages.

The author endeavors to present concisely and clearly the results of his experience in the installation, organization, and operation of industrial plants, with the object of showing, by comparison and illustration, methods for increasing output and reducing expenses.

Papers on the Design of Alternating-Current Machinery. By C. C. Hawkins, S. P. Smith, and S. Neville. Sir Isaac Pitman & Sons, Ltd., London and New York, 1919. Cloth, 6 x 9 in., 392 pp., illus., plates, tables.

Contents: Notes on the Theory and Design of Alternating Current Generators; the Flux Wave-form of the Turbo-alternator with Cylindrical Rotor; Magnetic Calculations for Tapered Teeth; Notes on the Theory and Design of the Polyphase Induction Motor.

Originating out of many discussions on technical subjects, the papers here collected find a connecting link in their common purpose, which is to deal scientifically and practically with problems arising in the design of alternating-current machinery. The point of view throughout is that of the practical designer.

The Principles of Electric Wave Telegraphy and Telephony. By J. A. Fleming. Fourth edition. Longmans, Green & Co., New York, 1919. Cloth, 6 x 9 in., 707 pp., illus., plates, tables.

Dr. Fleming's well-known treatise has again been revised by additions which bring it up to date, while antiquated matter has been deleted in order that the volume might not become unwieldy. The book is a statement of principles rather than a full account of actual apparatus, and is intended to provide a comprehensive view of the subject, particularly with regard to its scientific side, and of that part of it which is concerned with quantitative measurements and the underlying theory.

Steam Turbines. A Practical and Theoretical Treatise for Engineers and Students, including a discussion of the Gas Turbine. By James Ambrose Moyer. Fourth edition, revised and enlarged. John Wiley & Sons, Inc., New York, 1919. Cloth, 6 x 9 in., 496 pp., illus., diag., tables, 1 folded chart.

This edition differs from the preceding ones by containing fuller discussions of the methods of governing, the calculation of the strength of disk-type blade wheels, and of recent developments in marine practice. The text as a whole has also been revised. The general purpose of the volume is to provide the designer, operator, or manufacturer of steam turbines with a concise manual of information based on practical experience.

Timber. Its Strength, Seasoning, and Grading. By Harold S. Betts. First edition. McGraw-Hill Book Co., Inc., New York, 1919. Cloth, 6 x 9 in., 234 pp., illus., maps, charts, tables.

This volume, for engineers, manufacturers and users of lumber and wood material, is intended to meet the lack of a work on wood as a structural material, similar to existing handbooks on steel, concrete, etc. The methods of testing the strength of wood and wood products, such as telephone poles, packing boxes, and vehicle parts, are described and the results of numerous tests by the Forest Service are tabulated. A table based on 130,000 tests, showing the average mechanical properties of 121 American woods, is given. Proper methods of seasoning wood are fully discussed. The grading rules of the different manufacturers' associations are given and the book closes with extensive statistics on the lumber produced and used in the United States.

Waterproofing Engineering. For Engineers, Architects, Builders, Roofers, and Waterproofers. By Joseph Ross. First edition. John Wiley & Sons, Inc., 1919. Cloth, 6 x 9 in., 452 pp., 140 illus., 41 tables.

The absence of any systematic treatise on waterproofing has led to the preparation of this book, which is based on the author's practical experience and researches, as well as his study of the existing literature. The function of waterproofing, the systems in use, methods, and results are described and specification and cost tables are given. A useful glossary of waterproofing terms and a bibliography are appended.

WAGE PAYMENT

(Continued from page 940)

every human activity can be scheduled and analyzed, yet by far the greater part of industrial operations can be treated in this way. The relatively few operations which cannot be classified and treated in this manner would be such a small part of the total that it would be easy to find a way to compromise when such exceptions should occur.

In estimating the value of operations we must drop, to a large extent, the idea that wage is the compensation for time. It should be made a compensation for product delivered. The value of the product changes constantly. Changes may be due to the desirability of the product, or to the means employed to produce the product, or to the law of supply and demand, or to other causes. In other words, the relations existing between various products is ever changing; consequently, whatever estimate is placed on the value of the product of labor should be changed from time to time, so as never to have too large a difference between the actual and the estimated value.

It hardly need be pointed out that to set such standards of value of work must necessarily be a gigantic task. In addition to the many technical difficulties in estimating values of products, there are other elements which must not be forgotten. There are many cases where operations are required which call for extreme skill, possessed by only a few, a skill which can never be found in the mass of the people. There are operations where steady nerves are essential, some where physical courage is required, others which cannot be successfully carried out without many years of experience, et cetera. Such points should all be considered.

Consideration should also be given to what constitutes a proper minimum and a proper maximum wage. In repetition operations it is sometimes possible for the operator to produce large amounts of work, but only at the expense of extreme weariness, and in the long run such a man is not employed to the best advantage of the world at large. Recognition of this fact has led to the prescription of rest periods. On the other hand, there may be cases where it is expedient to employ men not skilled in the operation they are supposed to do. This may happen because skilled men are not available at that time or at that place, or because special conditions call for an unusual amount of this class of work. Though the value of the product of such a man might be low, he should receive not less than a minimum wage. This minimum wage, however, is in itself difficult to determine. A satisfactory minimum wage for an unmarried young man is not at all satisfactory for a married man with a large family.

It is really superfluous to point out the many disturbing factors acting against the establishment of wages in proportion to product. What the writer wishes to emphasize is his belief that, notwithstanding all the difficulties, it will be found possible to classify a large portion of the work of the world in such a manner that wages can be set to such a degree of scientific accuracy that the variations caused by the disturbing facts will not be so large but that they will lend themselves to compromise. It is further his belief that such a classification cannot be accomplished by the employers alone, nor by the laboring men alone, but that when these two classes are working together for a constructive purpose, they will find so many things in common that they will be more apt to forget their differences. Finally, he wishes to state once more this belief: That the real cause of the present-day unrest lies in the fact that there is no unit of measurement which both employers and employees can use; or, in other words, the fact that our present wage system is not based on knowledge and justice, but only on guesswork and on the fear that the one may "do" the other.

Dec. 1920. pp. 1a-38a. 1a

THE ENGINEERING INDEX

(Reg. U. S. Pat. Off.)

Published Monthly by The American Society of Mechanical Engineers

The Engineering Index was Founded in 1884 by the Association of Engineering Societies; Published from 1895 to 1919 by The Engineering Magazine Company; and Acquired January 1919 by The American Society of Mechanical Engineers

THE following pages form a descriptive Index to articles on engineering and related subjects in current periodicals. In its preparation the Society's engineering staff regularly examines all of the technical journals and society publications received by the Engineering Societies Library, which form one of the greatest and most complete collections of scientific periodicals in the world, comprising upward of 1100 distinct publications in some ten languages. Cross-references are freely introduced in the Index, and in all cases where the titles of articles are not sufficiently descriptive, explanatory sentences are appended. The main abbreviations used in the items are given at the bottom of this page.

Mechanical Engineering

AIR MACHINERY

Air Compression

Some Elements of Economy in Air Compression, Wm. Carter. Can. Min. Jl., vol. 40, no. 43, Oct. 29, 1919, pp. 808-809. Observes that in steam-driven air compressors first element of economy lies in using compounded steam cylinders operating under pressures lower than would be advisable in ordinary engine practice.

Utilization of Exhaust Steam for the Direct Production of Compressed Air (Utilisation des vapeurs d'echappement pour la production directe de l'air comprimé). Auguste Dessemond. Bul. et Comptes Rendus Mensuels de la Société de l'Industrie Minérale, vol. 16, no. 3, 1919, pp. 5-32, 23 figs., partly on six supp. plates. Installations resembling scheme developed by Rateau, in which mixed turbine capable of operating with steam at low or high pressure is directly connected to multi-cellular compressor.

Air Compressors

Development of Reciprocating Air Compressors, S. T. Nelson. Eng & Min. Jl., vol. 108, no. 13, Sept. 27, 1919, pp. 533-536, 3 figs. It is said that machines of small capacity were formerly not expected to be efficient and that change from steam to electric drive resulted in many makeshift devices.

Air Pumps

The Marine Air Pump as a Power Factor. Harold C. Walker. Trans. Inst. Mar. Engrs., vol. 31, no. 246, Sept. 1919, pp. 341-358 and (discussion) pp. 358-362, 1 fig. Possibilities and performance of various types studied from vacuum point of view, together with notes on value of air pump efficiency as factor influencing turbine power.

Centrifugal Machinery

Centrifugal Ventilators and Centrifugal Pumps and their Drive (Die Zentrifugalventilatoren und Zentrifugalpumpen und ihre Antriebsmaschinen), V. Hüttig. Gesundheits-Ingenieur, vol. 42, nos. 14 and 15, Apr. 5 and 12, 1919, pp. 141-147 and 153-158, 11 figs. Calculating efficiency and power consumption under changed operating conditions. Suggestions for preventing humming noise and vibration of floor.

Experiments with Centrifugal Ventilators (Versuche an Sachsenwerk-Zentrifugal Lüftern), Hüttig. Gesundheits-Ingenieur, vol. 42, no. 24, June 14, 1919, pp. 241-252, 12 figs. Description of apparatus used for experiments; tables and curves showing results of tests.

Centrifugal Compressor Installation at Newport News Shipbuilding and Dry Dock Co., L. C. Loewenstein. Gen. Elec. Rev., vol. 22, no. 10, Oct. 1919, pp. 785-788. Turbo compressor is operated by exhaust steam from reciprocating engines and precompressed air delivered to reciprocating compressors. Output of compressor plant is said to have been increased in this way by about 50 per cent with very little additional expenditure for fuel, as reciprocating engines were operated non-condensing, a portion of steam being exhausted to air.

Governors

Volume Regulators for Air Compressors, C. S. Darling. Mech. World, vol. 66, no. 1711, Oct. 17, 1919, pp. 184-185. Comparative studies of various regulating systems.

Regulators, Volume

See Governors.

Wind Motors

Windmills. Times Eng. Supp., vol. 15, no. 540, Oct. 1919, p. 307. Their uses and limitations.

Windmills (Vindmollen). Ingeniören, vol. 28, no. 63, Aug. 6 & 9, 1919, pp. 401-408 and 409-411, 11 figs. Formulæ for finding correct skew of sails, power developed by given wind velocity pressure on sails, and velocity of arms. Tables and coefficients offered with view to facilitate calculations. (Concl.)

CORROSION

Boilers and Economizers

Pitting and Corrosion in Boilers and Economizers, F. F. Vater. Power Plant Eng., vol. 23, no 21, Nov. 1, 1919, pp. 963-964. Theories of corrosion causes, examples of pitting, effective preventives and cures.

Condenser Tubes

The Corrosion of Condenser Tubes, G. Costeceque. Eng. Rev., vol. 33, no. 3, Sept. 1919, pp. 60-61. Results of ten years' investigations of corrosion of surface condenser tubes by sea water. Translated from Revista de Obras Publicas.

Economizers

See Boilers and Economizers

Floor Material

Steel Plate Drip Floor for Niagara Railway Arch. Eng. News-Rec., vol. 83, no. 13, Sept. 25, 1919, pp. 620-621, 3 figs. Repairs necessitated by corrosion of floor-beams and stringers due to refrigerator drip and to locomotive blowoff.

FORGING

Die Pressings

The Manufacture of Die Pressings. J. H. Garnett. Machy. (Lond.), vol. 14, no. 362, Sept. 4, 1919, pp. 673-679, 20 figs. Describes advantages of and metals used for die pressings, as well as method for making dies.

Drop Forging

Drop-Stamping, Drop-Forging, etc.—IX, X, Joseph Horner. Mech. World, vol. 66, no. 1707 and 1711, Sept. 19 and Oct. 17, 1919, pp. 138 and 187, 21 figs. Sept. 19: Cast-iron or steel dies with hardened steel insertions. Oct. 17: Bevel-pinion blank.

Forging Temperatures

Forging Temperatures and Rate of Heating and Cooling of Large Ingots, F. E. Bash. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, supp. to Sept. 1919, pp. 2869-2880, 3 figs. Test carried out on 24-in. round ingot. It was possible to heat ingot from room temperature to forging temperature in 7 hr. No definite conclusion is arrived at as to whether this heat would be injurious to steel, but it is advised that in any particular case question should be decided in light of shop experience.

Furnaces

A Recuperative Furnace for the Forge Shop. Blast Furnace & Steel Plant, vol. 7, no. 10, Oct. 1919, p. 495, 3 figs. Furnace designed for economical firing. It employs recuperators of special design for reclaiming heat from waste gases.

Hammer Troubles

Hammer Troubles that Hinder Production. Am. Drop Forger, vol. 5, no. 10, Oct. 1919, pp. 486-489. Such as losses resulting when hammer is not pounding on hot stock. Also board-drop hammers are taken into consideration.

Nickel Chrome Forgings

Nickel Chrome Forgings, J. H. Andrew, J. N. Greenwood and G. W. Green. Iron and Steel Inst., meeting of Sept. 1919, paper no. 1, 93 pp., 26 figs. Investigations of specimens at various stages in process of manufacture are reported and suggestions are formulated relative to various conditions to realize in the castings in order to obtain faultless forgings.

FOUNDRIES

Aluminum Casting

Unsoundness in Aluminum Castings, Robert J. Anderson. Foundry, vol. 47, no. 330, Sept. 1, 1919, pp. 579-584, 24 figs. Results of experiments on porosity and on unsoundness of no. 12 alloy of aluminum, composed roughly of 92 per cent aluminum and 8 per cent copper, interpreted as establishing that number of blowholes present is function of pouring temperature, the higher the pouring temperature the greater being the number of blowholes and the more unsound the casting. It was also determined that unsoundness varies with temperature to which charge is heated, and is function of length of time of melting.

Brass Melting

Considerations Affecting Brass Melting, R. R. Clarke. Can. Foundryman, vol. 10, no. 10, Oct. 1919, pp. 295-298, 2 figs. Things to guard against when brass work is done in iron foundry.

Bronzes, Zinc

Five Foundry Tests of Zinc Bronzes. C. P. Karr. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, supp. to Sept. 1919, pp. 2485-2492 1 fig. Bur of Standards work with type metal known as "Admiralty bronze" in England and as "Government bronze" in United States and consisting of 88 copper, 10 tin, and 2 zinc.

Centrifugal Casting

Centrifugally Cast Pipe in South America. Iron Age, vol. 104, no. 13, Sept. 25, 1919 pp. 863-865, 7 figs. General features of plants in Brazil and Argentine using DeLavaud process for iron pipe.

Cost System

Practical Up-to-date Foundry Cost System, M. H. Potter. Can. Foundryman, vol. 10, no. 5, May 1919, pp 124-126, 9 figs. Illustrating requisition cards, moulders' cards, delivery sheet, progress record form and similar cards.

Cupolas

Fuel Economy in Cupola Practice. II. James Yates. Iron and Steel Inst., meeting of Sept. 1919, paper no. 2, 7 pp. Concerning making good heat losses (1) from casing by radiation, (2) due to sensible heat in waste gases, (3) resulting from undeveloped heat in unburned carbonic oxide. Also in Colliery Guardian, vol. 118, no. 3065, Sept. 26, 1919, pp. 834-835.

Design

An Achievement in Foundry Design. Gilbert L. Lacher. Iron Age, vol. 104, no. 13, Sept. 25, 1919, pp. 827-832, 13 figs Plant of Busch-Sulzer Bros. Diesel Engine Co. described as notable from viewpoint of equipment, transportation facilities, lighting, ventilation and sanitation.

Die Castings

Die-Casting and Die-Casting Metals. Erik Oberg. Machy. (N.Y.), vol. 26, no. 2, Oct. 1919, pp. 155-160, 11 figs. Also in Machy. (Lond.), Oct. 16, 1919, pp. 65-70, 11 figs. Article describes general organization of plant for making die-molded castings, and reviews metals now commercially used in die-casting practice.

Die-Casting. E. N. Dollin. Mech. World, vol. 66, no. 1711, Oct. 17, 1919, pp. 187-189. Reports of various English plants in regard to composition of alloys for different purposes.

Foreign Foundry Practice

Foreign Foundry Practice Analyzed. A. O. Backert. Foundry, vol. 47, no. 18, Nov. 1, 1919, pp. 769-770. Observes that fundamental differences in buyers' requirements render comparison between American and foreign manufacturing methods unfair unless viewpoint is understood.

Handling of Materials

Mechanical Handling of Foundry Material. Iron Age, vol. 104, no. 13, Sept. 25, 1919, pp. 870-872, 4 figs Plant where manual labor has been replaced by cranes and hoists in handling operations except in cupola charging.

See also Hoisting Equipment

Hoisting Equipment

Handling Foundry Jobs by Crane, W. C. Briggs. Iron Trade Rev., vol. 65, no. 14, Oct. 2, 1919, pp. 889-891, 3 figs. Illustrating uses of hoisting equipment. Paper presented before Am. Foundrymen's Assn.

Individual Plants

Plant of Hull Iron and Steel Foundries. Can. Machy., vol. 22, no. 13, Sept. 25 1919, pp. 316-317, 3 figs. Special feature said to be that works produce practically all of their own raw material. Description of system of recording and cost keeping.

Ingot Mold Foundry

Bethlehem's Ingot Mold Foundry, E. C Kreutzberg. Foundry, vol. 47, no. 330, Sept. 1, 1919, pp. 601-603, 7 figs. Direct metal from blast furnaces as well as cupola metal is used. Special attention is called to arrangement for storing and charging coke.

Lathe Casting

maintained by policy of employing non-union labor and paying piece-work scale which nets industrious workers more than union wages.

Molding

Makes Cope and Drag Simultaneously. Iron Trade Rev., vol. 65, no. 17, Oct. 23, 1919, pp. 1118-1119, 4 figs. Combination jar-ram, squeezer and stripping-plate molding machine.

Jolt Ram Moulding. H Pemberton. Machy. (Lond.), vol. 14, no. 362, Sept. 4, 1919, pp. 689-693, 19 figs. It is said that actual ramming of sand by impact movement of jolt machine results in sand being rammed around pattern in vertical stream lines, thus giving uniformity of packing.

New Molding Machines (Nouvelles machines à mouler). Fonderie Moderne, vol. 12, no. 4, Apr. 1919, pp. 77-80. Described as possessing lifting mechanism and feed and hydraulic motion.

Where Converter Castings Are Made. Foundry, vol. 47, no. 330, Sept. 1, 1919, pp. 608-611, 7 figs Illustrating plan of foundry showing location of molding machines, core room, melting units, power house and annealing ovens.

Pattern-Drawing Machine

Modern Gray-Iron Foundry in Utah. T. F. Jennings. Foundry, vol. 47, no. 330, Sept. 1, 1919, pp. 587-589, 5 figs. Noting special type of stand for holding cheek used in jar roll-over pattern-drawing machine equipped for making castings.

Patterns

Cylinder Patterns. Joseph A. Shelly. Machy. (N. Y.), vol. 26, no. 2, Oct. 1919, pp. 161-164, 9 figs. For vacuum pumps, core-boxes for jacketed cylinders, cylinder heads, cylinder feet and discharge covers.

Pulverized Coal

Powdered Coal for the Small Foundry, A. J. Grindle. Foundry, vol. 47, no. 16, Oct. 1, 1919, pp. 679-680. While quality of fuel is admitted to be an important consideration, conditions under which it is burned are said to be more so.

Records

Following Work Through the Plant. Alexander Mann. Foundry, vol. 47, no. 333, Oct. 15 1919, pp. 742-754, 4 figs. Illustrating system of recording castings in foundry.

Rigs

Special Rig Aids Foundry Output. Iron Trade Rev., vol. 65, no. 12, Sept. 18, 1919, pp. 769-773, 8 figs. Four machines make molds with green-sand cores for tractor transmission housings. Floor space saved by pouring as soon as molds are finished, and shaking out while hot.

Sand Molding

Occurrence and Testing of Foundry Moulding Sands. L. Heber Cole. Can. Dept. Mines, Mines Branch, Bul. no. 21, no. 476, 1917, 17 pp., 20 figs. partly on 8 supp. plates. With analyses and photomicrographs.

Compares Molding Sand Practice. P. G. H. Boswell. Foundry, vol. 47, no. 330, Sept. 1, 1919, pp. 592-595. Study made by English geologists and molding sand expert sent to America during war by Ministry of Munitions. Outstanding difference in practice on two sides of Atlantic is seen to hinge upon use of artificially bonded high-silica sands.

Semi-Steel

Semi-Steel and General Foundry Practice, David McLain. Can. Foundryman, vol. 10, no. 7, July 1919, pp. 180-183. Concerning possibilities of securing superior quality of gray iron, semi-steel or steel at reduced cost. Address delivered before Southern Metal Trades' Assn.

Silico-Manganese

Silico-Manganese for Steel Castings. E. F. Cone. Iron Age, vol. 104, no. 13, Sept. 25, 1919, pp. 855-857. Responses to circular addressed to foundries in which it was asked to state experience in use of one alloy instead of two.

FUELS AND FIRING

Air Furnace

Develop Firing System for Air Furnace, Milton W. Arrowood. Foundry, vol. 47, no. 16, Oct. 1, 1919, pp. 677-679, 2 figs. Burner designed to thoroughly mix powdered coal with air which burns it.

Bituminous Coal

Experiences in using Bituminous Coal as a Substitute for Anthracite, A. Bement. Heat. & Vent. Mag., vol. 16, no. 9, Sept. 1919, pp. 27-30, 1 fig. Changes made in firebox boilers said to have proved effective and suggestions for further improvements.

Brown Coal

Brown Coal as Boiler Fuel. Indus. Australian and Min. Standard, vol. 62, no. 1606, Aug. 21, 1919, pp. 347-349, 3 figs. Experiments conducted at Melbourne City Council's Power Station.

Coke and Coke Breeze

The Calorific Value of Commercial Coke and Coke Breeze. Kenneth Norton. Gas World, vol. 71, no. 1832, Aug. 30, 1919, p. 165, 1 fig. Suggested graphical method of determination.

Fuel Conservation

Methods for More Efficiently Utilizing Our Fuel Resources—XXX. Samuel S. Wyer. Gen. Elec. Rev., vol. 22, no. 10, Oct. 1919, pp. 760-766, 5 figs. Wastes involved in producing, transmitting and distributing natural gas are attributed to present low price of fuel. Conclusion is drawn that adequate conservation will be brought about only by raising price. Such a procedure, it is claimed, would render profitable expense that would have to be incurred by utility company to save its wastes and would induce consumer to use fuel efficiently.

Fuel Economy

Fuel Economy in Manufacturing Works. Charles F. Wade. Eng. & Indus Management, vol. 2, nos. 11 and 14, Sept. 11 and Oct. 2, 1919, pp. 330-333 and 426-429, 7 figs. Sept. 11: Equipment of boiler plant with a view to securing maximum economy. Oct. 2: Collection and tabulation of running data in connection with boiler plants.

Fuel Economy. Eng. & Indus. Management, vol. 2, no. 13, Sept. 25, 1919 pp. 390-394, 1 fig. Report of committee appointed by British Assn. for Investigation of Fuel Economy.

Fuel Oil

Fuel Oil—I, II, III, Charles W. Geiger. Power Plant Eng., vol. 23, nos. 19, 20 and 21, Oct. 1, 15 and Nov. 1, 1919, pp. 850-852, 908-914 and 958-961, 19 figs. Oct. 1: Present uses of California oil; gravity and heat value; advantages over coal as fuel. Oct. 15: Types of burners and settings: descriptions of plants Nov. 1: Records of use on Pacific coast steamships, with table showing saving of oil over coal.

Kiln

Notes on Forced Draft Firing in a Periodic Kiln, R. K. Hursh. Clay Worker, vol. 72, no. 4, Oct. 1919, pp. 322-324. Test carried out on round down-draft kiln, 26 ft. in diameter. Air was furnished at pressure of 1¼ to 1¾ in. water gage by a no. 30 Clarage fan.

Oil-Fuel Sprayer

Oil-Fuel Sprayer as Fitted in German Torpedo Boats. Trans. Inst. Mar. Engrs., vol. 31, no. 246, Sept. 1919, pp. 393-395, 1 fig. Parallel portion of needle is provided with three-start thread, 5/16-in. pitch, which gives whirling motion to oil and assures breaking up of particles for efficient combustion.

Pulverized Coal

The Use of Pulverized Coal, William H. Odell. Steam, vol. 23, no. 4, Oct. 1919, pp. 93-95, 3 figs. Description of Fuller Lehigh pulverized mill.

Firing Steam Boilers with Powdered Coal. Power House, vol. 12, no. 16, Oct. 6, 1919, pp. 446-447, 2 figs. Results of tests.

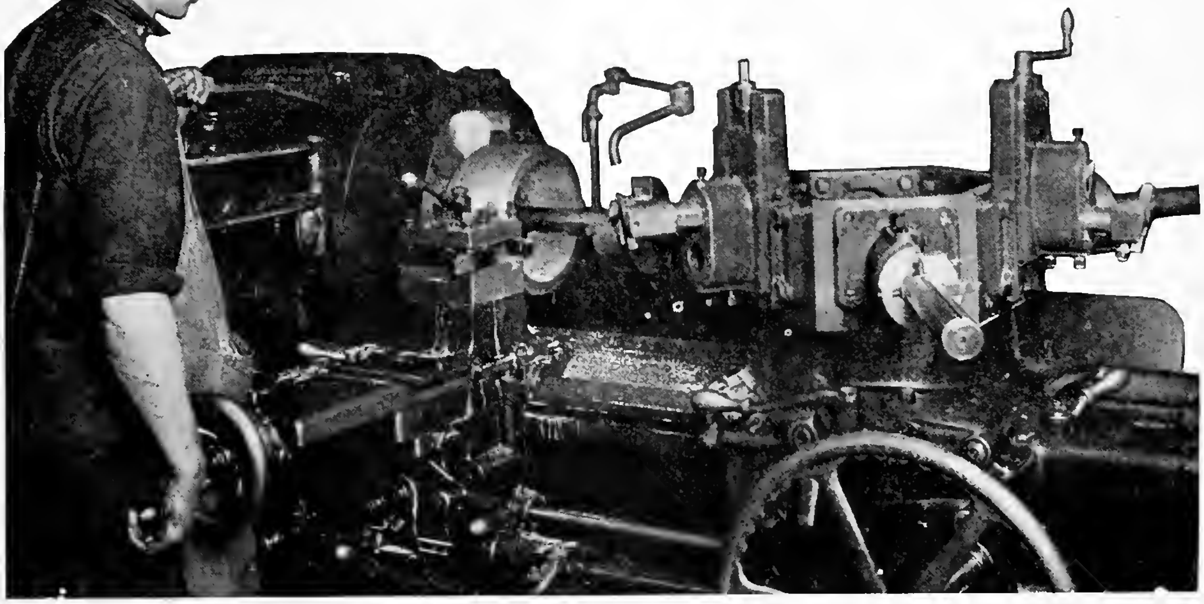
Apparatus for Burning Powdered Coal. Eng. & Indus. Management, vol. 2, no. 11, Sept. 11, 1919, pp. [illegible] fig. Describes Grindle system

ing rules of the different manufacturers' associations are given and the book closes with extensive statistics on the lumber produced and used in the United States.

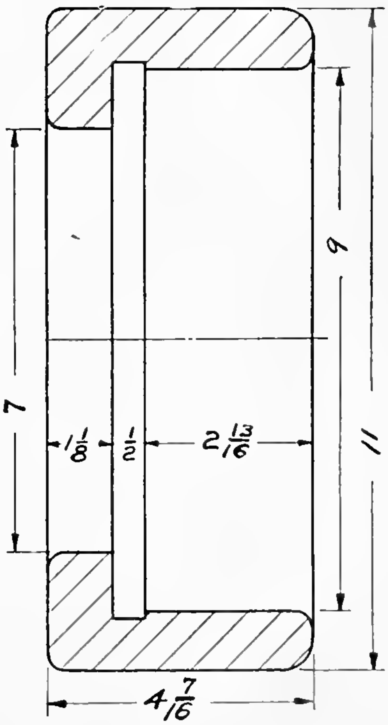
Waterproofing Engineering. For Engineers, Architects, Builders, Roofers, and Waterproofers. By Joseph Ross. First edition. John Wiley & Sons, Inc., 1919. Cloth, 6 x 9 in., 452 pp., 140 illus., 41 tables.

The absence of any systematic treatise on waterproofing has led

alone, nor by the laboring men alone, but that when these two classes are working together for a constructive purpose, they will find so many things in common that they will be more apt to forget their differences. Finally, he wishes to state once more this belief: That the real cause of the present-day unrest lies in the fact that there is no unit of measurement which both employers and employees can use; or, in other words, the fact that our present wage system is not based on knowledge and justice, but only on guesswork and on the fear that the one may "do" the other.



Breaks Another Time Record



The Hahn Manufacturing Company, a jobbing machine shop in Cleveland, reduced production time one-half on this drop forged Clutch Ring when the work was transferred from an engine lathe to a

No. 3-A Universal Hollow Hexagon Turret Lathe

Because of the flexibility of the tool equipment of the No. 3-A, the jobbing shop finds it adaptable for finishing small lots of different pieces as well as long runs of the same piece. Then the time saved by operating both square and hexagon turrets simultaneously, and the wide range of feeds and speeds for all classes of work makes the Universal Hollow Hex the machine for the jobber.

No. 4 Universal, 1½" x 10",	**16" Swing**
No. 2-A Universal, 2½" or 3¼" x 29",	**16½" Swing**
No. 3-A Universal, 3½" or 4½" x 44",	**21½" Swing**

THE WARNER & SWASEY COMPANY

CLEVELAND, OHIO, U. S. A.

TURRET LATHES—TURRET SCREW MACHINES—BRASS WORKING MACHINE TOOLS

NEW YORK Office—Singer Bldg. **Boston Office**—Oliver Bldg. **Buffalo Office**—Iroquois Bldg
Detroit Office—Ford Bldg. **Chicago Office and Show Room**—618-622 Washington Blvd.

FOREIGN AGENTS: Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. Allied Machinery Company, Paris, Turin, Barcelona, Zurich and Brussels. Stokvis & Zonen, Rotterdam. Wilhelm Sonesson Company, Malmo, Copenhagen, Gotenburg and Stockholm. Yamatake & Co., Tokio. Benson Brothers, Sydney and Melbourne. A. Asher Smith, Sydney. A. R. Williams Machinery Co., Ltd., Toronto, St. John, Winnipeg and Vancouver. Williams & Wilson, Ltd., Montreal.

Mahr Calorizer and Furnace

Description of a Mahr Calorizer and Furnace J. H. Rodgers. Can Machy., vol. 22, no. 14, Oct. 2, 1919, pp 341-342, 8 figs. Description of oil-burning furnace for forging and heat-treating purposes.

GAGES

Optical Methods

Some Optical Aids for the Engineer—III. Arthur C. Banfield. Machy. (Lond.), vol. 14, no 363, Sept. 11, 1919, pp. 705-709, 15 figs. Description of method of projection gaging developed by Adam Hilger, Ltd, during the war, principally for accurate gaging of small totally reflecting prisms which form Porro erecting system of modern binocular.

Screw Threads

Effect of Angle Error in Connection with the Pitch-Engagement System of Grading Threads, W. G. Dunkley. Machy. (Lond.), vol. 14, no. 362, Sept. 4, 1919, pp. 683-685, 4 figs. Purpose of article is to examine more fully question of effect of angle error or tolerance. Following ways of specifying angle limits are discussed: (1) To fix ideal angle as minimum and to allow positive tolerance, (2) to fix ideal angle as maximum and allow negative tolerance, (3) to fix ideal angle as the mean and allow positive and negative tolerances.

The Pitch Engagement System of grading Screw Threads, W. G. Dunkley, Machy. (Lond.), vol. 15, no. 367, Oct. 9, 1919, pp. 57-58, 3 figs. Suggested methods for determining effective diameter angle of thread profile and pitch. System was described in Machy. (Lond.), vol. 14, p. 529.

GAS ENGINEERING

Gas Analysis

Application of the Interferometer to Gas Analysis, Junius David Edwards. Dept. Commerce, Technologic Papers of Bur. of Standards, no. 131 Oct. 6, 1919, 19 pp. Principle of gas interferometer and its methods of use in gas analysis is discussed in connection with calibration of instrument. Effect produced upon observations by variations in gas composition and experimental conditions is analyzed and equations developed by which magnitude of such changes can be estimated.

Gas Industry

Vital Issues Affecting the Gas Industry Today, John D. Kuster. Gas Age, vol. 44, no 8, Oct 15, 1919, pp. 339-343. Heat unit standard, municipal ownership and rate increases. Presidential address before Pacific Coast Gas Assn.

Interferometer

See Gas Analysis.

Low-Grade Gas

What is Low Grade Gas? Wm. Cranfield. Gas World vol. 71, no. 1833, Sept. 6, 1919, pp. 178-182 and 183-184. Study of subject by means of flames. Structure and aeration of flames; low-grade gas in use; addition of air; addition of blue water gas; addition of producer gas.

Ovens

Chamber-Type Ovens for Gas Works (Die Verwendung von Kammeröfen für Gaswerke), Heinrich Koppers. Journal für Gasbeleuchtung, vol. 62, nos. 29 and 30, July 19 and 26, 1919, pp. 399-405 and 420-421, 10 figs. Preparing coal for gasification. Operating results of horizontal ovens with regenerative heating.

Retort House

Easily effected Economies in the Retort House, Carl B. Wyckoff. Am. Gas Eng. Jl., vol. 111, no. 13, Sept 27, 1919, pp. 271-272 and 276-283, 9 figs. Furnace operation and design iron and brick work, scurfing retorts, stand pipes, bridge pipes, hydraulic main, drafts and other features are discussed.

Practical Hints on Retort House Operation, Carl B. Wyckoff. Gas Age, vol. 44, no. 8, Oct. 15, 1919, pp 345-350, 6 figs. Suggestions in regard to selecting type of grate and clinker doors, manner and frequency of scurfing, cleaning stand pipes and taking care of hydraulic main. (To be continued.)

Retorts

New Types of Retorts for Medium and Small Gas Works (Neue Ofensysteme für mittlere und kleinere Gaswerke), G. Aicher. Journal für Gasbeleuchtung, vol. 62, no. 29, July 19, 1919, pp. 397-398. Details of Munich type sloping-chamber retorts.

Study on Gas Retorts and Heat Economy (Wärmewirtschaftliche Betrachtungen über Gaserzeugungsöfen), Osw. Peischer. Journal für Gasbeleuchtung, vol. 62, no. 28, July 12, 1919, pp. 381-385, 2 figs. Operating data of recuperative retorts obtained in tests lasting one week.

Vertical Retorts Lend Themselves to Steaming with Better Results than in the Case of Horizontals, L. J. Willien, Jr. Am Gas Eng. Jl., vol. 111, no. 16, Oct. 18, 1919, pp. 367-371, 386 and 389. Because, it is noted, by introducing steam at bottom and allowing it to pass up through retorts highly heated upward current of blue water gas is established at beginning of carbonizing period, and this helps to dilute rich gases without absorption or loss of heat and with greatly accelerated rate of travel towards gas outlet. Paper read before Am. Gas Assn.

Separator, Centrifugal

New Centrifugal Gas Separator. Gas Jl., vol. 147, no. 2939, Sept. 9, 1919, pp 554-575, 3 figs. Separated impurities are said not to be thrown against fixed wall of casing, but to collect on inner surface of revolving drum from the wider edge of which they are thrown into liquor gutter.

Steaming Horizontals

Steaming Horizontals, R. J. Rew. Gas Jl., vol. 147, no. 2939, Sept. 9, 1919, pp. 557-559, 2 figs. Discussing advantages of short-period steaming; channel retorts; superheater difficulties; mixing of gas; loss in coke and wear and tear on retort.

Sulphur Removal

Removal of Sulphur from Illuminating Gas, W. W. Odell and W. A. Dunkley. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, supp. to Sept. 1919, pp. 2301-2311. Because coals containing less than 1 per cent sulphur are becoming scarcer, it is pointed out that gas industry will be compelled to use coals that are now considered out of the question. Present processes of purification are outlined and discussed.

HANDLING OF MATERIALS

Army Supply Base

Boston Army Supply Base. Pac. Mar. Rev., vol 16, no. 10, Oct. 1919, pp. 110-113, 4 figs. Noting special freight-handling equipment.

Barge-Unloading Devices

Barge-Unloading Devices of Missouri Sand and Gravel Producers. Rock Products, vol. 22, no. 19, Sept. 13, 1919, pp. 24-26, 10 figs. Various types of derricks and travelers using clamshell buckets handle material from river barge to plant or stock pile.

Cement Materials

Conveying Raw Cement Materials, W. A. Scott. Cement, Mill & Quarry, vol. 15, no. 7, Oct. 5, 1919, pp. 11-13, 5 figs. Details of crushing and loading plant of International Portland and Cement Co. on Lake Pend Oreille, Northern Idaho.

Chemical Materials

Mechanical Handling of Chemical Materials, George Fred. Zimmer. Chem. Age, vol. 1, nos. 11 and 12, Aug. 30 and Sept. 6, 1919, pp. 294-296 and 322-323, 9 figs. With reference to nature of material and conditions to be met. The handling of coarse, crystalline or amorphous substances of fine dry powders, fine moist material, etc.

HEAT TREATING

Aluminum-Alloy Castings

Heat Treatment of Aluminum-alloy Castings, Zay Jeffries and W. A. Gibson. Bul. Am. Inst. Min & Metallurgical Engrs., no. 153, supp. to Sept. 1919, pp 2493-2512, 17 figs. Heat treatment of rolled and extruded aluminum alloy consists essentially in heating to temperature near 500 deg. cent. and quenching in water. It is suggested that non-uniform results obtained from heating aluminum-alloy castings in ordinary furnace atmosphere are due to porosity and oxidation of castings. Method designed to remedy these defects is proposed.

Case Hardening

Practical Talks on Casehardening; Why Failures Occur in Casehardening, T. G. Selleck. Jl. Am. Steel Treaters Soc., vol. 2, no. 1, Oct. 1919, pp. 40-47, 4 figs. Writer believes that the human element in carbonizing process "is responsible for all its failures."

Cast Steel

Heat Treatment of Cast Steel, John H. Hall, Arvid E. Nissen and Knox Taylor. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, supp. to Sept. 1919, pp. 2881-2922, 104 figs. Results of experimental work conducted on steel made in 3-ton button-blown converter, most of steel analyzing about 0.05 in phosphorus and sulphur. Numerous photomicrographs of steel specimens are presented.

Copper-Oxide Annealing

Copper Diffuses Through Cast Iron, H. E. Diller. Foundry, vol. 47, no. 18, Nov. 1, 1919, pp. 779-780, 8 figs. Results of annealing experiments with copper oxide packing, in which graphite changed so that it appeared like temper carbon.

Gun Metal

Influence of Heat Treatment on Gun Metal, C. F. Smart. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919 pp. 1875-1881, 9 figs. Investigation undertaken to study effect of annealing followed by different rates of cooling and in particular effect of quenching. Specimens quenched in water from 650 deg., 705 deg., or 760 deg. fahr. were found lacking in strength and ductility.

Heat-Treating Furnaces

Heating Furnaces and Annealing Furnaces—IX, W. Trinks. Am. Drop Forger, vol. 5, no. 10, Oct. 1919, pp. 495-498, 6 figs. Features determining the fuel economy of continuous furnaces; rate of heat transmission; fuel economy for best working conditions and overall fuel economy, including mill delays.

See also Furnaces; Electrical Engineering, Furnaces (Heat Treating).

Malleable Iron

Experiments in Annealing Malleable Iron, H. E. Diller. Can. Foundryman, vol. 10, no. 7, July 1919, pp. 184-186, 4 figs. Results of tests are interpreted as having indicated that it is immaterial whether bars are cooled slowly or rapidly after they have reached 500 deg. cent.

Nichrome Castings

Nichrome Castings for Heat Treatment, Harrison Jenkns. Can. Foundryman, vol. 10, no. 10, Oct. 1919, pp. 299-300, 2 figs. Raw material, vol. 1, no. 7, Sept. 1919, pp. 341-342, 3 figs. Points of merit in properties of nichrome for use as material in heat-treating receptacles.

Pulverized Coal

Using Pulverized Coal for Annealing, Charles Longenecker. Foundry, vol. 47, no. 16, Oct. 1, 1919, pp. 680-681, 3 figs. Table showing typical run illustrates uniform temperature maintained with powdered coal.

Quenching Liquids

Cooling Properties of Technical Quenching Liquids, N. B. Pilling and T. D. Lynch. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, supp. to Sept. 1919, pp. 2347-2367, 23 figs. Experiments made with cylinder, 50 mm. long, 6 mm. in diameter and made from nickel with 5 per cent silicon. Method used involved recording of fleeting temperatures within cylinder after being heated to fixed initial temperature and rapidly transferred to bath of quenching liquid. Quenching liquids used were water, brine, soap solution, three oils and sulphuric acid.

HEATING AND VENTILATION

Factory Buildings

The Ventilation of Factory Buildings. Eng. & Indus. Management, vol. 2, no. 15, Oct. 9, 1919, pp. 460-461, 2 figs. Importance of considering ventilation before designing factory.

The Ventilation of Industrial Establishments, Leonard Hill. Eng. & Indus. Management, vol. 2, no. 11, Sept. 11, 1919, pp. 326-328, 1 fig. Problem of ventilation is considered from three points of view: (1) cooling and evaporative powers of air (2) keeping of air free from noxious fumes or dust arising in process of manufacture, (3) spacing of workers. Author presents suggestions with a view to minimizing spread of infection among workers.

Heating Load Forecast

Forecasting Heating Loads, William B. Campbell. Heat & Vent. Mag., vol. 16, no. 10, Oct. 1919, pp. 19-22, 16 figs. From examination of curves representing annual range for "normal" outdoor temperature of locality as constructed from government records extending back for long periods.

Isolated Rooms

More Air for Offices and Drafting Rooms, Charles L. Hubbard. Factory, vol. 23, no. 5, Nov. 1919, pp. 1050-1052, 10 figs. Showing how ventilation in isolated rooms may be improved and draft prevented.

Nozzle Effect

See Ship Ventilation.

Remodeling Heating System

Remodeling a Heating System, Helen R. Louis. Heat & Vent. Mag., vol 16, no. 10, Oct. 1919, pp. 30-32, 1 fig. How piping connections were rearranged in building in order to secure greater economy and efficiency.

Ship Ventilation

Utilization of the Nozzle Effect for Ventilating Ships (Die Ausnutzung der Düsenwirkung für die Luftung auf Schiffen), Freudenthal. Schiffbau, vol. 20, no. 19, July 9, 1919, pp 518-522, 13 figs. Discussing older and more recent tests with water; utilization of nozzles for carrying off of water, steam and sounds. (To be concluded.)

Ventilating Equipment and Health

Ventilating Equipment Reduces Mortality during Winter, E. Vernon Hill. Domestic Eng., vol. 89, no. 4, Oct. 25, 1919, pp 167-168, 2 figs. Based on statistical figures of Octennial Report of Department of Health of City of Chicago.

HOISTING AND CONVEYING

Bucket Gear

A New Type of Enclosed Gear Bucket. Coal Trade Jl., vol. 50, no. 43, Oct. 22, 1919, pp. 1245-1246, 1 fig. Design in which all working parts are enclosed in tight casing, eliminating wear and facilitating lubrication.

Cranes

Overhead Electric Cranes in Steelworks, James Smith. Elecn., vol. 83, no. 2158, Sept. 26, 1919, pp. 355-362, 17 figs. Application in steel works of various types of overhead electric cranes such as traveling cranes, lifting magnets and charging machines.

Portable Floating Cranes of Huge Capacity. Commercial America, vol. 16, no. 3, Sept. 1919, pp. 43-49, 3 figs. Designed to lift 150 tons at radius of 105 ft. and at speed of 4 ft. per min. with vertical range from 25 ft. below to 95 ft. above level of water.

Protecting Mill Cranes from Overload, A. G. Place. Blast Furnace & Steel Plant, vol. 7, no. 10, Oct. 1919, pp. 493-494. Recommends protection of individual circuits rather than main line. Paper read before Assn. of Iron & Steel Elec. Engrs.

Grain Elevators

The Palatine Patent Grain Elevator and Automatic Weighing Machine. Eng. & Indus. . no. 13, Sept. 25, 1919. It consists of hopper sup- ... mns from ordinary lorry ... ovided with two automatic ... suitable for filling sacks. buckets mounted on chains ... ets.

Heel Angles for Different Loads

Crane Lighter No. 4 Engineer, vol. 128, no. 3323, Sept. 5, 1919, pp. 225-226, 12 figs., partly on supp. plates. Diagrams showing angles of heel for various loads.

Winding Plant

Notes on the Overhead Koepe Winding Plant at Plenmeller Colliery, Haltwhistle, Northumberland, George Raw. Trans. North of England Inst. Min. & Mech. Engrs. vol. 68, no. 7, Aug. 1918, pp. 186-202 and (discussion) 202-204, 9 figs. Koepe hoist, applied first by Fr. Koepe in Westphalia, is described as winding counterpart of endless rope haulage in much the same way as drum winder is to main-and-tail rope haulage.

HYDRAULIC MACHINERY

Flow Measurement

The Orifice as a Means of Measuring Flow of Water through a Pipe, Raymond E. Davis and Harvey H. Jordan. Univ. of Illinois Bull., vol. 16, no. 14, Dec. 2, 1918, 56 pp., 14 figs. Results of tests made to determine practicability of using flow of water by means of thin-plate circular orifice inserted in pipe, to determine experimental coefficients for calculating flow in pipe and discharge, and to determine conditions most favorable to use of such an orifice as flow-measuring device.

Governors for Turbines

Seewer Universal Governor for High Pressure Hydraulic Turbines (Le régulateur universel système Seewer pour turbines hydrauliques à haute chute) A. Strickler. Bulletin Technique de la Suisse Romande, vol. 45, nos. 18, 19 and 20, Sept. 6, 20 and Oct. 4, 1919, pp. 181-184, 193-197 and 205-206, 11 figs. Sept 6: Mechanism connecting guiding plates with regulating rod. Sept. 20: Account of official tests at laboratory of Federal Polytechnic School at Zurich. Oct. 4: Operation of guide plates in controlling form of jet. (Concluded.)

Hydrodynamic Analogies

Hydrodynamic Analogies (Analogie Idrodinamiche), G. Spataro. Annali d'Ingegneria e d'Architettura, vol. 34, nos. 5 and 6, March 1 and 15, 1919, pp. 73-76 and 82-90. Generalization of law of reciprocity. Method is along lines followed by Lorentz in his demonstration of this law for viscous liquids.

INTERNAL-COMBUSTION ENGINES

Air Washers

Air Washers for Internal Combustion Motors (Ueber Luftfilter für Explosionsmotore), Thieme. Motorwagen, vol. 22, no. 15, May 31, 1919, pp. 268-270, 5 figs Radio air filter in air duct of older type of air suction.

Alcohol Engines

Alcohol Engines. Times Eng. Supp., vol. 15, no. 540, Oct. 1919, pp. 320, 1 fig. Tests and experiments on starting of internal combustion engines from cold made by Committee on Alcohol and Fuel appointed by Commonwealth of Australia Institute of Science and Industry.

Crossley Heavy-Oil Engine

Crossley Cold-Starting Heavy-Oil Engine. Engineer, vol. 128, no. 3324, Sept. 12, 1919, pp. 252-254, 5 figs. Combustion chamber is of spheroidal shape. This, it is said, gives least wall surface exposed to water jacket and permits of central core of air being heated by compression and cooled as little as possible by contact with walls.

Diesel Engines

Notes on Operation of Submarine Diesel Engines, Frederick C. Sherman. Jl. Am. Soc. Naval Engrs., vol. 31, no. 3, Aug. 1919, pp. 615-623. Notes taken by writer while operating under war conditions submarine Diesel engines of 440 hp., 4-cycle, 6-cylinder type installed on O-class of submarines.

Fuels

Power Characteristics of 20 Per Cent. Benzol Mixture, Jl. Soc. Automotive Engrs., vol. 5, no. 3 Sept. 1919, pp. 272-274, 4 figs. Based upon tests made in altitude laboratory of Bureau of Standards.

Governors for Gas Turbines

Governors for Constant-Pressure Internal-Combustion Turbines when using Turbo-Compressors (Beitrag zur Frage der Regulierung der Gleichdruck-Verbrennungsturbine bei Verwendung von Turbokompressoren), Adolf Borger. Zeitschrift für das gesamte Turbinenwesen, vol 16, no. 14, May 20, 1919, pp. 128-134, 11 figs. Comparison and practical application of governing methods in filling. Overload and mixture are also discussed. (Concluded.)

Horsepower Formula

A Practical Brake Horse Power Formula for Internal-Combustion Engines, Hermann Lemp. Gen. Elec. Rev., vol. 22, no. 10, Oct. 1919, pp. 808-809, 1 fig. Numerical coefficients of familiar formula for indicated horse power are combined into single round number 100,000,000.

Natural Gas

Natural Gas for Power, F. H. Bivens. Natural Gas & Gasoline Jl., vol 13, no. 10, Oct. 1919, pp. 352-354, 1 fig. How to equip an internal-combustion engine to use natural gas.

Supercharging

The Supercharging of Internal-Combustion Engines—I, Georges Funck. Automobile Engr., vol. 9, no. 131, Oct. 1919, pp. 318-322, 5 figs. Technical study of possibilities and limitations of forced induction.

Valves

High-Chromium Steel for Exhaust Valves. Jl. Soc. Automotive Engrs., vol. 5, no. 3, Sept. 1919, pp. 262-263, 2 figs. Properties and uses. From report of Sub-Division appointed at joint meeting of Iron and Steel Division of Soc. of Automotive Engrs. Standards Committee and Sub-Committee X, Committee A-1 of Am. Soc. for Testing Materials.

LUBRICATION

Oil Testing

Lubrication and Lubricating Oils, R. C. Demary. Power Plant Eng., vol. 23, no. 21, Nov. 1, 1919, pp. 955-958. Suggested tests for oils and summary of characteristics desirable for different purposes.

Power-Plant Management—II, Robert June. Refrig. World, vol 54, no. 10, Oct. 1919, pp. 25-26 and 30. Importance of viscosity tests as guide to lubrication.

Power-Plant Lubrication

Power-Plant Management—Lubrication, Robert June. Power House, vol. 12, no. 15, Sept. 20, 1919, pp. 411-413, 2 figs. Data relative to lubrication problems usually found in power plants.

Viscosity

See Oil Testing.

MACHINE ELEMENTS AND DESIGN

Crankshafts

Engine Crankshafts, Edward Ingham. Elec. Rev., Lond., vol. 85, no. 2182, Sept. 19, 1919, pp. 359-360. As principal causes of failure are stated: (1) unsuitable material; (2) restricted dimensions; (3) want of alignment; (4) fatigue; and (5) overloading.

Interchangeable Manufacture

Machine Design in Interchangeable Manufacturing Practice, Earle Buckingham. Machy. (Lond.), vol. 15, no. 366, Oct. 2, 1919, pp. 18-20. Considerations in regard to simplifying design to enable standard equipment to be used and factors governing choice of material.

Pulleys

Some Suggestions on Pulleys. Paper, vol. 25, no. 3, Sept. 24, 1919, pp. 15-18, 3 figs. States points that should be kept in mind when purchasing a pulley; strength, weight, coefficient of friction, balance, ease of mounting and durability.

Rings

The Bending of Thin Rings, John Prescott. Automobile Engr., vol. 9, no. 130, Sept. 1919, pp. 295-302, 13 figs. Investigation having special reference to behavior of piston rings under radial pressures.

Screws

The Strength of Screws, Bolts and Nuts, C. E. Stromeyer. Can. Machy., vol. 22, no. 13, Sept. 25, 1919, pp. 320-321. Data regarding items of mechanical design as stated in author's memorandum to Manchester Steam Users' Assn.

Springs

Laminated Springs—I, T. H. Sanders. Automobile Engr., vol. 9, no. 131, Oct. 1919, pp. 333-341, 20 figs. Theoretical characteristics of design.

Parallel Helical Springs, R. J. Cousins. Automobile Engr., vol. 9, no. 130, Sept. 1919, pp. 302-304, 4 figs. Method for quickly determining their approximate dimensions.

Williams Internal Gearing

Design and Calculation of Williams Internal Gearing, Reginald Trautschold. Machy. (N. Y.), vol. 26, no. 2, Oct. 1919, pp. 110-115, 5 figs. In Williams system, profiles of internal gear teeth are straight lines so that tooth spaces are similar to those of involute rack, while teeth of mating pinion have curved profiles of conjugate form.

MACHINE SHOP

Automatic Machines

Production Milling on Automatic Machines, Edward K. Hammond. Machy. (N. Y.), vol. 26, no. 2, Oct 1919, pp. 150-154, 11 figs. Also Machy. (Lond.), vol. 14, no. 364, Sept. 18, 1919, pp. 741-748, 14 figs. Machines built by Pratt & Whitney Co., Hartford, Conn. These millers have been evolved from Lincoln type and are equipped with intermittent table feed and fast traversing mechanism, and automatic quick return for table. Practice in milling of duplicate parts. Second of two articles.

Belt Adjustments

Unusual Adjustments of Belts, Pulleys and Shafting, H. C. Shields, Jr. Belting, vol. 15, no. 6, Sept. 20, 1919, pp. 24-25, 8 figs. General suggestions for superintendent and shop foreman.

Conveyors for Jigs

How Two Conveyors keep Jigs in Use, P. F. O'Shea. Factory, vol. 23, no. 5, Nov. 1919, p. 1045. Instead of waiting for jigs to pile up and then returning them in a bunch, this conveyor is said to return them to start of process so that they get back into use quickly.

Cutters, Milling

The Fastening of Milling Cutters, Joseph Horner. Machy. (Lond.), vol. 14, no. 363, Sept. 11, 1919, pp. 710-713, 46 figs. Showing methods used for driving cutters, forms of end mill fittings, methods for securing arbors, and examples of collet chucks.

Gear Cutting

Tooth Gear Cutting, W. Duckett. Machy. Market, no. 986 and 987, Sept. 26 and Oct. 3, 1919, pp. 21-22 and 23-24, 6 figs. Review of methods and machines. Sunderland gear cutter and Fellows gear shaper. Paper read before Coventry Eng. Soc.

Jigs

A Discussion of the Various Types of Jigs, Robert Mawson. Can. Machy., vol. 21, nos. 15 and 17, Oct. 16 and 23, 1919, pp. 387-390 and 407-410, 22 figs. Noting specially variations of fundamental principle involved in order to suit various requirements. Article is illustrated by reference to shop practice. Open type location jigs and holding jigs.

Metal-Cutting Tools

Relation of Heat Treatment, Design and Selection of Steels for Metal Cutting Tools to Factory Production, C. P. Berg. Jl. Am. Steel Treaters Soc., vol. 2, no. 1, Oct. 1919, pp. 7-11. Writer observes that it is first necessary to have proper kind of metal and tool, and secondly, to know how to use it in order to obtain maximum production in a factory. As there is no proper kind of cutting tool unless it is properly heat-treated, he concludes: "It appears that development of proper heat-treating process is most important for securing successful production."

Models

Purpose of Models in Interchangeable Manufacturing. Earle Buckingham. Machy. (N. Y.), vol. 26, no. 2, Oct. 1919, pp. 129-130. Also Machy. (Lond.), vol. 15, no. 367, Oct. 9, 1919, pp. 59-60. Points out relative value of models in constructive development of new article which is to be made in large quantities by interchangeable methods.

Pump Repairs

Repairing a Large Centrifugal Pump, J. H. Rodgers. Can. Machy., vol. 22, no. 13, Sept. 25, 1919, pp. 322-323, 2 figs. Completed work said to have meant a saving in time of several weeks and nearly $2,500 to contractor.

Taylor Methods

Supplement to Frederick W. Taylor's "On the Art of Cutting Metals"—II, Carl G. Barth. Indus. Management, vol. 58, no. 4, Oct. 1919, pp. 282-287, 5 figs. How principles and experimental results of cutting metals are applied in machine-shop practice.

Turret-Lathe Practice

Turret-Lathe Practice, Erik Oberg. Machy. (N. Y.), vol. 26, no. 2, Oct. 1919, pp. 99-109, 31 figs. Examples of turret lathe practice based upon experience and practice of Service Dept. of Gisholt Machine Co., Madison, Wis.

MACHINERY, METAL-WORKING

British Shops

The Works and Products of Messrs. Barr and Stroud, Limited. Engineering, vol. 108, no. 2800, Aug. 29, 1919, pp. 263-266 and 278, 11 figs, partly on two supp. plates. Details of machine shops, with reference specially to automatic and gear-cutting machines.

Chucks

Collet Chucks—X, Fred Horner. Mech. World, vol 66, no. 1708, Sept. 26, 1919, pp. 146-147, 4 figs. Example of chuck which incorporates geared lever action in combination with cam ring and ball closing. (Concluded.)

Cutters, Milling

Inserted Tooth Milling Cutters. Machy. (Lond.), vol. 14, no. 364, Sept. 18, 1919, pp. 753-754, 5 figs. Tables showing proportions of various types of cutters.

Lathes

A New Form of Lathe and Some of Its Products. Automotive Industries, vol. 41, no. 13, Sept. 25, 1919, pp. 624-626, 9 figs. Description of a machine which is said to simplify multi-tool operations in several ways.

Notes on Capstan and Turret Lathes—IV, Joseph Horner. Mech. World, vol. 66, no. 1709, Oct. 3, 1919, pp. 158-159, 3 figs. Types of vertical-axis and inclined-axis designs.

Machine-Tool Developments

Recent Machine-Tool Developments—IV and V, Joseph Horner. Engineering, vol. 108, no. 2800 and 2802, Aug. 29 and Sept. 12, 1919, pp. 266-271 and 330-332, 37 figs. Drilling machine framings: pillar machines. Beds, ways and reciprocating slides, planers, shaping, machine framing and milling machines.

Milling Machines

The Ingersoll Differential Type Continuous Milling Machine, J. V. Hunter. Am. Mach., vol. 51, no. 14, Oct. 2, 1919, pp. 645-650, 6 figs. It consists of two main parts, namely, work-carrying table and head-carrying milling-cutter spindles, each of which may be arranged for simultaneous operation on different pieces of work.

Planer, Bevel-Gear

Sunderland 24-inch Bevel Gear Planer. Machy. (Lond.), vol. 15, no. 367, Oct. 9, 1919, pp. 40-42, 6 figs. Machine is based on principle that bevel gear teeth require to be planed along lines which meet at apex of cone, cross-section of teeth being in proportion to their distance from apex.

Thread-Milling Machines

British Thread-Milling Machines—I and II. Engineer, vol. 128, no. 3324 and 3325, Sept. 12 and 19, 1919, pp. 249-252 and 274-277, 15 figs. Machine built by Charles Taylor, Ltd., Birmingham. Both headstocks are adjustable on slots within base plate, work headstock longitudinally and cutter headstock transversely. Machine is capable of cutting either internal or external, right-hand or left-hand threads.

MACHINERY, SPECIAL

Cylinder Boring and Reaming Fixtures

Cylinder Boring and Reaming Fixtures. Machy. (Lond.), vol. 14, no. 362, Sept. 4, 1919, pp. 680-683, 11 figs. Different designs of fixtures for locating and holding automobile engine cylinder castings during boring and reaming operations.

Dredge, Hydraulic

Features of Electrically Operated Hydraulic Dredge, Charles W. Geiger. Cement, Mill & Quarry, vol. 15, no. 6, Sept. 20, 1919, pp. 35-37, 5 figs. Description of dredge owned and operated by City of Oakland, Cal.; advantages of electric drive and savings effected. Central-station service is used.

Excavating Machinery

British Excavating Machinery, A. E. Collins. Eng. & Contracting, vol. 52, no. 18, Oct. 29, 1919, pp. 492-493, 3 figs. Blondin machine which consists of steel wire main cable suspended between two towers; on main cable runs load-carriage supporting hoisting block. From Water & Water Eng., Lond.

Steam Pile Hammers

Steam Pile Hammers. Bulletin of Gen. Contractors Assn., vol. 10, no. 8, Aug. 1919, pp. 159-161, 3 figs. Uses of various types.

Tin-Plate Machine

Invent Novel Tin-Plate Machine. Iron Trade Rev., vol. 65, no. 16, Oct. 16, 1919, pp. 1054-1055, 2 figs. Four plates handled simultaneously in unusual type of machine in Welsh mill which automatically feeds, pickles, tins and cleans plates at rate of 125 boxes in 24 hr.

MACHINERY, WOODWORKING

Sawing Machine

Rapid Vertical Sawing Machine. Engineering, vol. 108, no. 2801, Sept. 5, 1919, pp. 308-309, 8 figs. Hack-sawing machine capable of cutting through bar 9 in. in diameter and of beveling 12-inch girder at any angle, and also suitable for cutting out forks of connecting rod forgings.

MATERIALS OF CONSTRUCTION AND TESTING OF MATERIALS

Bearing Metals

Observations on a Typical Bearing Metal, Hilda E. Fry and W. Rosenhain. Automobile Engr., vol. 9, no. 131, Oct. 1919, pp. 323-325, 14 figs. Microscopic examinations and Brinell measurements of alloy consisting of 4 per cent copper, 9 per cent antimony and 87 per cent tin. Paper presented before Inst. of Metals.

Bronzes, Lead-Zinc

Physical Properties of Certain Lead-Zinc Bronzes, Homer F. Staley and C. P. Karr. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, supp. to Sept. 1919, pp. 2513-2522, 5 figs. Of nine variations in composition of lead-zinc bronzes containing 90 per cent copper studied, the one found to be most satisfactory contained 90 per cent copper, 6.5 per cent tin, 0.5 per cent lead, and 3 per cent zinc. This composition showed proportional limit of 12,200 ± 650 lb. per sq. in., tensile strength 40,700 ± 1500 lb. per sq. in., elongation in 2 in. of 37.6 ± 6.4 per cent, and reduction in area of 34.1 ± 4.5 per cent.

Chrome-Nickel Steels

See Nickel-Chrome Steels.

Constantan

Manufacture and Electrical Properties of Constantan, F. E. Bash. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, supp. to Sept. 1919, pp. 2409-2430, 12 figs. Experiment work conducted by International Nickel Co. in co-operation with Electrical Alloys Co. for the purpose of developing constantan that would give e.m.f. of 47.40 millivolts against pure iron at 1500 deg. fahr.

Insulators, Heat

The Thermal Conductivities of Insulators in Relation to the Lagging of Steam Pipes, R. Thomas. Chem. Indus., vol. 38, no. 19, Oct. 15, 1919, pp. 357t-360t, 5 figs. Results of experiments are tabulated and curves are given showing effect of thickness of insulator on heat lost.

Leather Substitutes

Leather Substitute Products and Markets. Raw Material, vol. 1, no. 7, Sept. 1919, pp. 322-327, 7 figs. $50,000,000 worth of leather substitutes said to be produced and consumed annually in the U. S. A.

Malleable-Iron Machinability

Machining Qualities of Malleable, Edwin K. Smith and Wm. Barr. Foundry, vol. 47, no. 16, Oct. 1, 1919, pp. 682-684, 2 figs. Cutting and drilling tests made on malleable iron samples with different physical properties to determine relation of high elongation and tensile strength to machinability of metal.

Nickel

Physical Properties of Nickel, David H. Browne and John F. Thompson. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, supp. to Sept. 1919, pp. 2693-2720. Synopsis of information found in textbooks and reports of various investigators, compiled for use by practical men.

Nickel-Chrome Steel

Temper-Brittleness of Nickel-Chrome Steel, R. H. Greaves. Iron and Steel Inst., meeting of Sept. 1919, paper no. 7, 20 pp., 7 figs. By "temper-brittleness" is meant condition induced in nickel-chrome steel by slow cooling from tempering temperature, and revealed by low absorption of energy in single blow impact test on notched bars. With a view to promote discussion on subject, writer presents results of experiments which he performed to determine effect of slow cooling after tempering on impact figure of these steels.

Brittleness in Nickel-Chrome and Other Steels, F. Rogers. Iron and Steel Inst., meeting of Sept. 1919, paper no. 11, 4 pp. Tests to examine possibility of discriminating as to toughness or brittleness without destroying article.

Fatigue Tests of Nickel and Chrome-Nickel Steel. Eng. World, vol. 15, no. 8, Oct. 15, 1919, pp. 31-34, 4 figs. It is concluded that static elastic strength is not reliable index of fatigue resisting strength under repeated stress, and that perfection of surface finish is appreciable factor in developing resistance to fatigue under repeated stress. Paper presented before Am. Soc. for Testing Materials.

Notched-Bar Tests

Notched Bar Tests, W. C. Unwin. Engineering, vol. 108, no. 2802, Sept. 12, 1919, pp. 329-330. Suggestions in regard to establishing empirical formula for reduction.

Rolling of Steel and Mechanical Properties

Influence of Rolling on Mechanical Properties of Steel (Observations sur le corroyage de l'acier), Ch. Fremont. Génie Civil, vol. 75, no. 1936, Sept. 20, 1919, pp. 274-276, 6 figs. Experiments similar to those described by Georges Charpy (see C. R. July 1, 1918, and Revue de Metallurgie, Sept.-Oct. 1918) are reported and it is claimed that longitudinal deformations obtained did not have undulations described by M. Charpy.

Steel, Physical Tests

Practical Notes on Physical Tests of Steel—II, Austin B. Wilson. Am. Drop Forger, vol. 5, no. 10, Oct. 1919, pp. 499-501, 3 figs. Also Blast Furnace & Steel Plant, vol. 7, no. 10, Oct. 1919, pp. 500-502, 3 figs. Discussion of hardness test; sclerometric methods; Brinell tests; Shore scleroscope; Fremont, Charpy and Izod dynamic tests; practical notes for conducting tests to secure accurate results.

Steel, Testing by Magnetic Analysis

Testing Steel by Magnetic Analysis, R. L. Sanford. Iron Trade Rev., vol. 65, no. 18, Oct. 30, 1919, pp. 1181-1183, 10 figs. Apparatus used and results obtained. Paper presented before Am. Iron & Steel Inst.

Stellite

Stellite, the New Cobalt Alloy, Thomas Southworth. Can. Chemical Jl., vol. 2, nos. 2 and 3, Feb. and March 1918, pp. 38-39 and 57-58. Made of cobalt and chromium. It is said to resist oxidation or tarnishing better than any metal excepting gold and metals of platinum groups, specially when chromium content is over 15 per cent.

Stress Lines in Steel

Stress Lines in Steel after Permanent Deformation, Andrew McCance. Sci. Am. Supp., vol. 88, no. 2282, Sept. 27, 1919, pp. 196-197, 15 figs. Study of hardening at various distances from the point altered by hammering, punching or shearing. From Trans. Instn Engrs. & Shipbuilders, Scotland.

Tubing

Manufacture and Properties of Light-Wall Structural Tubing, H. J. French. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1855-1874, 4 figs. Including tables showing physical properties of low-carbon seamless tubes, effect of varying cold reduction in outside diameter on seamless steel tubing, effect of low-temperature annealing on properties of low-carbon cold drawn seamless steel tubes, effect of furnace temperature variation in final annealing on properties on low-carbon seamless steel tubing, and properties of hard-drawn and partly annealed 0.3 to 0.4 per cent carbon seamless steel tubes and of cold-drawn 3½ per cent nickel-steel seamless tubing under varying thermal treatment.

Tungsten Steel

On some physical Constants of Tungsten Steels, Kotaro Honda and Tokujiro Matsushita. Sci. Reports of Tohoku Imperial University, vol. 8, no. 2, Aug. 1919, pp. 89-98, 7 figs. Experiments with specimens containing different percentages of tungsten, contents of carbon being 0.3 per cent in one series and 0.6 per cent in another.

Work, Effect on Metals

The Effect of Work on Metals and Alloys, Owen Wm. Ellis. Engineering, vol. 108, no. 2800, Aug. 29, 1919, pp. 290-292, 13 figs. Results of research work of investigators into effect of cold work on mechanical properties of metals and alloys are collated, and evidences are noted of existence of points of inversion in graphs connecting percentage reduction by work and mechanical properties of certain metals and alloys, for example, steel, brass, copper, etc. Hypothesis that for every temperature there exists a critical range of deformation at which recrystallization of amorphous material accruing as result of cold work is extremely rapid is discussed. Paper read before Inst. of Metals.

MEASUREMENTS AND MEASURING APPARATUS

Angle Measurement

Some New Johansson Measuring Appliances. Automotive Industries, vol. 41, no. 13, Sept. 25, 1919, pp. 611-612, 3 figs. One of the sets is said to be for the measurement of angles to a degree never before attempted.

Comparator, Wilson Projection

Some Optical Aids for the Engineer—IV, Arthur C. Banfield. Machy. (Lond.), vol. 14, no. 364, Sept. 18, 1919, pp. 737-740, 10 figs. Description of Wilson projection comparator. Operator avoids distortion by special twin optical system of such a nature that respective optical centers are adjustable to diameter of screw under test.

Johansson Apparatus

See Angle Measurement.

Meters, Venturi

Computation of the Coefficient of Discharge of Venturi Meters, W. S. Pardoe. Eng. News-Rec., vol. 83, no. 13, Sept. 25, 1919, pp. 606-608, 6 figs. Tests at University of Pa. said to have indicated that coefficients may be computed within 0.5 per cent of experimental values.

Pyrometers

Pyrometer Protection Tubes, Otis Hutchins. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1811-1816, 3 figs. Experiments to determine effectiveness of protection appliances used for high-temperature pyrometer insulations involving use of platinum couples, and outline of characteristics of carborundum protection tube.

Self-checking Galvanometer Pyrometer, H. F. Porter. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1803-1805, 2 figs. Galvanometer circuit so arranged that by means of simple adjustment resistance of entire circuit is rendered equal to constant predetermined value, as substitute of continuously deflecting pyrovolter.

Resistance Thermometry, F. W. Robinson. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1829-1836, 1 fig. Advantages of electric resistance method, its limitations; construction and protection of resistance spirals; types of measuring apparatus; and table giving resistance values for quartz-resistance thermometers.

Alloys Suitable for Thermocouples and Base-metal Thermoelectric Practice, J. M. Lohr. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1837-1843, 2 figs. Development of "chromel" and "alumel." Also notes on methods of controlling temperature at cold end and diagrams for installing thermocouple extensions.

Application of Pyrometry to Problems of Lamp Design and Performance, I. H. Van Horn. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, supp. to Sept. 1919, pp. 2271-2300, 7 figs. In studying temperature description in vacuum lamp and in gas-filled lamp, gas loss for coil filament in gas-filled lamp, and measuring filament temperature.

Report of Pyrometer Committee of National Research Council, George K. Burgess. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, supp. to Sept. 1919, pp. 2271-2300, 7 figs. Committee was formed Sept. 20, 1919, for purpose of developing pyrometric method suitable for open-hearth steel practice so that effects of temperature in various stages of process of steel making might be correlated quantitatively with other factors influencing production of sound steel. It is reported that use of Acheson graphite, either in block or tube form, as target after immersion to desired depth and location in metal bath and sighted upon by optical pyrometer, was found in experiments to be serviceable method of temperature control.

Recent Improvements in Pyrometry, R. P. Brown. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1979-1994, 5 figs. Improvements in applications of pyrometers to industry. Writer observes that while certain foreign countries were formally recognized as leaders in manufacture of scientific instruments and particularly pyrometers, this lead has now been taken by United States.

Automatic Compensation for Cold-Junction Temperatures of Thermocouple Pyrometers, Felix Wunsch. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 2065-2071, 7 figs. Illustrating various systems of automatic compensation, notably by carbon discs, by nickel and manganin coils and method used in Leeds and Northrup split-circuit potentiometer system.

Teaching Pyrometry in Our Technical Schools, George V. Wendell. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 2097-2106. Mere acquaintance with constructional details of pyrometers and their operations is not considered sufficient for intelligent application of pyrometers to scientific and industrial measurement of temperature. It is suggested that a course in pyrometry should rather lay such a sound foundation that any subsequent heat problem can be attacked with confidence and good judgment.

The "Wedge" optical Pyrometer. Engineer, vol. 128, no. 3323, Sept. 5, 1919, pp. 229-230, 3 figs. Instrument consists of rectangular brass tube across which, at right angles, there is fitted a small telescope.

Tables and Curves for Use in Measuring Temperatures with Thermocouples, Leason H. Adams. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 2111-2124, 6 figs. Calibration tables covering range zero to 1755 deg. cent. for platinum, platinrhodium couple, zero to 385 deg. cent. for copper-constantan and zero to 1283 deg. cent. for chromel-alumel. Curves show variation of thermoelectromotive force with temperature, sensitivity of couples at various temperatures and similar characteristics.

Fundamental Laws of Pyrometry, C. E. Mendenhall. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 2111-2124, 6 figs. Survey of physical basis of pyrometry.

Application of Pyrometry to the Manufacture of Gas-mask Carbon, Kirtland Marsh. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1611-1626, 7 figs. Pyrometry equipment at works of Astoria Light, Heat & Power Co., Astoria, N. Y., where gas-mask carbon was produced from cocoanut shells and fruit pits.

Recording Pyrometry, C. O. Fairchild and Paul D. Foote. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1627-1654, 22 figs. Pyrometers that can be made to record automatically are classified under (1) gas saturated vapor, and liquid thermometers, (2) resistance thermometers, (3) thermoelectric pyrometers, and (4) radiation pyrometers. Of these, thermoelectric pyrometers have greatest applicability. Various types of thermocouple recorders, some operating on galvanometric principle and some on potentiometric system, are described.

Recording Thermocouple Pyrometers, Leo Behr. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1655-1660, 5 figs. Device consisting of Wheatstone bridge network in series with thermocouple, one arm of bridge being of nickel and being located at cold end of thermocouple, described as permitting accurate automatic cold-junction compensation.

Pyrometry in Rotary Portland Cement Kilns, Leo I. Dana and C. O. Fairchild. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1661-1673, 1 fig. Measurements of temperatures in dry-process, coal-burning kiln, made by High-temperature Measurements Section of Bur. of Standards.

Some Factors Affecting the Usefulness of Base-Metal Thermocouples, O. L. Kowalke. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1751-1761, 7 figs. Factors considered are indicating and recording instruments, insulation on elements, constancy and homogeneity of wires and resistance to oxidation in furnace.

Potentiometers for Thermoelement Work, Walter P. White. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1763-1772, 3 figs. Methods of reading thermocouple pyrometers, specially by potentiometers and by intermediate instruments, such as pyrovolter.

Theory and Accuracy in Optical Pyrometry with Particular Reference to the Disappearing-Filament Type, W. E. Forsythe. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, supp. to Sept. 1919, pp. 2547-2578, 10 figs. Including tables giving results obtained by experience of observers using different red glasses and different absorbing glasses, and also results of intercomparison temperature scales.

Thermoelectric Pyrometry, Paul D. Foote, T. R. Harrison and C. O. Fairchild. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, supp. to Sept. 1919, pp. 2631-2686, 35 figs. Analytical presentation of physical phenomena underlying operation of indicating instruments, outline of their commercial forms, discussion of correction for irreproducibility of couples and comparative study of protection tubes for thermocouples.

Pyrometry in the Tool-manufacturing Industry, J. V. Emmons. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 2155-2158. Suggests establishing regular system of inspection and testing to safeguard unsatisfactory service from all types and makes of pyrometers.

Protecting Tubes for Thermocouples, R. B. Lincoln. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 2147-2150. Care taken in selection of proper tubes, locating it in most favorable place in furnace, and then inspecting and replacing it before it has deteriorated enough to injure couple, are suggested as means of increasing accuracy and decreasing up-keep charges.

A Reference Standard for Base-Metal Thermocouples, N. E. Boon. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 2135-2137. It is concluded from investigation undertaken to determine third metal against which iron and constantan might be checked, that copper is ideal standard for checking of base-metal thermoelements, because it can be easily obtained in electrolytic form, in which it has same thermoelectric properties regardless of its origin.

Shadow Measurement

New Method of Measuring Shadows (Ein neuer Weg zur Messung von Schatten), Konrad Norden. Journal für Gasbeleuchtung, vol. 62, no. 30, July 26, 1919, pp. 416-420, 3 figs. Calculation and valuation of shadows in lighting installations.

Scale Testing

The Personal Equation in Testing Scales. Scale Jl., vol. 6, no. 1, Oct. 10, 1919, p. 7, 2 figs. Diagrams indicating how a person can be influenced by convenience and prejudice in coming to a decision while making measurements or carrying out tests.

Temperature Control

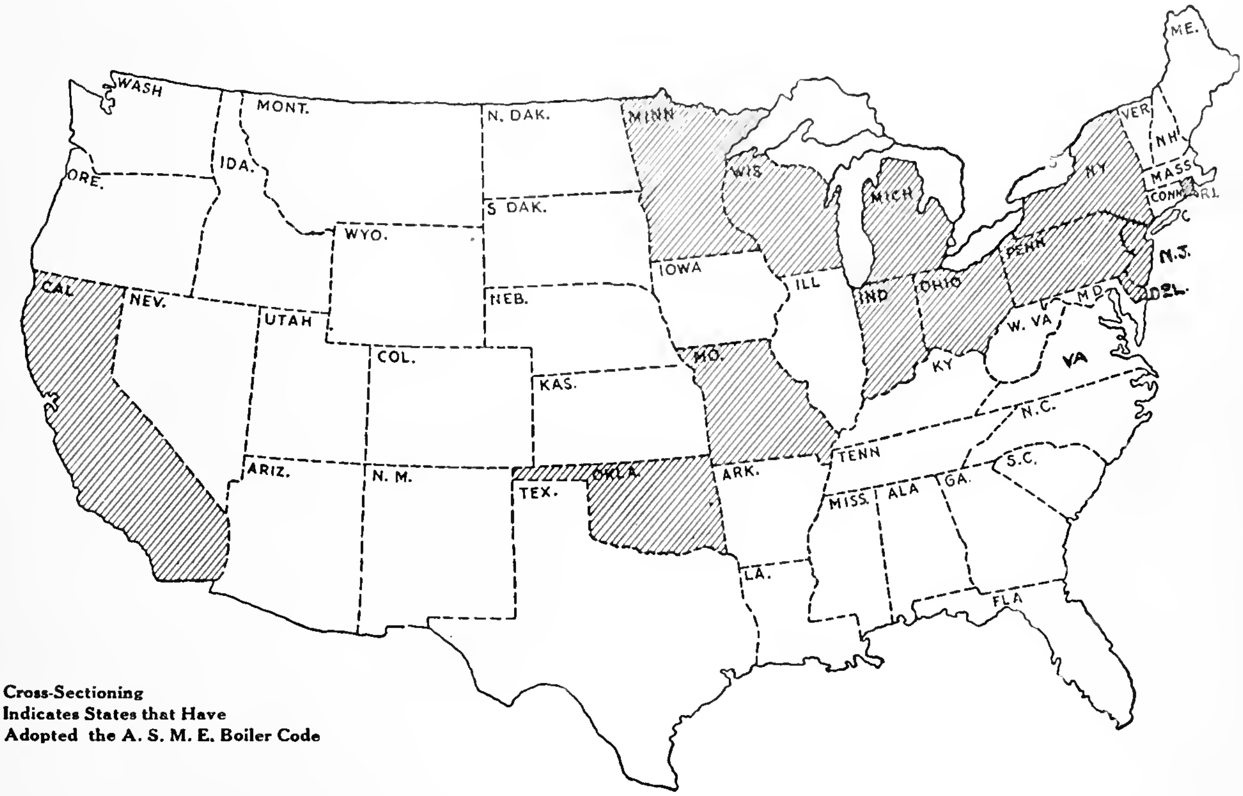
High-Temperature Control, C. O. Fairchild and Paul D. Foote. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1701-1715, 9 figs. Relation of temperature variations to other factors involved in control of furnace, kilns, ovens, tanks, etc., operated at high temperatures is discussed and brief description given of devices used in high-temperature control.

Temperature Measurements

Temperature Measurements of Incandescent Gas Mantles, Herbert E. Ives. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1681-1686, 3 figs. Comparative study of measurements effected by three methods—optical, total radiation, and by thermocouples. Of these, the last method was found to be most accurate.

See also Pyrometry.

HEINE BOILERS
are
"CODE BOILERS"



Cross-Sectioning Indicates States that Have Adopted the A. S. M. E. Boiler Code

We are and will continue to be staunch supporters of the A. S. M. E. Boiler Code or any other code that specifies quality and honesty.

From the very first we were closely identified with the development of this excellent code. In fact, Col. E. D. Meier, our first president, was in a measure the originator of this code because while serving as President of the A. S. M. E. he appointed the first boiler code committee.

The work of that committee and of subsequent committees has resulted in the code as it now stands. We take much pride in the prominent rôle of our first president in placing steam boiler design upon a firm and safe foundation.

So, regardless of the state or country in which Heine Boilers are sold, they will all pass the rigid requirements of the A. S. M. E. Code. We believe in the Code to that extent.

The Heine Boiler is fully illustrated ard described in our treatise "Boiler Logic."

HEINE SAFETY BOILER CO.

5321 Marcus Avenue, St. Louis, Mo.

Temperature Scale

Standard Scale of Temperature, C. W. Waidner, E. F. Mueller and Paul D. Foote. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 2051-2063. Outline of proposed international scale of temperatures in interval from — 40 per cent to 1100 per cent; also account of work done and data obtained to devise uniform scale above 1100 per cent.

High-Temperature Scale and Its Application in the Measurement of True, Brightness, and Color Temperatures, Edward P. Hyde. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1969-1974. Discussion of Boltzman's and of Planck's equations.

Thermometers

High-temperature Thermometers, R. M. Wilhelm. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1687-1700, 5 figs. Industrial forms of high temperature mercurial thermometers and indicating and recording thermometers of vapor-pressure, liquid or gas-filled, and bimetallic or graphite-metal expansion tubes.

Vacuum Gage

A Simple Theory of the Knudsen Vacuum Gauge, George W. Todd. Lond., Edinburgh, and Dublin Phil. Mag., vol. 38, no. 225, Sept. 1919, pp. 381-382. Expression of pressure in terms of constants of instruments.

Vapor-Pressure Estimation

Improved Apparatus for the Estimation of Vapor Pressures, Allan Morton. Chem. Indus., vol. 38, no. 19, Oct. 15, 1919, pp. 363t-364t, 1 fig. Apparatus in which taps of ordinary type have been eliminated.

MECHANICS

Balancing of Rotating Parts

Dynamic Balancing of Quickly rotating Machine Parts (Ueber die dynamische Auswuchtung von rasch umlaufenden Maschinenteilen), Hans Heyman. Elektrotechnische Zeitschrift, vol. 40, nos. 21, 22 and 23, May 22 and 29, and June 5, 1919, pp. 234-237, 251-254 and 263-265, 59 figs. Discussing Norton, Akimoff and Heyman methods. Progressive balancing method of writer was illustrated on a machine built by Schenk, Darmstadt, built in six sizes, making as high as 20,000 r.p.m., at which figure recording takes place by means of optical mirror apparatus. (Concluded.) Paper read before Elektratechnischer Verein, Berlin.

Beams

New Formulæ for the Economical Design of Rectangular Beams Particularly as Regards Shear Resistance, John C. Gammon. Indian Eng., vol. 66, no. 10, Sept. 6, 1919, pp. 137-138. Condition for no-shear reinforcement in a slab.

Determination of Secondary Stresses in Level Truss Constructions with Rigid Joints (Zeichnerisches Verfahren zur Ermittlung der Nebenspannungen des ebenen steifknotigen Fachwerkes), Chr. Vlachos. Eisenbau, vol. 10, no. 1, Jan. 1919, pp. 2-10, 11 figs. Discussing elastic funicular polygons of continuous beams, determination of change of angles and moment of support. Curves and formulæ.

Contribution to the Study of the Vierendeel Beam (Contribution à l'étude de la poutre Vierendeel), F. Keelhoff. Annales de l'Association des Ingénieurs de Gand, vol. 7, no. 5, 1914, pp. 431-448. Determining lines of influence by means of Maxwell theorem relative to reciprocity of deformations.

Engine Columns

The Design of Engine Columns—IV, W. K. Wilson. Mech. World, vol. 66, no. 1708, Sept. 26, 1919, p. 150, 2 figs. Method of stiffening columns by webplates. (Concluded.)

Mechanisms

The Design of Small Machinery, W. E. Thompson. Machy. (Lond.), Oct. 16, 1919, pp. 76-80, 7 figs. Qualifications necessary for single purpose machines, with notes on selection of bearing materials. Details of such mechanisms as hoppers for screw-slot machines and some special machines are taken up.

Motion

A Time-Scale independent of Space Measurement. Parabolic and Hyperbolic Kinematics, L. Silberstein. Lond., Edinburgh, and Dublin Phil. Mag., vol. 38, no. 225, Sept. 1919, pp. 382-394, 3 figs. Based principally on assumption that among all possible motions leading from one world point to another there is one and only one uniform motion.

Resistance of Materials

Application of Principle of Mechanical Similitude to Structures (Applicazioni del principio di similitudine meccanica alle costruzioni). Annali d'Ingegneria e d'Architettura, vol. 34, no. 15, Aug. 1919, pp. 228-235. Formula and calculations for determining resistance of material.

Shafts, Critical Speed

Critical Speeds of Torsion Shafts (Kritische Drehzahlen von Torsionswellen), H. Lorenz. Zeitschrift für das gesamte Turbinenwesen, vol. 16, no. 16, June 10, 1919, pp. 149-153, 4 figs. Shaft with one gyrating mass; shaft with several gyrating masses.

Shafts, Whirling of

The Whirling of a Coplanar Crankshaft, J. Morris. Aeronautics, vol. 17, no. 308, Sept. 11, 1919, pp. 258-259, 3 figs. Applies alternative method to cover cases of two-cranked and four-cranked coplanar crankshafts and shows further that same method is applicable to case of crankshaft having any number of coplanar cranks.

Vibrations

Shaking Motion in Coupling Rod Gear (Ueber die Schüttelschwingungen des Kuppelstangenantriebes), Karl E. Müller. Schweizerische Bauzeitung, vol. 74, nos. 12, 13 and 14, Sept. 20, 27 and Oct. 4, 1919, pp. 141-144, 155-158, and 169-172, 14 figs. Deduction of differential equation; calculation of instability area; resonance vibrations; course of rod power in rigid shafts; description of experimental arrangement of apparatus. (Concluded.)

MECHANICAL PROCESSES

Ball Bearings

The Manufacture of Ball Bearings. Automobile Engr., vol. 9, no. 130, Sept. 1919, pp. 305-310, 25 figs. Describing works and equipment of Rudge-Whitworth, Ltd., Birmingham, Eng.

Belting, Rubber

Details of the Manufacture of Rubber Belting. Belting, vol. 15, no. 8, Oct. 20, 1919, pp. 26-27, 4 figs. How crude rubber is gathered, prepared for market, then processed and united with cotton duck in the belting factory.

Blooming Mills

New Davy Brothers Blooming Mills (Nouveaux trains de laminoirs blooming système Davy Brothers), Génie Civil, vol. 75, no. 1936, Sept. 20, 1919, pp. 261-263, 6 figs. At steel works of Bolckow, Vaughan and Co., Middlesbrough (Cleveland), England. Blooming mills have cylinders of 40 in. in diameter. Works will turn out rails and large beams of various sections.

Crushing Plants

Crushed-Stone Plant without Conveyors. Rock Products, vol. 22, no. 19, Sept. 13, 1919, pp. 36-42, 24 figs. Details of Laurin & Leitch Eng. & Construction Co.'s plant near Montreal. Material is elevated once and for all and no rehandling is said to be necessary.

Coal Crushing in a By-Product Coke Oven Plant. Gas Age, vol. 44, no. 8, Oct. 15, 1919, pp. 337-339, 4 figs. Notes on possibilities of coke ovens and use of crushers.

Engines, Marine

Construction of Marine Engines at the Joshua Hendy Iron Works' Plant, H. L. Rexworthy. Pac. Mar. Rev., vol. 16, no. 10, Oct. 1919, pp. 133-134. Engines are of 2800 hp. and of triple-expansion reciprocating type.

Extrusion of Metals

The Extrusion of Metals, J. H. Garnett. Machy. (Lond.), vol. 15, no. 367, Oct. 9, 1919, pp. 43-48, 10 figs. Methods by which process is carried out and description of various presses.

Sanding Machine

Building a Sanding Machine. Machy. (Lond.), vol. 14, no. 363, Sept. 11, 1919, pp. 721-724, 15 figs. Article deals with methods of machining important parts and describes jigs and fixtures used and general procedure in building machines.

Screening

Sand and Gravel Plant Has Concrete Screening Tower and Buildings. Rock Products, vol. 22, no. 21, Oct. 11, 1919, pp. 37-41, 14 figs. Sand and gravel is removed from 40-ft. bank by 2½-cu. yd. bottom-dump cars. Screens are mounted in batteries of twos so that half the gravel goes through each.

MOTOR-CAR ENGINEERING

Caterpillar Tractors

Caterpillars and Their Construction—I, K. H. Condit. Am. Mach., vol. 51, no. 13, Sept. 25, 1919, pp. 601-604, 5 figs. Types built by Holt Mfg. Co., Peoria, Ill.

Diesel Engine

The Diesel Engine and Automobiles, Charles Day. Practical Engr., vol. 60, no. 1703, Oct. 16, 1919, pp. 185-188, 6 figs. Modifications which will be necessary to introduce in present design of Diesel engine to make it applicable to automobile work, particularly in regard to spraying of fuel into cylinders, range of speed, and production of turbulent conditions of gases at time of ignition. Paper read before Inst. Automobile Engrs.

Gas Storage

High-Pressure Gas Storage for Motor Vehicles. Engineering, vol. 108, no. 2799, Aug. 22, 1919, pp. 248-249. Discussion of views contained in report of Inter-Departmental Committee on Gas Traction in regard to manufacture of containers for compressed gas.

Heavy Fuels

Heavy-Fuel Carbureter Type Engines for Vehicles, J. H. Hunt. Jl. Soc. Automotive Engrs., vol. 5, no. 3, Sept. 1919, pp. 202-207, 5 figs. Survey of experiments reported in various technical papers interpreted to indicate that "there is no demonstrated means by which the heavy fuel carburetor engine will improve the fuel situation to any great extent," because "equipments which have shown promising results in service have handled nothing heavier than kerosene."

Impact Tests of Trucks on Roads

Preliminary Report of Impact Tests of Auto Trucks on Roads, E. B. Smith. Public Roads, U. S. Dept. Agriculture, Bur. Public Roads, vol. 2, no. 15, July 1919, pp. 8-10, 3 figs. Also Eng. & Contracting, vol. 52, no. 14, Oct. 1, 1919, pp. 390-392, 3 figs. Apparatus used consisted of heavy steel cylinder in which was fitted plunger 4 in. in diameter and 8 in. long, similar in construction to hydraulic jack. Results indicated general tendency increased impact toward higher speed, although increment of increase was less as speed increased.

Truck Weights

The Economic Limit to Motor-Truck Weights, Robert C. Barnett. Eng. & Contracting, vol. 52, no. 14, Oct. 1, 1919, pp. 374-380, 5 figs. Discussing relation between thickness of pavement and weight of truck, between weight of truck and its capacity, between cost of truck and its capacity. Cost of operation, economic speed and annual cost of transportation. Continuation of article published in E. & C., Jan. 1, 1919.

Valve-Spring Anchorage

Valve-Spring Anchorage. Autocar, vol. 43, no. 1247, Sept. 13, 1919, pp. 399-401, 6 figs. Critical review of various systems frequently adopted in current engine design.

PIPE

Joints

Making of Cement Joints for Cast Iron Pipe, W. M. Henderson. Gas Age, vol. 44, no. 8, Oct. 15, 1919, pp. 343-344, 2 figs. Experience with these joints at Pacific coast. Paper read before Pacific Coast Gas Assn.

Pipe Line

The Yarhola Pipe Line, Wynn Meredith. Eng. World, vol. 15, no. 8, Oct. 15, 1919, pp. 37-43, 12 figs. With notes on field transportation problems which involved 720,000 ton-miles of haul.

POWER GENERATION

Blast-Furnace Gases

Utilization of Blast-Furnace Gases and of Low-Grade Fuels (Utilisation des gaz de hauts-fourneaux et de charbons maigres), P. Moutier. Electricien, vol. 49, no. 1233, July 31, 1919, pp. 42-44. Utilization of gases from blast furnaces considered as important of being developed as utilization of hydraulic energy.

Tidal Power

Proposed Tidal Hydro-Electric Power Development of the Petitcodiac and Memramcook Rivers. Jl. Eng. Inst. Can., vol. 11, no. 10, Oct. 1919, pp. 647-658, 8 figs. Also Can. Engr., vol. 37, no. 15, Oct. 9, 1919, pp. 362-366 and pp. 372-374, 7 figs. Dams and power house at confluence of Petitcodiac and Memramcook Rivers. Initial installation of 90,000 hp. would cost, it is said, about $122 per hp.

Lamson Conveyors

He Swore Us to Secrecy for a Year

WE cannot tell the name of the product in this case. Some time ago we installed a Lamson System in the plant. It made possible an entirely new procedure in an old industry — and that new procedure saved over 5% of manufacturing cost. No competitor could make that saving until that procedure was copied. Hence the need of secrecy.

It is not an uncommon happening that the installation of a Lamson System makes possible a saving in other ways than merely in conveying.

Lamson Conveying Systems are tireless, capable of working twenty-four-hour days seven days a week; they save space; they cut out confusion and congestion; they don't make mistakes, nor drop and smash packages. They carry castings as well as electric-light bulbs, packed boxes as well as hats; they are universally adaptable. They set fixed and orderly pace for production. They place the thing wanted, where it is wanted, just when it is wanted.

The Lamson booklet on Conveying shows some of the many variations of Lamson Systems. We will gladly send a copy upon request, or better, we will instruct our nearest representative to call and show you just how Lamson will fit into your plant and meet your needs. Such a call involves no obligation.

The Lamson Company
100 BOYLSTON ST., BOSTON, MASS.

Branches and Service Stations

Boston	100 Boylston St.	Cleveland	2063 East 4th St.	Los Angeles	221 San Fernando Bldg.
New York	15 West 44th St.	Cincinnati	119 East 5th St.	St. Louis	70[illegible] Pine St.
Philadelphia	210 North Broad St.	Indianapolis	Cor. Washington and Illinois	Dallas	905½ Elm St.
Pittsburgh	319 Third Ave.	Chicago	6 No. Michigan Ave.	Seattle	215 Stewart St.
Baltimore	Equitable Building	Minneapolis	320 Tribune Annex	Washington, D. C.	426 Colorado Bldg.
Rochester	194 Main St. East	Omaha	4[illegible]8 McCague Bldg.	Atlanta	30 Moore Bldg.
Detroit	97 Woodward Ave.	San Francisco	617 Mission St.	Montreal, Jones & Glassco Reg'd.,	St. Nicholas Bldg
Toronto	136 Simcoe St.	Vancouver, B. C.	603 Hastings St.		

Additional Service Stations

Denver, 1622 Arapahoe St. New Orleans 124 St. Charles St. Albany, 22 So. Pearl St Buffalo, 1[illegible]4 Main St. Kansas City, [illegible]10 New Ridge Bldg.

LAMSON SERVICE

Winnipeg

Low-Cost Hydro Power in Winnipeg. Power House, vol. 12, no. 14, Sept. 5, 1919, pp. 381-384, 7 figs. General layout of plant having output of 45,000 hp. generated at 60,000 volts and sent over 65-mile duplicate line which is supported on standard steel towers, 40 ft. high and placed at 500-ft. intervals.

POWER PLANTS

Boiler Explosion

A Boiler Explosion in a Creamery. Power House, vol. 12, no. 16, Oct. 6, 1919, pp. 438-439, 3 figs. Low water and dynamite are conjectured as causes for accident.

Boiler House

Methods of Increasing Boiler-Room Efficiency, D. S. Jacobus. Boiler Maker, vol. 19, no. 8, Aug. 1919, pp. 239-242. Discussion of effect of stoker and furnace on boiler operation with remarks on burner system and comparative study of gas engines and steam installations.

Economy in the Power House, George Frederick Zimmer. Eng. & Indus. Management, vol. 2, no. 12, Sept. 18, 1919, pp. 355-357, 2 figs. Efficient utilization of coal advocated and to minimize waste and increase productiveness writer advises careful handling of coal from colliery to furnace door and scientific burning in grate.

Coal and Ash Handling

Equipment for Handling Coal and Ashes in Power Plants—II, Robert June. Elec. Rev., vol. 75, no. 17, Oct. 25, 1919, pp. 691-692, 1 fig. Influence of methods upon plant operation.

Condensers

The Design of Surface Condensers. Mech. World, vol. 66, no. 1706, Sept. 12, 1919, pp. 124-125. With special reference to Prof. Whitham's formula.

Contraflow System of Utilizing Exhaust

The Contraflo System of Utilizating Exhaust. Power House, vol. 12, no. 15, Sept. 20, 1919, pp. 417-419, 4 figs. It is claimed that by means of this arrangement all heat of the exhaust steam from engine-room auxiliaries is made available and less of heat in main engine exhaust is rejected.

Feedwater Heating

Feed Water Heating, A. R. Hodges. Boiler Maker, vol. 19, no. 9, Sept. 1919, pp. 274-276, 1 fig. Description of heater construction and notes on fuel saved by use of properly designed feedwater heater.

Steam, Superheated, Uses

Industrial Uses of Superheated Steam, Alexander Bradley. Blast Furnace & Steel Plant, vol. 7, no. 10, Oct. 1919, pp. 519-522, 5 figs. Tests made by U. S. Steel Corporation on blowing engines said to have indicated average saving of 13.33 per cent.

POWER TRANSMISSION

Belt Transmission

Belt Economy (Rationel Remdrift), Harald Holstein. Teknisk Tidsskrift, vol. 45, no. 33, Aug. 20, 1919, pp. 116-134, 26 figs. Design and calculation of pulleys and belting; belt coupling; graphs.

Problem of Belt-Edge Tear and How to Solve It. Belting, vol. 15, no. 8, Oct. 20, 1919, pp. 17-19, 4 figs. Improper alignment of pulleys believed to be principal cause.

Gearing, Reduction

Gearing as applied to the Marine Steam Turbine, John Houston. Trans. Inst. Mar. Engrs., vol. 31, no. 246, Sept. 1919, pp. 363-387, 4 figs. Design, workmanship and materials of helical spur wheel reduction gear.

PRODUCER GAS

Gas-Producer Practice

Gas-producer Practice at Western Zinc Plants, G. S. Brooks and C. C. Nitchie. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, supp. to Sept. 1919, pp. 2721-2773, 35 figs. Illustrating details in process of classifying Ill., Ind. and Kan. coals. Among devices noted are Chapman floating agitator installed on remodeled Duff gas producer at roast kilns and various particulars of Hughes gas producer.

Producer-Gas Investigation

Résumé of Producer Gas Investigations, Oct. 1, 1904-June 30, 1910, R. H. Fernald and C. D. Smith. Dept. Interior, Bur. Mines, Bul. 13, 1911, 393 pp., 250 figs. Tests reported were of two classes: (1) made with pressure-producer installation, and (2) made with down-draft producer plant. Efficiencies obtained are interpreted as showing possibility of gas producer as factor in reducing waste in use of coal and lignites and preserving fuel resources of U. S. A.

Sulphur in Producer Gas

Sulfur in Producer Gas, Frederick Crabtree and A. R. Powell. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, supp. to Sept. 1919, pp. 2687-2692. Method for estimation of carbon bisulphide constituent of commercial gas.

PUMPS

Anthony Steam Pump

"Anthony" Patent Steam Pump. Steamship, vol. 31, no. 364, Oct. 1919, pp. 93-96, 4 figs. Steam distribution gear is mechanically operated, and all working parts are embodied in one complete unit.

Bunsen Aspirating Pump

The Bunsen Aspirating Pump and the Bernouilli Principle, Will C. Baker. Phys. Rev., vol. 14, no. 3, Sept. 1919, pp. 228-233, 3 figs. Usually given application of Bernouilli theorem to Bunsen aspirating pump is shown to be fallacious. Experiments are described that show this pump to be an impact pump.

Pump Selection

Considerations Affecting the Choice of Pumps for Small Water Works, Henry A. Symonds. Mun. & County Eng., vol. 57, no. 4, Oct. 1919, pp. 178-180. Particularly as determined by comparative fuel and first costs of various types.

Pumps, Multi-Stage

Methods of Lifting Sulphuric Acid, Sidney J. Tungay. Chem. Age, vol. 1, no. 12, Sept. 6, 1919, pp. 326-328, 2 figs. Writer traces progress made and describes multi-stage pumps which appear to have solved problem.

REFRACTORIES

Clay

Tests to Determine Uses for Clay, R. F. MacMichael. Brick & Clay Rec., vol. 55, no. 9, Oct. 21, 1919, pp. 762-767, 11 figs. Forms used for recording physical characteristics of clays, methods of testing them in laboratory and examples of curves and data obtained.

Melting Points

Melting Point of Refractory Materials, Leo I. Dana. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1571-1586, 1 fig. Factors and conditions that effect values of melting points and outline of methods for their determination.

Porcelain for Pyrometers

Porcelain for Pyrometric Purposes, Frank H. Riddle. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 2207-2217, 3 figs. Comparative study of various kinds of porcelain protecting tubes and notes on their manufacture.

Pyrometer Porcelains and Refractories, R. W. Newcomb. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1975-1977. Concerning selection of protecting tubes.

Pyrometry

Application of Pyrometers to Ceramic Industry, John P. Goheen. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, supp. to Sept. 1919, pp. 2255-2264, 3 figs. Specially as continuous guide for burning of kilns from start until kiln is finally burned off.

Temperature Measurements

Refractory Materials and High-Temperature Measurements, C. W. Kanolt. Jl. Franklin Inst., vol. 188, no. 4, Oct. 1919, pp. 489-505. Notes on uses of thermocouples, resistance thermometers, optical and radiation pyrometers and pyrometric cones.

REFRIGERATION

Carbonic Anhydride Machine

The Carbonic Anhydride Refrigerating Machine, Peter Neff. A.S.R.E. Jl., vol. 5, no. 4, Jan. 1919, pp. 266-269 and (discussion) pp. 269-271. Conditions existing with regard to this type of apparatus in United States.

Clothel Refrigerating Machine

Test of Two-Ton Clothel Refrigerating Machine, M. C. Stuart. Jl. Am. Soc. Naval Engrs., vol. 31, no. 3, Aug. 1919, pp. 624-634, 6 figs. Refrigerant used was Ethyl-Chloride. Results showed that refrigerating effect was increased with higher brine temperatures and lower circulating water temperatures; with circulating water temperature of 70.1 deg. fahr. net refrigerating effect was 2.13 tons per day.

Gas Warfare

Refrigeration in Connection with Gas Warfare, A. M. Heritage. Am. Soc. Refrig. Engrs. Jl., vol. 5, no. 6, May 1919, pp. 403-415, 14 figs. Methods used, particularly in connection with transfer of phosgene from drums into system for filling shells and other projectiles.

Industrial Applications

Industrial Applications of Refrigeration, Charles L. Hubbard. Indus. Management, vol. 58, no. 4, Oct. 1919, pp. 289-294, 13 figs. Illustrating such applications as are employed for preservation of food, cooling of drinking water, control of certain chemical reactions, cooling workrooms, manufacturing confections and many others.

Machinery Arrangement

Machinery and Pipe Arrangement—XXIII, C. C. Pounder, Mech. World, vol. 66, no. 1711, Oct. 17, 1919, p. 186, 5 figs. In refrigerating plant. (Continuation of serial.)

Plant Efficiency

Refrigerating Plant Efficiency, George Naylor. Power House, vol. 12, no. 15, Sept. 20, 1919, pp. 420-421. Significance of correct proportioning for securing maximum operating plant economy.

Railroad Car Precooling

Precooling Loaded Refrigerator Cars. Ice & Refrigeration, vol. 57, no. 4, Oct. 1919, pp. 133-140, 5 figs. Commercial aspect of railroad car precooling studied from records of actual operation.

Storage, Cold, Plant

British Design for small Cold Storage. Ice & Refrigeration, vol. 57, no. 4, Oct. 1919, pp. 144-146, 6 figs. Sketch design for warehouse of about 120 tons capacity which can be constructed for approximately $40,000 exclusive of cost of land.

Improved Cold-Storage Methods a Means to Better World Provisioning, F. E. Matthews. Am. Soc. Refrig. Engrs. Jl., vol. 5, no. 6, May 1919, pp. 416-426 and (discussion) pp. 426-433. Extension and improvement of cold storage emphasized by statements in U. S. Government reports that 15 per cent of all food stuffs grown in this country is wasted before it reaches market, and that 25 per cent of amount reaching market is wasted before it reaches consumer.

Synchronous Motors

Synchronous Motors for Refrigerating Compressor Operation. Power Plant Eng., vol. 23, no. 21, Nov. 1, 1919, pp. 992-993, 2 figs. Installation of Brooklyn ice plant which consists of six 15 x 15 in. compressors driven in sets of 2 x 3 350-hp. direct-connected synchronous motors.

RESEARCH

Agriculture

Problems and Methods in Agricultural Research, H. J. Wheeler. Jl. Indus. & Eng. Chem., vol. 11, no. 11, Nov. 1, 1919, pp. 1056-1060. Warns against types of work from which false and misleading conclusions have been drawn.

Chemical Engineers, Canada

The Value of Scientific Work and the Training of Chemical Engineers in Canada. Can. Chemical Jl., vol. III, no. 10, Oct. 1919, pp. 335-340. From report of proceedings of Chemistry Committee of Honorary Advisory Research Council.

Foundries and Machine Shops

The Necessity and Advantages of a Laboratory in Foundries and Machine Shops (Gesichtspunkte über die Notwendigkeit und den Nutzen eines Laboratoriums für eine Giesserei und Maschinenfabrik), Fr. Meese. Giesserei-Zeitung, vol. 16, no. 14, July 15, 1919, pp. 209-214, 6 figs. One of advantages claimed is that by determining injurious factors it is possible to reduce inferior or rejected grades to minimum. Photomicrographs.

Minerals, Non-Metallic

Non-metallic Mineral Research. Cement, Mill & Quarry, vol. 15, no. 8, Oct. 20, 1919, pp. 27-31. Observes that war work of Bureau of Mines provides foundation for valuable development of industrial minerals if properly encouraged by cement, mill and quarry industries.

Organization and Equipment

Industrial and electrical Laboratories (Les laboratoires d'usines et d'électricité industrielle), G. Lebaupin. Electricité, vol. 49, no. 1232, July 15, 1919, pp. 8-13, 4 figs. Suggestions in regard to organization and selection of equipment.

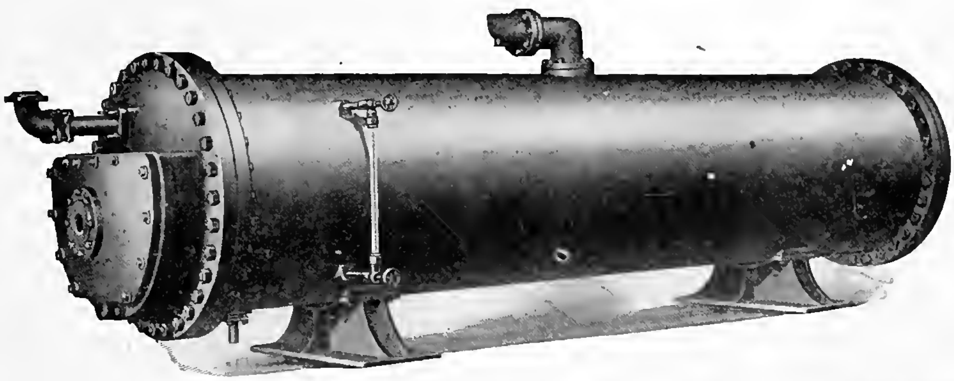
Vogt

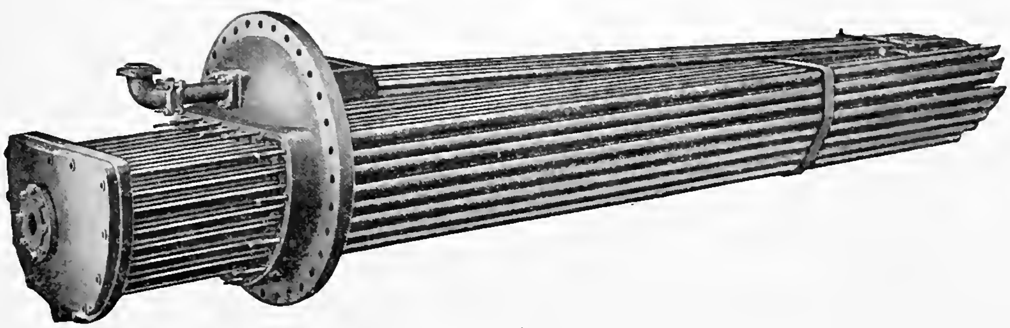
ICE MAKING AND REFRIGERATING MACHINERY

Engineers prefer—

the VOGT EXHAUST STEAM AMMONIA GENERATOR, on account of its SUPERIOR FEATURES, which are—

No
- Return Bends
- Bent Pipe
- Exposed Heating Surface
- Stuffing Boxes on Steam Coils
- Thread Joints inside of Shell





Patented

Henry Vogt Machine Company

Louisville, Ky.

SPECIFICATIONS

Creosote Oil

Specifications for Creosote Oil. Bul. Am. Ry. Eng. Assn., vol. 21, no. 217, July 1919, pp. 30-40, 12 figs. Including precautions to be followed in purchase and use of creosote-coal-tar solutions. Adopted by Association on recommendation of one of its committees.

Steel

Standard Specifications for Steel. Times Eng. Supp., vol. 15, no. 540, Oct. 1919, pp. 301-302. Their possibilities and uses.

Specifications for High Speed Steels, B. Polikoff. Mech. World, vol. 66, no. 1706, Sept. 12, 1919, pp. 128-129. Description of test tools and discussion of European practice and test factors.

STANDARDS AND STANDARDIZATION

Concrete-Reinforcement Bars

Concrete Reinforcement Bars rolled from Billets. Assn. Am. Steel Manufacturers pamphlet, Mar. 22, 1910. Standard specifications revised 1912 and Apr. 21, 1914.

Economical Results of Standardization

Engineering Standardisation, Gerald Lightfoot. Commonwealth Australia Inst. Sci. & Industry, Pamphlet no. 2, 1919, 30 pp., 1 fig. Economical results of standardization work carried out in England, America and Japan quoted as argument for convenience of introducing engineering standardization in Australian industry.

STEAM ENGINEERING

Boiler Explosions

Boiler Explosions, F. Carruthers. Mar. Engr. & Naval Architects, vol. 42, no. 505, Oct. 1919, pp. 81-82, 2 figs. Explosion of multitubular marine type boiler in steel cargo steamer found from inquiry to have been caused by overheating of tube ends and combustion chamber plates, due to accumulation of scale on their surfaces on water side.

Feeding Water-Tube Boilers

The Feeding of Water Tube Boilers (Das Speisen von Wasserrohrkesseln). Zeitschrift des Bayerischen Revisionsvereins, vol. 23, no. 7, Apr. 15, 1919, pp. 49-51. The arrangement of the feed pipe and its relation to water circulation and safety of boilers.

Flues

Flues for Internally-Fired Boilers—II, W. H. Grantham. Mech. World, vol. 66, no. 1708, Sept. 26, 1919, p. 151, 5 figs. British Board of Trade formula for computing working pressure for flues having sections connected together by joints. (Continuation of serial.)

Hochwald Piston Valve

See Piston Valves.

Piston Valves

Steam Engines with Shaft Governor and Piston Valve with automatic Compression Control (Dampfmaschinen mit Achsregler und Kolbenschieber mit selbsttätiger Regulierung der Verdichtung), M. Hochwald. Zeitschrift des Bayerischen Revisionsvereins, vol. 23, no. 7, Apr. 15, 1919, pp. 52-53, 4 figs. Description of the Hochwald piston valve, which automatically controls compression under varying working and filling conditions.

Turbines

The Westinghouse Rateau Reducing Pressure Steam Turbine. Mech. World, vol. 66, no. 1709, Oct. 3, 1919, pp. 163-165, 4 figs. Designed to satisfy requirements of industrial concerns such as chemical works, textile works, sugar factories, which, besides needing supply of steam of comparatively low pressure for heating, boiling, and drying processes, also requires supply of electric power for general purposes.

TEXTILES

Yarn and Acids

The Action of Dilute Sulphuric Acid Solutions upon the Tensile Strength of Cotton Yarn, Walter A. Lawrence. Can. Chemical Jl., vol. 111, no. 10, Oct. 1919, pp. 329-331, 4 figs. Experimental investigation described as having shown that cotton fibres are sensitive to very dilute sulphuric acid solutions, specially when allowed to dry on fibre, the higher the temperature of solution containing inorganic acid, the higher being the temperature of drying cotton treated with such a solution.

THERMODYNAMICS

Gas Explosion Phenomena

The Effect of Carbon Dioxide when present in inflammable gaseous Mixtures on Explosion Phenomena, W. T. David. Engineering, vol. 108, no. 2801, Sept. 5, 1919, pp. 300-302, 6 figs. Pressure records obtained for explosions of following mixtures: (1) 20.7 per cent coal-gas, 26.3 per cent oxygen and 53 per cent CO_2; (2) 15 per cent coal-gas, 26.4 per cent oxygen and 58.6 per cent CO_2; (3) 15 per cent coal-gas, 19.7 per cent oxygen and 65.3 per cent CO_2.

Heat Transmission

Heat Transmission of Steam containing Air to Water (Die Wärmeübertragung von lufthaltigem Dampf an Wasser), L. Schneider. Zeitschrift des bayerischen Revisions-Vereins, vol. 23, no. 11, June 15, 1919, pp. 85-87, 2 figs. It is claimed that even small quantities of air in steam reduce heat transmission by 50 and even 75 per cent.

WELDING

Electric Welding

Direct and Alternating Current Welding, A. M. Candy. Blast Furnace & Steel Plant, vol. 7, no. 10, Oct. 1919, pp. 484-486, 4 figs. Schemes of connections.

Electric Welding: Its Theory, Practice, Application and Economics, H. S. Marquand. Elecn., vol. 83, no. 2157, Sept. 19, 1919, pp. 300-302, 7 figs. Description of various methods of preparing welds; illustrations of various kinds of work and discussion of economies effected by machine welding. (To be concluded.)

Electrodes, Chemical Composition

Effects of the Chemical Composition of Welding Electrodes, J. S. Orton. Am. Mach., vol. 51, no. 13, Sept. 25, 1919, pp. 625-626. Results of tests made by Welding Research Committee of Shipping Board.

Portable Welding Outfits

Arc Welding for the Commercial Welding Shops, Robert E. Kinkead. Welding Engr., vol. 4, no. 10, Oct. 1919, pp. 42-44, 4 figs. Illustrating various portable welding outfits.

Quasi-Arc Welding

Quasi-Arc Welding, L. B. Dickerson. Southern & Southwestern Ry. Club, vol. 15, no. 4, July 1919, pp. 6-29, 16 figs. Outline of scientific principles upon which electric welding depends.

Slot Cutting

Milling Machine versus Oxy-Acetylene Machine. Can. Machy., vol. 22, no. 14, Oct. 2, 1919, pp. 349-350, 2 figs. Descripton of work done by straight line cutting blowpipe in cutting slots in slip socket.

Soldering

Solder, Soldering Flux and Soldering, F. A. Kartak. Power Plant Eng., vol. 23, no. 21, Nov. 1, 1919, pp. 975-977, 2 figs. Solders and fluxes required for soft and hard soldering of various metals.

Tipping Device

Improved Tipping Device for Oxy-Acetylene Welding Table, J. T. Smoody. Eng. & Min. Jl., vol. 108, no. 13, Sept. 27, 1919, pp. 553-554, 1 fig. Advantages claimed are positive lock from worn gears and one-man adjustment of table.

Weld-Metal Analysis

Determination of Oxygen and Nitrogen in Electric Weld Metal, J. H. Paterson and H. Blair. Jl. Soc. Chem. Indus., vol. 38, no. 17, Sept. 15, 1919, pp. 328T-330T. Suggested method in which electrolytic hydrogen is passed through tower filled with soda-lime and wash bottle containing strong sulphuric acid and from thence is carried into silica tube filled with fine iron borings and heated to bright redness in tube furnace, where any trace of oxygen contained in gas is reduced to water.

WOOD

Fungi

Fungi, the Cause of Decomposition of Timber, P. H. Dudley. Bul. Am. Ry. Eng. Assn., vol. 21, no. 217, July 1919, pp. 49-63, 12 figs. Illustrating how antiseptic arrests decomposition of lumber and timber.

Jarrah

See Seasoning.

Pattern Making

Pattern Turning—II, Joseph A. Shelley. Machy. (Lond.), vol. 15, no. 366, Oct. 2, 1919, pp. 10-15, 17 figs. Equipment required and methods used in turning shoulders, fillets, small core-prints, cylindrical patterns and irregular forms.

Seasoning

On the Rapid Seasoning of Jarrah, Alfred Tomlinson. Engineering, vol. 108, nos 2800 and 2801, Aug. 29 and Sept. 5, 1919, pp. 287-289 and 323-325, 13 figs. Illustrating forms of (1) progressive, and (2) compartment classes of kilns for drying timber. Results of experiments. (To be continued.) Paper read before Western Australia Instn. of Engrs.

VARIA

Diamond Polishing

Diamond Polishing. Times Eng. Supp., vol. 15, no. 540, Oct. 1919, p. 310. An industry for disabled soldiers.

Grindstone Manufacture

The Manufacture of the artificial Grindstone of Carborundum, Y. Nakazawa (in Japanese). Denki Gakkwai Zasshi, no. 374, Sept. 10, 1919.

Organization and Management

ACCOUNTING

Cost Accounting

Fundamentals of Uniform Cost Accounting System for the Concrete Pipe and Tile Industry, G. A. Schonlau. Cement & Eng. News, vol. 31, no. 10, Oct. 1919, pp. 24-26. A reliable system of cost and financial accounting should record, it is said, where every item of material and time and expense goes in making of product or in process of buying and selling goods.

Cost Keeping

See Office Routine.

Costs

Relationship of Items of Cost under Pre-war Conditions and To-day, F. W. Doolittle. Elec. Ry. Jl., vol. 54, no. 15, Oct. 11, 1919, pp. 9-11. Effect of higher cost of labor and materials of construction is analyzed and illustrated by example. Paper presented before Am. Elec. Ry. Assn.

Foundry

Handling Costs in a Steel Foundry, Clifford E. Lynn. Iron Trade Rev., vol. 65, no. 18, Oct. 30, 1919, pp. 1179-1180, 7 figs. Forms used in foundry cost keeping.

Mechanical Devices

Mechanical Devices in Railroad Accounting, S. O. Price. Ry. Rev., vol. 65, no. 17, Oct. 25, 1919, pp. 600-601, 3 figs. Cards used in classifying wages and for showing cost statement of additions and betterment work.

Office Routine

Cost Records for Cost-Plus-Fixed-Fee System, F. A. Wells. Contract Rec., vol. 33, no. 41, Oct. 8, 1919, pp. 944-947, 5 figs. Illustrating office routine of purchase order, invoices and vouchers.

Cost Keeping under Cost-Plus-Fixed-Fee Contracts, F. A. Wells. Eng. & Contracting, vol. 52, no. 16, Oct. 15, 1919, pp. 447-449, 6 figs. Illustrating purchase orders, invoices and vouchers.

Overhead

The Overhead Cost in Contracting, Dan. Carey. Eng. & Contracting, vol. 52, no. 17, Oct. 22, 1919, pp. 463-465. Importance of correctly estimating overhead costs and suggestions in regard to figuring them.

Records

The Block-Number System. Machy. (Lond.), vol. 15, no. 366, Oct. 2, 1919, pp. 7-9, 3 figs. Illustrating various methods of keeping records.

EDUCATION

Engineering Colleges

Engineering Colleges and Administration, Ira N. Hollis. Eng. Education, vol. 10, no. 2, Oct. 1919, pp. 33-68. Recommends that time of teacher be occupied with administration as little as possible, and that national engineering societies coöperate with Society for Promotion of Engineering Education and with colleges themselves towards broadening out engineering education.

EXPORT

Boilers

Foreign Demand for American Boilers, L. W. Alwyn-Schmidt. Boiler Maker, vol. 19, no. 9 Sept. 1919, pp. 271-272. Establishment of liberal foreign credit emphasized as necessary to open up extensive field for American boiler products.

Cement

International Trade in Cement. Cement, Mill & Quarry, vol. 15, nos. 6 and 8, Sept. 20 and Oct. 20, 1919, pp. 15-19 and 35-39. Statistics of imports into foreign countries; although figures mentioned were compiled from pre-war data, they may serve as basis to guide American manufacturers in computing and obtaining share of cement trade of the world. This article deals with imports into France, Germany and Mexico. Export opportunities in Spain, Portugal and South America are quoted.

FACTORY MANAGEMENT

Code Calling

Code Calling in Factories, V. Karapetoff. Indus. Management, vol. 58, no. 4, Oct. 1919, pp. 306-308, 1 fig. Points out advantages of electro-acoustic systems for increasing effectiveness of management and promoting good will among executives and employees.

Audible Signals in the Foundry, Vladimir Karapetoff. Iron Trade Rev., vol. 65, no. 14, Oct. 2, 1919, pp. 894-895, 2 figs. Suggested electrical calling mechanism. Paper presented before Am. Foundrymen's Assn.

Control Board

How I know where each Job stands, C. E. Fairbanks. Factory, vol. 23, no. 5, Nov. 1919, pp. 1036-1038, 1 fig. Chart mounted on control board warning of minimum stocks.

Employment

Placing the right Man in the right Job, W. D. Stearns. Machy. (N. Y.), vol. 26, no. 2, Oct. 1919, pp. 136-139, 4 figs. Methods used by Westinghouse Electric Manufacturing Co., East Pittsburgh, for analyzing jobs and classifying them with a view to obtaining standard wage rates. Second of two articles.

Foundries

System is a Factor in Production, W. C. Briggs. Foundry, vol. 47, no. 333, Oct. 15, 1919, pp. 735-737, 3 figs. Standardizing and classifying flasks and adopting plan based upon requirements of work as essentials in increasing output of foundry. Paper presented before Am. Foundrymen's Assn.

Graphic Control

Graphic Metallurgical Control, H. M. Merry. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, supp. to Sept. 1919, pp. 2313-2321, 5 figs. Methods and records developed for use of executives of copper company in New Mexico. Particular attention is directed to use of large wall-charts, reference display of large charts, scale notation of metallurgical charts and inclusion of mesh extraction on screen-analysis diagrams.

Layout

New National Acme Screw Products Plant. Machy. (N. Y.), vol. 26, no. 2, Oct. 1919, pp. 120-122, 5 figs. Special attention is called to arrangement of plant which permits material to pass in one continuous stream through shop.

Laundry

The Factory Laundry. Eng. & Indus. Management, vol. 2, no. 16, Oct. 16, 1919, pp. 488-489, 3 figs. Details of establishment used in factory for washing overalls, caps, refectory table-cloths and lavatory towels.

Machine-Tool Plant

Organization and Management of a Machine Tool Plant—IV. Machy. (Lond.), vol. 14, no. 363, Sept. 11, 1919, pp. 711-716, 7 figs. Dealing with factory control, departmental efficiency records, progress reports, advertising department, employment department.

Production Manager

The Production Manager and the Progress Chief, W. J. Hiscox. Machy. (Lond.), vol. 14, no. 362, Sept. 4, 1919, pp. 693-694, 1 fig. Defining duties of both, viz., for one to get the work and the other to produce the article, writer claims that there are many firms who, although they accept the principle in connection with appointment of business manager and works manager, will not adopt it in connection with the factory organization.

Progress Chief

See Production Manager.

Repetition Work

Seek Economy in Repetition Work. Foundry, vol. 47, no. 18, Nov. 1, 1919, pp. 761-766, 13 figs. Arrangement of factory which manufactures parts for electric washing machines, ironers and vacuum cleaners. Machines are made in only a few standard heights and this keeps down number of patterns required.

Scientific Management

Scientific Management—V, Henry Atkinson. Eng. & Indus. Management, vol. 2, no. 13, Sept. 25, 1919, pp. 402-406, 4 figs. Charts suggesting organization for general engineering works.

Positive Contributions of Scientific Management. The Elimination of some Losses characteristic of present-day Manufacture, Henry H. Farquhar. Bul. Taylor Soc., vol. 4, no. 5, Oct. 1919, pp. 15-28. Mechanical aspects of scientific management are seen to be increased production, decreased cost, stimulus of knowledge. Human factors enumerated are industrial peace, high wages, proper working hours, promotion of health and well-being, free scope for individual initiative, opportunity for advancement and reduction of labor turnover.

Taylor's Principles in modern British Management, Robert Stelling. Eng. & Indus. Management, vol. 2, no. 15, Oct. 9, 1919, pp. 451-456. Writer explains principles of F. W. Taylor system. He observes that their adoption means shouldering of responsibility by management and that disinclination to do this must be overcome by education before a start can be made.

Signals

See Code Calling.

Working Conditions

The Influence of Hours of Work and of Ventilation on Output in Tinplate Manufacture, H. M. Vernon. Eng. & Indus. Management, vol. 2, nos. 14 and 15, Oct. 2 and 9, 1919, pp. 419-423 and 466-472, 7 figs. Records obtained at various plants in regard to effect in output of reducing working day from eight to six hours. Seasonal variation of output and its relation to surrounding temperature and ventilation. Report of Indus. Fatigue Research Board.

INSPECTION

Automobile Work

Defective Work. Automobile Engr., vol. 9, no. 130, Sept. 1919, pp. 286-288, 1 fig. Causes of and some suggestions for reducing rejections.

Leather Belting

Inspection of Leather Belting, Harry A. Hey. Indus. Management, vol. 58, no. 4, Oct. 1919, pp. 273-281, 20 figs. Methods for predetermination of performance and durability, noting special apparatus required for effecting tests.

LABOR

Engineers

Classification and Salaries of Engineers. Can. Engr., vol. 37, no. 17, Oct. 23, 1919, pp. 397-402. Schedule adopted by Toronto engineers includes titles, qualifications, and minimum salaries for technically trained men ranging from $1,200 to $12,000 per annum.

Housing

Building on a "Unit" System. Iron & Coal Trades Rev., vol. 99, no. 2691, Sept. 26, 1919, pp. 415-416, 2 figs. Arrangement for artisan's dwellings suggested by London company.

Colliery of Granby Consolidated Mining Smelting and Power Co., Ltd., E. A. Haggen. Min. & Eng. Rec., vol. 24, no. 15, Aug. 15, 1919, pp. 209-219, 21 figs. Plans and details of industrial homes provided for workers are included.

The Report of the U. S. Housing Corporation. Am. Architect, vol. 116, no. 2283, Sept. 24, 1919, pp. 399-408 and 412-414, 15 figs., partly on supp. plates. Illustrated with examples of community and group building.

Solving the Industrial Housing Problem. Am. Drop Forger, vol. 5, no. 10, Oct. 1919, pp. 491-493, 4 figs. How Westinghouse Airbrake Co. formed new company to handle situation at Welmerding, Pa.

A Plan for Industrial Peace, Stephen C. Mason. Am. Industries, vol. 20, no. 3, Oct. 1919, pp. 7-8. Suggests entering into agreement containing, among other features, strongly worded provision pledging employers to give employees honest and generous day's pay, workers in turn pledging themselves to give honest and generous day's work.

Relations between Employer and Employee, Wm. M. Leiserson. Monthly Labor Rev., vol. 9, no. 4, Oct. 1919, pp. 207-216. Suggestions in regard to planning labor relations policy and creating labor administration organization.

Industrial Overstrain and Unrest, Charles S. Myers. Eng. & Indus. Management vol. 2, no. 16, Oct. 16, 1919, pp. 483-485. Determination of hours of labor and periods of rest in factories as well as distribution of periods of labor and rest during day, seen as questions which can best be settled by establishing National Institute of Psycholology and Physiology, applied to Industry and Commerce, such as advocated in Eng. & Indus. Management of Sept. 25.

Labor Turnover

Labor Turnover in Chicago, Emil Frankel. Monthly Labor Rev., vol. 9, no. 3, Sept. 1919, pp. 44-59. Summary of results of inquiry made by Bur. of Labor Statistics into nature and extent of labor turnover in Chicago during war period.

Running away from Work and Jobs, Dale Wolf. Indus. Management, vol. 58, no. 4, Oct. 1919, pp. 269-271. Based on experience of writer who visited and investigated conditions in 32 plants representing various industries and a few mercantile establishments.

Language

The one Language industrial Plant, Winthrop Talbot. Indus. Management, vol. 58, no. 4, Oct. 1919, pp. 313-320. It is observed that over 500 industrial plants have found it good business to establish language classes for foreigners in their employ. Difficulties which are encountered in this form of teaching and manner in which they can be overcome are exposed.

Profit Sharing

The Industrial Problem, Charles Plez. Pac. Mar. Rev., vol. 16, no. 10, Oct. 1919, pp. 96-98. Profit sharing and partnership discussed as remedies for labor unrest.

A Means of Harmonising Capital and Labour, Frank Graham. Eng. & Indus. Management, vol. 2, no. 16, Oct. 16, 1919, pp. 498-500. Advocates copartnership or profit sharing in industrial enterprises.

Vocational Training

Management and Training of Employes, W. W. Gidley. Coal Industry, vol. 2, no. 10, Oct. 1919, pp. 471-473. Results of vocational training of worker in industries said to lie in convincing him that real efficiency reflects and conserves human element and increases earning power.

Wages

Cost of Living in Relation to Wage Adjustments, LeRoy D. Williams and Alfred B. Holt. Bul. Taylor Soc., vol. 4, no. 5, Oct. 1919, pp. 29-46, 4 figs. Research made at works of Holt Mfg. Co., Peoria, Ill.

A Defense of the Piece Rate Method of Wage Payment, Leon Bing. Indus. Management, vol. 58, no. 4, Oct. 1919, pp. 325-327. It is claimed that there are no practical administrative or psychological objections to any piece-rate system involved that cannot be removed by right-minded management.

Women

Women in Industry. Monthly Labor Rev., vol. 9, no. 4, Oct. 1919, pp. 217-221. Output of women workers in relation to hours of work in shell making.

Works Councils

Austrian Law Establishing Works Councils. Monthly Labor Rev., vol. 9, no. 3, Sept. 1919, pp. 133-134. Election of workers' councils is made obligatory in establishments and factories where at least 20 workers are employed continuously for wages.

German Workers' Councils—Their Organizations and Functions, Alfred Maylander. Monthly Labor Rev., vol. 9, no. 3, Sept. 1919, pp. 125-133. Status planned for workers' councils in new economic structure of Germany. Article is based on announcement of government as to its legislative program with respect to workers' councils, comments in German press on this program, and resolutions adopted by second congress by workers' councils.

Works Council Serves as Court. Iron Trade Rev., vol. 65, no. 16, Oct. 16, 1919, pp. 1041-1043. Method of industrial administration followed by International Harvester Co. Right of appeal and arbitration are among important features of plan.

Tenth German Trade-Union Congress, Nuremberg, June 30 to July 5, 1919. Monthly Labor Rev., vol. 9, no. 4, Oct. 1919, pp. 284-290. Public boycott, work councils and joint industrial leagues discussed among other topics.

Taylor-Wharton Plan. Eng. & Indus. Management, vol. 2, no. 14, Oct. 2, 1919, p. 439. Details of Work Council by which employees share in management.

LEGAL

Resale Prices

The Fixing of Resale Prices—III, Chesla C. Sherlock. Am. Mach., vol. 51, no. 13, Sept. 25, 1919, pp. 604-605. Decisions of bar studied in order to determine extent to which law sanctions restraint of trade.

Trademarks

The Use of Trade-Marks—I. Chesla C. Sherlock. Am. Mach., vol. 51, no. 14, Oct. 2, 1919, pp. 651-653. Difference between patent and trade-mark emphasized, and attitude of courts in regard to protection provided by trade-marks explained.

RECONSTRUCTION

European Industrial Needs

Industrial Needs of Europe Outlined. Iron Trade Rev., vol. 65, no. 18, Oct. 30, 1919, pp. 1197-1199. Opinions expressed at International Conference held at Atlantic City under auspices of Chamber of Commerce of U. S.

Machine-Tool Industry

From Engines of War to Instruments of Peace, W. H. Lloyd. Iron Trade Rev., vol. 65, no. 15, Oct. 9, 1919, pp. 974-981, 18 figs. Conditions in machine tool industry.

SAFETY ENGINEERING

Accident Classification

"Safety First"—Criticism of Accidents. Ry. Gaz., vol. 31, no. 13, Sept. 26, 1919, pp. 391-393, 3 figs. Great Western Railway's (England) system of classifying and recording causes of accidents.

Accident Reduction by Bonus

The Foreman's Bonus for Accident Reduction, Lucian W. Chaney. Monthly Labor Rev., vol. 9, no. 3, Sept. 1919, pp. 272-281. From statistics it is concluded that foreman's bonus for accident reduction tends very greatly to reduce minor injury but it does not necessarily operate to satisfactory reduction of more severe accidents. It is suggested that the bonus be reinforced by vigorous application of other measures.

Accidents

Industrial Accidents, Lucian W. Chaney. Monthly Labor Rev., vol. 9, no. 4, Oct. 1919, pp. 222-232, 1 fig. War-time trend of employment and accidents in a group of steel mills.

Cement Manufacture

Hazards of Cement Manufacture, R. Frame. Cement, Mill & Quarry, vol. 15, no. 7, Oct. 5, 1919, pp. 15-17. Based on experience of Alpha Co. at eight stock houses and six packing rooms during period from Jan. 1, 1918 to July 31, 1919.

Electrical Hazards

Industrial Safety—III, F. H. Reid. Power Plant Eng., vol. 23, no. 19, Oct. 1, 1919, pp. 873-874. Electrical hazards. Discussing power circuits, trolley wires, crowded shop conditions, etc. From lecture delivered before Schools for Safety Engrs., of Nat. Safety Council.

Erection, Steel

Safety Measures for Preventing Accidents in Steel Erection, E. A. Gibbs. Eng. & Contracting, vol. 52, no. 17, Oct. 22, 1919, pp. 460-461. Necessity for employing suitable equipment and selecting proper men for particular tasks is emphasized. Paper read before Eighth Annual Safety Congress.

Explosives

Safety Factors in Use of Explosives in Rock Quarrying, Walter O. Snelling. Cement, Mill & Quarry, vol. 15, no. 7, Oct. 5, 1919, pp. 27-31. Precautions to observe while firing, loading, tamping cartridge and preparing charge. It is particularly advised to avoid making electrical connections in too great haste while connecting up blast.

Safety Measures in Blasting Operations. Contract Rec., vol. 33, no. 42, Oct. 15, 1919, pp. 967-968. How to handle explosive to eliminate danger. Third Article.

See also MINING ENGINEERING, Explosives.

Fire Protection

Fire Protection for Military Establishments in the Home Commands. "Red Books" of the British Fire Prevention Committee, no. 206, London, 1917, 48 pp. Dangers of fire, fire-protective arrangements and fire service organization at military establishments.

The Legislation and Administration of the Fire Brigade Service of the United Kingdom together with a Scheme for its Reorganization, H. S. Bell. "Red Books" of the British Fire Prevention Committee, no. 233, 1919, 60 pp. Scheme proposed aims at remedying inefficiency of local authority brigades and absence of power to compel such authority to provide brigade in cases of necessity.

Hoisting Operations

Safety Measures in Hoisting Operations. Contract Rec., vol. 33, no. 43, Oct. 22, 1919, pp. 984-986, 1 fig. Precautions to observe about location of equipment, brakes, signals, selection and care of cables, and operators.

Mine Safety

Electrical Apparatus and Mine Safety, Graham Bright. Coal Indus., vol. 2, no. 9, Sept. 1919, pp. 370-372. Outlines safety precautions in installation of electrical apparatus at mines, with special reference to equipment for gaseous mines, power plants, fans, hoists, pumps and general conditions.

Safety Committees

Safety Committees in Workshops. Eng. & Indus. Management, vol. 2, no. 16, Oct. 16, 1919, pp. 493-494. Suggestions offered in pamphlet published by British Government in regard to duties of committees.

Methods of selecting Committees and maintaining Interest in Safety. Railroad Herald, vol. 23, no. 11, Oct. 1919, pp. 21-23. Suggests use of statistics either in statement form or by graphic chart showing common causes of accidents and class of employees suffering therefrom.

Safety Measures

The Fundamental Principles of Safeguarding, Sidney J. Williams. Can. Machy., vol. 22, no. 17, Oct. 23, 1919, pp. 410-411 and 415. Devices guarding every moving part, wherever located, on which workman might be injured if he came in contact with it in any way, or from any cause whatsoever. Paper read before Eighth Annual Safety Congress.

Steel Plants

Promoting Safety in Steel Plant, H. P. Heyne. Iron Trade Rev., vol. 65, no. 17, Oct. 23, 1919, pp. 1110-1111. It is noted that main qualification of safety engineering must be to study human nature and to be capable of winning coöperation of all employees. Experiences of one company in reducing accidents are quoted. Paper read before National Safety Council.

See also Accidents.

Welding

Oxy-acetylene and the Safety First Movement, A. Cressy Morrison. Can. Machy., vol. 22, no. 15, Oct. 9, 1919, pp. 372-375. Address delivered before Western Pa. Division of National Safety Council.

West Virginia

Progress in Rescue and First Aid in W. Va., W. J. Heatherman. Coal Indus., vol. 2, no. 9, Sept. 1919, pp. 356-358, 2 figs. Claims that West Virginia is foremost state in first-aid, rescue and mining education; it has seven rescue stations.

SALVAGE

Foundry Practice

Educational Value of the Scrap Pile, Henry Traphagen. Iron Trade Rev., vol. 65, no. 14, Oct. 2, 1919, pp. 892-893. Said to lie principally in affording opportunity to study conditions in foundry practice. Paper presented before Am. Foundrymen's Assn.

Oil and Waste

Reclaiming Waste and Oil, J. Emile Coleman. Machy. (N. Y.), vol. 26, no. 2, Oct. 1919, pp. 132-133, 1 fig. Outfit consisting of steam turbine-driven centrifugal machine, in which oil is extracted by centrifugal force, waste is washed in boiling water and subsequently rinsed in fresh water and finally dried centrifugally.

New Process for Removing and Salvaging Oil in Copper Manufacture (Die neue Entölungs und Oelrückgewinnungsanlage für die Rheinisch-Westfal. Kupferwerke Akt. Ges. Olpe Westfalen), Meukner. Gesundheits-Ingenieur, vol. 42, no. 27, July 5, 1919, pp. 273-274, 2 figs. Description of installation.

Paper Manufacture

Centrifugal Device as Mill Save-All. Paper, vol. 25, no. 3, Sept. 24, 1919, pp. 21-23, 11 figs. Describing apparatus for recovering pulp fibers, etc., from liquids.

Rubber Factories

Reducing Waste in Rubber Factories, Robert C. Kelley. India Rubber World, vol. 61, no. 1, Oct. 1, 1919, pp. 7-9, 4 figs. Forms of scrap reports and methods for handling waste.

TRANSPORTATION

Automobile Factories

Automobile Factory Transportation Systems, Edward K. Hammond. Machy. (N. Y.), vol. 26, no. 2, Oct. 1919, pp. 123-128, 10 figs. Also Machy. (Lond.), vol. 15, no. 357, Oct. 9, 1919, pp. 33-38, 10 figs. Types of equipment used for transporting raw materials and parts of product through plant of Willys-Overland Co., Toledo, O.

Contractor's Trucks

Maintenance Methods for Contractor's Trucks. Commercial Vehicle, vol. 21, no. 5, Oct. 1, 1919, pp. 170-172, 5 figs. Details of solution of special problems created by severe service and necessity for speed in contract.

Electric Trucks

Industrial Electric Trucks and Tractors in Machine Shops, Bernard J. Dillon. Elec. Rev., vol. 75, no. 17, Oct. 25, 1919, pp. 683-685, 4 figs. Illustrating various applications to hauling materials around shop and lifting them on to machines.

Electrical Engineering

BATTERIES

Dry Cells

Tests to Determine Deterioration of Small Dry Cells with Age, A. J. Helfrecht. Elec. Rev. (Chicago), vol. 75, no. 15, Oct. 11, 1919, pp. 603-604, 4 figs. Curves showing variations in performance as cells decreased in size.

Storage Batteries

Large Batteries for Power Purposes, E. C. McKinnon. Jl. Instn. Elec. Engrs., vol. 57, no. 284, July 1919, pp. 493-509 and (discussion) pp. 510-531, 7 figs. Discussing the evolution of large batteries, battery-room design, standardization, high-tension batteries, central station batteries, stand-by batteries, working results, control of large batteries and future aspect relative to large batteries.

ELECTROPHYSICS

Cables

Tables of Maxima Values of Current Intensity in Electrical Conductors of Cables (Tabelle dei valori massimi delle intensità di corrente nei conduttori e cavi elettrici), E. Soleri. Elettrotecnica, vol. 6, no. 27, Sept. 25, 1919, pp. 574-579, 4 figs. Comparative study of permissible values standardized by technical associations in Italy, France, England, Switzerland and Austria.

Current Distribution in Armature Conductors

Current Distribution in Armature Conductors, Waldo V. Lyon. Mass. Inst. Technology, Elec. Eng. Dept., Research Division, no. 19, July 1919, 13 pp., 3 figs. Equations are derived showing how a. c. resistance depends upon depth of slot. Scheme is then proposed for investigating circulations of deep-slot indication motors with high torque.

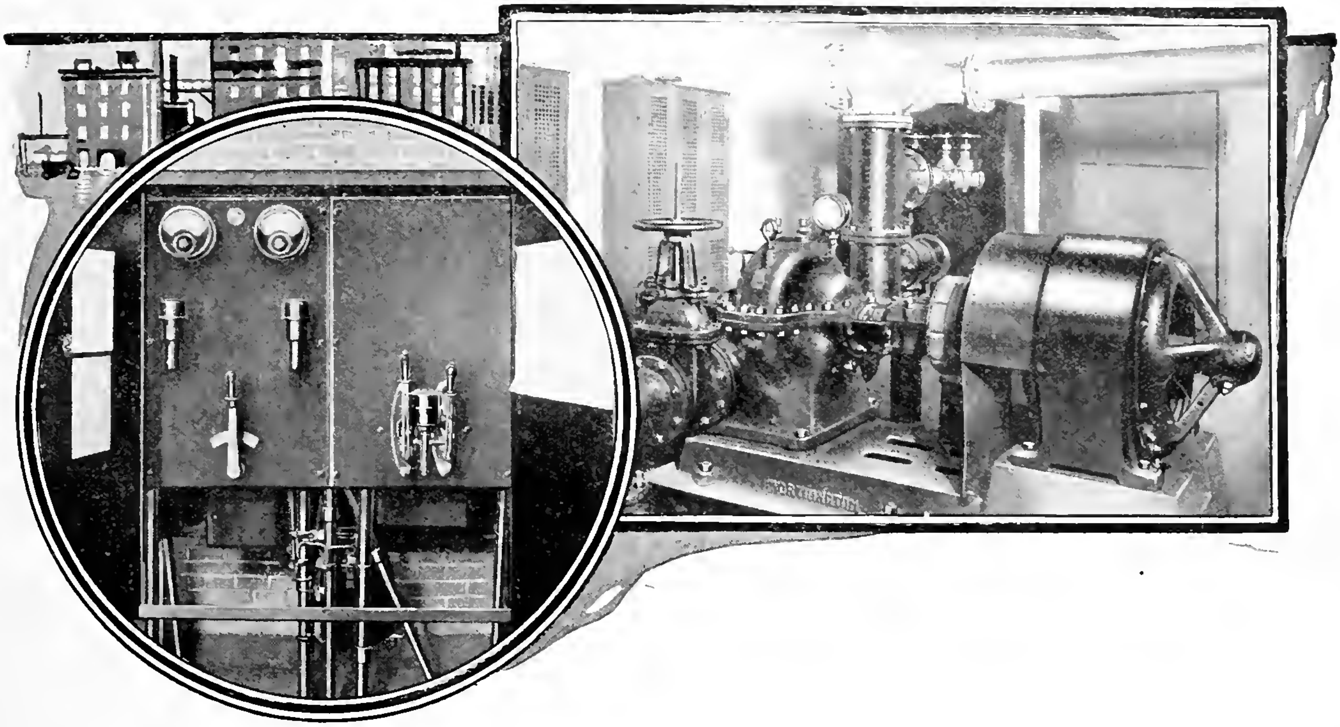
De-Ionization

Determination of Rate of De-Ionisation of Electric Arc Vapor, Henry G. Cordis. Proc. Inst. Radio Engrs., vol. 7, no. 5, Oct. 1919, pp. 527-539, 5 figs. After discussing de-ionization and consequent loss of conductivity of mercury vapor carrying momentary arc, writer considers arrangement of circuits for determining rate of de-ionization, and effect of this rate of voltage required for subsequent reignition. Theory of circuits is given and illustrated by numerical examples.

High-Tension, High-Frequency Apparatus

High Potential, High Frequency Apparatus and Experiments. Jl. Eng. Inst. Can., vol. 11, no. 10, Oct. 1919, pp. 663-668, 10 figs. Experiments were concerned with alternating current of very high frequencies, which consisted of separate groups of alternating currents, each group beginning with same amplitude but damping down more or less rapidly to zero and after short period of time beginning again. General arrangement of apparatus for high-potential high-frequencies experimental cabinet is illustrated.

Fire risk is practically eliminated by electric motor-driven pumps which start when a switch is closed



This Fire Pump Guards Our Factory

ELECTRIC power from either our power plant or from the Philadelphia Gas and Electric Company, with its duplicate stations, generators, and power lines, is used to operate this G-E motor-driven fire pump in our Philadelphia factory if a sprinkler head is opened. This starting up is done quickly, not slowly, as is necessary with steam engine driven pumps.

If the fire-proof cellar in which this pump is located should be flooded the pump would work, as the motor and its control equipment will operate under water.

Many of these G-E motor-driven fire pump installations all over the country are reducing premiums for their owners. May we reduce yours?

General Electric Company

General Office Schenectady, N.Y.

43-258

Inductances

A Note on the Comparison of Inductances, or of an Inductance and a Capacity by an Electrometer Method. Alva W. Smith. Phys. Rev., vol. 14, no. 4, Oct. 1919, pp. 356-360, 3 figs. Equation connecting deflection of electrometer with inductance capacity and current in circuit is developed.

Polarization of Geissler Discharge

Polarisation in the Geissler Discharge (Ueber die Polarisation in der Geisslerentladung), Erich Rumpf. Annalen der Physik, vol. 59, no. 1, June 13, 1919, pp. 1-27, 7 figs. Method which makes it possible to demonstrate polarization, manifesting itself in various ways, similar to electrolytic polarization, in a Geissler tube.

Resistance of Pure Metals

Study on Resistance of pure Metals (Ueber die Abhängigkeit des Widerstandes reiner Metalle von der Temperatur), L. Holborn. Annalen der Physik, vol. 59, no. 2, June 20, 1919, pp. 145-169, 1 fig. Tables and curves showing resistance coefficient of iron, nickel, tungsten, molybdenum, rhodium, aluminum, platinum and others.

Vacuum Valve

The Three-Electrode Thermionic Valve as A. C. Generator, C. L. Fortescue. Elecn., vol. 83, nos. 2157 and 2160, Sept. 19, 1919 and Oct. 10, 1919, pp. 294-295 and 414-416, 9 figs. Also in Elec. Rev. (Lond.), vol. 85, no. 2185, Oct. 10, 1919, pp. 456-457, 9 figs. Work done during war in wireless telegraphy department of English Signal School at Portsmouth. Calculations for determining conditions for maintenance of oscillations. Paper read before British Assn. for Advancement of Sci.

A Method of Using Two Triode Valves in Parallel for Generating Oscillations, W. H. Eccles and F. W. Jordan. Elecn., vol. 83, no. 2157, Sept. 19, 1919, p. 299, 5 figs. In order to obtain more symmetrical oscillations, writers suggest arranging two tubes in such a way that flywheel circuit is acted upon by a triode and high-voltage battery symmetrically in every half period.

X-Rays

Soft X-Rays. H. M. Dadourian. Phys. Rev., vol. 14, no. 3, Sept. 1919, pp. 234-246, 8 figs. Produced by impact of electrons hot lime cathode against platinum anode, using potentials of 20 to 1000 volt.

FURNACES

Duplex Process

Electric Furnace Improves Gray Iron, George K. Elliott. Foundry, vol. 47, no. 330, Sept. 1, 1919, pp. 585-586. Duplex process of melting in cupola and finishing in electric furnace is advocated for certain classes of gray-iron casting where quality is first requisite. Paper read at meeting of Am. Electrochem. Soc.

Heat-Treating Furnaces

Electric Furnaces for Heat Treatment of Steel, Elecn., vol. 83, no. 2158, Sept. 26, 1919, pp. 375-377. It is stated that while electric heating alone cannot compete with cost of gas or coke firing, advantages of control, accuracy, uniformity, absence of distortion and smallness of rejections are so enormous that there is no question that future is with electric furnace.

Steel Furnaces

Electrical Furnaces from a Steel Maker's Point of View, J. W. Naylor. Elecn., vol. 83, no. 2158, Sept. 26, 1919, pp. 363-367, 6 figs. It is observed that electric furnaces served their purpose during war by increasing output, which was of vital importance, but are now being superseded by Siemens, owing to competition, except for steels of superior quality, for which better price can be obtained.

Wild-Barfield Furnace

The Wild-Barfield Electric Furnace. Automobile Engr., vol. 9, no. 130, Sept. 1919, pp. 290-293, 8 figs. Decalescent point is employed for electro-magnetic temperature recording.

GENERATING STATIONS

Canadian Plant

Hydroelectric Plant and Paper Mill at Ocean Falls, B. C., W. A. Scott. Elec. Rev. (Chicago), vol. 75, no. 14, Oct. 4, 1919, pp. 551-574, 7 figs. Featuring Canadian properties of Pacific Mills, Ltd., and electric drive of large paper machines said to be unique.

China

Electrical Enterprise in China. Elec. Times, vol. 56, no. 1460, Oct. 9, 1919, pp. 278-280, 8 figs. Types of electrical stations and sub-stations used.

Denver

New Electric Generating Station at Denver, H. H. Kerr and T. O. Kennedy. Jl. Electricity, vol. 43, no. 7, Oct. 1, 1919, pp. 306-308, 4 figs. Concerning boiler-room equipment, ventilation arrangement and pumping units of 15,000 kw. station.

High D. C. Voltages

New Connection for Producing high D. C. Voltages (Eine neue Schaltung für die Erzeugung hoher Gleichspannungen), M. Schenkel. Elektrotechnische Zeitschrift, vol. 40, no. 28, July 10, 1919, pp. 333-334, 2 figs. Especially designed for testing and scientific purposes. Principal advantage said to be that the required alternating voltage itself need not be high.

Large Stations

Large High-Tension Alternating-Current Electric Stations (Les grands postes électriques à courant alternatif haute tension), A. Ha, et. Revue Générale de l'Electricité, vol. 6, no. 10, Sept. 6, 1919, pp. 299-309, 6 figs. Concerning selection of transformers, connections of network, distances between insulators and earth connections. (Continuation of serial.)

Merz-Price Protection Methods

Merz-Price Protection for Alternators and Transformers, C. W. Marshall. Elec. Rev., London, vol. 85, no. 2181, Sept. 12, 1919, pp. 345-346, 3 figs. System said to be of great value in maintaining continuity of supply.

Power Factor

The Improvement of Power Factor, E. W. Dorey. Electrical Review, vol. 85, no. 2186, Oct. 17, 1919, pp. 484-485, 2 figs. Tables showing effect of speed and load on power factors, based on actual data of motors. (To be continued.)

Rates

Central-Station Rates in Theory and Practice, H. E. Eisenmenger. Elec. Rev. (Chicago), vol. 75, nos. 14, 15, 16 and 17, Oct. 4, 11, 18 and 25, 1919, pp. 555-558, 599-602, 643-648 and 686-690, 19 figs. Oct. 4: Differentiating between classes of service; value of service according to size of customers and use; isolated plants and other competitions in light. Oct. 11: Study of systems of charge in vogue. Oct. 18: Study of stepmeter rate. Oct. 25: Methods for applying lower average kilowatt hour for larger consumers.

Simplon Tunnel

New Installations of Simplon Tunnel (Les nouvelles installations du tunnel du Simplon), Génie Civil, vol. 75, no. 15, Oct. 11, 1919, pp. 337-344, 20 figs. Details of hydro-electric plant at Massaboden, near Brig, Switzerland. (From Schweizerische Bauzeitung.)

GENERATORS AND MOTORS

Asynchronous Motors, Starting

Starting of Asynchronous Motors by Means of Tertiary Eddy Currents, R. Rudenberg. Elecn., vol. 83, no. 2160, Oct. 10, 1919, pp. 422-423, 4 figs. Proposed arrangement where secondary circuit of motor is connected through transformer with tertiary circuit in which considerable resistance is inserted. When at rest, rotor winding receives full frequency of network, so that transformer produces very small effect on current. Translated from Elektrotechnische Zeitschrift.

Bearings, Railway Motor

Railway Motor Bearings, J. S. Dean. Elec. Jl., vol. 16, no. 10, Oct. 1919, pp. 443-446, 18 figs. Method of manufacturing outlined and operations illustrated.

Coolers

New Types of Coolers for Electric Machinery (Neuere Kühleinrichtungen für elektrische Maschinen), Elektrotechnischer Anzeiger, vol. 36, nos. 65, 66 and 73, June 29, July 1 and 17, 1919, pp. 297-298, 303-304, and 339-340, 17 figs. Describing methods and designs for cooling turbo generators, for preventing overheating of commutator and collector rings and fires in air filters and for cooling three-phase motors. (Concluded.)

Gears, Helical

Decreased Operating Costs with Helical Gears, G. M. Eaton. Elec. Jl., vol. 16, no. 10, Oct. 1919, pp. 430-433, 2 figs. Because, it is said, these gears operate under conditions where weight reduction may be effected.

Induction Motor

The Synchronized Induction Motor, F. Keith D'Alton. Elec. News, vol. 28, no. 20, Oct. 15, 1919, pp. 39-41 and 44, 10 figs. Account of tests of standard one horsepower, four-pole squirrel cage motor, made in order to study possibilities of having machine synchronizing itself by modifying rotor.

Parallel Operation

Parallel Running of D. C. Series Motors for Traction Purposes (Das Parallelarbeiten von Gleichstrom-Reihenschlussmaschinen im Bahnbetriebe), Hans Engel. Elektrische Kraftbetriebe und Bahnen, vol. 17, no. 18, June 25, 1919, pp. 137-143, 20 figs. Discussion of problems in trains with direct control, having large number of motors. Systematic investigation of their possible parallel connections.

Rolling-Mill Drives

Motors for Rolling-Mill Table Drives, W. S. Hall. Blast Furnace & Steel Plant, vol. 7, no. 10, Oct. 1919, pp. 505-507, 2 figs. Curves and data obtained from existing installations.

LIGHTING AND LAMP MANUFACTURE

Filament Temperature

Temperatures of Incandescent-lamp Filaments, Benj. E. Shackelford. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, supp. to Sept. 1919, pp. 2265-2269, 6 figs. Relations between temperature, efficiency, lamp size, and life of incandescent lamps, insofar as they effect rating of product and its use by individual consumer.

Flash Lights

Pocket Electric Flash Light Fitted with Mechanical Generator (Lampe électrique de poche à générateur méchanique d'électricité), Industrie Electrique, vol. 28, no. 655, Oct. 10, 1919, pp. 367-369, 3 figs. Armature of magneto is operated by action of lever arranged to be pressed by hand.

Indirect Lighting

Indirect Lighting with Marble Plates (La lumière de marbre), Electricien, vol. 48, no. 1231, Aug. 1, 1914, pp. 65-67, 2 figs. Experiments on transparency of marble plates three to twenty millimeters thick and their use in electric lamps.

Motor-Car Lighting

Powell and Hanmer Electric Lighting Installations. Autocar, vol. 43, no. 1247, Sept. 13, 1919, pp. 423-426, 7 figs. System incorporates mechanical control of dynamo speed, which is said to simplify electrical gear and permit standard practice to be followed.

National Electric Light Association

National Electric Light Association Lighting Exhibit, G. P. Morrison. Gen. Elec. Rev., vol. 22, no. 10, Oct. 1919, pp. 776-782, 13 figs. Exhibit featured recent development in industrial, home, and educational lighting.

A Review of the N. E. L. A. Lamp Committee Report, G. F. Morrison. Gen. Elec. Rev., vol. 22, no. 10, Oct. 1919, pp. 767-775, 8 figs. Statistics and record of progress of incandescent lighting equipment.

Street Lighting

Street Lighting Reconstruction Problems, L. Gaster. Illuminating Engr., vol. 12, no. 8, Aug. 1919, pp. 225-232 and (discussion) pp. 233-236, 5 figs. Remarks based on official data in city of London on street accidents which took place at the time street lighting was diminished during the war.

Street Lighting and Traffic Accidents, Ward Harrison. Elec. Rev. (Chicago), vol. 75, no. 15, Oct. 11, 1919, pp. 605-606, 2 figs. Analysis of year's traffic accidents in Cleveland as to time of day and season shows large percentage due to lack of light. Hence the value of good street lighting is emphasiezd.

Weave-Room Illumination

A Few Examples of Weave-Room Illumination in Textile Mills, Kenneth A. McIntyre. Elec. News, vol. 28, no. 19, Oct. 1, 1919, pp. 43-44, 4 figs. With suggestions in regard to problems of industrial illumination.

MEASUREMENTS AND TESTS

Alternator Tests

Tests of Alternators while Running at Part Load. (Essai à puissance réduite des alternateurs), M. Togna. Revue Générale de l'Electricité, vol. 5, no. 25, June 21, 1919, pp. 875-879, 8 figs. Generalization of uses of flux meter. Sequel to discussion presented by writer in R. G. E., May 31, 1919.

Anemometer

A Hot-wire Anemometer with Thermocouple, T. S. Taylor. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1605-1608, 2 figs. A hot-wire anemometer consisting of small platinum heating wire and having copper-constantan thermocouple attached at its mid point is said to have been found useful in measuring distribution of gas flow across small channels.

Conductivity Measurement

Application of the Thermionic Amplifier to Conductivity Measurements, R. E. Hall and L. H. Adams. Jl. Am. Chem. Soc., vol. 41, no. 10, Oct. 1919, pp. 1515-1525, 4 figs. It is claimed that amplifier used in conjunction with telephone in measurement of resistance on solutions makes much simpler determination of balance position of bridge; electron tube suggested as source of alternating current for conductance measurements because of its cheapness and wide range of frequencies which may be obtained with it.

A Method of Measuring without Electrodes the Conductivity at Various Points along a Glow Discharge and in Flames, Balth. van der Pol. Lond., Edinburgh, and Dublin Phil. Mag., vol. 38, no. 225, Sept. 1919, pp. 352-364, 8 figs. Experiments with body placed near free ends of Lecher wires where potential loop occurs. Mathematical theory of phenomena involved is also presented.

Electrometer-Condenser Operation

Operation of the Variable Condenser in Combination with a Quadrant Electrometer (Condensateur variable modifié pour l'emploi avec l'électromètre à quadrants), Harry Clark. Radium, vol. 11, no. 8, June 1919, pp. 235-236, 3 figs. For the purpose of maintaining equal capacity of apparatus throughout experiment.

Electron Tubes

Measurements on Electron Tubes (Ueber Messungen an Elektronenröhren), H. G. Möller, Archiv für Elektrotechnik, vol. 8, no. 1, July 15, 1919, pp. 46-58 21 figs. Describing experimental arrangement of amplifiers sender and audion tubes, as well as measurements made; points which have to be considered in order to avoid errors.

Fault Localization

Some Notes on Fault Localisation, G. W Stubbings. Elec. Rev. (London), vol. 85, no. 2185, Oct. 10, 1919, pp. 452-454. Bridge tests for fault localization on underground cables are believed to have advantage that they are not susceptible to inaccuracies through variation of resistance of fault.

Galvanometers

The Six-String Einthoven Galvanometer, Engineering, vol. 108, no. 2799, Aug 22, 1919, p. 255, 4 figs. Six wires replace coil of moving coil galvanometer. They are stretched in narrow air gap between poles of powerful electromagnet. When a current passes up or down them they are deflected in direction of right angles to magnetic field. Movement is observed with aid of microscope which passes through pole pieces.

Potentiometer

A Rectangular-Component Two-Dimensional Alternating-Current Potentiometer, A. E. Kennelly and Edy Velander. Mass. Inst. Technology, Elec. Eng. Dept., Research Division, no. 18, July 1919. 26 pp., 20 figs. Form developed by Alfred E. Hanson, said to be particularly adapted to telephonic frequency measurements.

New Blondel-Touly Potentiometer Amplifying Devices (Sur de nouveaux dispositifs amplificateurs potentiometriques de Blondel et Touly), A. Blondel. Revue Générale de l'Electricité, vol. 6, no. 14, Oct. 4, 1919, pp. 427-441, 10 figs. Combining two audions connected in cascade and three batteries. Armstrong principle of regeneration is utilized.

Wave, Alternating Measurements

The Measurement of Alternating Waves with the Braum Tube, E. Lübke. Elecn., vol. 83, no. 2156, Sept. 12, 1919, pp. 270-272, 9 figs. Describes inertialess contact maker consisting of ionization of a gas by means of cathode rays, for purpose of delineating oscillatory curves by Joubert method. Arrangement of special double Braun tube, using glowing cathode and steady voltage of 220, said to lend itself to measurement of high-frequency fields on account of very small current requirements. From Archiv fur Elektrotechnik.

MATERIALS OF CONSTRUCTION

Commutators

The Making of Commutators, W. F. Sutherland, Power House, vol. 12, no. 14, Sept. 5, 1919, pp. 387-389, 8 figs. Materials of construction and mechanical details. First article.

Insulators

Deterioration of High-Tension Insulators (Zerstorungserscheinungen an Hochspannungsisolatoren), E. O. Meyer. Elektrotechnische Zeitschrift, vol. 40, nos. 16, 18 and 24, Apr. 17, May 1 and June 12, 1919, pp. 173-176, 198-200 and 278-282, 31 figs. Effect of thermic influences on insulating material.

POWER APPLICATION

Blast-Furnace Plants

Electrical Practice in the Equipment of Blast-Furnace Plant, J. Percy Hodges. Elecn., vol. 83, no. 2158, Sept. 26, 1919, pp. 333-338, 9 figs. Including uses of capstans, transfer and telpher cars, hoists and overhead travelling cranes equipped with electro-magnets for clearing pig beds.

Docks

Electrical Control of the Sluices and Lock Gates of the Floating Dock at Boulogne (La commande électrique des vannes et des portes de l'écluse à cas du bassin à flot du port de Boulogne), A. Foillard. Génie Civil, vol. 75, no. 15, Oct. 11, 1919, pp. 348-361, 9 figs. Schematic arrangement and details of winches.

Domestic Uses

Notes on the Application of Electricity to Domestic Services, J. H. Dobson, H. A. Tinson and R. H. Gould. Trans. South African Inst. Elec. Engrs., vol. 10, no. 8, Aug. 1919, pp. 114-120 and (discussion) pp. 120-123. Tests on economical value of application of electricity to domestic uses, carried out at laboratory of Johannesburg Elec. Supply Dept.

Drives, Electric

Outline Status of Electric Drive, Wilfred Sykes. Iron Trade Rev., vol. 65, no. 18, Oct. 30, 1919, pp. 1184-1185, 1 fig. It is noted that development of electrically-driven reversing rolling mills has been rapid and that reversing motor has been used economically on all types of mills. Paper read before Am. Iron & Steel Inst.

Magnets, Lifting

Developments in Lifting Magnet Practice, F. N. Pickett. Elecn., vol. 83, no. 2158, Sept. 26, 1919, pp. 349-352, 7 figs. Illustrating uses and various applications including handling of pig-iron steel rails and plates.

Mill Auxiliaries

The Electric Control of Steel-Mill Auxiliaries, C. Howard. Elecn., vol. 83, no. 2158, Sept. 26, 1919, pp. 339-348, 15 figs. Automatic control as against hand control is considered particularly advantageous in steel works; with regard to types of control writer gives details of four classes.

Mills, Reversing

The Future of the Electrical Equipment of Small Reversing Mills, L. Rothera. Elecn., vol. 83, no. 2158, Sept. 26, 1919, pp. 368-369, 3 figs. It appears to writer that at present capabilities and advantages of small reversing mill plant have not been fully grasped by manufacturers, but he anticipates that, with increasing necessity for large output and reduction in operating cost, future will see wide extension of electrical reversing drive for small mills.

Rolling Mills

The Electrical Driving of Rolling Mills, A. P. Pyne. Elecn., vol. 83, no 2158, Sept. 26, 1919, pp. 324-332, 18 figs. Most suitable type of motor to fulfill given requirements is considered; also conditions under which rope or gear drives should be adopted.

See also Mills, Reversing.

Tools, Portable

Portable Electric Tools, E. Preston. Eng. & Indus. Management, vol. 2, no. 16, Oct. 16, 1919, pp. 486-487, 2 figs. Development in Great Britain during the war, notably in electric drills and hammers for riveting.

STANDARDS

Voltage Standardization

Voltage Standardization in Switzerland—V (Zur Frage der Vereinheitlichung der Betriebsspannungen in der Schweiz). Bul. Assn. Suisse des Electriciens, vol. 10, no. 8, Aug. 1919, pp. 215-232. Advantages and difficulties of introducing higher voltage as standard; its relation to cost of manufacture of incandescent lamps and motors, cable lines and installations for domestic purposes.

TELEGRAPHY AND TELEPHONY

Amplifiers

High-Vacuum Amplifiers—I and II (Ueber Hochvakuumverstärker), W. Schottky. Archiv der Elektrotechnik, vol. 8, no. 1, July 15, 1919, pp. 1-31, 10 figs. Constructional details.

Application of Amplifiers to the Mechanical Inscription of Wireless Signals (Application des amplificateurs à l'inscription mécanique des signaux de télégraphie sans fil), Henri Abraham and Eugène Bloch. Revue Générale de l'Electricité, vol. 6, no. 11, Sept. 13, 1919, pp. 323-324. Describing method of inscribing wireless signals by aid of amplifiers without employing mechanical relay.

See also Vacuum Tubes.

Antennæ

Radiation of the Antenna (Die Strahlung von Antennen-systemen). Max Abraham. Jahrbuch der drahtlosen Telegraphie und Telephonie, vol. 14, no. 2, July 1919, pp. 146-152. Points to theory of electromagnetic field as basis of wireless telegraphy since it determines radiation and thereby efficiency of system.

Airplane Antenna Constants, J. M. Cork. Dept. Commerce, Sci. Papers of Bur. of Standards, vol. 15, no. 341, Sept. 14, 1919, pp. 199-213, 12 figs. Measurements of effective capacity, effective resistance, true capacity, true inductance, and wave length, and study of directional effect of various types of airplane antennæ.

Cables, Telephone

Engineering Problems Involved in the Use of Telephone Cables. Jl. Eng. Inst. Can., vol. 11, no. 10, Oct. 1919, pp. 669-671. Concerning mechanical details of construction required by reason of electric phenomena taking place between wire in cable.

Cathode-Ray Tube

Applications of the Cathode-Ray Tube in Radio Work, L. E. Whittemore and L. M. Hull. Phys. Rev., vol. 14, no. 3, Sept. 1919, pp. 266-267, 1 fig. Tube using platinum filament coated with mixture of calcium and barium oxides said to have proven successful in work undertaken by Bureau of Standards.

Direction Finder

An Electrostatic Direction Finder, E. Bellini. Elecn., vol. 83, no. 2156, Sept. 12, 1919, pp. 273-275, 13 figs. Describing new radiogoniometer utilizing electrostatic coupling between aerials and apparatus for detecting or generating oscillations.

Eilvese Radio Station

Radio Station at Eilvese (Hanover), (Radio-Grosstation Eilvese, Hanover), Aage S. M. Sörensen. Elektrotechnische Zeitschrift, vol. 40, no. 21, May 22, 1919, pp. 233-234, 4 figs. Detailed description of high frequency apparatus, antenna, operation and efficiency of Eilvese station.

Interference

Influence of Railroad Electrification on Telephone Lines, Fred W. Scholz. Telephone Engr., vol. 22, no. 4, Oct. 1919, pp. 37-40, 3 figs. Technical study of electric field in interior of telephone cable as affected by an electric traction line. Translated from Annales des Telegraphes et Telephones.

Multiple Telephony and Telegraphy

Multiple Telephony and Telegraphy by Means of High-Speed Alternating Currents (Mehrfach-Telephonie und Telegraphie mit schnellen Wechselströmen), Karl Willy Wagner. Telegraphen-und Fernsprech-Technik, vol. 8, no. 3, June 1919, pp. 29-35, 11 figs. Historical account; damping of high-speed a. c. in overhead lines and cables; experiments with multiple telephony; future of new method.

Receiver Circuits

On the Theory of Radiotelegraphic and Radiotelephonic Receiver Circuits, J. F. J. Bethenod. Proc. Inst. Radio Engrs., vol. 7, no. 5, Oct. 1919, pp. 517-525, 3 figs. Proceeding

from theory of approximate rectifying detector, most advantageous proportioning of constants of secondary circuits of receiver is obtained. Constants of most desirable telephone winding and value of most suitable telephone shunting condenser are then derived.

Receivers, Air

The Uni-Control Receiver, Roy E. Thompson. Proc. Inst. Radio Engrs., vol. 7, no. 5, Oct. 1919, pp. 499-511 and (discussion) pp. 515-516. Design and construction of air receiver operating efficiently and selectively over a long range of wave lengths of antenna of ordinary dimensions, and controlled by single handle, are described, and possibilities of such a receiver for solution of interference problems are discussed. Addition of motor for driving wave changing adjustment continuously is shown.

Telegraphy, Wireless

Wireless in the A. E. F., L. R. Krumm and Willis H. Taylor. Wireless Age, vol. 7, no. 1, Oct. 1919, pp. 9-21, 26 figs. Account of organization of radio division of signal corps with remarks on obstacles which Americans had to overcome.

Telephone, Hot-Wire

The Hot-Wire Telephone. Telephone Eng., vol. 22, no. 4, Oct. 1919, pp. 35-36, 1 fig. Form used for range finding in war.

Telephones, Los Angeles

Los Angeles Manual-Automatic Unification, D. E. Wiseman. Telephone Engr., vol. 22, no. 4, Oct. 1919, pp. 19-24, 10 figs. Plans for physical consolidation of Bell manual and automatic electric telephone systems which previously to June 1, 1918, operated as separate systems. Under new system each subscriber has access to every other subscriber and to all long-distance lines center in district. Paper presented at Section Meeting of A. I. E. E. at San Francisco.

Telephony, Radio

Radio Telephony, E. H. Colpitts. Jl. Soc. Automotive Engrs., vol. 5, no. 3, Sept. 1919, pp. 212-218, 11 figs. Historical review of experimental work and description of apparatus available at present.

Thermionic Valve

See Electrophysics.

Trigger Relay

A Trigger Relay Utilising Three-Electrode Thermionic Vacuum Tubes, W. H. Eccles and F. W. Jordan. Elecn., vol. 83, no. 2157, Sept. 19, 1919, p. 298, 2 figs. Describing what may be called a one-stroke relay which, when operated by a small triggering electrical impulse, undergoes great changes in regard to its electrical equilibrium and then remains in the new condition until re-set. Paper read before British Association.

Tube Transmitters

Tube Transmitter (Ueber Rohrensender), A. Meissner. Jahrbuch der drahtlosen Telegraphie und Telephonie, vol. 14, no. 1, May 1919, pp. 5-26, 22 figs. Experiments said to have shown that efficiency increases as grid voltage decreases; however, at the same time the power too is somewhat reduced.

Vacuum Tubes

Vacuum Tubes as Amplifiers and Vibration Producers (Vakuumrohren als Verstarker und Schwingungserzeuger), K. Mühlbrett. Archiv der Elektrotechnik, vol. 8, no. 1, July 15, 1919, pp. 32-42, 8 figs. Experimental investigation of tubes.

High-Vacuum Tube with One Electrode (Die Hochvakuum-Eingitterrohre), H. Rukop. Jahrbuch der drahtlosen Telegraphie und Telephonie, vol. 14, no. 2, July 1919, pp. 110-146, 15 figs. Constants of one-electrode tube; the tube as amplifier; the tube as vibration producer; inner resistance of tube, relations between efficiency and inner and outer resistance.

See also Amplifiers.

Vacuum-Tube Circuit

Some Modern Vacuum-Tube Circuits and Their Operation, J. Scott-Taggart. Wireless Age, vol. 7, no. 1, Oct. 1919, pp. 25-27, 4 figs. "Stand-by" and "tuned" continuous-wave receiver, and continuous-wave transmitter.

TRANSFORMERS, CONVERTERS, FREQUENCY CHANGERS

Fires in Transformers

Fires in Oil Transformers (Oel-Transformatorenbrande), Willibald Fuhrmann. Elektrotechnischer Anzeiger, vol. 36, no. 71, July 13, 1919, pp. 329-330. To prevent such fires writer recommends contact thermometer, to be connected with maximum automat in the case of unguarded stations; also fuses of metals having low melting point such as tin, lead or bismuth.

Heating of Transformers

The Heating Problem in Dry Transformers (Das Erwarmungsproblem des Trockentransformators), Milan Vidmar. Elektrotecanische Zeitschrift, vol. 40, no. 15, Apr. 10, 1919, pp. 164-167, 5 figs. Discussing inner and outer heat currents, surface heat of coils. Comparison of vertical and horizontal column transformers.

Rectifiers, Mercury-Vapor Arc

Shape of Curve of Current and Tension in Mercury Vapor Arc Rectifiers for Single-Phase Alternating Current (Ueber die Kurvenform des Stromes und der Spannungen an Quecksilberdampf-Gleichrichtern für Einphasen-Wechselstrom), Hans Nielsen. Elektrotechnische Zeitschrift, vol. 40, no. 20, May 15, 1919, pp. 224-227, 3 figs. Special formulæ for rectifiers without a. c. choking coil. Method is shown for simplified calculation of approximate size of a. c. choking coil.

Tank for Static Transformers

A New Form of Tank for Static Transformers, W. S. Moody. Gen. Elec. Rev., vol. 22, no. 10, Oct. 1919, pp. 756-759, 9 figs. Also in Elec. Rev., vol. 75, no. 16, Oct. 18, 1919, pp. 651-653, 7 figs. How conservator type reduces to minimum possibility of moisture entering, removes any combustible gases as soon as formed, and prevents hot oil from coming into contact with air.

Transformers, Limiting Sizes

Large Power Transformers, A. G. Ellis and J. L. Thompson. Elecn., vol. 83, nos. 2156 and 2157, Sept. 12 and 19, 1919, pp. 276-278 and 296-298, 6 figs. Limiting sizes of transformers as effected by handling and cooling are discussed, and prices per kilovolt-ampere in relation to output, voltage and cooling are presented. Conditions affecting choice of types and relative advantages of shell and core transformers are dealt with. (To be concluded.)

Transformer, Special

Special Transformer Delivers Arc Voltage, C. J. Holslag. Blast Furnace & Steel Plant, vol. 7, no. 10, Oct. 1919, pp. 487-488, 4 figs. Electric Arc Cutting Welding Company portable machine weighing 260 lb. Voltage increase accompanied by corresponding ampere decrease keep heat automatically constant.

TRANSMISSION, DISTRIBUTION, CONTROL

Benzinoform in High Tension Switches

Benzinoform in High-Tension Oil-Break Switches, M. Vogelsang. Sci. Am. Supp., vol. 88, no. 2282, Sept. 27, 1919, pp. 194-195. Some recently revealed German experiences with substitute materials. From Elektrotechnische Zeitschrift.

Cable-Fault Location

New Method for Locating Cable Faults (Ein neues Verfahren zum Auffinden von Kabelfehlern), Erwin Wurmbach. Elektrotechnische Zeitschrift, vol. 40, no. 19, May 8, 1919, pp. 211-212, 2 figs. Method consists in observing direction of a d. c. artificially sent through a cable armature by means of very sensitive instrument located at opposite ends of place where trouble occurs.

Conductor Supports

Generating and Sub-Station Conductor Supports, J. P. Collopy. Power Plant Eng., vol. 23, no. 19, Oct. 1, 1919, pp. 868-869, 5 figs. Types and methods utilized to insure safety and continuity of service.

High-Tension Networks

High Tension Alternating Current Underground and Over Head Network (Canalisations souterraines et aériennes à haute tension à courant alternatif), W. Kummer. Revue Générale de l'Electricité, vol. 6, no. 13, Sept. 27, 1919, pp. 115-117, 2 figs. Curves showing diameter of conductor in terms of tension by reference to lead shell; also characteristic curves of underground cable of 100 mm. total diameter having only one conductor of 36 mm. diameter. From Schweizerische Bauzeitung.

Overload Control

Preventing Overloads on Steel-Mill Motors, P. M. Lincoln. Blast Furnace & Steel Plant, vol. 7, no. 10, Oct. 1919, pp. 496-497, 3 figs. Description of ammeter depending on temperature for its indications and having the same mass-ventilation ratio as mill motor to be protected against overload. Paper read before Assn. of Iron & Steel Elec. Engrs.

Electric-Machinery Control. Engineering, vol. 108, no. 2800, Aug. 29, 1919, pp. 274-276, 3 figs. Types built by Igranic Elec. Co., Lond., notably magnetic lock-out "clapper" switch, chief feature of which is that two independent magnetic circuit coils are provided, a central big coil for operating switch and a lower boxed in coil for effecting lock-out.

Overload Protection

Influence of Characteristics of Overload Release on the Overload Protection of entire Systems (Ueber den Einfluss der Charakteristik von Ueberstromauslosern auf den Ueberstromschutz ganzer Netze), Georg Gorman. Elektrotechnische Zeitschrift, vol. 40, no. 25, June 19, 1919, pp. 297-299, 12 figs. Detailed discussion of characteristics and possible characteristics of overload releases. Deductions are made for the interconnection of several systems.

Poles

Method of Calculating the Class and Number of Poles required for Telegraph and Telephone Lines, Stanley Rhoads. Telegraph & Telephone Age, vol. 37, no. 19, Oct. 1, 1919, pp. 478-483. Method of calculating applies to straight away ("tangent") pole lines. Corners and terminals are special cases. Storm guys are assumed to strengthen and stiffen only pole to which attached and are designed to prevent swaying of line; line is designed with desired factor of safety without them.

Reinforced Concrete Bases for Poles. Telephone Engr., vol. 22, no. 4, Oct. 1919, pp. 13-14, 4 figs. Structure comprises ordinary wood on pole or shaft concrete base and iron socket for union between base and shaft.

Substations

Outdoor Substations in Connection with Coal-mining Installations, H. W. Young. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1883-1894, 9 figs. Instances illustrating recent developments in design.

Outdoor Substations in Connection with Coal-Mining Installations, H. W. Young. Elec. Rev. (Chicago), vol. 75, no. 15, Oct. 11, 1919, pp. 595-598, 6 figs. General requirements and station design, with notes on high-tension current control.

Transmission Line Calculation

Practical Calculations of Electric Transmission Lines (Calcul pratique des lignes de transmission de l'énergie électrique), Revue Générale de l'Electricité, vol. 6, no. 13, Sept. 27, 1919, pp. 395-400, 1 figs. Formulæ for selection of most economical tension. Third article. Preceding articles appeared in R. G. E., Apr. 7 and Nov. 10, 1917.

Transmission Line Capacity

Methods of Increasing Capacity of Existing Tranmission Lines, E. C. Stone. Elec. Rev. (Chicago), vol. 75, no. 14, Oct. 4, 1919, pp. 562-566, 5 figs. Discussing line limitations and determination of relative costs of increasing capacity. Paper read before Pennsylvania Assn.

Transmission Line, High Tension

High-Tension Lines- II (Hochspannungsleitungen), W. Petersen. Elektrotechnische Zeitschrift, vol. 40, no. 14, Apr. 3, 1919, pp. 152-156, 13 figs. Comparison of various types; influence of temperature; excess voltage and influence of temperature; excess voltage and grounding. (Concluded.)

VARIA

Electromagnet, Plunger

On the Preliminary Calculation of the Characteristics of an A. C. Plunger Electromagnet, N. Hanada (in Japanese). Denki Gakkwai Zasshi, no. 374, Sept. 10, 1919.

See also Solenoids.

Japan

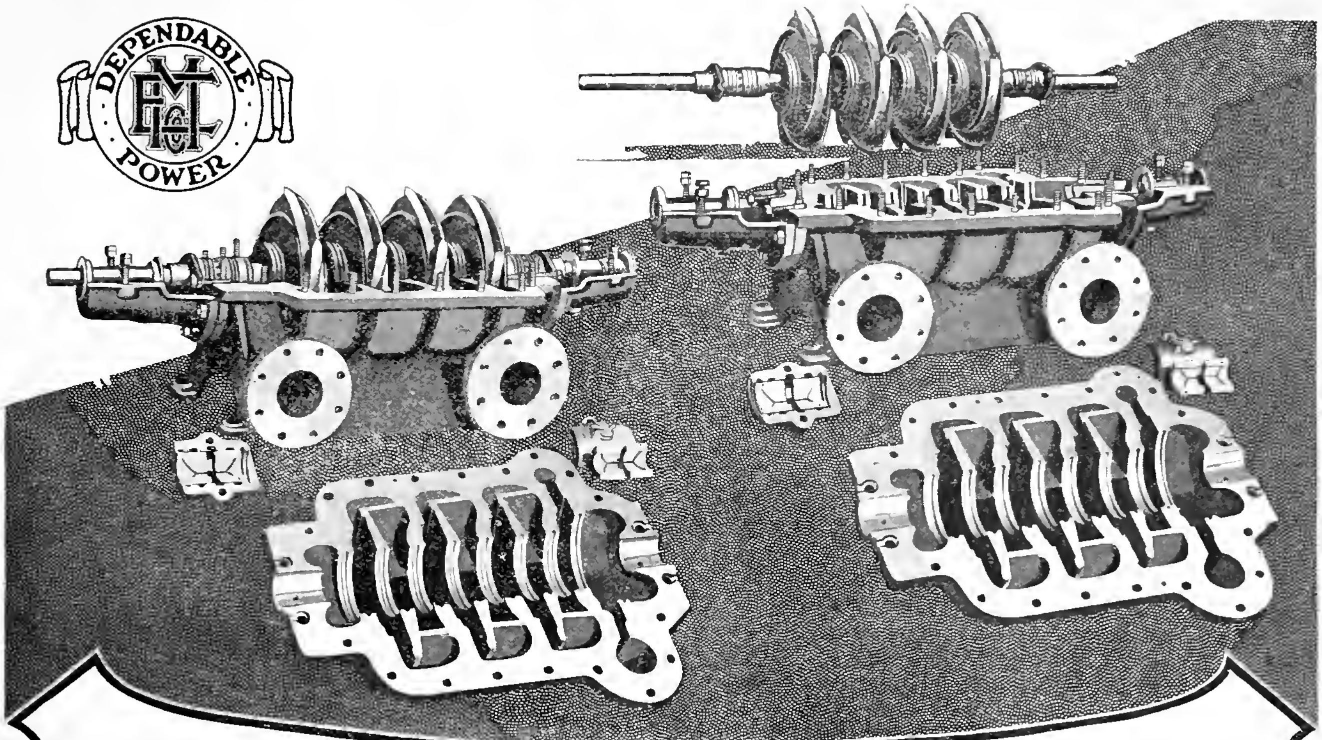
Statistical Report of Electric Undertakings in Japan. Direction General of Electric Exploitations, Dept. of Communications, Tokyo, Japan, June 1919, 20 pp. Summary of statistics showing conditions of existing electric undertakings in Japan at end of 1917, except in Formosa, Corea, Saghalin and Kwantung.

Shock, Electric

How to treat Persons suffering from Electric Shock (Secours aux personnes frappées par le courant électrique). Electricien, vol. 48, no. 1231, Aug. 1, 1919, pp. 73-75, 2 figs. Apparatus for producing artificial respiration.

Solenoids

On the Solenoid with Rectangular Cross Section, Y. Niva (in Japanese). Denki Gakkwai Zasshi, no. 374, Sept. 10, 1919.



MIDWEST
Dependable Power

Absolutely interchangeable parts are an assured feature of the Midwest boiler-feed pumps shown here. This is made possible by the skillful workmanship and the extreme accuracy of construction.

Rotating elements are readily accessible, and the entire pump is exceedingly simple, rugged and dependable.

The particular equipment illustrated is the 4-inch, 4 stage, horizontally split pump of the diffuser type. It operates under the following conditions:

350	G.P.M.	63% Efi.
1700	R.P.M.	180 lbs. Boiler Pressure

There is a Midwest Boiler-Feed pump to fit every operating condition, driven either by motor or by Midwest-Wait type steam turbines.

For detailed information see the Midwest representative in your nearest large city.

Midwest Engine Company Products

Midwest—Utilitor
Midwest—Truck Engines
Midwest—Tractor Engines
Midwest—Diesel Engines
Midwest—Hvid Engines
Midwest—Parsons Turbines (*Reaction Type*)
Midwest—Wait Turbines (*Impulse Type*)
Midwest—Centrifugal, Reciprocating and Deep Well Pumps and Auxiliaries
Werkspoor Diesel—American Licensees

New York
111 Broadway

New Orleans
617 Maison-Blanche Building

El Paso, Texas
303 Caples Building

Jacksonville, Florida
231 East Bay Street

Representatives in all principal cities.

MIDWEST
ENGINE COMPANY
INDIANAPOLIS, U. S. A.

Civil Engineering

BRIDGES

Bear River Bridge

The Construction of the Bear River Bridge. Jl. Eng. Inst. Can., vol. 11, no. 10, Oct. 1919, pp. 658-662, 5 figs. It consists of thirteen spans, varying in length from 50 ft. to 156 ft., carried on concrete piers resting on pile foundations with exception of 3 piers which rest on bed of coarse gravel and boulders.

Headgates with Bridge

Headgates Combined with Bridge over Aqueduct Canal. Eng. News-Rec., vol. 83, no. 13, Sept. 25, 1919, pp. 610-611, 5 figs. Heavy reinforced-concrete structure in three spans with stoney gates closing waterways 57 ft. wide and 17 ft. high.

Load Concentration, Wood-Floor Bridge

Load Concentrations on Steel Floor-Joists of Wood Floor Highway Bridges. Eng. & Contracting, vol. 52, no. 17, Oct. 22, 1919, pp. 466-467, 5 figs. Results of investigation made by Iowa State College of Agriculture and Mechanic Arts to determine manner in which heavy wheel loads such as those of traction engines are distributed to the various I-beams and channel joists in a highway bridge floor system consisting of I-beams and channel joists and wood planking.

Pontoons

Concrete Pontoons in the Panama Canal Zone. Shipbuilding & Shipping Rec., vol. 14, no. 13, Sept. 25, 1919, pp. 347-348, 5 figs. General arrangement and particulars of four reinforced concrete pontoons for supporting gangways at Balboa.

Spans, Best Number

Economic Comparison of Engineering Projects—I, George Higgins. Commonwealth Engr., vol. 6, no. 11, June 1, 1919, pp. 344-346, 3 figs. Illustrated in problem of determining best number of spans for a viaduct of given length and height, assuming financial conditions to be the only ones that influence decision.

BUILDING AND CONSTRUCTION

Churches

St. Augustine's Church. Contract Rec., vol. 33, no. 43, Oct. 22, 1919, pp. 982-983, 1 fig. Foundations are to be of concrete and exterior of rubble course stone backed with 8-in. brick and 4-in. terra cotta with Montreal limestone trimmings.

Cost-Plus-Fee Contract

Building Construction Under the Cost-Plus-Fixed-Fee Contract, A. E. Wells. Heat. & Vent. Mag., vol. 16, no. 10, Oct. 1919, pp. 27-29. Coöperation among owner, architect and builder said to be insured by this form of building contract.

Gypsum Plant

Planning Construction of Gypsum Plants, Curtis F. Columbia. Cement, Mill & Quarry, vol. 15, no. 6, Sept. 20, 1919, pp. 21-24, 5 figs. Brief discussion of various types of buildings which comprise usual large gypsum plant, including power plant, water supply, fireproofing and heating and ventilation.

Machinery in Buildings

Critical Speeds of Machinery Placed on Upper Floors of Buildings, as related to Vibration, A. B. Eason. Lond., Edinburgh and Dublin Phil. Mag., vol. 38, no. 225, Sept. 1919, pp. 395-402, 4 figs. Analytical discussion of system consisting of motor resting upon elastic supports upon floor capable of deflection.

Pile Renewal in Trestles

Renewing Piles in Timber Trestles, Geo. W. Rear. Ry. Maintenance Engr., vol. 15, no. 10, Oct. 1919, pp. 340-341, 1 fig. Discussing diversity in character of equipment, organization of crews and methods of doing work.

Roofing

Proper Methods of Applying Roofing on a Gypsum Roof Deck, Curtis F. Columbia. Eng. & Contracting, vol. 52, no. 17, Oct. 22, 1919, pp. 457-459, 7 figs. Comparative advantages of "poured roof" and "precast tile."

CEMENT AND CONCRETE

Adherence of Concrete to Steel

Research on Adherence of Concrete to Steel in Reinforced Concrete Structure (Recherches sur l'adhérence du béton aux armatures dans les constructions en béton armé), M. Mercier. Annales des Ponts et Chaussées, vol. 50, no. 3, May and June 1919, pp. 370-374, 2 figs. It is concluded that adherence is due to special property of cement. Concrete used was made of 300 kg. of portland cement, 400 l. of sand and 800 l. of gravel. After ninety days it showed adherence of 6.5 kg. per sq. cm.

Beams

Concrete Arched Beams and Open Girder Carry Roof of Toronto Theatre. Contract Rec., vol. 33, no. 42, Oct. 15, 1919, pp. 953-954, 4 figs. Roof and balcony are built in reinforced concrete on Hennebique system.

Burnt Earth Concrete

Burnt Earth Concrete with Iron and Wood Reinforcement, L. P. Hodge. Engineering, vol. 108, no. 2801, Sept. 5, 1919, pp. 302-304, 10 figs. Tests of burnt earth concrete beams lead to conclusion that well burnt earth can be substituted for stone in concrete with safety and advantage when cost of stone is prohibitive.

Cold-Weather Concreting

Concreting in Cold Weather Offers Strong Advantages to Owners, A. E. Wells. Can. Engr., vol. 37, no. 17, Oct. 23, 1919, pp. 411-412. Outline of plant layout for winter.

Concrete Roofing Tile

Manufacture of Large Concrete Roofing Tile. Concrete, vol. 15, no. 4, Oct. 1919, pp. 157-159, 9 figs. Method of manufacturing slabs for roof purposes, pitched interlocking tile, flat slabs and channel slab.

Concrete Storage

Warehouse for Concrete and Lime Storage. Concrete, vol. 15, no. 4, Oct. 1919, pp. 154-156, 5 figs. Plan and construction details of structure built for Superior Sand & Gravel Co., Detroit.

Electrolysis

Electrolysis in Concrete, E. B. Rosa, Burton McCollum and O. S. Peters. Tech Papers Bur. Stand., no. 18, Aug. 1, 1919, 141 pp., 31 figs. Laboratory and field investigations relating to nature and cause of phenomena produced by passage of electric currents through concrete, undertaken with view to establish probable extent of danger in practice and circumstances under which trouble is most likely to occur. Specific recommendations are offered in regard to mitigating trouble from this source.

Graphic Tables

Graphic Table for Dimensioning of Reinforced Concrete Slabs for n=20 (Graphische Tabelle zur Dimensionierung einfach armierter Eisenbeton-Platten für n=20), R. Forter. Schweizerische Bauzeitung, vol. 74, no. 9, Aug. 30, 1919, pp. 105-107, 1 fig. Table devised for dimensioning or testing reinforced concrete slabs, eliminating all formulæ.

Gunite

Guniting Piling, Harry B. Sewall. Stone & Webster Jl., vol. 25, no. 4, Oct. 1919, pp. 292-294, 14 figs. on 7 supp. plates. Illustrating work of guniting piling of water front trestle on Bellingham Division of Puget Sound Traction, Light and Power Co.

Naval Construction

Properties of Reinforced Concrete Used in Naval Constructions (Les propriétés du béton armé employé dans les constructions navales), M. Poncet. Génie Civil, vol. 75, no. 1936, Sept. 20, 1919, pp. 266-271, 15 figs. Experiments to determine imperviousness to water and petroleum of concrete, both alone and after being painted with various preparations.

Permeability

Permeability of Concrete, S. Bowman. Jl. Soc. Chem. Indus., vol. 38, no. 17, Sept. 15, 1919, pp. 325R-327R, 1 fig. Method of investigating (1) comparative merits of various waterproofing agents, (2) effect of such compounds on chemical and physical properties of Portland cement and reinforced concrete, and (3) economic aspect of use of such compounds.

Scottish Mode for Measuring Concrete

The Scottish Mode for Measuring Concrete. Contract Rec., vol. 33, no. 42, Oct. 15, 1919, pp. 962-965. Rules applying to taking off of quantities. Established as part of National Building Code of Scotland.

Slag Aggregates

Slag Aggregates in Concrete and Mortar, Emmanuel Mavaut. Iron & Steel of Can., vol. 11, no. 9, Oct. 1919, pp. 232-235, 5 figs. Report of comparative tests of basic steel, slag, limestone and banc rouge used as coarse aggregates in concrete, also basic steel slag screenings, commercial and standard sands used as fine aggregates.

Wood Reinforcement for Concrete

Wood as Reinforcement for Concrete. Eng. & Contracting, vol. 52, no. 18, Oct. 29, 1919, p. 505, 2 figs. Table showing relative strength of beams of wood, wood concrete and reinforced concrete. (From Beton und Eisen.)

EARTHWORK, ROCK EXCAVATION, ETC.

Concrete Block Tunnel

Concrete Block Tunnel at River Rouge, Michigan. Bulletin of Genrl. Contractors Assn., vol. 10, no. 8, Aug. 1919, pp. 148-149, 2 figs. O'Rourke interlocking concrete blocks, 18 in. in thickness, used.

Hydraulic Fill Dams

Methods of Constructing Hydraulic Fill Dams of Miami Conservancy District. Eng. & Contracting, vol. 52, no. 16, Oct. 15, 1919, pp. 432-435, 6 figs. Noting specially stream control and features of retarding basin dams. Paper read before New England Waterworks Assn.

Pipe Lines, Underground

A New Method of Installing Underground Pipe Lines, John C. White. Wisconsin Engr., vol. 24, no. 1, Oct. 1919, pp. 12-15, 5 figs. Worked out by Dept. of Eng. of State of Wisconsin.

Safety Measures

Safety Measures in Excavating Operations. Contract Rec., vol. 33, no. 40, Oct. 1, 1919, pp. 927-928. Precautionary steps for prevention of accidents in excavation work and proper methods of handling equipment.

Tunnels

Some Tunnels in India. Ry. Engr., vol. 40, no. 477, Oct. 1919, pp. 212-216, 10 figs. Constructional details of tunnel 5704 ft. long. (Continuation of serial.)

HARBORS

Turning Basin

Turning Basin and Ship Channel in Toronto's New Industrial Area. Contract Rec., vol. 33, no. 43, Oct. 22, 1919, pp. 975-978, 5 figs. Improvements to Toronto Harbor include provision of a water frontage for industrial sites. Walls of basin and channel were built of concrete on piles, site having been exposed by sand-fill cofferdam.

RECLAMATION AND IRRIGATION

Drainage, Electric

Electric Drainage in Holland (Electrische Bemalingsinrichting voor het Boezemwaterschap Electra), Ingenieur, vol. 34, no. 31, Aug. 2, 1919, pp. 570-571. How district is drained by three stork screw-propeller pumps each having capacity of 209,000 gal. per min. Pumps are driven by 2000-volt three-phase 550-hp. motors.

Irrigation, Cost

Cost of Engineering Work for Maintenance and Operation of large Irrigation Project, H. M. Chadwick. Eng. & Contracting, vol. 52, no. 15, Oct. 8, 1919, pp. 418-419, 2 figs. Engineering order system evolved, operating Valier project, which permitted each job to be covered by an engineering order showing number, canal, reservoir, structure or land involved, class of work and information regarding necessity of survey.

South Africa

Union Irrigation Works and Projects—IV. South African Jl. Industries, vol. 2, no. 7, July 1919, pp. 663-672, 1 fig. Unper Modder River Conservation Scheme; details of catchment area, dam and reservoir site; geological description of site. (Concluded.)

ROADS AND PAVEMENTS

Aggregate Field Testing

Testing Aggregates in the Field, F. H. Jackson. Public Roads, U. S. Dept. Agriculture, Bur. Public Roads, vol. 2, no. 15, July 1919, pp. 11-13. Outfit developed by Bur. of Public Roads, for making field analysis of aggregates, together with suggested methods for its use.

Asphalt Macadam Pavements

Recommended Procedure in the Design, Construction and Maintenance of Asphalt Macadam Pavements, Prevost Hubbard. Mun. & County Eng., vol. 57, no. 4, Oct. 1919, pp. 152-156. Calls emphasis especially to importance of attending to details, that is, following rule of constructing "asphalt macadam by square yard and not by the mile."

Bitoslag Pavements

Characteristics of Bitoslag Pavement, J. R. Draney. Mun. & County Eng., vol. 57, no. 4, Oct. 1919, pp. 156-157. Bitoslag is pavement composed of specially prepared asphalt and finely crushed slag combined with filler and mixed in regular asphalt paving plants. It is laid to depth of not less than 2 in. in thickness after compression.

Brick Pavements

Resurfacing Old Brick Pavement. Mun. Jl. & Public Works, vol. 47, no. 13, Sept. 27, 1919, pp. 196-198, 3 figs. Method of preparing old pavement for new surface; handling traffic during construction.

Contract Awards

Should Contracts for grading upon extensive Highway Improvements be awarded separately? Eng. & Contracting, vol. 52, no. 14, Oct. 1, 1919, pp. 389-390.

Curvature, Continuous in Roads

Design of Roads with Continuous Curvature (Tracés de routes à courbure continue), Ch. Galatoire-Malegarie. Annales des Ponts et Chaussées, vol. 50, no. 3, May and June 1919, pp. 332-362, 13 figs. By continuous curvature is meant smoothed-out curve when radii of components are less than 30 m. How to do this by Bernoulli's lemniscate is shown in article.

Foundations

The Construction of Portland Cement Concrete Pavement Foundations, James W. Routh. Mun. & County Eng., vol. 57, no. 4, Oct. 1919, pp. 169-171, 6 figs. Illustrating methods of carrying out the various operations.

Granite-Block Pavements

How to Secure Best Results in Construction of Improved Granite Block Pavements. Eng. & Contracting, vol. 52, no. 14, Oct. 1, 1919, pp. 382-385. Standard sizes of blocks, laying of blocks, concrete base, sand or mortar cushion, ramming and grouting are among features discussed.

Road Impact Test

First Reports on Road Impact, E. B. Smith. Power Wagon, vol. 23, no. 179, Oct. 1919, pp. 27-29, 3 figs. Studies to determine destructive effect of heavily loaded motor trucks on highways and streets undertaken by Bureau of Public Roads at Arlington experimental farm.

See also MECHANICAL ENGINEERING, Motor-Car Engineering, Impact of Trucks and Roads

Water Pockets in Roadbed

Means for Prevention or Cure of Water Pockets in Roadbed. Bul. Am. Ry. Eng. Assn., vol. 21, no. 217, July 1919, pp 9-10. Recommendations proposed by Committee of Am. Ry. Eng. Assn.

SANITARY ENGINEERING

Refuse Collection

Street Cleaning and Refuse Collection in Newark. Mun. Jl. & Public Works, vol. 47, no. 13, Sept 27, 1919, pp. 200-202, 1 fig. Details of collection service, records of men and teams employed, amount and nature of work performed and personal efficiency. (Continued from p. 182.)

Sewer Inlets

More Engineering on Sewer Inlets, W. W. Horner. Mun. & County Eng., vol. 57, no. 4, Oct. 1919, pp. 147-150, 14 figs. Account of research work made by St. Louis engineers to determine intake capacity of different style inlet under various conditions of installation and particularly intake capacity of double inlet.

Sewage Treatment

Operating Results of "Direct Oxidation" Experimental Sewage Treatment Plant at Easton, Pa. Can. Engr., vol. 37, no. 16, Oct 16, 1919, pp. 389-393, 395 and 396. It was determined that combined action upon sewage of fine screen lime treatment and electrolytic cell rendered sewage in such a condition that after sedimentation in properly designed tanks affluent could be discharged into stream affording reasonable dilution of relatively clean water without danger of creating nuisance.

Sewers, Odors

Causes of Offensive Odors from Sewers and Remedial Measures, Edward B. Savage. Eng. & Contracting, vol. 52, no. 18, Oct. 29, 1919, pp. 511-512. Based on anemometer and other tests of ventilation system. Paper read before Inst. of Mun. and County Engrs.

WATER SUPPLY

Coagulating Basins

Some Observations and Experiences in the Operation of Coagulating Basins, James Wadsworth Armstrong. Can. Engr., vol. 37, no. 17, Oct. 23, 1919, pp. 405-407, 5 figs. Account of current measurements made with aluminum floats, readings of which were taken every five minutes.

Feedwater Treating

Feed-Water Treating and Purifying Plant for the Republic Iron & Steel Company, Youngstown, Ohio, S. H. McKee. Proc. Engrs.' Soc. Western Pa., vol. 35, no. 6, July 1919, pp. 283-301 and (discussion) pp. 302-309, 7 figs. Plant has treating capacity of 300,000 gal. per hr. and is laid out to permit 25 per cent extension.

Filtered Sand

Purification Effected by Mechanical Drifting Sand Filtration in Toronto, Norman J. Howard. Contract Rec., vol. 33, no. 41, Oct. 8, 1919, pp. 937-943; Can. Engr., vol. 37, no. 14, Oct. 2, 1919, pp. 342-345 and Eng. & Contracting, vol. 52, no. 15, Oct. 8, 1919, pp. 402-404, 15 figs. Average reduction said to have been 85.4 per cent in total bacteria and 94.8 per cent in b. coli during year 1918; chlorination killed practically all remaining bacteria.

Metalium Joints

Methods of Effecting Economies in Water Works Operation, Homer V. Knouse. Eng. & Contracting, vol. 52, no. 15, Oct. 8, 1919, pp. 405-406. Suggests special rigs and methods of handling work and use of metalium as jointing for pipe lines.

Water-Works Reconstruction

How to Reconstruct Small Water-Power Plants, Ray K. Holland. Mun. & County Eng., vol. 57, no. 4, Oct. 1919, pp. 180-182. Examples of plant reconstruction.

WATERWAYS

Stream Pollution

Stream Pollution and Its Relation to the Chemical Industries, Earle B. Phelps. Jl. Indus. & Eng. Chem., vol. 11, no. 10, Oct. 1, 1919, pp. 928-929. Suggests desirability of federal control of stream pollution under conditions that will permit of adequate scientific study of problems involved and of correlation of these problems with those of public health, navigation, fisheries, and other matters related to waterways.

HYDRAULIC ENGINEERING

Floods

Technical Study of the Propagation of Floods (Etude sur le mouvement graduellement varié non permanent et la propagation des crues), Edmond Maillet. Annales des Ponts et Chaussées, vol 50, no. 3, May and June 1919, pp. 289-331, 8 figs. Derivation of Baumgarten law.

Water Storage

The General Principles of the Development and Storage of Water for Electrical Purposes, J. W. Meares. Engineering, vol. 108, no. 2799, Aug 22, 1919, pp. 258-260, 5 figs. Comparative study of cost, both of installation and maintenance, of hydroelectric schemes and power house and steam power house. (Concluded.)

MUNICIPAL ENGINEERING

City Planning

The Planning of Residential Suburbs with Special Reference to Engineering Features, F. L. Olmsted. Mun. & County Eng., vol. 57, no. 4, Oct. 1919, pp. 161-164. Residential neighborhood plan under direction of U. S. Housing Corporation offered as example of engineering development.

Street Planning

Rules of Practice for the Establishment of Street Widths and their Subdivisions, B. A. Haldeman. Can Engr., vol. 37, no. 17, Oct. 23, 1919, pp. 409-410. Practice suggested by Zoning Commission, Philadelphia, Pa.

Zoning

Zoning, Edward M. Bassett. Can. Engr., vol. 37, no. 17, Oct. 23, 1919, pp. 410-411. Writer is chairman of zoning committee of New York City.

Mining Engineering

BASE MATERIALS

Clays

Clays and Shales of Minnesota, Frank F. Grout. Dept. of Interior, U. S. Geol. Survey, bul. 678, 1919, 259 pp., 38 figs. Object of investigation was to examine brick supply for every town of 1000 or more inhabitants and for every county in the state, to ascertain extent of various deposits now developed, to find new deposits, and to determine qualities of these deposits and of certain mixtures with a view to finding out whether it is possible to produce refractory wares, pottery, paving brick, and other high-grade products.

Clay Products Statistics in 1918. Cement, Mill & Quarry, vol. 15, no. 6, Sept. 20, 1919, pp. 41-43. Unusual conditions last year resulted in restricted operation of clay working industries, with consequent decrease in production.

Gravel

New Gravel Plant on Puget Sound, W. A. Scott. Cement, Mill & Quarry, vol. 15, no. 6, Sept. 20, 1919, pp. 11-13, 4 figs. Describing modern features at recently completed sand and gravel works of Independent Asphalt Paving Co., Seattle, Wash.

Phosphates

Investigation of a Reported Discovery of Phosphate in Alberta, Hugh S. de Schmid. Can. Dept. Mines, Mines Branch Bul. no. 12, 1916, 38 pp., 14 figs. partly on supp. plates. Area examined; nature of phosphate; analyses of samples of phosphate; results of examination of Rocky Mountain quartzite for phosphatic horizons; economic importance of deposits.

Coral Island Phosphates in the Making, F. Danvers Power. Bul. Instn. Min. & Metallurgy, no. 181, Oct. 16, 1919, 10 pp., 8 figs., on four supp. plates. Different shaping between phosphate deposited by animal or chemical means.

COAL AND COKE

Chemistry of Coal

Researches on the Chemistry of Coal—I. The Action of Pyridine upon the Coal Substance, William A. Bone and Reginald J. Sarjant. Proc. Roy. Soc., vol. 96, no. A-675, Sept. 4, 1919, pp. 119-136, 3 figs. Account of research carried out in Departments of Chemical Technology at Imperial College of Science and Technology, with object of clearing up various claimed discrepancies in work of previous investigators.

Coal Stocking

Coal Stocking and Reclaiming—I, II. Coal Trade Jl., vol. 50, nos. 40 and 44, Oct. 1 and 29, 1919, pp. 1195-1196 and 1266-1268, 7 figs. Oct. 1: Discusses deterioration in stocking, handling methods and machinery required. Oct. 29: Railroad large capacity plants are discussed.

Coal Washing

The Examination of Coal in Relation to Coal-Washing, M. Wynter Blyth and L. T. O'Shea. Trans. Instn. Min. Engrs., vol. 57, no. 5, Sept. 1919, pp. 261-276 and (discussion) pp. 276-288. Suggested method of testing. Ash in washed coal is taken as standard of purity by which to judge its suitability for coke making.

Coke-Oven Practice

Some Economic Considerations in Coke-Oven Practice, W. Colquhoun. Proc. Midland Inst. Min., Civil & Mech. Engrs., vol. 24, no. 7, Nov. 9, 1918, pp. 195-222 and (discussion) pp. 222-234, 6 figs. Comparison with beehive coke ovens develops that process of coking cannot be called economically perfect until, writer believes, some inventor devises more direct application of heat necessary to distill coal. General bibliography of technical articles on coking is appended.

Colliery Managers

The Education of Colliery Managers for Administrative and Social Responsibilities, William Maurice. Tran. Instn. Min. Engrs.,

vol. 57, no. 5, Sept. 1919, pp. 289-296 and (discussion) pp. 296-299. Importance of training colliery managers argued because of exceptional position in which they are placed, as illustrated by statistics which show that 1,500 managers control over 1,000,000 miners, these figures being interpreted as indicating extent of national influence that could be exerted if every manager made a point of rendering whatever form of social service was compatible with his temperament and abilities.

Fire Prevention

Fire Prevention in Anthracite Mines, M. W. Price. Coal Industry, vol. 2, no. 10, Oct. 1919, pp. 469-470. Equipment necessary for fighting mine fires and plans for organizing fire fighting squads at mining camps. Paper presented at 8th Annual Safety Congress.

Large-Scale Production

Engineering Features of Modern Large Coal Mines in Illinois and Indiana, C. A. Herbert and C. M. Young. Bull. Am. Inst. Min. & Metallurgical Engrs., no. 153, supp. to Sept. 1919, pp. 2445-2473, 10 figs. Important feature of development is production of coal by large consumers. Six mines planned for outputs of 6000 to 8000 tons per 8-hr. day are selected for discussion as exemplifying best practice in coal-mine engineering in central district at present time.

Low-Temperature Coking

New Method of Coking at Low Temperatures (Ueber eine neue zweckmässige Art der Durchführung der Tieftemperatur-Verkokung), Franz Fischer and W. Glund. Berichte der deutschen chemischen Gesellschaft, vol. 52, no. 6, 1919, pp. 1035-1039, 2 figs. Rotating cylinder used for distillation.

Power Plants

Some Useful Instruments for Colliery Power Plants, H. W. Ravenshaw. Proc. Midland Inst. Min., Civil & Mech. Engrs., vol. 24, no. 5, Mar. 9, 1918, pp. 141-151, 9 figs. D. c. and a. c. leakage recorders, over-volt vacuum-breaker, continuous steam engine indicator and apparatus for measuring orifices.

Purification of Coal

Purification of Coal, B. J. Roberts. Power Plant Eng., vol. 23, no. 20, Oct. 15, 1919, pp. 906-908. Concentration table method and results obtained.

Research

Research in the Coal-mining Industry, E. A. Holbrook. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1723-1737. Possible fields of research are pointed out, notably as to resources, origin, occurrence, constitution, development and exploitation.

Retort Tests

Experimental-Retort Tests of Orient Coal, R. S. McBride and I. V. Brumbaugh. Coal Age, vol. 16, no. 14, Oct. 2, 1919, pp. 567-569, 3 figs. Experiments conducted at Bur. of Standards in order to determine effect of coking temperature upon quantity and quality of gas produced.

Spitzbergen

Coal and Iron from the Arctic, Harold J. Shepstone. Sci. Am., vol. 120, no. 15, Oct. 11, 1919, pp. 362-363, 376 and 378, 5 figs. British syndicate reports finding iron mountain, 17 miles long, extensive coal beds and asbestos field at Spitzbergen.

Storage

A System of Storing and Filling Small Coal, with Remarks upon the Prevention of Spontaneous Heating in Coal Heaps, John Morison. Trans. North of England Inst. Min. & Mech. Engrs., vol. 68, no. 5, Apr. 1918, pp. 154-157 and (discussion) pp. 157-164, 3 figs. System of stocking by means of traveling cranes in use at Cramlington Collieries.

Sulphur in Coal

Sulfur in Coal. Geological Aspects, Geo. H. Ashley. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 2073-2079. Modes of occurrence, and comparison of sulphur content in beds of various regions, noting how percentage of sulphur is controlled by conditions existing during laying down of each bed.

Forms in Which Sulfur Occurs in Coal, A. R. Powell and S. W. Parr. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 2041-2049, 2 figs. Synopsis of investigation published as Bul. 111 (1919) of University of Ill. Eng. Experimental Station.

Effect of Sulfur in Coal Used in Ceramic Industries, C. W. Parmelee. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1845-1850. Figures showing maximum percentage of sulphur permitted in coal used by various companies in pottery ovens for manufacturing various kinds of clay products. Objections to sulphur are clinkering of fuel in firebox, action of oxides of sulphur in waste-heat driers, and effect of oxides of sulphur on clays, glazes and colors during burning and unburned clay products.

Occurrence and Origin of Finely Disseminated Sulfur Compounds in Coal, Reinhardt Thiessen. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, supp. to Sept. 1919, pp. 2431-2444, 10 figs. It is reported that all coals that have been examined microscopically contain microscopic grains of pyrite disseminated through them, which are distributed very irregularly and usually occur in colonies. Microscopic pyrites and organic sulphur in coal are accounted for by same reasoning; lenses, balls, and sheets of pyrite are believed to have secondary origin.

Sulfur in the Coking Process, S. W. Parr. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1807-1809. Organic sulphur in coal, which is for the most part discharged at relatively low temperatures, is not considered as responsible for formation of CS_2 in gases discharged from high-temperature coking process.

Mechanical Separation of Sulfur Minerals from Coal, J. R. Campbell. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1779-1789, 4 figs. Plant where elimination of sulphur is accomplished by jigging in water and concentrating tables.

Testing of Coal

Testing of Coals for By-product Coking and Gas Manufacture, Horace C. Porter. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1587-1595, 3 figs. Writer believes it is possible by careful control of conditions, to judge both coking quality and by-product yields by laboratory carbonizing tests, giving weight in this judgment to approximate analysis of coal, nature of its volatile matter and its geologic history. Such a test, he advises, should be made comparative by choosing standard coal for known commercial performance.

Thick-Seam Working

New Methods of Working Thick Seams of Coal, Dudley S. Newey. Iron & Coal Trades Rev., vol. 99, no. 2689, Sept. 12, 1919, pp. 324-326, 13 figs. Advantages claimed are: complete extraction of coal, gradual and diminished subsidence, greater safety and improved conditions of work for miners, control of excessive weight, as well as better supervision.

Washability

Some Factors that Affect the Washability of a Coal, Thomas Fraser and H. F. Yancey. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1817-1827, 3 figs. From investigation and experimental research it is formulated as principal condition that characterizes easily washed coal that excess undesirable sulphur and ash should be present in form of shale or pyrite particles large enough to be detachable from coal without crushing finer than ¼ in. in size.

Wedging Holes

Wedging Diamond-drill Holes, O. Hall and V. P. Row. Bul. Am. Inst. Min & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1597-1602, 2 figs. Mond Nickel Co. follows standard practice of wedging holes back to vertical or back to straight line as soon as they show deflection of over 3 deg. This is accomplished by means of wooden plug, drive wedge, pilot wedge, deflecting wedge, special clinometer and special reaming bit.

West Virginia

Geographic Distribution of Sulfur in West Virginia Coal Beds, I. C. White. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 2197-2203, 8 figs. Including maps showing how percentages of sulphur in W. Va. coal are distributed geographically over State.

EXPLOSIVES

Shipping Containers

Shipping Containers, C. P. Beistle. Jl. Soc. Chem. Indus., vol. 38, no. 17, Sept. 15, 1919, pp. 330T-337T, 1 fig. Origin and present status of efforts of Bur. of Explosives to permit safety in transportation of dangerous articles.

See also ORGANIZATION AND MANAGEMENT, Safety Engineering (Explosives).

GEOLOGY AND MINES

Alaska

Mining Methods of Alaska Gastineau Mining Co., G. T. Jackson. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1547-1570, 14 figs. Deposits worked consist of single band, several hundred feet wide, in which stringers and veins of quartz carrying gold occur in slate formation near its contact with some altered volcanic rock. Article includes description of combination of shrinkage caving method of stoping used.

Canadian Springs

The Chemical Character of Some Canadian Mineral Springs—II, R. T. Elworthy. Can. Dept. Mines, Mines Branch. Bul. vol. 20, no. 472, 1918, 173 pp., 12 figs., partly on supp. plates. Classification of waters and methods of analysis; description of springs and tabulated analyses; relation of chemical constituents to geologic formations; therapeutics of mineral waters and economic value of springs.

See also Radioactivity, Canadian Springs.

High Temperatures in Deep Mines

High Temperatures in Deep Mines, William Garforth. Proc. Midland Inst. Min., Civil and Mech. Engrs., vol. 24, no. 8, Oct. 17, 1918, pp. 235-241. Examination of committee reports of various scientific societies on effects of working in atmosphere of high temperature and study of present systems of haulage and methods of working in deep mines.

Huronian Group, Michigan

Correlation of Formations of Huronian Group in Michigan, R. C. Allen. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, supp. to Sept. 1919, pp. 2579-2594, 1 fig. Proposed amendments to U. S. Geological Survey correlations, prepared by C. R. Van Hise and C. K. Leith, in Geology of the Lake Superior Region, U. S. Geol. Survey Monograph 52.

Mesabi Range

The Nature and Origin of the Biwabik Iron-Bearing Formation of the Mesabi Range, Minnesota, Frank F. Grout. Economic Geology, vol. 14, no. 6, Sept.-Oct. 1919, pp. 452-464, 8 figs. Discussing precipitation, conditions of deposition, texture of deposit, primary modification of deposit and metamorphism.

Radioactivity, Canadian Springs

The Radioactivity of some Canadian Mineral Springs, John Satterly and R. T. Elworthy. Can. Dept. Mines, Mines Branch, Bul. 16, no. 435, 1917, 55 pp., 23 figs. on supp. plates. Methods used for determination of radioactivity; detailed description of apparatus; relation between radioactivity and other properties; description of wells and springs in various districts.

IRON

Great Britain

Recent Iron-Ore Developments in the United Kingdom, F. H. Hatch. Geol. Mag., vol. 6, no. 9, Sept. 1919, pp. 387-397, 2 figs. Table showing relative production and iron-content of Jurassic ironstones; analyses; statistics of production during 1918.

LEAD, ZINC, TIN

Elmore Process

The New Elmore Process. Min. & Sci. Press, vol. 119, no. 14, Oct. 4, 1919, pp. 479-480. Invention relates to extraction and separation of lead and zinc from ores, concentrates, and the like, in which these metals associated together in form of sulphites. It consists in treating ore, etc., with certain acid agents whereby lead sulphide is converted into soluble lead compound while zinc sulphide remains substantially unattacked.

Slag Melting

Slag Melting at Lead Works at Babe, Serbia (Ueber das Schlackenschmelzen in der Bleihütte des einstigen k. u. k. Militärbergbaues Babe in Serbien), Anton Lissner. Berg-und Hüttenmännisches Jahrbuch, vol. 67, no. 3, 1919, pp. 192-218, 6 figs. on supp. plate. Processes of melting, and results of operation.

Zinc Strip and Rod

Some Properties and Applications of Rolled Zinc Strip and Drawn Zinc Rod, C. H. Mathewson, C. S. Trewin and W. H. Finkeldey. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, supp. to Sept. 1919, pp. 2775-2846, 57 figs. Survey of information on rolled zinc found in current literature, and study of characteristics of zinc from theoretical point of view. Several microstructures of typical specimens.

MINES AND MINING

Cementation Process of Shaft Sinking

Cementation Process of Shaft Sinking. Iron & Coal Trades Rev., vol. 99, no. 2692, Oct. 3, 1919, pp. 440-441. Particulars of bore holes for cementation, walling and sinking, and statement of costs. Paper read before North Staffordshire Inst. Min. Engrs.

Cost Keeping

Cost Keeping for Mines—III, K. D. Armstrong. Chem. Eng. & Min. Rev., vol. 11, no. 131, Aug. 5, 1919, pp. 319-322. Suggested system for time keeping.

Foremen

Law and the Dual Duties of Mine Foremen, Joseph J. Walsh. Coal Indus., vol. 2, no. 9, Sept. 1919, pp. 378-379, 2 figs. Application of anthracite mining law and dual duties of mine foreman are discussed; writer claims that campaign of education and enforcement of law have not produced desired results.

Mine Valuation

The Federal Taxation of Mines—II, L. C. Graton. Min. & Sci. Press, vol. 119, no. 16, Oct. 18, 1919, pp. 567-570. Methods of mine valuation.

Pit Props

The Strength of Pit-Props, Fred L. Booth. Trans. North of England Inst. Min. & Mech. Engrs., vol. 68, no. 5, Apr. 1918, pp. 165-169 and (discussion) pp. 169-176. Tables given of results of tests of crushing strength of various sizes of pit-props.

Rescue-Training Standardization

Standardizing Mine-Rescue Training, D. J. Parker. Coal Industry, vol. 2, no. 10, Oct. 1919, pp. 474-475. Historical account of development of self-contained breathing apparatus, especially as modified by researches of Bureau of Mines, and discussion of desirability and plan of mine rescue training. Paper read before Eighth Annual Safety Congress.

Settling Sumps and Filters

Notes on the Settlement of Mine Water on the Witwatersrand, J. Whitehouse. Jl. South African Instn. Engrs., vol. 18, no. 1, Aug. 1919, pp. 8-22, 9 figs. Describes details of settling sumps and filters installed on Village Deep Mine, and some points concerning their operation.

Shot Firing

Electric Shot-Firing, MM. Taffanel, Dautriche, Durr and Perrin. Quarry, vol. 24, no. 272, Oct. 1919, pp. 273-276, 7 figs. Experiments undertaken to investigate intensity at which misfire may occur when detonators are ranged in series, effect of excessive voltage, alternating versus direct current and effect of earth contacts or shunts.

See also Explosives.

Timber Treating

The Preservation of Mine Timber, N. T. Williams. Trans. Manchester Geol. & Min. Soc., vol. 36, no. 4, Sept. 1919, pp. 79-87, 4 figs., partly on supp. plate. Illustrating operation of open-tank plant for treating timber in hot and cold baths.

OIL AND GAS

Bore Holes

Graphic Charts for Petroleum Bore-Holes, T. Sington. Engineering, vol. 108, no. 2801, Sept. 5, 1919, pp. 321-322, 1 fig. Illustrating system of daily record of progress made as well as of accidents, water erosion and other difficulties incidental to petroleum search, which cause delay.

Dehydration of Oil

Electrical Dehydration of Oil, H. N. Sessions. Jl. Electricity, vol. 43, no. 7, Oct. 1, 1919, pp. 316-318, 2 figs. Instances quoted where it is said installation of electrical dehydrators at wells resulted in tremendous saving in transportation cost.

Gasoline in Natural Gas

Gasoline in Natural Gas, D. B. Dowling. Can. Dept. Mines, Geological Survey, Summary Report, 1918, part C, pp. 17C-42C, 1 fig. Account of absorption tests on Alberta Gas.

Prospecting

Geologic Factors in Oil Prospecting, Frederic H. Lahee. Economic Geology, vol. 14, no. 6, Sept.-Oct. 1919, pp. 480-490, 5 figs. Geologic factors governing conclusions enumerated as follows: Classification of rock formation, thickness percentage of rock types, relation to original shore lines, reservoir or sand conditions, structural conditions, depth to possible oil-bearing horizons, carbon ratio. All these are discussed.

Shales

The Oil Shales of Northwestern Colorado, Bur. Mines of State of Colorado, bul. no. 8, 1919, 59 pp., 5 figs. Noting commercial possibilities and precautions that must be taken in mining, including geological notes and general bibliography on oil shale industry.

Valuation of Oil Properties

Essential Factors in Valuation of Oil Properties, Carl H. Beal. Bull. Am. Inst. Min. & Metallurgical Engrs., no. 153, supp. to Sept. 1919, pp. 2219-2227. Factors discussed are (1) amount of oil property will produce, (2) amount of money this oil will bring, (3) development and production costs, (4) rate of interest on investment, (5) amortization of invested capital, and (6) scrap value of equipment when property is exhausted.

Metallurgy

ALUMINUM

Research

Aluminum Research (Untersuchungen über Aluminium), W. Jaeger and K. Scheel, and L. Holborn. Elektrotechnische Zeitschrift, vol. 40, no. 14, Apr. 3, 1919, pp. 150-152, 5 figs. Observations on the specific resistance and its temperature coefficients, on thermic expansion and tensile strength. The resistance coefficient in its relation to the structure and the chemical purity of aluminum.

IRON AND STEEL

Acid-Furnace Structure

The Action of Iron Oxides Upon the Acid-Furnace Structure, J. H. Whiteley and A. F. Hallimond. Iron and Steel Inst., meeting of Sept. 1919, paper no. 13, 21 pp., 10 figs. on 2 supplement plates. Method is outlined by which comparative amounts of oxides present in gases at various stages of open-hearth furnace operation may be ascertained. Various photomicrographs of solidified melts of silica and iron oxides are described.

Analysis, Steel

Analytical Chemistry Researches Relative to Steels (Recherches de chimie analytique relatives aux aciers), A. Travers. Annales de Chimie, vol. 11, July-Aug. 1919, pp. 17-128. Experiments covered (1) manner of effecting analysis of carbon by combustion, (2) analysis of sulphur by combustion in oxygen at temperature near 1200 deg. C, (3) investigation of method of manganese analysis by means of persulfate in presence of silver nitrate and (4) application in volumetry of titanium chloride as reducing agent.

Decarburization of Steel with Hydrogen

On the Decarburisation of Steel with Hydrogen, E. D. Campbell. Iron and Steel Inst., meeting of Sept. 1919, paper no. 3, 8 pp. Experiments conducted to determine best conditions under which small bars of commercial steels might be decarburized and effect of such decarburization on electrical resistivity of annealed bars. Results are interpreted to have indicated that pure carbides of iron are less stable and more completely dissociated when in solid solution than are carbides which are formed if other elements are present.

Effervescing Steel

Effervescing Steel, Henry D. Hibbard. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, supp. to Sept. 1919, pp. 2595-2608, 6 figs. Illustrating fractures of soft plate steel ingots and steel slabs.

Fuel Economy

Report on "Fuel Economy and Consumptions in the Manufacture of Iron and Steel," William A. Bone, Robert Hadfield and Alfred Hutchinson. Iron and Steel Inst., meeting of Sept. 1919, paper no. 2, 42 pp., 1 fig. Based on inquiries made as to practice in British iron and steel works by British Assn. Fuel Economy Committee.

German Practice

Analyzes German Iron Practice. Iron Trade Rev., vol. 65, no. 17, Oct. 23, 1919, pp. 1105-1109, 3 figs. Report of commission appointed by British ministry of munitions to visit steel works in Lorraine and in that part of Saar valley occupied by French authorities.

Manganese and Carbon Steels

On the Influence of Manganese on the Physical Properties of Carbon Steel, Tokujiro Matsushita. Sci. Reports of Tohoku Imperial University, vol. 8, no. 2, Aug. 1919, pp. 79-88, 5 figs., partly on supp. plates. Specimens tested were made by alloying metallic manganese from Kahlbaum with low-carbon steel and were tested in form of rods 20 cm long and 5 mm thick. From investigations it is concluded that structure of manganese steels is very similar to that of tungsten steels.

Manganese Steel

Manganese Steel Produced in Heroult Furnaces (Ueber Manganstahl und dessen Herstellung für Stahlformguss im Heroult-Elektroofen), Berthold Schudel. Schweizerische Bauzeitung, vol. 74, no. 11, Sept. 13, 1919, pp. 129-131. Describing method of charging and phenomena observed as regards tensile strength, etc.

Metallurgical Calculations

Modern Steel Metallurgical Calculations—III, Charles H. F. Bagley. Blast Furnace & Steel Plant, vol. 7, no. 10, Oct. 1919, pp. 502-505. Average analysis per 100 tons charged in (1) acid open-hearth process with 50 per cent iron and 50 per cent scrap and (2) basic open-hearth process with 50 per cent common forge iron and 50 per cent steel scrap.

Nickel Steel

Some Experiments on Nickel Steel, N. Hudson. Iron and Steel Inst., meeting of Sept. 1919, paper no. 9, 13 pp., 1 fig. Undertaken to determine whether nickel in nickel steel would combine with carbon monoxide to form nickel carbonyl gas in a manner similar to that in Mond process for purification of nickel.

Reactions, Balanced

Balanced Reactions in Steel Manufacture, Andrew McCance. Trans. Faraday Soc., vol. 14, no. 3, July 1919, pp. 213-223 and (discussion) pp. 224-227, 1 fig. Question is studied from standpoint of physical chemistry, and connection between final quality of solid steel and antecedent conditions during manufacture is traced with special reference to contained gases. Writer deals mainly with open-hearth process.

Slag Inclusions

Slag Inclusions. Trans. Faraday Soc., vol. 14, no. 3, July 1919, pp. 188-190, 21 figs. on five supp. plates. Photomicrograph showing longitudinal and transverse sections in wrought-iron bars of various qualities. Bibliography on occluded gases is appended.

Steel Alloys

Engineering Science Before, During and After the War, Charles A. Parsons. Science, vol. 50, no. 1293, Oct. 10, 1919, pp. 333-338. Extensive use of alloys of steel is specially noted. (To be continued.) Address of President of British Assn. for Advancement of Sci.

Sulphur in Malleable Iron

Sulphur Reduced in Malleable Iron, A. W. Merrick. Foundry, vol. 47, no. 16, Oct. 1, 1919, pp. 685-687, 3 figs. Cupola metal refined in electric furnace. Sulphur is lowered by reducing slag containing calcium carbide. Advantages of duplexing process are considered.

Temperatures

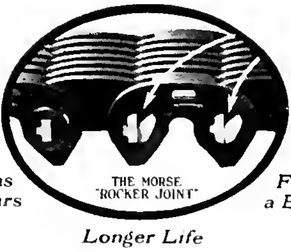
Electric, Open-hearth, and Bessemer Steel Temperatures, F. E. Bash. Bul. Am. Inst. Min. & Metallurgical Engrs., no. 153, Sept. 1919, pp. 1739-1750, 3 figs. For purpose of comparison, tapping temperatures of two 25-ton Heroult electric furnaces and one 6-ton with one 50-ton acid, one 40-ton basic, and one 65-ton acid open-hearth, all making nickel ordnance steel for guns are given.

Woody Fractures

On the Woody Structures of Fractures of Transverse Test-Pieces taken from Certain Special Steels, J. J. Cohade. Iron and Steel Inst., meeting of Sept. 1919, paper no. 4, 15 pp., 7 figs. It is concluded from experimental research work that forging finished at a high temperature improves results of transverse tests, although not to a great extent. Hence it is recommended that if very good results are sought it is preferable to diminish percentage of carbon below 5.30 per cent, if the percentage of nickel has to be increased in order to obtain necessary tensile strength after quenching.

The Drive of Efficiency *The Drive of Durability*

MORSE CHAINS



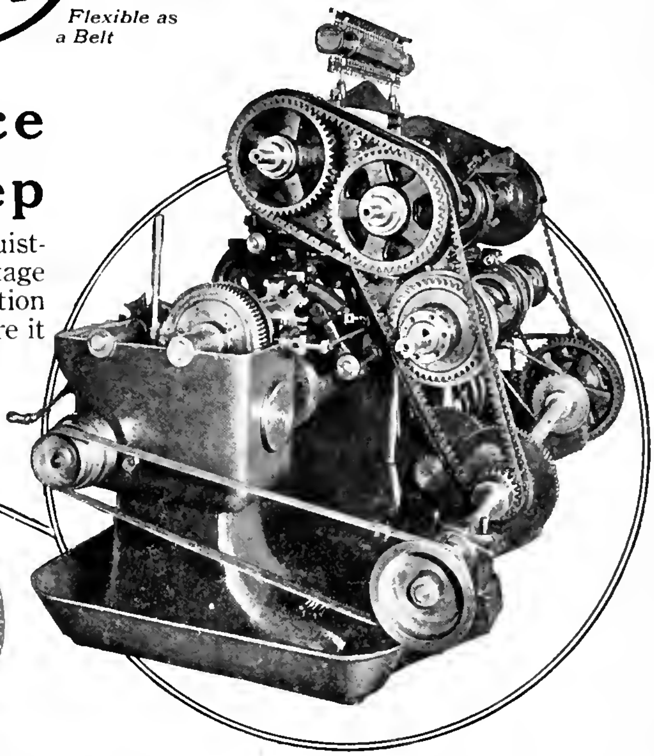
Positive as Gears *Flexible as a Belt*

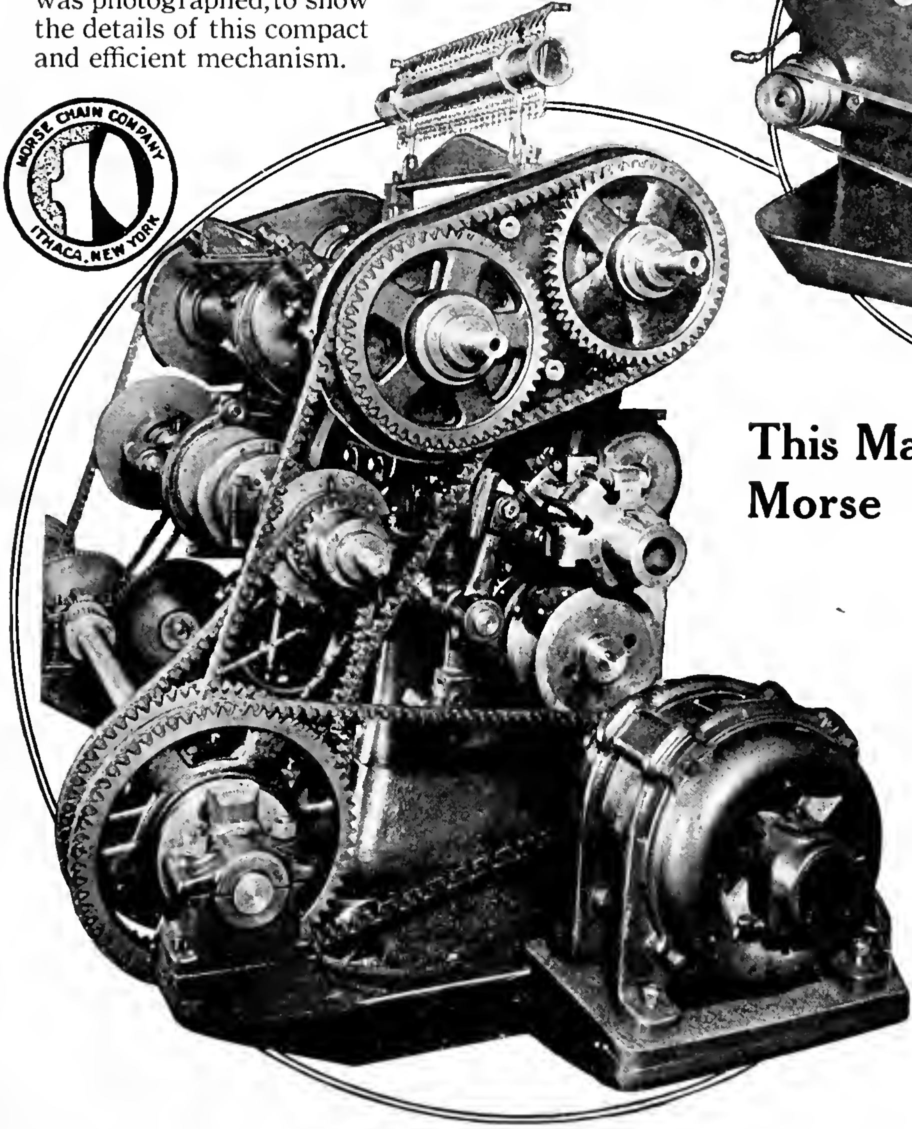
Longer Life

For Economy in Space and Economy in Upkeep

This automatic hub boring machine, built by the Blomquist-Eck Machine Co., of Cleveland, Ohio, shows to advantage the application of Morse Silent Chain to speed reduction in small power drives. All guards were removed before it was photographed, to show the details of this compact and efficient mechanism.

MORSE CHAIN COMPANY ITHACA, NEW YORK





This Machine is Driven with Morse Chain Throughout

Seven Morse Silent Chains—.9″ pitch, 1″ face—transmit power from a 10 H. P. motor to and through this mechanism.

In some cases they eliminate intermediate gears; in others, bevel gears, shafts, brackets and other units which take up more space and deteriorate more rapidly.

This machine has given five years of complete satisfaction to its owners and is good for many more The patent "Rocker Joint" reduces wear to a minimum. Easy to take up wear, when necessary. Consult us when planning important drives—large or small.

MORSE CHAIN CO., LARGEST MANUFACTURERS OF SILENT CHAINS IN THE WORLD ITHACA, N. Y.

Morse Engineering Service **WRITE FOR BOOKLETS** *Assistance Without Obligotion*

1920 Vest Pocket Memo. and Diary. Give Firm Name, Position

Address Nearest Office

BOSTON, MASS.	141 Milk Street	SAN FRANCISCO, CAL.	Monadnock Bldg.
CHICAGO, ILL.	Merchants L. & T. Bldg.	ATLANTA, GA., Candler Bldg	Earl F. Scott, M. E.
CLEVELAND, OHIO	Engineers Bldg.	CANADA	Jones & Glasco, Regis'd
DETROIT, MICH.	1003 Woodward Ave.	MONTREAL, St. Nicholas Bldg	Toronto, Traders' Bank Bldg.
GREENSBORO, N. C.	805 Ashboro Street	KANSAS CITY, MO., Long Bldg.	Morse Engineering Co.
NEW YORK CITY	50 Church St.	MINNEAPOLIS, MINN., 413 3rd St., S.	Strong-Scott Mfg. Co.
PITTSBURGH, PA.	Westinghouse Bldg.	ST. LOUIS, MO., Chemical Bldg.	Morse Engineering Co

MORSE CHAIN COMPANY ITHACA, NEW YORK

"Morse" is the Guarantee Always Behind the Efficiency, Durability and Service

Aeronautics

AEROPLANE PARTS

Starters

The Liberty Starter. Aerial Age, vol. 10, no. 3, Sept. 29, 1919, pp. 88 and 89, 3 figs. Design is single compact unit enclosing both hand and electric starting.

AUXILIARY SERVICE

Pumps, Fuel

Wind-Driven Petrol Pumps for Aeroplanes. Engineering, vol. 108, no. 2799, Aug. 22, 1919, pp. 239-240, 8 figs. Types constructed by Vicker's, Ltd. Air screw and pump impeller are mounted on same shaft, which is of steel, case-hardened and ground, and runs in pair of ball bearings. Impeller, which is of aluminum with radial vanes, is pinned to shaft and runs in bronze casting that forms volute chamber and also carries suction and delivery connections.

DESIGN

Performance

Prediction of Aeroplane Performance, I. M. Laddon. Flight, vol. 11, no. 41, Oct. 9, 1919, pp. 1342-1343, 1 fig. Method based in comparing performance of airplane under investigation with actual performance of similar type on a power and surface-loading basis.

Radiators

Radiator Position, R. F. Mann. Flight, vol. 11, no. 41, Oct. 9, 1919, pp. 1338-1340, 5 figs. Position as determined by necessity of varying effective area during flight and other requirements radiator must fulfil in relation to other parts of engine and operations of aviator.

Resistance

The Horsepower of Resistance in Airplane Design, N. L. Lieberman. Jl. Soc. Automotive Engrs., vol. 5, no. 3, Sept. 1919, pp. 252-261, 9 figs. Formulæ and graphs establishing conditions of fluid motion, and discussion of relation between theoretical conclusions, laboratory models and full-scale findings. (To be concluded.)

DYNAMICS

Climbing

Theory of Airplanes (Théorie des aéroplanes), M. Rateau. Aeronautique, vol. 1, no. 4, Sept. 1919, pp. 146-151, 1 fig. Formula establishing that ascensional velocity when climbing under maximum angle is inversely proportional to square root of specific weight of air. (Continuation of serial.)

ENGINES

Vibration

Airplane Engine Vibration—II, Glenn D. Angle. Aviation, vol. 7, no. 5, Oct. 1, 1919, pp. 212-216, 19 figs. Writer discusses torque reaction, variation in torque, showing torque curves for one to eighteen-cylinder engines. (Concluded.)

INSTRUMENTS

Air-Speed Indicators

Air Speed Indicators for Dirigibles. Jl. Franklin Inst., vol. 188, no. 4, Oct. 1919, pp. 535-544, 10 figs. Description of two forms of air speed indicator developed by Aeronautics Staff of U. S. N., both based on double-throat venturi, but made waterproof by shielding smaller inner venturi from direct impact of drops or spray.

METEOROLOGY

Cyclones

The Travelling Cyclone, Lord Rayleigh. Lond., Edinburgh, and Dublin Phil. Mag., vol. 38, no. 225, Sept. 1919, pp. 420-424, 1 fig. General problem is studied analytically in two dimensions, starting from usual Eulerian equations.

Electrical Phenomena

Electrical Phenomena in the Upper Atmosphere—I, S. Chapman. Sci. Am. Supp., vol. 88, no. 2282, Sept. 27, 1919, pp. 198-199 and p. 202. Electrical phenomena occurring in stratosphere and above levels of instrumental observation. (To be continued.) From Instn. Elec. Engrs., London.

Meteorological Information

The Supply of Meteorological Information, H. G. Lyons. Aeronautical Jl., vol. 23, no. 103, July, 1919, pp. 397-406, 1 fig. In order to efficiently and economically issue forecasts and weather maps, wide and prompt cooperation, careful coordination of effort and ready sharing of all information are said to be necessary.

PLANES

Cato

The Cato Sporting Monoplane. Flight, vol. 11, no. 41, Oct. 9, 1919, pp. 1334-1336, 5 figs. Sporting machine. General specifications are: Overall span, 28 ft. 11½ in.; overall length 20 ft. 10 in.; weight fully loaded, 727 lb., climb in 10 min. 4500 ft.; ceiling 1200 ft.

Hospital Aeroplanes

Hospital Airplanes (Avions sanitaires). Aeronautique, vol. 1, no. 4, Sept. 1919, pp. 129-132, 10 figs. Special design of fuselage to carry wounded, and provided with radio-surgical apparatus and medical supplies.

Oertz

The Oertz Flying Boats. Flight, vol. 11, no. 41, Oct. 9, 1919, pp. 1345-1349, 10 figs. Made in two types, biplane and tandem biplane; both are fitted with Maybach engines of from 150 to 240 hp. in single biplane and two 240 hp. in tandem.

Westland

The Westland Limousine Aeroplane. Engineer, vol. 128, no. 3325, Sept. 19, 1919, pp. 271-272 and 280, 21 figs., partly on supp. plates. Fuselage is much broader and deeper than usual. Machine is capable of carrying 3 passengers and pilot or 500 to 600 lb. of mail.

PROPELLERS

Variable-Pitch Propellers

Variable Pitch Propellers (Verstellbare Luftschrauben), C. Eberhardt. Motorwagen, vol. 22, no. 18, June 30, 1919, pp. 309-313, 4 figs. Since opinions as to necessity of variable pitch propellers differ, writer attempts to clarify this question by calculating first of all tractive power of propeller necessary for horizontal flight of a given machine at various heights and to present it graphically, basing his calculations on Kann's theory of ascension. (To be continued.)

TESTING

Altitude Laboratory

Altitude Laboratory for the Testing of Aero Engines, H. C. Dickinson and H. G. Boutell. Flight, vol. 11, no. 42, Oct. 16, 1919, pp. 1378-1380, 4 figs. Aerial Age, vol. 10, no. 3, Sept. 29, 1919, pp. 85-87 and 97, 7 figs. For measuring horsepower and brake mean effective pressure at full throttle for various conditions, mechanical losses, heat distribution, exhaust gas analysis, oil consumption and distribution, carburetor performances and low air pressures and temperatures as affecting performances of engines and accessories.

Marine Engineering

SHIPS

Deadweight Carrier

What Constitutes a Good Deadweight Carrier? Shipbuilding & Shipping Rec., Sept. 25, 1919, pp. 7-9. Factors affecting selection of size, form, type and structure, derrick arrangement, and propelling machinery.

Diesel-Engine Drive

Trawler Has Gas-Electric Drive, Herbert R. Simonds. Mar. Rev., vol. 49, no. 11, Nov. 1919, pp. 503-505, 5 figs. Two 8-cylinder Diesel engines are direct-connected to generators which energize motor driving propeller shaft.

Drive for Wooden Ships

Diesel Engine, Electric Drive planned for Wooden Ships. Mar. News, vol. 6, no. 6, Nov. 1919, pp. 158-159, 5 figs. Plan of Winton Engine Works, Cleveland, Ohio, consists of removing from wooden steamers of U. S. Shipping Board reciprocating engines and other equipment now in them, replacing these with Diesel engines operating electric generators.

Geared Turbines

Geared Turbine Propelling Machinery of H. M. S. "Raleigh." Engineering, vol. 108, no. 2802, Sept. 12, 1919, pp. 340-341 and 344, 6 figs. Machinery is of Brown-Curtis type, having four shafts, each of which is driven by a high-pressure and low-pressure turbine through single-reduction gearing.

Propellers

Propeller Data from U. S. S. New Mexico's Trials, S. M. Robinson. Jl. Am. Soc. Naval Engrs., vol. 31, no. 3, Aug. 1919, pp. 598-614, 9 figs. Two sets of trials were held—one when ship had been out of dock about seven weeks and one just after she had been docked. A difference between two trials of about 4250 shaft horsepower at 21 knots was obtained due to foul condition of ship's bottom. From this and similar experiences with other ships it is noted that fouling occurs very rapidly in first few weeks that a ship is out of dry dock.

Propulsion

The Passing of the Direct-Connected Turbine for the Propulsion of Ships, C. W. Dyson. Jl. Am. Soc. Naval Engrs., vol. 31, no. 3, Aug. 1919, pp. 555-576, 4 figs. Tables and graphs showing comparative steam economy of turbines and reciprocating engines in warships of various types. Difference is decidedly in favor of Parsons installations except where geared cruising element is used, in which case Curtis installation with medium-speed propeller is seen to be slightly superior from 10½ knots down.

See also Geared Turbines, Diesel-Engine Drive, Drive for Wooden Ships.

YARDS

Burntisland Company Yard

The New Shipyard of the Burntisland Shipbuilding Company, Limited. Shipbuilding & Shipping Rec., Sept. 25, 1919, pp. 12-16, 6 figs., partly on supp. plates. Notes on yard equipment and machinery; also details of 300-ft., 6000-ton vessels being built for French Wine Trade.

Shipways

New Shipways at Newport News Departure from Ordinary Practice, A. F. Mattson. Eng. & Contracting, vol. 52, no. 17, Oct. 22, 1919, pp. 462-463, 1 fig. Chief departure from ordinary is location of lower portion of incline plane partly below mean water level, this portion to be pumped out and kept free from water during entire time of construction of ship.

Welding

Electric Welding in Steel Ship Building, George R. Cooley. Pac. Mar. Rev., vol. 16, no. 10, Oct. 1919, pp. 102-103, 5 figs. Illustrating process of welding angle iron corners.

Railroad Engineering

ELECTRIC RAILROADS

Armature Leads Breakage

Preventing the Breakage of Armature Leads on Railway Motors, A. L. Broomall. Elec. Jl., vol. 16, no. 10, Oct. 1919, pp. 440-443, 1 fig. Methods for overcoming trouble by (1) reducing vibration, or (2) increasing resistance of armature leads so that these can resist vibration, are classified and discussed.

Emergency Car

Emergency Car for Electric Railways (Störungswagen für elektrische Bahnen), H. Uhlig. Elektrische Kraftbetriebe u. Bahnen, vol. 17, no. 14, May 14, 1919, pp. 105-106, 1 fig. Principal requirements of such a car said to be: Independence from tracks; radius of at least 100 km.; and must be equipped for handling derailment, collisions, overhead line trouble, as well as for caring of wounded. Such a design is described.

Freight Haulage

Electric Railway Freight Haulage, A. B. Cole. Elec. Jl., vol. 16, no. 10, Oct. 1919, pp. 453-456, 6 figs. Economical value discussed and organization suggested.

Operation

Electric Railway Passenger and Freight Transportation, C. E. Morgan. Elec. Jl., vol 16, no. 10, Oct. 1919, pp. 422-426, 4 figs. Observes that electric railways are not generally operated to fullest capacity inasmuch as they do not operate either freight or passenger service between midnight and 5 A.M. and urges managers to develop their freight business to such a point that there will be no portion of the 24 hours of the day during which railways are not productive.

ELECTRIFICATION

Spain

Electrification of Spanish Railways (Electrificacion de los ferrocarriles espanoles), D. Luis Sánchez Cuervo. Revista de Obras Publicas, vol. 67, nos. 2294, 2295 and 2296, Sept. 11, 18 and 25, 1919, pp. 449-453, 464-469 and 275-480. Sept. 11: Technical aspect of problem. Sept. 18: Question of whether electrically operated systems are dependable to give steady service; comparison in this respect with steam roads. Sept. 25: Traffic in Spanish railways is considered as too reduced to permit their economical electrification.

EQUIPMENT

Inspection

The Inspection and Construction of Modern Carriage and Wagon Stock. Ry. Engr., vol. 40, no. 477, Oct. 1919, pp. 220-224; 3 figs. English practice of inspection and specifications of steel-rolled sections and plates used for underframe members of rolling stock. (To be continued.)

Standardization of Equipment

Standardization of Railway Equipment. Ry. Rev., vol. 65, no. 15, Oct. 11, 1919, pp. 534-536. Views of railway supply trade as expressed to Congress.

Standardization of Painting

Standardized Painting of Railroad Equipment, W. A. Buchanan. Ry. Rev., vol. 65, no. 14, Oct. 4, 1919, pp. 491-493. Outline of plan of painting of equipment as practiced on Delaware, Lackawanna & Western Railway. Suggestions in regard to stenciling of equipment are included.

LOCOMOTIVES

Dutch Express Locomotives

New Dutch Express Locomotives (De snelreinlocomotieven Serie 71/78 der Nederl. Centraal Spoorweg-Maatschappij), J. H. Gehlen. Ingenieur, vol. 34, no. 31, Aug. 2, 1919, pp. 565-570, 9 figs. Eight engines of following characteristics were supplied before war by German firm to Dutch Central Ry.: Four 15¾ in. by 25¾ in cylinders; tractive force 20,300 lb.; total weight 70 tons; working steam pressure 174 lb.

OPERATION AND MANAGEMENT

Train Resistance

Passenger Train Resistance, Edward C. Schmidt and Harold H. Dunn. Univ. of Illinois Bull., vol 16, no. 15, Dec. 9, 1918, 44 pp., 11 figs. Results of experiments made with passenger trains throughout their ordinary range of speed.

Vibration

Apparatus for the Registration of Oscillations of Railway Material to Judge Cars and Track (Toestellen voor het aanteekenen van slingeringen van spoorwegmaterieel en het gebruik voor de beoordeeling der voertuigen en van het spoor), E. Bolleman Kijlstra. Ingenieur, vol. 34, no. 37, Sept. 13, 1919, pp. 672-681 and (discussion) pp. 681-682, 31 figs. Description of Rossignol, Sabouret, van Schlick and other designs.

RAILS

Standard Open-Hearth and Bessemer-Steel Rails. Assn. Am. Steel Manufacturers pamphlet, July 7, 1915, 16 pp. Standard specifications.

SHOPS

Automatic Tools

Automatics in Railroad Shops, M. H. Williams. Mech. World, vol. 66, no. 1711, Oct. 17, 1919, pp. 183-184, 5 figs. Automatic machines are divided into three classes: Single-spindle machines in which one bar is worked on at a time; multiple-spindle machine on which four or more bars are worked on at one time; and automatic chucking machine used for machining castings and forgings. Machines of these types are illustrated. (To be continued.)

Baltimore and Ohio Shops

Baltimore & Ohio Shops, Cumberland, Md. Ry. Rev., vol. 65, no. 16, Oct. 18, 1919, pp. 557-559, 4 figs. For handling heavy locomotive repairs. Special feature is grain equipment which makes it possible to handle by power all work passing into and through shops.

Blacksmith Shop

The Up-to-Date Railroad Blacksmith Shop, George Fraser. Ry. Rev., vol. 65, no. 14, Oct. 4, 1919, pp. 490-491. Outlines essential features of modern railway blacksmith shop including specially those required by structure in which department is housed as well as those pertaining to modern furnaces and forging machines and their arrangement.

Flue Replacement

Flues—III, IV and V, George L. Price. Boiler Maker, vol. 19, nos. 6, 7 and 8, July and Aug. 1919, pp. 154-156, 199-201 and 242-245, 4 figs. Method of removing and replacing set of flues in locomotive boiler; work done in roundhouse. Precautions observed in expanding flues; method of removing scale; applying arch tubes; welding superheater tubes.

STREET RAILWAYS

Controls

Automatic HL Control for Boston Surface Cars, A. D. Webster. Elec. Jl., vol. 16, no. 10, Oct. 1919, pp. 459-464, 10 figs. Installation provides for multiple unit operation for side cars where private right-of-way is employed in more congested districts.

Gasoline-Motor Traction

Gasoline vs. Electric Motors, N. W. Storer. Aera, vol. 8, no. 3, Oct. 1919, pp. 375-378. Elec. Ry. Jl., vol. 54, no. 15, Oct. 11, 1919, pp. 27-29. Oct.: Study of their respective merits for street railway service. Oct. 11: Writer believes present gasoline motors cannot compete with electric motor as railway motive power because of greater depreciation of gasoline equipment than that of electric equipment and because electric motors excel in low-maintenance cost. Paper read before Am. Elec. Ry. Assn.

Locomotives

Comparison of Low-Speed and High-Speed Interurban Freight Locomotives, D. C. Hershberger Elec. Jl., vol. 16, no. 10, Oct. 1919, pp. 436-440, 5 figs It is concluded that adequate energy supply and service to be performed are factors which influence locomotive of proper speed characteristics and hauling capacity.

Management

Transportation and Traffic Problems, Luke C. Bradley. Stone & Webster Jl., vol. 25, no. 4, Oct. 1919, pp. 275-282 Concerning various details of management.

Municipal Operation

Municipal Railway Operation at Seattle, Washington, Thomas F. Murphine. Elec. Jl., vol. 16, no. 10, Oct. 1919, pp. 428-430. Résumé of operating receipts for the first quarter of 1919 during which time the city has operated its railway system, fare being kept at 5 cents.

One-Man Cars

Are High Costs of Service Likely to Develop Permanent Competition? L. H. Palmer. Elec. Ry. Jl., vol. 54, no. 15, Oct. 11, 1919, pp. 11-13. Suggests use of one-man cars and adoption of zone system of fare collection. Paper read before Am. Ry. Assn.

Safety Car

The Safety Car, N. H. Callard, Jr. Elec. Jl., vol. 16, no. 10, Oct. 1919, pp. 447-452, 6 figs. Figures and experiences of various cities quoted in proof of assertion that "safety car" permits increased service without increasing cost of operation.

Service with the Safety Type Car, E. A. Palmer. Elec. Jl., vol. 16, no. 10, Oct., 1919, pp. 426-428, 1 fig. Advantages of safety car specially noted are said to be: (1) reduction of accidents, (2) faster schedule speed and increased service with same number of cars, (3) satisfaction of city government and operators, and (4) reduction in rolling equipment maintenance.

Safety Car Scores a Success in Kansas City, P. J. Kealy. Elec. Ry. Jl., vol. 54, no. 15, Oct. 11, 1919, pp. 31-36. Testimonials of operating men, manufacturers and consulting engineers on what frequent service car has accomplished and may be expected of it in reducing cost and increasing revenues. Abstracts of papers presented before meeting of Transportation and Traffic Assn.

TERMINALS

Freight Terminal

Minor Buildings of a Large Freight Terminal. Ry. Rev., vol. 65, no. 14, Oct. 4, 1919, pp. 481-483, 5 figs. Plans and illustrations of frame structures adopted to office purposes and convenience and public welfare of employees engaged in operating yards.

Locomotive Handling

Caring for Locomotives at Terminals. Ry. Rev., vol. 65, no. 14, Oct. 4, 1919, pp. 483-490, 18 figs. Committee report read at Convention of Travelling Engineers' Assn.

General Science

CHEMISTRY

Adsorption

Studies of the Adsorption of Gases by Charcoal—1, Harvey Brace Lemon. Phys. Rev., vol. 14, no. 4, Oct. 1919, pp. 281-292, 8 figs. Variations due to heat treatment examined for case in which mass of air used was less than that required to saturate charcoal.

Analysis

An Improved method for Determination of Carbon by Wet Combustion, Using Barium Hydroxide as Absorbent, P. L. Hibbard. Jl. Indus. & Eng. Chem., vol. 11, no. 10, Oct. 1, 1919, pp. 941-943. Substance is heated in Kjeldahl flask with chromic anhydride and sulfuric acid whereby carbon is oxidized to carbon dioxide which is carried into solution of barium hydroxide by current of purified air; after reaction is completed excess of barium hydroxide is determined by titration with standard hydrochloric acid.

Catalysis

A Study of Catalytic Actions at Solid Surfaces—I. Hydrogenation of unsaturated Fats in the Liquid State in Presence of Nickel, E. F. Armstrong and T. P. Hilditch. Proc. Roy. Soc., vol. 96, no. A-675, Sept. 4, 1919, pp. 137-146, 2 figs. Comparison of behavior of unsaturated fatty oils towards hydrogen in presence of finely disseminated nickel, with that of glucosides, towards water in presence of enzymes.

PHYSICS

Acoustics

Engineering Science Before, During and After the War—II, Charles A. Parsons. Science, vol. 50, no. 1294, Oct. 17, 1919, pp. 355-362. Account of development of sound-range and listening devices. (To be concluded.)

Propagation of Sound in an Irregular Atmosphere, G. W. Stewart. Phys. Rev., vol. 14, no. 4, Oct. 1919, pp. 376-378. Under poor atmospheric conditions lower frequencies in aeroplane engine sounds become relatively enhanced; under good conditions frequencies of order of 1000 d. v. are heard at greatest distances.

Electricity

Several Problems Relative to Polymorphous Transformation. (Sur quelques problèmes relatifs aux transformations polymorphiques.) F. Guéry. Revue Générale de l'Electricité, vol. 6, no. 10, Sept. 6, 1919, pp. 291-297, 9 figs. Technical discussion of possibilities (1) to transform alternating current into direct current or vice versa by electromagnetic induction, (2) to construct a synchronous motor without commutator, and (3) to transform current of given frequency into one of any other frequency and the frequency of which may be varied without a commutator.